International Symposium on Networked Cyber-Physical Systems

Net-CPS 2016

September 19-20, 2016

Institute for Advanced Study, Technische Universität München, Garching

Program

The symposium program consists of three plenaries and twelve invited lectures by international top-experts related to the area of networked cyber-physical systems. Apart from that there will be two panel sessions that address the question on the main research challenges within Net-CPS. In a poster session more junior researchers such as Postdocs may present the recent research and views on Net-CPS.

Concretely, the program looks as follows, the list of plenary and invited speakers is provided below.

Day 1 - September 19, 2016

Time	Program item
9:00-9:15	Welcome, introduction of goals and objectives of the symposium
9:15-10:15	Plenary lecture by Prof. Manfred Broy (TUM, Zentrum Digitalisierung.Bayern) Towards comprehensive models for connected cyber physical systems
10:15-10:30	Coffee break
10:30-12:00	**Session 1: Verification of networked CPS** 1. Model checking and strategy synthesis for mobile autonomy: from theory to practice (Marta Kwiatkowska/ Univ Oxford) 2. Towards the Symbolic Analysis of Networked Systems (Klaus Wehrle / RWTH Aachen Univ) 3. Online Verification of Cyber-Physical Systems (Matthias Althoff/

	TUM)
12:00-13:30	Lunch and poster session
13:30-14:30	Plenary lecture by Prof. Karl Hendrik Johansson (KTH, Sweden) on networked control for smart transportation systems
14:30-15:00	Coffee break
15:00-16:30	**Session 2: Traffic system as networked CPS** 1. Formal Methods for Control of Traffic Networks (Calin Belta/ Boston Univ) 2. Future Traffic Management: Towards a Cyber-Physical System Network (Markos Papageorgiou / Tech Univ Crete) 3. Human Roles in CPS Networks: Toward a Classification and a Roadmap (Tariq Samad / Univ Minnesota)
16:30-17:00	Coffee break
17:00-18:00	Panel I

Day 2 - September 20, 2016

Time	Program item
9:00-9:15	Welcome note
9:15-10:15	Plenary lecture by Prof. Werner Damm (Universität Oldenburg) Understanding systems of cyber-physical systems
10:15-10:30	Coffee break
10:30-12:00	**Session 3: Electric energy system as networked CPS** 1. Toward a Unified Approach to Sustainable and Resilient Electric Energy Systems-- Modeling, Control and Testbeds (Marija Ilic / Carnegie Mellon Univ) 2. Real-Time Control of Electrical Distribution-Grids (Jean-Yves Le Boudec/ EPFL) 3. Challenges in simulating future energy systems (Antonello Monti/ RWTH Aachen Univ)
12:00-13:30	Lunch and poster session
13:30-15:00	**Session 4: Control and security in networked CPS** 1. Security problems of networked cyber-physical systems as centrality-based zero-sum games (Ming Cao/ Univ Groningen) 2. Predictive Control Methods for Networked Cyber-Physical Systems (Daniel Quevedo/ Univ Paderborn) 3. CPS with Mixed Time- and Event-Triggered Communication (Samarjit Chakraborty/ TUM)
15:00-15:30	Coffee break
15:30-16:30	Panel II

List of speakers and their lecture topics

1. Plenary Speakers:

Prof. Karl Henrik Johansson
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Bio:

Karl H. Johansson is Director of the Stockholm Strategic Research Area ICT The Next Generation and Professor at the School of Electrical Engineering, KTH Royal Institute of Technology, Sweden. He received MSc and PhD degrees from Lund University. He has held visiting positions at UC Berkeley, California Institute of Technology, Nanyang Technological University, Institute of Advanced Studies Hong Kong University of Science and Technology, and Norwegian University of Science and Technology. His research interests are in networked control systems, cyber-physical systems, and applications in transportation, energy, and automation systems. He is a member of the IEEE Control Systems Society Board of Governors and the European Control Association Council. He is past Chair of the IFAC Technical Committee on Networked Systems. He has been on the Editorial Boards of Automatica, IEEE Transactions on Automatic Control, and IET Control Theory and Applications. He is currently a Senior Editor of IEEE Transactions on Control of Network Systems and Associate Editor of European Journal of Control. He was the General Chair of the ACM/IEEE Cyber-Physical Systems Week 2010 in Stockholm and IPC Chair of many conferences. He received the Best Application Paper Award of IEEE Transactions on Automation Science and Engineering 2015, the Best Theory Paper Award of the World Congress on Intelligent Control and Automation 2014, and the Best Paper Award of the IEEE International Conference on Mobile Ad-hoc and Sensor Systems 2009. In 2009 he was awarded Wallenberg Scholar, as one of the first ten scholars from all sciences, by the Knut and Alice Wallenberg Foundation. He has held a Senior Researcher Position with the Swedish Research Council. He was awarded Future Research Leader from the Swedish Foundation for Strategic Research in 2005. He received the triennial Young Author Prize from IFAC in 1996 and the Peccei Award from the International Institute of System Analysis, Austria, in 1993. He was granted Young Researcher Awards from Scania in 1996 and from Ericsson in 1998 and 1999. He is a Fellow of the IEEE.

Title: Cyber-physical control of road freight transport

Abstract: Freight transportation is of outmost importance for the development of our society and economy. At the same time, transporting goods on roads accounts for a significant amount of all energy consumption and greenhouse gas emissions. Despite this influence, road transportation is mainly done today by individual long-haulage trucks with no real-time coordination or global optimization. In this talk, we will discuss how modern information and communication technology supports a cyber-physical transportation system architecture with an integrated logistic system coordinating fleets of trucks traveling together in vehicle platoons. From the reduced air drag, platooning trucks traveling close together can save more than 10% of their fuel consumption. Control and estimation challenges and solutions on various level of this transportation system will be presented. It will be argued that a system architecture utilizing vehicle-to-vehicle and vehicle-to-infrastructure communication enables safe and optimal control of individual trucks as well as optimized vehicle fleet collaborations. Empirical evidence will be presented for why large-scale fleet coordination is mainly a scheduling (not a routing) problem. Incentives for cooperation and pricing of transport services will also be discussed. Several experiments done on European highways will illustrate achievable system performance and potential obstacles to be overcome. The presentation will be based on joint work with collaborators at KTH and at the truck manufacturer Scania.

Prof. Manfred Broy
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Bio:

Manfred Broy is a full professor at the Department of Informatics at the TUM in Munich. In 1994, he received the Leibniz Prize from the German National Science Foundation (DFG) for his academic achievements. In 2003, he obtained a Doctor Honoris Causa from the University of Passau. Prof. Broy is a member of the Deutsche Akademie der Naturforscher “Leopoldina” and a member of acatech, which is the Deutsche Akademie der Technikwissenschaften.

Professor Broy (b. 1949) conducts research on the scientific modeling and development of complex, software-intensive systems. This focus also includes the use of targeted processes, precise specification of requirements, durable and flexible software architectures and modern tools based on mathematical and

logical methods. The goal is to support and advance the methods of software and systems engineering, with a focus on quality assurance and long-term system evolution.
After studying mathematics with a minor in computer science, Professor Broy received a doctorate from the Department of Mathematics and Computer Science of TUM and remained there to complete his lecturer qualification. In 1983, he was appointed professor of computer science at the University of Passau, where he was the founding Dean of the Department of Mathematics and Computer Science. In 1989, he succeeded Professor F.L. Bauer as professor of computer science at TUM. Professor Broy is the founding dean of the TUM Department of Computer Science (1992) and a member of the European Academy of Science, Leopoldina, Acatech and the Bavarian Academy of Sciences and Humanities. He also holds an honorary doctorate from the University of Passau and is a fellow of the organization Gesellschaft für Informatik. He has over 350 scientific publications to his name.

Title: Towards comprehensive models for connected cyber physical systems

Abstract
It is one of the important properties of connected cyber physical systems that they are not only connected to other embedded systems within one device but also via communication links to global networks and to other devices and services in the internet. This means that cyber physical systems in the future will always have to be seen on a level of connectivity. This is also important for modeling and reasoning for embedded systems that are cyber physical and connected. What is needed therefore is a notion of time, of probability and of modeling of context as a reaction to the systems. To achieve modularity we have to be able to describe components and elements of connected of cyber physical systems in isolation and to describe the effects when connected to other systems. One of the leading paradimes for that is an assumption guarantee paradime.

Prof. Werner Damm
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Bio:
Prof. Werner Damm holds the Chair for Safety Critical Embedded Systems at the Carl von Ossietzky University of Oldenburg. He is the Scientific Director of the Transregional Collaborative Research Center AVACS (SFB/TR 14 Automatic Verification and Analysis of Complex Systems), the Director of the

Interdisciplinary Research Center on Critical Systems Engineering for Socio-Technical Systems. He is a member of acatech, the German National Academy of Science and Engineering. Since the beginning of 2015 he is engaged as a director in the working group “highly automated systems” and, in the framework of acatech pushing on autonomous driving. Moreover he is a member of the Scientific Advisory board of the strategical project FAST – zwanzig20-Partnerschaft für Innovation” of the Bundesministerium für Bildung und Forschung in Germany since 2014. As a member of the steering board he contributed similarly to the Automotive Roadmap Embedded Systems and to the Acatech-Survey “New autoMobility– the future World of Automated Road Traffic” published by the end of 2015. Since 2016 he is member of the working group “Autonomous Systems in Rail and Road” of the Hightech-Forum “Autonome Systeme” of the Federal Government.

He is a member of the Board of Directors of the Applied Research Institute OFFIS, and the Chairman of the German competence cluster SafeTRANS, integrating leading companies and research institutes in the transportation domain, the co-founder and member of the steering board of the European Institute for Complex Safety Critical Engineering EICOSE, the Chairman of the Artemis Working Group Tool Platforms.

Werner Damm has been a member of various expert groups of the European Commission and the US National Science Foundation, notably on the topics of future strategies for Systems-of-Systems in Europe, and on Cyber-Physical Systems in the Transportation domain in the US.

His recent foundational research addresses mathematical models of embedded systems, systems-of-systems, and cyber physical systems, specification languages, hybrid systems, formal verification methods, formal synthesis, and real-time and safety analysis. This is complemented by applied research with industrial partners in avionics, automotive, space, and medical systems on system-and-safety development processes for safety related systems, where he pioneered contract-based systems engineering for functional requirements, safety and timeliness requirements, and stability requirements, the use of patterns for capturing such contracts, and tools for automatic test generation, consistency checking, and virtual integration testing based on formalized contracts.

Title Understanding systems of cyber-physical systems

Abstract: What can cause a System of Cyber-Physical Systems (SoCPS) to fail? Can we design a conceptual model of SoCPS that is able to explain the key categories of failures and hence allows to analyse, whether a given design expressed in this conceptual model is robust against such failures? Can we in fact define generically a formal mathematical semantics of this conceptual model allowing rigourous verification of the robustness of such systems in achieving their objectives even in the presence of such failures?
Given that SoCPS represent the essence of Smart Systems (such as smart grid, smart transportation, smart production, smart health, smart city), answering these questions is of extreme relevance. We discuss the key ingredients of the model

drawing on example of crisis management systems and autonomous driving, and provide a game-theoretic foundation in a setting based on dynamically communicating, hierarchical, probabilistic hybrid automata reflecting the capabilities of humans and technical systems to achieve prioritized objectives expressed in a first-order timed variant of linear time temporal logic.

The talk is based on joint work with Alberto Sangiovanni-Vincentelli, UCB.

2. Invited Speakers:

Prof. Marija Ilic
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Bio:

Dr. Marija Ilić holds appointments in the departments of ECE and EPP at Carnegie Mellon University, where she has been a tenured faculty member since October 2002. Dr. Ilic received her M.Sc. and D.Sc. degrees in Systems Science and Mathematics from Washington University in St. Louis and earned her MEE and Dip. Ing. at the University of Belgrade. She is an IEEE Fellow and an IEEE distinguished lecturer, as well as a recipient of the First Presidential Young Investigator Award for Power Systems. In addition to her academic work, Dr. Ilic is a consultant for the electric power industry and the founder of New Electricity Transmission Software Solutions, Inc. (NETSS, Inc.). From September 1999 until March 2001, Dr. Ilic was a Program Director for Control, Networks and Computational Intelligence at the National Science Foundation.Dr. Ilic has co-authored several books on the subject of large-scale electric power systems, and has co-organized an annual multidisciplinary Electricity Industry conference series at Carnegie Mellon (http://www.ece.cmu.edu/~electriconf) with participants from academia, government, and industry. Dr. Ilic is the founder and co-director of the Electric Energy Systems Group at Carnegie Mellon University (http://www.eesg.ece.cmu.edu). She is currently on leave from CMU at the MIT Lincoln Laboratory.

Title: Toward a Unified Approach to Sustainable and Resilient Electric Energy Systems-- Modeling, Control and Testbeds

Abstract

In this talk we present the changing objectives of the electric energy systems as complex dynamical systems. We briefly provide the basic landscape in the industry first. We take a broader look at the objectives of deploying cyber into these physical systems in light of viewing them as general socio-ecological systems (SES). We highlight that in the approach taken by late Elinor Ostrom on how one can assess sustainability of a complex SES, key metric concerns interactions between different system members. Motivated by her work, we discuss modeling of dynamical interactions within a physical electric power system. We highlight that existence of such physical interaction variables can be proven from the most general conservation laws between any component and the rest of the system. This becomes the basis for proposing a transformed state space for general modeling of electric energy systems; the lowest component level is modeled in terms of technology-specific physical variables, and local control design is done so that the interaction variable dynamics with the rest of the system is as specified. The higher-level model which captures dynamics of the interactions within an interconnected system and does not have to know the details about the internal variables of individual (groups of) component(s). Once this is understood it becomes straightforward to define what must be exchanged in electricity markets, and one can interpret distributed bidding and market clearing using this higher level model only. In this sense electricity markets could and should become technology agnostic. Similarly, it becomes possible to design protocols/standards for cyber design to enable robust/resilient system operation over broad ranges of operating conditions and equipment status. In closing, our Smart Grid in a Room Simulator (SGRS) under development at CMU in collaboration with NIST is fundamentally based on this multi-layered modeling. As such it sets the basis for simulating electricity markets, their effects on physical system response. We have used it now over several years for demonstrating novel control concepts introduced by several doctoral students at CMU.

Prof. Tariq Samad
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Bio:
Tariq Samad holds the Honeywell/W.R. Sweat Chair in the Management of Technology at the Technological Leadership Institute, University of Minnesota. Until May 2016 he was with Honeywell, retiring as Corporate Fellow after a 30-year career. His research and technology management interests relate broadly to automation, intelligence, and autonomy in complex engineering systems.

Dr. Samad was President of IEEE Control Systems Society and of the American Automatic Control Council. He is a Fellow of IEEE and IFAC. Other recognitions include the IEEE CSS Control Systems Technology Award, an IEEE CSS Distinguished Member Award, and an IEEE Third Millennium Medal. He is editor-in-chief of IEEE Press. He also leads thee newly formed Industry Committee for IFAC. His recent publications include the Encyclopedia of Systems and Control (Springer, co-editor-in-chief). He was a founding member of the Board of Directors of the Smart Grid Interoperability Panel and he co-led a technology team on sensing, control, and platforms for the U.S. Advanced Manufacturing Partnership. He holds a B.S. from Yale University and an M.S. and a Ph.D. from Carnegie Mellon University.

Title: Human Roles in CPS Networks: Toward a Classification and a Roadmap

Abstract: As we extend the CPS vision from embedded systems to networks and infrastructures, the roles of human users and other stakeholders become

increasingly prominent and the successful operation of the net-CPS systems (or systems of systems) becomes critically dependent on the people in (and in some cases out) of the loop. Humans in large-scale CPSs are heterogeneous in many ways, and in developing a taxonomy or ultimately science of networked CPSs this heterogeneity must be understood and modeled. I will discuss a categorization consisting of the following: Human-machine symbiosis, humans as operators of complex systems, humans as agents in multi-agent teams, and humans as elements within controlled systems. Examples will be presented and the state of the art and practice assessed. I will also attempt to lay out next steps in each of these dimensions--these could be elaborated into a roadmap with CPS community contributions if deemed useful. I will conclude with some comments on the human role (or lack thereof?) in CPS autonomy.

Prof. Calin Belta
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Bio:

Calin Belta is a Professor in the Department of Mechanical Engineering, where he holds the Tegan Family Distinguished Faculty Fellowship. He is the Director of the BU Robotics Lab, and is also affiliated with the Department of Electrical and Computer Engineering, the Division of Systems Engineering at Boston University, the Center for Information and Systems Engineering (CISE), and the Bioinformatics Program.
His research focuses on dynamics and control theory, with particular emphasis on hybrid and cyber-physical systems, formal synthesis and verification, and applications in robotics and systems biology. He received the Air Force Office of Scientific Research Young Investigator Award and the National Science Foundation CAREER Award.

Title: Formal Methods for Control of Traffic Networks

Abstract: Traffic network control is a challenging problem that received a lot of attention in recent years. Most of the existing approaches generate control strategies by optimizing a cost, such as traffic delay, while satisfying physical constraints, such as road capacities. Model predictive control is a popular approach to this problem. In this talk, we discuss additional temporal logic constraints, which can express gridlock avoidance, liveness of vehicular flows, sequentiality of traffic lights, etc. We focus on a particular type of logic that can capture explicit time constraints, called Signal Temporal Logic (STL). We present MPC-like algorithms and illustrate the results with traffic network examples.

Prof. Ming Cao
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Short bio: Ming Cao is currently professor of network analysis and control with the Engineering and Technology Institute (ENTEG) at the University of Groningen, the Netherlands, where he started as a tenure-track assistant professor in 2008. He received the Bachelor degree in 1999 and the Master degree in 2002 from Tsinghua University, Beijing, China, and the PhD degree in 2007 from Yale University, New Haven, CT, USA, all in electrical engineering. From September 2007 to August 2008, he was a postdoctoral research associate with the Department of Mechanical and Aerospace Engineering at Princeton University, Princeton, NJ, USA. He worked as a research intern during the summer of 2006 with the Mathematical Sciences Department at the IBM T. J. Watson Research Center, NY, USA. He is the 2017 recipient of the Manfred Thoma medal from the International Federation of Automatic Control (IFAC) and the 2016 recipient of the European Control Award from the European Control Association (EUCA). He is an associate editor for IEEE Transactions on Circuits and Systems and Systems and Control Letters, and for the Conference Editorial Board of the IEEE Control Systems Society. He is also a member of the IFAC Technical Committee on Networked Systems. His main research interest is in autonomous agents and multi-agent systems, mobile sensor networks and complex networks.

Title: Security problems of networked cyber-physical systems as centrality-based zero-sum games

Abstract: As society grows more reliant upon networked and cyber-physical systems for communication, transportation, sensing, control, and other applications, these systems occupy larger and more complex networks and are

thus increasingly vulnerable to attack by malicious adversaries. With consequences ranging from costly inefficiencies to catastrophic failures, it is critical to understand how to secure these networks against such attacks. Recently the use of tools from social network analysis, such as centrality measures, is starting to gain traction, and along this line of research, we formulate a network security problem as a zero-sum game between an attacker who tries to disrupt a network by disabling one or more nodes, and the nodes of the network who must allocate limited resources in defense of the network. The key idea is to use several network centrality measures from social network study to characterize the utility of the zero-sum game. We first present a fast centralized algorithm that uses a monotonicity property of the utility function to compute saddle-point equilibrium strategies for the case of single-node attacks and single- or multiple-node defense. We then extend the approach to the distributed setting by computing the necessary quantities using a finite-time distributed averaging algorithm. For simultaneous attacks to multiple nodes the computational complexity becomes quite high, so we propose a method to approximate the saddle-point equilibrium strategies based on a sequential simplification.

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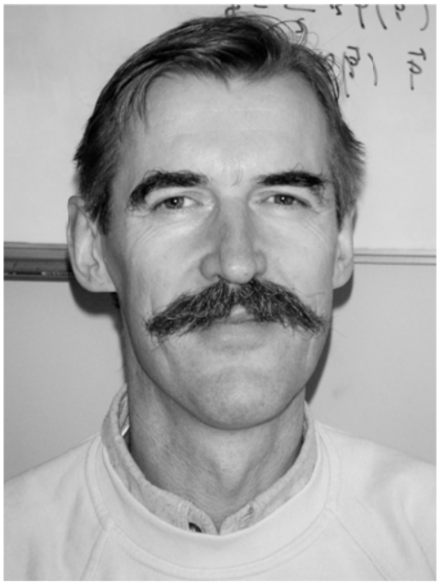

Bio:

Jean-Yves Le Boudec is professor at EPFL and fellow of the IEEE. He graduated from Ecole Normale Supérieure de Saint-Cloud, Paris, where he obtained the Agrégation in Mathematics in 1980 and received his doctorate in 1984 from the University of Rennes, France. From 1984 to 1987 he was with INSA/IRISA, Rennes. In 1987 he joined Bell Northern Research, Ottawa, Canada, as a member of scientific staff in the Network and Product Traffic Design Department. In 1988, he joined the IBM Zurich Research Laboratory where he was manager of the Customer Premises Network Department. In 1994 he became associate professor at EPFL. His interests are in the performance and architecture of communication systems and smart grids. He co-authored a book on network calculus, which forms a foundation to many traffic control concepts in the internet, an introductory textbook on Information Sciences, and is also the author of the book "Performance Evaluation".

Title : Real-Time Control of Electrical Distribution-Grids

Abstract: A large penetration of distributed renewable-energy sources causes problems such as quality-of-service and amount-of-reserve in the grid. The real-time control of electrical distribution-grids is a proposed solution to these problems. We present the architecture of one such control framework, called

COMMELEC. It uses a hierarchy of controllers, where only the lower-level controllers interact with the physical resources. The controllers communicate by exchanging explicit setpoints (from top to bottom) and advertisements (from bottom to top); they use an abstract protocol that hides the specificity of physical resources. We describe how the framework achieves the goals of: real-time operation, management of uncertainty, separation of concern and composability. The framework is deployed at EPFL on a real-scale microgrid that implements a CIGRE benchmark.

Joint work with Prof. Mario Paolone of EPFL.

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BIOGRAPHY	Markos Papageorgiou received the Diplom-Ingenieur and Doktor-Ingenieur (honors) degrees in Electrical Engineering from the Technical University of Munich, Germany, in 1976 and 1981, respectively. He was a Free Associate with Dorsch Consult, Munich (1982-1988), and with Institute National de Recherche sur les Transports et leur Sécurité (INRETS), Arcueil, France (1986-1988). From 1988 to 1994 he was a Professor of Automation at the Technical University of Munich. Since 1994 he has been a Professor at the Technical University of Crete, Chania, Greece. He was a Visiting Professor at the Politecnico di Milano, Italy (1982), at the Ecole Nationale des Ponts et Chaussées, Paris (1985-1987), and at MIT, Cambridge (1997, 2000); and a Visiting Scholar at the University of California, Berkeley (1993, 1997, 2001, 2011) and other universities. Dr. Papageorgiou is author or editor of 5 books and of over 400 technical papers. His research interests include automatic control and optimisation theory and applications to traffic and transportation systems, water systems and further areas. He was the Editor-in-Chief of *Transportation Research – Part C* (2005-2012). He also served as an Associate Editor of *IEEE Control Systems Society – Conference Editorial Board*, of *IEEE Transactions on Intelligent Transportation Systems* and other journals. He is a Fellow of IEEE (1999) and a Fellow of IFAC (2013). He received a DAAD scholarship (1971-1976), the 1983 Eugen-Hartmann award from the Union of German Engineers (VDI), and a Fulbright Lecturing/Research Award (1997). He was a recipient of the IEEE Intelligent Transportation Systems Society *Outstanding Research Award* (2007) and of the IEEE Control Systems Society *Transition to Practice Award* (2010). He was presented the title of Visiting Professor by the University of Belgrade, Serbia (2010). The Dynamic Systems and Simulation Laboratory he has been heading since 1994, received the IEEE Intelligent Transportation Systems Society *ITS Institutional Lead Award* (2011). He was awarded an ERC Advanced Investigator Grant (2013-2018).

Title: Future Traffic Management: Towards a Cyber-Physical System Network?

Abstract: Traffic congestion on urban road and motorway networks has a strong economic and social impact. A significant and growing interdisciplinary effort by the automotive industry, as well as by numerous research institutions, has been devoted in the last decades to planning, development, testing and deployment of

a variety of Vehicle Automation and Communication Systems (VACS) that are expected to revolutionise the features and capabilities of individual vehicles within the next decades. If exploited appropriately, the emerging VACS may enable sensible novel traffic management actions aiming at mitigating traffic congestion and its detrimental implications. This creates yet another complex cyber-physical system network, potentially comprising a high number of vehicles connected with each other (V2V) and with the road infrastructure (V2I). The presentation starts with a brief introduction to the rationale and impact of traffic management, along with an overview of expected changes in the years and decades to come. Existing, planned and emerging VACS, which have an impact on the traffic flow characteristics, are discussed and classified; and potential implications for future traffic management are presented. Related research needs and specific tasks and challenges are identified and commented. Some relevant results from the ERC advanced project TRAMAN21, referring to traffic state estimation, system architecture, local and network-wide control tasks and approaches, are briefly outlined.

Prof. Daniel Quevedo
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Bio: Daniel Quevedo holds the Chair for Automatic Control (Regelungs- und Automatisierungstechnik) at Paderborn University, Germany. He received Ingeniero Civil Electrónico and M.Sc. degrees from the Universidad Técnica Federico Santa María, Chile, in 2000. In 2005, he was awarded the Ph.D. degree from the University of Newcastle in Australia.
Dr. Quevedo was supported by a full scholarship from the alumni association during his time at the Universidad Técnica Federico Santa María and received several university-wide prizes upon graduating. He received the IEEE Conference on Decision and Control (CDC) Best Student Paper Award in 2003 and was also a finalist in 2002. In 2009 he was awarded a five-year Research Fellowship from the Australian Research Council.
Prof. Quevedo is Editor of the International Journal of Robust and Nonlinear Control, Steering Committee Member of the IEEE Internet of Things Initiative, and serves as Chair of the IEEE Control Systems Society Technical Committee on Networks & Communication Systems. His research interests are in control of networked systems and of power converters.

Title: Predictive Control Methods for Networked Cyber-Physical Systems

Abstract: The opportunities provided by feedback control of networked dynamical systems are enormous. Yet it is by no means clear how to harness modern communication, network and computation technologies to obtain high-quality designs. The main stumbling blocks stem from the significant gaps which exist between understanding of constituent parts and the challenges faced when bringing them together. The vast realm of applications of networked cyber-physical systems brings a variety of issues. A common thread is that many of the standard paradigms that allow the separation of computation, communications and systems control are no longer valid. Thus, the need for more holistic approaches arises. This talk illustrates how various communication and computation aspects can be integrated into suitable predictive control formulations.

Prof. Samarjit Chakraborty
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Bio:
Samarjit Chakraborty received his PhD in electrical and computer engineering from ETH Zurich in 2003. He is a professor of electrical engineering at TU Munich in Germany, where he holds the chair for Real-Time Computer Systems. From 2011 to 2016, he also led a research program on embedded systems for electric vehicles at the TUM CREATE Centre for Electromobility in Singapore, where he also served as a scientific advisor. Prior to taking up his current position at TU Munich in 2008, he was an assistant professor of computer science at the National University of Singapore from 2003 to 2008. His research interests include distributed embedded systems, hardware/software codesign, embedded control systems, and sensor network-based information processing for healthcare, smart buildings and electromobility. He was the general chair of Embedded Systems Week (ESWeek) 2011, and the program chair of EMSOFT 2009 and SIES 2012, and regularly serves on the TPCs of various conferences on real-time and embedded systems. During 2013 to 2014, he also served on the Executive Committee of DAC, where he started a new track on Automotive Systems and Software along with Anthony Cooprider from the Ford Motor Company. He is on the editorial boards of the IEEE Transactions of Computers, ACM Transactions on Cyber-Physical Systems, the Leibnitz Transactions on Embedded Systems, Design Automation for Embedded Systems and the EURASIP Journal on Embedded Systems. For his PhD thesis, he received the ETH Medal and the European Design and Automation Association's Outstanding Doctoral Dissertation Award in 2004. In addition, he has received Best Paper Awards in ASP-DAC 2011 and EUC 2010, a Best Demo Award in Mobisys 2013, and several Best Paper Award nominations at RTSS, EMSOFT, CODES+ISSS, DAC, and ECRTS.

Title: CPS with Mixed Time- and Event-Triggered Communication

Abstract: Many embedded control systems have distributed implementations, in which sensor values and control signals have to be communicated over shared communication buses. The participants sharing the bus along with the bus protocol being used determine the delay suffered by the control signals, which in turn affect stability and control performance. Two broad classes of communication protocols exist, which are based on either the time-triggered or the event-triggered paradigms. While the former results in more deterministic communication and is hence easier to use when guarantees on stability and control performance are required, the latter has several advantages like better bus utilization and easier extensibility. This has also resulted in hybrid protocols that combine the event- and time-triggered paradigms. However, there has been little work on how to exploit such hybrid protocols when designing control algorithms, in order to utilize the benefits of both the communication paradigms. In this talk we will discuss this problem and propose some promising research directions that involve the co-design of control strategies and communication protocols.

Prof. Klaus Wehrle
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Bio:

Klaus Wehrle is professor of Computer Science and head of the Chair of Communication and Distributed Systems at RWTH Aachen University, Germany. He received his Diploma and PhD from University of Karlsruhe, both with honors. In 2002 and 2003, he was postdoctoral researcher at ICSI at UC Berkeley. From 2004 till 2006 he headed junior research group on Protocol Engineering and Distributed Systems at University of Tübingen. In 2006, he joined RWTH Aachen University as associate professor, later as full professor. His research activities are focused on (but not limited to) engineering of networking protocols, (formal) methods for protocol engineering and network analysis, network simulation, reliable communication software as well as all operating system issues of networking.

Title: Towards the Symbolic Analysis of Networked Systems

Abstract: The behavior of networked systems is determined by their implementation, their configuration, and most importantly their interactions: any input may arrive at any time. To ensure that networked systems function as intended, a thorough analysis of their behavior is of upmost importance. Since network interactions are beyond the influence of the system developer the implementations of networked systems must be able to handle all possibilities and uncertainties of network input and input timings. The difficulty of considering these in all implementations is the source of most reliability and interoperability

issues.
This talk will present the first steps towards a new methodology based on Symbolic Execution that aims at combining the benefits of model checking (rigorous exploration) and of dynamic software testing (analyzing real systems' code) to enable a thorough analysis and prediction of the behavior of networked systems.
The talk presents KleeNet, the first symbolic analysis tools for network input and discusses the path towards the analysis of temporal uncertainty in network interactions.

Prof. Marta Kwiatkowska
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Bio

Marta Kwiatkowska is Professor of Computing Systems and Fellow of Trinity College, University of Oxford. She led the development of the PRISM model checker (www.prismmodelchecker.org), the leading software tool in the area, winner of the HVC Award 2016, and widely used for research and teaching. Applications of probabilistic model checking have spanned communication and security protocols, nanotechnology designs, power management, game theory, planning and systems biology, with genuine flaws found and corrected in real-world protocols. Kwiatkowska gave the Milner Lecture in 2012 in recognition of "excellent and original theoretical work which has a perceived significance for practical computing" and was awarded an honorary doctorate from KTH Royal Institute of Technology in Stockholm in 2014. Her research is supported by the ERC Advanced Grant VERIWARE "From software verification to everyware verification" and the EPSRC Programme Grant in Mobile Autonomy.

Title: Model checking and strategy synthesis for mobile autonomy: from theory to practice

Abstract: Design of autonomous systems is facilitated by automatic verification and synthesis of controllers from temporal logic objectives. If components that cannot be controlled are present in the environment, it is natural to view such systems as games between the controllable computer system (Player 1) and its

(uncontrollable) environment (Player 2). When, additionally, stochastic uncertainty is present, e.g., due to unreliable communication media or faulty components, we need to consider stochastic games. Examples of such systems appear in many domains, from robotics and autonomous transport, to networked and distributed systems. To specify objectives, we work with probabilistic extensions of temporal logic, which can reason about the probability or expectation of an event. Given a stochastic game and a probabilistic temporal logic property, verification and strategy synthesis problems, respectively, focus on the existence and construction of a winning strategy for Player 1 that guarantees satisfaction of the property against all strategies of Player 2. This lecture will give a high-level overview of recent advances in verification and strategy synthesis for turn-based stochastic games with single and multiple objectives implemented in PRISM-games (http://www.prismmodelchecker.org/games/), an extension of the PRISM model checker. The techniques will be illustrated with examples drawn from autonomous driving and smartgrid protocols.

Prof. Antonello Monti
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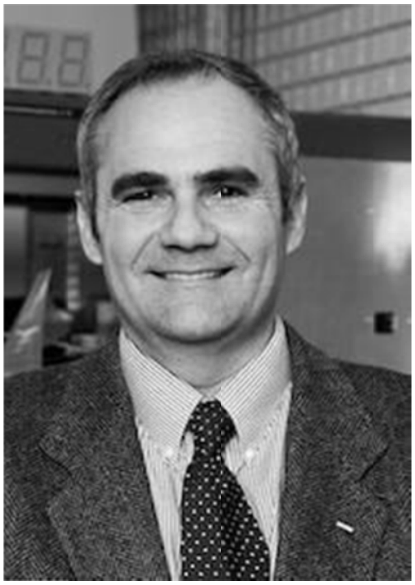

Bio:

Antonello Monti received his M.Sc degree (summa cum laude) and his PhD in Electrical Engineering from Politecnico di Milano, Italy in 1989 and 1994 respectively. He started his career in Ansaldo Industria and then moved in 1995 to Politecnico di Milano as Assistant Professor. In 2000 he joined the Department of Electrical Engineering of the University of South Carolina (USA) as Associate and then Full Professor. Since 2008 he is the director of the Institute for Automation of Complex Power System within the E.ON Energy Research Center at RWTH Aachen University. Dr. Monti is author or co-author of more than 300 peer-reviewed papers published in international Journals and in the proceedings of International conferences. He is a Senior Member of IEEE and Associate Editor of the IEEE System Journal and of IEEE Electrification Magazine.

Title: Challenges in simulating future energy systems

Abstract: Energy systems and in particular electrical systems are facing an unprecedented period of changes. Most of the assumptions used in the past to define models are losing validity but, on the other hand, there is little knowledge on the real requirements for the future. Testing new concepts is also difficult because real life experiences are usually small in scope. How can then modelling support the transformation? The presentation will approach this challenge with the support of the experience of some relevant projects.

Prof. Matthias Althoff
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Bio:

Matthias Althoff received the diploma in Mechatronics and Information Technology from the department of mechanical engineering at the Technische Universität München, Germany, in 2005. He received his PhD degree (summa cum laude) in electrical engineering from the same university under the supervision of Univ.-Prof. Dr.-Ing./Univ. Tokio Martin Buss in 2010. From 2010 - 2012 he was a postdoctoral researcher at Carnegie Mellon University, USA, with a joint appointment in electrical engineering and the Robotics Institute. He joined the computer science department at Ilmenau University of Technology, Germany, in 2012 as assistant professor for automation systems. Since 2013 Matthias Althoff is assistant professor in computer science at the Technische Universität München.

His research interests include the design and analysis of cyber-physical systems, formal verification of continuous and hybrid systems, reachability analysis, planning algorithms, robust and fault-tolerant control. Main applications of his research are automated vehicles, robotics, power systems, and analog and mixed-signal circuits.

Title: Online Verification of Cyber-Physical Systems

Abstract: Imagine you are riding in the future in an autonomous vehicle that faces a situation that has not been foreseen by a designer. You will hope that the vehicle ”does the right thing”, but since this is an untested situation, nobody can guarantee that you will be safe when the current state-of-the-art in verification techniques has been applied. I propose a new verification concept that can ensure safety with respect to giben assumptions and specifications in unforeseeable situations: Instead of verifying the correctness of a system before deployment, I propose to verify the system online where the system continuously checks the correctness of its next action in
the current environment. Since all future autonomous systems will have a tight interconnection of of computing and physical elements, I will develop online verification for this class of systems, which are also referred to as cyber-physical systems. In order to prove correct behavior, I will use formal verification techniques based on reachability analysis. Results will be primarily demonstrated for automated driving and to a lesser extent to human-robot collaborative manufacturing and smart grids.

3. Panelists (partially confirmed):

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4. Organizer/panel moderators:

Prof. John Baras
Institute for Systems Research
University of Maryland
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Prof. Sandra Hirche
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