Analysis of FEC proposal for Backplane Ethernet

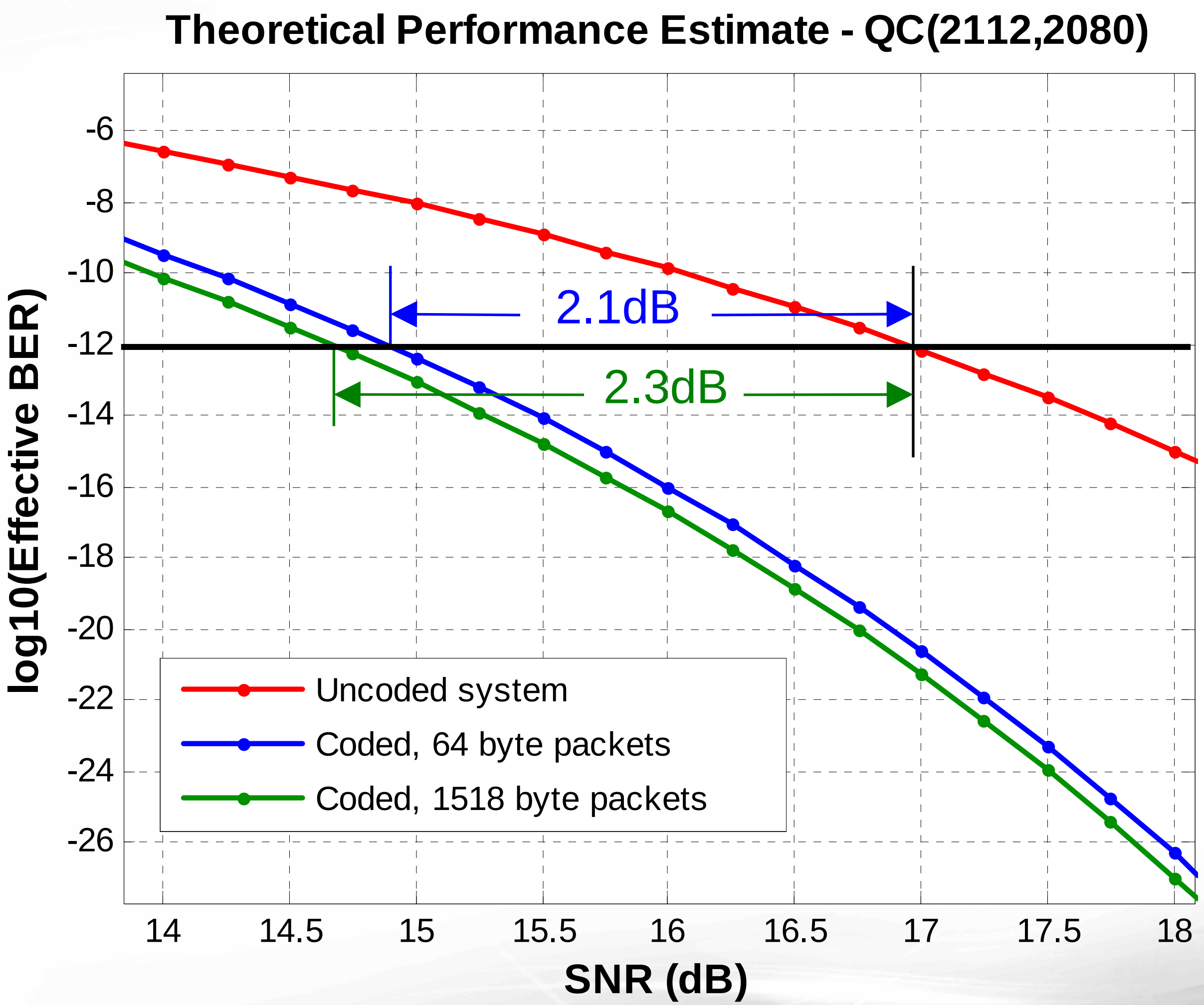
Magesh Valliappan

Theoretical Performance Estimate

- Assumptions:
  – Assume memory-less Binary Symmetric Channel (BSC), but with finite error propagation (to model DFE effects)
  – Probability of first error in a burst based on Gaussian noise model
  – DFE does not propagate errors beyond decoder's capability
  – Uncorrected errors are detected and entire code block is rejected
- Method:
  – Estimate Ethernet Frame Error Rate for each SNR using probabilities
  – Translate Frame Error Rate to "Effective BER" of ideal memory-less BSC with Gaussian noise
- Results
- Coding Gain Estimate (from Analysis):
  – 64 byte packets: 2.1 dB
  – 1518 byte packets: 2.3 dB

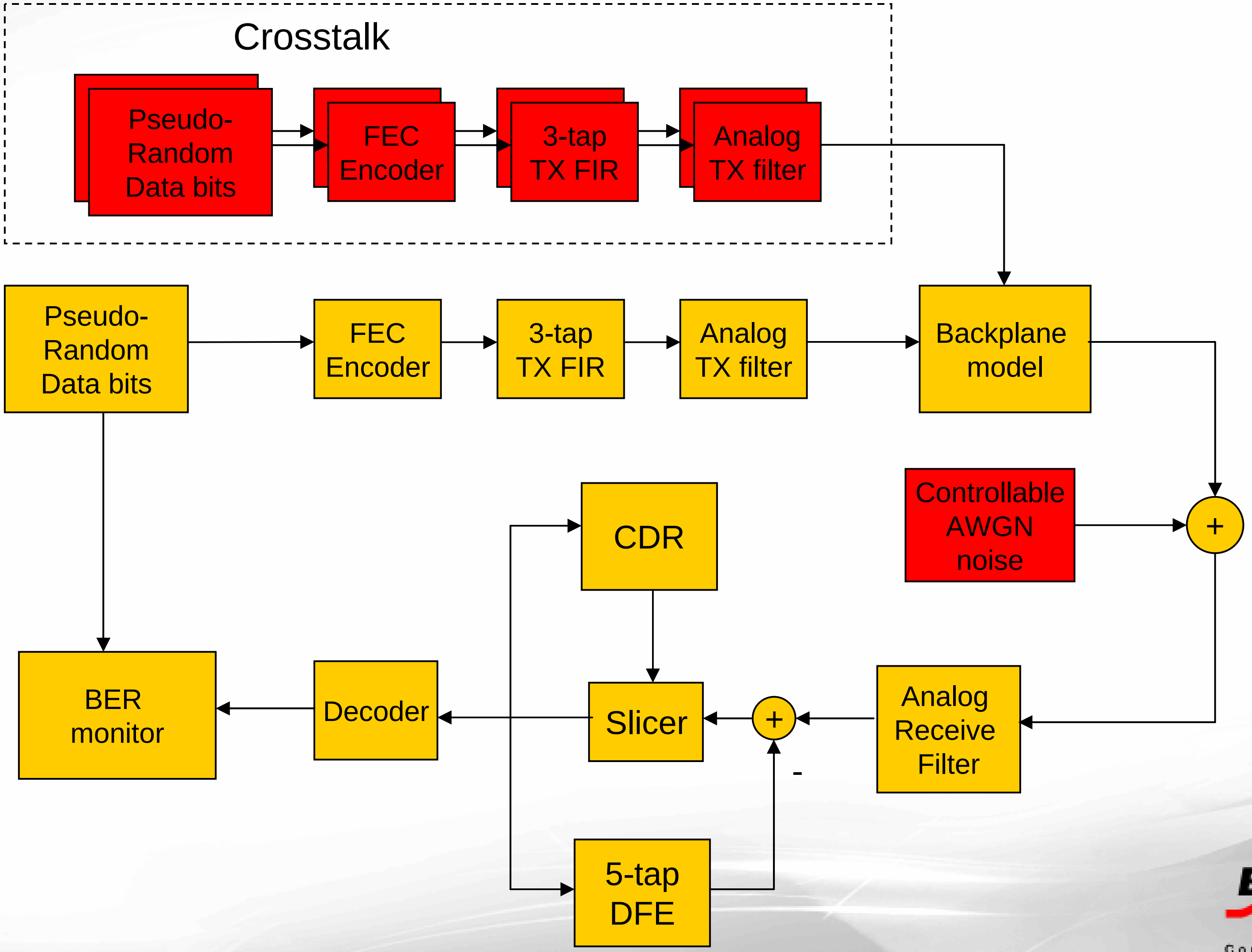
BROADCOM. Connecting everything®

Analysis Results



BROADCOM.
Connecting everything®

Time Domain Simulation Setup

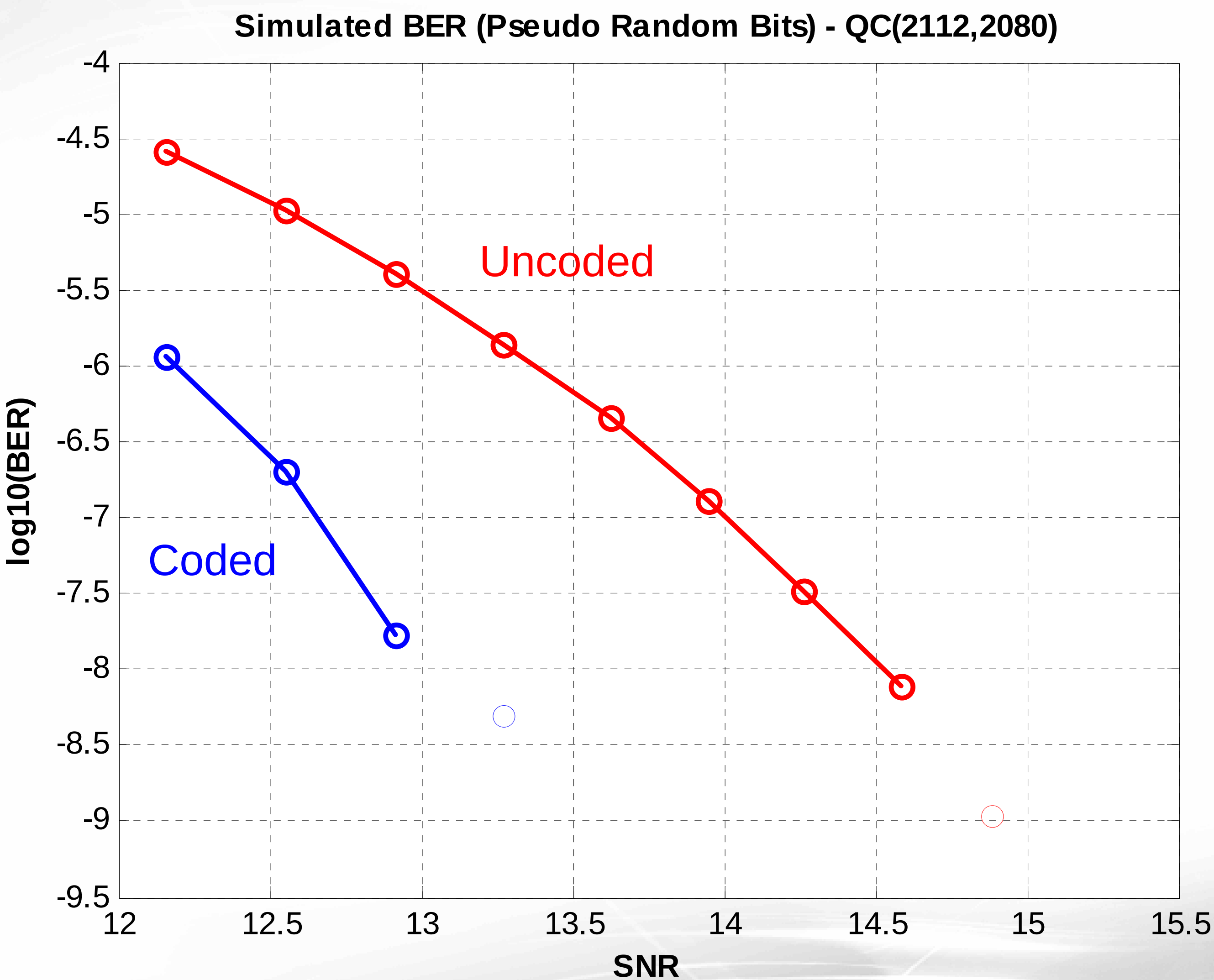


Time Domain Simulation Setup

- Tyco Backplane model from 802.3ap website
- TX
  - 0.01 UI RJ
  - 3-tap FIR
  - Simple RC model for transmitter
- Package model included
- Crosstalk – 2 aggressors, with similar TX configuration
- RX
  - Adaptive CDR circuit
  - 5-tap DFE
  - Ideal slicer
- AWGN noise source controlled to change BER
- Simulated over 1800 million bits
- Pseudo random bits, PCS not modeled

BROADCOM.
Connecting everything®

Simulation Results



BROADCOM.
Connecting everything®

Simulation Results

- Consistent with 2 - 2.5 dB coding gain at 1e-12
  - 1.20dB at 1e-6
  - 1.35dB at 1e-7
  - 1.55dB at 1e-8
  - Projected to 1e-12, that gives 2.35dB (0.2dB per decade in BER)
- At 13.25dB, the error propagation statistics are

Burst length	Percent	Burst length	Percent
1	74.6	7	0
2	16.4	8	0
3	7.6	9	0
4	1.3	10	0
5	0.1	11	0
6	0	>11	0.1

BROADCOM.
Connecting everything®

Conclusions

- Independently analyzed and simulated QC(2112,2080) code
  - Code provides 2+ dB of additional margin
- Implementation cost is small for 2dB margin
- Margin can be used to accommodate additional noise, jitter, crosstalk or reflections
- Backplane Ethernet should include FEC at least as an option

BROADCOM.
Connecting everything®