IEEE 1900.7 White Space Radio

PHY layer based on FBMC

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Abstract

- This contribution presents some parameters and performance analysis for Filter Bank Multi Carrier (FBMC) physical layer.
- Bit Error Rate (BER) performance are presented for different modulation and coding schemes.

Background (1/2)

- P1900.7 general requirement (1900.7-12-0021-r1) identifies that:
  - "The P1900.7 shall provide means to protect primary systems according to the national and international radio regulations."
  - "The P1900.7 shall support multi free bands for secondary users access."
- This means that P1900.7 shall be able to operate with a minimal interference to potential adjacent primary user.
- The P1900.7 general requirement identifies Multi-Carrier systems as a good approach to meet operation flexibility in the spectrum domain.

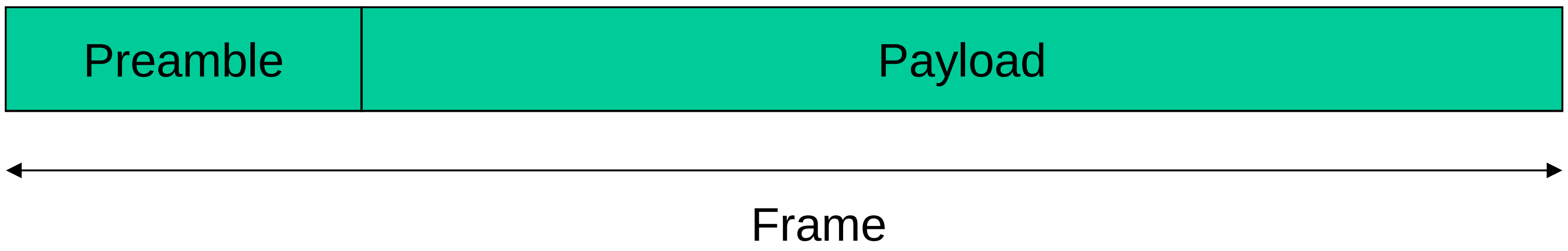
Background (2/2)

- In 7-12-0037r1, the good ACLR performance of FBMC was stressed and outperforms the one of OFDM
- It was shown in 7-12-0038 that FBMC has good spectrum efficiency properties in comparison to OFDM
- UHF TV bands is a prime option where White Space Radio (WSR) is applicable.
- A motion passed on June 28th saying that TVWS is a target band for P1900.7
- Therefore TVWS parameters will be used for quantitative evaluation and comparison without any loss of generality

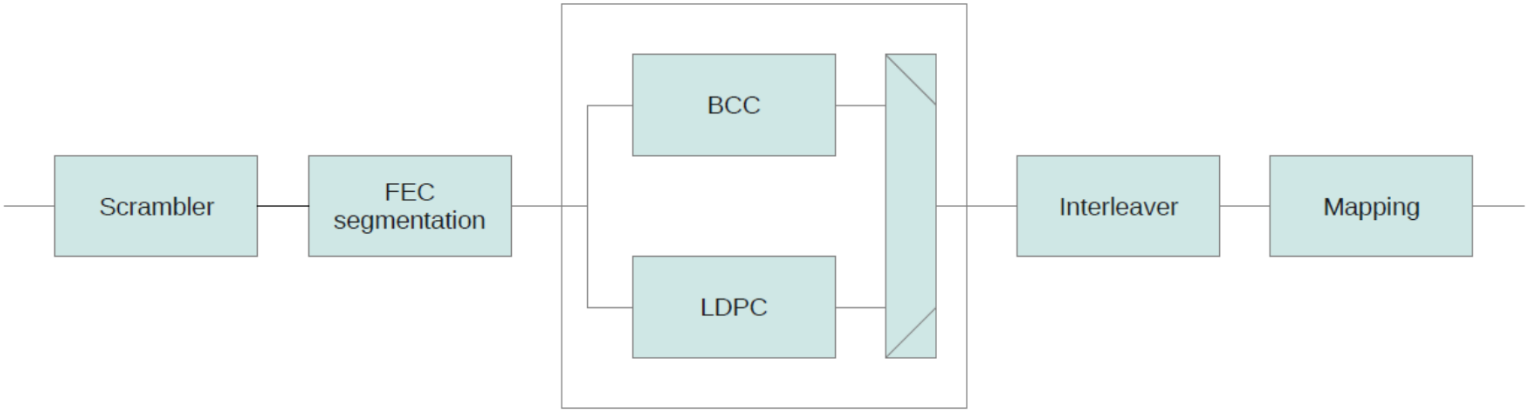
* In this presentation TVWS refers to the channels of the UHF interleaved spectrum that are not used by a primary user in the area covered by the WSR.

Frame Structure

- Burst transmission
  - A Frame is composed of a preamble and a payload



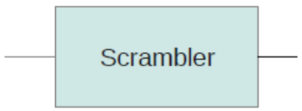
Channel coding: overview



- Scrambler (PN17)
- FEC - N=648,1296 or 1944 bits, R=1/2, 2/3, 3/4
  - Binary Convolutional Code (BBC) or LDPC

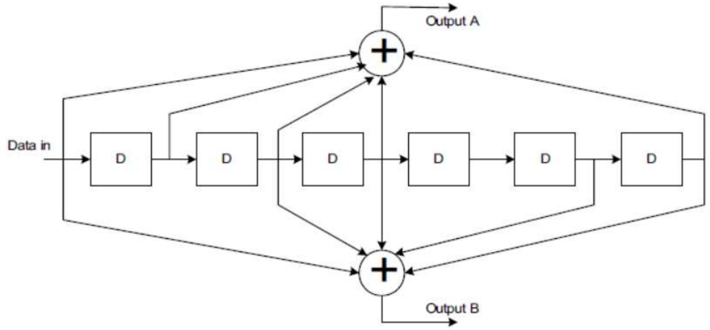
Channel coding: Scrambler

- Scrambler (PN17)
  - $X^{17} + X^{14} +1$
  - Initialisation 0x1000



Channel coding: FEC (1/2)

- **Binary convolutional code**
  - The data burst is encoded using a rate: 1/2 binary convolutional encoder.
  - The constraint length of this coder is equal to 7 and its generator polynomials are 171o and 133o
  - 8 bits of tail bit
  - The output size is N=648, 1296 or 1944
  - Output : A0 B0 A1 B1 A2 B2 ….
- Puncturing
  - Rate ½, 2/3,3/4
  - Pattern:
    - ½ : A0 B0 A1 B1
    - 2/3 : A0 B0 A1 X
    - ¾: A0 B0 X X



Channel coding: FEC (2/2)

- **LDPC code**
  - QC LDPC with staircase like structure
    - 802.11n LDPC codes
  - 12 LDPC matrices
    - N=648 bits, R=1/2,2/3,3/4 and 5/6
    - N=1296 bits, R=1/2,2/3,3/4 and 5/6
    - N=1944 bits, R=1/2,2/3,3/4 and 5/6

Channel coding: Interleaver

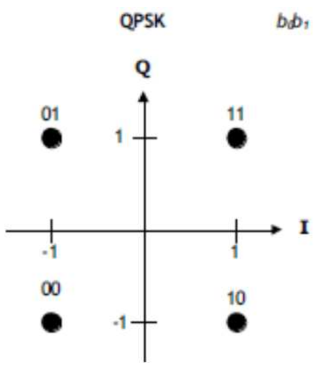
- Basic row column interleaver
  - m columns and l rows
    - m: modulation order
    - l = kN/m where k is an integer (depends on latency constraints)
      - k = 1 to 32
      - k = 1 : bit are interleaved on one FEC block
      - k = 32 : bit are interleaved on 32 FEC blocks

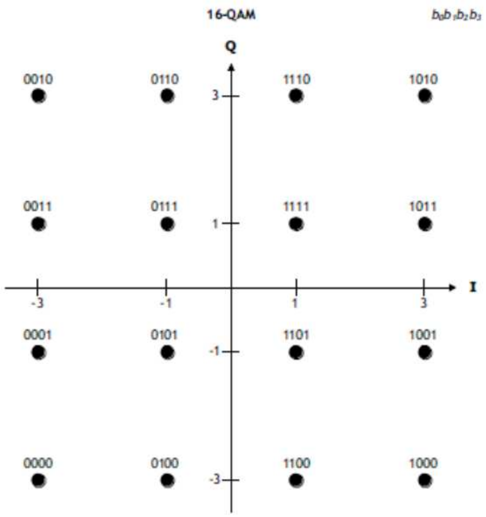
Channel coding: Padding

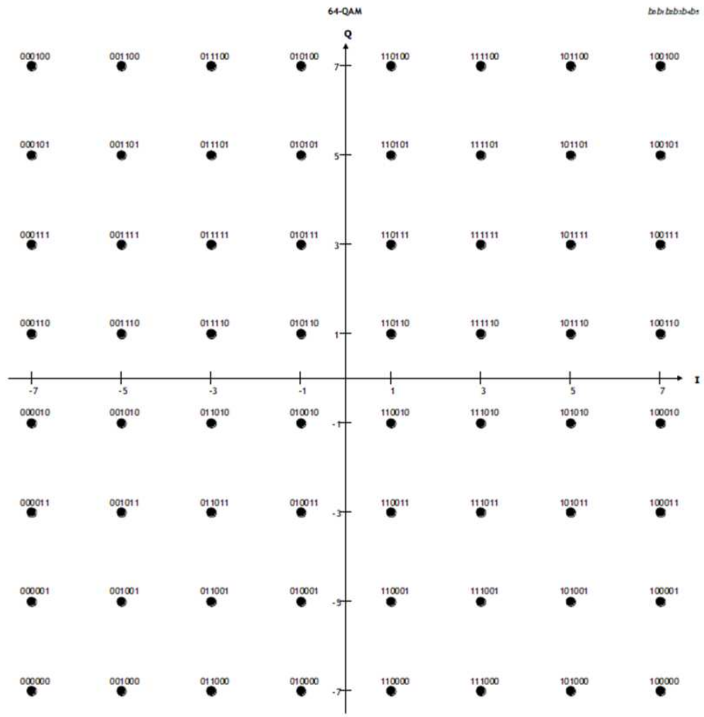
- Padding are introduced after interleaving at the bit level to fill the last FBMC symbol
- Padding are used a PRBS generator PN17
  - $X^{17} + X^{14} +1$
  - Initialisation 0x1000

Constellation mapping

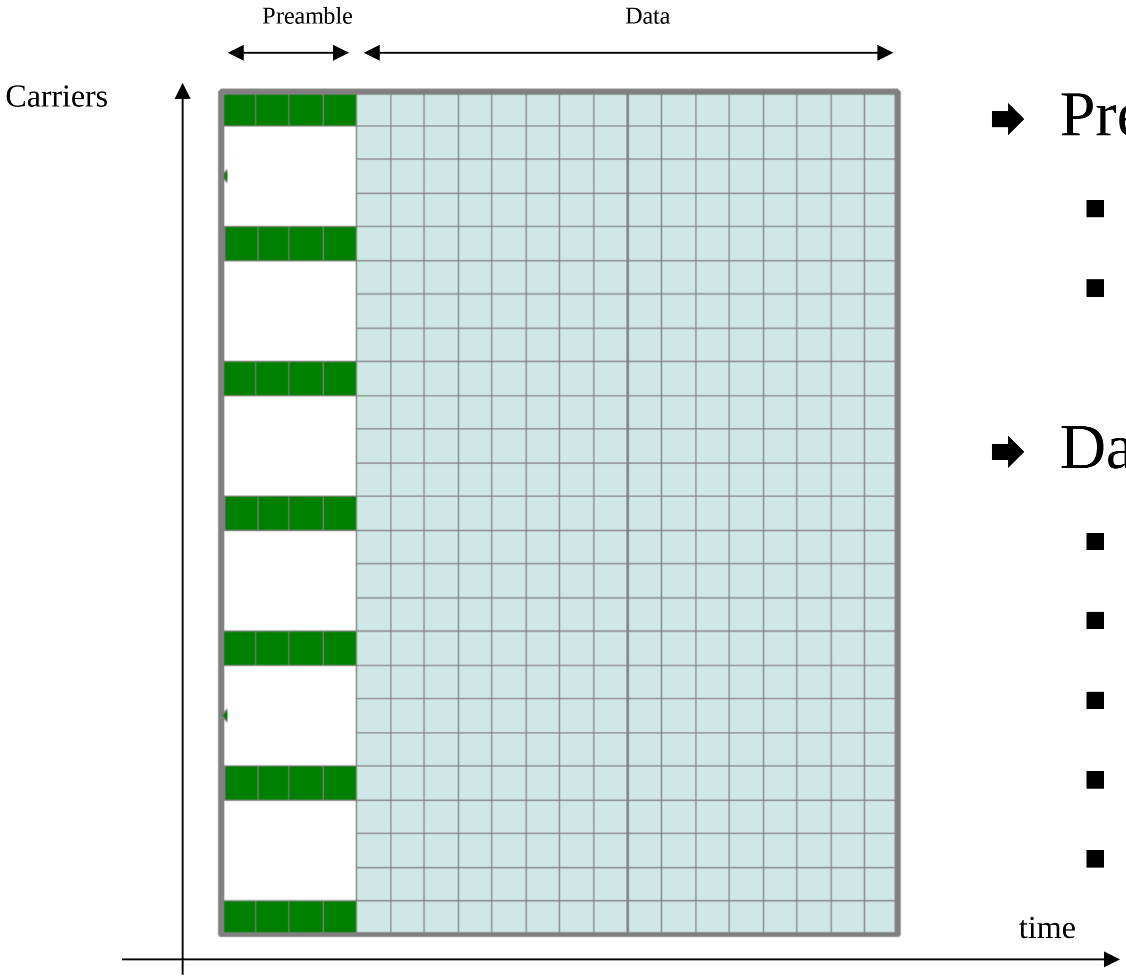
- The output of the bit interleaver are entered serially to the constellation mapper
  - QPSK, 16 QAM or 64 QAM using Gray mapping





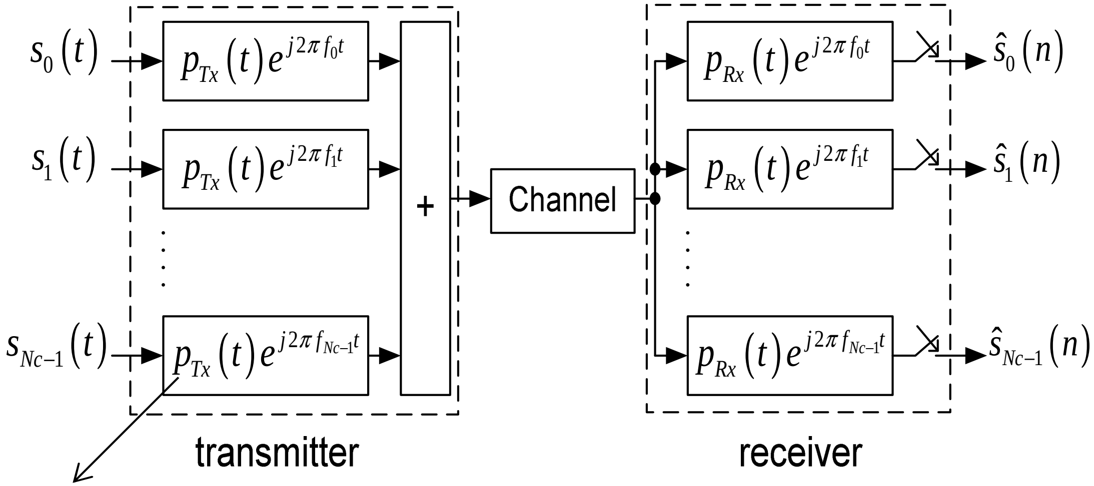


FBMC mapping



- Preamble
  - Pilots BPSK
  - Length = 4 blocks
- Data
  - FFT size = 1024
  - Max Active carriers = 489
  - Nb Active carriers = 4p+1
  - QAM
  - Length = 4 to 64

FBMC: Generic scheme



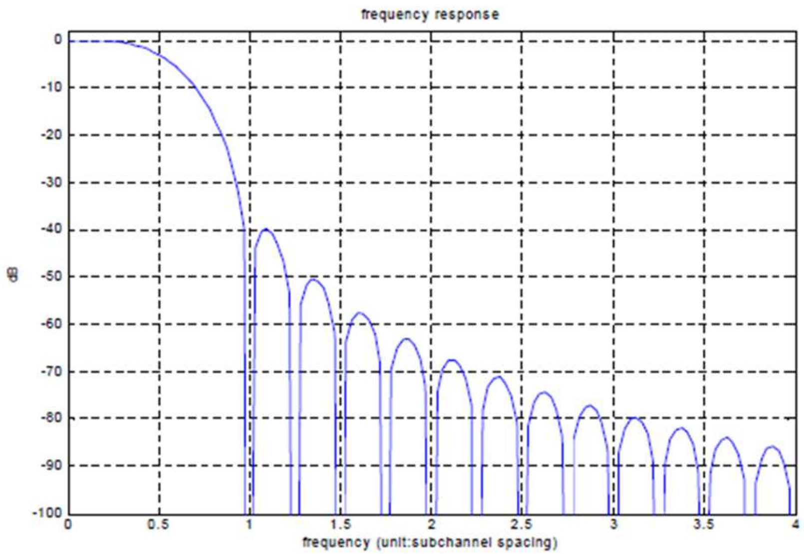
- prototype filter: Typically $KN_c \pm 1$ samples long.
  Very well localized in frequency.
  Only adjacent carriers overlap.

- Number of carriers: N_c
  Symbol rate: $T = N_c\, T_s$
  Sampling duration: T_s
  InterCarrier Spacing: Δf

FBMC: Parameters

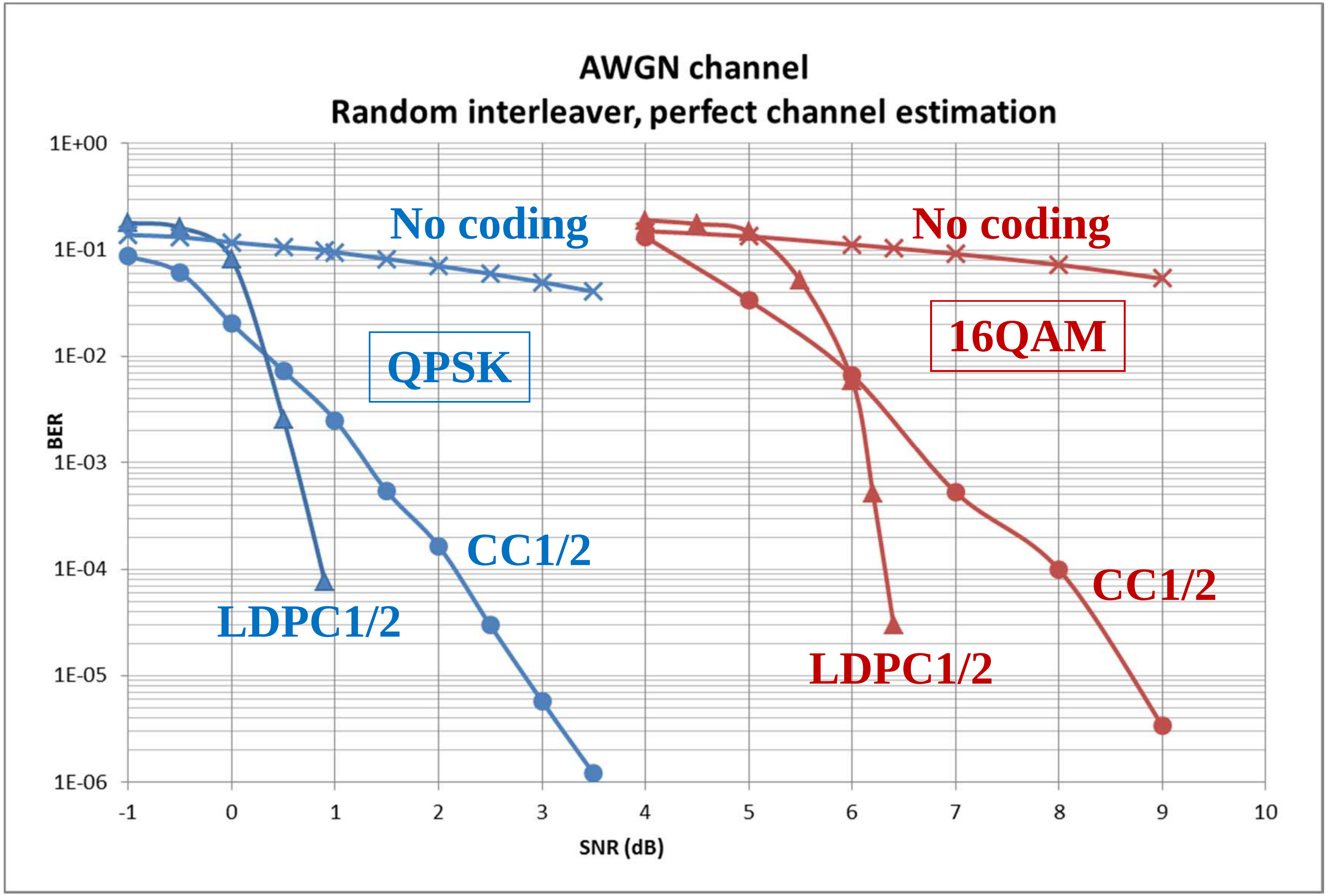
- K = 4 optimized for ACLR
  - 60dB rejection for the frequency range above 2 sub channels

$$H(0) = 1$$
$$H(1/L) = 0.971960$$
$$H(2/L) = 1/\sqrt{2}$$
$$H(3/L) = \sqrt{1 - H^2(1/L)} = 0.235147$$
$$H(k/L) = 0 \quad ; \quad 4 \le k \le L-1$$



[Phy09] M.G. Bellanger et al, « D5.1: prototype filter and structure optimization», FP7 ICT-PHYDYAS, 01/2009

BER performance. Efficiency of LDPC



Conclusion

- In this presentation, some link levev simulation have been presented for an FBMC PHY
- We proposed a frame structure based on a preamble and a payload
- A flexible outer coder strategy is proposed for flexible rate