Simulation of an LDPC decoder using Min-Sum algorithm

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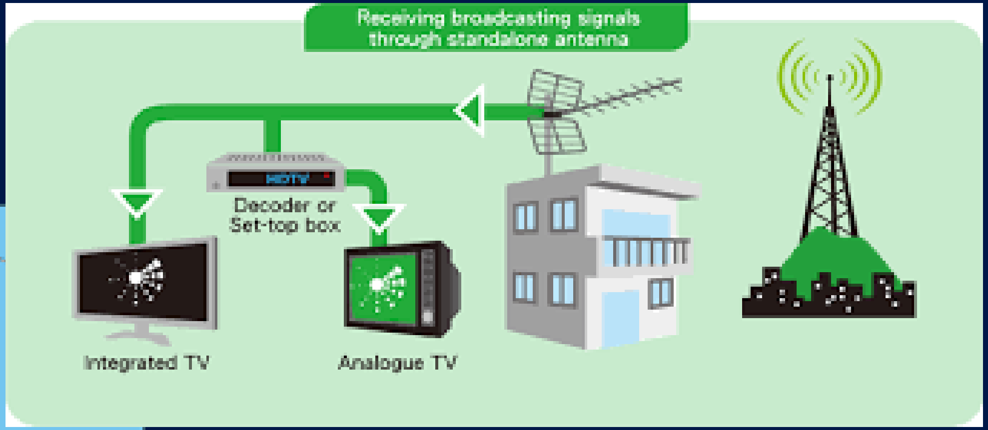
Outline

- Introduction
- Problematic Situation
- LDPC Codes
- Simulation of an LDPC decoder
- Results
- Conclusions
- Future Work

Introduction

Digital Television Deployment since 2013



Introduction

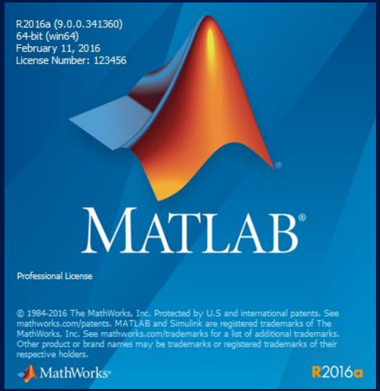
Technological Transference Process

ASSIMILATION → REPRODUCTION → INNOVATION → DEVELOPMENT → KNOWLEDGE DIFFUSION

Introduction

- DTMB Transmission/Reception Simulation Model

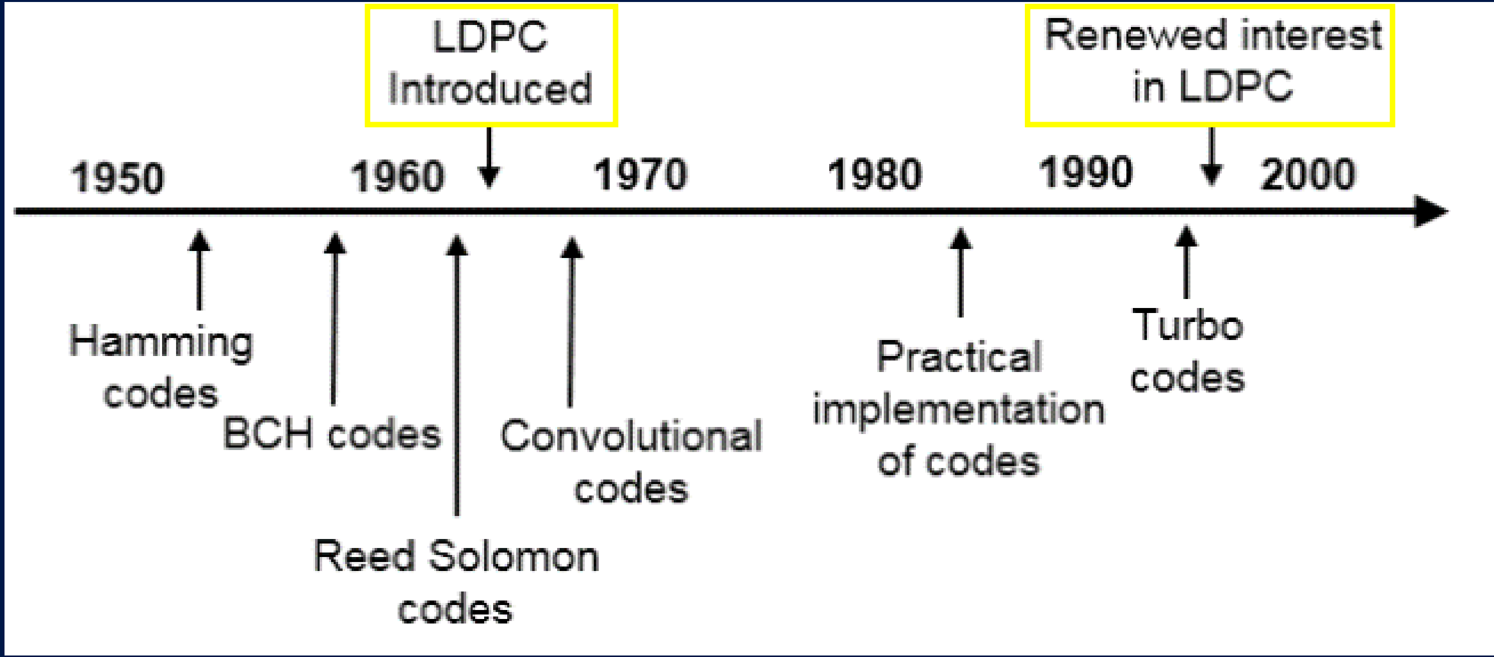
Transmitter → Channel → Receiver



Problematic Situation

- LDPC decoding identified as a critical processing stage.
- Problem: LDPC Parity Check Matrix used in DTMB is not compatible with MATLAB LDPC decoding block
- Solution: Development of an LDPC decoder in MATLAB that works with LDPC Parity Check Matrix used in DTMB.

LDPC Codes


LDPC Introduced
Renewed interest in LDPC
1950
1960
1970
1980
1990
2000
Hamming codes
BCH codes
Reed Solomon codes
Convolutional codes
Practical implementation of codes
Turbo codes

LDPC codes

Low Density Parity Check

- Linear block code.
- Defined by a Parity Check Matrix with low density of “1”s.

Encoding:

- Based on Generator Matrix

Decoding:

- Based on iterative process

Processing Complexity

LDPC codes

Message-Passing Decoding Algorithms

Binary information
(Hard decision)

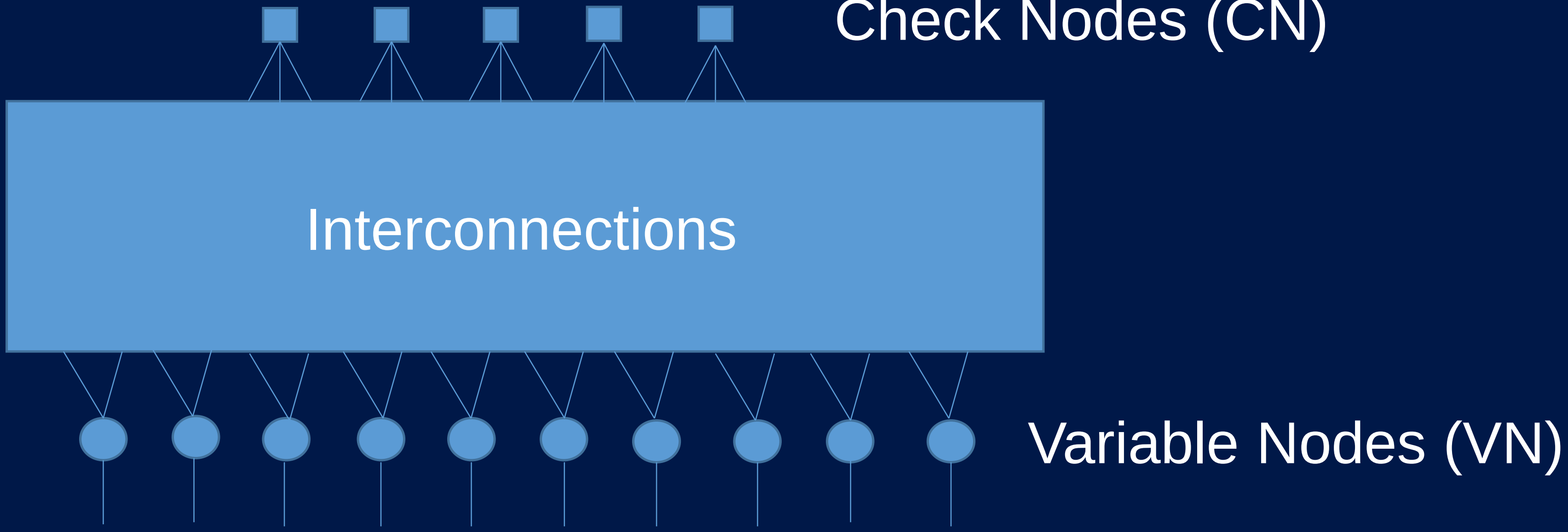
Probability
(Soft decision)

LDPC codes

Log-Likelihood Ratio (LLR)

- Estimation of the trasmitted bits.
- Sign: Transmitted bit is 0 (+) or 1 (-)
- Magnitude: Reliability of being 0 or 1

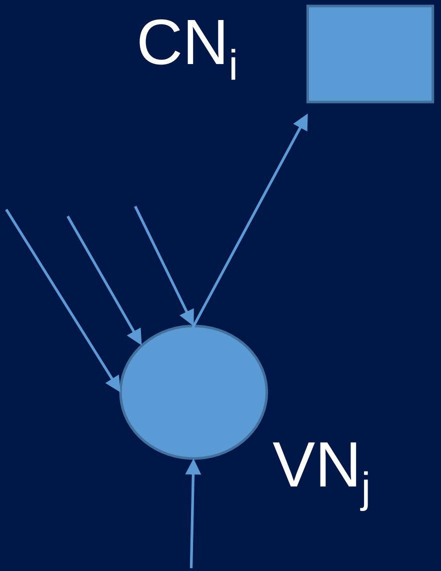
LDPC codes



Tanner Graph

LDPC codes

LDPC codes



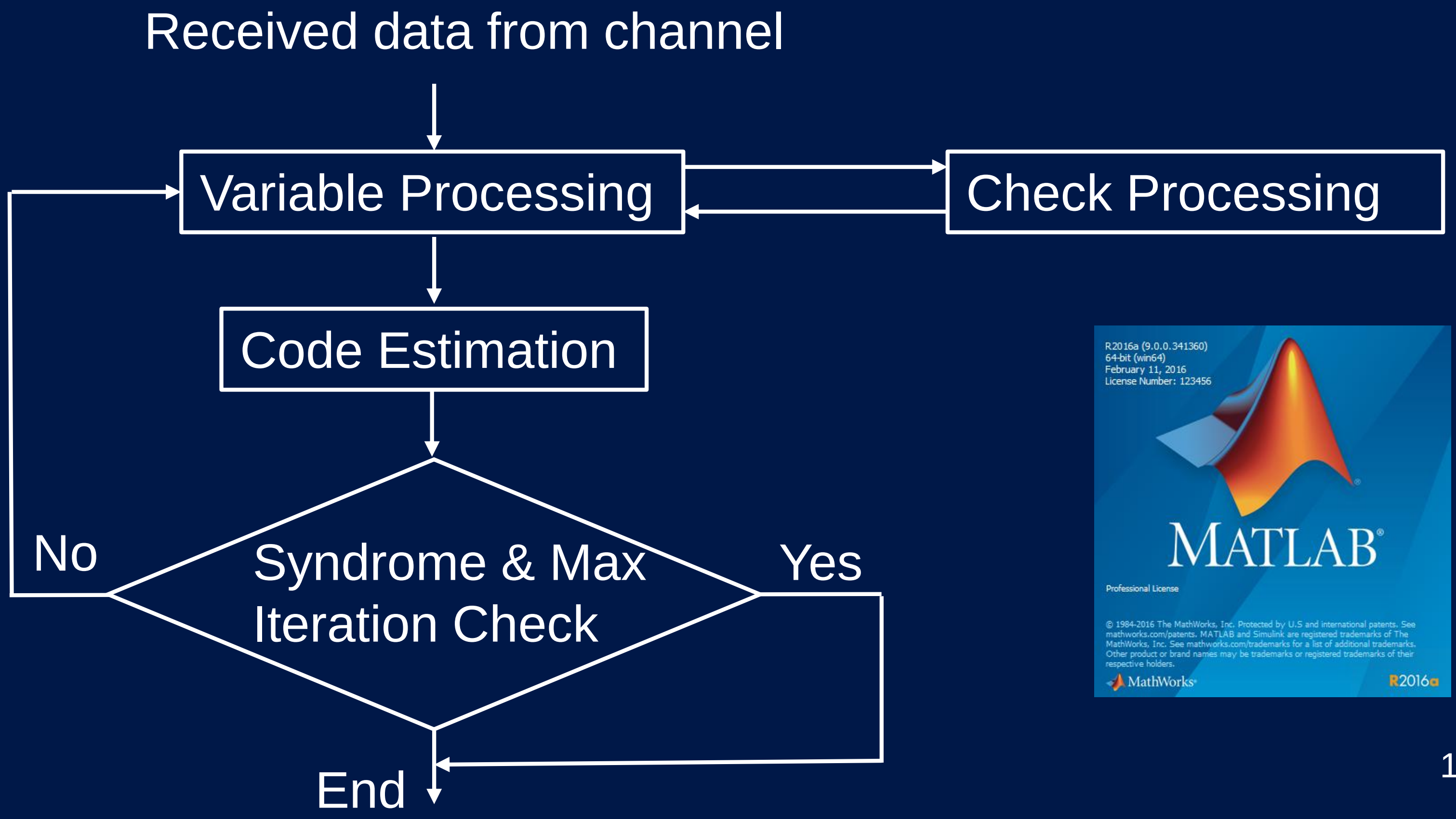
$\prod$ (Based on tanh) $\approx$ Minimum value

$\sum$

Sum-Product Algorithm (SPA)

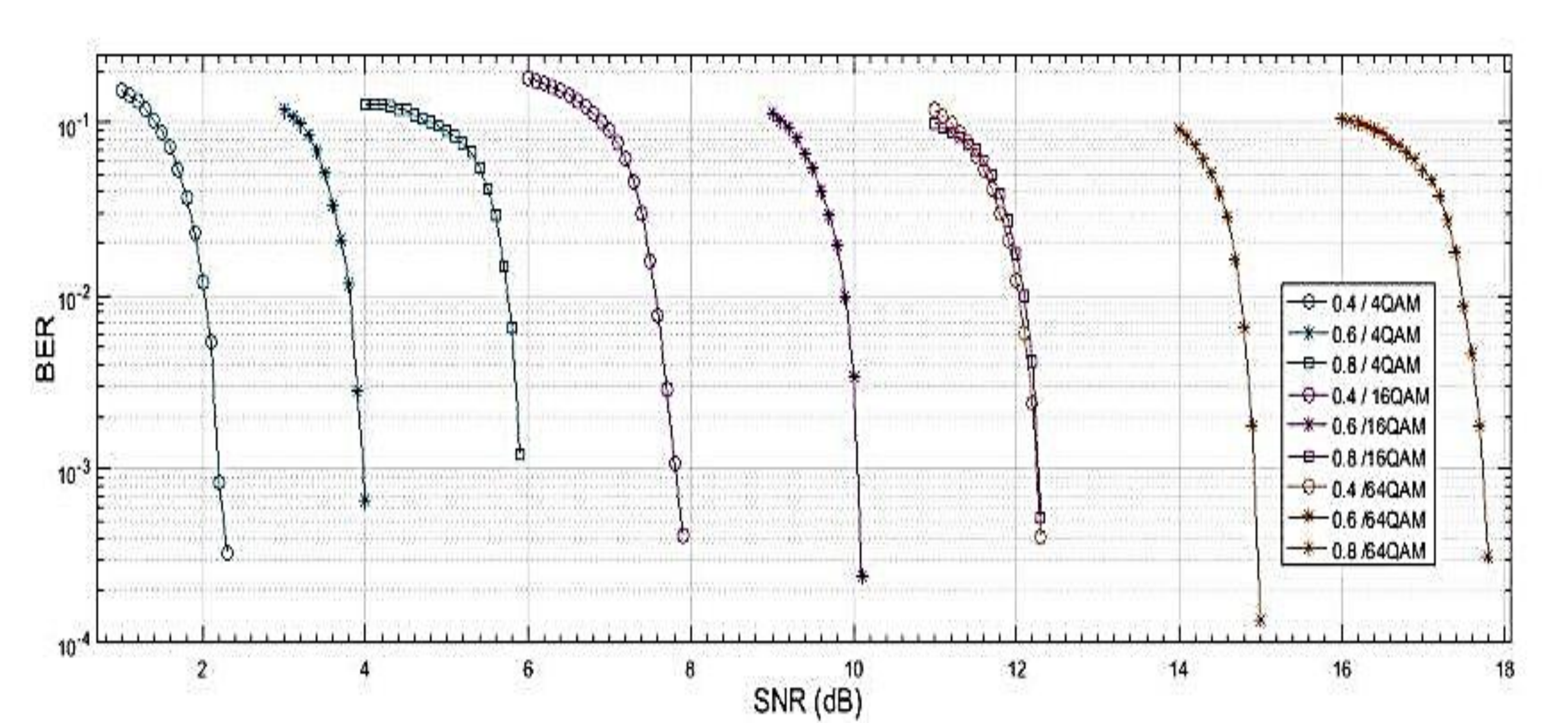
Reduced Complexity SPA Approximation → Min-Sum

Simulation of an LDPC decoder



Results

BER vs SNR (0.4, 0.6 and 0.8 code rates)



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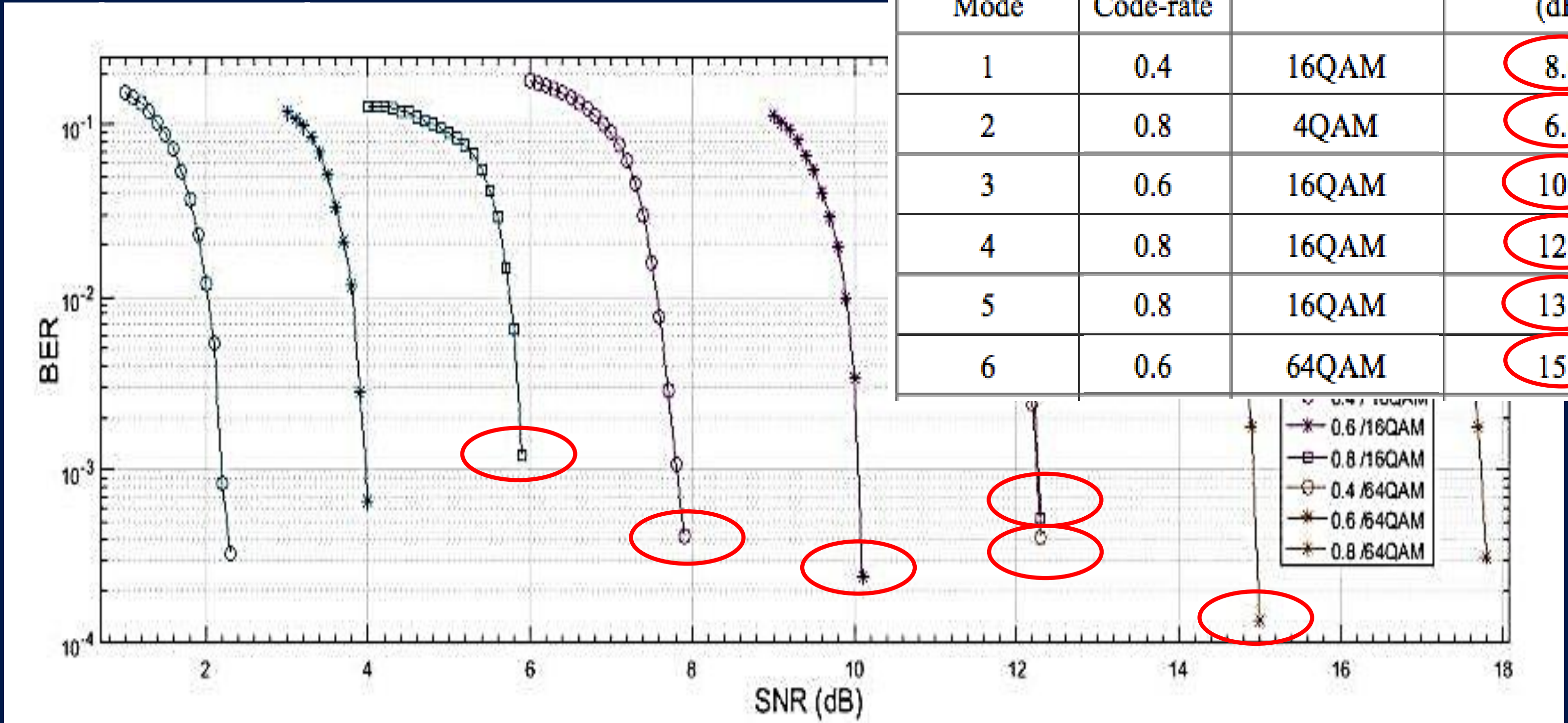
Results

GB/T 26686—2011

BER vs SNR (0.4, 0.6 and 0.8



Working Mode	FEC Code-rate	Constellation	C/N threshold (dB)
1	0.4	16QAM	8.0
2	0.8	4QAM	6.0
3	0.6	16QAM	10.7
4	0.8	16QAM	12.6
5	0.8	16QAM	13.2
6	0.6	64QAM	15.7

Results

Time Performance

- Delay for a 740-microsecond frame: 1000 seconds

Non-practical delay

- Software Optimization
- Hardware implementation

Conclusions

- The BER vs SNR graphics for the LDPC decoder simulated in MATLAB approximates DTMB specifications.
- When inserting the LDPC decoder in the Reception Model, it shows a high processing delay.

Future Work

- Software optimization of current LDPC decoder.
- Hardware implementation of optimized LDPC decoder to achieve parallel processing.

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