PERFORMANCE OF NEW WAVEFORMS AND NON UNIFORMS CONSTELLATION APPLIED TO DVB-T2 TRANSMISSIONS

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INTRODUCTION

CONTEXT

- Digital Video Broadcasting - Terrestrial_second generation (DVB-T2) is the European terrestrial digital broadcasting standard which presents a high flexibility and performance (when compared to the first-generation DVB-T).
- DVB-T2 system has been the subject of many researches during the last decade.
- Improvement of DVB-T2 system performance by substituting Orthogonal Frequency Division Multiplexing (OFDM) waveform by 5G proposed waveforms, Universal Filtered Multicarrier (UFMC) and Filter Bank Multicarrier (FBMC).
- Improvement of DVB-T2 system performance by substituting QAM by Non Uniform Constellations (NUCs) in Bit Interleaved Coded Modulation (BICM) in order to be closer to the Shannon capacity limit.

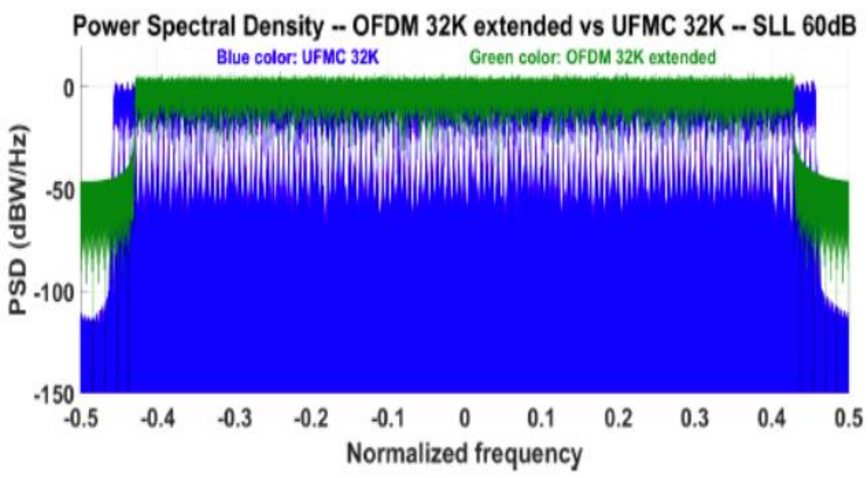
Achievements OF THIS WORK

- Comparison of FBMC and UFMC to OFDM in DVB-T2 system in terms of spectral efficiency, Power Spectral Density (PSD), performance gain and implementation complexity.
- Comparison of BICM/NUCs to BICM/QAM in DVB-T2 system.
- The choice of FBMC in DVB-T2 system induces a high spectral efficiency and a better performance gain but with a cost of implementation complexity
- UFMC induces a medium spectral efficiency and a noticeable performance gain with a complexity comparable to that for OFDM. It is the best compromise
- NUCs outperform QAM in DVB-T2 system.
- UFMC/NUCs outperform OFDM/QAM in DVB-T2 system

THEORICAL BACKGROUND

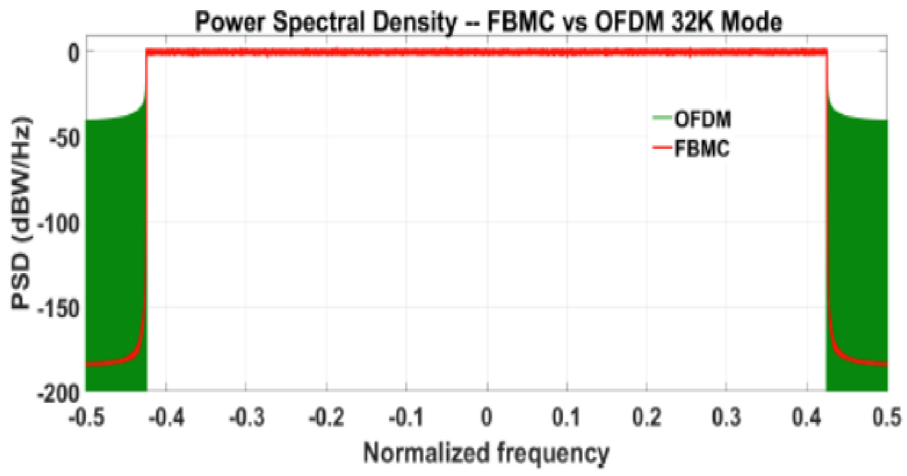
Topics of the work

UFMC PSD to compared OFDM



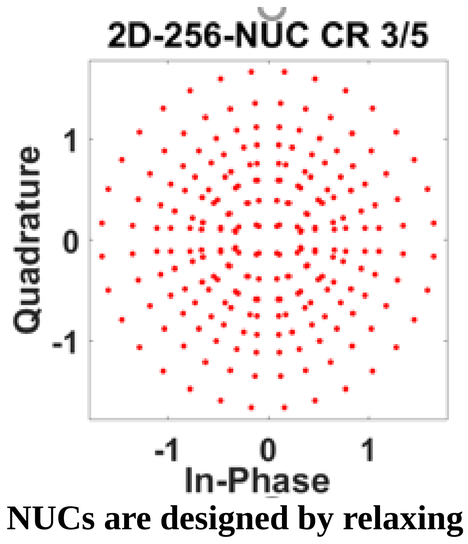
The side lobe level (SLL) of UFMC is lower than the OFDM PSD

FBMC PSD compared to OFDM



The SLL of FBMC is very lower than the OFDM PSD

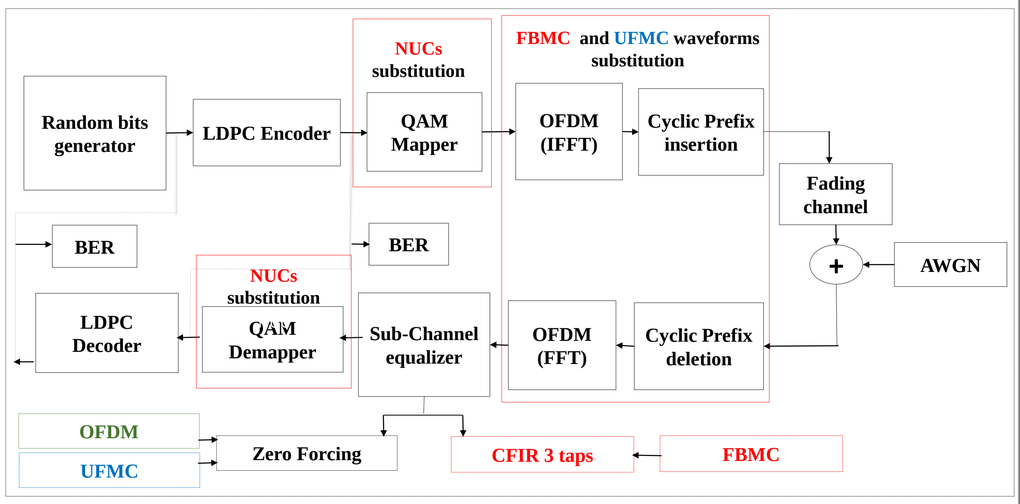
Non Uniform Constellations



NUCs are designed by relaxing the constellation square shape and the uniformity constraint.

SYSTEM IMPLEMENTED, METHOD AND PARAMETERS

System implemented



Simulation parameters

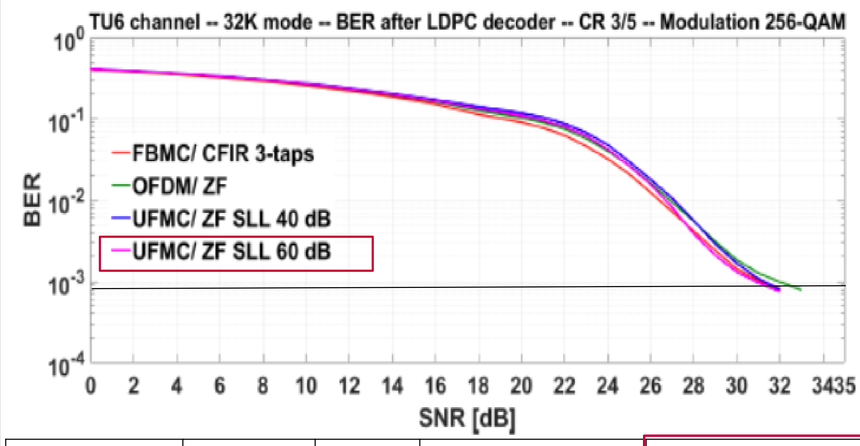
Parameters	OFDM	UFMC	FBMC
M	1024|32768	1024|32768	1024|32768
Data sub-carriers	853|27841	936|29952	1024|32768
QAM	256-QAM	256-QAM	256-QAM
Code rate	3/5, 1/2	3/5, 1/2	3/5, 1/2
Cyclic prefix	1/128|1/16	--	--
Overlapping factor	--	--	4
Filter length	--	K*CP=64|256	K*2M=8192|262142
Sub-band number	--	4|128	--
Sub-band bandwidth	--	234	--
Side Lobe Level	--	40|60dB	--

Fading channel, method

- Typical Urban 6 channel is the channel which emulates DVB-T2 urban environment and includes only a Non Line of Sight (NLOS) path.
- The BER after QAM demapper and Low-Density Parity Check (LDPC) have been computed

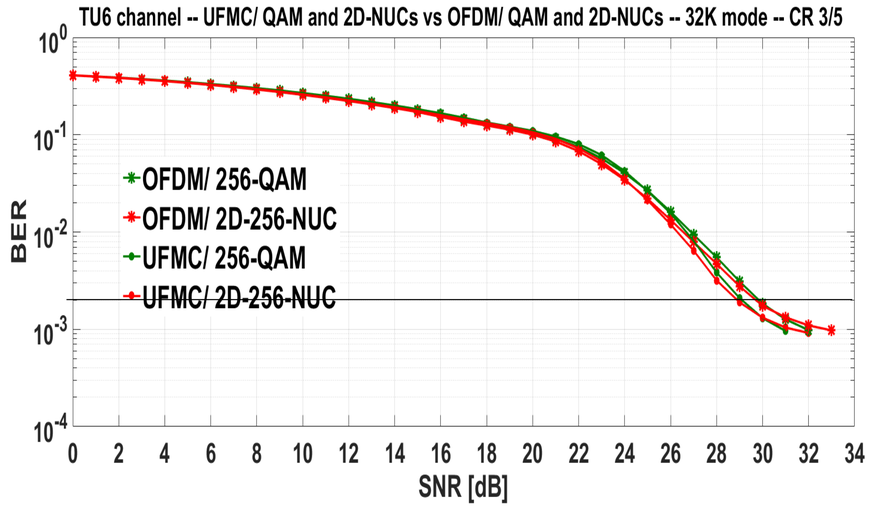
SIMULATION RESULTS AND DISCUSSIONS

BER after LDPC decoder (UFMC, FBMC and OFDM)



Waveforms	OFDM	FBMC	UFMC/ SLL 40 dB	UFMC/ SLL 60 dB
BER	10^{-3}	10^{-3}	10^{-3}	10^{-3}
SNR	32	31	31	30.8

BER after LDPC decoder (UFMC/NUCs and OFDM/QAM)



Discussions

UFMC/QAM vs OFDM/QAM	CR	BER	10^{-2}	3.10^{-3}	2.10^{-3}	10^{-3}
	1/2	Gain[dB]	0.2	0.7	0.6	1.2
	3/5	Gain[dB]	0.2	0.8	0.8	1.2
UFMC/NUCs vs OFDM/QAM	CR	BER	10^{-2}	3.10^{-3}	2.10^{-3}	10^{-3}
	1/2	Gain[dB]	0.9	1.2	0.6	-1.5
	3/5	Gain[dB]	0.7	1.2	1	1

- Both FBMC and UFMC are suitable for DVB-T2
- UFMC gain: 1.2dB at BER=10^{-3}, spectral efficiency: 128%, equal complexity
- FBMC gain: 1 dB at BER=10^{-3}, spectral efficiency: 133%, complexity equal to two time OFDM complexity
- UFMC/NUCs gain: 1.2dB at BER=3.10^{-3}

CONCLUSIONS

From all the results obtained, UFMC is chosen as the compromise between the complexity, the spectral efficiency and the SNR performance gain. This waveform has been combined jointly with NUCs in order to obtain the maximum reachable gain in DVB-T2 using these techniques. One can conclude that these techniques allow DVB-T2 system to be closer to the Shannon capacity limit.

REFERENCES

[1] A-C Honfoga, T. T. Nguyen, M. Dossou and V. Moeyaert, "Application of FBMC to DVB-T2: a comparison vs classical OFDM transmissions," IEEE GlobalSIP conference, 2019.
[2] A-C. Honfoga, M. Dossou, P. Dassi, V. Moeyaert, "Filtered based UFMC waveform applied on joint DVB-T2/NUC system", EAI AFRICOMM – 12th EAI International Conference on e-Infrastructure and e-Services for Developing Countries, 2020.
[3] European Broadcasting Union, "Digital Video Broadcasting (DVB); implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)," ETSI TS 102 831 V1.2.1, 2012.