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

Submission Title: Performance Evaluation of Channel Coding with Interleaver Based on TG6ma Channel Model for Some Classes of Coexistence

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Re: In response to call for technical contributions

Abstract: This provides a preliminary investigation of the effect of interleaving on channel coding defined in TG6ma under multiple BAN coexistence situations, and some simulation results are discussed.

Purpose: Material for discussion in P802.15.6a TG corresponding to comments in EC Meeting

Performance Evaluation of Channel Coding with Interleaver Based on TG6ma Channel Model for Some Classes of Coexistence

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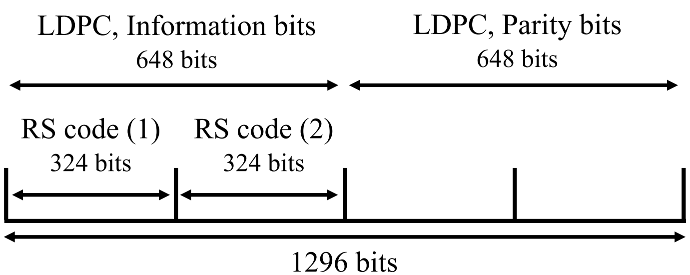
Forward error correcting codes in TG6ma

User priority	Inner code	Outer code	HARQ
0	15.4ab LDPC or BCC (R=1/2)		-
1	15.4ab LDPC or BCC (R=1/2)		-
2	15.4ab LDPC or BCC (R=1/2)		-
3	15.4ab LDPC or BCC (R=1/2)		-
4	15.4ab LDPC or BCC (R=1/2)	(54, 46) shortened RS code	-
5	15.4ab LDPC or BCC (R=1/2)	(54, 38) shortened RS code	-
6	15.4ab LDPC or BCC (R=1/2)	(54, 28) shortened RS code	-
7	15.4ab LDPC or BCC (R=1/2)	(54, 14) shortened RS code	-

- As an outer code, shortened Reed-Solomon (RS) codes with N=54 (original code length N=63) will be selected to correct burst errors due to interference from other WBANs and the coding rates are changed according to each QoS and channel condition
- As an inner code, 15.4ab LDPC (K=324, 648, 972, R=1/2) or BCC will be selected for the coexistence of 15.6ma and 15.4ab
- This updated concept table is considered as the first priority

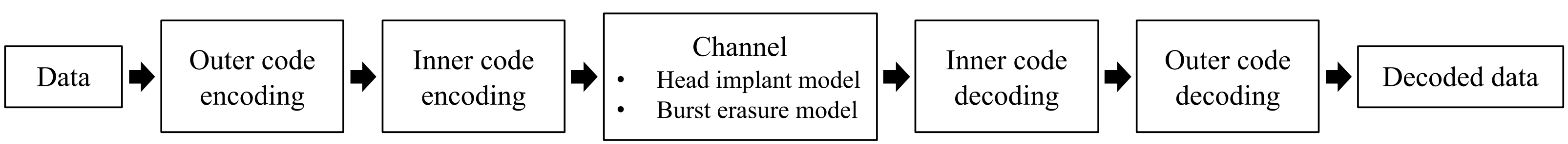
Simulation settings

- Concatenated code
  - Outer code : Two shortened RS codes
  - Inner code : LDPC code
- BPSK modulated



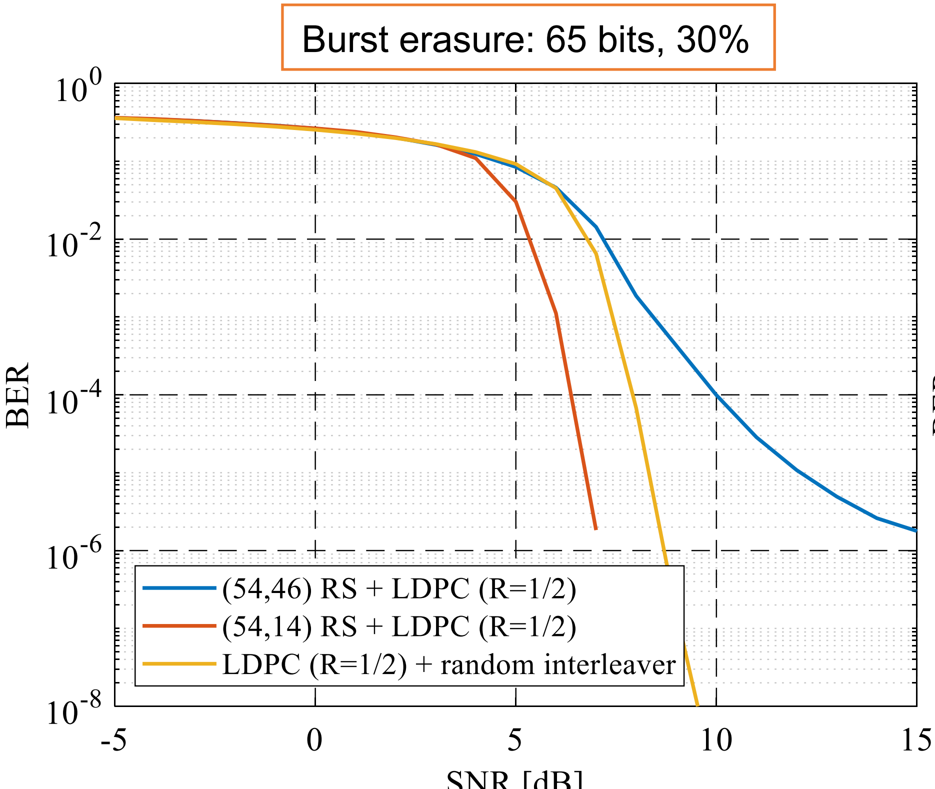
Configuration of concatenated code

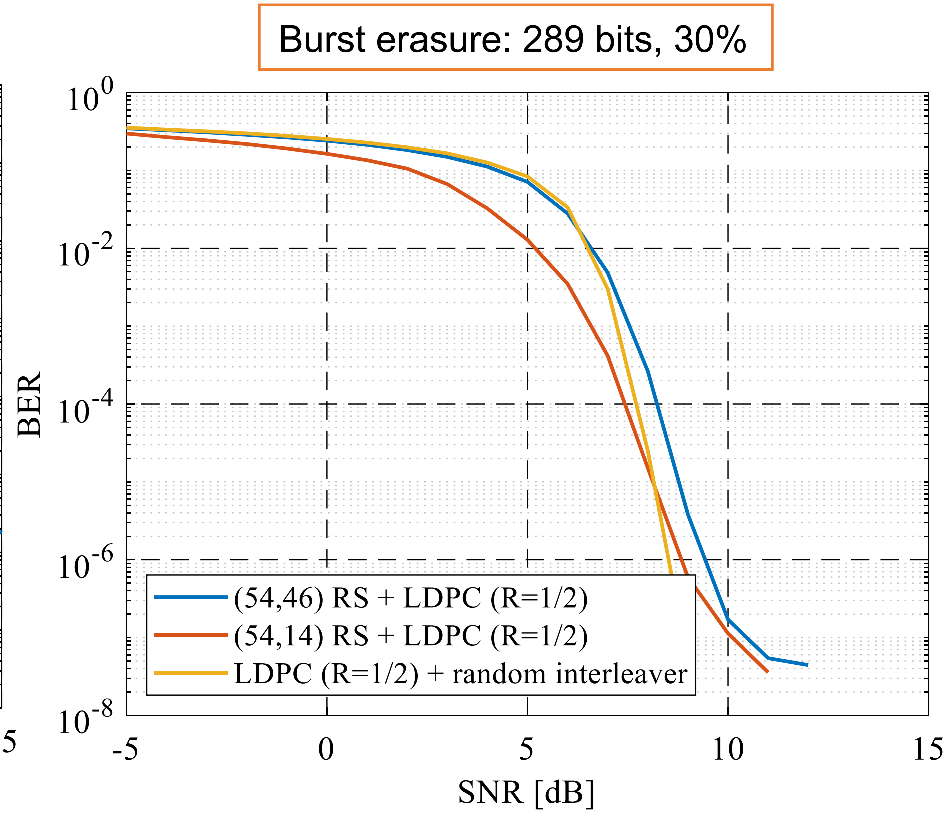
- Shortened RS code
  - 1 symbol = 6 bits
  - Codeword : 63 symbols
  - Shortened symbol : 9 symbols
  - Code length : $(63-9) \times 6 = 324$ bits
  - Coding rate : 46/54, 38/54, 28/54, 14/54
- LDPC code
  - Code length : 1296 bits
  - Coding rate : 1/2
  - Number of iteration : 30
  - Decoding algorithm : Min-sum algorithm



Channel coding

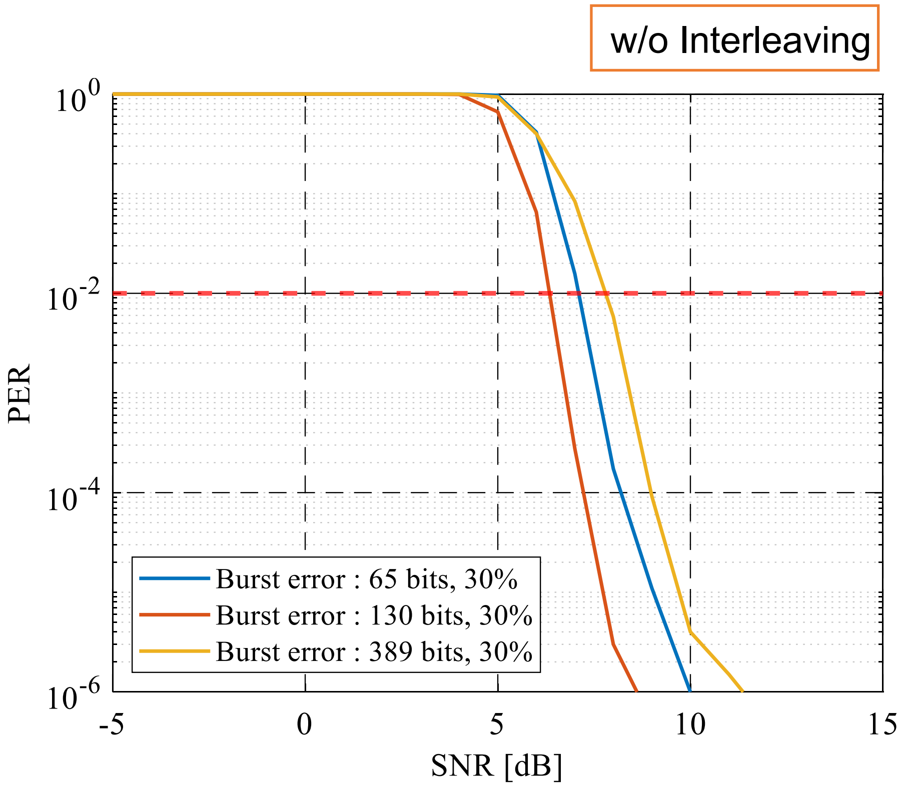
Effect of interleaving on BER performance

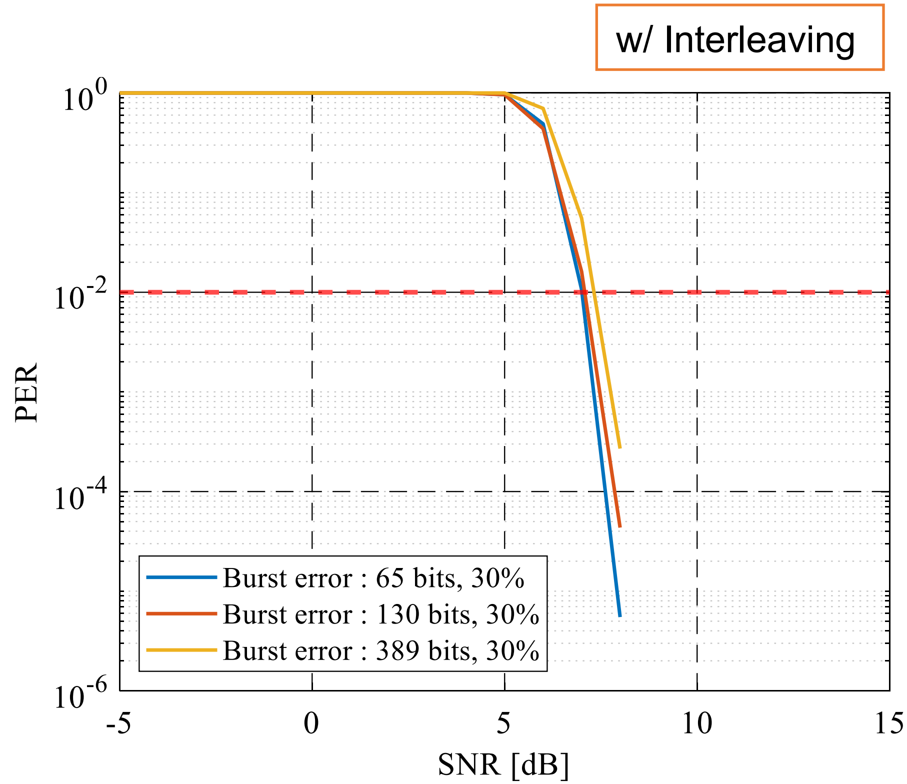




- Modulation: BPSK
- Interleaver type: Random
- Channel: AWGN + burst erasure channel

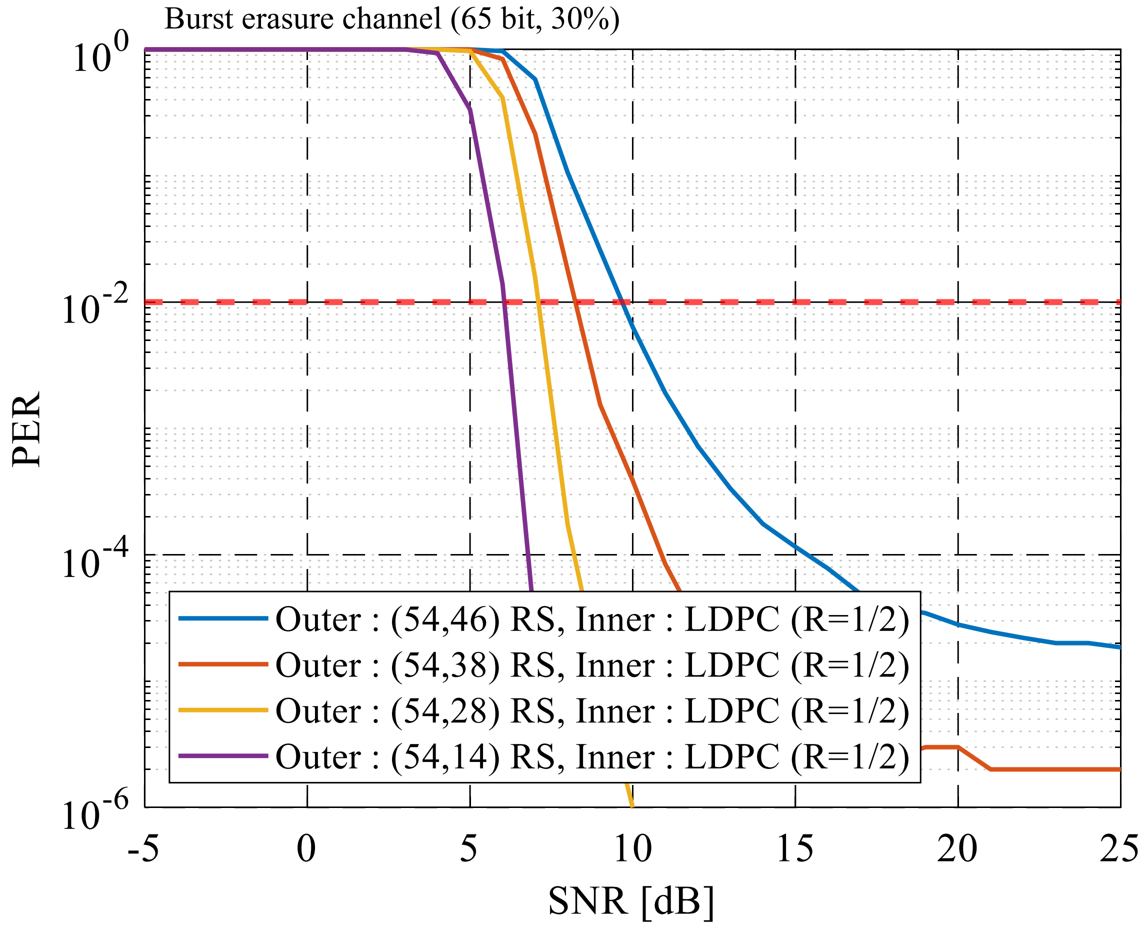
Effect of interleaving on BER performance





- Modulation: BPSK
- RS(54, 28) + LDPC(R=1/2)
- Channel: AWGN + burst erasure channel

Effect of channel coding parameters



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FEC performance evaluation under TG6ma channel model

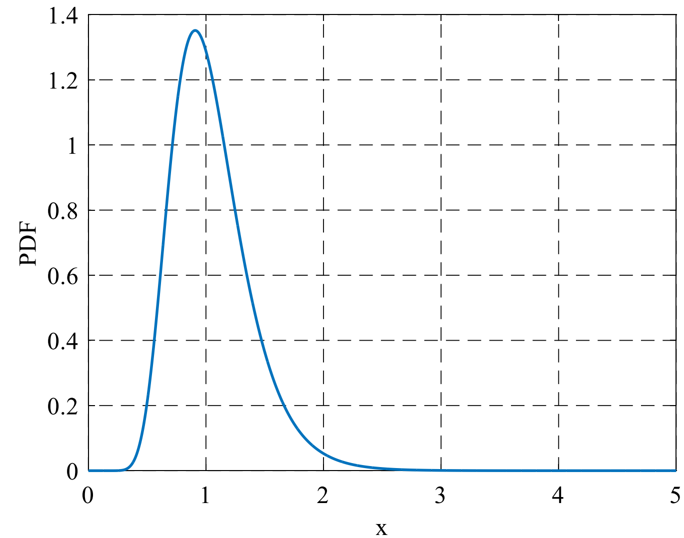
- The PDF of shadowing in path-loss is as follows:

$$g(y) = \frac{1}{\sqrt{2\pi\sigma_s^2}} \exp\left(-\frac{(y-\mu_s)^2}{2\sigma_s^2}\right)$$

- From the above, the voltage amplitude ratio follows a log-normal distribution, and the PDF is as follows:

$$f(x) = \frac{1}{\sqrt{2\pi\left(\frac{\sigma_s}{a}\right)^2}\,x} \exp\left(-\frac{\left(\ln x - \frac{\mu_s}{a}\right)^2}{2\left(\frac{\sigma_s}{a}\right)^2}\right)$$

μ_s: mean of shadowing [dB]
σ_s: standard deviation of shadowing [dB]
$\mu = \frac{\mu_s}{a}$: mean of logarithmic amplitude ratio
$\sigma = \frac{\sigma_s}{a}$: standard deviation of logarithmic amplitude ratio



PDF of log-normal distribution ($\mu = 0, \sigma = 0.31$)

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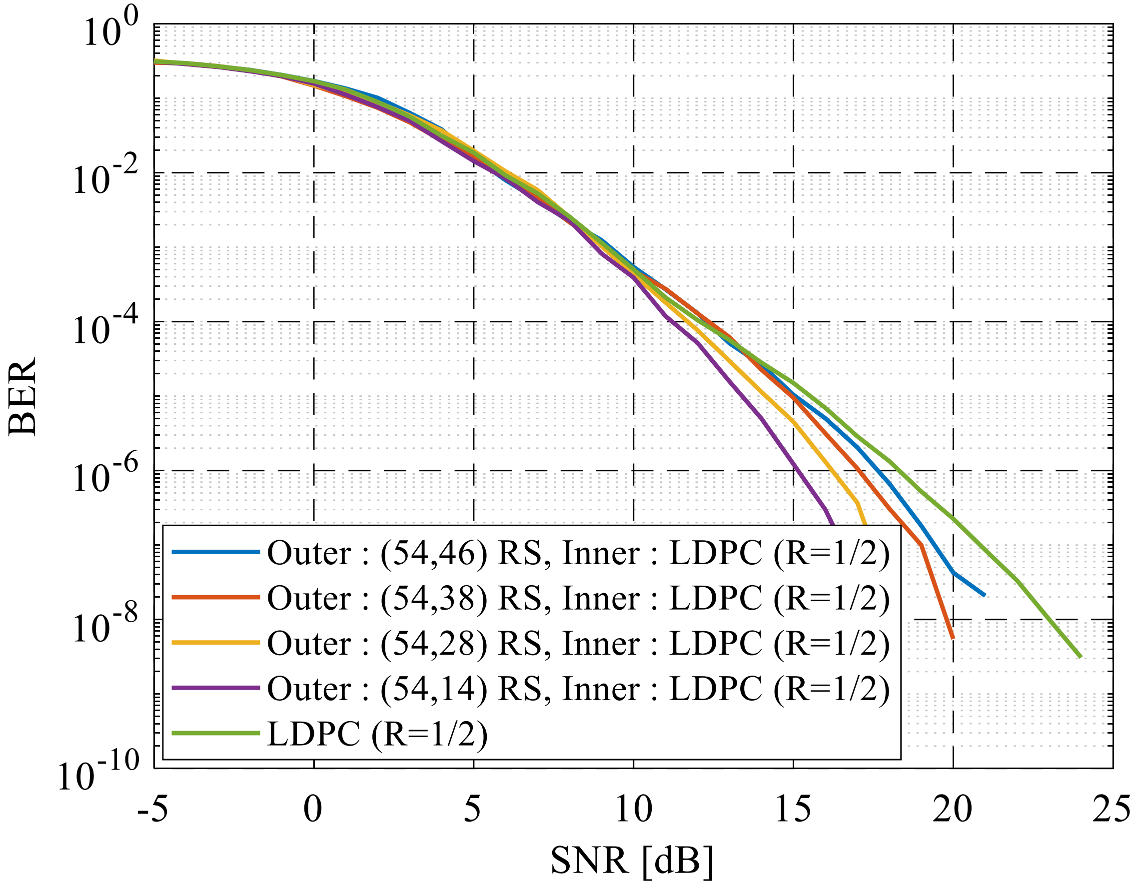
Evaluation results in shadow fading



BPSK modulation

AWGN and Shadowing

- LDPC
- Outer: RS, Inner: LDPC

RS parameter
Code length: 324 bits

LDPC parameter
Code length: 1296 bits

Fading parameter
Variance: 2.69 [dB]

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References

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