dtv group

UNIVERSITY OF TURKU

Error control coding studies: Enhancement to DVB-H MPE-FEC and future terrestrial broadcasting standard DVB-T2

Tero Jokela

Outline

DVB-H

- Brief introduction
- Soft RS decoding for MPE-FEC

DVB-T2

- Introduction
- LDPC coding
  - Comparison to DVB-T RS+convolutional coding scheme
    - Performance
    - Error distributions

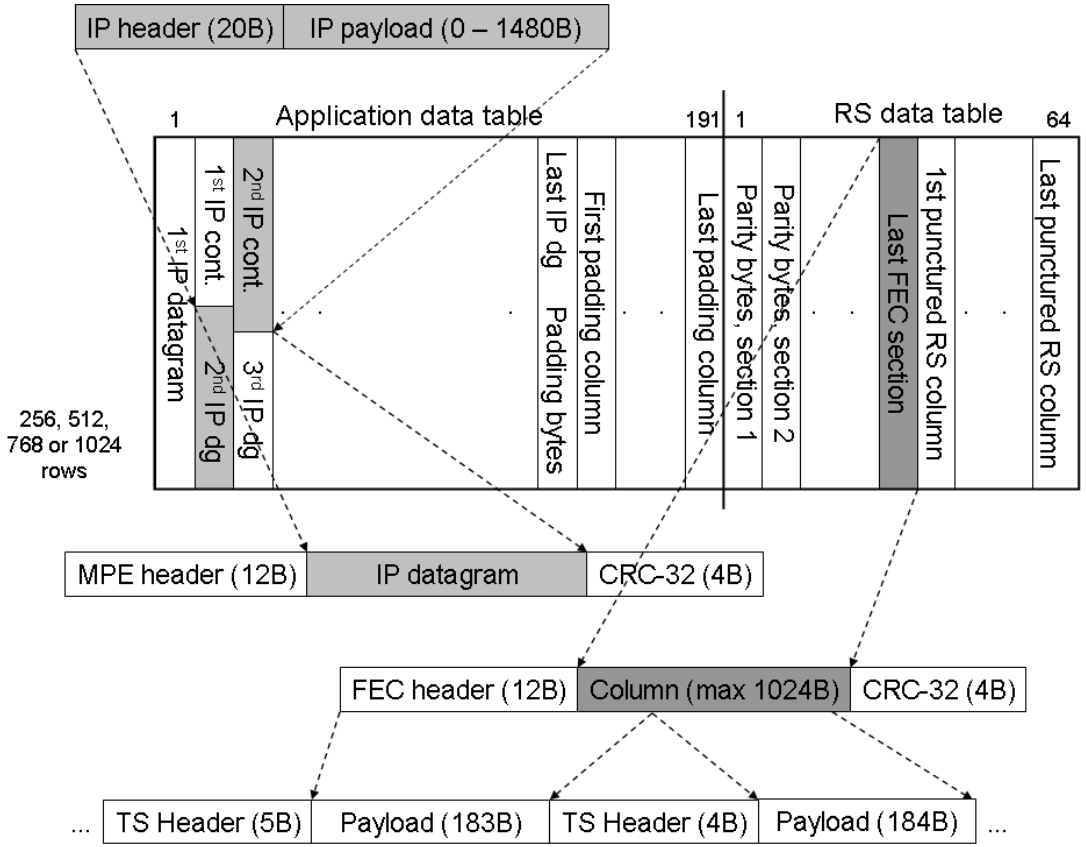
Conclusions and future research

DVB-H

- Based on DVB-T (Digital Video Broadcasting – Terrestrial)
- Amendments to support mobility
  - Time Slicing
    - Transmission in bursts to obtain power saving
  - Link-layer MPE-FEC
    - Additional FEC code to combat the effects of mobility
    - Based on Reed-Solomon (RS) coding
- DVB-H services have been launched in Italy, Finland, Vietnam, India, the Philippines and Albania (August 2007)
- Studies and field measurements on DVB-H have been performed at the University of Turku

MPE-FEC

- IP datagrams are inserted in MPE-FEC frame columnwise and RS(255,191) coding is performed row by row

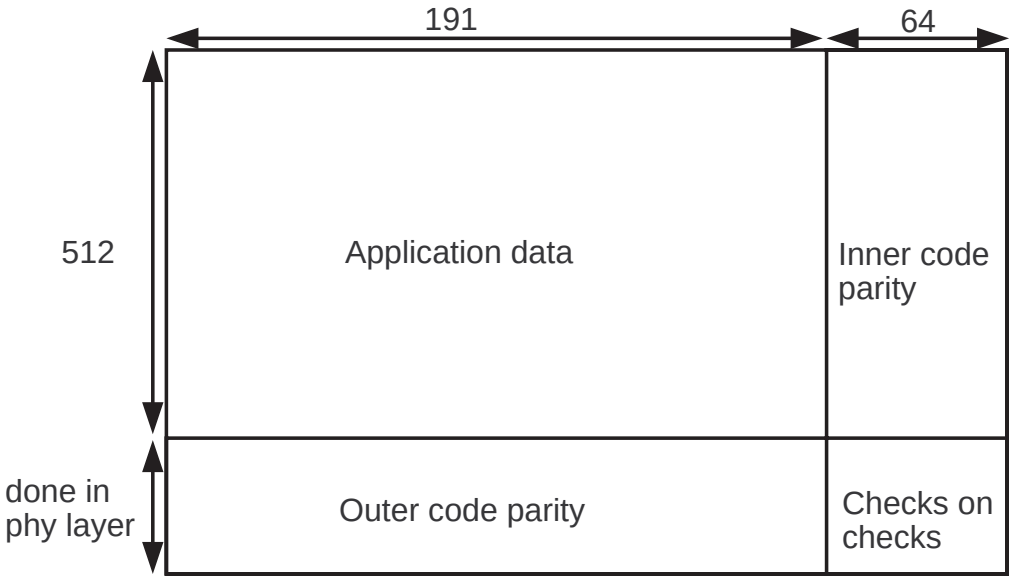


Soft input RS decoding

- The performance of Reed-Solomon decoding can be enhanced by utilizing soft-decision decoding
- For Kötter-Vardy (KV) soft-decision decoding algorithm performance gain of 2.5 dB over the hard-decision decoding at codeword error rate 10^{-4} is reported in fast Rayleigh-fading channel
- KV algorithm is based on list decoding algorithm for RS codes proposed by Guruswami and Sudan (GS algorithm)
- The idea of list-decoding was proposed in the late 1950s by Elias and Wozencraft
- In list-decoding the decoder tries to output a list of code words within distance t' of the received vector where $t'>t$ (conventional error correction capability)
- GS algorithm is based on interpolation and factorization of polynomials in finite field
- KV algorithm uses the known symbol reliability (soft information) to assign interpolation multiplicities in GS algorithm

Utilization of soft decision decoding in MPE-FEC

- How could soft-decision decoding of RS codes be used in DVB-H systems?
- At the physical layer concatenated code SISO (Soft Input Soft Output) viterbi decoding could be used and soft information fed to physical layer RS decoder based on KV decoding algorithm
- In MPE-FEC also soft decision could be possible if it is reasonable to convey soft information all the way from demodulator to link layer
- Also a product code like structure could be used in MPE-FEC



Next generation video broadcasting standard DVB-T2

- DVB-T2 is intended for HDTV transmissions in terrestrial environment
- The most important improvement as compared to DVB-T is to increase the bandwidth to allow for increased data rate of HDTV services as compared to current SDTV services
- Call for Technologies issued by DVB organization on 26. April 2007 states that LDPC codes used in DVB-S2 are to be used in DVB-T2 if these are not shown to have some major undesirable behaviour in terrestrial system
- Here, the performance of DVB-T system where the concatenated RS-convolutional coding is replaced by LDPC code is presented

LDPC codes

- Proposed in 1962 by R. Gallager but their use didn't become applicable until late 1990s
- LDPC codes are so called near-capacity codes, i.e. they are capable providing reliable data transmission at rate close to the theoretical capacity of the channel
- The most common decoding method used with LDPC codes is iterative one, based on belief propagation

DVB-S2 LDPC codes

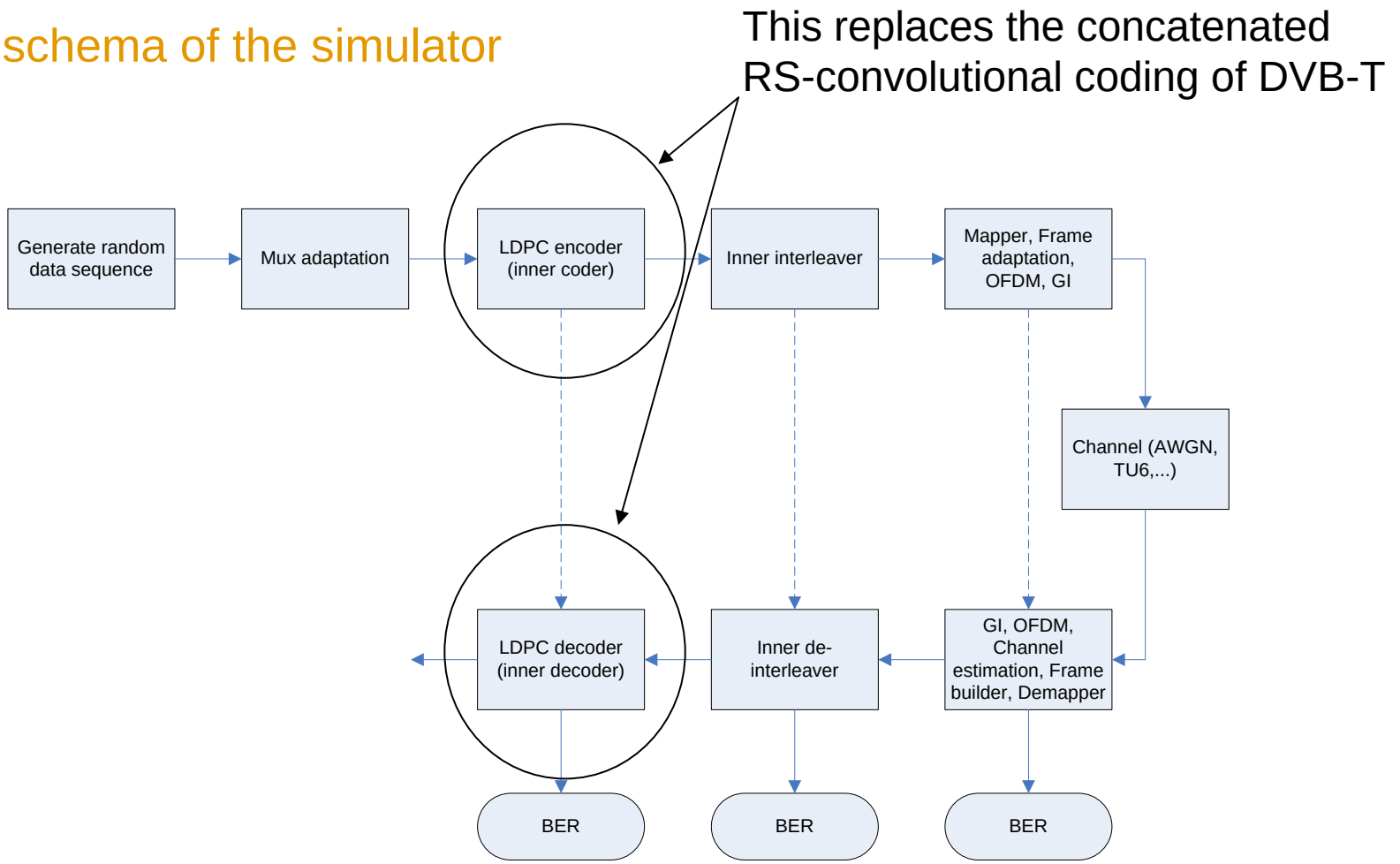
- DVB-S2 LDPC codes are of lengths 16200 and 64800 bits with coderates varying from ¼ to 9/10

- Idea: Substitute the concatenated RS+convolutional code with (almost) equal rate DVB-S2 LDPC code and see how it affects the performance of the system
- DVB-S2 LDPC code parameters:

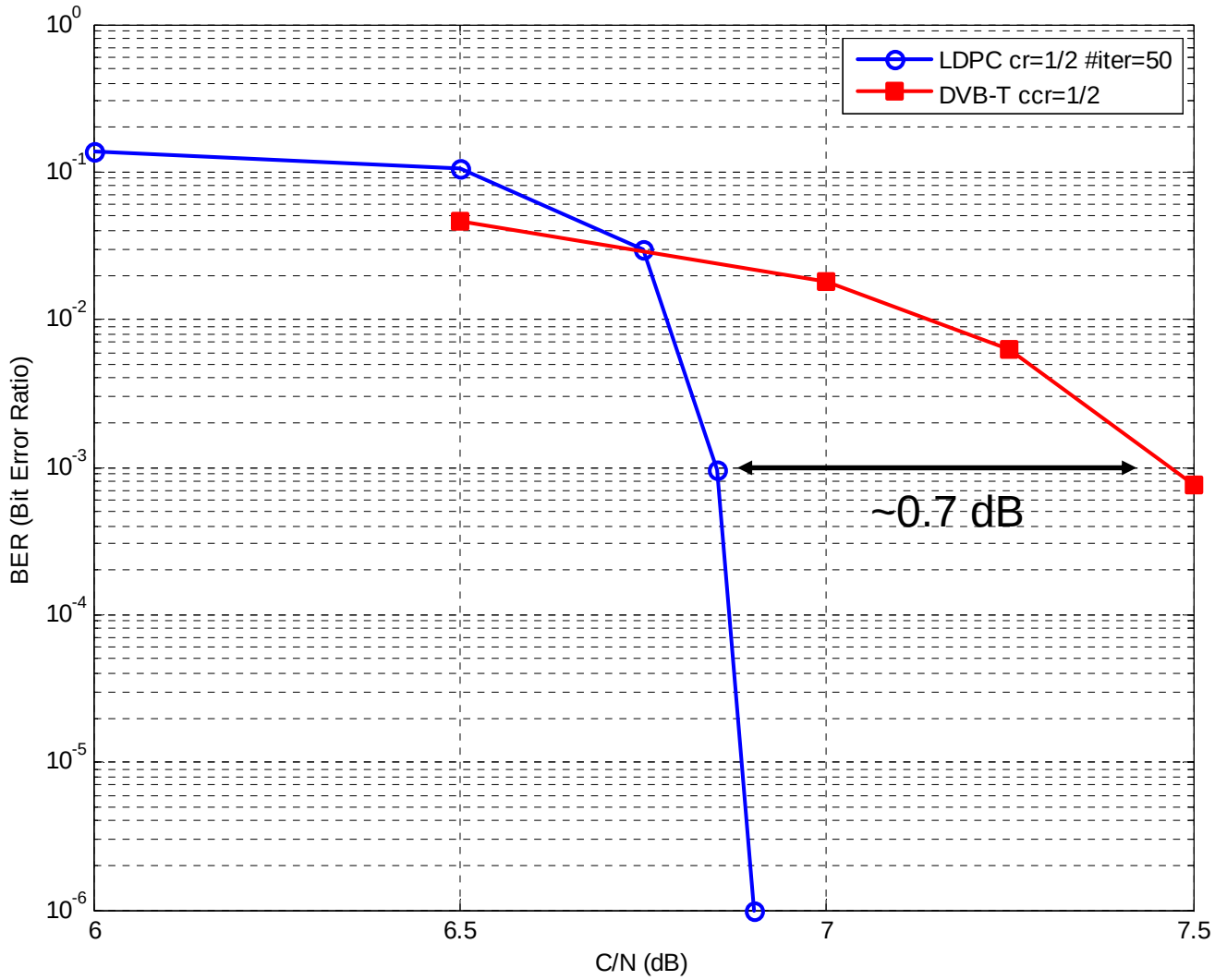
  n=64800, k=32400 (r=1/2)

  50 iterations, soft decision decoding

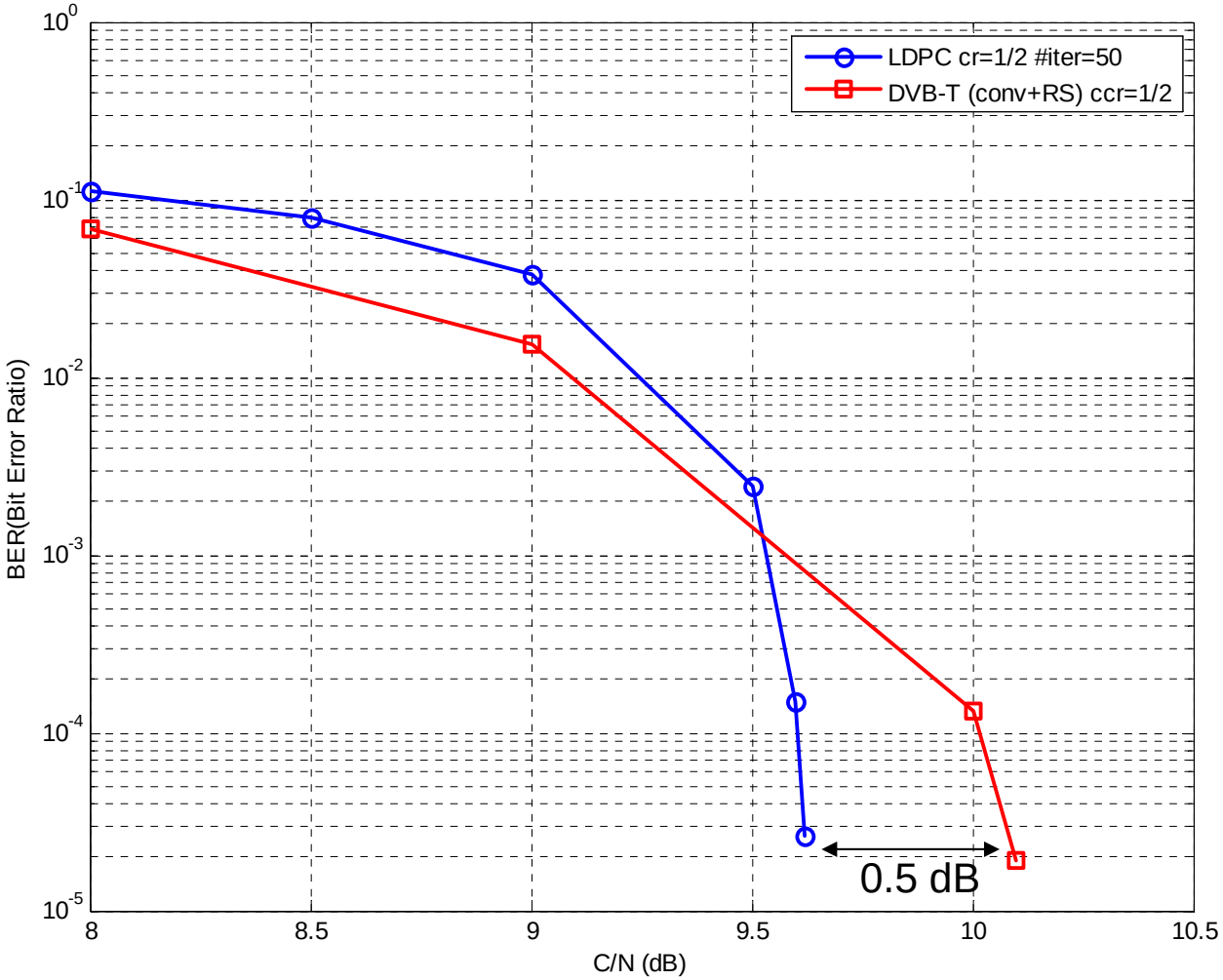
Block schema of the simulator



Simulations in AWGN channel



Simulations in TU6 multipath channel



TU6 channel
f_D=30 Hz

16-QAM
2k OFDM mode
GI 1/32

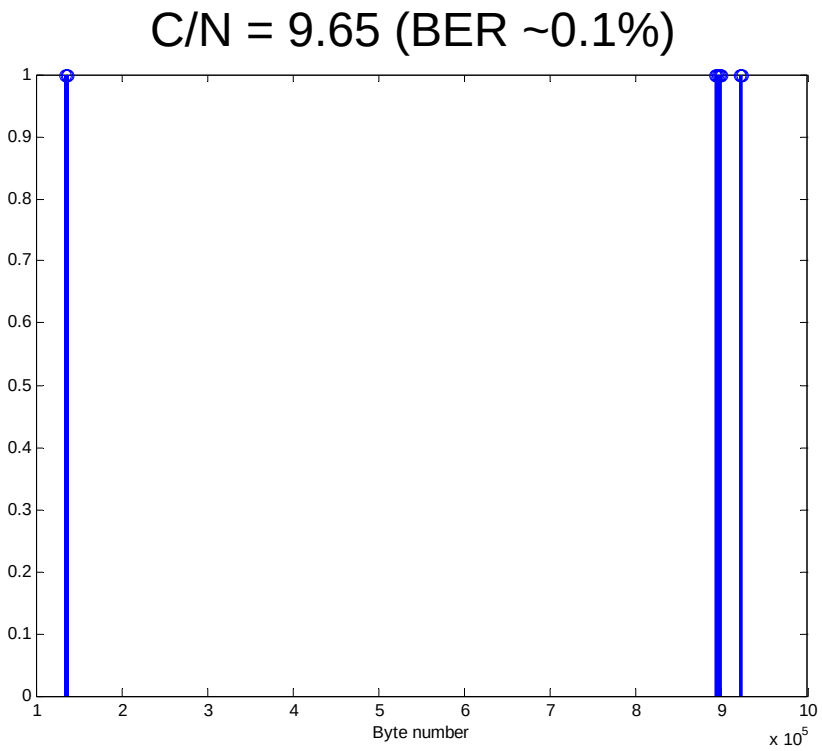
LDPC coderate ½

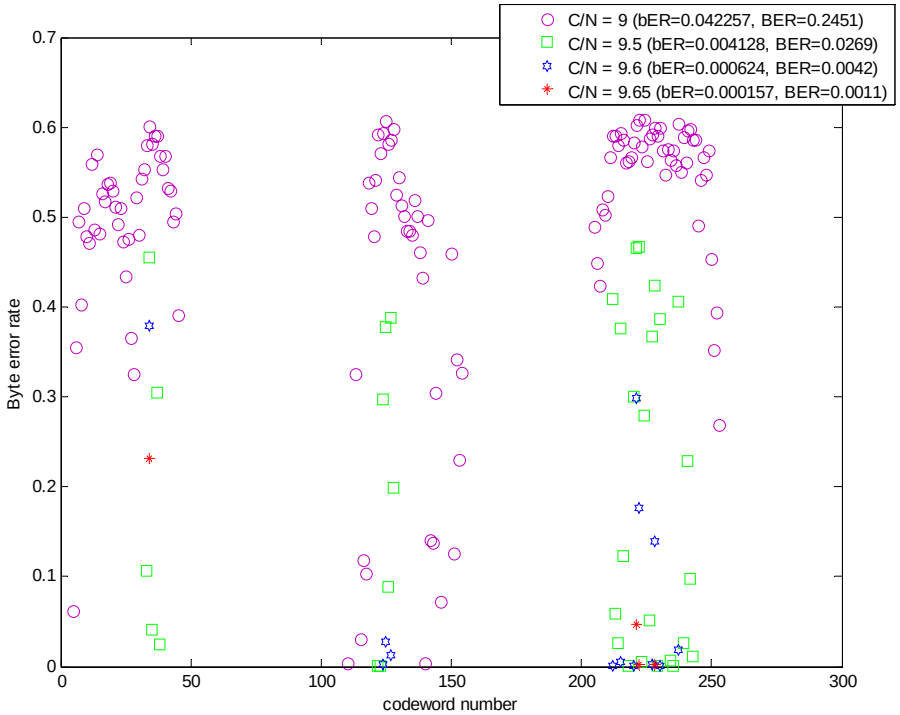
DVB-T coderate:
½*(188/204)~0.46

Error distributions

- Byte error distributions after LDPC decoding are stored
- These are compared to the distributions obtained by DVB-T system
- 16-QAM, cr=1/2, 8k OFDM, TU6 10Hz, GI=1/4
- Results are presented in the following slides
- In conclusion, LDPC seems to provide shorter error bursts with higher density of errors

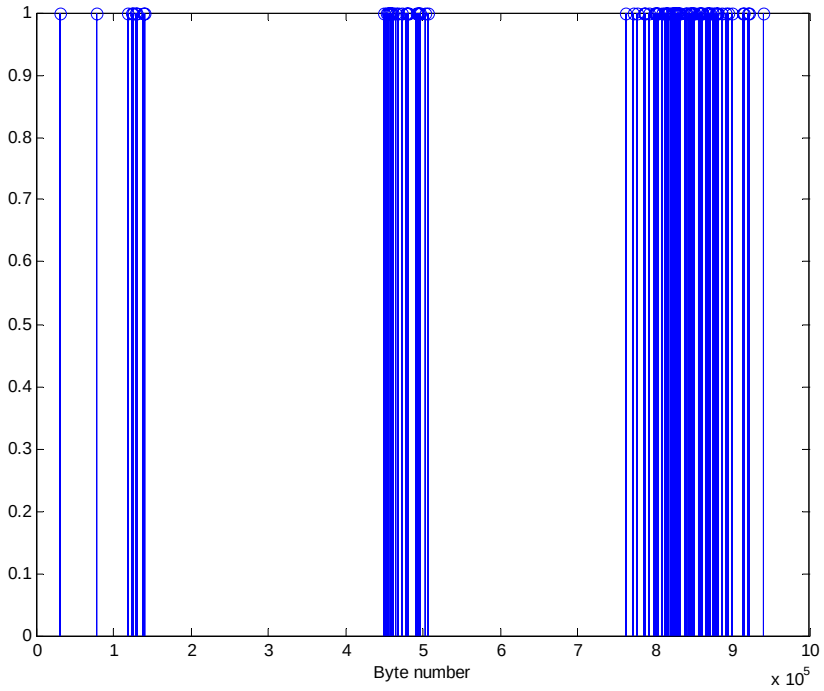
DVB-T with LDPC

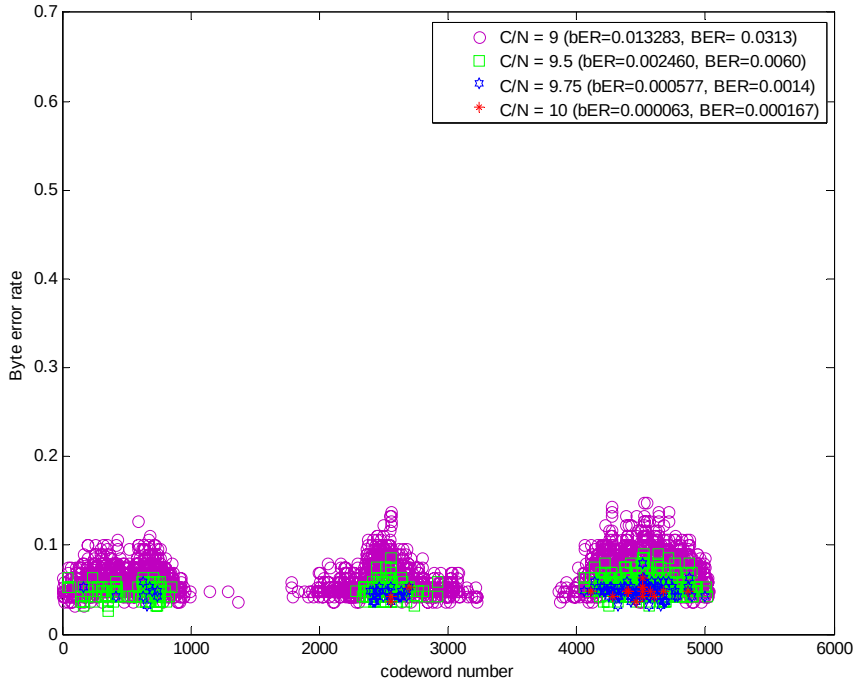




DVB-T

C/N = 9.75 (BER ~0.1%)





Future research topics

- Interleaving for LDPC code
- Puncturing/shortening LDPC codes
- ...

Thank You!
Questions?