

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]

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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]

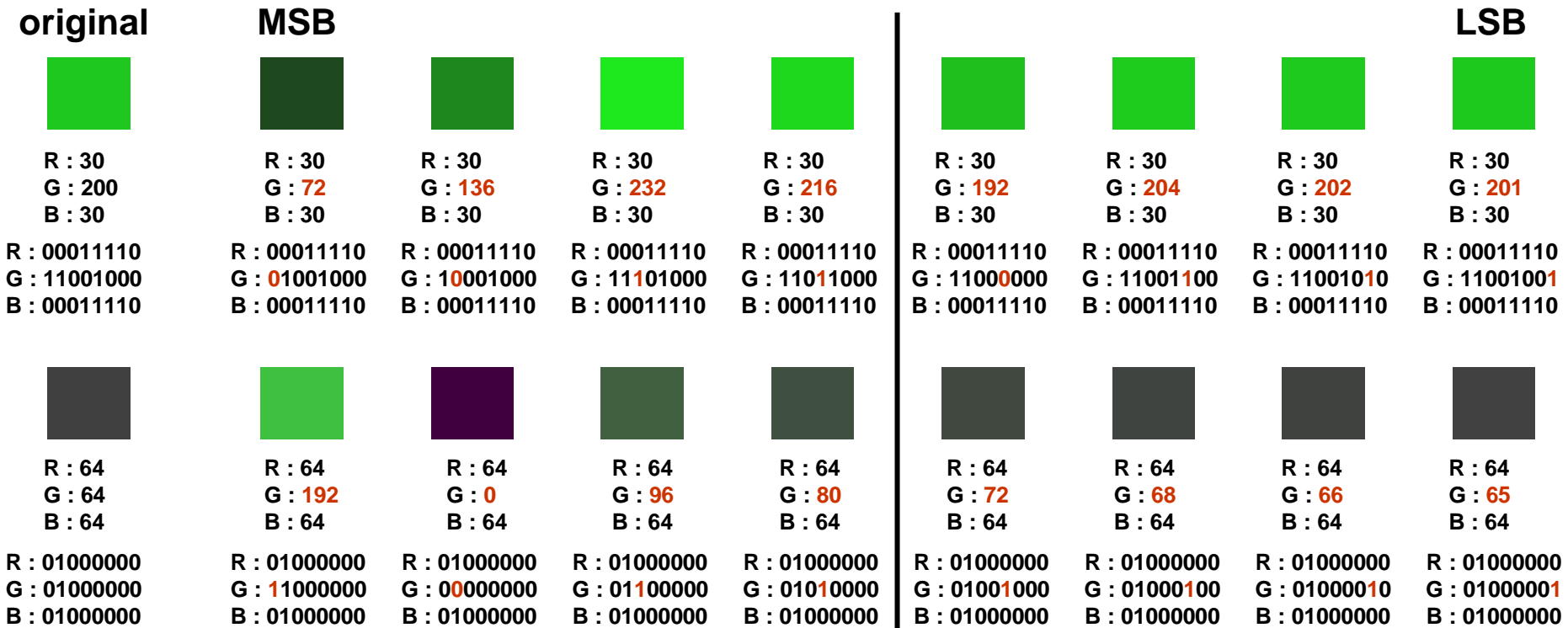
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Motivation for unequal error protection (UEP) for video applications

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



Strategy: Unequal Error Protection (UEP)

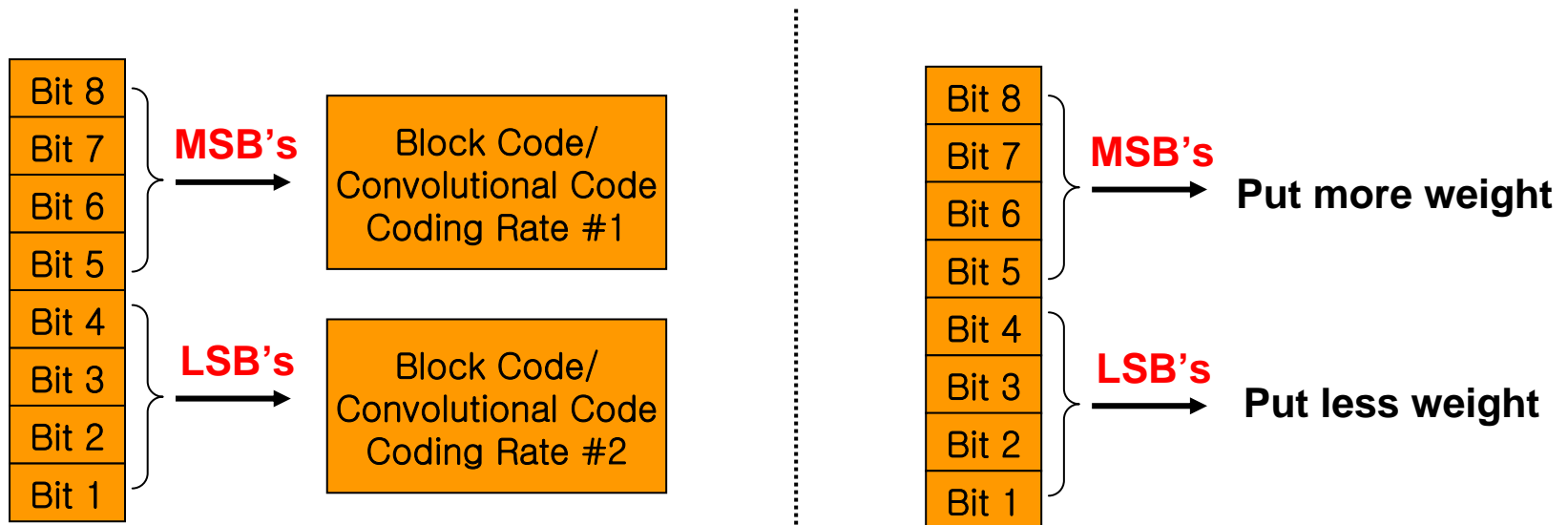
Method 1 : Imposing different coding rates on MSB's and LSB's

→ Effective use of the limited coding redundancy

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

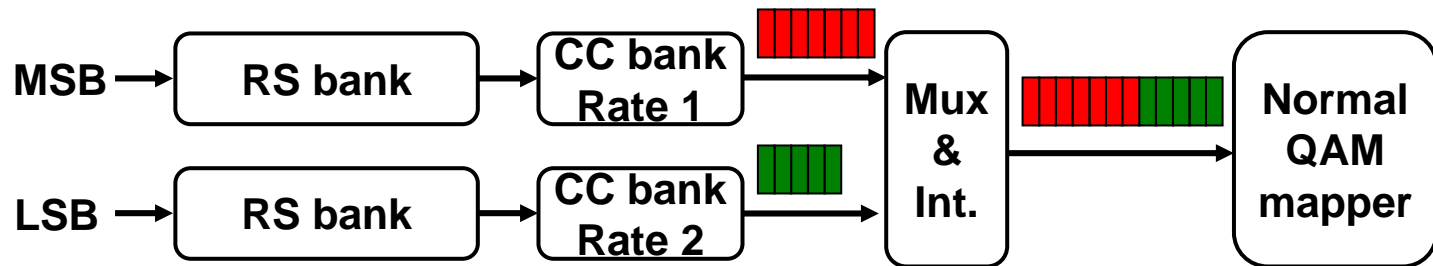
→ Effective use of the limited transmit power

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

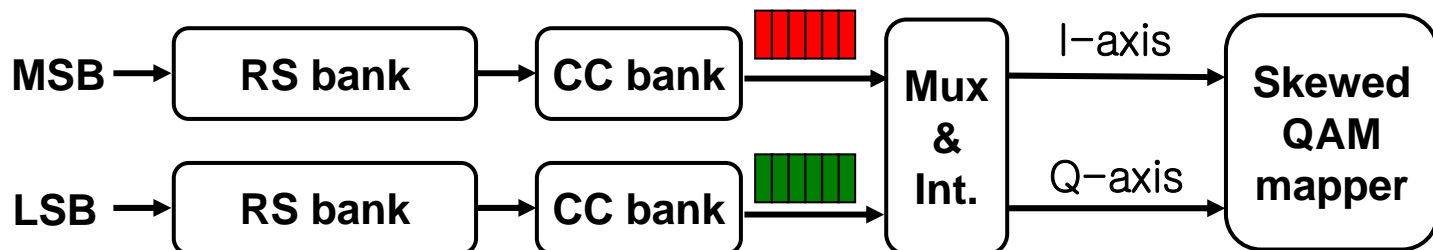


UEP Description

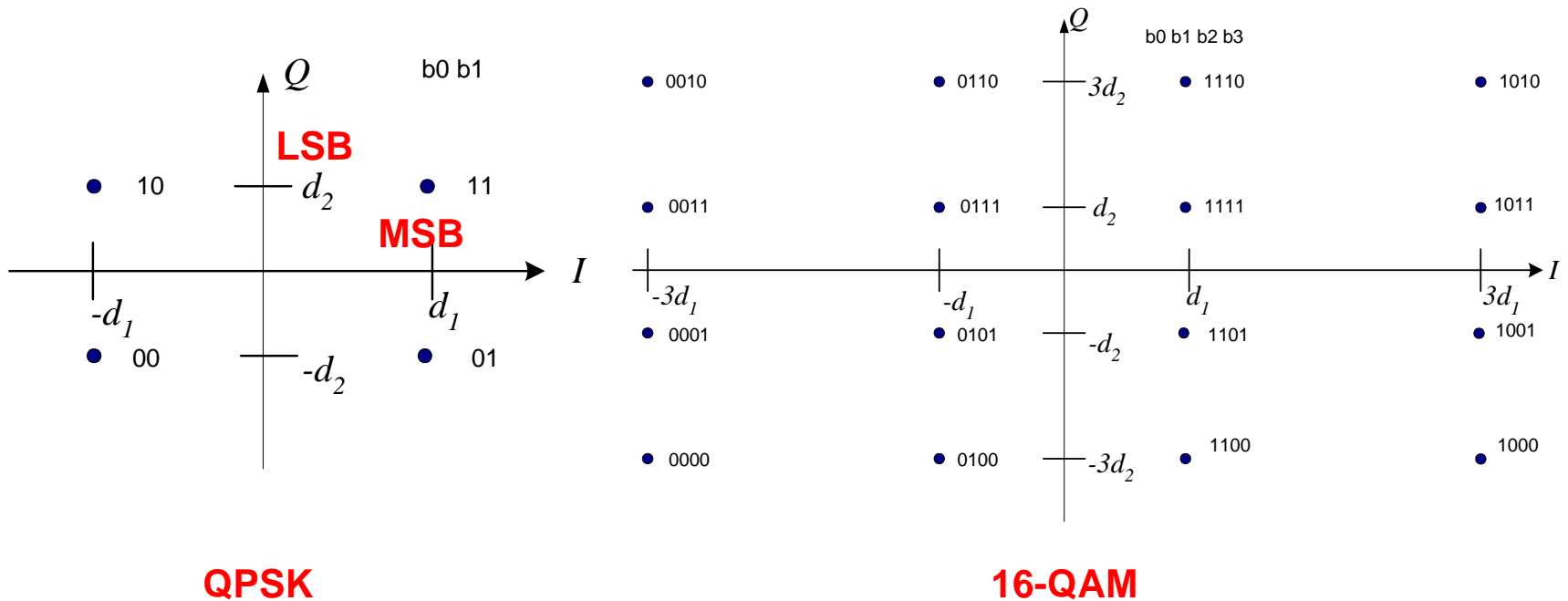
• UEP - Coding



• UEP - Mapping

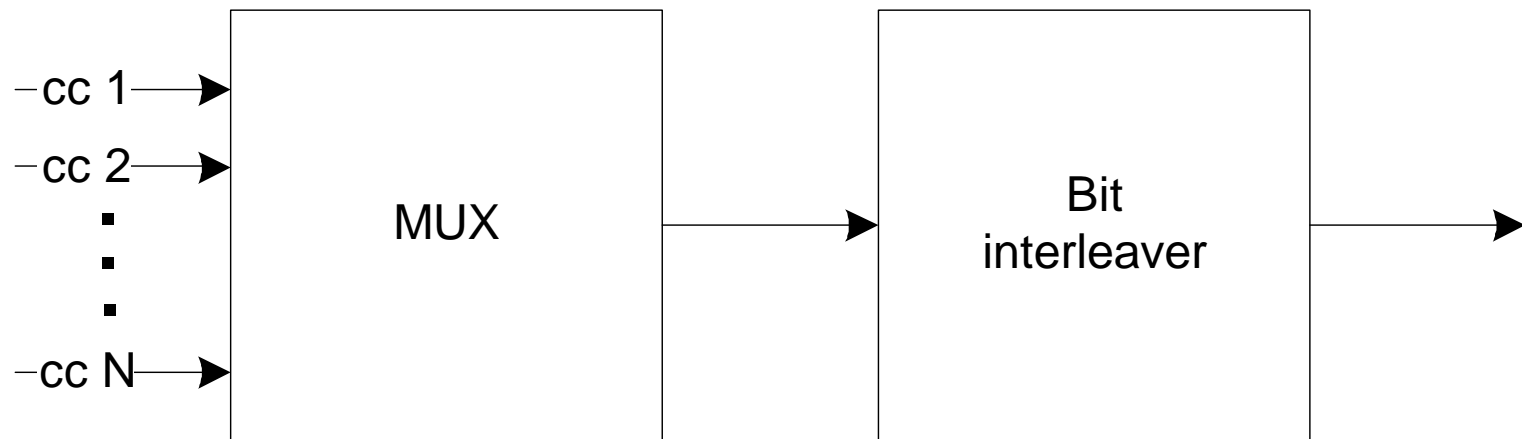


Skewed Constellation for UEP-mapping



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



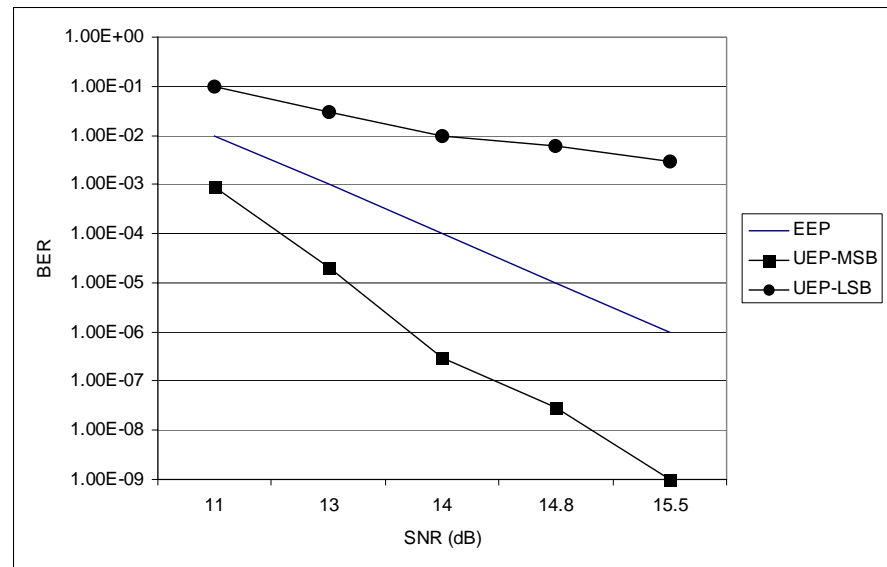
cc : convolutional encoder

Simulations

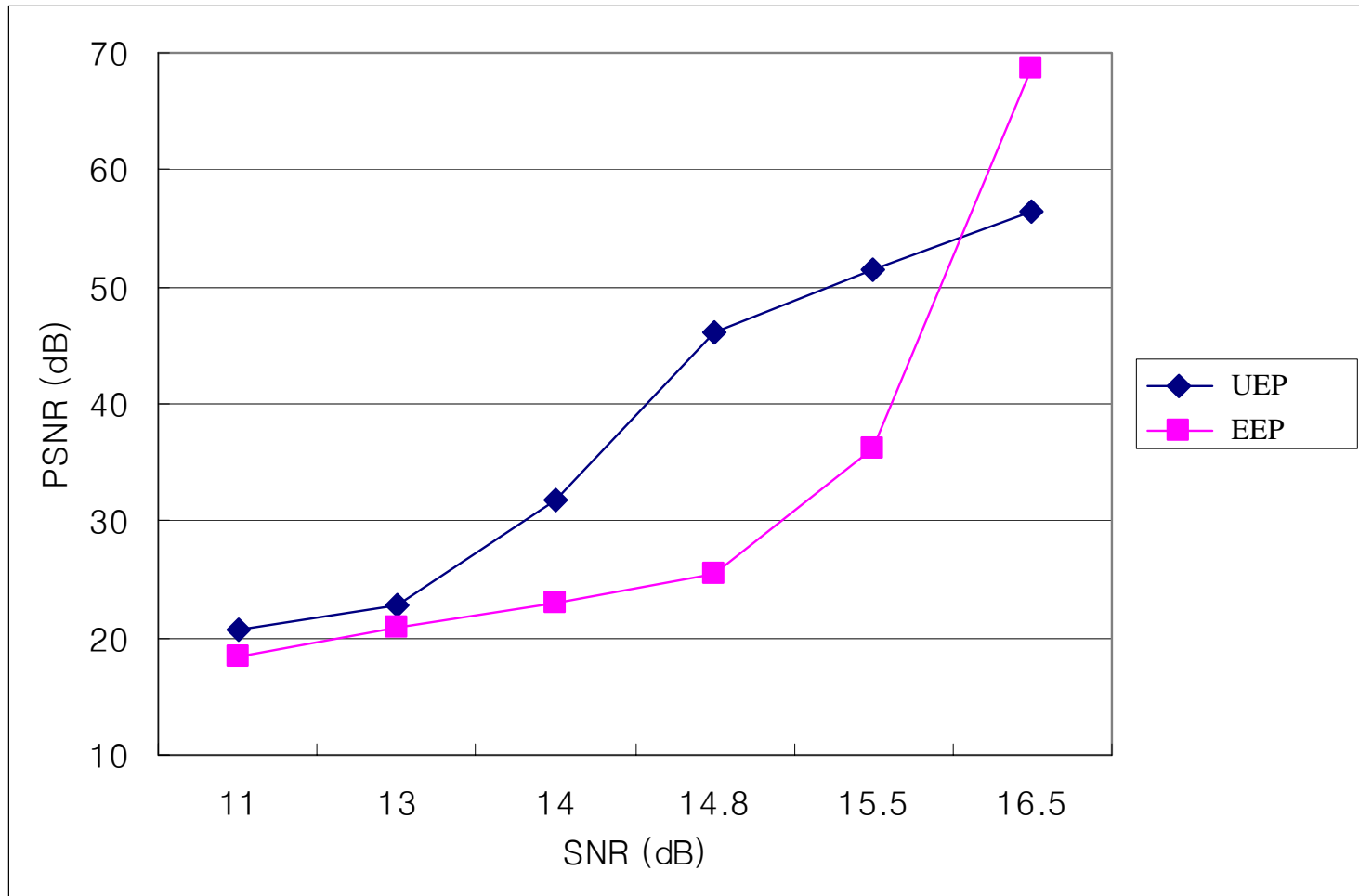
- ✓ Measure average PSNR

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

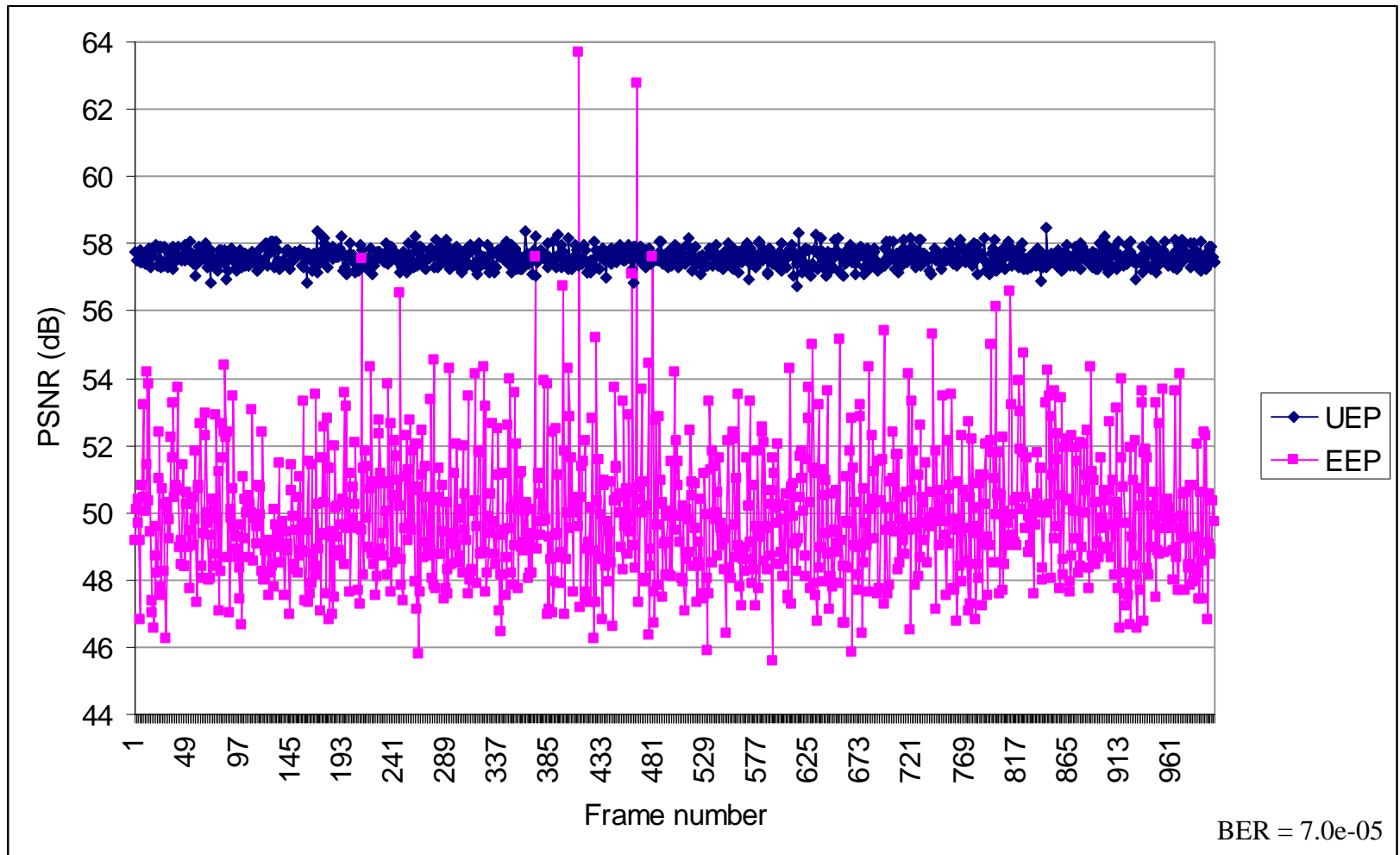
- ✓ BER performance of UEP and EEP



UEP Effect



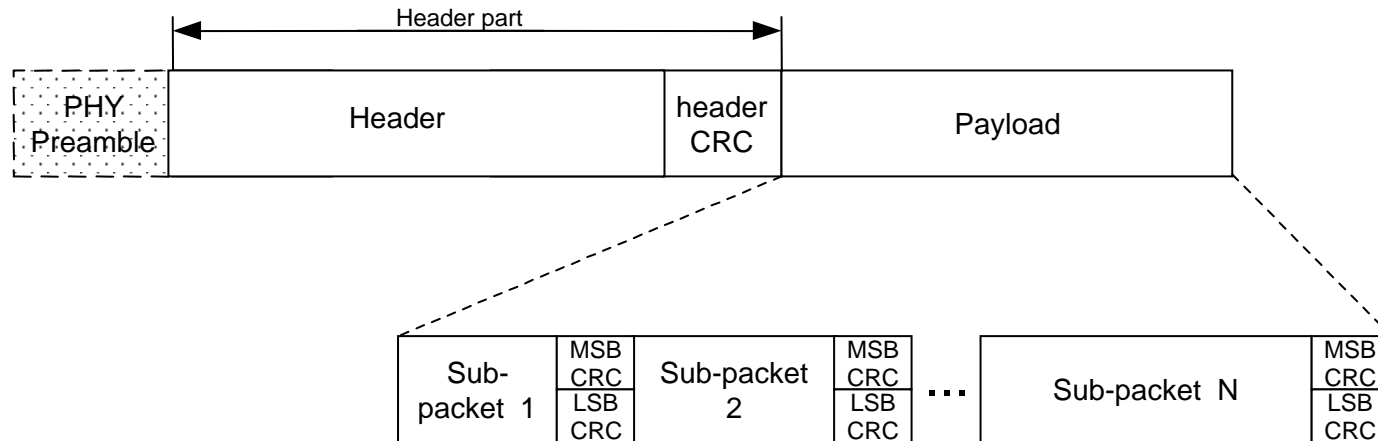
UEP Effect: Stability



Further Discussion on UEP

- UEP schemes are adopted in different proposals
- Different UEP for SC/OFDM
 - OFDM mode: as in our current proposal
 - SC mode: slight modification to COMPA proposal

PHY UEP frame format



- Each sub-packet can carry command, data, audio, video etc.
- Header part uses most robust modulation and coding scheme (MCS)
- Different sub-packets can use different MCSs

ACK Policy

– Selective-ACK for UEP

- Selective ACKs indicating Separate CRCs for MSB's and LSB's
- Used for both single MPDU and Aggregated MPDU

Sub-Packet 1		Sub-Packet 2		...	Sub-Packet N	
MSB indication	LSB indication	MSB indication	LSB indication		MSB indication	LSB indication

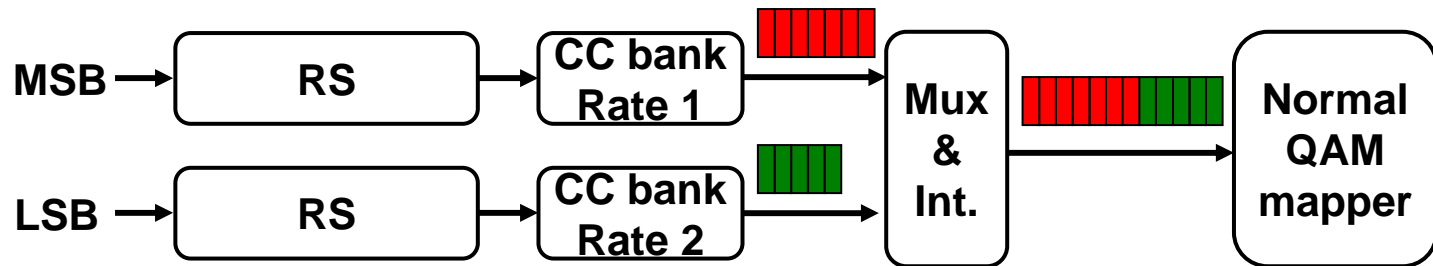
ACK for aggregated packet

Retransmission Policy

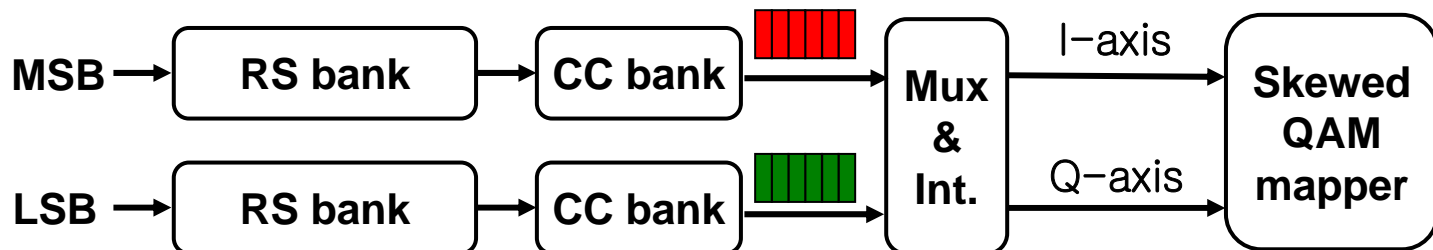
- Transmitter can choose appropriate retransmission mechanism depending on the Acknowledgement and available bandwidth
 - MSB/LSB retransmission
 - MSB only
 - LSB only

PHY architecture for OFDM mode

• UEP - Coding

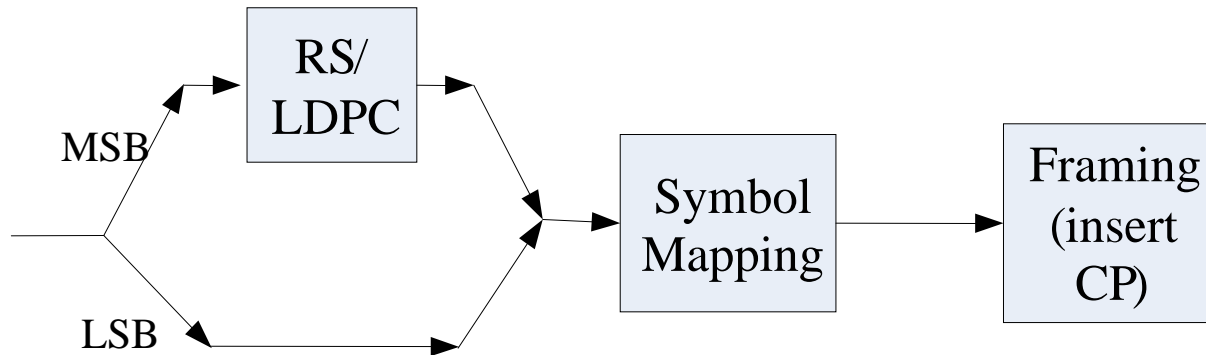


• UEP - Mapping



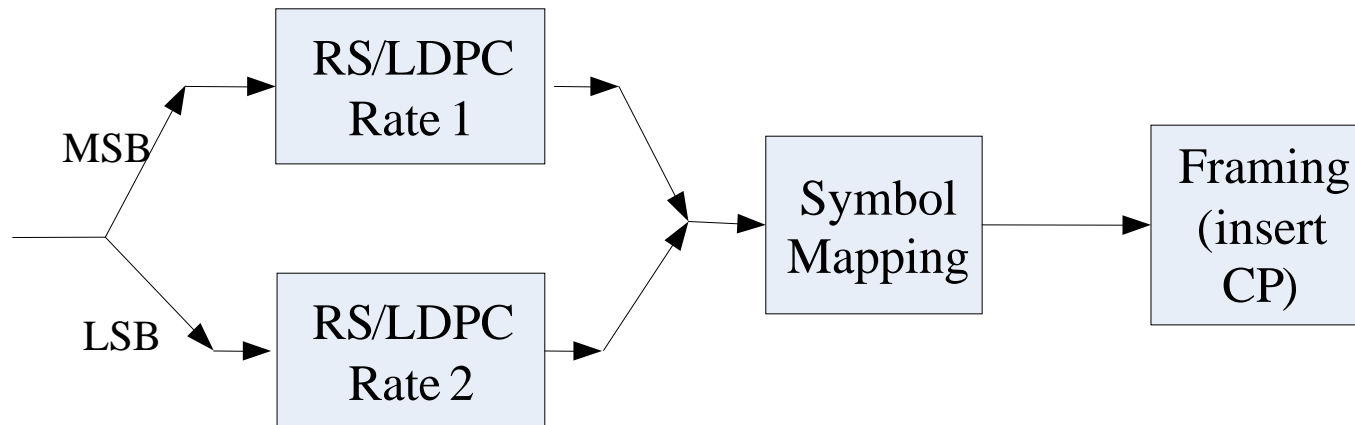
PHY architecture for SC (I)

- The simplest architecture, which has similar UEP capability as COMPA UEP



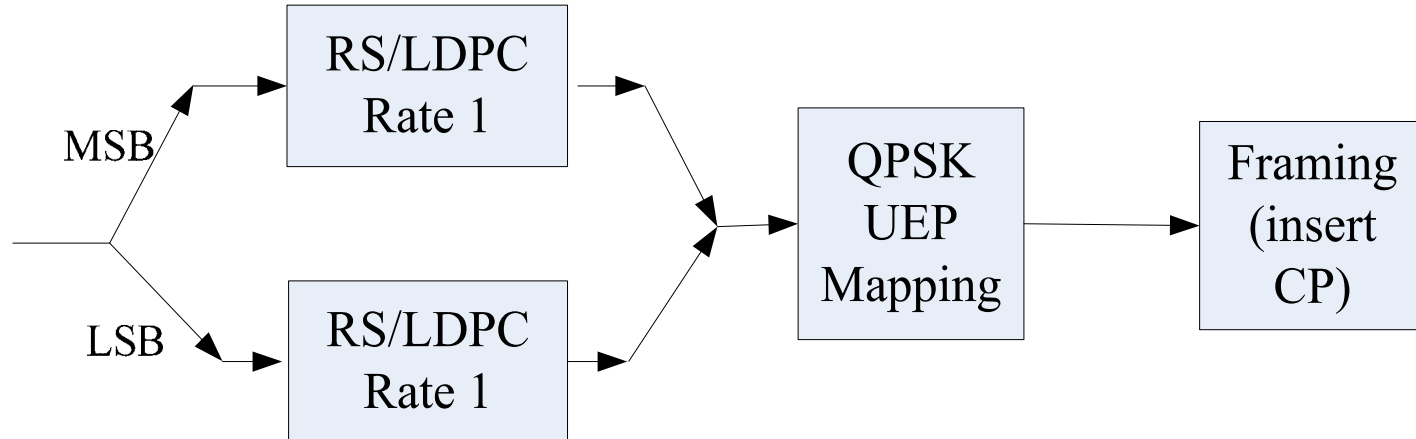
PHY architecture for SC (II)

- The modified PHY architecture providing more flexibility to different level of MSB/LSB protection



PHY architecture for SC (III)

- The PHY architecture providing more flexibility to different level of MSB/LSB using non-square QPSK constellation



Summary

- UEP is a key technology to improve QoS for video applications
- UEP provides stable PSNR compared to EEP
- UEP methods can be applied to both single carrier and OFDM proposals (On-going discussion)
 - Samsung and CoMPA are under discussion for collaboration.

Remark: Samsung supports a common channel plan