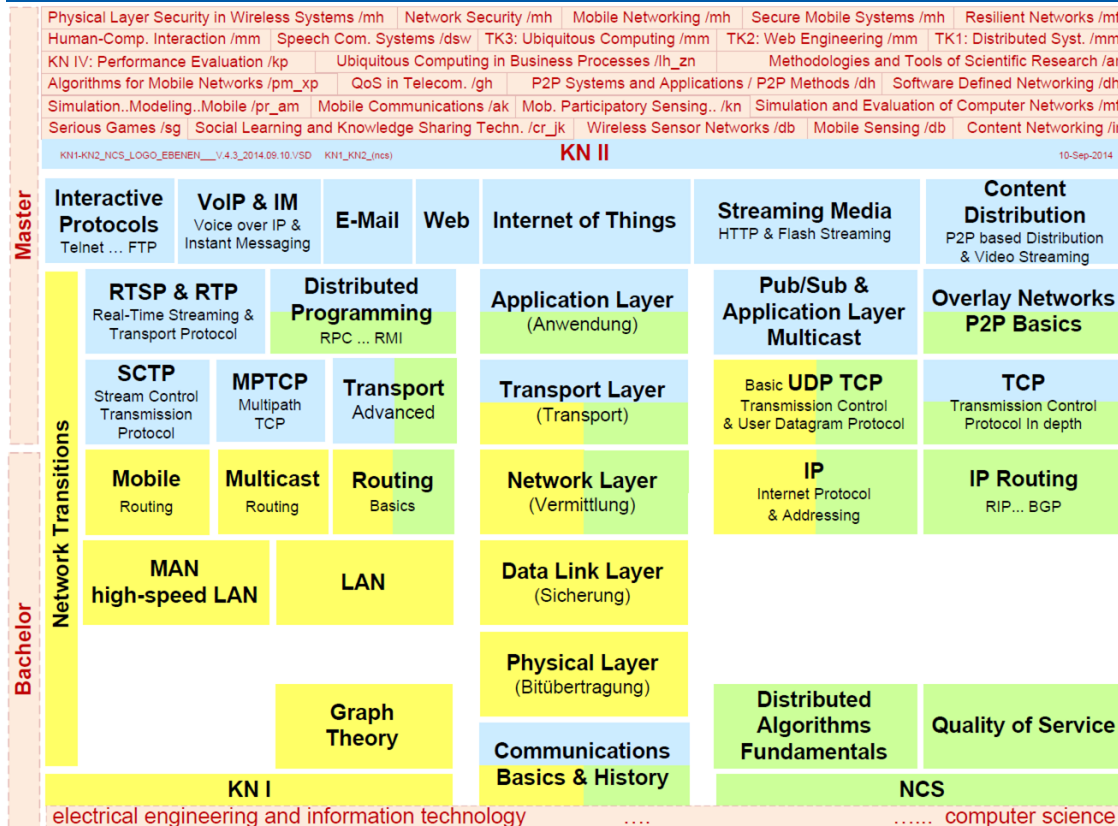


# Communication Networks 2

## Preliminary Information



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DARMSTADT



10. September 2014



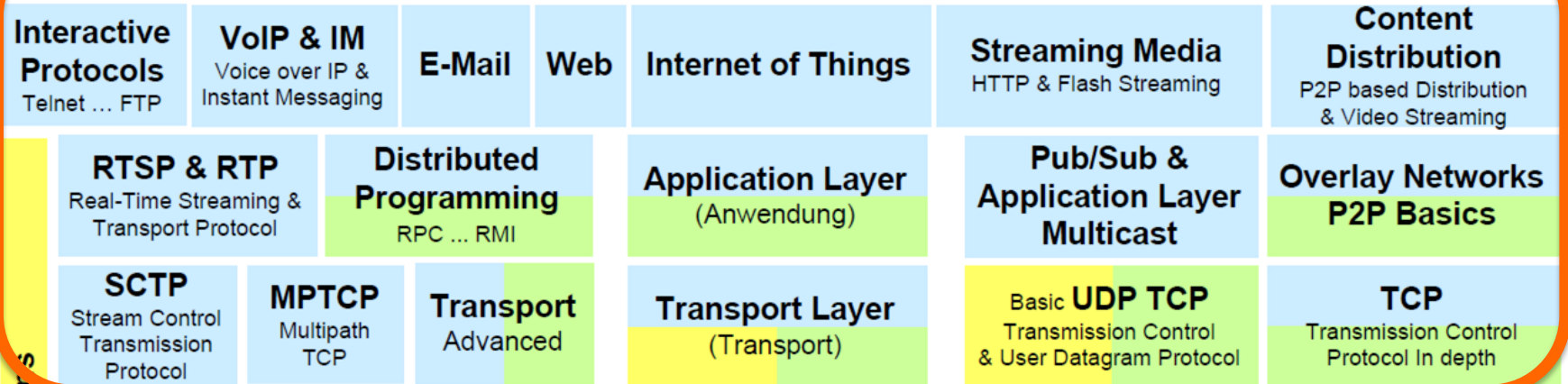
Physical Layer Security in Wireless Systems /mh   Network Security /mh   Mobile Networking /mh   Secure Mobile Systems /mh   Resilient Networks /mf  
 Human-Comp. Interaction /mm   Speech Com. Systems /dsw   TK3: Ubiquitous Computing /mm   TK2: Web Engineering /mm   TK1: Distributed Syst. /mm  
 KN IV: Performance Evaluation /kp   Ubiquitous Computing in Business Processes /lh\_zn   Methodologies and Tools of Scientific Research /ar  
 Algorithms for Mobile Networks /pm\_xp   QoS in Telecom. /gh   P2P Systems and Applications / P2P Methods /dh   Software Defined Networking /dh  
 Simulation..Modeling..Mobile /pr\_am   Mobile Communications /ak   Mob. Participatory Sensing.. /kn   Simulation and Evaluation of Computer Networks /mf  
 Serious Games /sq   Social Learning and Knowledge Sharing Techn. /cr\_ik   Wireless Sensor Networks /db   Mobile Sensing /db   Content Networking /ir

KN1-KN2\_NCS\_LOGO\_EBENEN\_\_\_V.4.3\_2014.09.10.VSD   KN1\_KN2\_(ncs)

## KN II

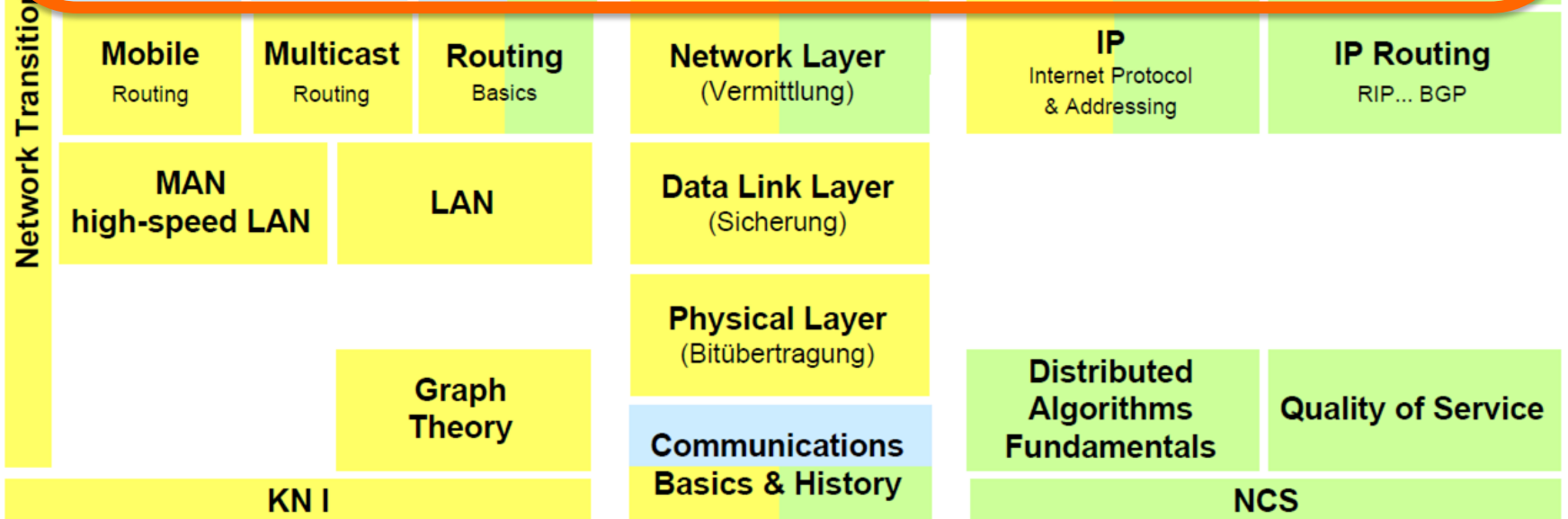
10-Sep-2014

Master



Network Transitions

Bachelor



electrical engineering and information technology

....

..... computer science

# Lectures related to KN 2 and/or KOM



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|   |   |                   |
|---|---|-------------------|
| Physical Layer Security in Wireless Systems /mh | Network Security /mh                                | Mob               |
| Human-Comp. Interaction /mm                     | Speech Com. Systems /dsw                            | TK3: Ubiquitous C |
| KN IV: Performance Evaluation /kp               | Ubiquitous Computing in Business Proc               |                   |
| Algorithms for Mobile Networks /pm_xp           | QoS in Telecom. /gh                                 | P2P System        |
| Simulation..Modeling..Mobile /pr_am             | Mobile Communications /ak                           | Mob. Partici      |
| Serious Games /sg                               | Social Learning and Knowledge Sharing Techn. /cr_jk | Wi                |

|                              |  |                                 |
|------------------------------|--|---------------------------------|
| Mobile Networking /mh        | Secure Mobile Systems /mh                          | Resilient Networks /mf          |
| Ubiquitous Computing /mm     | TK2: Web Engineering /mm                           | TK1: Distributed Syst. /mm      |
| Business Processes /lh_zn    | Methodologies and Tools of Scientific Research /ar |                                 |
| Systems and Applications /   | P2P Methods /dh                                    | Software Defined Networking /dh |
| Participatory Sensing.. /kn  | Simulation and Evaluation of Computer Networks /mf |                                 |
| Wireless Sensor Networks /db | Mobile Sensing /db                                 | Content Networking /ir          |



# About Us



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# Teaching Team KN2



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UNIVERSITÄT  
DARMSTADT

## Lecturer

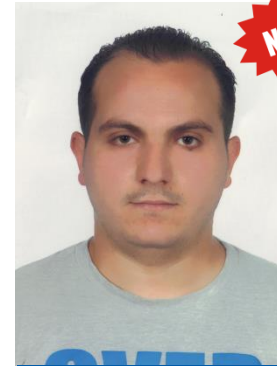


Ralf Steinmetz

## Student tutors



Philipp  
Neubrand



Shadi Shahood



Christian Klos

## Teaching assistants – scientific staff members



Irina Diaconita



Rahul  
Dwarakanath



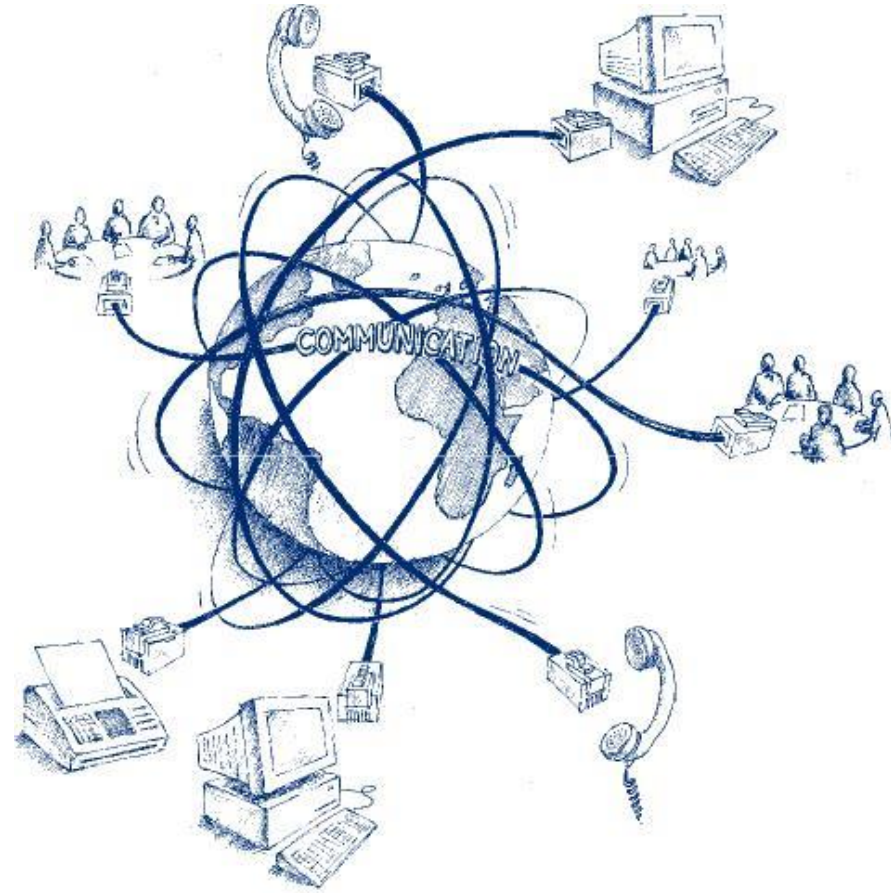
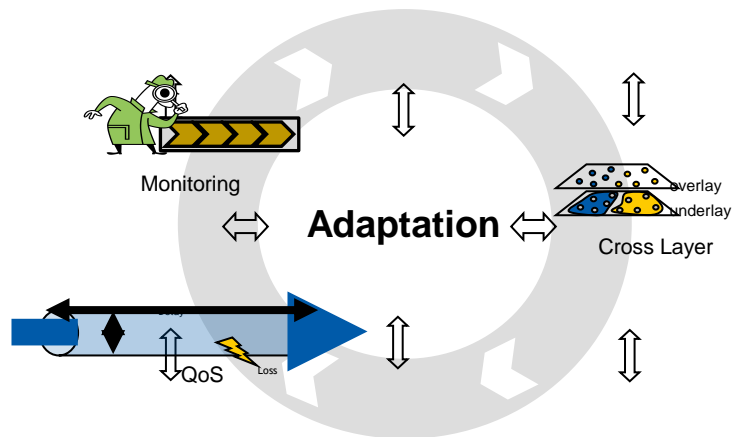
Frank Englert



## Towards Seamless Multimedia Communications

by

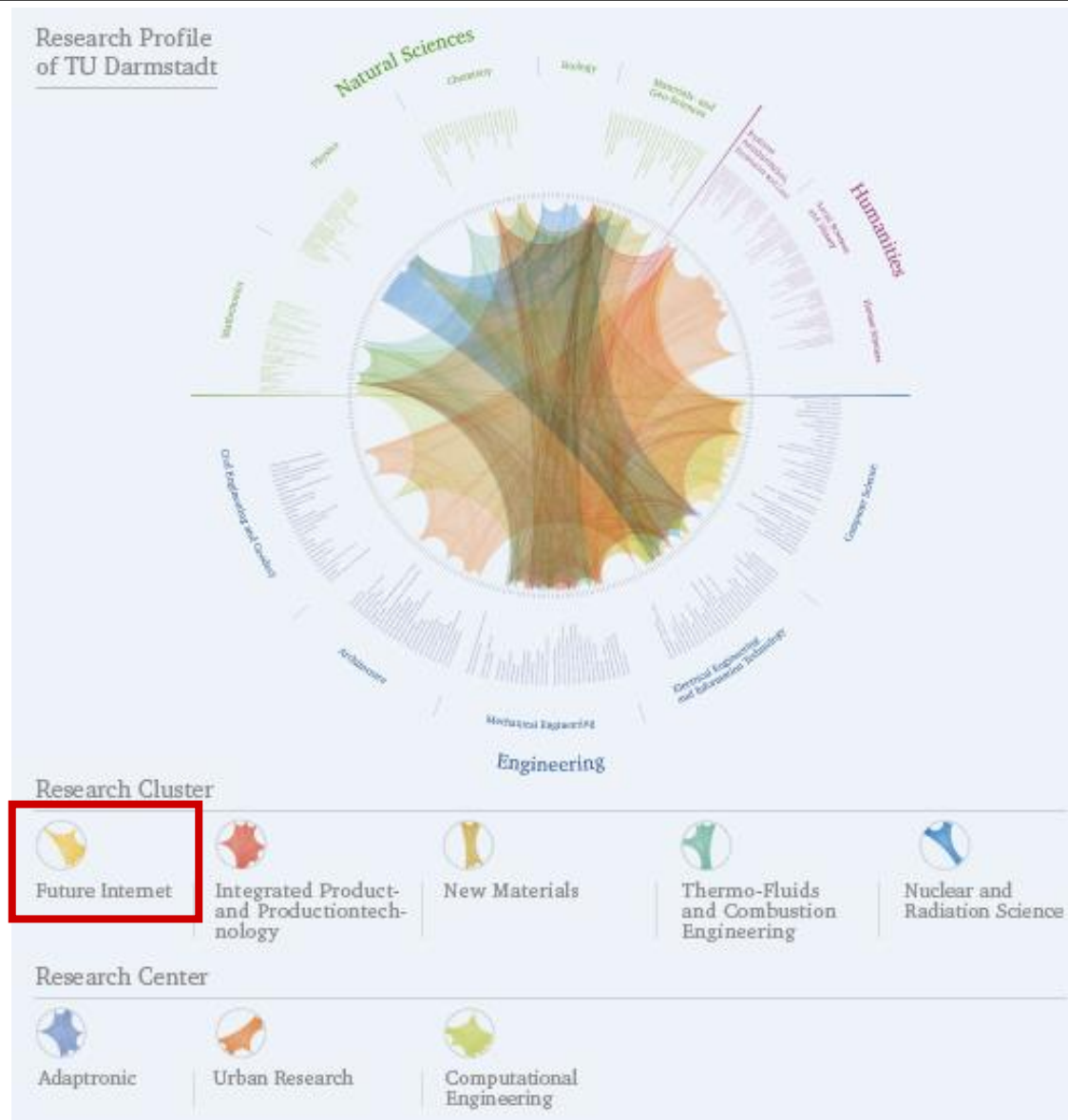
## Adaptation ... Transition



# Research Cluster Future Internet @ Technische Universität Darmstadt

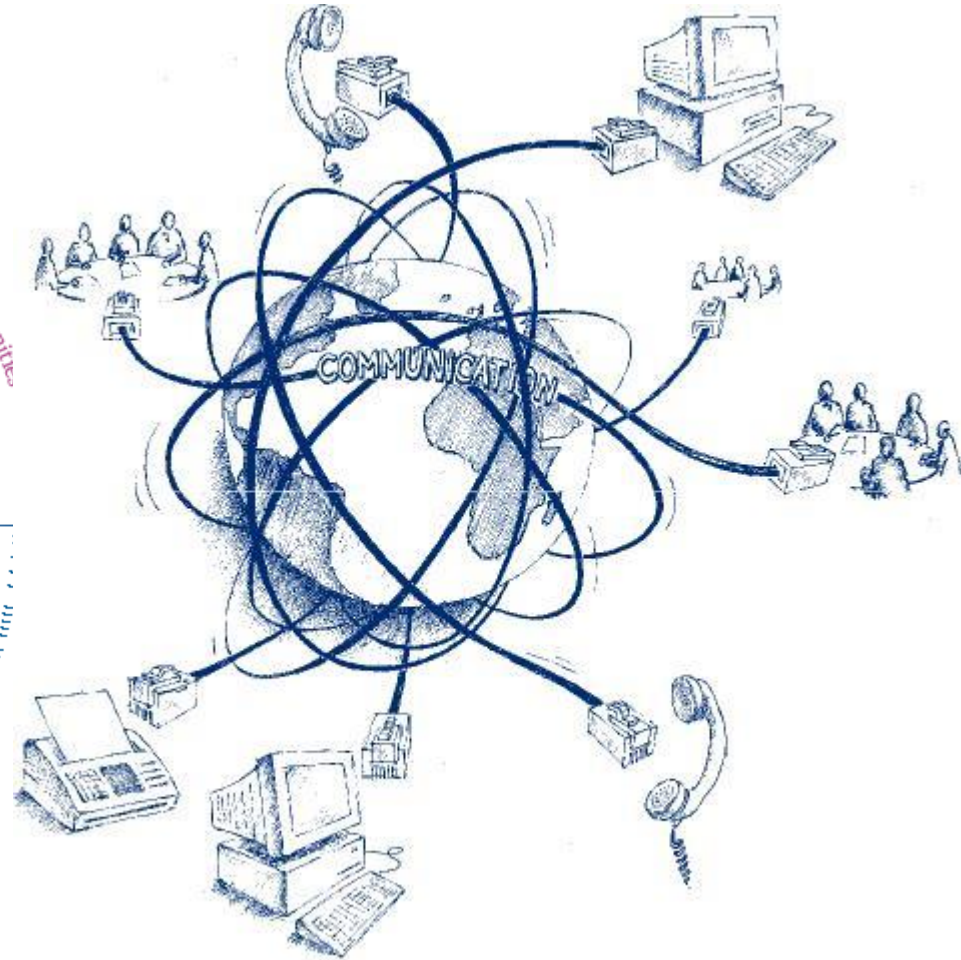


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## Future Internet

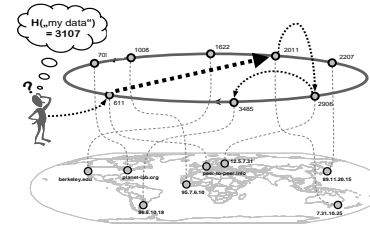


## Adaptive Seamless Multimedia Communications

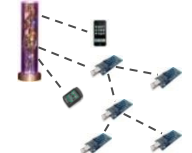
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Testbeds

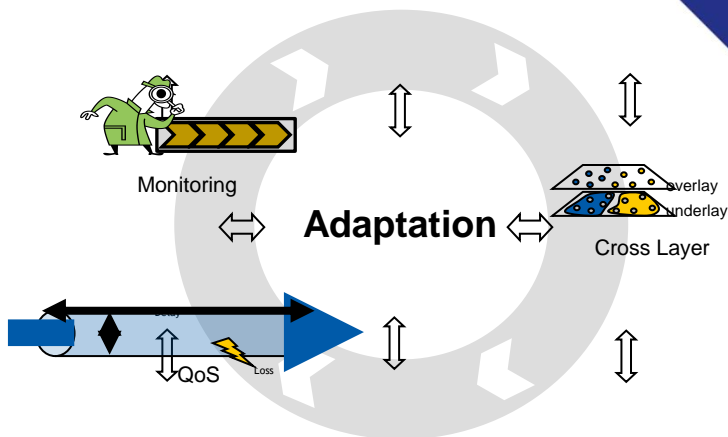
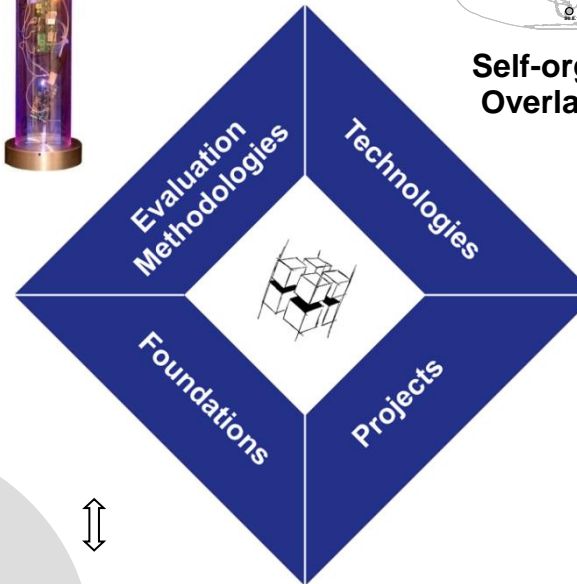


Self-organizing Systems &  
Overlay Communications



Mobile Systems &  
Sensor Networks

Service-oriented Computing

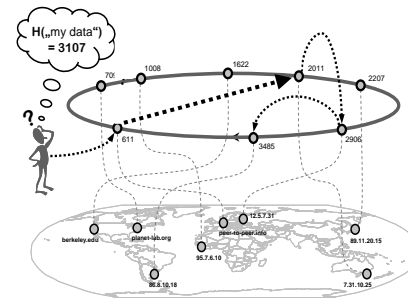
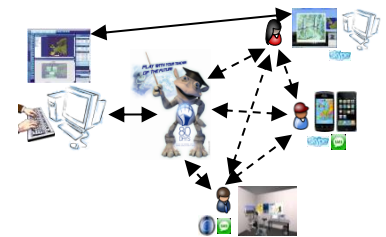


- Knowledge & Educational Technologies
- Multimedia Technologies & Serious Games
- Mobile Systems & Sensor Networks
- Self organizing Systems & Overlay Communications
- Service-oriented Computing

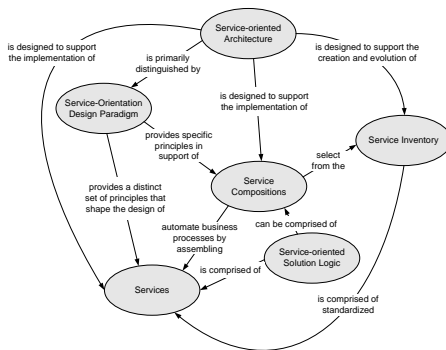
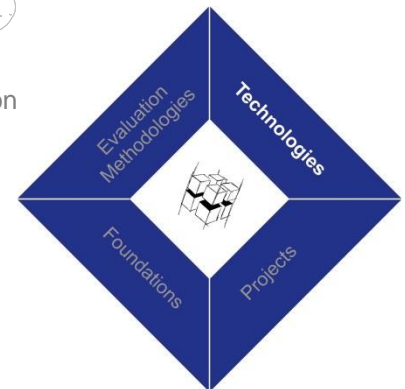


Knowledge &  
Educational Technologies

Multimedia Technologies &  
Serious Games



Adaptive Overlay Communication



Service-oriented Computing

Distributed  
Sensing Systems



# Our former Researchers - now Alumnae



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## @ Scientific.World

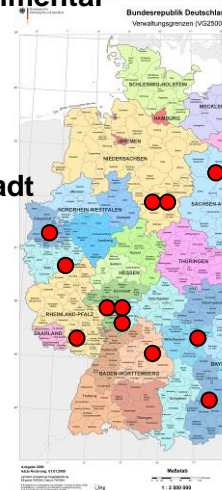
Dr. A. Aqqal, Marocco  
Prof. J. Dittmann, Magdeburg  
Prof. A. Faatz, Osnabrück  
Prof. M. Fidler, Hannover  
Prof. K. Graffi, Düsseldorf  
Prof. C. Griwodz, Oslo, Norway  
Prof. M. Hollick, Darmstadt  
Prof. M. Karsten, Waterloo, CA  
Dr. A. Mauthe, Lancaster, UK  
Dr. Y. Miao, Duisburg  
Prof. A. Miede, Saarbrücken  
Dr. C. Müller-Tomfelde, AUS  
Dr. S. Offenbartl, Darmstadt  
Dr. A. Reinhardt, Sydney, AUS  
Dr. N. Repp, Darmstadt  
Dr. U. Roedig, Lancaster, UK  
Prof. A. El Saddik, Ottawa, CA  
Prof. J. Schmitt, Kaiserslautern  
Dr. S. Schulte, Wien, A  
Dr. C. Seeberg, Darmstadt  
Dr. Sandra Siebert, Darmstadt  
Dr. J. Sonnberger, München  
Prof. A. Steinmetz, Darmstadt  
Prof. C. Vielhauer, Brandenburg  
Prof. L. Wolf, Braunschweig  
Prof. M. Zink, Amherst, US

## @ Entrepreneur & Governmental

Dr. R. Eberhardt, Erbach  
Dr. T. Kamps, Darmstadt  
Dr. T. Klug, Darmstadt  
Dr. R. Lokaiczky, Darmstadt  
Dr. M. Moschgath, Bonn  
Dr. G. On, Darmstadt  
Dr. D. Tietze, Darmstadt

## @ Industry

Dr. O. Abboud, Akamai, München  
Dr. R. Ackermann, SAP, Dresden  
Dr. R. Berbner, T-Systems Int., Bonn  
R. Bertram, BWI, München  
Dr. V. Darlagiannis, Athens, Greece  
Luka Divac-Krnic, aoloa, Gerlingen  
Dr. R. Domínguez García, Plath, Hamburg  
Dr. J. Eckert, Merck, Darmstadt  
Dr. S. Fischer, SAP, Waldorf  
Dr. M. Görtz, AGT, Darmstadt  
Dr. O. Heckmann, Google, Zürich  
Dr. S. Hörmann, Carl Zeiss, Aalen  
Dr. S. Kaune, Merck, Darmstadt



Dr. A. Kovacevic, AGT, Darmstadt  
Dr. A. König, Deutsche Bahn, Frankfurt  
Dr. M. Kropff, wer denkt was, Darmstadt  
Dr. L. Lehmann, AGT, Darmstadt  
Dr. N. Liebau, SAP, Walldorf  
Dr. M. Liepert, Siemens, Renningen  
Dr. M. Meyer, AGT, Darmstadt  
Dr. P. Mogre, Siemens, München  
Dr. P. Mukherjee, Kybeidos, Heidelberg  
Dr. M. Niemann, Adrena Objects, Frankfurt  
Dr. K. Pandit, Siemens, Erlangen  
Dr. A. Papageorgiou, NEC, Heidelberg  
Dr. K. Pussep, Capgemini, Offenbach  
K. Reichenberger, i-views, Darmstadt  
Dr. R. Reinema, Vodafone, Düsseldorf  
Dr. I. Rimac, Alcatel-Lucent, Stuttgart  
Dr. J. Schmitt, ABB, Ladenburg  
Dr. P. Scholl, SAP, Walldorf  
Dr. M. Schumacher, Virtual Forge, Hdlbg.  
Dr. A. Steinacker, i-views, Darmstadt  
Dr. M. Steinebach, FhG, Darmstadt  
Dr. L. Turczyk, Deutsche Post, Bonn  
Dr. M. Wessner, FhG, Kaiserslautern  
Dr. F. Zaid, Opitz Cons., Bad Homburg  
Dr. B. Zimmermann, SAP, Darmstadt



# KOM Research Groups - Adjunct Chairs and Research Groups



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## Research Area

### Service-oriented Computing

- Dieter Schuller / Ulrich Lampe

## University Lecturers (adjunct)

- Gerhard Hasslinger
  - T-Systems, Darmstadt
- André Miede
  - HTW, Saarbrücken
- Parag Mogre
  - Siemens AG, München
- Zoltán Nocht
  - SAP, Karlsruhe
- Krishna Pandit
  - Siemens AG, Erlangen
- Xavier Perez Costa
  - NEC Laboratories Europe, Heidelberg
- Harald Rau
  - Ostfalia Hochschule für angewandte Wissenschaften
- Andreas Reinhardt
  - University of New South Wales, Sydney, Australia
- Ivica Rimac
  - Alcatel-Lucent, Stuttgart

## Network and Systems Management (KOM-httc)

- Ronny Hans

## Adaptive Overlay Communications

- Christian Groß /  
Dominik Stingl

## Distributed Sensing Systems

- Doreen Böhnstedt

## Knowledge Media

- Christoph Rensing

## Serious Games

- Stefan Göbel

## Adjunct Assistant Professors

- David Hausheer
  - Peer-to-Peer Systems Engineering Lab
- Martin Knöll
  - Digitale Stadtspiele
- Silvia Santini
  - Wireless Sensor Networks

## Adjunct Associate Professor

- NN
  - Consumer Privacy Preserving Monitoring of Smart Energy Grids

## Adjunct Full Professor

- Klara Nahrstedt (KIVA guest professorship)
  - Multimedia Operating System and Networking Group
  - UUC, Illinois, US
- Paul Müller
  - Integrated Communication Systems
  - TU Kaiserslautern

## Adjunct Full Professor & 'Kooperationsprofessur'

- Wolfgang Effelsberg
  - Distributed Multimedia Systems

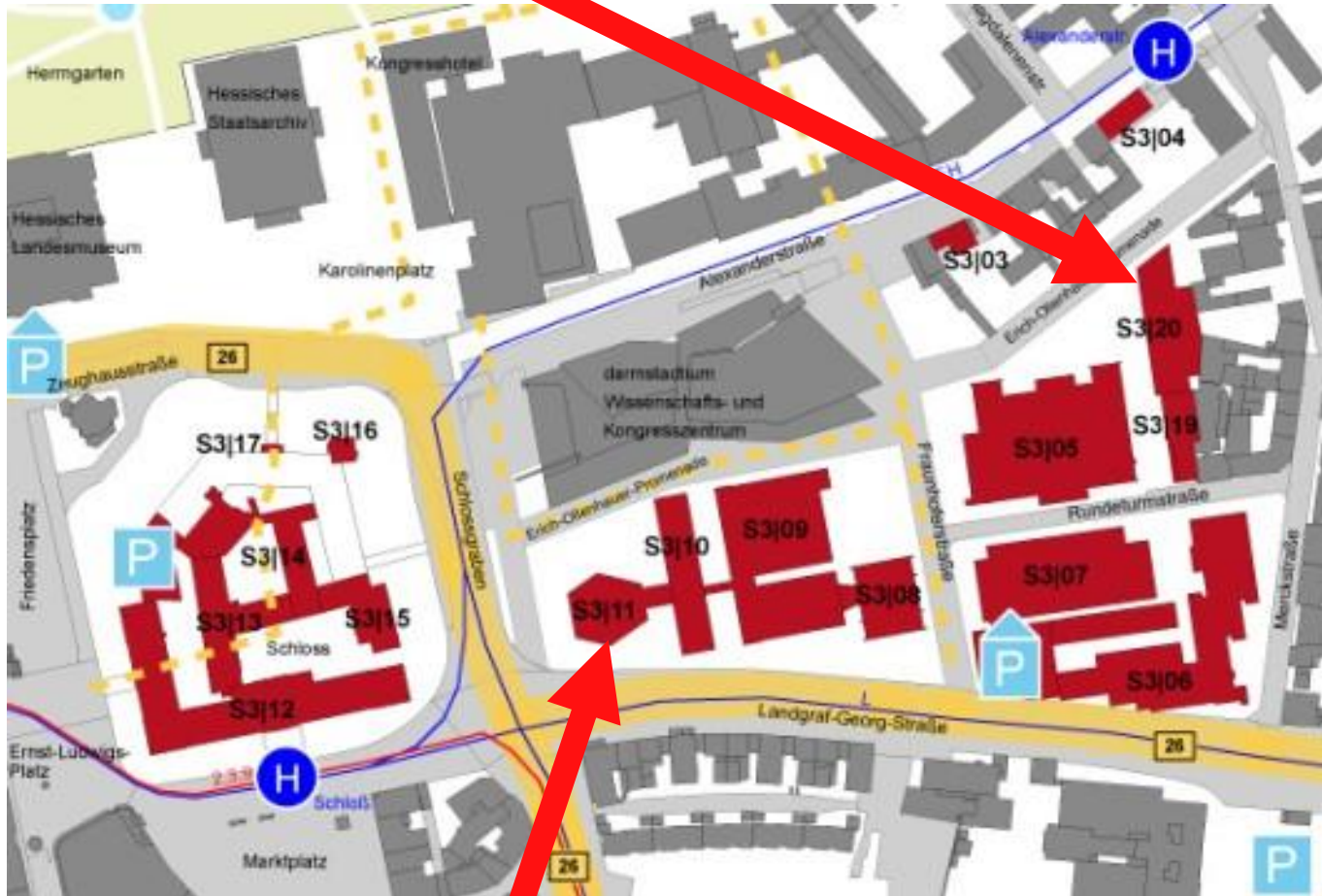
# Our Location



TECHNISCHE  
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KOM Offices at S3|20  
First and second floor

Thursday: KN2 Lectures at S1|05 -122



Monday: KN2 Lectures at S3|11 – 0012 (former S3|06 051)





## Teaching

### Current Courses

- Communication Networks I
- Communication Networks II
- Communication Networks III: Mobile Networking
- Communication Networks IV: Performance Evaluation
- Serious Games Lecture
- Ubiquitous Computing in Business Processes
- Distributed Multimedia Systems (MM I)
- Distributed Multimedia Systems: Selected Topics (MM II)
- Advanced Topics in Distributed Systems
- Net Centric Systems
- Algorithms for Mobile Networks
- Content Networking

## Current Courses

| Course Title   | Dual Mode Course   | Winter Term | Summer Term | L + E      |
|--|--|-------------|-------------|------------|
| <b>Lectures on Communications - Overview</b>   |  |             |             |            |
| <u>Communication Networks I (KN I)</u><br>(Prof. Dr.-Ing. Ralf Steinmetz)                                      |  |             | X           | 3 + 1      |
| <u>Communication Networks II (KN II)</u><br>(Prof. Dr.-Ing. Ralf Steinmetz)                                    |  | X           |             | 3 + 1      |
| <u>Communication Networks III (KN III)</u><br>(Prof. Dr.-Ing. Matthias Hollick, Prof. Dr.-Ing. Ralf Steinmetz) |  | X           |             | 2+0 or 2+2 |
| <u>Communication Networks IV (KN IV)</u><br>(Prof. Dr.-Ing. Ralf Steinmetz, Dr.-Ing. Krishna Pandit)           |  |             | X           | 2+0        |
| <b>Lectures on Multimedia - Overview</b>   |  |             |             |            |
| <u>Ubiquitous Computing in Business Processes</u>  |  | X           |             | 2 + 0      |



KOM - Multimedia  
Communications Lab

## Contact



Prof. Dr.-Ing.  
Ralf Steinmetz

Technische Universität Darmstadt  
Fachgebiet Multimedia  
Kommunikation  
Rundeturmstr. 10  
64283 Darmstadt  
S3/20

+49 6151 16-6150





Multimedia Communications Lab » Teaching » Current Courses » Communication Networks II » General Information

## Teaching

### Current Courses

Communication Networks I

Communication Networks II

General Information

Description

Resources

Communication Networks III:  
Mobile Networking

Communication Networks IV:  
Performance Evaluation

Social Learning and Knowledge  
Sharing Technologies

Serious Games Lecture

## Communication Networks II – General Information

*Communication Networks II*

*TUCaN course ID: 18-sm-2010-vl, 18-sm-2010-ue*

*Organization: Irina Diaconita, Frank Englert, Rahul Chini Dwarakanath*

*Contact: ✉ [kn2@kom...](mailto:kn2@kom...)*

## Course Information

All materials including important dates, slides, recordings, exercises and sample solutions are available on the CN2 moodle page. Please make sure to subscribe at our Moodle course in order to stay informed.





# How to Participate



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## Feel free to contact us

- We always offer bachelor and master theses, HiWi positions,...

## Take a look at open topics

- <http://www.kom.tu-darmstadt.de/en/teaching/theses/open/>

## Open topics, e.g.:

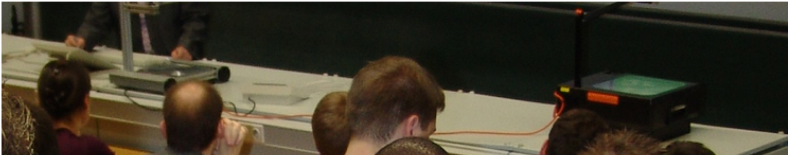
- Templates for Collaborative Multiplayer Games
- Entwicklung von Methoden zur Modellbasierten Schätzung des Energieverbrauchs von Cloud-Diensten
- Real-Time Facial Expression Recognition on Smartphones
- Android based Participatory Crowd Computing

## We promote your work

- E.g., best thesis is awarded each year and proposed for further awards <http://www.kom.tu-darmstadt.de/en/teaching/theses/best/>
- E.g. Thesis abroad at a partner institute

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TU | [etit & Informatik](#) | [KOM - Multimedia Communications Lab](#) | [Teaching](#) | [Research & Results](#) | [News & Events](#)



Multimedia Communications Lab > Teaching > Theses > Open

**Teaching**

- Current Courses
- Former Courses

**Theses**

- Open »
- In Progress
- Completed
- Best
- Guidelines
- Templates
- Plagiarism
- Exams
- E-Learning
- Relevant Links for Students


**Currently open theses**

Displaying results 1 to 20 out of 21

Page 1 Page 2 Next >

- [Preissetzung im Cloud Computing-Markt für Infrastrukturdienste](#)  
Thema Cloud Computing ist ein relativ neues Architekturparadigma für die Bereitstellung von Informationstechnologie (IT). Die Grundidee besteht darin, verschiedene Arten von Diensten – Infrastruktur, aber auch komplexe Software-Systeme – als Utility, ähnlich zu Strom, ... [\[more\]](#)  
**Tutor:** [Ronny Hays](#)
- [Templates for Collaborative Multiplayer Games](#)  
Topic Aside from being widely popular with gamers and developers alike, it has been shown that cooperative / collaborative games offer huge potential as serious games. They do not only provide additional motivation by providing the opportunity to play with friends, but also... [\[more\]](#)  
**Tutor:** [Christian Reuter](#)
- [Collaborative Database Assisted Route Calculation](#)  
Collaborative Database Assisted Route Calculation... [\[more\]](#)  
**Tutor:** [Daniel Burgtahler](#)
- [Entwicklung von Methoden zur Modellbasierten Schätzung des Energieverbrauchs von Cloud-Diensten](#)  
Hintergrund und Idee Seit Jahren nimmt die Bedeutung von SaaS (Software as a Service) Diensten zu, welche über das Internet bereitgestellt werden. Bedingt durch steigende Nutzerzahlen und erweiterte Funktionalitäten steigt der Ressourcen und somit der Energiebedarf von SaaS... [\[more\]](#)  
**Tutor:** [Ronny Hays](#)
- [Recognition of Game Genre using Smartphone Sensing and In-Game Screenshots](#)  
App stores for smartphones offer a large collection of games. For the classification of these games, it may be useful to extract information from the game description offered on the store. However, these listings don't always offer enough information about games. By exploi... [\[more\]](#)  
**Tutor:** [Laila Shoukry](#)
- [Computer Vision Based Interaction for Learning Games on Smartphones](#)  
Smartphones offer new opportunities for developing games based on new interaction paradigms. A main concern for letting children play learning apps on smartphones is the unhealthy posture and the long periods without movement which are not healthy. In this research the appli... [\[more\]](#)  
**Tutor:** [Laila Shoukry](#)

**Contact**



**Prof. Dr.-Ing.  
Ralf Steinmetz**

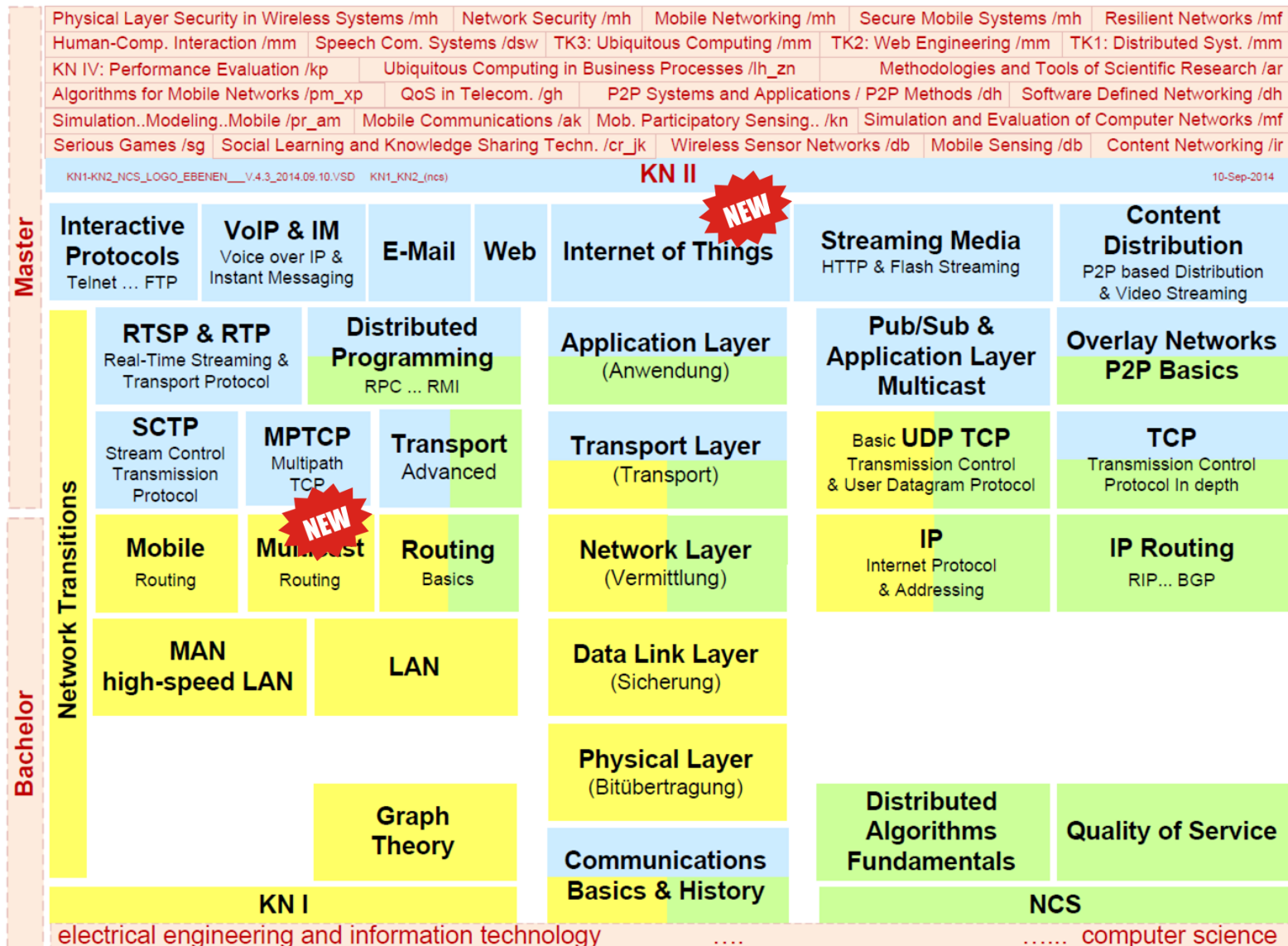
Technische Universität Darmstadt  
Fachgebiet Multimedia Kommunikation  
Rundeturmstr. 10  
64283 Darmstadt  
S3/20  
☎ +49 6151 16-6150

Visited on  
30.09.2014

# About KN2



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# Lecture, Exercise, Office Hours

## Lectures

- Mondays, 11:40 – 13:20 in **S3 11/0012**
- Thursdays, 11:40 – 12:30 in **S1 05/122**
- Recorded and provided online
  - However, attending lecture is strongly recommended



**Different Rooms on  
Mondays and Thursdays**

## Exercises

- Thursdays, 12:35 – 13:20 in **S105/122**
- Tasks provided one week ahead
- Solutions presented during exercise hours
  - Only 45 minutes for presentation →  
you should prepare yourselves well before

## Office hours

- Directly during and after lectures and exercises → interactivity!
- Additional consultation will be provided by us on demand (ask per mail)
  - But only if you used online forum beforehand → benefit for all!

## Moodle course

- <https://moodle.tu-darmstadt.de/> (Login with TU-ID)
- Teaching materials (slides, recordings, exercises, solutions, ...)
- Discussion forums
- Password is required to subscribe for course: KN2

## Moodle will be explained on

- Thursday, 16.th October 2014

## General information also available on our website

- <http://www.kom.tu-darmstadt.de/en/teaching/courses-overview/>



## Structure

- The grading consists of two parts:
  - Written exam
  - Practical task/exercise to be solved by a specified date during the semester
- Both allow to obtain together a maximum 120 points:
  - 108 in the written exam and
  - 12 for the practical task (10%)
- There is no exam bonus

## Relevant for any exam is (Prüfungsrelevante Inhalte)

- Complete contents of the respective last course of this subject
  - Lecture (Vorlesungen)
  - Exercises (Übungen) → style of exam is similar

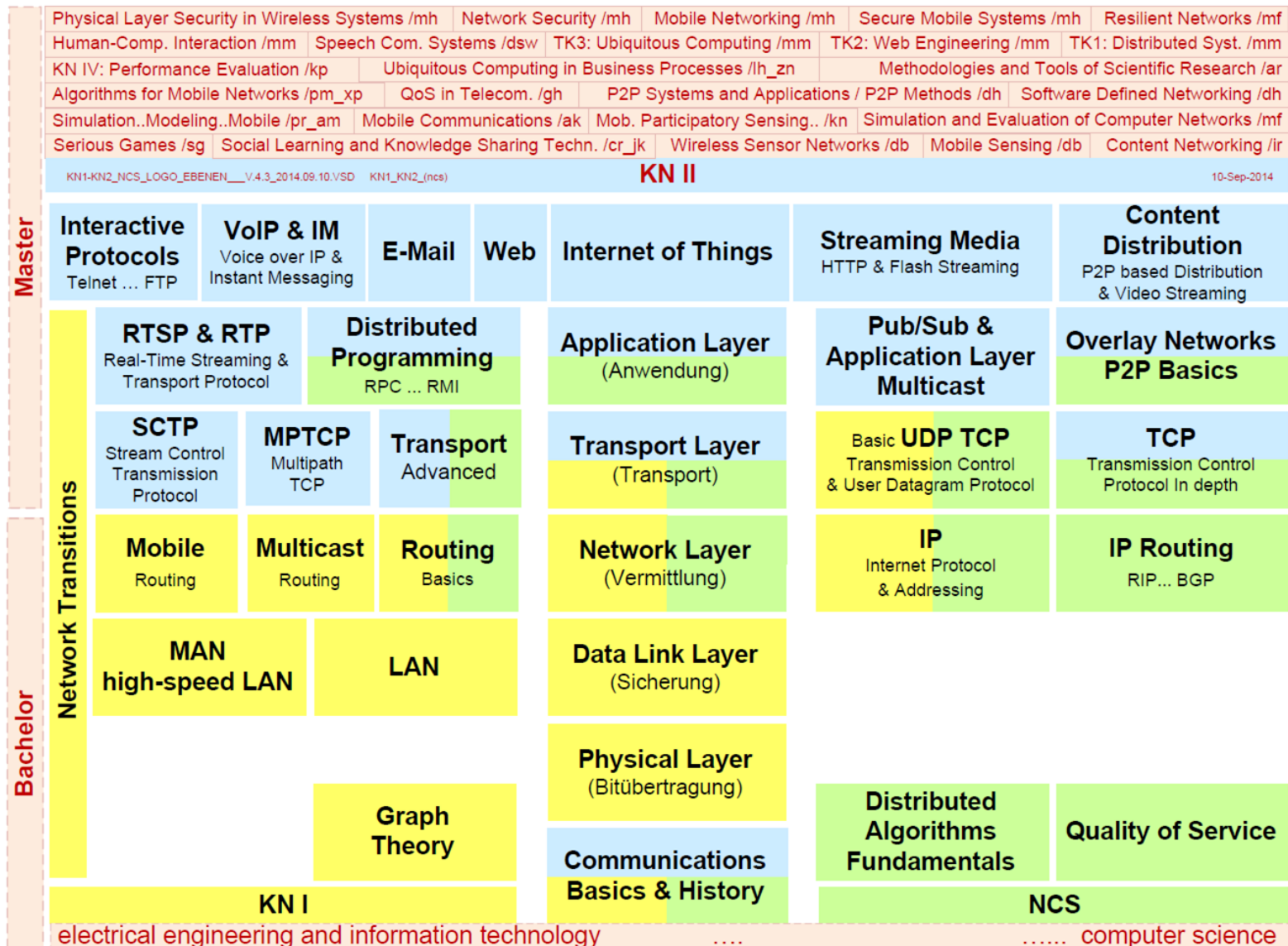
## Written exam

- Typically written exam (oral possible if only few students register)
- The default language is English, but answers in German are accepted
  - Duration: 120 minutes
- Allowed aids: non-programmable calculator and dictionary, nothing else
- Don't forget to bring a photo ID (or Athene Card)
- Don't forget to register in TUCaN (module, lecture, and exam!)
- Students who leave Germany before the exam,
  - please contact us at the first 3 weeks of the lecture




## Practical task

- Goal:
  - To gain hands-on experience on a project during the semester
- Pick one task from the list published on Moodle
- You will work in groups of three
- Solve the task during the semester
  - Until 22.01.2015
- Present your results in front of your colleagues
  - During the lecture hours specifically arranged for this

# Topics and (Tentative Schedule)



# Topics and (Tentative) Schedule

|                   |  | #                         | Lecture  |
|-------------------|--|---------------------------|--|
| Transport Layer   |  | 1                         | Intro & Basics of Communication Networks   |
|                   |  | 2                         | Transport Layer Basics & Advanced  |
|                   |  | 3                         | TCP & UDP in depth   |
|                   |  | 4                         | SCTP & MPTCP                      |
| Application Layer |  | 5                         | Interactive Protocols  |
|                   |  | 6                         | Web, Mail  |
|                   |  | 7                         | Distributed Programming  |
|                   |  | 8                         | Streaming, VoIP, IM  |
|                   |  | 9                         | Christmas Lecture, Special Issue  |
|                   |  | <b>Christmas Holidays</b> |  |
|                   |  | 10                        | P2P, Overlay Networks  |
|                   |  | 11                        | Content Distribution, Pub/Sub  |
|                   |  | 12                        | Internet of Things              |
|                   |  |                           |  |



## Lecture is based on

- Andrew S. Tanenbaum: Computer Networks; 5<sup>th</sup> Edition, Prentice Hall, 2010
- W. Richard Stevens: TCP/IP Illustrated, Volume 1 – The Protocols; 29<sup>th</sup> printing, Addison-Wesley, 2007
- James F. Kurose, Keith W. Ross: Computer Networking – A Top-Down Approach; 6<sup>th</sup> Edition, Prentice Hall, 2012
- Olivier Bonaventure: Computer Networking: Principles, Protocols and Practice; Open-source textbook, <http://inl.info.ucl.ac.be/CNP3>, 2011
- Further references as announced on the particular slides

## We have books available for borrowing

- Limited number of books by Tanenbaum (4<sup>th</sup> Edition) and Stevens
- Maximum duration is one (1) semester
- 10 EUR deposit
- Ask our secretary Marion Ehlhardt
  - S3|20 122
  - Monday through Thursday, 09:00 – 12:00

### What did you especially like in this lecture and exercise?

The Exercise allow me to completely understand to topic. which are important in this subject.

Use of model

The recordings of the lecture were very good and helped to understand parts of the lecture better when looking at them again at home.

The way ~~the~~ professor Steinmetz presents.

friendly assistants

### What did you especially dislike in this lecture and exercise?

There is a lot of information. The learning part is very important compare to the reasoning.

→ We removed some topics and added more reasoning and calculation parts

Erklärung teilweise ein bisschen langwierig

Einige Beispiele in den Folien waren etwas unverständlich  
(Chord file lookup, finger creation)

→ We changed the order of the topics, added more application examples and improved the existing ones

# Further Multimedia Communications Teaching Offers



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|   |   |  |  |                            |
|---|---|--|--|----------------------------|
| Physical Layer Security in Wireless Systems /mh | Network Security /mh                                | Mobile Networking /mh                          | Secure Mobile Systems /mh                          | Resilient Networks /mf     |
| Human-Comp. Interaction /mm                     | Speech Com. Systems /dsw                            | TK3: Ubiquitous Computing /mm                  | TK2: Web Engineering /mm                           | TK1: Distributed Syst. /mm |
| KN IV: Performance Evaluation /kp               | Ubiquitous Computing in Business Processes /lh_zn   |  | Methodologies and Tools of Scientific Research /ar |                            |
| Algorithms for Mobile Networks /pm_xp           | QoS in Telecom. /gh                                 | P2P Systems and Applications / P2P Methods /dh | Software Defined Networking /dh                    |                            |
| Simulation..Modeling..Mobile /pr_am             | Mobile Communications /ak                           | Mob. Participatory Sensing.. /kn               | Simulation and Evaluation of Computer Networks /mf |                            |
| Serious Games /sg                               | Social Learning and Knowledge Sharing Techn. /cr_jk | Wireless Sensor Networks /db                   | Mobile Sensing /db                                 | Content Networking /ir     |

## Lab Exercises

- Multimedia Communications Lab I (WS+SS)
- Multimedia Communications Lab II (WS+SS)

## Projects

- Multimedia Communications Project I (WS+SS)
- Multimedia Communications Project II (WS+SS)

## Seminars

- Multimedia Communications I (SS+WS)
- Multimedia Communications II (SS+WS)
- Advanced Topics in Future Internet
- Participatory Sensing
- Digital Storytelling (WS+SS)

and

- Topics in P2P
- Topics in Sensor Networks
- Topics in Serious Games