Mobile Communication Networks
International Master of Science in Research in Computer and System Engineering (RCSE)

Winter Semester 2010/11

Integrated Communication Systems Group
Ilmenau University of Technology
Outline

• Motivation
• Objectives
• Organizational Stuff
• Contents
• Working Method
• Overview on Courses
Motivation

Why is it important?

– The Internet and mobile communication networks are experiencing an enormous growth and are a crucial factor of today’s economy

Future networks

– Heterogeneous fixed and mobile networks interconnected by a common IP core
– Quick introduction of new network elements, applications and services
– Higher bandwidth, reduced delay and lower cost

Challenges:

– Heterogeneity, dynamics, complexity, scalability of systems
– Self-organization, mobility management, QoS, security
Objectives

• Provide an in-depth understanding of research issues in mobile communication networks
• Understand protocol and networking issues of future mobile communication networks, esp. ad hoc networks and cognitive radio systems
• Focus on mobility management and Quality of Service (QoS)
• Focus on communication systems (GSM, UMTS and LTE)
• Overview about research in IGS Mobicom and ICS
• Get prepared for research in mobile networking
Organizational Stuff

• Course prerequisites
  – Required: basics of communication networks
  – Strongly recommended: basics of IP-based mobile communication systems
  – Course description is provided at www.tu-ilmenau.de/ics

• Credits:
  – 4 ECTS

• Course budget
  – 3 SWS for front-up course
Organizational Stuff

• Instructor contact information
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    • Phone: 03677-69-1379
Contents

• Lectures
  – Introduction
  – PHY
  – Medium access schemes
  – Mobility management – Basic
  – Mobility management – Advanced
  – IP review
  – TCP, esp. flow control
  – Quality of Service (QoS) – Basic
  – Quality of Service (QoS) – Advanced
  – IP Security
  – IEEE 802.11
  – IEEE 802.11 security
  – Ad hoc networks
  – GSM overview
  – UMTS overview
  – LTE overview
  – Self-organization in communication systems
  – Cognitive radio networks
  – Research in the IGS on Mobile Communications
  – Research in the ICS group
## Contents and Schedule

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<th>Date</th>
<th>Time</th>
<th>Lecturer</th>
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<td>Introduction</td>
<td>Oct. 13, 2010</td>
<td>11.00 - 12.30</td>
<td>Mts</td>
<td>Sr Oe 110</td>
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<td>PHY</td>
<td>Oct. 14, 2010</td>
<td>09.00 - 10.30</td>
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<td>TCP, esp. flow control</td>
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<td>IEEE 802.11</td>
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<td>09.00 - 10.30</td>
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<td>IEEE 802.11 security</td>
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<td>13</td>
<td>Ad Hoc Networks</td>
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<td>11.00 - 12.30</td>
<td>Kalil</td>
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<td>14</td>
<td>GSM overview</td>
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<td>09.00 - 10.30</td>
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<td>15</td>
<td>UMTS overview</td>
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<td>Self-Organization in communication systems</td>
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<td>Kalil</td>
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<td>18</td>
<td>Cognitive Radio Networks</td>
<td>Jan. 05, 2011</td>
<td>11.00 - 12.30</td>
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<td>Research in the IGS on Mobile Communications</td>
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<td>Research in the ICS group</td>
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<td>09.00 - 10.30</td>
<td>Mts</td>
<td>Sr K 2035</td>
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Working Method

• Lectures/lessons
  – Acquire knowledge of mobile communication networks and protocols
  – Focus on research trends

• Exams
  – 20 minutes oral exam (mPL) covering contents of the course
# Overview on Courses Provided by ICS Group

## B.Sc.
1. **Techn. Informatik 1/ Rechnerorganisation**
4. **Integrierte Hard- und Softwaresysteme 1**
5. **Mobilkommunikationsnetze**
6. **Projektseminar Mobilkommunikationsnetze**

## M.Sc.
- **Wireless Internet (SS)**
  - M.Sc. II, MIKS & Remote Engineering
- **UMTS Networks (WS)**
- **Mobile Communication Networks (WS)**
- **Advanced Networking (SS)**

## Doctoral Studies …
What's next?

International Graduate School on MOBILE COMMUNICATIONS

Home

Message from the Head
The Graduate School is committed to encouraging a spirit of cooperation, open-mindedness and independence. The school's central commitments are:

- our doctoral students' early independence, empowering them to develop freely without constraints,
- an open-mindedness that supports the development of successful, independent minds with an eye on contemporary problems and solutions for an increasingly complex world.

The School welcomes new members and partners worldwide, both individuals and institutions, who can

www.gs-mobicom.de
Graduate School Research Goals

- Problem of today’s networks:
  Heterogeneity – Dynamic – Complexity

- Method:
  Self-organization – autonomous, dynamic, distributed

- Application scenario:
  Disasters – self-organization of communication systems under severe impact

- Demonstration:
  Simulation, experimental network
Graduate School Research Areas

- **R**: Reconfigurable Radio Interfaces
- **S**: Self-organized Service Recovery
- **I**: Decentralized Information Management
- **T**: Cognitive Management of Transport Resources
Introduction
Wireless Business and Markets
State of the Wireless Data Business

**Telecommunication World**
- 2G Mobile Communication Systems are in place (GSM, GPRS, EDGE)
- 3G Mobile Systems (UMTS incl. HSDPA) are up and running
- First B3G systems (LTE/SAE) are getting deployed
- Wireless voice market is saturating
- Data traffic is growing, flat rates are getting common
- Traditional Telecom Operator and infrastructure providers target the Internet market

**Internet World**
- Fast fixed Internet access is common (DSL)
- WLAN hot spots are installed at airports, campus areas, coffee shops, etc.
- 802.11a products are standard, 802.11n is establishing
- 802.16 (WiMAX) products are available
- 802.20 (Mobile Broadband Wireless Access - MBWA) standards approved
- Internet Service Providers (ISP) and Internet infrastructure provider target the mobile market
Mobile Networks in Germany

Thousands of subscribers

- C-Netz
- 2G-GSM/GPRS
- 3G-UMTS/HSPA
- Total Mobile Subscribers

Oct 2007

Mobile Networks in Germany

Thousands of subscribers

- C-Netz
- 2G-GSM/GPRS
- 3G-UMTS/HSPA
- Total Mobile Subscribers

Oct 2007
## German Mobile Operators Revenues, 2007 Estimates

<table>
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<tr>
<th></th>
<th>Total revenue In 2007</th>
<th>Average revenue per user (ARPU)</th>
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<tbody>
<tr>
<td></td>
<td>[US$\text{m}]</td>
<td>[US$]</td>
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<tr>
<td><strong>Total Mobile Revenues</strong></td>
<td>$27,559</td>
<td>$25.33</td>
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<tr>
<td>Voice Revenue</td>
<td>$21,417</td>
<td>$19.68</td>
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<tr>
<td>Data Revenue</td>
<td>$6,142</td>
<td>$5.64</td>
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<tr>
<td><strong>Messaging Revenue</strong></td>
<td>$4,704</td>
<td>$4.32</td>
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<tr>
<td>SMS</td>
<td>$4,026</td>
<td>$3.70</td>
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<td>MMS</td>
<td>$260</td>
<td>$0.24</td>
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<tr>
<td>Email</td>
<td>$399</td>
<td>$0.37</td>
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<td>Other Messaging</td>
<td>$19</td>
<td>$0.02</td>
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<tr>
<td><strong>Non-Messaging Revenue</strong></td>
<td>$1,438</td>
<td>$1.32</td>
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<tr>
<td>Ringtones</td>
<td>$332</td>
<td>$0.31</td>
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<tr>
<td>Graphics/Images</td>
<td>$162</td>
<td>$0.15</td>
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<td>Games</td>
<td>$263</td>
<td>$0.24</td>
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<tr>
<td>Information Services</td>
<td>$163</td>
<td>$0.15</td>
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<tr>
<td>Music</td>
<td>$59</td>
<td>$0.05</td>
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<td>Video</td>
<td>$88</td>
<td>$0.08</td>
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<tr>
<td>Mobile Data/Remote Access</td>
<td>$371</td>
<td>$0.34</td>
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Public and Community WLAN/WiFi/802.11 Systems

www.fon.com

www.wlan-weimar.de
IEEE 802.16/WiMAX Systems

2005: Fixed Outdoor
- E1/T1 level service for enterprises
- Backhaul for hotspots
- Limited residential broadband access

2006 (802-16d): Fixed Indoor
- Indoor ‘last mile’ access for consumers
- Wireless DSL
- Metrozone / Enterprise campus piconet

2008 (16e): Portable/Mobile
- ‘Portable’ broadband access for consumers
- Always best connected
Future Networks/Next Generation Network (NGN)

- is a packet-based network
- provides telecommunication services and more
- uses multiple broadband, QoS-enabled transport technologies
- offers unrestricted access by users to different service providers
- supports generalized mobility
- allows consistent and ubiquitous provision of services to users
- service-related functions are independent from underlying transport-related technologies
- improved handling and management of middle-boxes
Unlicensed Mobile Access (UMA)

Idea:
Access to GSM and GPRS mobile services over unlicensed spectrum (WLAN, Bluetooth) for consistent user experience

User View:
- Voice and data services
- Same mobile identity on GSM and WLAN
- Seamless delivery (roaming and handover)
- Security equivalent to GSM

Operator view:
- Preserves investment in mobile core network infrastructure
- Independent of underlying unlicensed spectrum technology (e.g. WLAN, Bluetooth)
- Transparent to existing, standard devices (e.g. access points, routers and modems)
- No impact to operations of GSM/UMTS (e.g. spectrum engineering, cell planning, …)

Participants: T-Mobile, Alcatel, BT, Cingular, Ericsson, Motorola, Nokia, Nortel, O2, Siemens, Sony-Ericsson, …
UMA Architecture

For details see www.umatechnology.org/overview/
Fixed Mobile Convergence

FMC Solution: SIP over Wi-Fi

• Centralized Application Server or IP-PBX controls VoIP services

• advanced VoIP services on mobile, enterprise, home and public Wi-Fi networks

• Enables wireline or wireless replacement

http://www.thefmca.com/
5G: Interplanetary Internet
Contact

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