Implementation and measurement of Power Adapted-OFDM using OpenAirInterface

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Introduction

The Fifth Generation of mobile communications (5G) is being standardized in order to reach higher data rates and deploy new services. In this frame, researchers are looking for possible waveforms to improve the air interface. Orthogonal Frequency Division Multiplexing (OFDM) has high Out-of-Band Emissions (OBE) which force us to leave wider guard bands, reducing so the spectral efficiency. Recently, we have proposed the Power Adapted-OFDM (PA-OFDM) [1] which is capable of fulfilling the requirements of 5G and avoids the main issues of other proposed candidates. OpenAirInterface (OAI) [2] is a powerful and flexible wireless technology platform based on the Long-Term Evolution (LTE) ecosystem [3], which offers the possibility of evaluating the effects of introducing a new technology on the entire mobile communication system. In this paper, we will evaluate and show the performance of the proposed technique using the OAI.

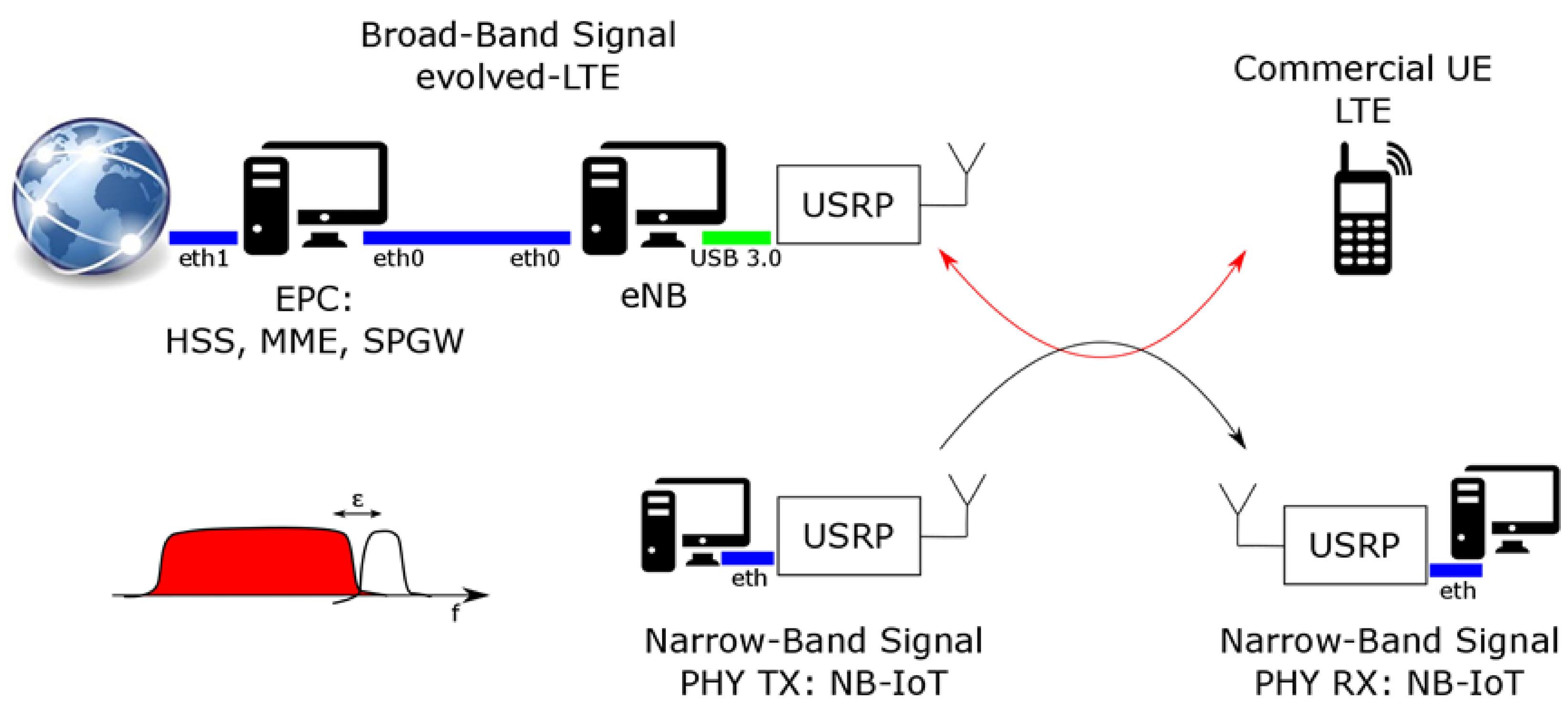
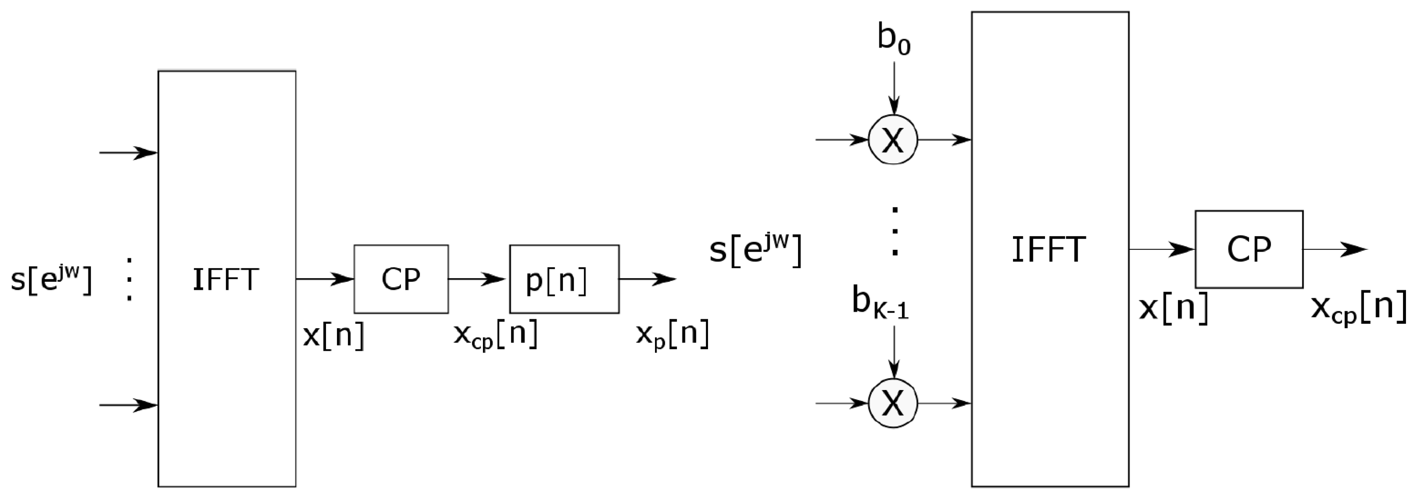


Figure 1: Diagram of the testbed

Reduction of out-of-band emissions in OFDM



(a) Implementation of f-OFDM. (b) Implementation of PA-OFDM.

Figure 2: Comparative of the architectures

Benefits of PA-OFDM:

- Fully backward compatible to any OFDM-based system
- Low OBE which implies a higher spectral efficiency
- Low-complexity which enables low-latency applications
- The power shaping provides an additional degree of freedom which allows a better scheduling

Description of the testbed

Hardware list for the deployment of e-LTE signal:

- Two host PCs Intel Core-i5@3.5 GHz with UBUNTU 14.03.02 and the proper low-latency kernels
- Universal Software Radio Peripheral (USRP) B210 by Ettus, it has two independent radio-frequency (RF) chains which cover from 70 MHz to 6 GHz
- Omnidirectional antenna of 3 dBi and duplexer
- Commercial 4G Android cell-phone
- Programmable SIM cards for testing: sysmoUSIM-SJS1
- Card reader: Omnikey CardMan 3121 USB CCID reader

Hardware list for the deployment of NB-IoT signal:

- Two host PCs Intel Core-i5@3.5 GHz with Windows 7 and LabVIEW 2015
- USRP NI-USRP-2920 by National Instruments, it has two independent RF chains which cover from 50 MHz to 2.2 GHz
- Omnidirectional antenna of 3 dBi and duplexer

Figure 3: Hardware

Performance of PA-OFDM

Bandwidth	5 MHz	**Cyclic Prefix**	Normal
Duplexing	FDD	**Trans. Mode**	1
DL Carrier Freq.	2122.5 MHz	**UL Carrier Freq.**	1932.5 MHz

Table 1: Physical parameters of the e-LTE signal

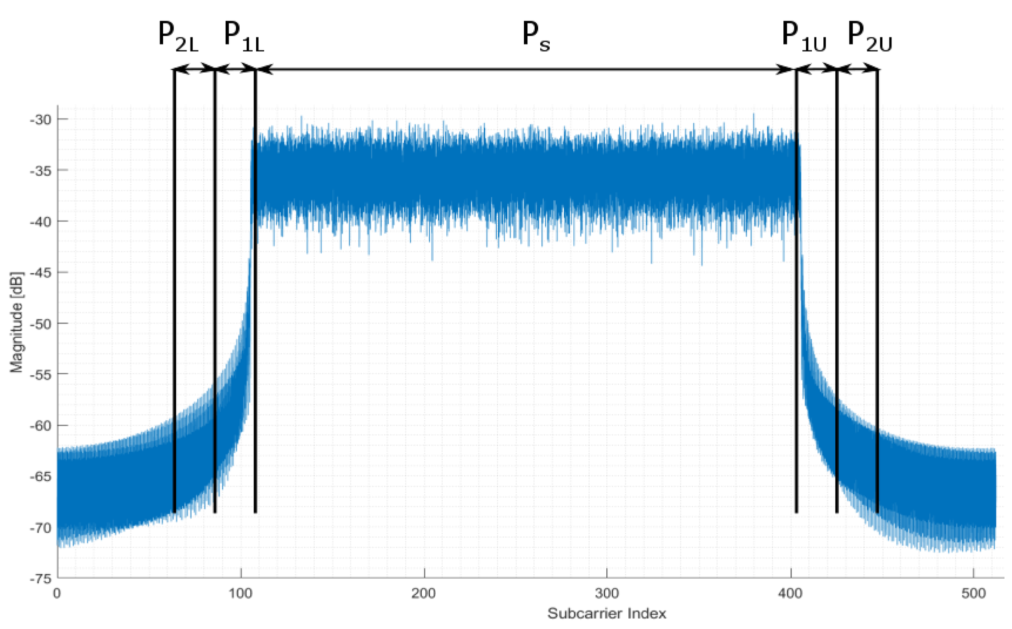


Figure 4: Procedure of the measurement of OBE

$$R_{vL} = 10\log\left(\frac{P_{vL}}{P_s}\right), \quad R_{vU} = 10\log\left(\frac{P_{vU}}{P_s}\right)$$

	OFDM	**PA-OFDM** 1**PRB, 3dB**	**PA-OFDM** 3**PRB, 3dB**	**PA-OFDM** 1**PRB, 6dB**
R_{1L}	-30.40	-33.57dB	-33.31dB	-36.04dB
R_{1U}	-29.12	-33.51dB	-34.63dB	-37.86dB
R_{2L}	-45.32	-47.43dB	-46.67dB	-49.06dB
R_{2U}	-44.88	-46.96dB	-47.20dB	-47.94dB

Table 2: Measurements of the OBE

Performance of NB-IoT signal in the presence of e-LTE signal

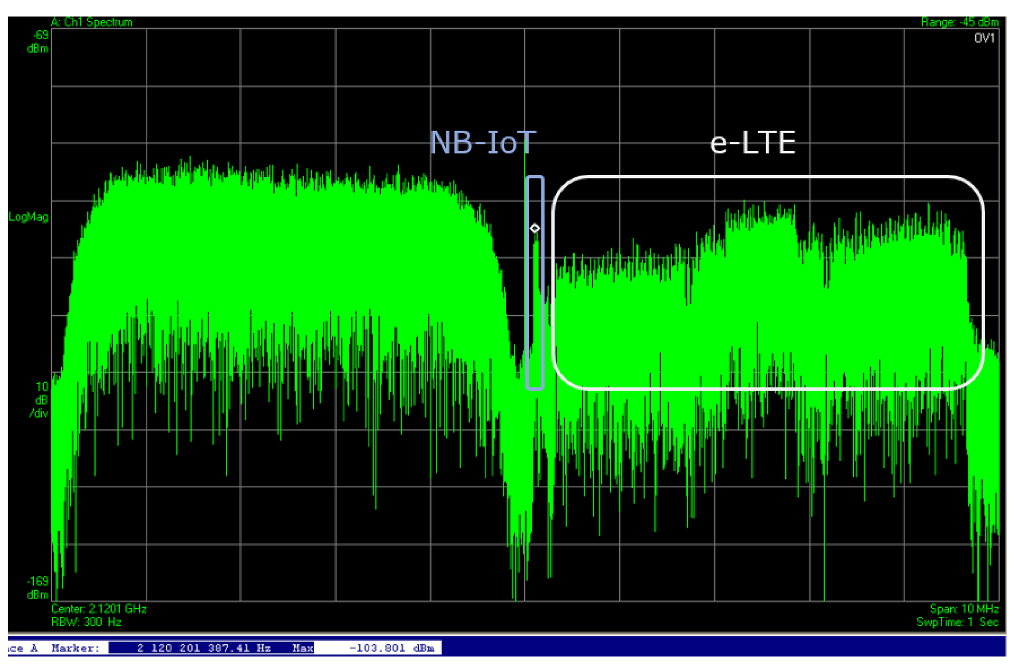


Figure 5: Spectrum-sharing among NB-IoT, e-LTE and other signals

Case	without e-LTE	with e-LTE OFDM	with e-LTE PA-OFDM
EVM	13.56%	29.64%	19.39%

Table 3: Comparison in terms of EVM of NB-IoT signal for different cases

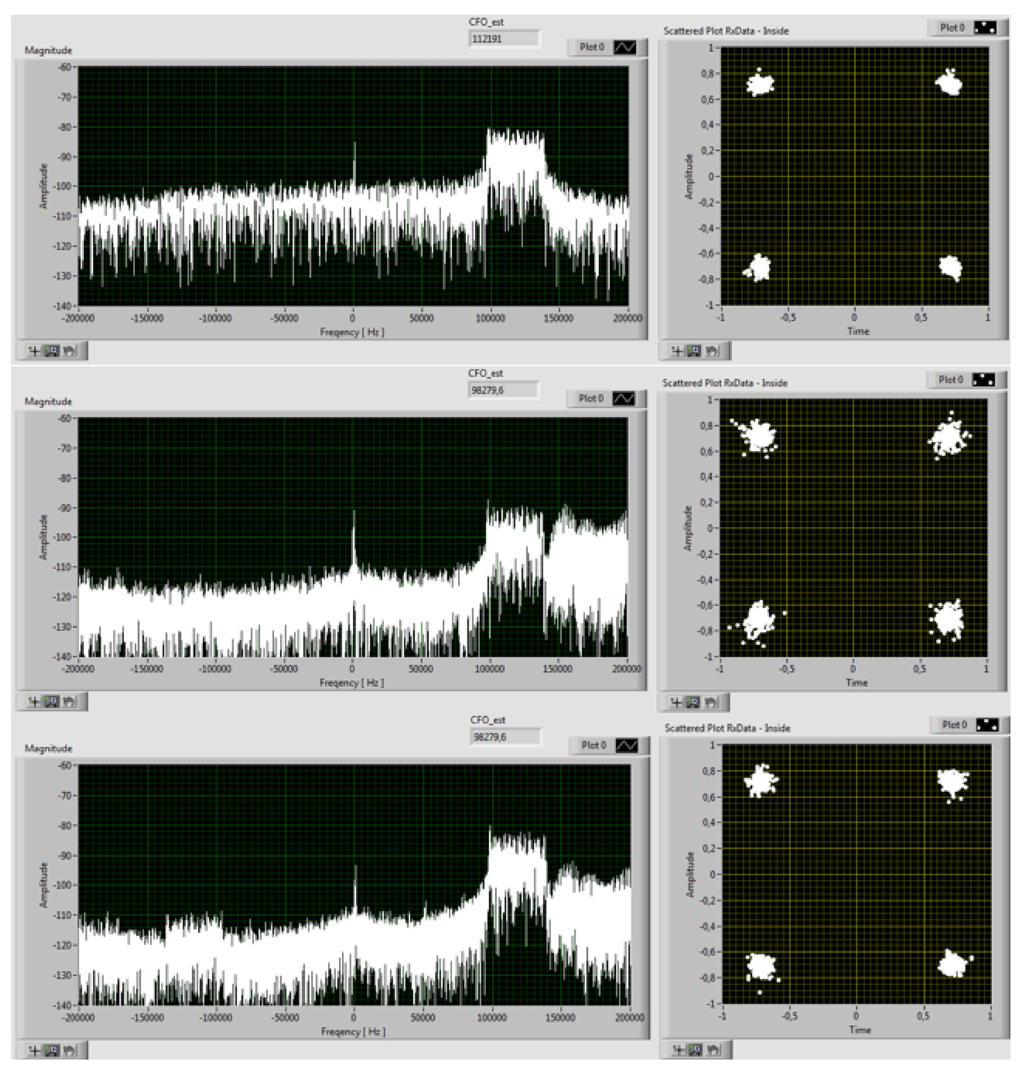


Figure 6: Constellation of NB-IoT signal without e-LTE signal (top), with e-LTE signal using OFDM (medium) and e-LTE signal with PA-OFDM (bottom)

References

[1] K. Chen-Hu, R. Perez-Leal, and A. G. Armada, "Reducing the interference by adapting the power of OFDM for mMTC," in *2018 IEEE 87th Vehicular Technology Conference, VTC2018-Spring*, Accepted.

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Acknowledgements

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