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Abstract	This document provides the simulation results for FEC using convolutional code with CSI
Purpose	This proposal shows the performance of convolutional code with CSI in IEEE 802.16 systems
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Simulation results for FEC in 802.16 OFDM system

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1. Introduction

There are several FEC methods is suggested such as concatenated Reed Solomon and covolutional coding, Turbo Product codes in 802.16 system [1]. In this proposal for 802.16 OFDM modes FEC, we propose the simulation results using only convolutional code with CSI(Channel State Information). CSI is often defined as signal-to-noise ratio in a carrier position. In case of channel with only Additive White Gaussian Noise, the signal power estimation is sufficient enough to calculate the CSI. But in the case of channel with frequency selective fading or narrow band interfering signal in OFDM system, the noise power differs from sub-carrier to sub-carrier and the noise power estimation becomes essential for the performance improvement. To calculate the signal-to noise ratio it requires estimated signal power and noise power. This means that we have to estimate the signal power from the channel estimator of frequency domain equalizer then estimate the noise power of each pilot carrier positions and divide the estimated signal power by the estimated noise power. CC only scheme is supported by the result shown in [2]

2. FEC scheme

The proposed convolutional code used is the standard rate=1/2 and punctured to a desired rate. The modulation and coding rate for this proposal are shown in table 1

Modulation	Coding rate
QPSK	1/2
QPSK	3/4
16QAM	1/2
16QAM	3/4
64QAM	2/3
64QAM	3/4

Table 1. Modulation and coding rate

3. Simulation results

In this section, several simulation results are presented. Figure 1 shows this proposal system block diagram. We assume the perfect synchronization, no frequency offset, perfect OFDM symbol synchronization. The viterbi decoder with CSI is shown in Figure 2. To decode the received data, it is decoded according to the subsequent block, such as branch metric calculation(BMC), path metric calculation and ACS(Add-Compare-Select) block. To generate CSI, first calculate the MSE(Maximum Sequence Estimation) in the pilot positions and calculate the inverse of MSE then normalize result values. Then, interpolate a calculated values to get the CSI in the useful data positions.

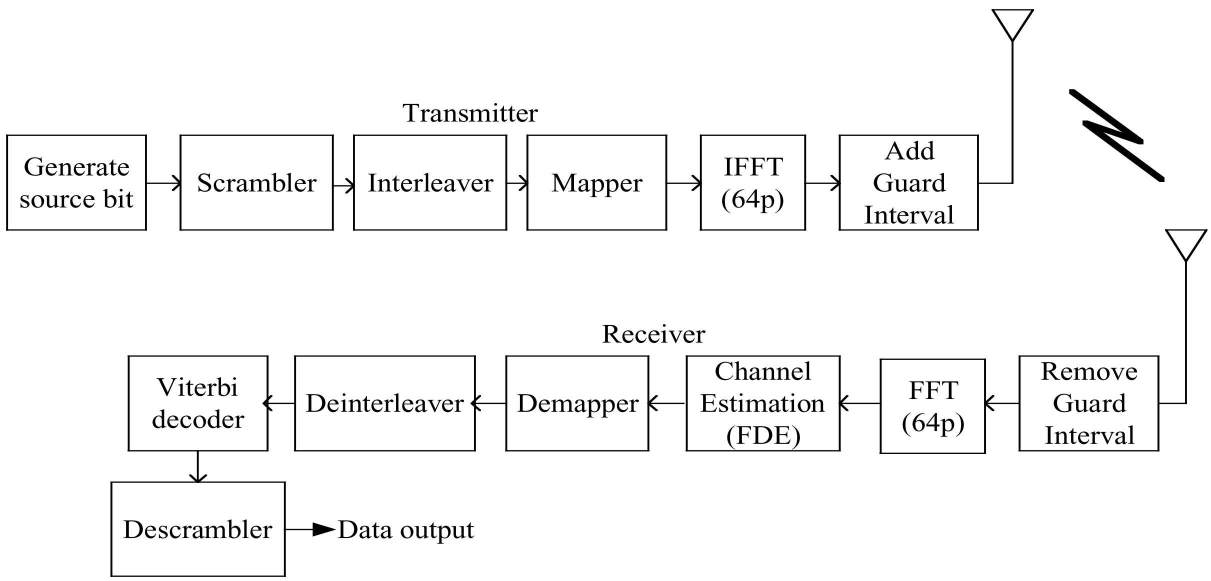

Figure 1. Simulation block diagram

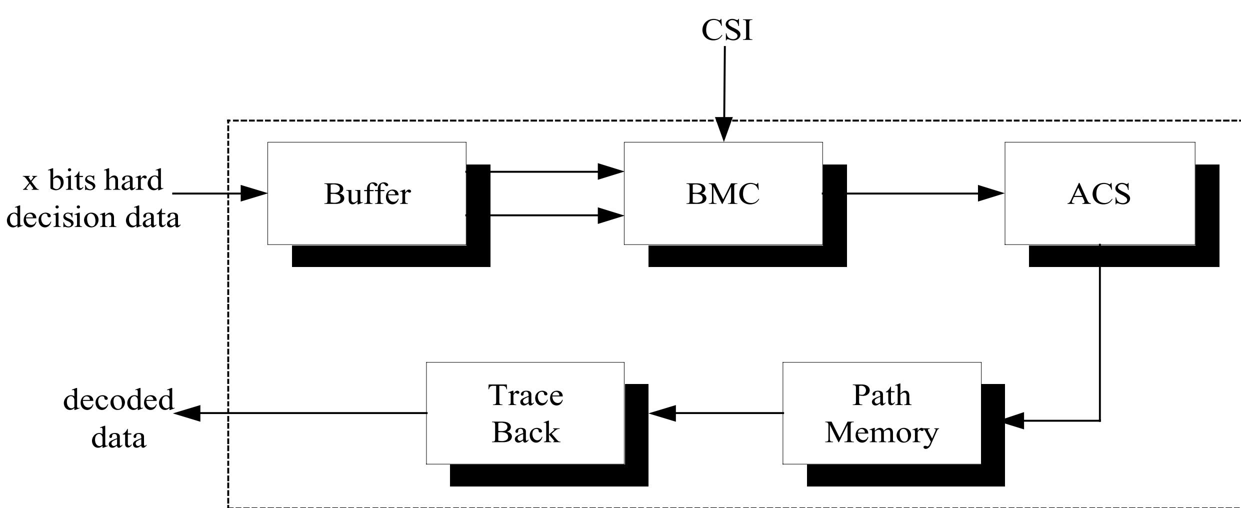

Figure 2. Viterbi decoder with CSI

The conditions for the simulations are as follows:

1. FFT size : 64 (52 subcarriers are used)
2. Bandwidth : 20 MHz
3. Multipath channel : SUI 1
4. Modulation/Coding : QPSK, 16QAM, 64QAM with CC

5. CC decoding uses hard decision with CSI
6. Perfect synchronization(No frequency offset, perfect OFDM symbol synchronization) is assumed. Channel estimation with long preamble in equalizer
7. 200 bytes of 10,000 packets

3.1 AWGN channel with CC

QPSK, 16QAM, 64QAM modulation is simulated in AWGN channel with different coding rate.

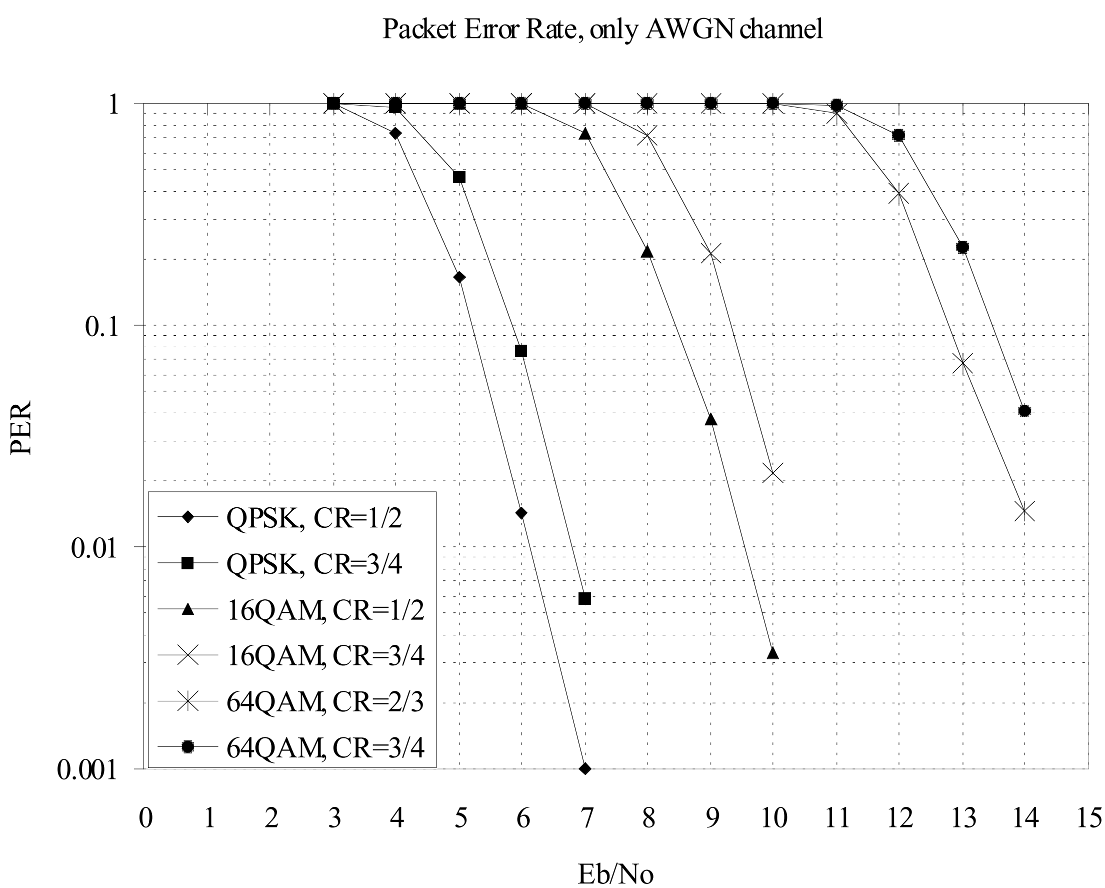

Figure 3. AWGN Simulation results

3.2 SUI 1 channel with CC

The SUI 1 channel model [3] is used to simulate multipath conditions. We compare the performance of CC with CC+CSI according to modulation methods.

As showing in Figure 4, Figure 5, Figure 6 the used channel state information performance is improved by 3dB rather than without CSI. If the soft decision viterbi decoder is used in this simulation the performance will be improved by 1~2dB.

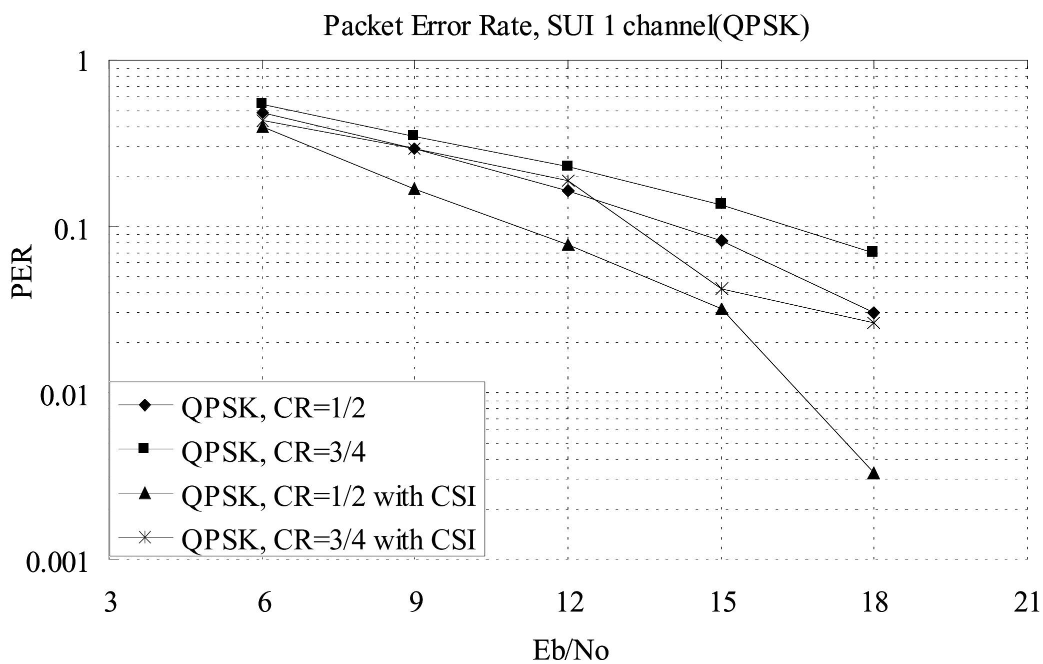

Figure 4. SUI 1 QPSK simulation results

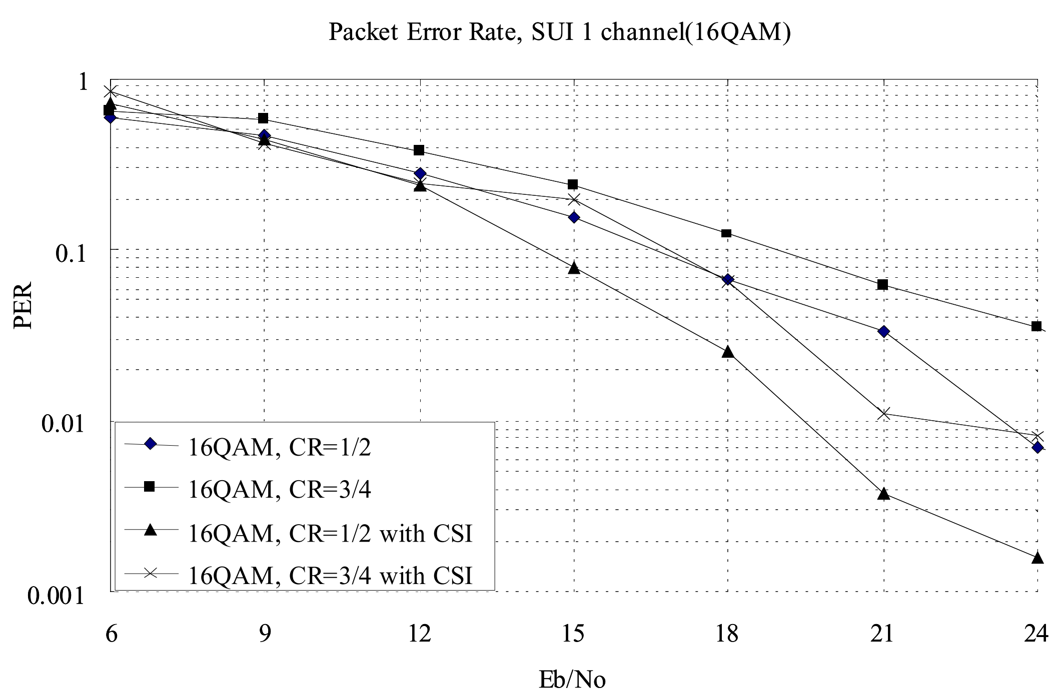

Figure 5. SUI 1 16QAM simulation results

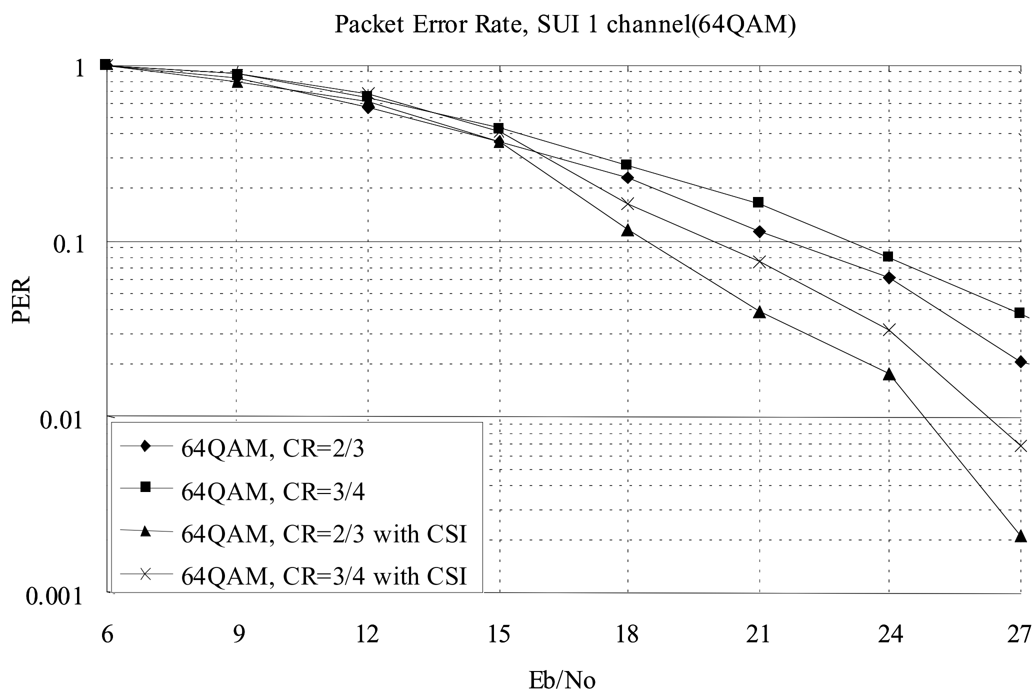

Figure 6. SUI 1 64QAM simulation results

4. Conclusion

In this document, we proposed a Viterbi decoding using channel state information and compared several coding rate system by means of the packet error rate. The channel state information was derived from the pilot carriers. The used channel state information is defined as a signal-to-noise ratio and we used this channel state information in Viterbi decoder to improve the system performance. From the simulation results, the performance of convolutional coding with CSI is improved by 3dB rather than without CSI.

Reference

[1] IEEE 802.16ab-01/01. Air Interface for fixed broadband wireless access systems part A: Systems between 2 and 11 GHz. June

[2] 802.16.3c-01/77. Options and results for reducing FEC complexity in 802.16a OFDM modes. Einan Regev

[3] 802.16.3c-01/29r2. Channel Models for Fixed Wireless Applications