Berichte aus der Kommunikationstechnik

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Shaker Verlag
Aachen 2014

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Zugl.: D 82 (Diss. RWTH Aachen University, 2013)

Printed in Germany.

ISBN 978-3-8440-2924-6
ISSN 0945-0823

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen
Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9
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Current broadband wireless standards are based on Orthogonal frequency division multiplexing (OFDM), a multicarrier modulation scheme that provides strong robustness against multipath fading. However, due to the increasing demand for new high data rate services, an important task in the design of future OFDM systems is to exploit frequency diversity offered by a broadband channel. The efficient way to preserve power and bandwidth efficiency is to perform an efficient resource allocation by adapting transmission parameters (bandwidth, coding/data rate, power) while satisfying certain system requirements.

However, the investigation and assessment of information theoretic concepts in a radio frequency (RF) environment is limited in the literature. This is mostly due to the lack of commercial hardware that can support adaptable transmission parameters. Currently, these functionalities are only offered by Software Defined Radio (SDR) technology supported by general purpose hardware.

This work aims at bringing information theoretic concepts for wireless resource management closer to the practical application by identifying and addressing the important challenges that arise from the implementation of an adaptive OFDM communication system. This comprises the presence of a real radio frequency (RF) channel, as well as the critical influence of the SNR estimation and hardware imperfections on the system performance. The contributions in this theses are of *theoretical* and *practical* nature.

Because the signal-to-noise ratio (SNR) provides the measure of signal quality often used as an input parameter for many resource allocation algorithms, the *theoretical* contribution of this work focuses largely on proposing an efficient algorithm for the SNR estimation in wireless OFDM systems. Furthermore, this work contains the study of the rate adaptive resource allocation algorithms in a synchronization mismatch scenario with the proposed SNR estimator. This discussion provides information about performance degradation of a real implementable transceiver with respect to an ideal transmission system with perfectly estimated parameters.

The main *practical* contribution of this work is the design and implementation of an SDR-based reconfigurable framework for testing the capacity-achieving adaptive OFDM transmission in a wireless RF environment. The implementation comprises a complete reconfigurable OFDM physical layer transceiver with a large set of reconfigurable parameters, which are normally static in real systems. This framework enables adaptivity of individual subcarriers such that practical evaluation of resource allocation algorithms can be performed.

The transceiver performance is characterized and analyzed through the concept of SNR loss and corresponding rate-power function. The performance evaluation of the resource allocation algorithms in real RF conditions using the TIGR framework is presented. The results are compared with the simulation results showing the applicability of hardware imperfections models and robustness of the proposed SNR estimator to the design of efficient resource allocation algorithms.