FEC Code Evaluation Methodology for EPoC

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Evaluation Criteria

- Complexity measures
  - Codeword size
  - Sub-matrix size (lifting size for parallelism)
  - Number of edges per transmitted bit (in Tanner graph)
  - Number of parity check equations per transmitted bit
- Performance measures in channel impairments
  - AWGN
  - AWGN + downstream burst error events
  - AWGN + upstream burst error events

Downstream LDPC Code Parameters

- Codeword size of 16200 bits
- Code Rate of 8/9

- This gives 14400 information bits (payload)

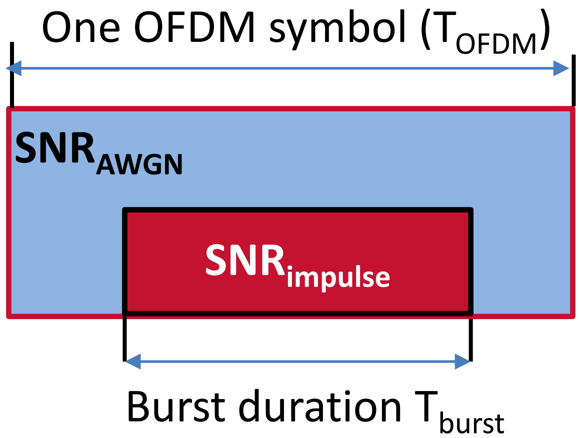
Simulation Methodology

- Decoding procedure
  - Based on standard floating-point iterative sum-product algorithm
  - Maximum of 20 and 30 flooding iterations (to avoid biasing toward slow-converging codes using unlimited iterations)

Evaluation Parameters

- Modulation order
  - 4096 QAM downstream
  - 1024 QAM upstream
- Two OFDM symbol durations
  - 20 µs and 40 µs
- Cyclic prefix
  - 2.5 µs
- WER target of 10^{-6}
- BER target of 10^{-8}
- AWGN SNR threshold with and without burst error events
- Channel assumptions for burst error events
  - Downstream burst noise: 16 µs at 20 dB SNR or 16 µs at 5 dB SNR (two consecutive OFDM symbols)
  - Upstream burst noise: 1 µs at 0 dB SNR (1 OFDM symbol) or 10 µs at 10 dB SNR (two consecutive OFDM symbols)

Impulse Noise Model SNR Calculation



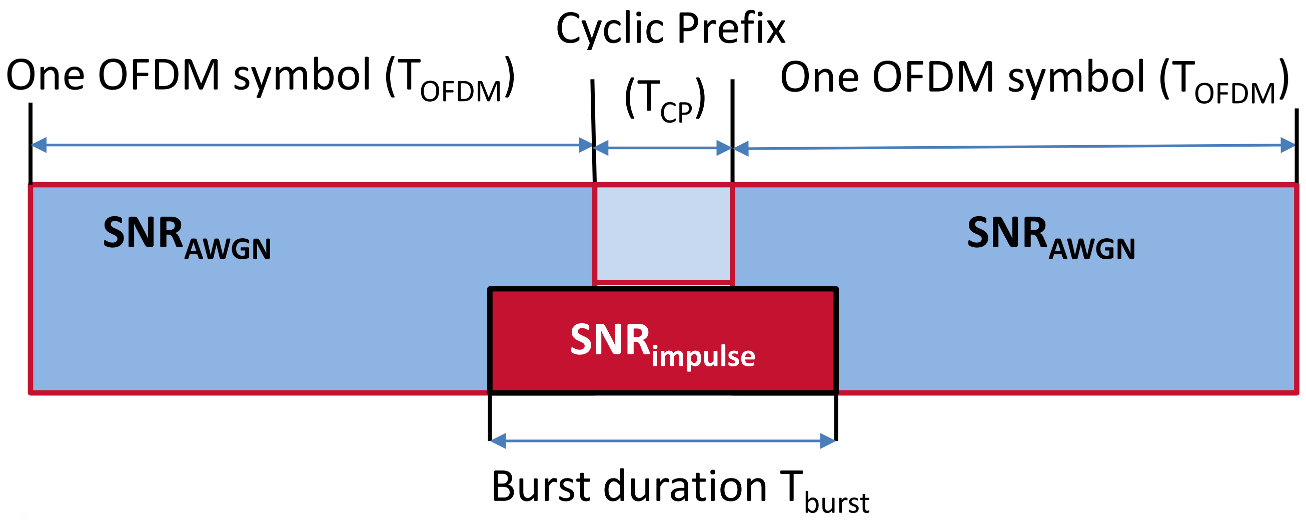
- Case I: the burst hits one OFDM symbol
  - SNR experienced by all sub-carriers in the OFDM symbol due to burst noise only is:

$$SNR_{burst} = SNR_{impulse} - 10 \log (T_{burst} / T_{OFDM})$$

T_{OFDM}:	OFDM symbol duration without cyclic prefix
T_{CP} :	duration of cyclic prefix
T_{burst}:	burst duration
$SNR_{impulse}$:	impulse SNR

- SNR experienced by all sub-carriers in the two OFDM symbols due to background noise only is: $SNR_{background} = SNR_{AWGN} - 10 \log (1 - [T_{burst} / T_{OFDM}])$

Impulse Noise Model SNR Calculation



- Case II: the burst hits two consecutive OFDM symbols equally
  - SNR experienced by all sub-carriers in the two OFDM symbols due to burst noise only is: $SNR_{burst} = SNR_{impulse} – 10 \log (0.5 * (T_{burst} – T_{CP}) / T_{OFDM})$

T_{OFDM}:	OFDM symbol duration without cyclic prefix
T_{CP} :	duration of cyclic prefix
T_{burst}:	burst duration
$SNR_{impulse}$:	impulse SNR

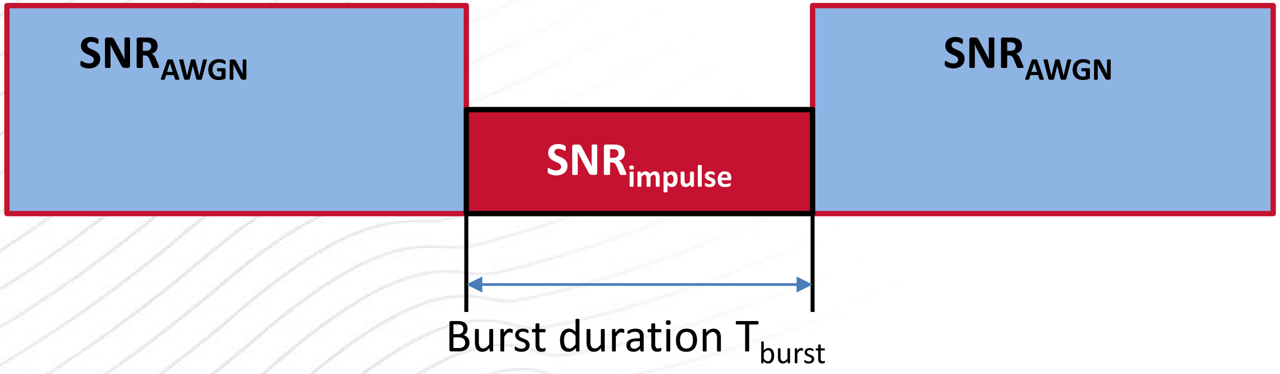
- SNR experienced by all sub-carriers in the two OFDM symbols due to background noise only is: $SNR_{background} = SNR_{AWGN} – 10 \log (1 – [0.5 * (T_{burst} – T_{CP}) / T_{OFDM}])$

Impulse Noise Model SNR Calculation

- SNR on the burst noise impacted subcarrier in the presence of background AWGN is:
  - $SNR_{sub\text{-}carrier} = -10 \text{ Log } (10^{[-SNR_{burst} / 10]} + 10^{[-SNR_{background} / 10]})$

$SNR_{sub\text{-}carrier}$: SNR experienced by all sub-carriers in the OFDM symbol
$SNR_{background}$: Background (thermal) Additive White Gaussian noise contribution
SNR_{burst}: impulse SNR contribution

- SNR assumptions for downstream simulation:
  - Burst length is 16 µs spanning two OFDM symbols equally with a 2.5 µs cyclic prefix
  - SNR during the burst event is either 20 dB (moderate) or 5 dB (strong) impulse noise
  - SNR outside the burst event is the background AWGN

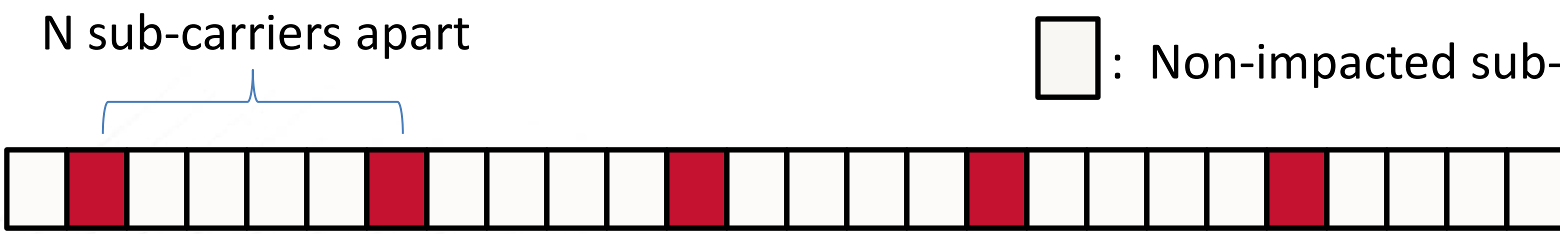


Time Interleaving Model

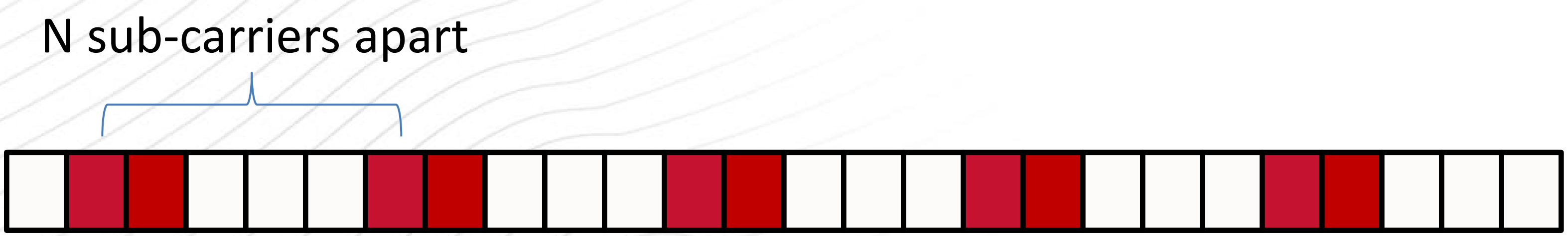
- Simulations show the minimum value for interleave depth N in order for BER to reach 10^{-8}
- Simulated cases
  - Case 1: one OFDM symbol is impacted:

: Burst impacted sub-carriers

: Non-impacted sub-carriers



  - Case 2: two consecutive OFDM symbols are impacted equally:

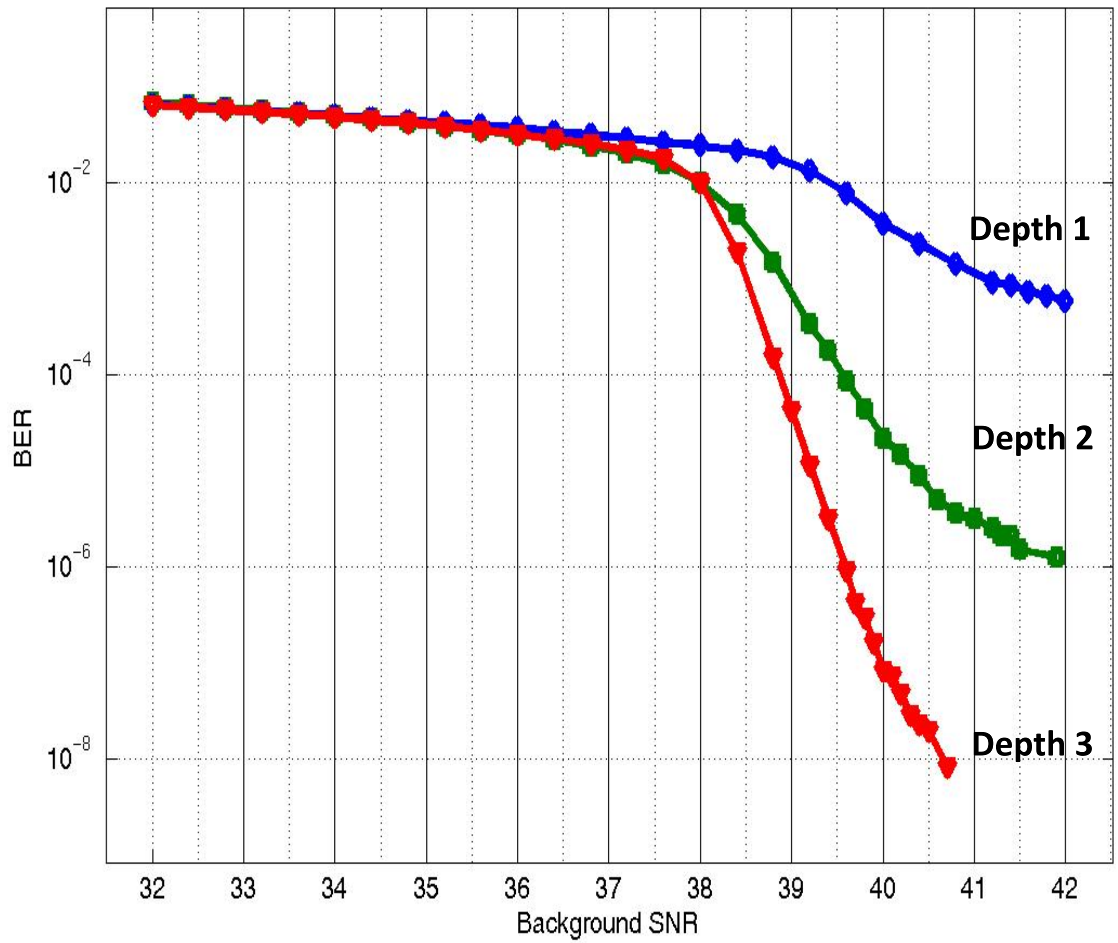


Burst Noise Performance Metrics

- For each burst noise condition, find the minimum interleaver depth that is needed to achieve
  - a BER of 10^{-8}
  - a WER of 10^{-6}
- Plot the AWGN SNR vs. BER for the minimum interleaver depth to achieve a BER of 10^{-8}
- Plot the AWGN SNR v6. BER for the minimum interleaver depth to achieve a WER of 10^{-6}
- This will yield the minimum interleaver depth and background AWGN SNR (Depth @ SNR (dB)) to achieve target objective error rates

Depth @ SNR to achieve a BER of 10^{-8}

Depth 1 < Depth 2 < Depth 3



Thank You