University of Dortmund

Broadband Wireless Research in Dortmund

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Dortmund:
- 6th largest City in Germany
- Located in the heart of the Ruhrgebiet

Uni Do:
- Founded in 1968
- 25,000 Students
- Ranked 6th of all Technical Universities in Germany
- ECIU member
Research Profile

Information Technology
Spatial Planning
Building Sciences
Statistics
Computer Science
Chemical Engineering
Business, Economics & Social Sciences
Teacher Training
Journalism
Special Education
Vocational and Social Education
Automation & Robotics
Logistics
Bilingual Teaching & Learning
Engineering for Vocational Teaching
Electrical Engineering & Information Technology

- 15 Departments and Institutes
- Information Technology
  - Wireless Communication
  - Optical Switching
- Chip Design
  - System on a Chip (SoC) Design and Verification
  - Automatic Generation of Application Specific Embedded Processors (ASIPs)
- Power Generation
  - Decentralized regenerative Energy Control

Automation and Robotics

- Masters course
- Cooperative control of multi-robot systems (Robot soccer, Skylab)
- Simulation and training of work machines (e.g. forest harvester)
- Intelligent (dis-)assembly systems
- Field bus systems
Communication Networks connect people and intelligent devices

The research at the Communication Network Institute focusses on the development of future communication networks and services.

We cooperate with national and international partners from industry and research institutes.

Telefomy and the Internet are part of daily life for more than 1 Billion people worldwide.

Source: Network Agency (Federal Register for Post and Telecommunication)
Novel Network Concepts and Services

- Development and Implementation of Novel Network Architectures and Communication Protocols
- Performance Evaluation in a Realistically Modelled Environment
- Optimal Distribution of Service Intelligence between Infrastructure and Terminal in Heterogenous Networks
- Business cases modelling from an operator’s and manufacturer’s perspective

CNI Multi-Network Technology Lab

UMTS „Network-in-the-box“ Emulator

Research on Novel Services, Protocols and Network Architectures at CNI
Mobility and Real Time-Internet-Services

High Quality of Services even under extreme conditions, e.g.:
- Pattern Recognition and Mobility Prognosis for improving Quality of Service Parameters
- Determination of Key Performance Indicators on Network- and Service Layer

Entirely new Services and service features:
- IP-based Multimedia-Group-Communications
- Farewell to the Telephone Number: one Address for all Services by ENUM DNS
- Embedded Systems for Civil Protection and disaster management

Specific targeted research projects

IP-based Multimedia Group Communication

Jörn Seger
Current projects

Analysis of group communication

Video group communication

Push-to-Talk on embedded devices

Analysis of voice group communication

Scenario

Three alternative methods for talk request:

1. Server Floor Control:
   Server handles talk requests
   (Mastermind)

2. Peer Floor Control:
   Talker requests all group members avialability

3. Zero Floor Control:
   Mixing of audio packets
   All group members can speak at all time
Analysis of voice group communication

Measurement

Problem:
How to measure the quality of a group communication?

• End-to-End Measurement
  • Timestamps must be synchronized
  • Mobile equipment does not provide any timestamps
  • Every client has to collect data

• Round-trip Measurement

Reference Curve and KPI Definition

Simulation result with 2 users with 600ms delayed access links and with server floor control
Simulation Results
Regarding the Access Link Delay – Server Floor Control

Simulation Results
Regarding the Access Link Delay – Peer Floor Control
Simulation Results
Regarding the Access Link Delay – Zero Floor Control

Simulation results with 4 users with delayed access links and without floor control

Simulation Results
Regarding the Access Link Delay - KPI
Conclusion and Outlook

Next Steps

• Taking network link delay into account
  • It is expected, that the KPIs for server floor control will increase
• Impact of video transfer on group communication
  • Implementation of Load-balancing strategies
• Projects in that area:
  • European Research Project MORE
  • Mobile EmerGIS

Specific targeted research projects

User Mobility Pattern Detection and Prediction Algorithms to increase Handover Trigger Accuracy in Broadband Mobile Networks

Stefan Michaelis
Motivation

• Predicting next base station
• QoS reservation for premium customers
• Pattern detection to recognise path
Pattern Detection Algorithms

Prerequisites:

- Input data available for pattern detection
- Selection of algorithms from distinct fields of pattern detection
  - Lazy algorithms, trees and functions
- K-Nearest Neighbour (KNN)
- Decision Trees (DT)
- Support Vector Machines (SVM)

Input Traces for Pattern Detection

<table>
<thead>
<tr>
<th>Mobile1</th>
<th>Mobile2</th>
<th>Mobile3</th>
<th>Mobile1</th>
<th>MobileX</th>
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<td>A3</td>
<td>A4</td>
<td>A5</td>
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<td>UMTS</td>
<td>BS7</td>
<td>BS8</td>
<td>BS10</td>
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<td>OFF</td>
<td>BS5</td>
<td>BS4</td>
<td>BS2</td>
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<td>BS4</td>
<td>BS2</td>
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Testing
K-Nearest Neighbour

Searched Pattern:

| OFF | OFF | BS5 | BS4 | BS2 | ?? |

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Pros/Cons:
- Fast learning (lazy)
- High memory consumption
- Slow predictions (search space)

Decision Trees

Pros/Cons:
- Fast learning
- Intuitive structure
- Fast prediction
- Low memory
- Limited learning ability
Support Vector Machine

Pros/Cons:
- Slow learning
- Fast prediction
- High memory for training
- Low memory for prediction
- Flexible parameter settings

Simulation Scenario

2 Scenarios:
- LoRand
- HiRand (Noise)
### Prediction Accuracy
#### Assessment of Confusion Matrix vs. Topology

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<th>BS8</th>
<th>BS7</th>
<th>BS6</th>
<th>BS5</th>
<th>BS4</th>
<th>BS3</th>
<th>BS2</th>
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<th>UMTS</th>
<th>BS10</th>
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#### Prediction Stability
#### Comparison of Stability by Parameterisation

![Graph showing prediction accuracy vs. normalized fit to training data for different parameterisations.](image)

**Voting Strategy**

- SVM R
- SVM P
- DT
- KNN

**Prediction Accuracy [%]**

- 1.0 = high fit, 0.0 = low fit
Conclusions & Outlook

• Prediction accuracy depends on noise inside trace data
• Prediction stability depends on algorithm and parameterisation
  • Trade-off between stability and maximum accuracy
  • Effort to be spent to find optimal parameter settings vs. accuracy
• Strategies to raise accuracy
  • Geographical information to evaluate predictions
  • Voting Strategy
• Future work
  • Analysis of benefit of fine granular location data for pattern detection

Interested in More Information?

Requests from

• Potential Project Partners
• Students and
• Teachers or pupils

for detailed information on our competence in research and education are very welcome!

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