Forward Error Correction (FEC) for EPoC

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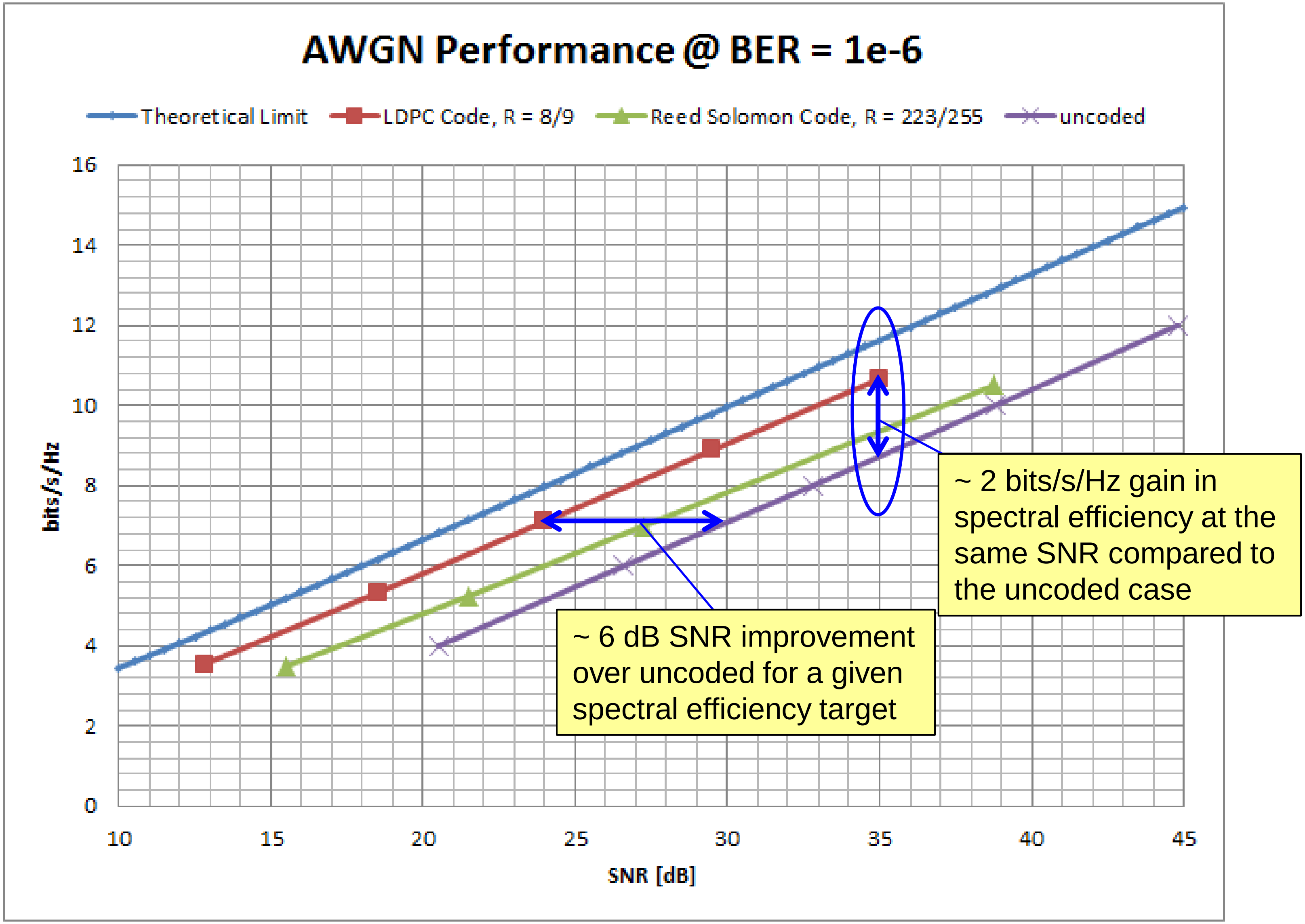
EPoC Objectives – A Motivation for FEC

- As part of the agreed EPoC objectives for 802.3bn, there is:
  - *"Provide a physical layer specification that is capable of a baseline data rate of 1 Gb/s at the MAC/PLS service interface when transmitting in 120 MHz, or less, of assigned spectrum under defined baseline plant conditions"*
  - *"PHY to have:*
    - *a downstream frame error rate better than 10^-6 at the MAC/PLS service interface*
    - *an upstream frame error rate better than 5x10^-5 at the MAC/PLS service interface"*
- In order to be able to meet very low error rate targets, while providing high spectral efficiency, Forward Error Correction (FEC) techniques have been successfully used in deployed digital communication systems
- This presentation briefly reviews the benefits of FEC coding, showing how modern Low Density Parity Check (LDPC) codes can achieve high data rates very close to the Shannon limit, and proposes to adopt LDPC codes as baseline FEC in EPoC for both the downstream and upstream

Forward Error Correction (FEC) Benefits

- At the transmitter, FEC adds redundancy to the information in a controlled way in order to detect and correct transmission errors at the receiver
  - This approach allows achieving very high reliability in data transmission
- FEC is well suited for EPoC to achieve the target error rates at the MAC/PLS interface at the given SNR
- State-of-the-art coding schemes, like LDPC codes, have been successfully used in commercial systems (e. g. 802.11n/ac, DVB-C2)
  - LDPC codes approach the theoretical upper limit in spectral efficiency in bits/s/Hz at a given SNR with low complexity and short delays
- Instead uncoded transmission would require significantly higher SNR to achieve the same spectral efficiencies (~ 6 dB more, see next slide), thus, increasing the transmit power and power consumption significantly

FEC Comparison



Discussion

- The previous slide compares LDPC codes, Reed Solomon codes and uncoded transmission in terms of SNR [dB] and spectral efficiency [bits/s/Hz] in AWGN conditions
  - The BER (after decoding in case of FEC) is fixed to 1e-6
  - The theoretical upper limit (Shannon curve) is given as well
- Results
  - For a given spectral efficiency, the LDPC code outperforms the Reed Solomon code by roughly 3 dB
  - For a given spectral efficiency, the LDPC code outperforms uncoded transmission by roughly 6 dB (~ 3dB better than the Reed Solomon code)
  - For a given SNR, the LDPC code improves the spectral efficiency compared to uncoded transmission by roughly 2 bits/s/Hz
- Conclusion
  - State-of-the-art FEC schemes allow improving spectral efficiency and/or power efficiency in EPoC considerably, fulfilling EPoC BER requirements

Baseline Proposal #1

- The PHY shall implement and use a mandatory Forward Error Correction (FEC) scheme for both downstream and upstream transmissions

- Moved by:
- Seconded by:
- Technical motion (>=75%)
- Yes / No / Abstain

Baseline Proposal #2

- The FEC shall use Low Density Parity Check (LDPC) codes for both downstream and upstream transmissions
  - The details of the LDPC code selection are for further study
  - The details of LDPC code block lengths are for further study

- Moved by:
- Seconded by:
- Technical motion (>=75%)
- Yes / No / Abstain

Thank you