Study and mitigation techniques of RF impairments for beyond 5G multi-carrier waveforms

Mots clés :
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Résumé du projet de recherche (Langue 1)
The main objectives of this thesis are the following: 1. Identify the major RF impairments that can occur in broadband multicarrier waveforms that would potentially be adopted for 5G systems. 2. Study the effect of these RF impairments on the performance of the wireless systems in terms of in-band and out-of-band distortions. In this part, a special care will be given to characterize the nonlinear distortion induced by some realistic PA models. The in-band and out-of-band PA effects will be studied on the most pertinent waveforms contenders for 5G. A concern will be given to theoretical studies, aiming to characterize, in closed-form, the resulting signal distortion levels and system level impairment impact due to the different imperfections, in terms of bit-error-rate (BER) [9], power spectral density (PSD) [8] re-growth, adjacent channel leakage ratio (ACLR) and other related performance indicators. 3. Design dedicated signal processing based algorithms to mitigate Dirty-RF impairments on both the transmitter and the receiver sides of a 5G communication system. In this part of the work, more emphasis will be given to improve the performance of the selected multicarrier waveforms in presence of nonlinear HPA. This objective can be reached by adopting one of the following approaches: - Apply a peak to average power ratio (PAPR) reduction technique followed by a predistortion one to improve the trade-off between linearity and efficiency in RF power amplifier, - Combine the PAPR reduction and the predistortion techniques and propose a joint optimized algorithm increasing the HPA performances [10].

Résumé du projet de recherche (Langue 2)
Fundamental research towards 5G cellular networks is ongoing and driven by Mobile Broad-band Communications, Machine Type Communications (MTC) and Internet of Thing (IoT) applications. The vision of 2020 and beyond also includes a significant amount use cases con-sidering a massive number of devices with a wide range of characteristics and demands [1, 2]. For IoTs devices, the exchanged data can be sporadic with large exchanged packet sizes. These high data rates are associated with reliable and robust communication, low latency and fully justify the use of multicarrier modulations. Reliability and low latency are critical for con-trol/command, tactical or monitoring/alarm applications. As an example, the maximum laten-cies envisaged in Critical-Machine Type Communications C-MTC applications should not ex-ceed a millisecond. In an IoT context, communications must be asynchronous, to minimize network access times and minimize power consumption. It is unlikely that these challenges can be satisfied using Orthogonal Frequency Division Mul-tiplexing (OFDM), adopted by the Long-Term Evolution Advanced standard (LTE-A). To fulfill the above IoT constraints, new multicarrier techniques have been proposed [3]. Among these modulations, we can cite: WOLA-OFDM, f-OFDM, FBMC-OQAM, FBMC-QAM, FMT, GFDM, MC-FTN, UFMC, WCP-COQAM, Lapped-OFDM. The above mentioned post-OFDM waveforms provide good spectral efficiency and relax the time domain localization to impose well localized spectrum shape, which is particularly im-portant for asynchronous, device-to-device (D2D) and MTC communications. To access such heterogeneous and mass-market applications within 5G networks, a major is-sue in the design and implementation of radio equipment is the cost-efficiency, in terms of ra-dio implementation size, cost and power consumption. On one hand, building compact and low-cost flexible and high quality radio equipment is a very challenging task. Then, various Dirty-RF impairments could take place in the used radio transceiver such as: oscillator phase noise, mirror-frequency interference due to IQ mismatch and Tx Leakage due to an adjacent antenna and non-linear distortion due to high power amplifier (HPA). Moreover, the issues of Dirty-RF imperfections and energy-efficiency are more pronounced when wideband multicarrier waveform is being deployed as this would be the case in 5G and beyond systems. Indeed, in presence of Dirty-RF , in particular HPA nonlinearity, most of the multicarrier waveforms lose rapidly their good properties in terms of frequency localization and energy-efficiency. Thus, this thesis will, in one hand, focus on developing deep understanding about the most essential analog RF impairments, affecting the performance of the selected waveform for 5G and the other candidates for the beyond 5G systems. In another hand, the Ph.D. student will establish new algorithms that aim at mitigating these RF imperfections jointly with increasing the system energy-efficiency.

Informations complémentaires (Langue 2)