

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)

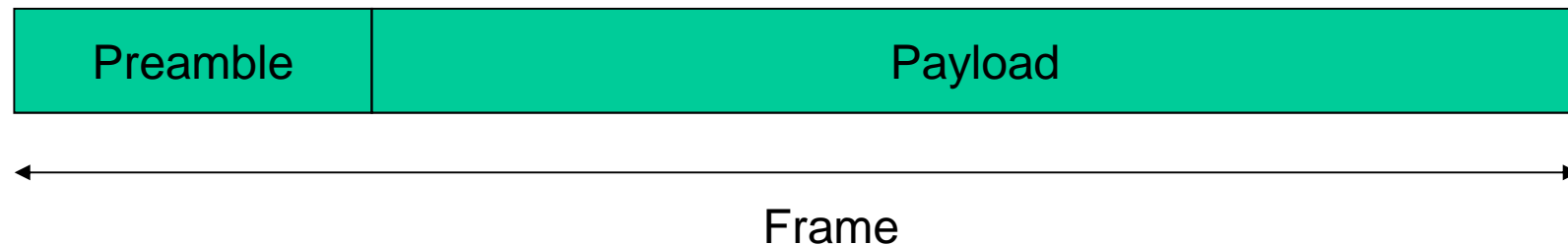
- ➔ In 7-12-0037r1, the good ACLR performance of FBMC was stressed and outperforms the one of OFDM
- ➔ It was shown in 7-12-0038 that FBMC has good spectrum efficiency properties in comparison to OFDM
- ➔ UHF TV bands is a prime option where White Space Radio (WSR) is applicable.
- ➔ A motion passed 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.

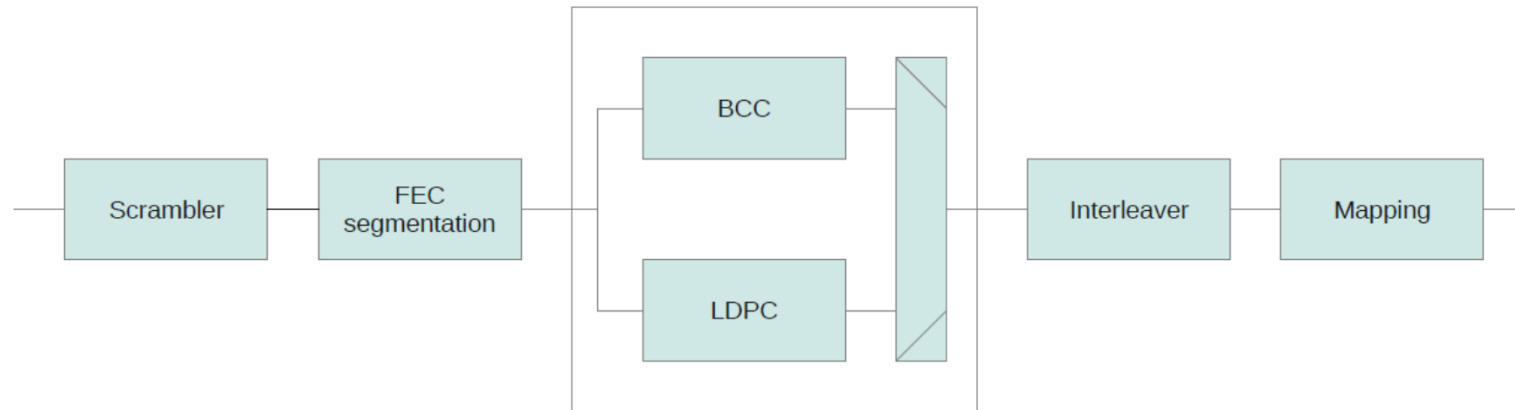
Frame Structure

➔ Burst transmission

- A Frame is composed of a preamble and a payload



Channel coding: overview

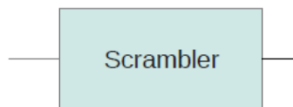


- ➔ Scrambler (PN17)
- ➔ FEC - $N=648, 1296$ or 1944 bits, $R=1/2, 2/3, 3/4$
 - Binary Convolutional Code (BCC) or LDPC

Channel coding: Scrambler

➔ Scrambler (PN17)

- $X^{17} + X^{14} + 1$
- Initialisation 0x1000



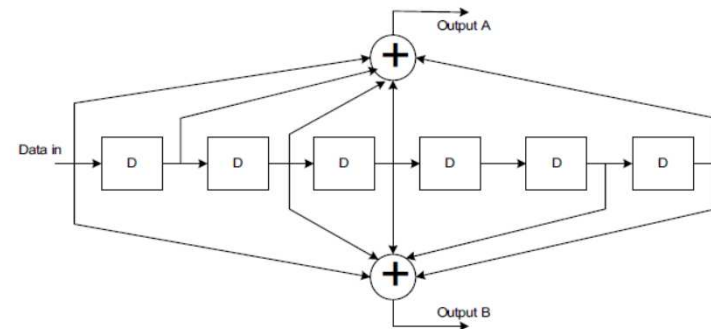
Channel coding: FEC (1/2)

➔ 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 171_o and 133_o
- 6 tail bits
- The output size is N=648, 1296 or 1944
- Output : A0 B0 A1 B1 A2 B2

➔ Puncturing

- Rate 1/2, 2/3, 3/4
- Pattern:
 - 1/2 : A0 B0 A1 B1
 - 2/3 : A0 B0 A1 X
 - 3/4 : 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

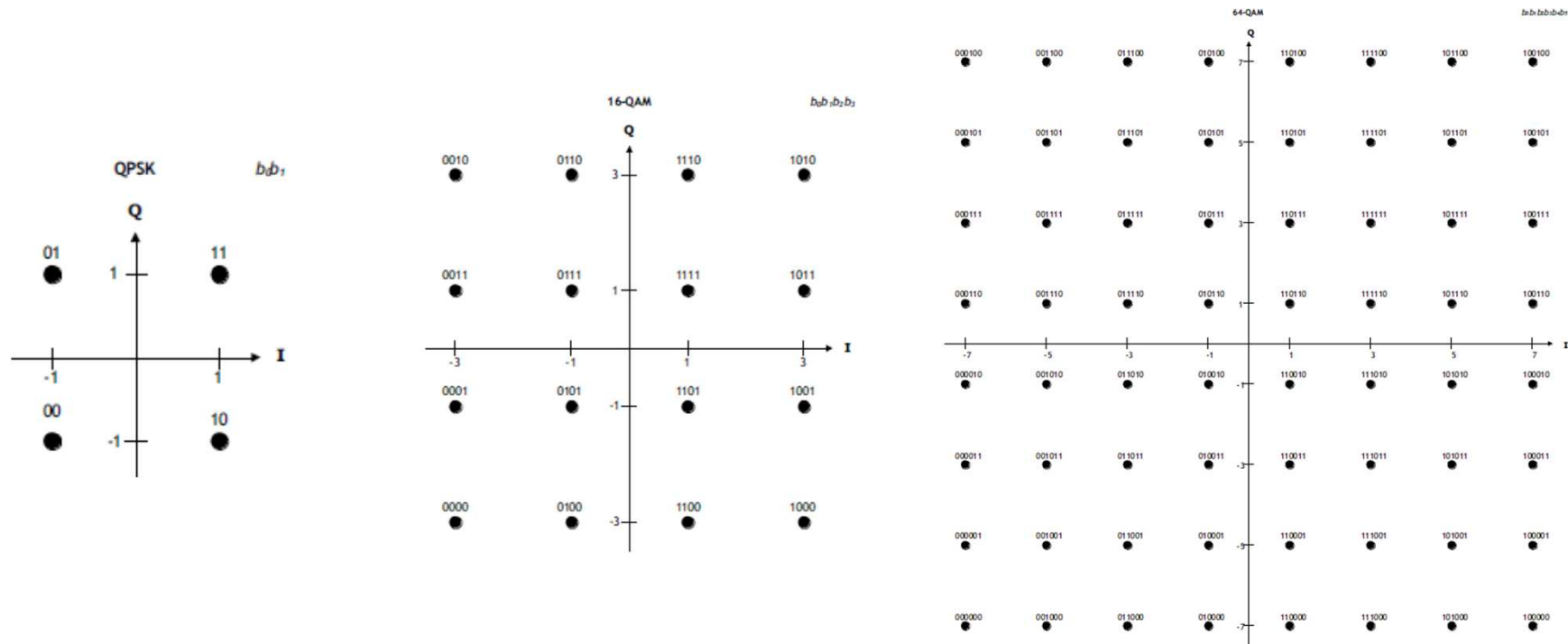
- m columns and l rows
 - m: modulation order
 - $l = kN/m$ where k is an integer (depends on latency constraints)
 - k = 1 to 32
 - k = 1 : bit are interleaved on one FEC block
 - k = 32 : bit are interleaved on 32 FEC blocks

Channel coding: Padding

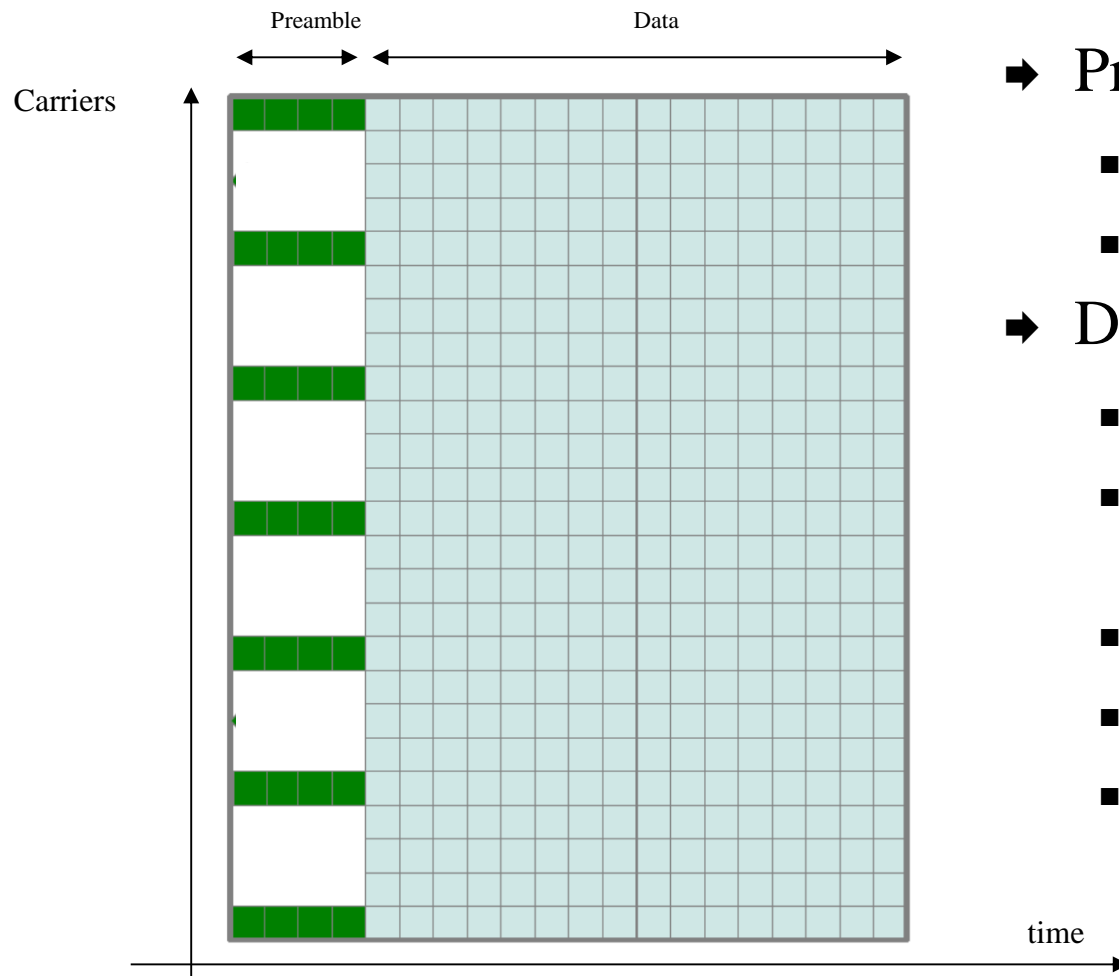
- ➔ Padding are introduced after interleaving at the bit level to fill the last FBMC symbol
- ➔ Padding uses PRBS generator PN17
 - $X^{17} + X^{14} + 1$
 - Initialisation 0x1000

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



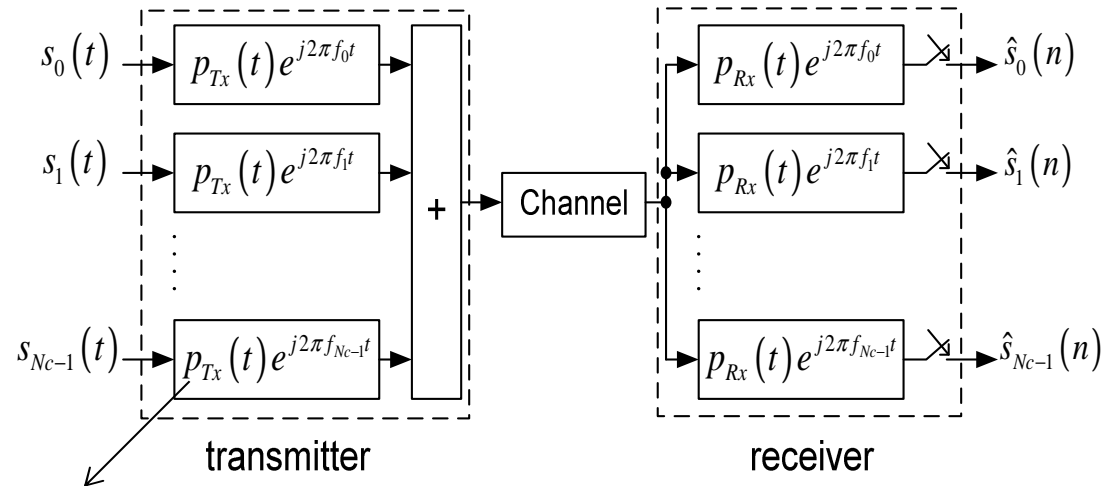
➔ Preamble

- Pilots BPSK
- Length = 4 blocks

➔ Data

- FFT size = 256 to 8192
- Max Active carriers = 149 to 4809
- Nb Active carriers = $4n+1$
- 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: $T = N_c T_s$

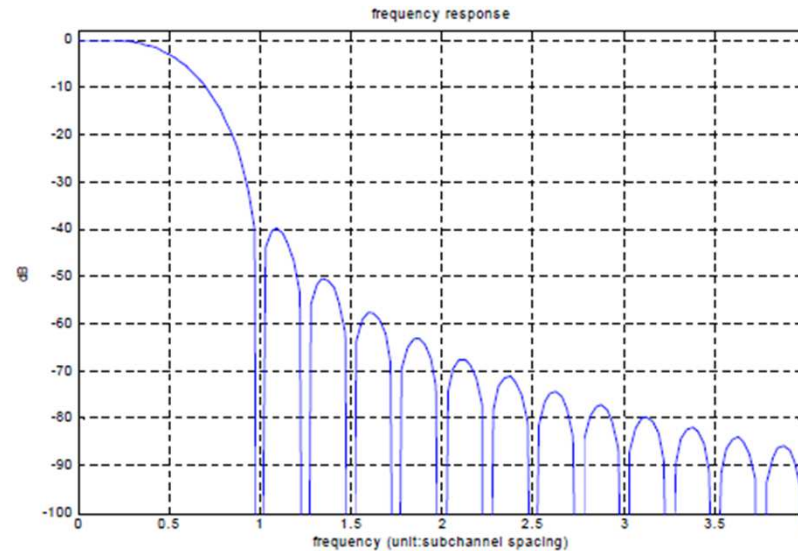
Sampling duration: T_s

InterCarrier Spacing: Δf

FBMC: Parameters

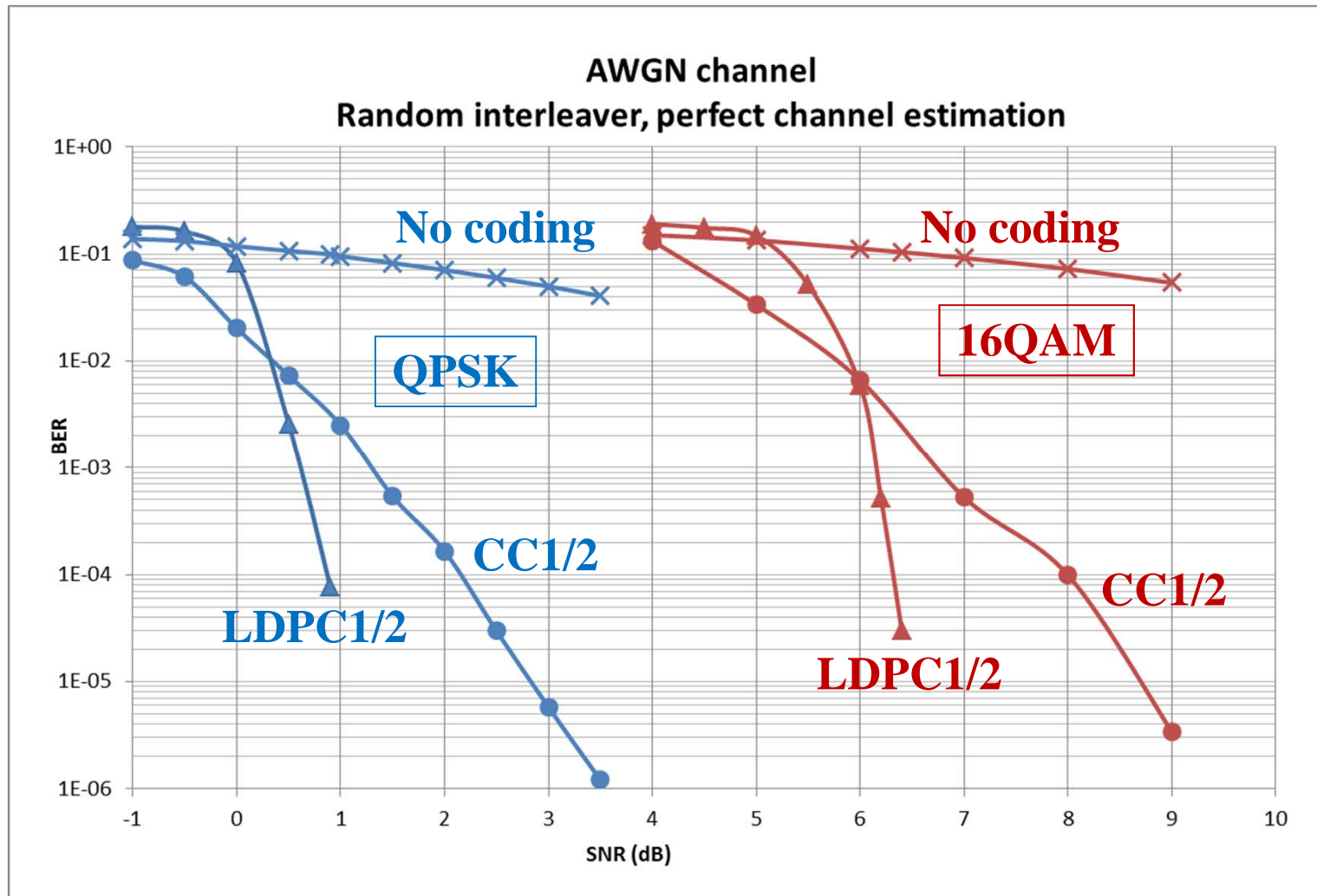
- ➔ $K = 4$ optimized for ACLR
 - 60dB rejection for the frequency range above 2 sub channels

$$\begin{aligned}
 K &= 4 \\
 \bar{P}[0] &= 1 \\
 \bar{P}[1] &= 0.97195983 \\
 \bar{P}[2] &= 1/\sqrt{2} \\
 \bar{P}[3] &= \sqrt{1 - \bar{P}[1]} = 0.23514695.
 \end{aligned}$$



[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 level 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