

Mimimum FFT input bit resolution of 64-QAM case according to Uncoded-BER(Bit Error Rate) Performance in Mobile-WiMAX system

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Abstract— This paper finds the optimum input bit size of FFT engine in 64-QAM case of WiBro system through the uncoded-BER performances of computer simulation.

Keywords— FFT, Mobile-WiMAX, OFDM

I. INTRODUCTION

In recent years, the multicarrier technique, OFDM (Orthogonal Frequency Division Multiplexing) has grown to an important alternative for wireless communications such as Mobile-WiMAX and LTE (Long Term Evolutions). One main advantage of OFDM technology is the robustness against the multipath interferences [1].

OFDM is the most important representative of the multicarrier technique, since it is easy to implement due to efficient FFT algorithms. But, the implementation costs for these algorithms are, compared to the rest of an OFDM modem, comparatively high, so the most efficient structure has to be chosen. But in this paper, we are not going to focus on FFT structures but the input bit size of those, because the implementation complexity of FFT engine mainly depends on the input bit size of it[5].

In a prior study[2], we analysed the BER performances according to the input bit resolutions of FFT in QPSK (Quadrature Phase Shift Keying) and 16-QAM (Quadrature Amplitude Modulation). According to that result, the minimum input bit size of FFT engine are close to 7 bits in QPSK case, however, in 16QAM case, the minimum input bit size of that are close to 8~9 bits.

However, we need to obtain the result of 64-QAM case. So, in this paper, we obtained the simulation results of 64-QAM case and also analysed the FFT input bit resolution ranges that have little effect on the uncoded-BER performance in Mobile-WiMAX system.

II. SIMULATION ENVIRONMENT

The parameters for our computer simulation are illustrated in Table 1[3]. These parameters are related to the standard IEEE 802.16e (WiBro in Korea). In particular, only the partial usage of subchannels (PUSC) allocation scheme is used for our computer simulation. The Modulation types of simulation are QPSK, 16-QAM and 64-QAM and FFT size is 1024 point. In this simulation, the channel is AWGN (Additive White Gaussian Noise) only, so the channel estimation is not performed. Therefore we can compare the uncoded-BER according to the input bit size of FFT engine with the theoretical uncoded-BER curve of QPSK, 16-QAM and 64-QAM cases and determine the minimum input bit size of FFT engine.

TABLE 1. SIMULATION PARAMETERS

Parameters	Value
Bandwidth	8.75 [Mhz]
Frequency	2.345 [GHz]
Modulation	QPSK, 16-QAM, 64-QAM
Sampling Frequency	10 [Mhz]
Subcarrier Spacing	9.765625 [Khz]
Frame Length	5 [msec]
Number of Symbols / Frame	42(DL:27, UL:15)
FFT Size	1024
Cyclic Prefix	128 [samples]
Subchannel Allocation	PUSC
Channel	AWGN
AGC	Perfect AGC

Fig. 1 shows the detailed process of simulation on the basis of standard IEEE 802.16e [3]. In Fig. 1, the A/D block represents analog-to-digital converter and AGC_GAIN is the

gain value of AGC (Automatic Gain Control). The demand of an AGC loop in wireless systems comes from the fact that all communication systems have an unpredictable receiver power [4]. That is to say, too much gain in the receiving front-end will saturate the ADC (Analog-to-Digital Converter) and clip the signal but insufficient gain will result in higher quantization noise. So, we assumed that the perfect AGC was performed to quantize the full range of input signals of ADC in our simulations. In other words, the ADC block have only minimum quantization error but don't clip the input signals. For example, if ADC block's outputs were small bit sizes such as 4-bits, the quantization noise would be large but if the outputs of that were large ones such as 14-bits, the quantization noise would be small. So this quantization errors will have an effect on the performance of FFT operation and we find out the minimum input bit size of FFT engine. In Fig. 1, the output of ADC, that is to say, the input of FFT engine are only fixed point value the other blocks are all floating point values.

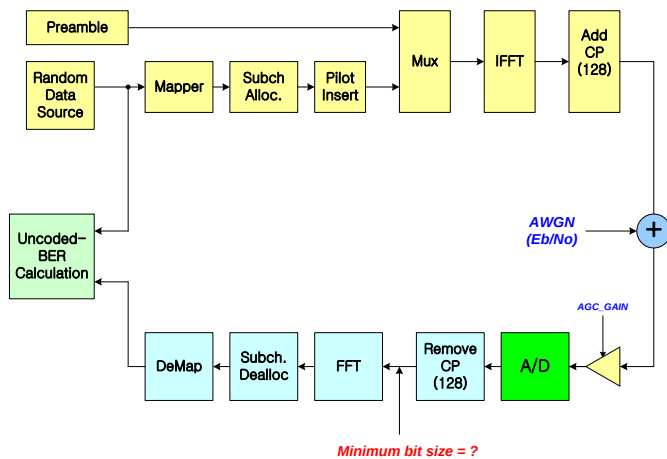


Figure 1. Simulation block diagram.

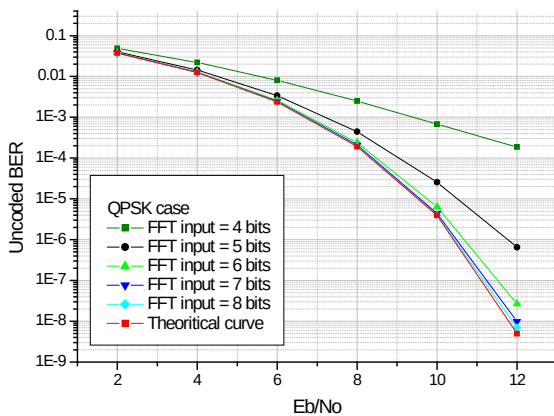


Figure 2. BER performance according to the input bit size of FFT engine (QPSK case).

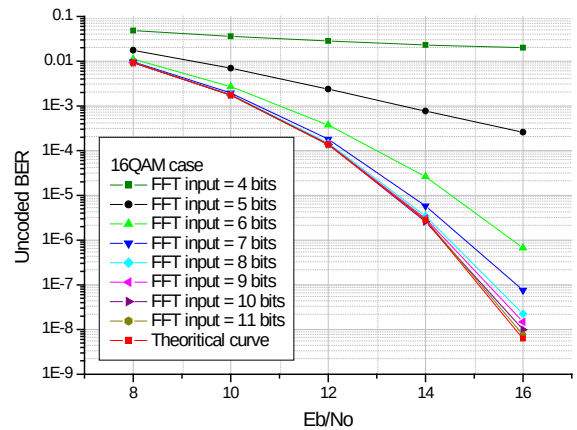


Figure 3. BER performance according to the input bit size of FFT engine (16-QAM case).

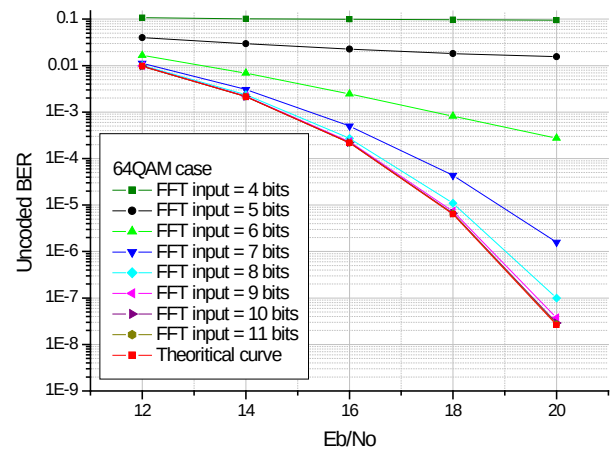


Figure 4. BER performance according to the input bit size of FFT engine (64-QAM case).

III. CONCLUSIONS

On the basis of the simulation results in Fig. 2 ~ Fig. 4, we summarize that the smaller the input bit size of FFT engine, the more degraded the uncoded-BER performance and vice versa. In QPSK case, the minimum input bit size of FFT engine are close to 7 bits, in 16-QAM case, the minimum input bit size of that are close to 8 bits, however, in 64-QAM case, the minimum input bit size of that are close to 9 bits if the target uncoded-BER is 1E-6. We decided the minimum input bit size of FFT engine when the uncoded-BER performance was close to theoretical curve within 0.1dB at the target uncoded-BER. So we conclude that the minimum bit size can be used adaptively in the input of FFT engine according to the modulation orders, and therefore we will reduce the complexity of FFT engine.

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