

**Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)****Submission Title:** [UEP for 802.15.3c PHY]**Date Submitted:** [May 7, 2007]**Source:** [Seongsoo Kim, Edwin Kwon, Chiu Ngo, Huaning Niu, Jisung Oh, Sandra Qin, Huai-Rong Shao, Harkirat Singh, Pengfei Xia, Su-Khiong Yong]**Company** [Samsung Electronics]**Address** [416 Maetan-3Dong, Youngtong-Gu, Suwon-Shi, Gyungki-Do 443-742, Korea]**Voice:** [], **FAX:** [],**E-Mail:** [[seongsoo1.kim@samsung.com](mailto:seongsoo1.kim@samsung.com) , [cy.kwon@samsung.com](mailto:cy.kwon@samsung.com) , [chiu.ngo@samsung.com](mailto:chiu.ngo@samsung.com) , [huaning.niu@samsung.com](mailto:huaning.niu@samsung.com) , [jisung0714.oh@samsung.com](mailto:jisung0714.oh@samsung.com) , [x.qin@samsung.com](mailto:x.qin@samsung.com) , [hr.shao@samsung.com](mailto:hr.shao@samsung.com) , [har.singh@samsung.com](mailto:har.singh@samsung.com) , [pengfei.xia@samsung.com](mailto:pengfei.xia@samsung.com) , [ysk@ieee.org](mailto:ysk@ieee.org)]**Re:** [In response to TG3c Call for Proposals (IEEE P802.15-07-0586-02-003c)]**Abstract:** [This document contains the partial PHY proposal for TG3c. This proposal provides explanations on the UEP technology in the complete proposal from WirelessHD. In general, UEP can be applied to any other 15.3c PHY proposals.]**Purpose:** [To describe the unequal-error-protection (UEP) for supporting video streaming in 802.15.3c PHY]**Notice:** This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.**Release:** The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.

# Motivation for unequal error protection (UEP) for video applications

## *Bit errors in AV streaming vs. Subjective Picture Quality*

- Each bit of RGB bytes has different value in color
- Need protect valuable bits more than the valueless ones
- Especially important for video transmissions

**original**

**MSB**

**LSB**



R : 30  
G : 200  
B : 30

R : 30  
G : 72  
B : 30

R : 30  
G : 136  
B : 30

R : 30  
G : 232  
B : 30

R : 30  
G : 216  
B : 30

R : 30  
G : 192  
B : 30

R : 30  
G : 204  
B : 30

R : 30  
G : 202  
B : 30

R : 30  
G : 201  
B : 30

R : 00011110  
G : 11001000  
B : 00011110

R : 00011110  
G : 01001000  
B : 00011110

R : 00011110  
G : 10001000  
B : 00011110

R : 00011110  
G : 11101000  
B : 00011110

R : 00011110  
G : 11011000  
B : 00011110

R : 00011110  
G : 11000000  
B : 00011110

R : 00011110  
G : 11001100  
B : 00011110

R : 00011110  
G : 11001010  
B : 00011110

R : 00011110  
G : 11001001  
B : 00011110



R : 64  
G : 64  
B : 64

R : 64  
G : 192  
B : 64

R : 64  
G : 0  
B : 64

R : 64  
G : 96  
B : 64

R : 64  
G : 80  
B : 64

R : 64  
G : 72  
B : 64

R : 64  
G : 68  
B : 64

R : 64  
G : 66  
B : 64

R : 64  
G : 65  
B : 64

R : 01000000  
G : 01000000  
B : 01000000

R : 01000000  
G : 11000000  
B : 01000000

R : 01000000  
G : 00000000  
B : 01000000

R : 01000000  
G : 01100000  
B : 01000000

R : 01000000  
G : 01010000  
B : 01000000

R : 01000000  
G : 01001000  
B : 01000000

R : 01000000  
G : 01000100  
B : 01000000

R : 01000000  
G : 01000010  
B : 01000000

R : 01000000  
G : 01000001  
B : 01000000

# Strategy: Unequal Error Protection (UEP)

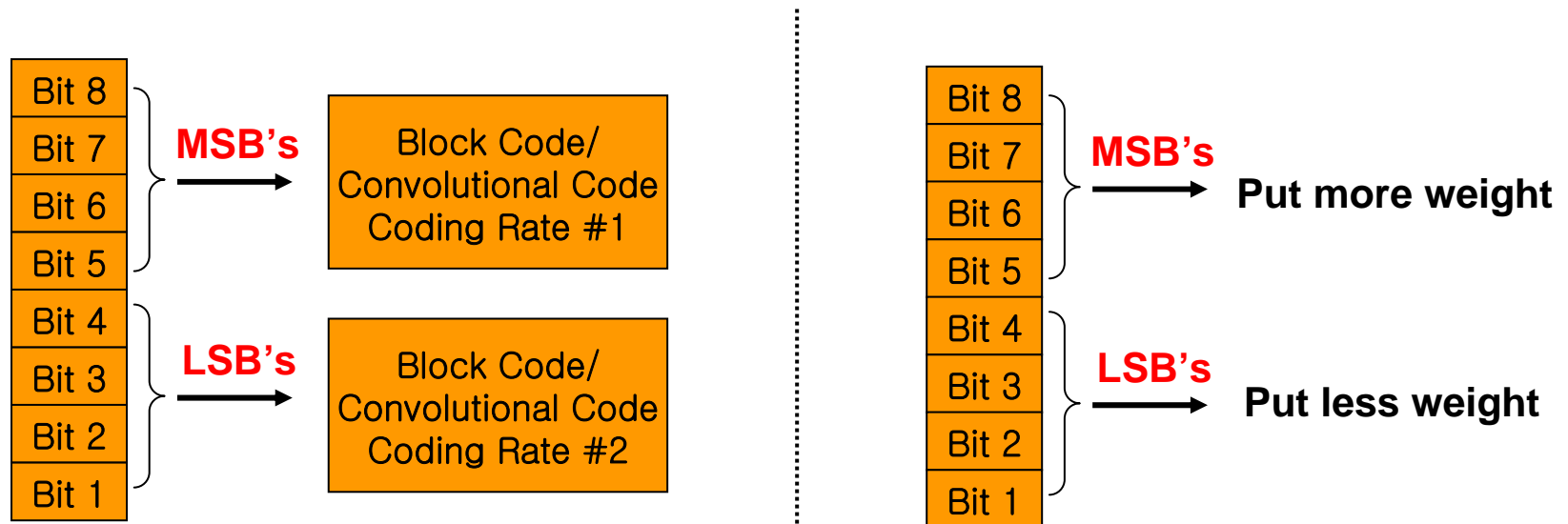
Method 1 : Imposing different coding rates on MSB's and LSB's

→ Effective use of the limited coding redundancy

Method 2 : Weighting MSB's and LSB's separately in the mapping

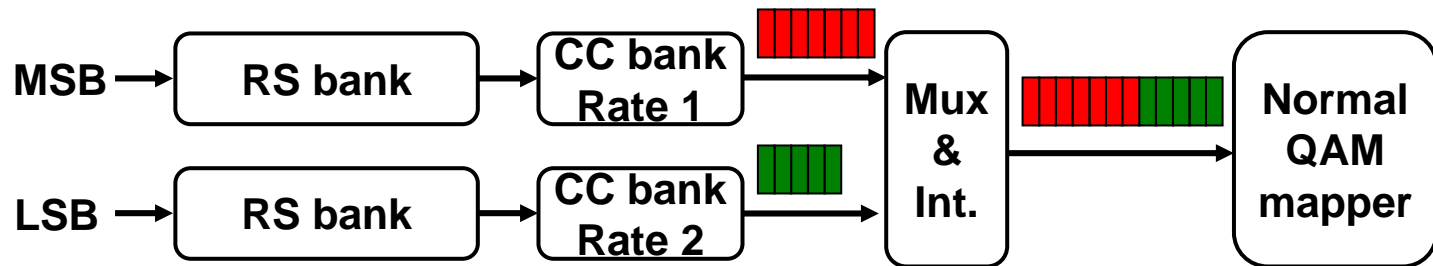
→ Effective use of the limited transmit power

With these two methods, different levels of UEP protection are provided.

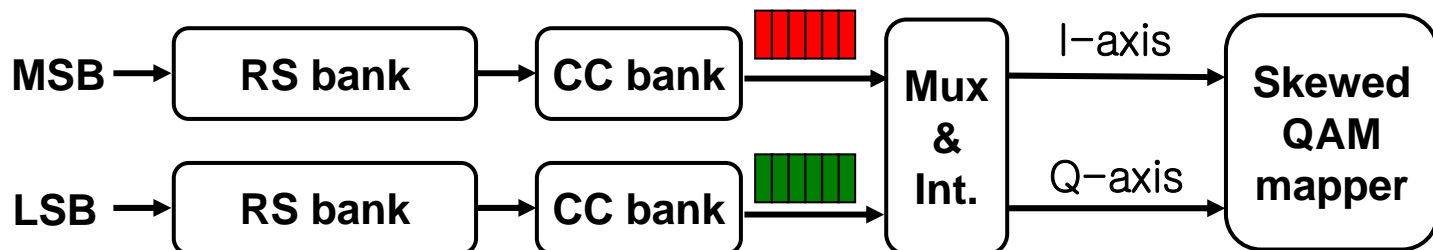


# UEP Description

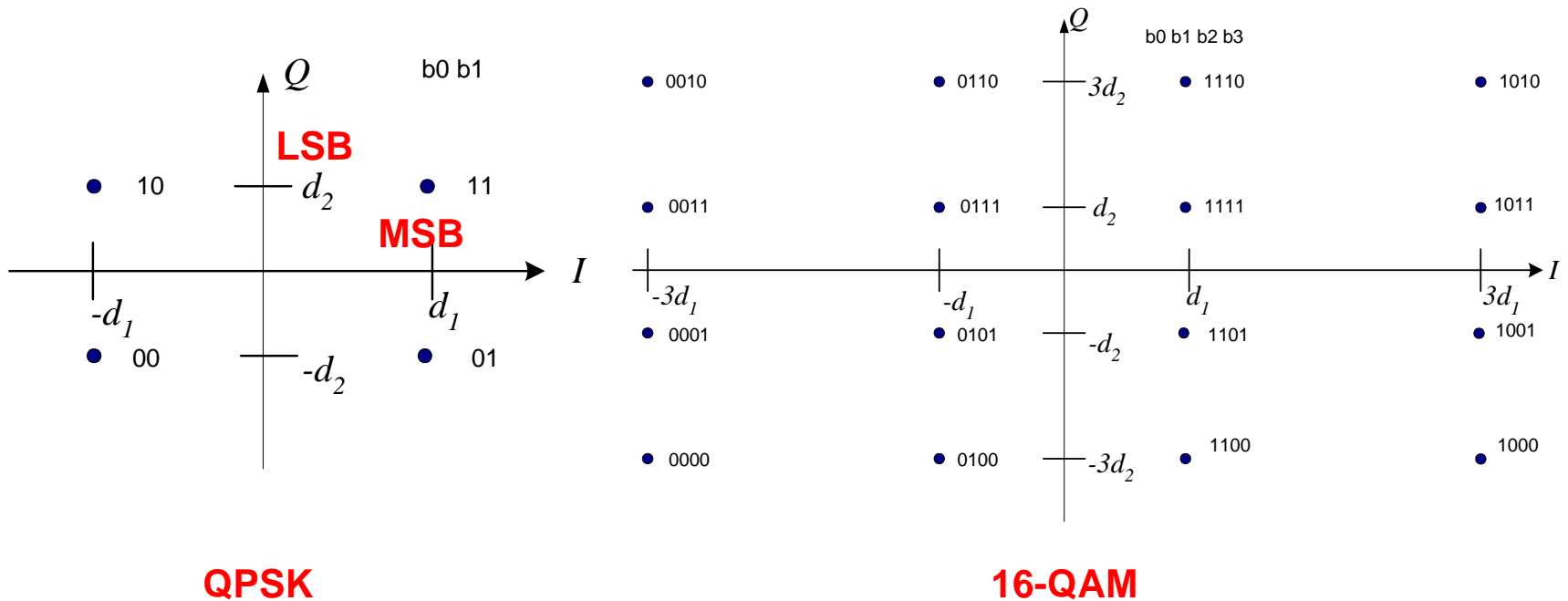
## • UEP - Coding



## • UEP - Mapping

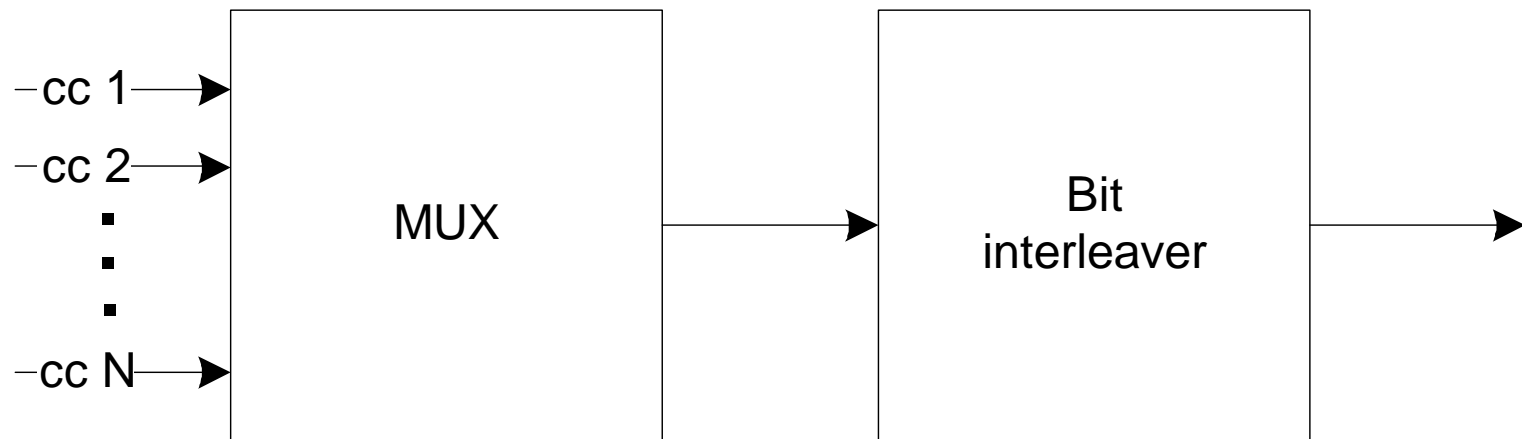


# Skewed Constellation for UEP-mapping



# Multiplexer and Bit Interleaver

- Parallel convolutional encoders and decoders are needed in order to support multi-gigabit data throughput
- Data multiplexer (MUX) combines data from all parallel convolutional encoders
- Bit interleaver shuffles bits from multiplexer to I/Q constellations



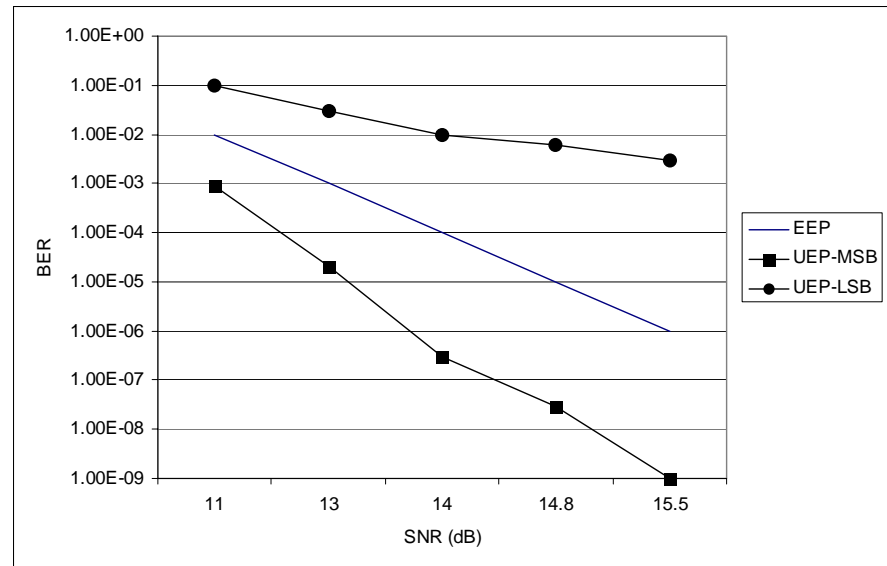
**cc : convolutional encoder**

# Simulations

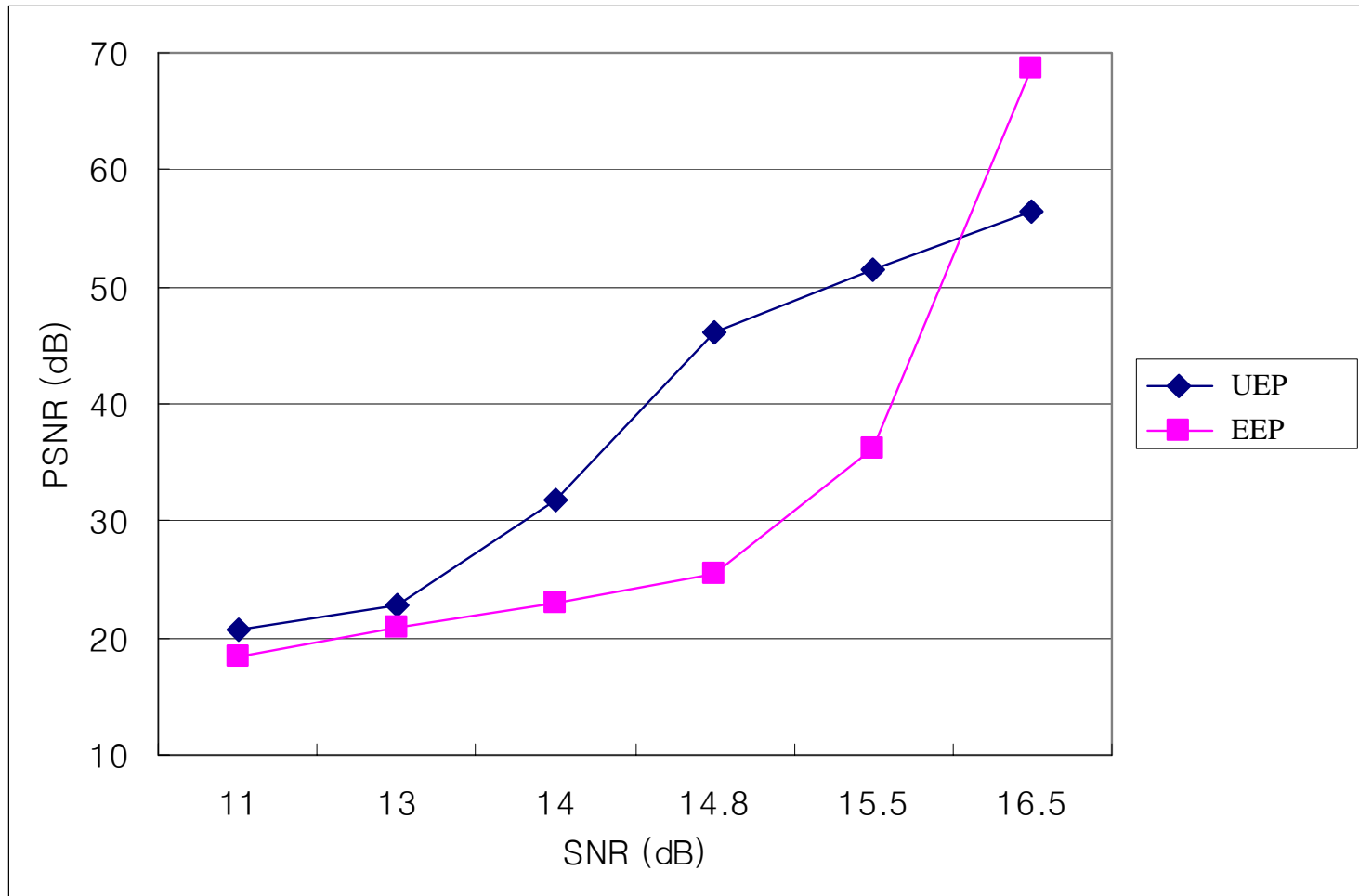
- ✓ Measure average PSNR

$$AP = \frac{1}{F} \sum_{i=1}^F 10 \log_{10} \frac{MAX^2}{MSE_i}$$

- ✓ BER performance of UEP and EEP

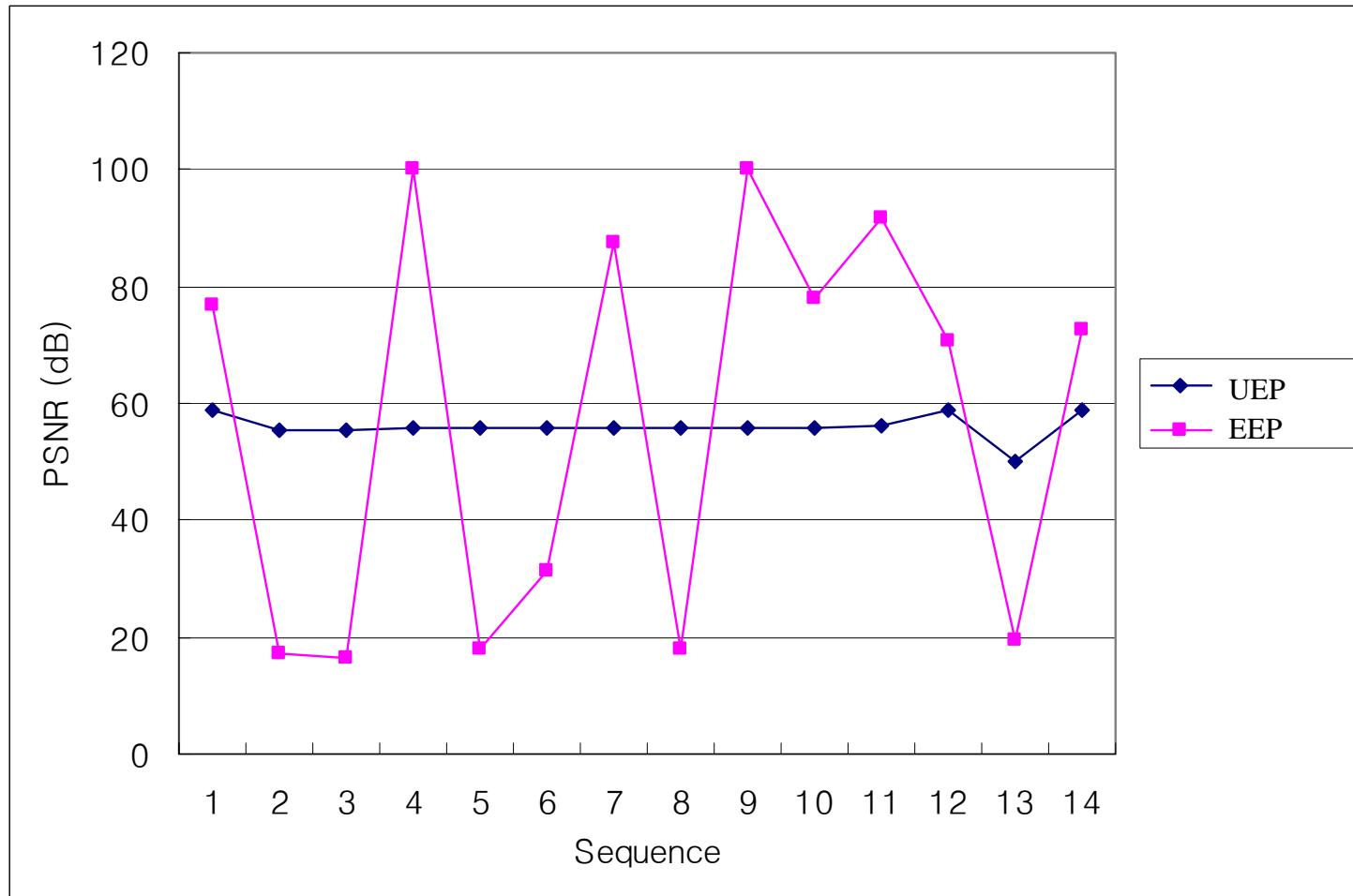


# UEP Effect





# *UEP Effect: Stability*



(SNR=16.5dB)

# Summary

- UEP is a key technology to improve QoS for video application
- UEP provide stable PSNR compared to EEP
- UEP methods can be applied to both single carrier and OFDM proposals