ITN-5VC

Integrated Telematics for Next Generation 5G Vehicular Communications

5G/6G School

Technische Universität Ilmenau

October 4th – 7th, 2022

Agenda

Day 1 – October 4th

Time	Title	Lecturer	Room	Lecture Type
08:30 – 09:00	Welcome and agenda	Prof. Giovanni Del Galdo	Wernstedt, FhG	Presentation
09:00 - 10:30	THz – Channel Sounding and Modelling for 6G and Beyond	Dr.-Ing. Diego Dupleich (FhG IIS)	HF 2 Lab, FhG	Presentation + Demo
Coffee break				
11:00 – 12:30	ICAS system aspects, radio access and estimation	Prof. Reiner Thomä (TUIL)	Wernstedt, FhG	Presentation
Lunch break				
13:15-14:45	Vehicular Communications for Smart Mobility: Industry Perspectives and Research Notes	Dr. David González G. (Continental AG)	Wernstedt, FhG	Presentation
Coffee break	Walk to VISTA + BIRA lab		ThIMo I	
15:30 – 17:00	VISTA and BIRA measurement facility	Prof. Reiner Thomä (TUIL)	ThIMo I, TU Ilmenau	Demo/Lab
19:00 - XY	Dinner at Hotel Tanne			

Day 2 – October 5th

Time	Title	Lecturer	Room	Lecture Type
08:30 – 09:00	Arrival and coffee		Wernstedt, FhG	
09:00 - 10:30	Integrated Sensing and Communication - empowering 5G and laying the foundations for 6G (1)	Prof. Andrea Giorgetti (Uni Bologna)	Wernstedt, FhG	Presentation
Coffee break				
11:00 – 12:30	Integrated Sensing and Communication - empowering 5G and laying the foundations for 6G (2)	Prof. Andrea Giorgetti (Uni Bologna)	Wernstedt, FhG	Presentation
Lunch break				
13:30-15:00	Innovation in Communication Systems and the Role of IPR	Prof. Michael Schlicht (FhG IIS)	Wernstedt, FhG	Presentation (remote)
Coffee break				
15:30-17:00	5G Physical Layer and Positioning Demo at Fraunhofer IIS / Ilmenau	MSc Michael Schubert, Dr.-Ing.	HF 1 Lab, FhG	Presentation + Demo

		Markus Landmann (FhG IIS)		
18:00 -	Free Use!			

Day 3 – October 6th

Time	Title	Lecturer	Room	Lecture Type
08:30 – 09:00	Arrival and coffee		Wernstedt, FhG	
09:00 - 10:30	The Path Towards 6G	Dr.-Ing. Thorsten Wild (Nokia)	Wernstedt, FhG	Presentation (remote)
Coffee break				
11:00 – 12:30	Standardisation in IEEE 802	Prof. Jörg Robert (TUIL)	Wernstedt, FhG	Presentation
Lunch break				
13:30-15:00	Multi-Node Channel Sounding	Daniel Stanko and Gerd Sommerkorn (TUIL & FhG)	HF 1 Lab, FhG	Presentation + Demo
Coffee break	Walk to FORTE (10min)			
15:30-17:00	FORTE & OTA Jamming & Spoofing	MSc. Renato Vintimilla (FhG)	FORTE, FhG	Presentation + Demo
18:00 -	Visit Erfurt and Dinner			

Day 4 – October 7th

Time	Title	Lecturer	Room	Lecture Type
08:30 – 09:00	Arrival and coffee		Wernstedt, FhG	
09:00 - 10:30	C-V2X: Application, Technology, Market Review and Testing	Holger Rosier, Ramez Khoury and Jose Fortes; (Rohde&Schwarz)	Wernstedt, FhG	Presentation (last 45min remote)
Coffee break				
11:00 – 12:30	The proof is in pudding: Experimental validations through proof of concepts	Dr.-Ing. Maximilian Arnold (Nokia)	Wernstedt, FhG	Presentation
Lunch break				
13:30-15:00	Development of a V2X simulation platform and lessons learned	MSc. Moustafa Roshdi (FhG IIS)	Wernstedt, FhG	Presentation
15:00-15:30	Wrap up and Closing	Prof. Giovanni Del Galdo	Wernstedt, FhG	

Logistics:

1. **Main venue**

   Fraunhofer-Institut für Integrierte Schaltungen IIS, Abteilung EMS
   Am Vogelherd 90
   98693 Ilmenau

   Including meeting room „Wernstedt" and lab HF 1 & 2.

2. **"FORTE – Facility for Over-the-Air Research and Testing**

   Am Vogelherd 61
   98693 Ilmenau

3. **Thüringer Innovationszentrum Mobilität**

   Ehrenbergstr. 15
   98693 Ilmenau

   Including meeting VISTA / BIRA test facility.

4. **Dinner venue**
   I.   Hotel Tanne
         Lindenstraße 38,
         98693 Ilmenau

   II.   Restaurant "Feuerkugel"
         Michaelisstraße 3-4
         99084 Erfurt

         Train departure @ Ilmenau: 17:18 or 17:48 @ main station
         Train departure @ Erfurt: 22:59 @ main station

5. **Webex Online Access:**
   - Separated links are available for each training school day.
   - Links are updated here**:**
     https://www.tu-ilmenau.de/universitaet/fakultaeten/profil/institute-und-fachgebiete/fachgebiet-elektronische-messtechnik-und-signalverarbeitung/aktuelles/termine

Speaker details:

Title: "Vehicular Communications for Smart Mobility: Industry Perspectives and Research Notes"

Lecturer: Dr. David González G., Continental

Abstract:

The industry of mobility and transportation has experienced substantial changes in the last few years, and many changes are still to come. In particular, the Automotive sector is undergoing important transformations mainly driven by digitalization, electrification, and vehicular communications (V2X). Continental is committed to make tomorrow's mobility safer, more efficient, sustainable, personalized, and enjoyable. However, important challenges are ahead. The lecture aims at providing, from the Automotive point of view, an overview of recent and future developments in the field of vehicular communications/networking and smart mobility. The discussion will include motivations and opportunities, illustrated with examples, of:

- the role and contribution of Continental within these complex, fast-changing, yet exiting, ecosystem of telecom-automotive collaboration,
- some key technological elements, including trends in both research and standards,
- the need for developments in and around vehicles, and
- the importance of keep increasing the collaboration between industry and academy.

Bio:

David González G. has 20 years of combined experience in basic- and applied-research and engineering in the telecommunications and automotive industry, usually in projects with multi-disciplinary teams in 5 different countries. David holds a Master and a Ph.D. degree, both focused on (2G-4G) mobile communications, from the Universitat Politècnica de Catalunya, Spain, has 3-years post-doctoral experience in Aalto University, Finland, and over 5 years of experience in standardization of mobile broadband (3GPP), mainly focusing on physical layer aspects (RAN1) and vehicular communications. Currently, David is with Continental and serves as Wireless Communications Researcher and his duties also include project management and *in-house* R&D, in fields related but not limited to vehicular communications. David has written and co-authored more than 50 scientific publications, holds several patents, is inventor or co-inventor of dozens of patents applications under examination, collaborates regularly with the academy (e.g., in research projects or giving lectures and talks), and has represented Continental is several Automotive-Telecomm committees, forums, and panels.

Title: "Integrated Sensing and Communication - empowering 5G and laying the foundations for 6G"

Lecturer: Prof. Andrea Giorgetti

Abstract:

We start with the key aspects to be considered and properly used to enable 5G for sensing, with some emphasis on vehicular applications. A concrete example is studying a multibeam system for joint sensing and communication (JSC) based on MIMO 5G NR waveforms. In particular, we will consider a BS acting as a monostatic sensor that estimates target range, speed, and direction. We will then extend the sensing functionality considering a bistatic configuration and discuss its pros and cons. Finally, capitalizing on some examples, we will find the dominant factors that influence the sensing performance to understand the key parameters that play a role in a JSC system.

Bio:

Andrea Giorgetti received the Dr. Ing. Degree (summa cum laude) in electronic engineering and the Ph.D. degree in electronic engineering and computer science from the University of Bologna, Italy, in 1999 and 2003, respectively. He joined the Department of Electrical, Electronic, and Information Engineering Guglielmo Marconi, University of Bologna, as an Assistant Professor, in 2006 and was promoted to an Associate Professor in 2014. In spring 2006, he was with the Laboratory for Information and Decision Systems (LIDS), Massachusetts Institute of Technology (MIT), Cambridge, MA, USA. His research interests include statistical signal processing, machine learning for communications, localization, cognitive radio, and integrated communications and sensing. He has been an Editor of IEEE Communications Letters and IEEE Transactions on Wireless Communications. He has been elected Chair of the IEEE Communications Society's Radio Communications Technical Committee from 2017 to 2018.

Title: " ICAS system aspects, radio access and estimation"

Lecturer: Prof. Dr.-Ing. Reiner Thomä, TU Ilmenau

Abstract:

In the first part, we discuss aspects of network only sensing, network to mobile sensing (up/downlink sensing) and sidelink sensing (device to device). In the second part, we address radio access and waveform issues: orthogonal waveforms vs. reuse of communication waveforms for radar sensing, broadcast and multisensor channel access, multilink coordination, pilot-based sensing and link adaption. In the third part, we refer to OFDMA processing and sparse signal estimation. Finally, we will show some demonstration results and discuss use cases.

Bio:

Reiner Thomä received his degrees in electrical engineering and information technology from TU Ilmenau, Germany. Since 1992, he has been a Professor at the same university. He has retired since 2018. In 2007, he received the Thuringian State Research Award for Applied Research and in 2014 the Vodafone Innovation Award, both for his contributions to high-resolution multidimensional channel sounding. In 2020, he received the EurAAP Propagation Award "For pioneering the multi-dimensional description of the mobile radio channel by advanced signal-processing methods." He has contributed to several European and German research projects and clusters. His research interests include multidimensional channel sounding, propagation measurement and model based parameter estimation, MIMO system over-the-air testing in virtual electromagnetic environments, MIMO radar, passive coherent location, and integrated communication and sensing.

Title: "Innovation in Communication Systems and the Role of IPR"

Lecturer: Prof. Dr.-Ing. Michael Schlicht, FhG IIS

Abstract:

This presentation will provide an introduction to innovation, innovation management and the role of IPR, especially in the context of research and development of communication systems. We will provide an overview of basics as well as discuss methods and circumstances necessary for successful innovations, in particular for large complex systems spanning entire value chains, as is typical for modern communication systems. The last part of the talk will deal with the role of IPR and standardization in this context.

Bio:

Michael Schlicht received his Engineering Diploma (Diplomingenieur Elektrotechnik) at the Friedrich Alexander Universität Erlangen-Nürnberg in 1990 with focus on Communications and Microelectronics.

He joined Fraunhofer already 1989 during his diploma thesis (equivalent to today's master thesis) which dealt with hardware description languages and implementation of ASICs for communication applications, when logic synthesis became the industry standard for integrated circuits mapping onto standard silicon technologies.

He started his professional career as scientific employee in the department of Digital IC Design at the Fraunhofer Institute for Integrated Circuits (IIS). In 1993 he assumed the position of group manager for ASIC developments and was appointed manager for satellite radio programs in 1998 especially for the development of end devices for portable handheld and automotive applications (Digital Satellite Broadcast Receivers). Expanding business in 2006 allowed the foundation of a new department focusing on Digital Terminal headed by Michael Schlicht with focus on satellite and terrestrial communication devices and systems. Research and development was hereby focus on the development of hardware and software IP and exploitation of results through licensing of copyright and patents.

In 2014 the new division for communication system was founded by Michael Schlicht encompassing six business fields including Automotive, Artificial Intelligence, Public Safety, Internet of Things, Mobile Broadband Communications and Satellite Communication.

Today his division has a solid representation in standardization for communication systems in 3GPP for 5G, ETSI for broadcasting and IoT/LPWAN systems and in IEEE for WIFI and LPWAN systems for next generation systems.

In 2019 he headed the founding committee of the MIOTY Alliance and was elected vice chair of the Executive Board of the Alliance, supporting the promotion and technical evolution of the MIOTY technology (standardized under ETSI TS 103357 – TS UNB in June 2018) as well as today's promotion of MIOTY commercial rollout in different verticals and sectors.

Michael Schlicht is also associate professor at the University of Navarra since 2007.

Title: "Development of a V2X simulation platform and lessons learned"

Lecturer: MSc. Moustafa Roshdi, FhG IIS

Abstract:

C-V2X (cellular vehicle-to-everything) promises to connect vehicles with "everything" including other vehicles, pedestrians, the traffic roadside equipment and the Internet in a reliable and efficient manner. This added connectivity is thought to be a major enabler of new applications and services such as automated driving, platooning and many other complex applications. It is a usual practice in the automotive sector that the first verification tests of the new SW- vehicle functions are conducted in the hardware after the new software function is developed and deployed. This means that the price of the problem in the software is high, since software team has to de-bug and test the SW again and then repeat the verification tests in the automotive hardware again. This was the main motivation behind the development of our C-V2XSim platform, which we are envisioning to be a key enabler to start this validation process much earlier with a realistic simulation environment that enables the test and verification of the performance and bottlenecks in new applications, deployments and algorithms. The focus of this talk is to showcase with some practical examples some tips and tricks on how to build a complex simulation environment and interface it with the outside world to use external features and/or allow interaction from external actors.

Bio:

Moustafa Roshdi received his Bachelor's degree in from the German University in Cairo Information Engineering and Technology in 2016 in and his Master's degree in Communication Engineering from the Technical University of Munich in 2020. He has joined Fraunhofer IIS as Full time researcher since 2020 where he has been one of the lead developers of the C-V2XSim platform and leading many contributions to various EU and industrial projects. Alongside the simulation development work, he is also conducting research into the use Reinforcement Learning in network Optimization with focus on near real-time RAN optimizations such as QoS managements and congestion control.

Title: "The Path Towards 6G"

Lecturer: Dr. Thorsten Wild, Nokia

Abstract:

Starting from the original vision of 5G, since release 15 there have been further technological developments in 5G and further possibilities for 5G improvements in areas such as positioning and AI/ML. Beyond 5G the 6G-era is already crystallizing out. Predicted from Nokia point of view the key vision for 6G is discussed together with use cases and key technologies. The talk provides a specific emphasis on the topic of "network as a sensor".

Bio:

Thorsten Wild received his Dipl.-Ing. degree in Electrical Engineering and Information Technology from the University of Karlsruhe in 2001 and his Dr.-Ing. (PhD) degree in Electrical Engineering and Information Technology from University of Stuttgart in 2016. In 2001 he joined Alcatel as a research engineer, became part of Bell Labs in 2006 and part of Nokia Bell Labs in 2016. In 2017 he became department head of the Next Generation Wireless Systems team.

He has authored and co-authored more than 50 conference papers and more than 20 standardization technical documents for 3GPP NR and LTE, and holds more than 70 filed and granted patent families in communications. He achieved numerous patent awards, such as being the top 10 inventor in Nokia Stuttgart for granted patents for all time and being nominated for the Bell Labs Inventors Award in 2011. He was active contributor in several european projects, such as being the technical manager of the European 5GNOW research project. Thorsten Wild's background is in signal processing, multi-antenna communication and physical layer design. He has been working on UMTS, LTE, LTE-A, multi-user MIMO, coordinated multi-point, channel estimation, limited feedback, 5G waveforms and 5G air interface design.

Title: "The proof is in pudding: Experimental validations through proof of concepts"

Lecturer: Dr. Maximilian Arnold, Nokia

Abstract:

General concepts are only valuable if they can be converted into real-products. As direct productization would be too costly, proof-of-concepts (PoC) are used to find the simulation to measurement gap. In this talk we are going to present different types of PoCs, ranging from software defined basestations to low level channel measurements in the terahertz regime. Our focus will lie on the higher concepts and how differently proof of concepts are designed and executed. To conclude we investigate two different use-cases in the integrated sensing and communication region via pre-recorded videos.

Bio:

Maximilian Arnold joined Nokia Bell Labs in 2020, as a Research Scientist. He received his B.S. (2014) and M.S. (2016) and his Ph.D. (2020) in electrical engineering from University Stuttgart. Over his research course he has two best paper awards (ISWCS2017,EUCNC2022), a Bell Labs Prize (2019) and hosted multiple deep learning dataset competitions (CTW2019,CTW2020, SPAWC2021). He authored over 10 publications and over 10 patents and pending patents. His current focus are machine learning applications for communication systems.

Title: "Standardization in IEEE 802"

Lecturer: Prof. Dr.-Ing. Jörg Robert, TU Ilmenau

Abstract:

Wireless LAN (IEEE 802.11) is the most popular standard of the IEEE 802 family. However, many other standards of the IEEE 802 family are used in our daily live. Examples are Bluetooth (IEEE 802.15.1) or IEEE 802.15.4z, which is used in the latest IPhone for precise localization and secure payment. Another example is IEEE 802.11p for Car-2-X communications. This presentation will give a short overview of the history of IEEE 802 standards and its applications. Furthermore, I will introduce the procedures of the IEEE standardization process, starting from the idea towards the final specification.

Bio:

Joerg Robert studied electrical engineering in Ilmenau and Braunschweig, Germany. From 2006 to 2012 he was researcher at the "Institut für Nachrichtentechnik" of TU Braunschweig. Here he was deeply involved in numerous standardizations of the DVB (Digital Video Broadcasting) project, e.g. DVB-T2, and DVB-C2. He finished his PhD in 2013, which was on the topic of using multi-antenna systems in broadcast applications. In 2012 he joined the "Lehrstuhl fuer Informationstechnik mit dem Schwerpunkt Kommunikationselektronik" (LIKE) of the Friedrich-Alexander Universitaet Erlangen-Nuernberg, Germany. His worked focued on energy efficient networking, e.g. based on the IEEE 802.15.4 standard family. From 2016 to 2020 he was chairing the IEEE standardization activities on Low Power Wide Area Networks (LPWAN), which resulted in IEEE Std 802.15.4w. Furthermore, he was deeply involved in the development of European LPWAN standard ETSI TS 103 357. Since February 2021 he is professor for Dependable Machine-to-Machine Communications at Technische Universitaet Ilmenau (Germany). His current work focuses on the development of highly energy-efficient and dependable communication and localization systems.

Title: "C-V2X: Application, Technology, Market Review and Testing"

Lecturer: Holger Rosier, Rohde & Schwarz

Abstract:

Cellular-V2X promises to make driving safer and more efficient and it is critical for the implementation of Advanced Driver Assistance Systems (ADAS). However, it also brings new challenges to maintain reliable connectivity between vehicles, infrastructure, pedestrians and other road users and ensure the correct operation of ADAS features. It is a very dynamic situation as the automotive industry in different regions around the world decides which technologies and features to implement and when, all within the framework of standards organizations such as 3GPP, ETSI and C-SAE. This talk explains developments in C-V2X standards from LTE to 5G as well as the global and regional market status. Finally, there is a special section on C-V2X RF, protocol and TCU application testing.

Bio:

Holger Rosier is a Technology Manager with Rohde & Schwarz within the Automotive Market Segment. His focus is on wireless communications technologies for vertical industries, in particular for connected cars. Prior to joining Rohde & Schwarz, Holger was a Senior Technology Lead for IoT with Huawei Technologies in Germany. In this position, he led joint 5G V2X research industry projects. Holger holds a University degree in Electrical Engineering & Information Technology from the RWTH Aachen University. He combined post-graduate studies on 3GPP technologies and ultra-wideband (UWB) communication with consultancy for Cooperative Intelligent Transportation Systems (C-ITS).