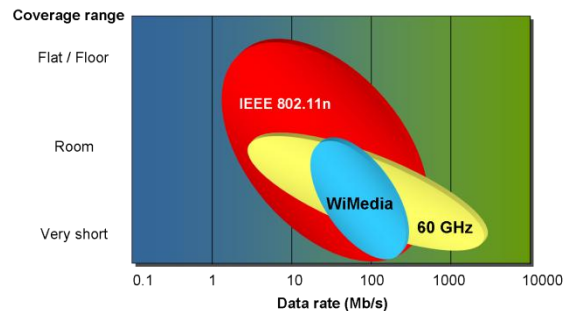


A. Title and abstract

Radio Communications: From the Basics to Future Developments

This tutorial intends to give an insight into radio communications by building a bridge between the fundamentals and the recent advancements. For this purpose, the tutorial starts with the basics of transmission techniques and channel coding. Afterwards, the principles of simulation and evaluation are summarized. The tutorial closes with an overview on recent and future developments of WLAN and WiMedia.



B. Lectures

1) Spectrally efficient multicarrier architectures and algorithms

Speaker: Andrea Tonello

Abstract:

Multicarrier modulation is enjoying great success in state-of-the-art physical layer wireless technologies. The most popular architecture is orthogonal frequency division multiplexing (OFDM). Aiming at increasing spectral efficiency more general architectures based on filter bank modulation (FBM) have been recently proposed - among these Filtered Multitone Modulation (FMT). This talk offers an overview of multicarrier modulation using a filter bank description of the modulation and demodulation stages. We discuss recent results on the efficient digital implementation and on the synchronization and detection/equalization problem. We briefly highlight the fact that FBM architectures allow the flexible implementation of user multiplexing via a combination of TDMA, FDMA, and CDMA. We discuss the advantages of the FBM schemes and their performance in doubly dispersive channels, and in the presence of hardware impairment as phase noise. Finally, we present adaptive MAC/PHY algorithms that optimally combine FBM with user multiplexing and bit-loading in statistically representative IEEE 802.11 WLAN channels.

2) Forward error correction in radio networks

Speaker: Stefan Nowak

Abstract:

Forward Error Correction (FEC) is essential for reliable radio communication. Starting from simple FEC schemes in the forties of the last century coding experts have now practically reached the Shannon limit by means of powerful Turbo codes and Low-density parity-check codes. This tutorial shortly summarizes the exciting development of FEC for radio communication from past to present and highlights state-of-the-art coding schemes such as Reed-Solomon codes, convolutional codes, Turbo codes and Low-density parity-check codes. Furthermore, their application in state-of-the-art radio communication systems will be addressed.

3) Advances in wireless LANs

Speaker: Oliver Hoffmann

Abstract:

WLAN applications have flourished tremendously over the last years. What started out as cable replacement for static desktops in indoor networks has been extended to a broad range applications including wide-area outdoor community networks, moving vehicles, high-speed trains, and even airplanes. For these purposes, the most important WLAN technology, namely IEEE 802.11, has experienced significant advancements in diverse aspects like data rates, robustness, medium access, quality of service and security. This tutorial provides a comprehensive overview on several key topics related to current and emerging IEEE 802.11 advancements. The focus will be on the key throughput enhancing PHY and MAC features. Therefore, the recently released 11n amendment will be extensively discussed and evaluated.

4) Future perspective of the WiMedia standard

Speaker: Holger Rosier

Abstract:

Since the members of the IEEE 802.15.3a Task Group have announced to develop a new physical and medium access control layer for short range communication with high data rates in March 2004, products are still missing. The reasons are manifold. It takes the Multi Band OFDM Alliance and further on the WiMedia alliance a long time for worldwide spectrum regulation and standardisation. But what is today's situation and what is the effort of WiMedia?

WiMedia's objectives are still valid. Users are waiting for high data rate in wireless personal area networks. Several regulation bodies around the world have decided to open a spectrum range for ultra wideband (UWB) communication. What makes it special is the fact that UWB as a secondary user shares the same bandwidth already licensed for narrow band systems.

ECMA-368, also referred to as WiMedia standard, is the only UWB standard for consumer electronics. It is characterized by a powerful medium access control, offering two different channel access mechanisms. In contrast to Bluetooth the medium access is organised in a fully distributed manner and makes WiMedia well suited for short range communication.

This tutorial will give an overview on ECMA-368 and further details about the medium access control layer, enriched by latest research results. It will deliver insights into WiMedia's efforts on future wireless personal area networks.

5) Performance evaluation of wireless networks using the open Wireless Network Simulator

Speaker: Sebastian Max

Abstract:

Event based simulation has been applied successfully since a long time to evaluate the system-level performance of wireless communication networks. A significant problem of this type of evaluation is the trustworthiness of the results: How can an external reviewer judge the correctness of the complex code, the applicability of the scenarios, the statistical confidence of the results?

This talk introduces the open Wireless Network Simulator (openWNS), developed in the last 5 years at the department of Communication Networks (ComNets) at RWTH Aachen University. It is designed especially to allow for both rapid protocol development and high-quality simulative performance evaluation. This is explained by the following details:

- (a) The modular simulation framework for protocol stack development, which includes unit tests of many functional parts.
- (b) The calibration of the simulator using analytical models that is integrated into a system-testing interface.
- (c) The GUI-assisted generation and evaluation of complex simulation campaigns to enable simulation of large parameter sets.
- (d) The LGPL-licence, allowing for open source publication to make generated results repeatable and verifiable.

All points are exemplified by the WiFiMAC module, which provides the functions of IEEE 802.11, including amendment e, n and s. The talk finishes with a distribution of the openWNS on a Ubuntu LiveDVD.

C. Preferred duration

In order to convey the comprehensive knowledge of this tutorial, we intend to have lectures of 30 minutes. Additionally, we would like to allocate 5 minutes per lecture for questions and answers. Including 30 minutes coffee break, the whole tutorial session would thus take 3.5 hours.

D. List of speakers

Andrea Tonello

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Andrea Tonello leads the Wireless and Power Line Communications group at the department of electrical engineering of the University of Udine (Italy) where he is an aggregate professor. Dr. Tonello is a former technical manager of Bell Labs – Lucent Technologies, Whippany (NJ), and the managing director of Bell Labs Italy. Herein from 1997 to 2002, he has conducted research on wireless systems, he has been involved in the standardization of 2-3G cellular systems, and he has been responsible for fostering research initiatives with industrial and academic institutions. He authored about 100 contributions among technical papers, patents, and standard contributions. He serves as an Associate Editor for the IEEE Transactions on Vehicular Technology. He has served as TPC co-chair in several conferences.

Stefan Nowak

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Stefan Nowak studied Electrical Engineering at Dortmund University of Technology. After receiving his diploma degree in 2007 he joined the Communication Technology Institute at Dortmund University of Technology where he is working towards his PhD. His current research interests cover modern error correction control mechanisms and their application in future communication systems.

Oliver Hoffmann

Communication Technology Institute
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Oliver Hoffmann studied Electrical Engineering and Information Technology at Dortmund University of Technology. After receiving his diploma degree with distinction in 2005 he joined the Communication Technology Institute at Dortmund University of Technology where he is working towards his PhD. His current research interests cover technologies and components of wireless networks for electronic media.

Holger Rosier

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After receiving his diploma degree in Electrical Engineering at the RWTH Aachen University, Holger Rosier began working in the ComNets research group in 2008, where he is currently working towards his PhD. His main focus is on wireless communication systems for home environments.

Sebastian Max

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Sebastian Max studied computer science at the RWTH Aachen University, and received his diploma degree with distinction in 2005. Since 2005 he is with the Chair of Communication Networks (ComNets) at RWTH Aachen University, Germany, where he is working towards his Ph.D. His main research field is wireless mesh networks for small-scale to city-wide Internet access.

E. Organization and prior history

This tutorial will be organized by the FP7 integrated project “OMEGA – Home Gigabit Access.” The aim of OMEGA is to integrate various appropriate technologies into a converged heterogeneous network, improving the quality of service, reliability and throughput. Gigabit radio and optical links, combined with more robust local area radio technologies and visible light communication will provide wireless connectivity within the home and its surroundings. The combination with a powerline communication (PLC) backbone will lead to a home network “without new wires.” From user perspective the goal is to provide ubiquitous and self-configurable networks, with simple installation and management.



In order to share the knowledge on OMEGA’s results, external hands-on training seminars are organized. Such tutorials are primarily aimed at technical experts in the telecoms industry who are interested to learn about the concept and specific technical subjects of OMEGA.

So far, OMEGA has organized three internal tutorials on MAC techniques, home networking technologies and FPGA implementation. At the “Third Workshop on Power Line Communications (WSPLC’09),” OMEGA organized its first external tutorial. This tutorial covered several topics of in-home PLC.