

UNIVERSAL DECODERS FOR SHORT CODES

- Short codes are needed for URLLC applications
- GRAND is a Universal Decoder for short-length and high-rate codes



PERFORMANCE EVALUATION FOR BCH (127,106)



FOR DECODING BCH (127,106):

 $0.2 \sim 0.3 \text{ dB gain compared to}$ **ORBGRAND** (target FER 10⁻⁷)

Partitioned Guessing Random Additive Noise Decoding MARWAN JALALEDDINE*, SYED MOHSIN ABBAS, THIBAUD TONNELLIER, FURKAN ERCAN, WARREN J. GROSS



PROPOSED PGRAND 4,2,2,1 4,2,0,1,0,0,0 3 1.2.2.0.0.0.0 2,3,2,0,0,0,03,2,0,1,0,0,0 2,0,2,0,0,0 4,3,0,0,0,0,0 4,1,2,0,0,0,0 3,2,1,0,0,0,0 *Mean 5,2,1,0,0,0,0 4,0,1,0,0,0,0 0,1,1,0,0,0,0 3,1,1,0,0,0,0 2,3,0,0,0,0,0 4,2,1,1,0.0.05,1,0,0,0.0.0 2,2,2,1,0,0,0 0,0,1,0,0,0 3,2,2,1,0,0,0 ^{2,2,0,1,0,0,0} 4,1,0,0,0,0,0 3,0,0,0,0 4,3,1,0,0,0,0 **3,2,0,0,0,0** 2,2,2,0,0,0,0 3,0,2,1,0,0,0 3.3,1,0,0,0,0 3,1,1,1,0,0,0 **3,1,0,0,0,0,0** 4,0,0,1,0,0,0 5,0,1,0,0,0,0 5,0,0,0,0,0 0,1 4,0,1,1,0,0,0 3,1,0,1,0,0,0 4,0,2,0,0,0,0 3,3,0,0,0,0,0 3,2,3,1,0,0,0 4,1,2,1,0,0,0 3,3,2,1

50% reduction of average computation complexity compared to ORBGRAND

GRAND VARIANTS

GRAND variants differ by the order of test error patterns (TEPs) applied:

• **ORBGRAND**[1]: Applies TEPs in Logistic Weight (LW) order

[2]: Applies TEPs in Maximum Likelihood (ML) order • SGRAND

TEST ERROR PATTERNS GENERATION FOR PGRAND

REFERENCES

[1] Duffy et al. "Ordered reliability bits guessing random additive noise decoding," IEEE ICASSP, 2021.

[2] Solomon et al. "Soft maximum likelihood decoding using GRAND," IEEE ICC, 2020. [3] Michael Helmling et al. Database of Channel Codes and ML Simulation Results. www.uni-kl.de/channel-codes, 2019.



5,1,2,0,0,0,0 0,0,0 0,2,0,0,0,0 0,2,0,0,0,0
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2,2,0,0,0,0,0 3,0,1,0,0,0,0 3,2,2,0,0,0,0 1,2,1,1,0,0,0
2,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
0,0,0,0,0 1,1,1,0,0,0 1,2,0,0,0,0 2,0,1,1,0,0,0 2,3,1,1,0,0,0 2,3,1,1,0,0,0
4,2,0,0,0,0,0 4,2,1,0,0,0,0 1,0,0,0 2,3,1,0,0,0,0
$3,0,2,0,0,0,0 \qquad 1,2,1,0,0,0,0 \qquad \begin{array}{c} 3,1,2,1,0,0,0 \\ 0,0,0,1,0,0,0 \end{array} \qquad 1,2,0,1,0,0,0 \\ 0,0,0,1,0,0,0 \end{array}$
1,0,0,0 1,1,2,0,0,0,0 2,1,3,0,0,0,0 3,1,3,0,0,0,0