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

Submission Title: [A new MC-CDMA structure for WPAN physical layer proposal]
Date Submitted: [May 07, 2007]
Source: [Juinn-Horng Deng[1], Jeng-Kuang Hwang[2], Yu-Lun Chiu[2], and Rih-Lung Chung[2], and Yu-Min Chuang[1], Tian-Wei Huang[3]]
Company: [CSIST Corporation[1], Yuan-Ze University[2], National Taiwan University[3]]
Address1: [P. O. Box No. 22-14 Luan-Tan, Tao-Yuan, 325, Taiwan, R.O.C.]
Address2: [135, Far-East Rd., Chung-Li, Tao-Yuan, 32026, Taiwan, R.O.C.]
Address3: [No.1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan, R.O.C.]
E-mail: [ymchuang@cm1.hinet.net, jh.deng@msa.hinet.net, eejhwang@saturn.yzu.edu.tw, twhuang@cc.ee.ntu.edu.tw]
Abstract: [This contribution describes a new MC-CDMA structure proposal for WPAN physical layer]
Purpose: [Contribution to 802.15 TG3c at May 2007 meeting in USA]

Outline

- Introduction
- Transmitter Block Diagram of Multi-Code CSOK MC-CDMA Systems
- Receiver Block Diagram of Multi-Code CSOK MC-CDMA Systems
- Simulation results
- Summary
- References

Introduction

- We propose the physical layer transceiver structure of a new class of MC-CDMA systems, which is used for 60 GHz WPAN system
- The proposed MC-CDMA system uses the cyclic-shift orthogonal keying (CSOK) symbol mapping in terms of the Chu sequence multi-codes with perfect orthogonality

Introduction

- The proposed MC-CDMA system involves the following key features:
  - To have low-complexity transceiver structure
  - To have much lower PAPR
  - To have better bandwidth efficiency
  - Can be used in both the LOS and non-LOS multipath channel environments

Transmitter Block Diagram of Multi-Code CSOK MC-CDMA Systems

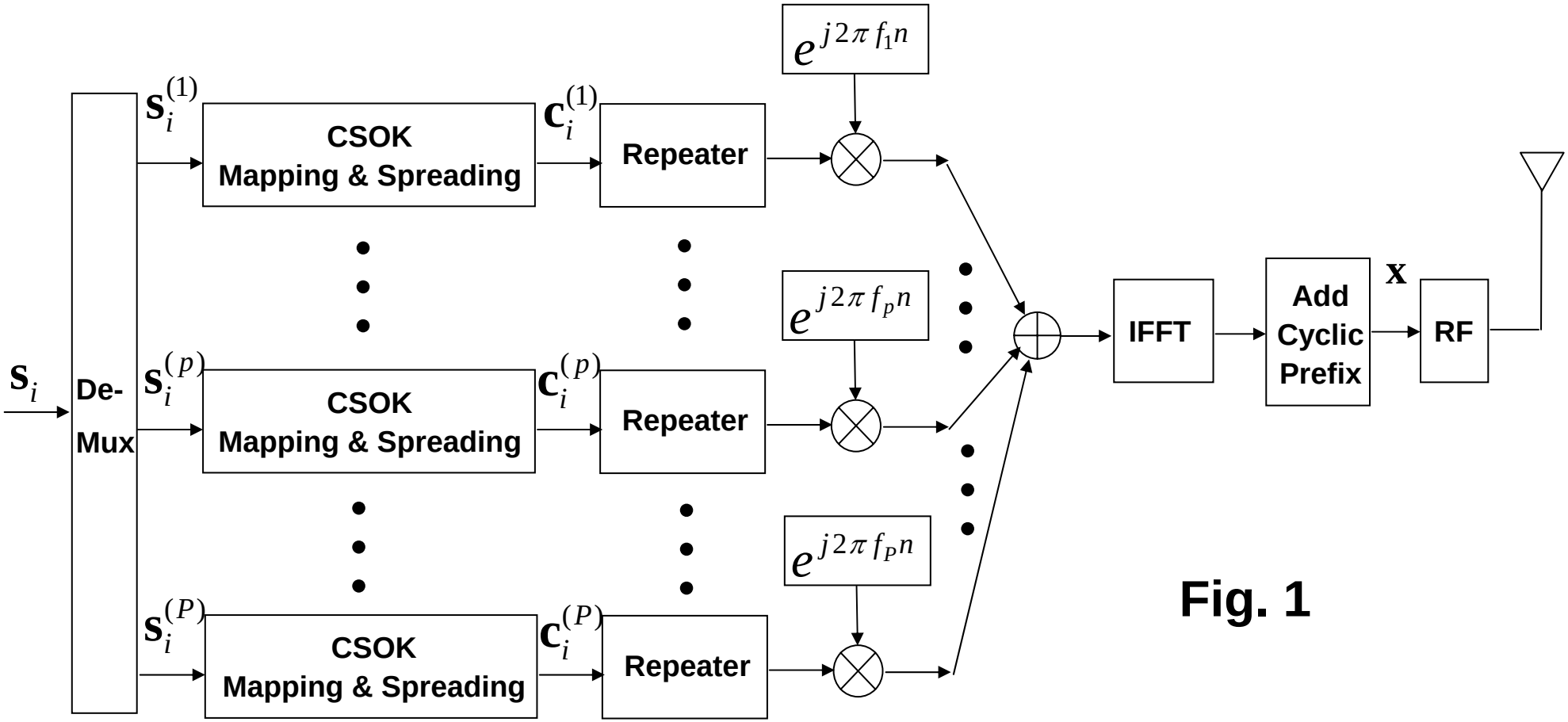
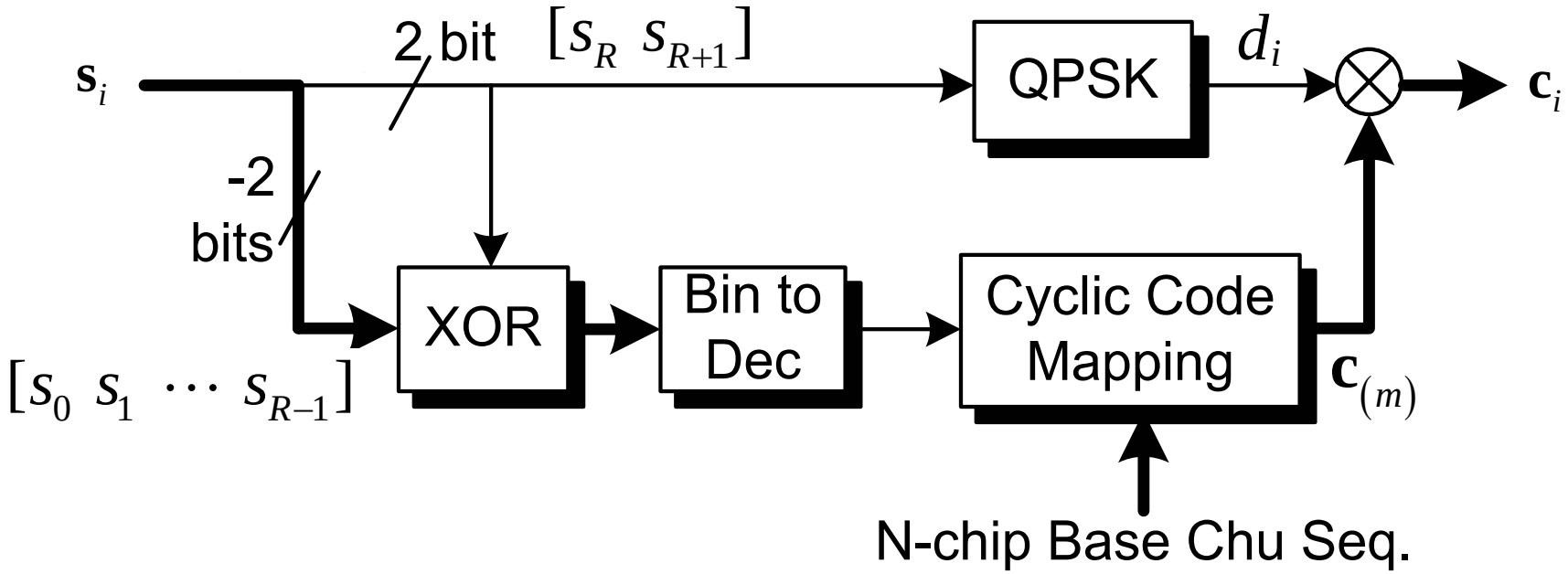


Fig. 1

Transmitter Block Diagram of Multi-Code CSOK MC-CDMA Systems

- Proposed multi-code multi-carrier CDMA transmitter system involves the following schemes
  - CSOK mapping and spreading
  - Repeater and frequency shift modulation
  - IFFT and Add cyclic prefix

QPSK-CSOK Symbol Mapping and Spreading



Repeater and Frequency Shift Modulation

- Under the same bandwidth and number of FFT points, we propose multi-code QPSK-CSOK MC-CDMA system which can result in *P*-fold increase in bit rate
- As shown in Fig.1, the multi-code QPSK-CSOK MC-CDMA system consists of *P*-substreams QPSK-CSOK symbols which are repeated *P* times, phase rotated, summed, and placed on IFFT subcarriers, resulting in a low-PAPR signal that preserves the desired orthogonality among substreams

IFFT and Add Cyclic Prefix

- Since each element of the **x** involves the constant envelope in time domain, the multi-code MC-CDMA system has much lower PAPR
- Add cyclic prefix used to combat multipath channel effect

Receiver Block Diagram of Multi-Code CSOK MC-CDMA Systems

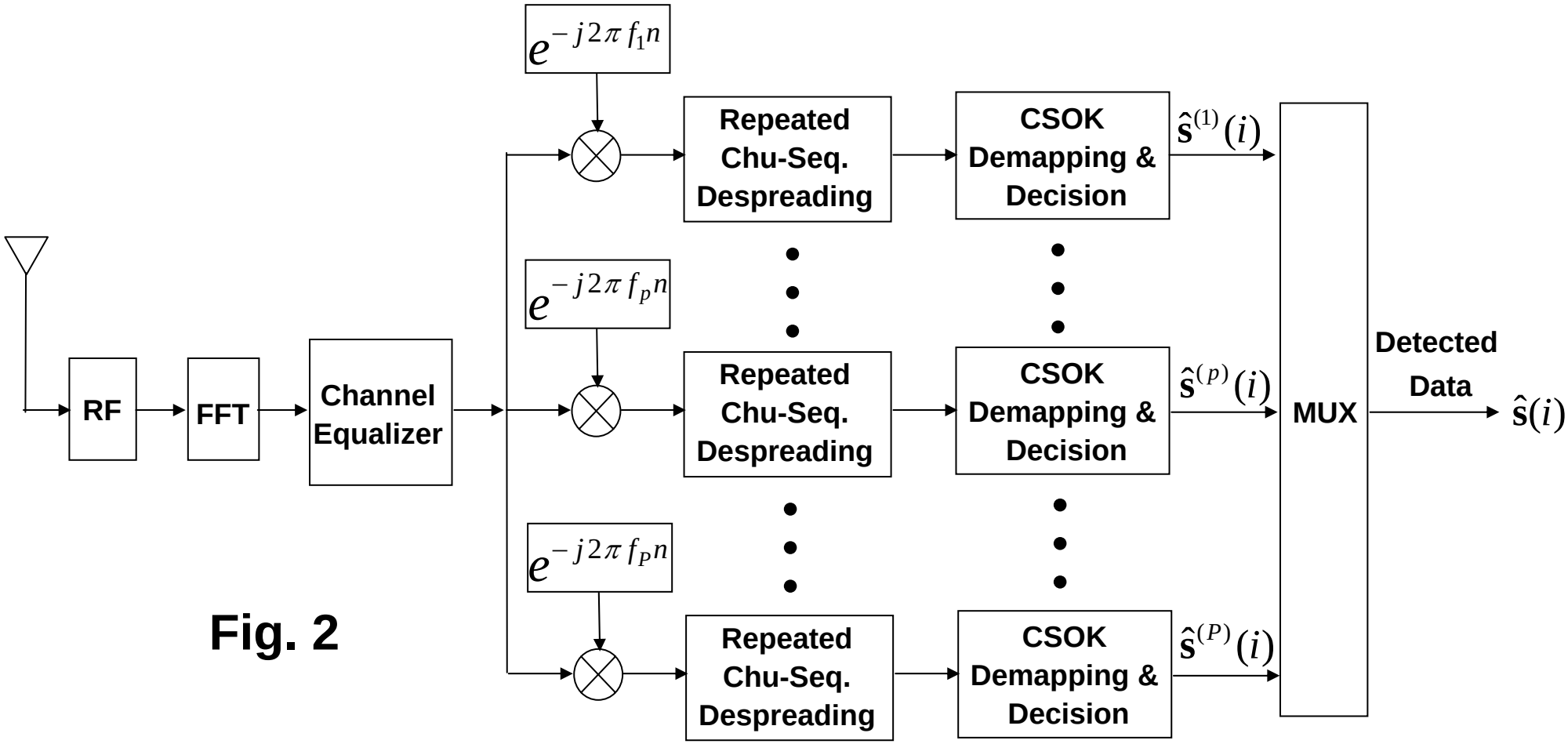


Fig. 2

RX Design of CSOK MC-CDMA System

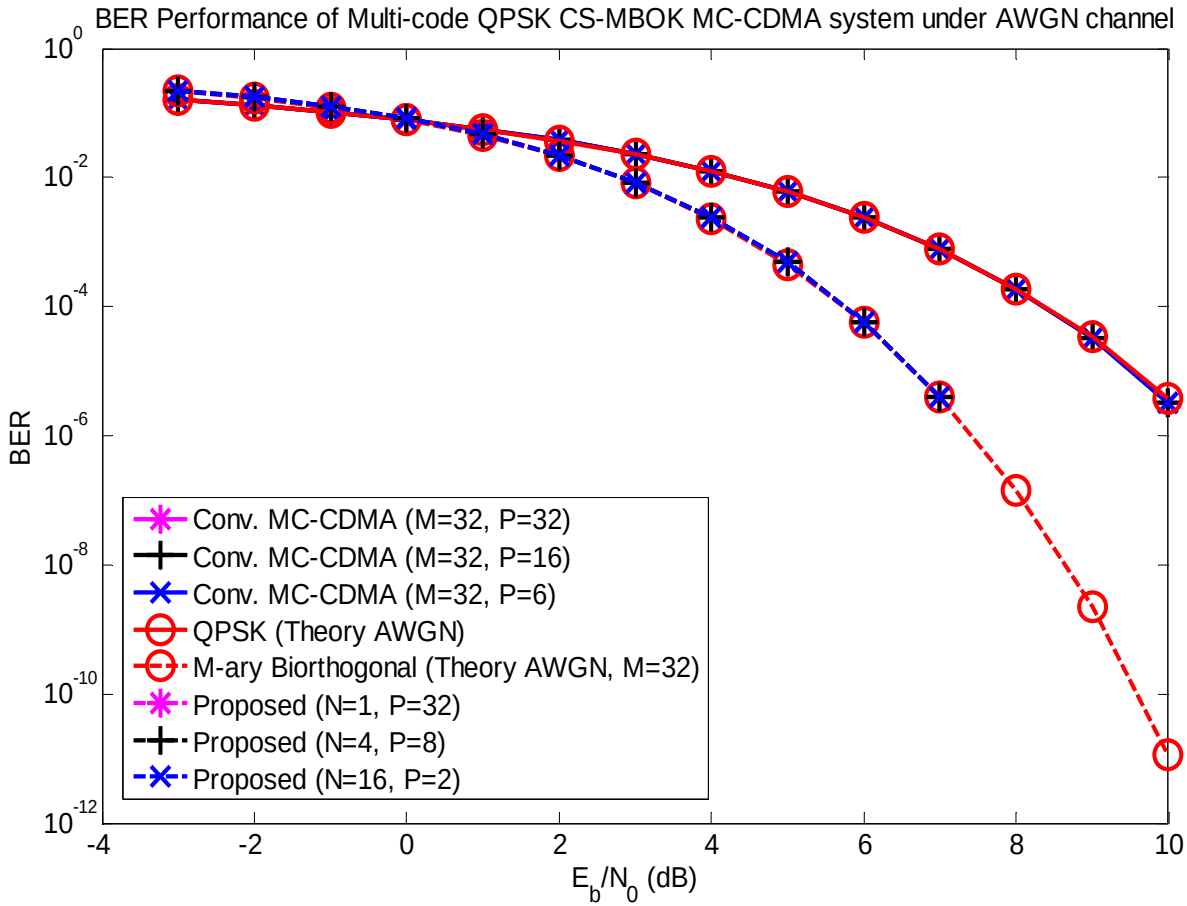
- At the receiver, frequency-domain equalization is performed on the post-FFT data
- Then an efficient despreading and demapping scheme is used to separate the substreams and detect the corresponding QPSK-CSOK symbols

Simulation Results

- Simulation results show that the proposed system, as compared to the conventional multi-code MC-CDMA system using Walsh-Hadamard code, attains lower bit error rate and PAPR

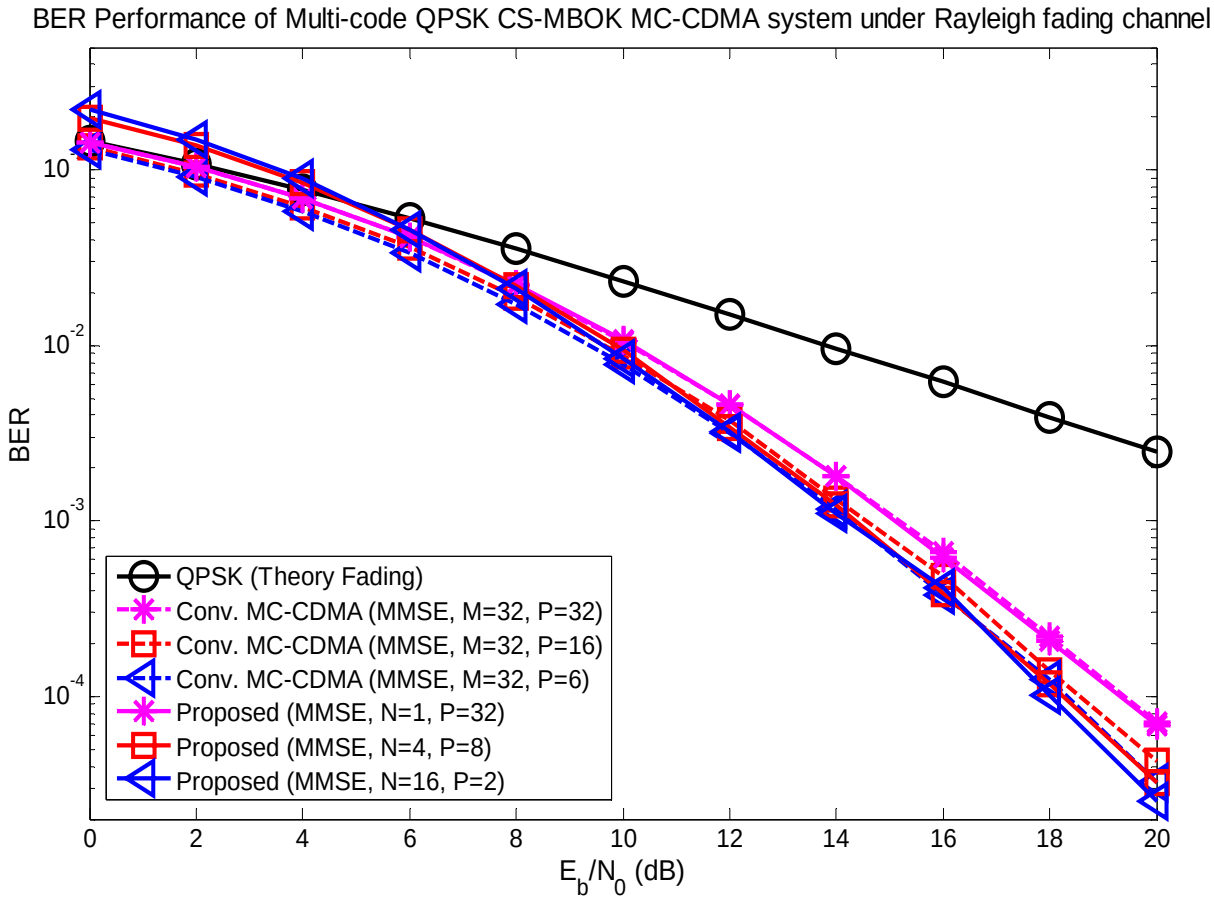
Simulation Results

- BER performance as a function of Eb/N0 for the proposed multi-code MC-CDMA systems over AWGN channel



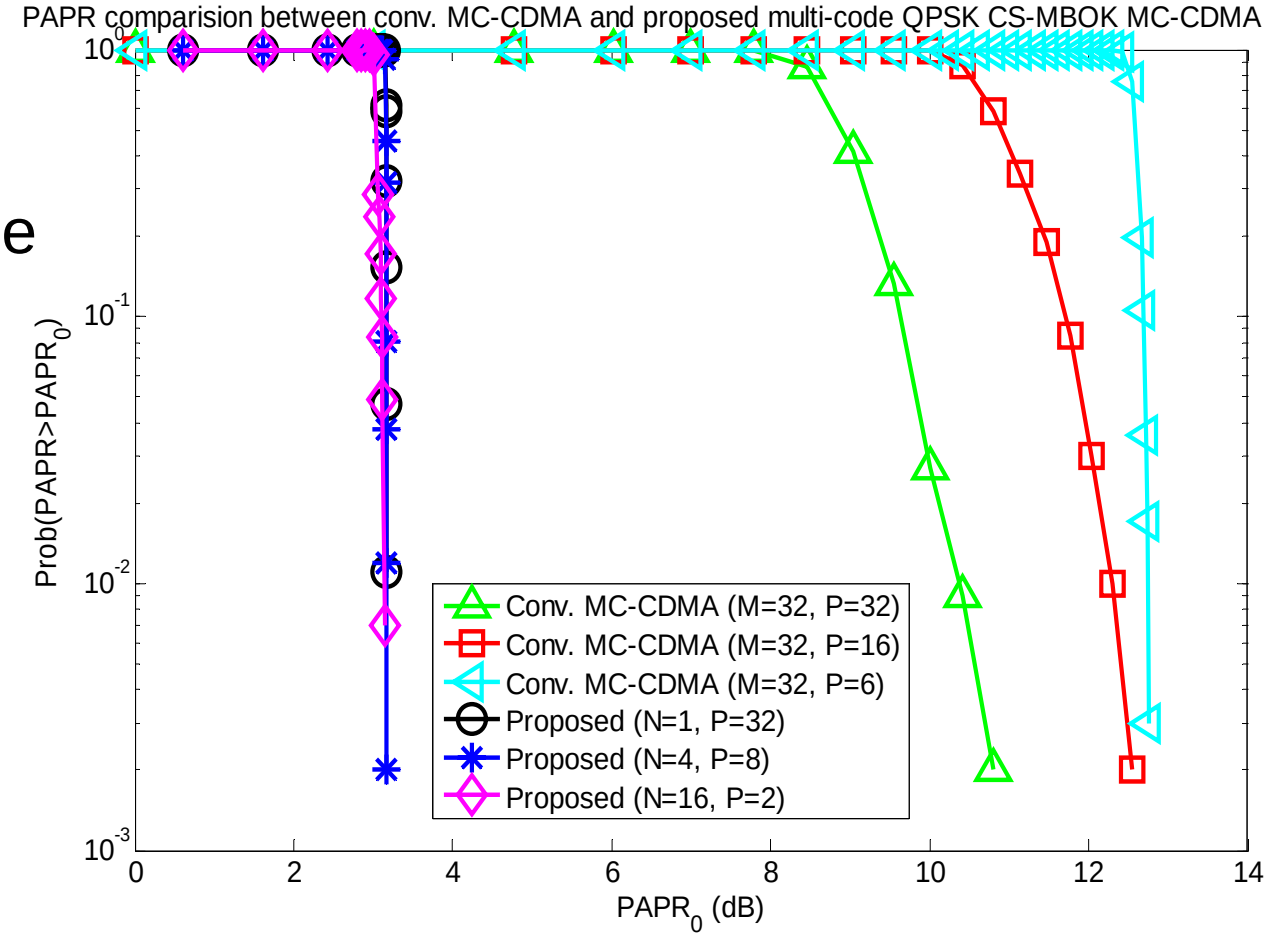
Simulation Results

- BER performance with MMSE receiver as a function of Eb/N0 for the proposed multi-code MC-CDMA systems over frequency selective Rayleigh fading channel



Simulation Results

- The PAPR CCDF comparisons of the proposed multi-code MC-CDMA and conventional MC-CDMA systems



Summary of System Merits

- Spread spectrum →Processing gain against interference
- CP insertion → multipath channel mitigation
- Chu sequence as spreading Code
  - Perfect autocorrelation property for CSOK
  - Lower PAPR TX signal for asymmetrical application
- Repeater and Frequency Shift Modulation
  - Improve the spectral efficiency

Summary of System Merits

- The proposed MC-CDMA system gives an excellent PAPR performance than the conventional MC-CDMA system
- Simulation confirmed that the proposed transceiver is suitable for the frequency selective fading channel and outperforms the conventional MC-CDMA system

References

- R. Van Nee and R. Prasad, OFDM Wireless Multimedia Communications. London: Artech House, 2000.
- J. K. Hwang, Y. L. Chiu, and R. L. Chung, “A New Class of MC-CDMA Systems Using Cyclic-Shift M-ary Biorthogonal Keying,” *International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS)*, Japan, Dec. 2006.
- M. K. Simon, S. M. Hinedi, and W. C. Lindsey: *Digital Communication Techniques*, Prentice-Hall, 1995.
- D. C. Chu, “Polyphase codes with good periodic correlation properties,” *IEEE Trans. Inform. Theory*, vol. 18, no. 4, pp. 531–532, 1972.
- J. G. Proakis, *Digital Communications*, 4th edition, McGraw-Hill, 2001.

Thank you!