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# Vorlesung

# Betriebssysteme und Systemsoftware

## SS 2021

Jan R  th

Communication and Distributed Systems

Chair of Computer Science 4

RWTH Aachen University

<https://www.comsys.rwth-aachen.de>

# Betriebssystem?!?

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- Was macht das?
- Wofür braucht man das?
- Wo ist das? Wo finde ich das denn überhaupt?
- Wie funktioniert das?

- **Wer sind wir?**
  - ▶ Lehrstuhl „Kommunikation und Verteilte Systeme“ (COMSYS)
  - ▶ Aktivitäten in Forschung und Lehre
- **Vorlesung „Betriebssysteme und Systemsoftware“**
  - ▶ Organisatorisches
  - ▶ Unterlagen
  - ▶ Übungen
  - ▶ Klausuren
  - ▶ Themenübersicht

# Wer sind wir?

- Lehrstuhl für Kommunikation und Verteilte Systeme  
(COMSYS, i4)

## Ansprechpartner für BuS



Ike Kunze



Martin Serror

## Team-Assistentin



Claudia  
Förster



Vielleicht du?  
Als Hiwi? Tutor/in?

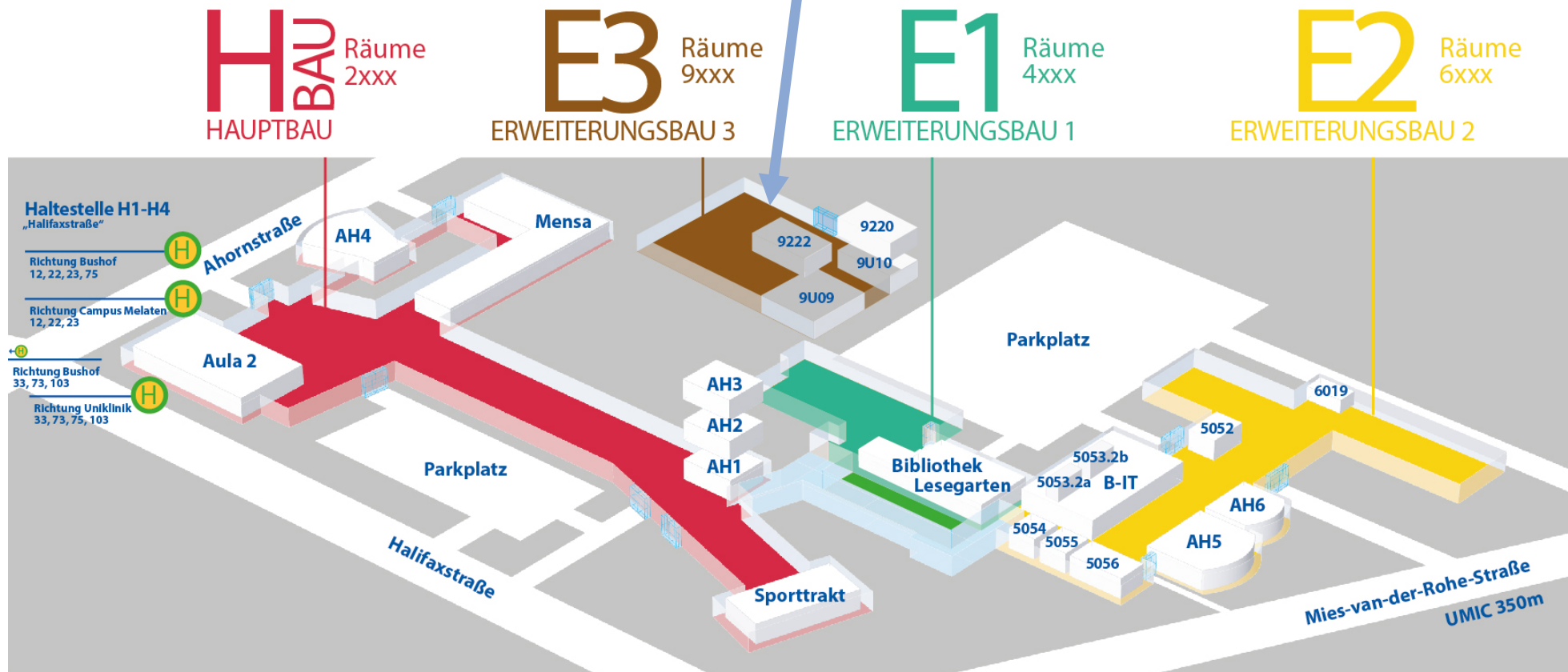


# Wo findet man uns?

- Informatikzentrum – Gebäude E3

- ▶ Erdgeschoss

- Eingang im Keller





## Research at COMSYS

- ▶ Research Vision



## Teaching at COMSYS

- ▶ Teaching Agenda



## COMSYS Team

- ▶ Your academic/innovational career with COMSYS



# COMSYS

## Research Vision

<https://comsys.rwth-aachen.de>



Communication and  
Distributed Systems

**RWTH**AACHEN  
UNIVERSITY

# The Internet, even mobile, is working!

... why doing research in communication?

- **Challenges caused by...**

- ▶ Large-scale distributed systems
- ▶ Heterogeneous devices with diverse resources
- ▶ Utilization of new/ubiquitous data sources
- ▶ Spontaneous interaction and cooperation
- ▶ Mobility of users, devices, and applications
- ▶ Limited resources in wireless networks
- ▶ Extreme performance requirements



→ *Internet of Things (IoT), Industrial IoT (IIoT), Cyber-Physical Systems*

Scalability?

Reliability?

Adaptability?

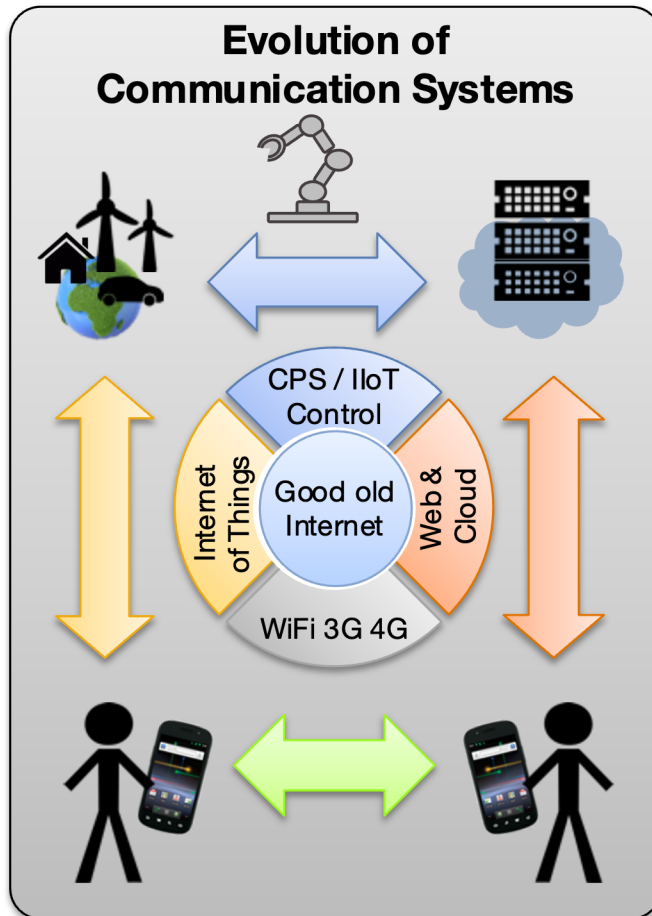
Performance?

Mobility?

Privacy?

Security?

# Research Vision



**Communication is an enabling technology for all aspects of our daily life and makes the world an amazing distributed system**

- ▶ COMSYS tackles all (interesting) research challenges of the modern connected world
- ▶ by **analyzing, understanding** and **engineering** the **fundamentals** of communication systems, distributed systems, and their usage in various areas
- ▶ Teaching and training of next generation's experts
- ▶ 36 years of experience in a great team

**System Analysis Group**

**Security & Privacy Group**

**Cyber-Physical-Systems**

**Network Architectures**

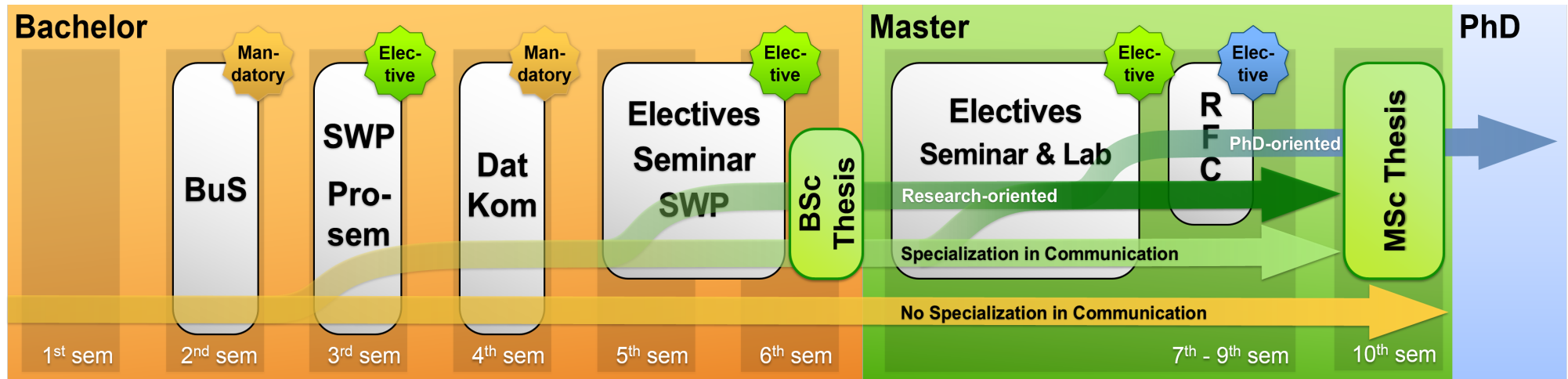


# COMSYS

## Teaching Agenda

<https://comsys.rwth-aachen.de>

# Teaching Agenda – B.Sc. und M.Sc.



<https://www.comsys.rwth-aachen.de/teaching/comsys-course-overview/>



Pflichtveranstaltungen



Bachelor & Master



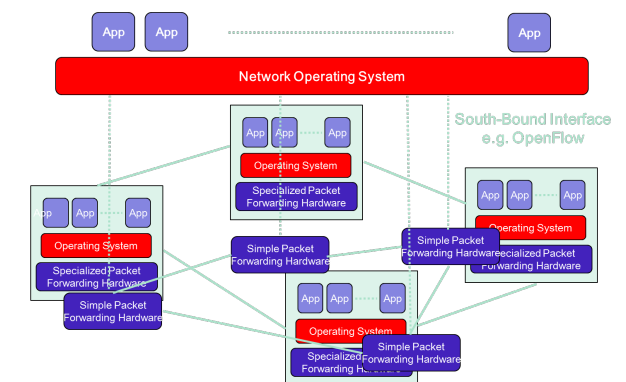
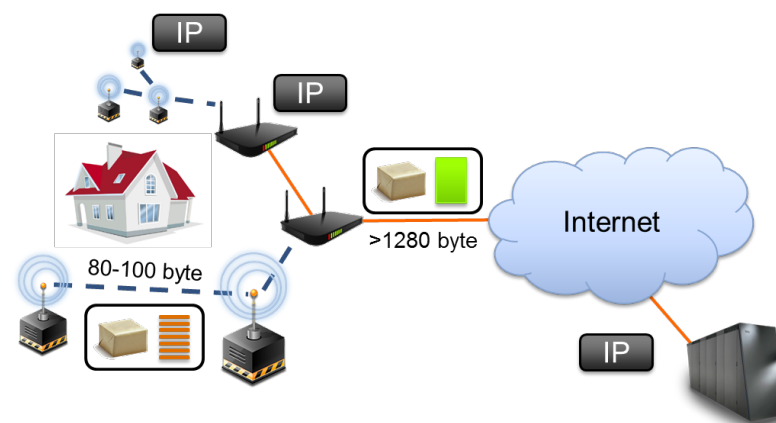
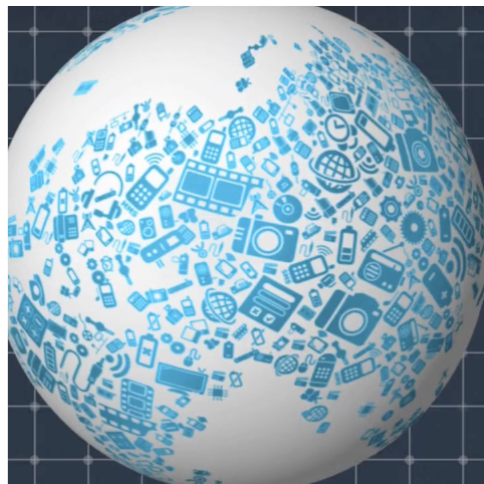
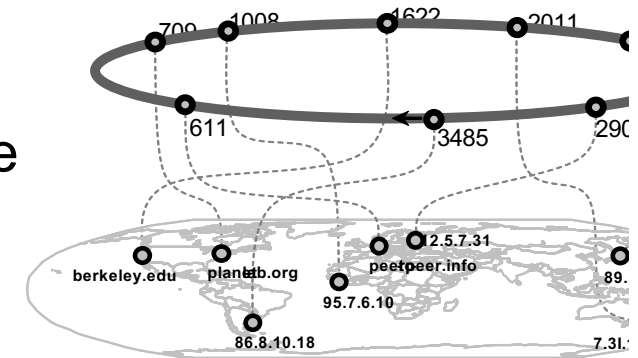
Nur Master

## • Electives (Wahlpflichtfächer)

- ▶ Advanced Internet Technology
- ▶ Communication Systems Engineering
- ▶ Mobile Internet Technology
- ▶ Research Focus Class

- **Modernere/aktuelle Entwicklungen im Bereich Kommunikationssysteme**

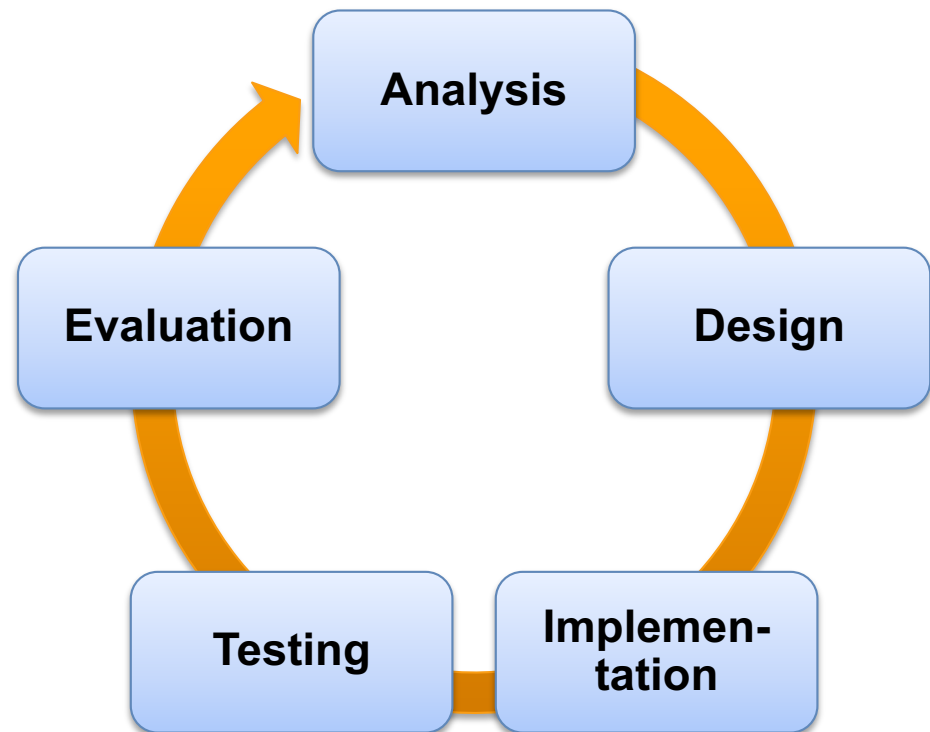
- ▶ Peer-to-Peer-Systeme, Cloud Computing
- ▶ Software Defined Networking, Quality of Service
- ▶ Cyber-Physical Systems, Internet of Things
- ▶ Security & Privacy Aspects



- **Entwicklung von Kommunikationssystemen**

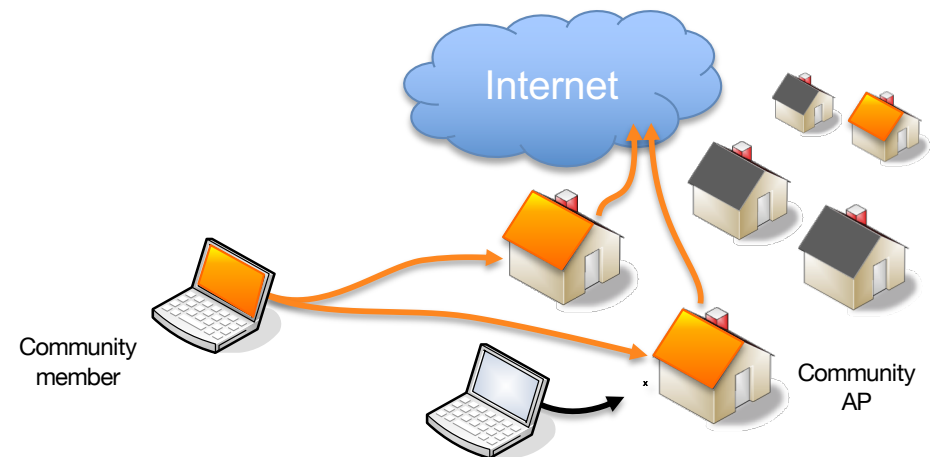
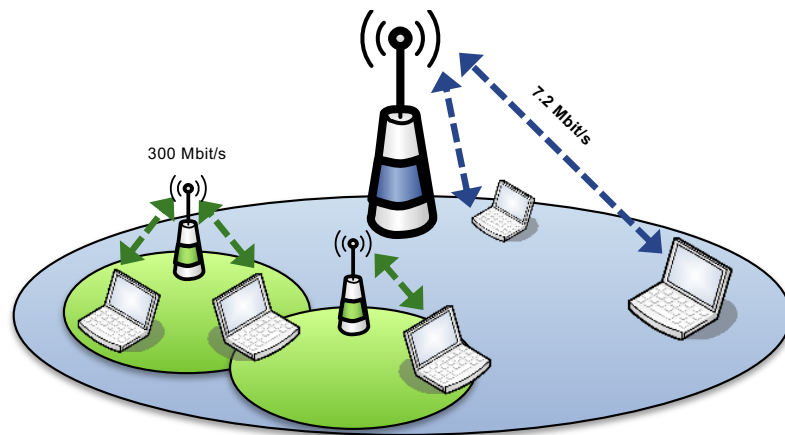
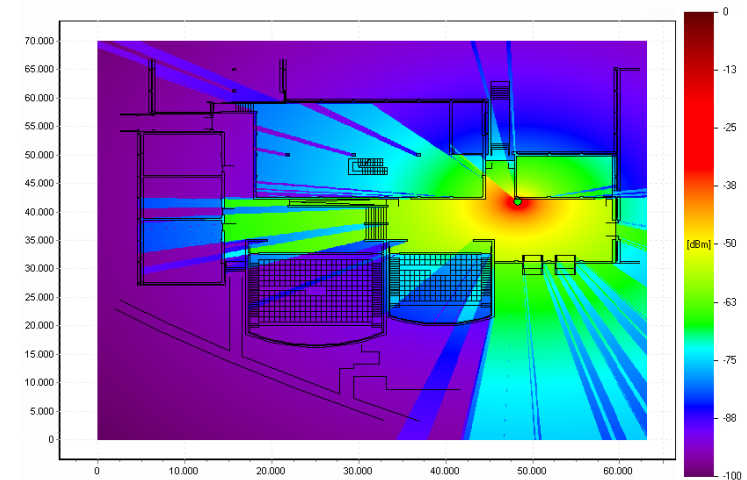
- ▶ ... teils basierend auf den Grundlagen dieser Vorlesung

- Netzwerkprogrammierung
    - Protokoll-Design
    - Networking & Kernel
    - Testing
    - Simulationen
    - Internet-Messungen



- **Datenkommunikation in drahtlosen Netzen**

- ▶ Modulation, Kodierung, Signalausbreitung
- ▶ Medienzugriff
- ▶ WLAN und 2/3/4/5G-Netze als Beispiele
- ▶ Internet-Protokolle und Mobilität



# Seminars and Labs

- **Seminars @ COMSYS**

- ▶ Scientific work on own topic
- ▶ Write paper & give presentation
- ▶ Conference-style organization
  - Peer-review other students' papers



- **Labs @ COMSYS**

- ▶ Internet and mobility, Wireless, IoT, Apps
- ▶ Linux operating system:
  - Networking, communication internals
- ▶ Mobile operating systems, typically Android
- ▶ Effective programming techniques
- ▶ Exercises: Hands-on, small 6-week projects on individual topics



- **Research Focus Class (RFC)**

- ▶ Credits wie für normale Vorlesungen
- ▶ Sehr forschungsorientiert
- ▶ Nur bei genügend ( $>5$ ) interessierten Teilnehmern

- **Inhalte & Konzept**

- ▶ Wechselnde Themen
  - Internet of Things, Privacy, Programmierbare Netze, ...
- ▶ Einführung durch COMSYS-Mitarbeiter – Grundlagen
- ▶ Auswahl von behandelten Themen im Team – hot topics
- ▶ Vorträge und Diskussionen organisiert durch Studierende – interaktiv
- ▶ Simulationen, Prototypen, Analysen, Experimente – echte Forschung!



- **Not an official course, but informal meetings**
  - ▶ Bring your lunch and watch current scientific talks with us!
  - ▶ **Currently no meeting due to Covid-19**
  - ▶ Mailing list: <https://lists.comsys.rwth-aachen.de/listinfo/sp-lunch>
    - Subscribe to get information on dates and topics
    - **Want a virtual meeting?**
      - **Subscribe and if there are enough people interested we can do it**
- **Who can join?**
  - ▶ Bachelor & Master students
  - ▶ No credits, thus you cannot take it as kind of elective...
  - ▶ ... but if you are interested in current Security & Privacy research, just step in!

# Interesse an einem Hiwi-Job oder einer Bachelorarbeit?

COM  
SYS

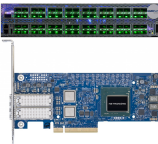
RESEARCH

## HiWi Positions: In-Network Processing in Industrial Environments

### Introduction

For our research in several projects involving in-network processing we are looking for motivated and capable student research assistants.

In our research projects, we investigate how (dumb) networking devices like switches can be equipped with small computation tasks, e.g. to allow for low latency communication or the transmission of large amounts of data. We pursue a very hands-on approach in that we analyze real-world scenarios provided by our industrial and academic cooperation partners and then develop, implement and evaluate our ideas on smart NICs and programmable switches.



### Your Task and Profile

You will be actively involved in our research activities and work closely together with us on state-of-the-art research topics which is why your tasks will vary between a very heterogeneous set. This can include tasks like analyzing the scenarios provided by our partners, implementing (parts of) new processing frameworks on the switches and/or NICs, and surveying possible research areas.

In return, you will have the opportunity to get your hands dirty in interesting real-world projects in a team of motivated people. Writing a thesis with us later on is also possible.

Due to the diverse nature of the tasks, we explicitly do not require a specific set of skills, although an interest in understanding network protocols and/or the (somewhat exotic) programming paradigms of network hardware is definitely helpful. COMSYS offers you a friendly, open-minded working atmosphere, candy and coffee close to purchasing price, occasional social gatherings and more. Your working hours can be freely arranged, as long as you can work on at least two different days per week. Thus, if you are motivated, willing to learn and eager to work on interesting and challenging projects, please contact us via our joint email address.

### Contact

René Giebke  
Ike Kunze

inp@comsys.rwth-aachen.de

<https://comsys.rwth-aachen.de/>

COM  
SYS

RESEARCH

## Bachelor

## QUICKly Breaking the Internet: Thorough Testing of QUIC Implementations

### Introduction

Over the last few years, a new transport layer protocol has been gaining prominence in the internet: QUIC. Originally developed at Google, the aim of QUIC is to provide a modern alternative to TCP that improves on all aspects of the protocol. Since 2016, the IETF has started standardization of this new protocol, and more and more implementations are becoming available. As any of these might become responsible for handling a large portion of the total internet traffic, we are interested in testing them as thoroughly as possible.



### Your Task

You will design and realize an approach for the automated testing of existing QUIC implementations, based on existing automated testing techniques. Your approach should be able to detect low-level bugs (such as memory violations) but should also cover semantic properties. For example, two different answers from two different implementations handling the same input could point to an incorrect implementation of the protocol in at least one of the implementations. This will also require developing an in-depth understanding of the protocol, in order to identify as many opportunities for semantic testing as possible. Finally, you will implement and evaluate your approach on real-world software, that is, on existing QUIC implementations.

### Useful Skills

For this thesis, you should have a basic understanding of network programming and protocols, as well as of C and C++. Additionally, knowledge of automated software testing techniques (such as symbolic execution) will be helpful, but can also be acquired during the initial phase of your thesis.

### Contact

Felix Rath

felix.rath@comsys.rwth-aachen.de

follow us on  
<http://comsys.rwth-aachen.de>

## ► Aktuelle Themenauswahl

- <https://www.comsys.rwth-aachen.de/teaching/available-theses>
- Nur innerhalb des RWTH-Netzes verfügbar



# Hiwi-Job: COMSYS Webmaster

lange Vertragslaufzeit möglich

## Student Webmaster / System Administrator

We currently have an opening for a HiWi (Student Assistant) at COMSYS to support our technical staff. This position is to be filled in early 2021. If you are interested in this position or have any questions, please contact Jan as soon as possible.



### Your Task

Mainly, you would be responsible to maintain the COMSYS website, i.e., its TYPO3 installation and underlying server(s). Besides, we can regularly assign smaller side projects related to our infrastructure (automation) to you (based on preference). Finally, you have the opportunity to dive into other parts of the system administration at our chair and potentially get into contact with the RWTH ITC center. Thus, you can explore different technical areas :-)

Some recent (side) projects included a maintenance script for our theses archive, automation of certain teaching activities, individual website content generation, among others.



- ▶ Bei Interesse bei Jan melden  
[pennekamp@comsys.rwth-aachen.de](mailto:pennekamp@comsys.rwth-aachen.de)
- ▶ Ausschreibung  
<https://www.comsys.rwth-aachen.de/fileadmin/misc/2020/2020-hiwi-website.pdf>

## Requirements & Environment

Ideally, we are looking to fill the position long term. The (flexible) weekly working hours can be set according to your preference. We also have an "office" in a student room for you available.

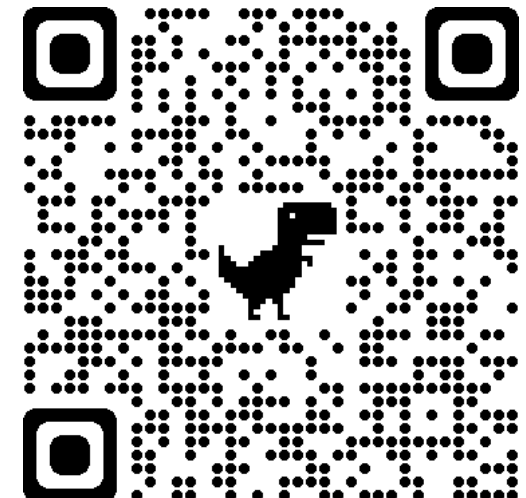
- A good understanding of **(web) server administration** (Unix), TYPO3, and PHP
- Good programming skills, preferably in Python and bash
- Experience with Docker, HotCRP, Perl, and CSS is a plus, but **not mandatory**

COMSYS offers an attractive work environment full of creativity. It is home to a crowd of enthusiastic Bachelor, Master, and PhD students. If you are interested in this position and working with our group, please drop us a message! During regular times, social life at the chair is quite well: With our large kitchen (incl. a fine coffee machine), a diverse offering of snacks, drinks, great colleagues, and the opportunity for billiard matches, we can account for most needs on the spot.

## Contact

Jan Pennekamp [pennekamp@comsys.rwth-aachen.de](mailto:pennekamp@comsys.rwth-aachen.de)

<https://comsys.rwth-aachen.de/>



# Interesse an einer Bachelorarbeit?

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- **Werde Teil von COMSYS**

- ▶ Zeige Interesse!
- ▶ Wir arbeiten an vielen Themen
  - Siehe Forschungsbereiche auf den Webseiten
  - Interesse an einem Bereich? Komm vorbei!
    - *Viele Themen für Bachelorarbeiten werden „an der Tür“ vergeben*
    - Diese Themen kommen nie auf die Webseite
    - Eventuell kann man sein Thema mit beeinflussen
  - Bitte beachten: wir haben nur endliche Kapazitäten
    - *Überzeuge uns, warum Du ein Thema bekommen sollst 😊*





# COMSYS Team and Career Opportunities

<https://comsys.rwth-aachen.de>

# COMSYS Team

- Currently...
  - ▶ 1 professor
  - ▶ 3 postdocs
  - ▶ 14 researchers
  - ▶ 15-20 student science assistants
  - ▶ SS21: 47 student assistants for BuS and Datkom
  - ▶ 2 external researchers

## Scientific Staff



[Julian Büning, M.Sc.](#)  
Researcher  
+49 241 80-21418  
julian.buening(at)comsys.rwth-aachen.de



[Markus Dahlmanns, M.Sc.](#)  
Researcher  
+49 241 80-21425  
markus.dahlmanns(at)comsys.rwth-aachen.de



[Ina Berenice Fink, M.Sc.](#)  
Researcher  
+49 241 80-21419  
ina.fink(at)comsys.rwth-aachen.de



[René Glebke, M.Sc.](#)  
Researcher  
+49 241 80-21424  
rene.glebke(at)comsys.rwth-aachen.de



[Jens Hiller, M.Sc.](#)  
Researcher  
+49 241 80-21426  
jens.hiller(at)comsys.rwth-aachen.de



[Johannes Krude, M.Sc.](#)  
Researcher  
+49 241 80-21413  
johannes.krude(at)comsys.rwth-aachen.de



[Ike Kunze, M.Sc.](#)  
Researcher  
+49 241 80-21422  
ike.kunze(at)comsys.rwth-aachen.de



[Roman Matzutt, M.Sc.](#)  
Researcher  
+49 241 80-21412  
roman.matzutt(at)comsys.rwth-aachen.de



[Jan Pennekamp, M.Sc.](#)  
Researcher  
+49 241 80-21411  
jan.pennekamp(at)comsys.rwth-aachen.de



[Felix Rath, M.Sc.](#)  
Researcher  
+49 241 80-21427  
felix.rath(at)comsys.rwth-aachen.de



[Dr. rer. nat. Jan Rüth](#)  
Postdoctoral Researcher  
+49 241 80-21417  
jan.rueth(at)comsys.rwth-aachen.de



[Constantin Sander, M.Sc.](#)  
Researcher  
+49 241 80-21428  
constantin.sander(at)comsys.rwth-aachen.de



[Daniel Schemmel, M.Sc.](#)  
Researcher  
+49 241 80-21420  
daniel.schemmel(at)comsys.rwth-aachen.de



[Martin Serror, M.Sc.](#)  
Researcher  
+49 241 80-21415  
martin.serror(at)comsys.rwth-aachen.de



[Dr. rer. nat. Mirko Stoffers](#)  
Postdoctoral Researcher  
+49 241 80-21423  
stoffers(at)comsys.rwth-aachen.de



[Dr. rer. nat. Dirk Thißen](#)  
Postdoctoral Researcher  
+49 241 80-21403  
thissen(at)comsys.rwth-aachen.de



[Christian van Sloun, M.Sc.](#)  
Researcher  
+49 241 80-21416  
christian.van.sloun(at)comsys.rwth-aachen.de

## External Researchers



[Eric Wagner, M.Sc.](#)  
External Researcher / FKIE  
wagner(at)comsys.rwth-aachen.de



[Konrad Wolsing, M.Sc.](#)  
External Researcher / FKIE  
+49 241 80-21465  
wolsing(at)comsys.rwth-aachen.de

# Opportunities for Students

- Interested in research?

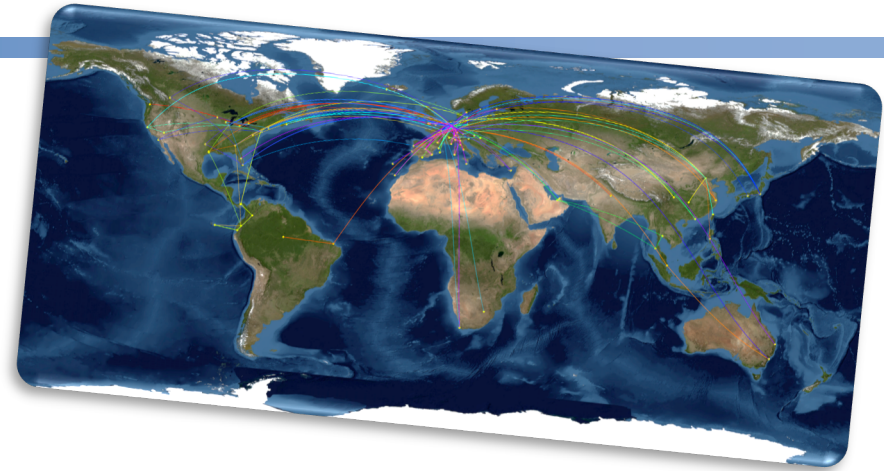
- ▶ Come along, talk to us
  - Maybe „just“ a thesis topic is found...
  - ... but sometimes, even conference papers are outcome of a thesis!
    - You might be financed by us to attend the conference 😊

- Interested in a student helper job?

- ▶ Again: come along, talk to us
  - Hiwi jobs a rare, they seldom come to public announcements

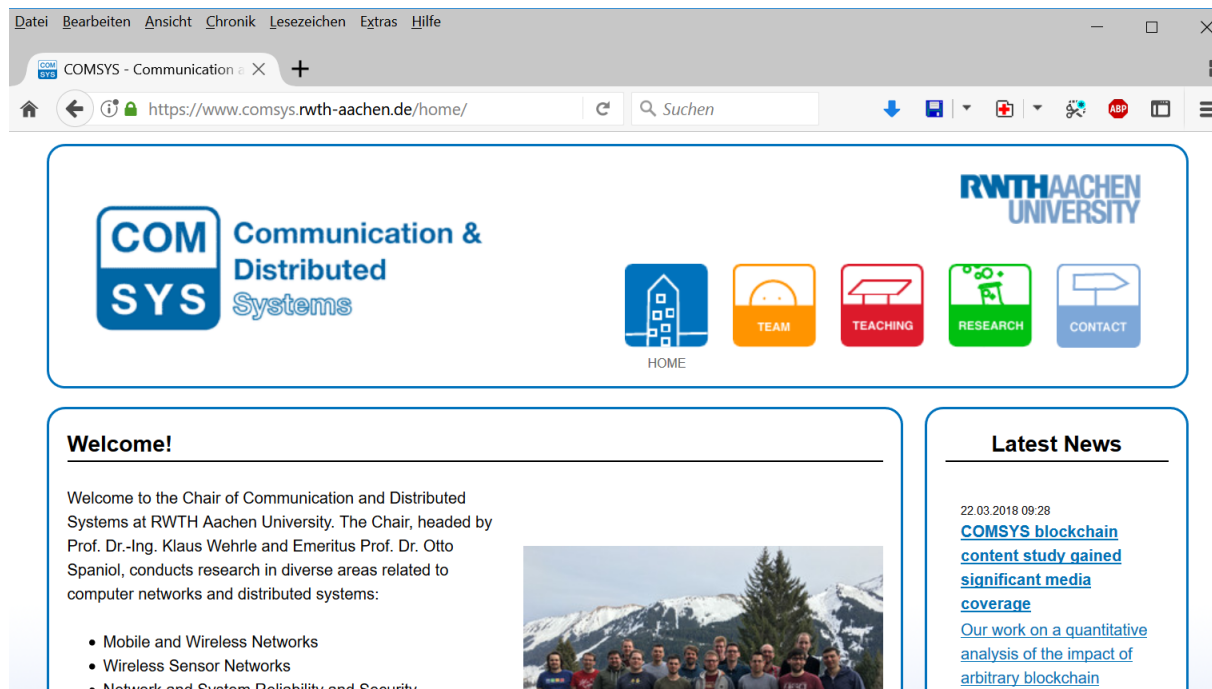
- FOLKS@COMSYS

- ▶ The COMSYS club
- ▶ E.g. scholarships / best thesis awards for students with outstanding achievements in communication systems



# Homepage

- All important information is available here
  - <https://www.comsys.rwth-aachen.de>



- COMSYS in social media



/comsysrwth



@COMSYS\_rwth