



LDPC Parity Code Matrix Update for Improved Alignment



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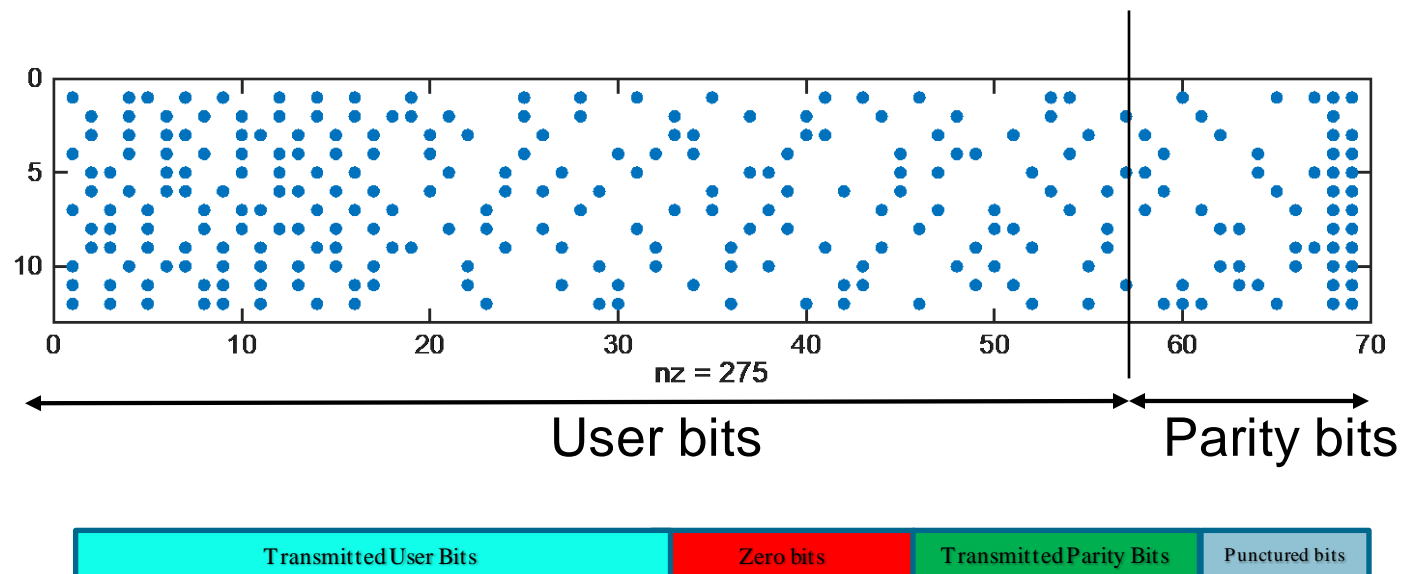
5 March 2018 IEEE 802.3 Plenary, Chicago, IL, USA

Introduction

- kramer_3ca_1_0318.pdf examines two options for adjusting LDPC FEC codeword length to improve alignment and state diagrams for data rate to line rate conversion.
- This presentation reviews the performance impact of the two options for consideration:
 - Option 1: Keep the adopted matrix as Jan18, only change puncture and shortening length.
 - Option 2: Re-optimize H matrix dimension to fit the new codeword size and maintain 256-bit circulant size.
- Note: interleaver is not impacted by either option.

Option 2 Parity Code Matrix

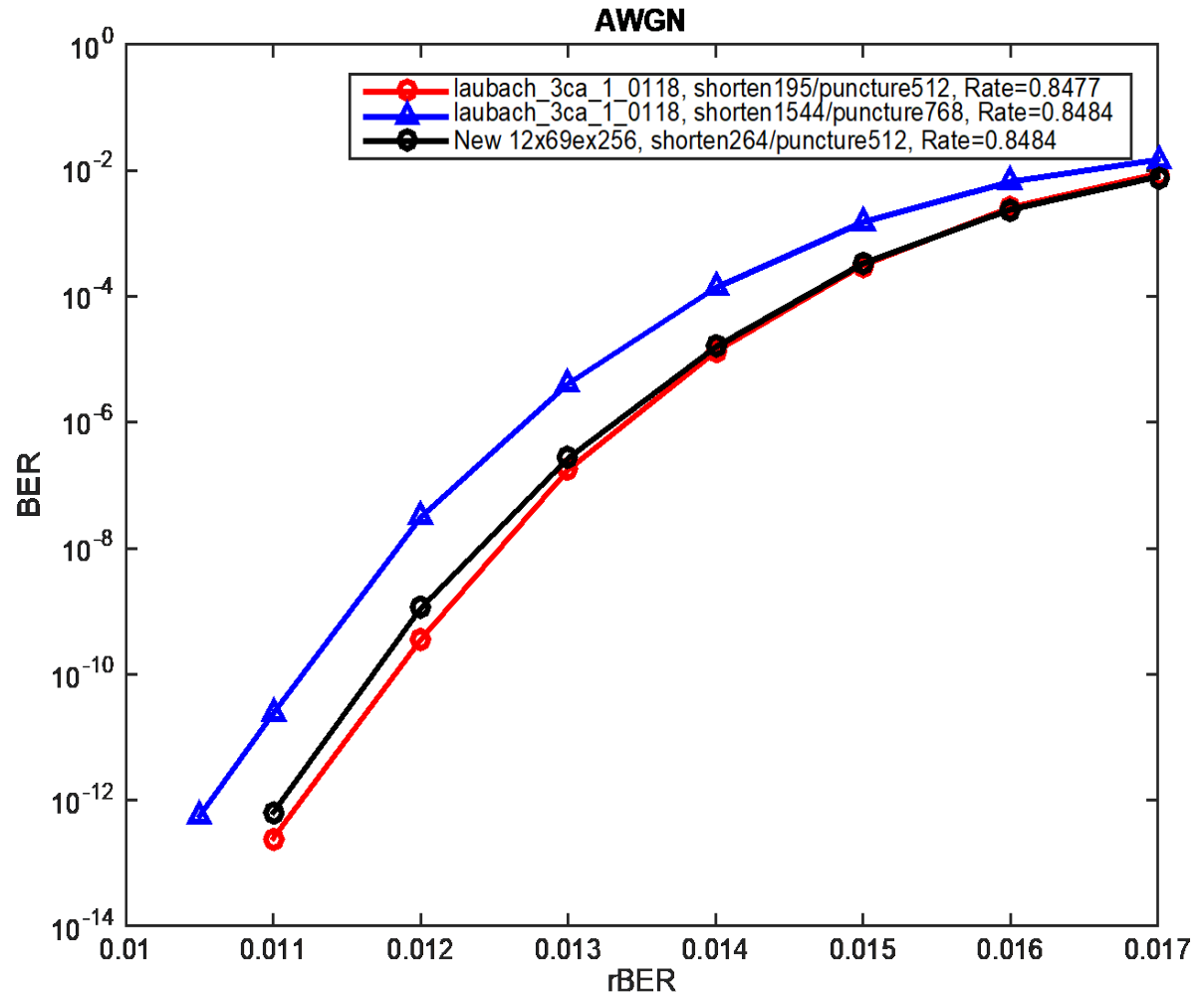
- Reduced matrix dimension (12x69x256).



80 -1 -1 60 169 -1 11 -1 143 -1 -1 222 -1 59 -1 218 -1 -1 178 -1 -1 -1 -1 105 -1 -1 19 -1 -1 126 -1 -1 -1 211 -1 -1 -1 -1 247 -1 255 -1 -1 85 -1 -1 -1 -1 -1 246 94 -1 -1 -1 -1 -1 242 -1 -1 -1 -1 129 -1 19 58 27
-1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 0 -1 0 -1 -1 -1 0 -1 -1 0 -1 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1
-1 91 -1 74 -1 237 202 -1 -1 201 136 -1 178 -1 239 -1 183 -1 -1 217 -1 232 -1 -1 -1 169 -1 -1 -1 -1 -1 129 60 -1 -1 -1 -1 -1 19 76 -1 -1 -1 -1 -1 77 -1 -1 -1 2 -1 -1 -1 101 -1 -1 217 -1 -1 -1 48 -1 -1 -1 -1 -1 172 42
105 -1 -1 87 -1 43 -1 165 -1 180 -1 80 227 -1 221 -1 77 -1 -1 0 -1 -1 -1 -1 16 -1 -1 -1 -1 252 -1 96 -1 0 -1 -1 -1 -1 17 -1 -1 -1 -1 219 -1 -1 198 165 -1 -1 -1 -1 36 -1 -1 -1 -1 171 -1 -1 -1 -1 228 -1 -1 -1 39 234
-1 170 250 -1 -1 195 139 -1 -1 135 -1 92 -1 147 -1 -1 -1 -1 -1 13 -1 -1 98 -1 -1 142 -1 -1 -1 225 -1 -1 -1 -1 -1 23 108 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 135 -1 -1 -1 -1 121 0 -1 -1 -1 -1 0 -1 -1 46 242 228
-1 46 -1 37 -1 49 150 -1 65 -1 -1 177 144 -1 70 -1 95 -1 -1 221 -1 -1 -1 192 -1 128 -1 -1 -1 214 -1 -1 -1 -1 51 -1 -1 -1 100 -1 -1 19 -1 -1 235 -1 -1 -1 -1 -1 4 -1 -1 251 -1 -1 109 -1 -1 -1 140 -1 -1 193 241
137 -1 104 -1 238 -1 -1 228 -1 225 247 -1 -1 191 -1 177 -1 255 -1 -1 -1 -1 192 -1 -1 -1 -1 51 -1 -1 -1 -1 195 -1 0 -1 -1 172 -1 -1 -1 -1 219 -1 -1 236 -1 -1 136 -1 -1 -1 0 -1 -1 -1 159 -1 -1 10 -1 -1 -1 -1 5 -1 25 94
-1 118 15 -1 93 -1 -1 228 -1 78 -1 16 0 -1 48 -1 0 -1 -1 -1 62 -1 0 -1 -1 0 -1 -1 -1 -1 0 -1 -1 -1 -1 112 -1 0 -1 -1 -1 -1 -1 0 -1 -1 -1 0 0 -1 -1 -1 -1 22 -1 -1 -1 -1 0 0 -1 -1 -1 -1 120 192
-1 208 0 -1 0 -1 0 -1 0 -1 0 -1 -1 251 0 -1 -1 44 123 -1 -1 -1 -1 0 -1 -1 0 -1 -1 -1 -1 0 -1 -1 -1 0 -1 -1 153 -1 -1 -1 -1 0 -1 -1 0 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 0 0 16 0
0 -1 -1 123 -1 -1 41 191 -1 211 -1 217 -1 243 -1 97 -1 252 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 0 -1 -1 41 -1 -1 -1 29 -1 0 -1 -1 -1 -1 0 -1 -1 -1 193 -1 145 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 140 46 -1 -1 58 -1 202 215
209 -1 252 -1 39 -1 -1 159 69 -1 37 -1 134 -1 -1 201 49 -1 -1 -1 -1 104 -1 -1 -1 129 -1 -1 157 -1 -1 -1 222 -1 -1 -1 -1 -1 139 39 -1 -1 -1 -1 203 -1 94 -1 -1 -1 -1 194 -1 -1 3 -1 -1 43 153 -1 -1 -1 207 109
53 -1 93 -1 216 -1 -1 57 9 -1 130 -1 -1 130 -1 238 -1 -1 -1 -1 -1 -1 144 -1 -1 -1 -1 -1 162 0 -1 -1 -1 -1 -1 175 -1 -1 -1 145 -1 0 -1 -1 -1 36 -1 -1 -1 -1 -1 91 -1 -1 22 -1 -1 -1 0 0 212 -1 -1 -1 0 -1 -1 69 88

AWGN Performance

- Option 1: puncturing and shortening
 - Puncturing: 512 bits -> 768 bits
 - Shortening: 195 bits -> 1544 bits
 - Reduces gain by 0.08 dB
 - Rate 0.8477 -> 0.8484 (minor change)
- Option 2: new matrix [12x69ex256]
 - Puncturing: 512 bits
 - Shortening: 264 bits
 - Reduces gain by 0.022 dB
 - Rate 0.8477 -> 0.8484 (minor change)



Gilbert Burst Model Performance

NOTE: performance simulations are still in progress at the time of submission. This note will be removed when the presentation is updated with the results.

Latency comparison

- New code is slightly more efficient due to fewer non-zero circulants compared to adopted matrix:

LDPC	laubach_3ca_1_0118	New Code
	µsec @ 15 iterations	µsec @ 15 iterations
Encoder	1.842	1.698
Buffer	0.77	0.77
Decoder	2.145	2.0625 (fewer non-zero circulants)
Buffer	0.77	0.77
Total one-way	5.527	5.3005

LDPC Performance Review

	Length	Rate	Non-Zero Blocks	NECG ¹ (dB ²) (optical gain)					Reference
				AWGN	Gilbert Burst				
					Precoder Off	Precoder On	Precoder Off	Precoder On	
LDPC	(18493,15677) [13x75x256]	0.848	290	2.6 (1.82-2.34)	1.76 (1.23 - 1.58)	2.03 (1.41 – 1.82)			laubach_3ca_1a_1117
			286	2.63 (1.84 - 2.37)	1.87 (1.31 – 1.68)	2.12 (1.48 – 1.91)	1.85 (1.3 – 1.67)	2.11 (1.48 – 1.9)	laubach_3ca_1_0118
	Option 1		286	2.55 (1.79 - 2.30)	T.B.D.	T.B.D.	T.B.D.	T.B.D.	laubach_3ca_1_0318
	Option 2		275	2.608 (1.82 - 2.34)	T.B.D.	T.B.D.	T.B.D.	T.B.D.	

¹ Electrical gain over RS(255,223) of 7.1 dB. Optical gain is 0.7 to 0.9 * NECG.

² Capped at 15 iterations.

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Summary

- Option 2 is preferred:
 - Satisfies conclusions stated in kramer_3ca_1_0318.
 - Small loss in gain relative to adopted LPDC matrix from laubach_3ca_1_0118.
 - Slightly lower latency.
- Updated draft text changes are provided in han_3ca_2_0318.pdf.
- Updated Parity code H_c matrix is provided in han_3ca_1_0318.txt for machine readable format.

Proposed motion

- Adopt the indicated draft text changes in “han_3ca_2_0318.docx” and update Draft 0.7 142.2.2.3.1 Low Density Parity Check Coding and 142.2.2.3.2 LDPC Encoder as needed. Provide machine readable format in “han_3ca_1_0318.txt” to the Editor.

Thank you



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