Hannoversche Beiträge zur Nachrichtentechnik

Band 1.9

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> Shaker Verlag Aachen 2009

## 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.: Hannover, Leibniz Univ., Diss., 2009

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Printed in Germany.

ISBN 978-3-8322-8592-0 ISSN 1616-5489

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9 Internet: www.shaker.de • e-mail: info@shaker.de

## A Software Defined Radio Approach for High Data-Rate Multi-Antenna Wireless Communications with Frequency Domain Processing

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## Abstract

The internet with its highly dynamic development of applications, new business models, and services are a or maybe the moving spirit behind innovations in information and telecommunications, as it challenges the communications technology with its sempiternal growing data-rate requirements. In wireless communications this growing demands for higher data-rates, are limited by country specific regulation, by technology, and by theory.

A true evolution in communications is the multi-antenna technology, which is enabled by multiple antennas at transmitter and receiver-side. These so called Multiple-Input Multiple-Output (MIMO) systems are leading to a re-formulation of Shannon-Hartley's law of capacity, implying a linear growth of the data-rate with the number of transmit and receive antenna pairs without requiring additional transmit power, lower noise, or broader bandwidth.

Therefore, this technology does not break with regulatory requirements to gain data-rate or range, but instead introduces challenges to the system architecture.

The convergence of the physical layers to the Orthogonal Frequency Division Multiplexing (OFDM) based schemes is an interesting fact, which is usually assisted by the claim that OFDM is the only efficient scheme able to cope with high data-rate transmission in frequency selective multi-path environments. Frequency Domain Equalization (FDE) for Single-Carrier (SC) schemes is in this regards often overlooked.

The combination of OFDM and MIMO is often studied, while the combination of MIMO with SC-FDE is more seldomly considered, especially combined with practical measurements via test-beds.

Hence, this contribution focuses on MIMO communication schemes employing FDE with special emphasis on the SC based schemes for high data-rate transmission via frequency selective multi-path channels with no, full, and limited channel knowledge at the transmitter. A joint view to OFDM and SC-FDE based MIMO systems yield to the development of a common mathematical framework for both. In addition, the related multi-user extension is studied, and a comprehensive multi-user simulation approach is proposed. The theoretical treatment of the schemes is enriched by practical views, which were obtained during the development of several MIMO test-beds. Furthermore, this contribution outlines the concepts, the developments, and the deployments of test-beds for MIMO communication systems based on software defined radio approaches, and reports a complete MIMO SC-FDE experimental setup using spatial multiplexing.