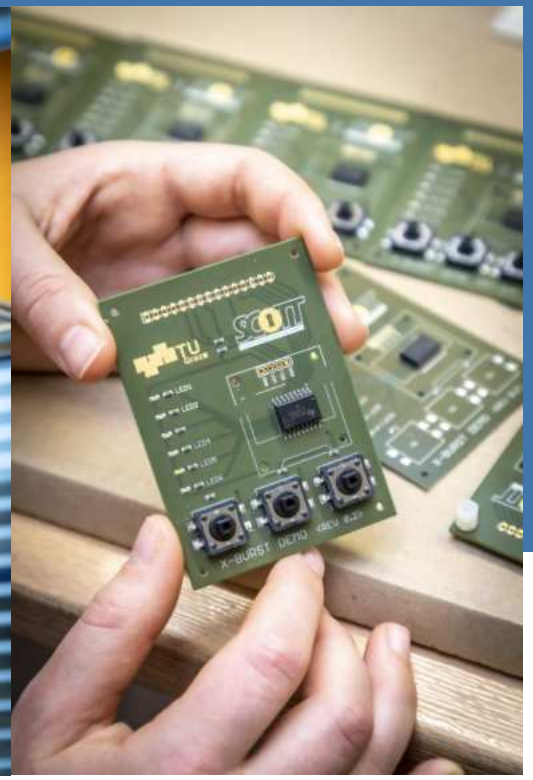
Seminars, Projects, Bachelor and Master Theses

Institute of Technical Informatics





Institute of Technical Informatics

We offer research and education on modern networked embedded systems (such as Internet of Things and Cyber-Physical Systems) with focus on software, hardware, networking, sensing and machine learning. Our working groups make significant contributions to improve dependability, real-time properties, safety security, and efficiency of these systems to enable novel applications.

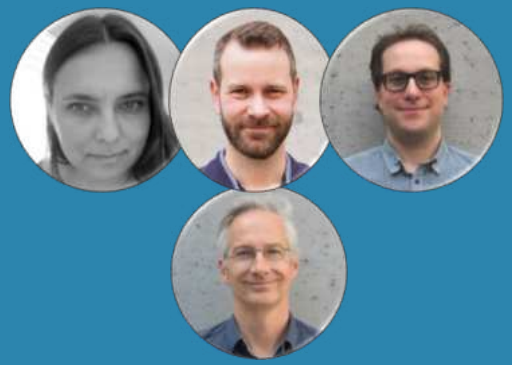
The institute offers attractive topics for student projects, bachelor and master theses – also in collaboration with our industry and academic partners. This booklet offers an overview of the institute, its working groups, topic areas for projects and theses, as well as contact persons. Get in touch with us!

The education focus is on foundations of Computer Engineering, Real-time systems, Distributed Systems and Networking, Functional Safety, and Machine Learning. The Institute significantly contributes to the courses of study in Information and Computer Engineering, Digital Engineering, Electrical Engineering, Informatics, and Software Engineering.

Research groups

Intelligent & Networked Embedded Systems

The Networked Embedded Systems group investigates dependable wireless mesh networks, embedded machine learning and their integration into innovative cognitive products that “think” and are networked among each other.



Headed by Prof. Kay Römer

Embedded Architectures & Systems

The EAS Group focuses on hardware and software for highly dependable and sustainable embedded systems. Novel processor architectures and operating systems are just some examples.

Headed by Prof. Marcel Baunach

Hardware/Software-Codesign

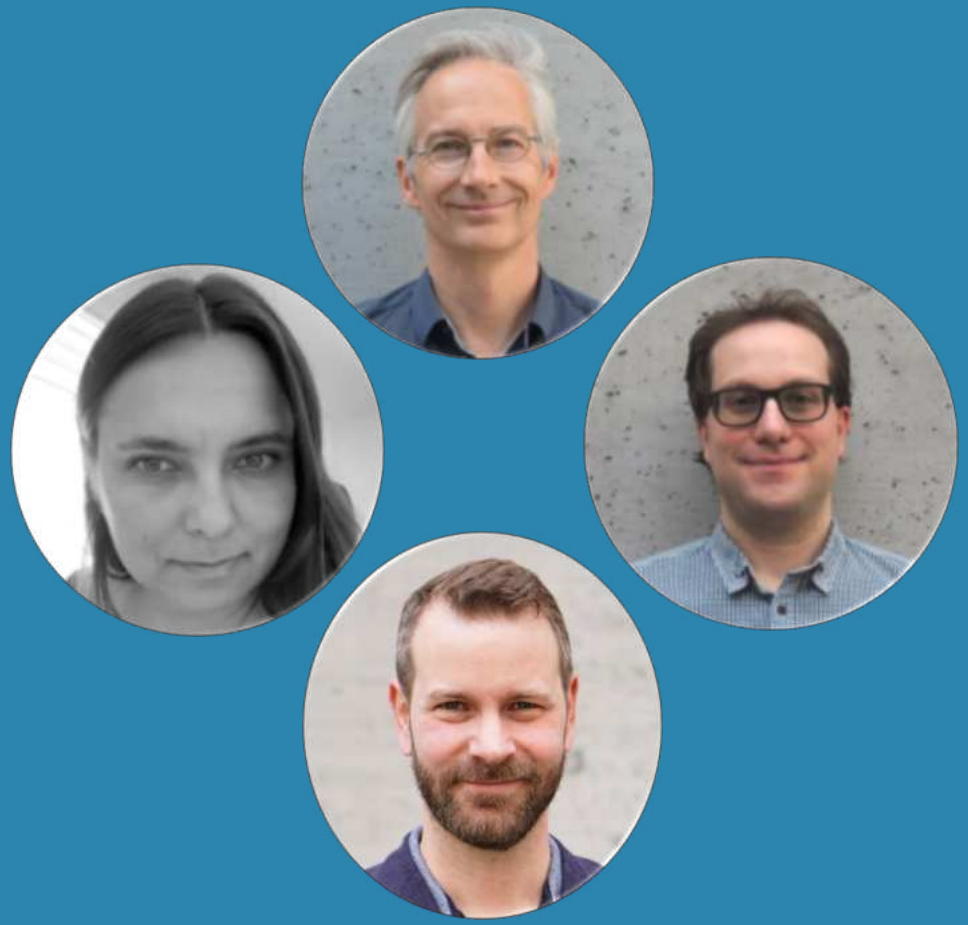
The HW/SW co-design group specializes in embedded systems, HW/SW codesign, and power awareness. Its focus is on optimizing systems to enhance performance, resource efficiency, contri-buting to a more sustainable future.

Headed by Ass.Prof. Christian Steger

Industrial Informatics

The Industrial Informatics group is tightly cooperating with industry to tackle the needs and challenges in technology, process improvement, and new compulsory standards.

Headed by Dr. Georg Macher, MBA



Intelligent & Networked Embedded Systems Group

Modern embedded systems typically consist of multiple computers that are connected by a wireless or wired network, where the computers are equipped with sensors to perceive the environment and process sensor data using embedded machine learning. Sensor networks, Internet of Things, Cyber-Physical Systems are all examples of this type of technology. The Intelligent & Networked Embedded Systems working group, headed by Prof. Kay Römer, investigates design, implementation, and test of such systems with special emphasis on low-power embedded networking (Prof. Carlo Alberto Boano), embedded learning and sensing (Prof. Olga Saukh) as well as their integration into innovative cognitive products (Dr. Michael Krisper).

Prof. Kay Römer
roemer@tugraz.at

Intelligent & Networked Embedded Systems

Team Boano: Low-power Embedded Networked Systems (LENS)

The LENS group is a young team of researchers focusing on the IoT and on future connected wireless embedded systems, with the aim of making them more dependable and sustainable.

The team's activities are at the intersection between wireless networking and embedded hardware/software, with a strong experimental and application-driven character (i.e., our ideas are often embodied in prototypes concretely showing their feasibility and improvements over the state of the art).

LENS

We are always looking for highly motivated and brilliant students interested in doing a project or thesis on our research topics.
We typically define the concrete topic after meeting with the student, in order to adjust the project/thesis to his/her interests/skills.

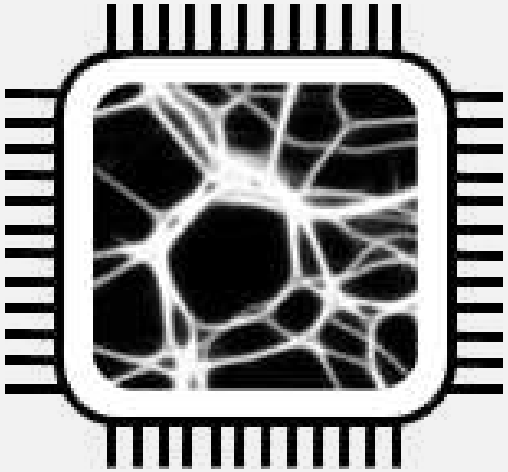
If you have any questions, please contact:

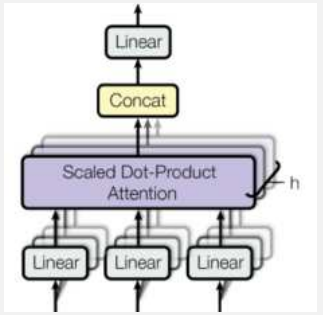
Assoc.Prof. Carlo Alberto Boano
cboano@tugraz.at

Team Saukh: Embedded Learning and Sensing Systems (ELSS)

Today, a wide range of sensors integrate with IoT devices to measure their surrounding contexts. As the number of integrated sensors and their complexity grows, so are the amounts of data they produce and need for this data to be processed. The state-of-the-art computational models that, for example, recognize a face, detect events of interest, track user emotions, or monitor physical activities are increasingly based on deep learning principles and algorithms. Unfortunately, deep models typically exert severe demands on local device resources, and this conventionally limits their adoption within mobile and embedded platforms.

Deep Learning + Embedded Systems





DNN compression & sparsity
On-device learning & reconfiguration
Adaptation, robustness, distribution shifts
Low-data & low-resource deep learning
Distributed & collaborative learning
Sensing, IoT data privacy, edge computing
AI-enabled embedded systems

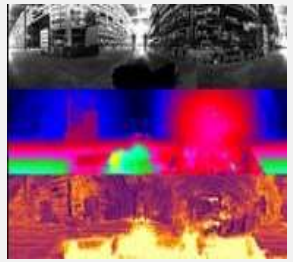
Our group works on the development of AI-powered embedded systems and solving challenges related to deep model compression and sparsity, sensing and learning from the surrounding context, and on-device model adaptation. We believe in "less is more" and "small can be mighty" when it comes to running deep models on resource-constrained devices.

We are always looking for highly motivated and brilliant students. If you have any questions, please contact:

Assoc.Prof. Olga Saukh
saukh@tugraz.at

Team Krisper: Cognitive Products and Production (PRO)

Cognitive products are products that perceive their environment, analyze it, make well-informed decisions and adapt to the situation to fulfill a higher goal. This requires basic technological building blocks of dependable but low-cost and low-power sensing, networking, SW- and HW-platforms, as well as infrastructures with industrial-grade robustness and performance. We explore and research these technological building blocks required for future products and production systems, and we demonstrate them by realizing case studies and prototypes together with our industry partners.



Perception & Recognition

Adapting to Humans and Environment

„Products that Think“

Co-Working in Mixed Environments

Adjust to Dynamic Situations

If you have a creative and growth mindset, you are a **maker**, a **creator**, or **builder**, then we happily invite you to join us bringing cognition to the world of products and production systems – let us make products that think.

We are always looking for highly motivated and brilliant students interested in doing a project or thesis on our research topics.

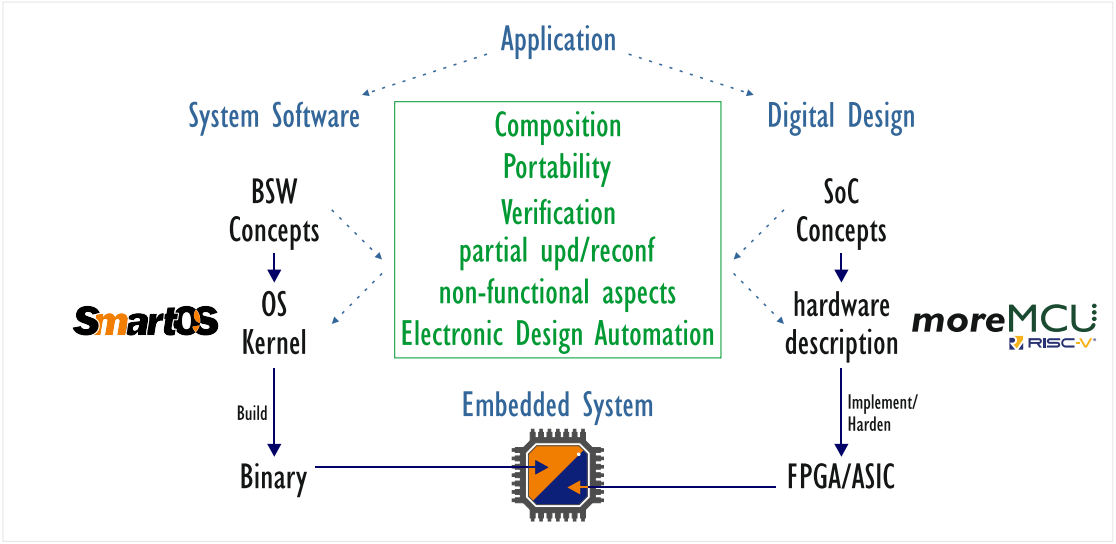
If you have any questions, please contact:

Dr. Michael Krisper
michael.krisper@tugraz.at

Embedded Architectures & Systems Group

We are committed to *hardware* and *software* for highly dependable and sustainable embedded systems.

Novel processors and operating systems for future vehicles, advanced robotics, and the IoT are just some examples.



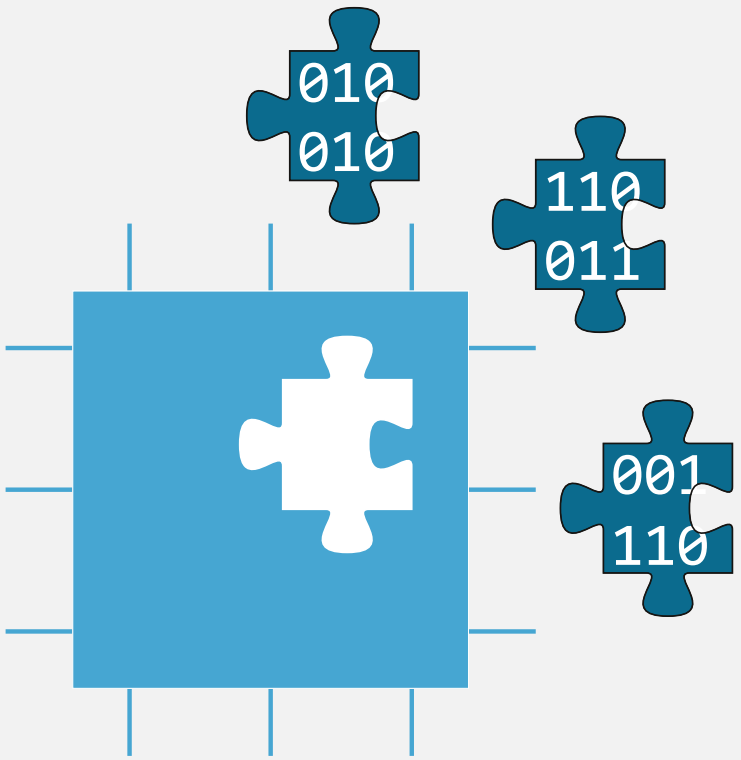
Prof. Marcel Baunach
baunach@tugraz.at

Dr. Tobias Scheipel
tobias.scheipel@tugraz.at

Research Area 1: Digital System Design / Processor Architectures

Embedded systems are electronic devices designed for a particular application. While their software can be updated, this is not yet possible for their hardware. As sustainability and flexibility are increasingly important, hardware must also become updateable.

Our research is on partially reconfigurable and extensible, yet dependable computing platforms. We focus on designing modular microcontrollers and optimize the design flows.



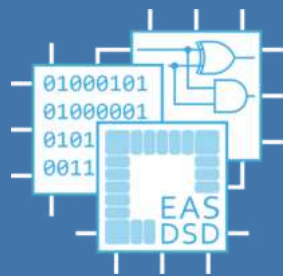
moreMCU

RISC-V®

Calling all motivated and exceptional students! If you are interested in exploring research projects or theses, we'd love to hear from you. Our approach is to craft each project or thesis around your individual interests and skills, and we will collaborate closely with you to define the perfect topic.

For any questions, please contact:

@ Dr. Tobias Scheipel
tobias.scheipel@tugraz.at



Research Area 2: Embedded System Software / Operating Systems

This area digs deep into OS concepts and basic software for future embedded systems.

Support us in creating versatile kernels and work closely together with our industry partners.

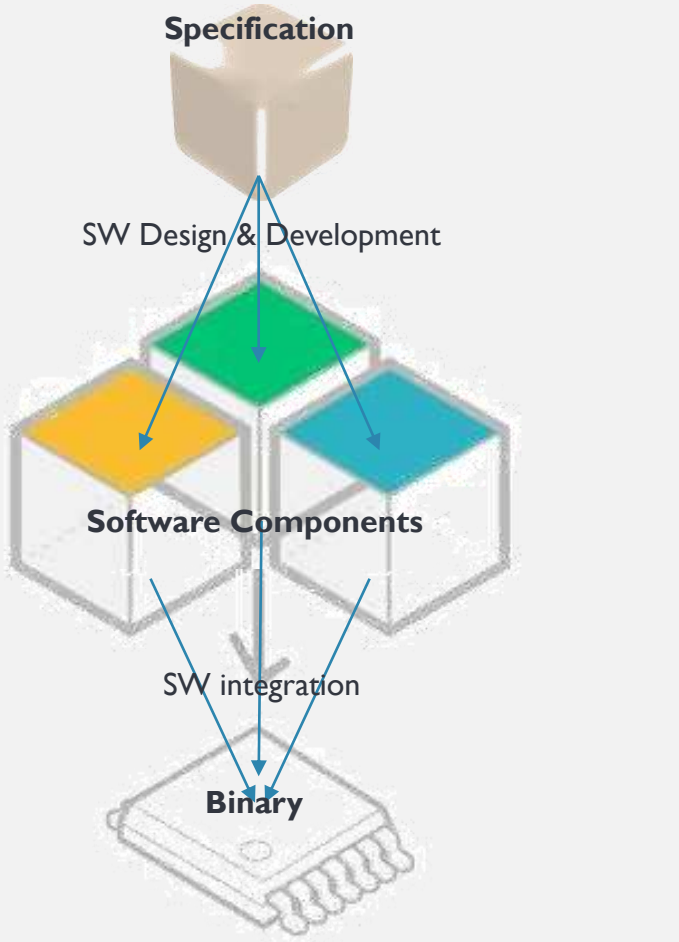
> Sustainability through updates

> Verified correctness

> Portability to new hardware

> Support re-configurable MCUs

> Integrate AI/ML into new kernels



SmartOS

Calling all motivated and exceptional students! If you are interested in exploring research projects or theses, we'd love to hear from you. Our approach is to craft each project or thesis around your individual interests and skills, and we will collaborate closely with you to define the perfect topic.

For any questions, please contact:

Prof. Marcel Baunach
baunach@tugraz.at

Elektrobit

Infineon

CompEAS

HW/SW Codesign

Hardware/Software Codesign Group

The HW/SW codesign group at the Institute for Technical Informatics deals, since 3 decades with embedded systems, HW/SW codesign, and power awareness. Design of embedded systems can be subject to many different types of constraints, including timing, security, power consumption, reliability, and cost.

New process technology systems with much higher complexity requires new methodologies to abstract the system and to handle the design complexity. HW/SW codesign (co-specification, cosimulation, profiling, and rapid proto-typing) is a set of methodologies and techniques specifically created to support the codesign of hardware and software systems.

Special focus is on power aware computing (green IT vs. IT for green) for sustainable IT systems (e.g., HW/SW, data centers, sharing platforms).

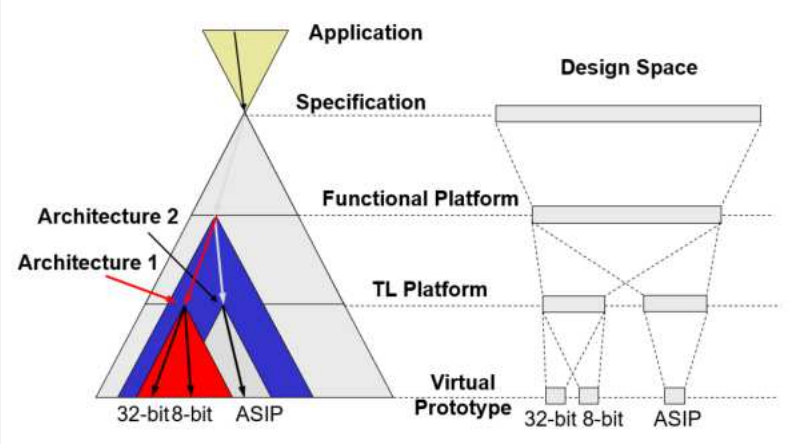
Contact

Ass.Prof. Dr. Christian Steger
steger@tugraz.at

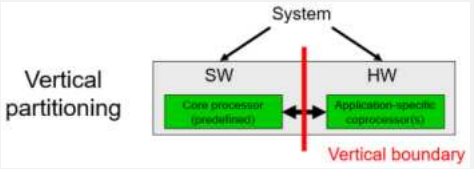
Research Area 1: Optimized System Architectures based on RISC-V

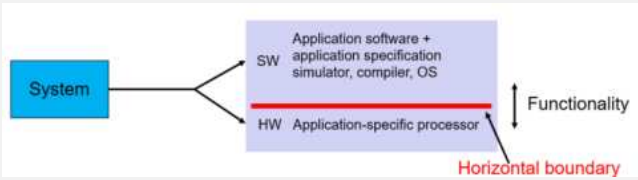
An architecture exploration process requires the availability of models (SystemC, SystemVerilog) and an easy way to build a virtual platform and exchange models by implementations as soon as they become available. This procedure enables early HW/SW codesign in a seamless and consistent manner. .

Driven by the requirements of the target applications, exploration and investigation of the opportunities offered by the RISC-V Standard Specifications to extend the ISA with application-specific custom instructions.



"TRISTAN - Together for RISc-V Technology and ApplicatioNs"





We are looking for motivated and brilliant students who have interest in architectural analysis, design and implementation of an RISC-V accelerated subsystem architecture within the European project TRISTAN together with our industry partner NXP.

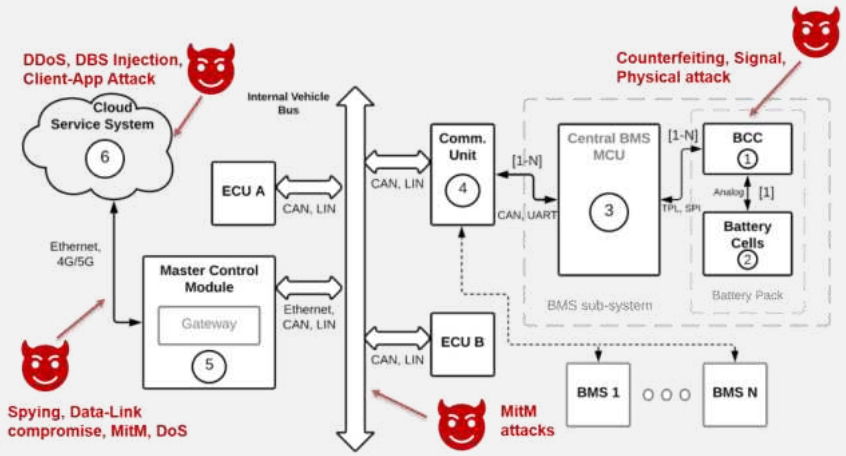
If you have any questions, please contact:

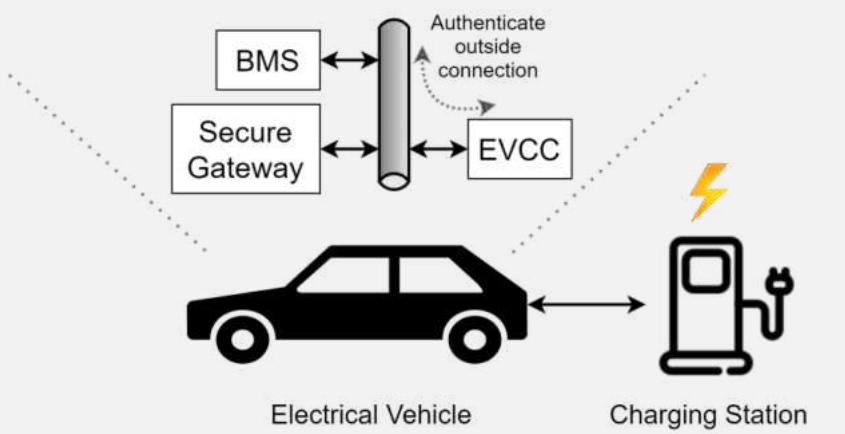
Ass.Prof. Christian Steger
steger@tugraz.at

Research Area 2: Advanced Battery Management Systems

Battery Management Systems (BMS) present the main building block behind modern electric vehicles. They allow for a safe and reliable use of large set of battery packs that power these vehicles.

However, most BMS today are relatively simple controllers that rely only on the local services. We aim to extend these services to also account for the external readouts for the upcoming battery passport initiative. In this regard, we investigate wireless and security solutions that enable for a new fast, cost-effective, and secure transfer of battery data from their sensor sources, through the local network, all the way to cloud.





We are looking for motivated and brilliant students who have interest in realizing secure and safety analysis, develop system design that accounts for wireless readout, design and implement secure architecture, digitalization and cloud connectivity.

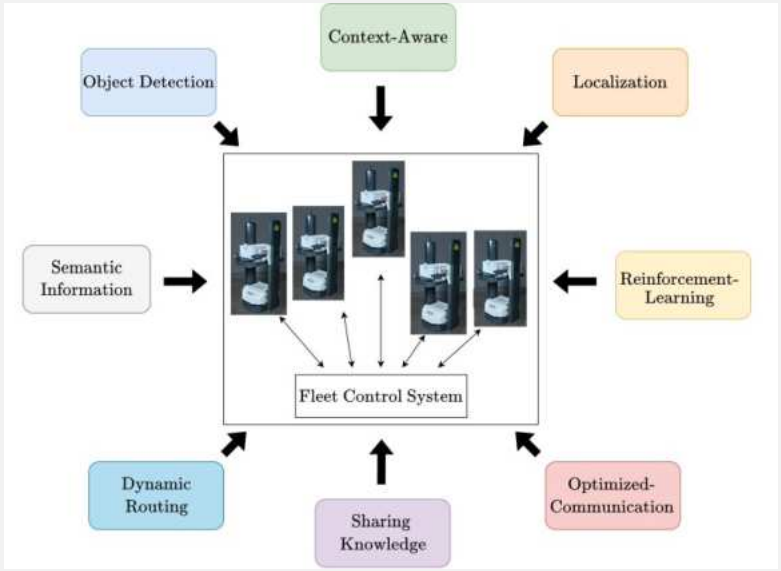
If you have any questions, please contact:

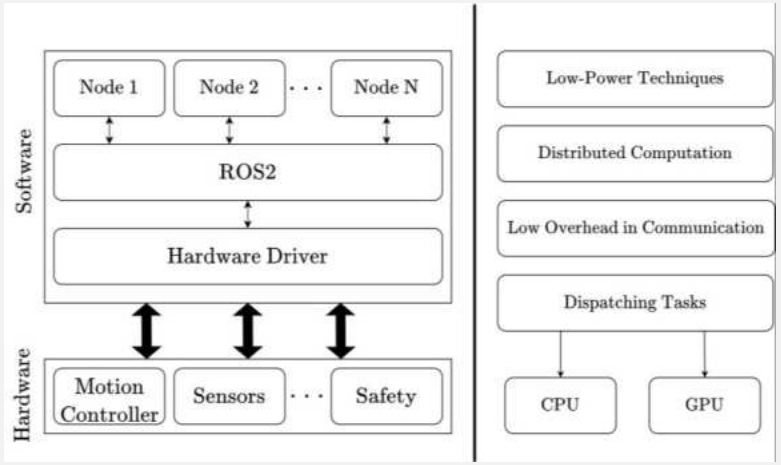
Ass.Prof. Christian Steger
steger@tugraz.at

Dr. Fikret Basic
basic@tugraz.at

Research Area 3: Layered Architecture for Collaborative Mobile Robots

Today, mobile robots are part of many industrial processes to increase the efficiency. One example is the warehouse, where they act autonomously and bring goods from A to B. This enables that human workers can focus on other tasks. One way to optimize the autonomous vehicle is to enable collaboration between the robots. This could, for example, consist of perceiving information from the environment such as semantic information (pallets, obstacles, people) and forwarding it to the fleet control system. This can be used, for example, to generate a new task for another robot or to avoid this area due to blocked paths. Another focus in this research area is the HW/SW optimization since the resources are limited in a mobile robot.





We are always looking for motivated students that want to gain experience in this growing and exciting area. There are many topics for beginners and more advanced topics for experienced students.

If you have any questions, please contact:

Ass.Prof. Christian Steger
steger@tugraz.at

Christof Schützenhöfer
schuetzenhoefer@tugraz.at

Industrial Informatics Group

The Industrial Informatics working group is tightly cooperating with industry to tackle the needs and challenges in technology, process improvement, and new compulsory standards. While the complexity increases in products and solutions for the automotive, automation, and IT domains, development cycle times are continuously shrinking. System development by singular domain specialists is no longer sufficient. Systems have to be engineered in integrated design processes across distributed supply chains, keeping track of changes in an agile manner. The group focuses on general functional viewpoints and system-wide feature thinking.

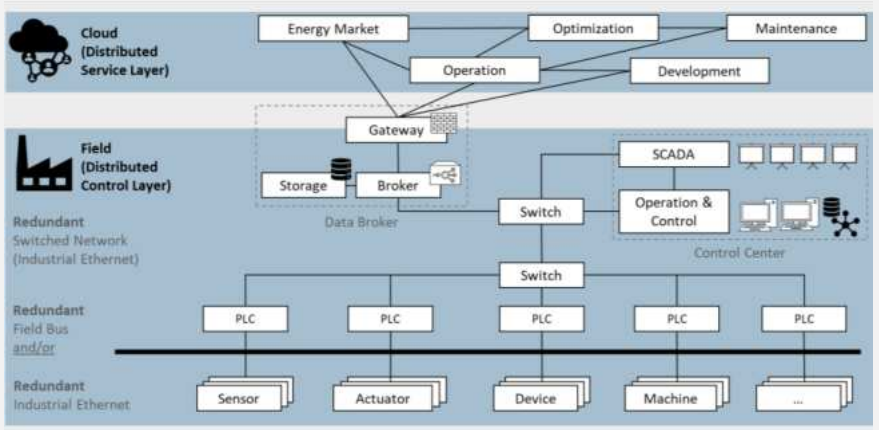
Contacts

Dr. Georg Macher, MBA (macher@tugraz.at) [Group leader]
Dr. Omar Veledar, MBA (omar.veledar@tugraz.at)
Thomas Krug (t.krug@tugraz.at)
Romana Blazevic (romana.blazevic@tugraz.at)
Thomas Faschang (faschang@tugraz.at)

Research Area 1: Distributed Embedded Real-Time Systems

Distributed embedded real-time systems are essential in multiple domains, from smart cars to advanced medical devices and power plant applications. These systems are designed to work under hard real-time constraints seamlessly together to achieve complex tasks that would otherwise be impossible.

With the abilities of these systems data collection and processing enable faster and better-informed decision makings, leading to improved customer experiences and increased profitability. Explore the possibilities of distributed embedded real-time systems and stay ahead in the rapidly evolving technology landscape.



Create a reliable industrial IoT system, explore the integration of AI in safety-critical (autonomous) applications, or build a real-time demonstrator platform for industrial control algorithms

If you have any questions, please contact:

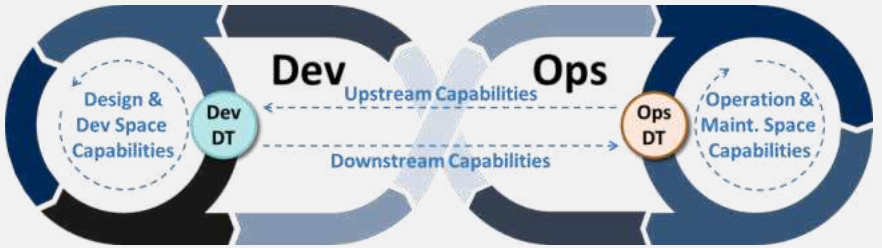
Thomas Krug
t.krug@tugraz.at

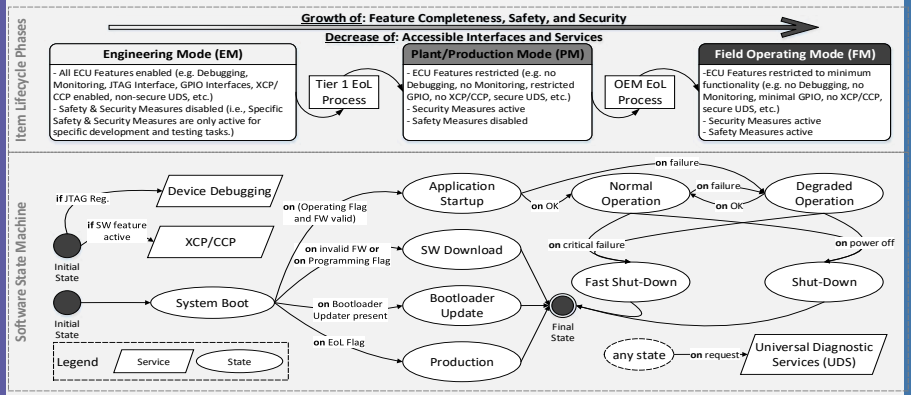
Dr. Georg Macher, MBA
georg.macher@tugraz.at

Research Area 2: Critical Industrial Systems Engineering

Critical industrial systems engineering is the backbone of multiple industries, from vehicle manufacturing to energy production. These systems are designed to ensure the safe, secure, efficient, and reliable operation of complex industrial processes.

Engineering of critical industrial systems is the key enabling factor to leverage the latest advancements in technology to the market and the customer. Whether it's designing automation solutions, optimizing operations, or ensuring customer acceptance, critical industrial systems engineering provides the basis for establishing trust, safety, and security in digitalization.





Check the cybersecurity measures of an embedded system, built a safety demonstrator, or support in designing, mining, and describing of best practices and patterns in different domains for industrial cybersecurity, safety, or risk management.

If you have any questions, please contact:

Thomas Faschang
faschang@tugraz.at

Romana Blazevic
romana.blazevic@tugraz.at

Research Area 3: Digitalization & Innovation Projects

In today's fast-paced business environment, digitalization and innovation projects are essential to maintain competitiveness. You may modernize company procedures, improve customer experiences, and streamline operations by embracing new technologies. Whether it's through the adoption of new software, the implementation of automation, or the investigation of the newest trends in data analytics.

These topics can be freely explored to come up with highly innovative and creative solutions. Create a prototype for your digitalization project that assesses, enriches, modifies, or advances the current status of science and industrial practice.

Either you come up with your own crazy or unusual ideas, or be inspired by some of our digitalization and innovation projects.

If you have any questions, please contact:

Dr. Georg Macher, MBA
georg.macher@tugraz.at

Dr. Omar Veledar, MBA
omar.veledar@tugraz.at

March 2025