Opportunities and Challenges with Vehicular Networks **Program –** Half Day

Session Chair: Tim Weil: Principal, SecurityFeeds LLC

Speakers and Moderators:
Walt Fehr : Transportation Specialist at US Department of Transportation
James Misener: Director, Technical Standards at Qualcomm
John Kenney: Director and Principal Researcher at Toyota InfoTechnology Center, USA
Tao Zhang: Chief Scientist for Smart Connected Vehicles at Cisco Systems
Weidong Xiang: Associate Professor at University of Michigan-Dearborn
Falko Dressler: Full Professor for Computer Science and head of Distributed Embedded Systems Group at the Dept. of Computer Science, University of Paderborn

Overview of the Vehicular Networks Workshop Program

The concept of vehicular networks has been discussed in the academic literature for nearly two decades and is finally being discussed with serious intent to deploy by a host of other stakeholders, ranging from those who see commercial opportunity here and now, through telecommunications network operators seeking expansion to vehicle connectivity. Significantly, road operators and governments are joining the deployment discussion, as they view vehicular networks as the fruition of years of research which point toward use of vehicular networks to significantly enhance transportation safety and improve movement of people and goods. Indeed, business models are fomenting, standards are becoming stable and potential rulemaking is on the horizon.

With the prospect of deployment, there are challenges and debates. Viable deployment models, pros and cons of different air interfaces, spectrum sharing issues and security and privacy concerns are but a few. Therefore, the opportunity for research is as strong if not stronger than ever.

These sessions covers these multiple aspects of opportunities and challenges with vehicular networks by first describing the near-term opportunities for deployment, not only with Dedicated Short Range Communications (DSRC) but also with evolving concepts in LTE up to and including 5G. The session will also cover network security and privacy issues. It will conclude with panels and presentations that describe current research in network simulation, vehicular cloud computing and vehicle telematics.

Dedicated Short Range Communication (DSRC) - Ready for Prime Time (Walton Fehr - US DOT)
Dedicated Short Range Communication (DSRC) is a key emerging vehicle communication technology. DSRC enables vehicles to communicate with each other, e.g. for crash avoidance, with roadside infrastructure, e.g. traffic signals, and with pedestrians, bicyclists, and road workers who are at risk. After an intense period of industry research, testing, and international standardization, DSRC is poised for deployment on a large scale in the coming years. The US Department of Transportation is pursuing a regulation that would require DSRC safety transmitters in new vehicles. This talk opens the workshop by providing background on DSRC technology and a status update on deployment plans in the US. The talk includes a discussion of various safety, mobility, and environmental applications that are being investigated in the US DOT Connected Vehicle (CV) Research program. It also examines the benefits expected from DSRC deployment. Information will also be provided about US DOT support for CV testbeds and Pilot DSRC Deployments, as well as for international harmonization of DSRC communication standards.

5.9 GHz Spectrum Sharing - (John Kenney - Toyota ITC)
DSRC has been allocated spectrum in the 5.9 GHz range by the US Federal Communications Commission (FCC). The US DOT plans to require DSRC equipment in new cars to enable crash avoidance applications based on vehicle-to-vehicle communication. DSRC is also planned to be used for a variety of other safety and mobility applications, for example to support automated driving. Recently the FCC asked stakeholders to consider whether unlicensed devices (e.g. Wi-Fi) should be permitted to share the spectrum with DSRC. Proponents of sharing point to the need for more Wi-Fi spectrum, and the likely economic benefits that wider Wi-Fi availability will bring. Automotive companies caution that sharing cannot be permitted to interfere with DSRC's safety-of-life mission. This talk examines the spectrum sharing issue, and addresses the following questions:

- Is it technically feasible for unlicensed devices to use the 5.9 GHz spectrum without harmfully interfering with DSRC transmissions?
- What sharing proposals have been offered?
- What are the positions of the automotive and Wi-Fi stakeholders?
- What is the status of industry and governmental activity on spectrum sharing?
- What are the next steps in the proceeding, and how is it likely to be resolved?

Is there LTE in V2V? (Jim Misener - Qualcomm)

This workshop session addresses the potential roles of LTE in Intelligent Transportation Systems (ITS). The session serves to give insight into trends and choices that satisfy emerging ITS applications and perhaps those that have yet to be conceived.

We begin with a broad definition of 'connected vehicles' and the plethora of ITS applications that are envisioned by such a concept. This enables categorization of applications by physical and architecture characteristics, and allows us to determine key performance indicators required for the communication link. From this basis, the session will address the access technologies that are currently available and, importantly, that may be available in the coming decade: DSRC (described in more depth elsewhere in the workshop) is of course a necessary and primary aspect of this mix, but there are in various parts or this world emerging research and standardization activities that envision LTE expansion into "LTE V2X" and a pan-European "5G Automotive Vision". This brings a mix of match of other over the air technologies, potential timelines and different emphases in different regions of the world into consideration. Moreover, there are ISO Communications Access for Land Mobile (CALM) standards that are communication link-agnostic but are conceived as an alternative to proprietary gateways for this broad array of communication links; these ISO standards and propriety gateway techniques are necessary consideration in the mix and match of technologies that deliver 'connected vehicle' communications. At the end of this segment, the

attendee will have an understanding of the applications, over-the-air technologies and standards that may integrate them into the vehicles.

Why We Need a New Paradigm for Securing the Internet of Vehicles (Tao Zhang)

Connected vehicles as a major component of the emerging Internet of Things (IoT) introduce many new security challenges that have attracted wide attentions over the past few years. However, there have been far from sufficient clarity on two fundamental questions: 1) what security challenges in connected vehicles in particular and in IoT in general are so unique that they cannot be adequately addressed by the existing security paradigm, and 2) what fundamental changes to the existing security paradigm will be needed to address these new challenges. This presentation will discusses several such unique new challenges and how they will necessitate a new security paradigm.

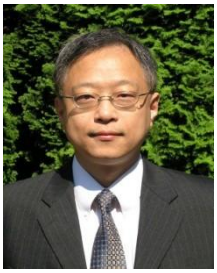
Research and Prototyping Activities of Dedicated Short Range Communications (DSRC) at the University of Michigan (Weidong Xiang)

In this speech, we will share our experience on the research and prototyping of DSRC systems. The contents will cover latest progress in related areas ranging from channel modeling, baseband algorithms, prototyping and vehicular network simulator, system level channel emulator and field testing, all upon our recent research funded projects. In addition, we will introduce the Mobile Transformation Center (MTC) Pillar Project, University of Michigan, of which the goal is to establish a citywide connected vehicle infrastructure with up to 9,000 vehicles to cover the city of Ann Arbor, MI, the largest infrastructure under development in its kind worldwide.

Towards the Vehicular Cloud (Falko Dressler)

We will primarily discuss the challenges and opportunities of the connected cars vision in relation to some of the most needed components in modern smart cities: improved road traffic safety combined with reduced travel times and emissions. Using selected application examples including the use of virtual traffic lights, intelligent intersection management, and platooning, we assess the needs on the underlying system components with a particular focus on inter-vehicle communication. We also shed light on the potentials of a vehicular cloud based on parked vehicles as a spatio-temporal network and storage infrastructure. Vehicular networking solutions have been investigated for more than a decade but recent standardization efforts just enable a broad use of this technology to build large scale Intelligent Transportation Systems (ITS). One of the key questions is whether some pre-deployed infrastructure is needed to enable and to boost vehicular networks. We see many benefits in such infrastructure to store information and to provide connectivity among the vehicles. Yet, instead of using Roadside Units (RSUs), we envision to rely on parked vehicles to provide such vehicular cloud services.

BIOGRAPHIES OF WORKSHOP COMMITTEE



Dr. Tao Zhang joined Cisco in 2012 as the Chief Scientist for Smart Connected Vehicles. Since then, he has also been developing architectures and strategies for Internet of Things and Fog Computing. Prior to joining Cisco, he had been Chief Scientist and Director of Mobile and Vehicular Networking at Telcordia Technologies. He was elected a Fellow of the IEEE in 2010. For over 25 years, he has been directing research and product development in broadband, mobile, and vehicular networks. His leadership and technical work have resulted in new technology, standards, and products. Dr. Zhang holds over 40 US patents and has co-authored two books "Vehicle Safety Communications: Protocols, Security, and Privacy" (2012) and "IP-Based Next Generation Wireless Networks" (2004) published by John Wiley & Sons. He was a founding Board Director of the Connected Vehicle Trade Association (CVTA). He has been serving on the industry advisory boards for several research organizations. Dr. Zhang is the Chair of the IEEE Communications Society Technical Sub-Committee on Vehicular Networks and Telematics Applications. He has been serving on editorial boards or as a guest editor for multiple leading technical journals. Dr. Zhang was an adjunct professor at multiple universities. He has been frequently invited to speak at international technical conferences.

Jim Misener is Director, Technical Standards at Qualcomm Technologies, Inc., leading Qualcomm's international automotive standardization efforts. Mr. Misener is Chair for the SAE Dedicated Short Range Communication Technical Committee and a member of the IEEE P1609 Working Group. He is US Expert in ISO TC/204 WG 17 (Nomadic Devices) and 18 (Cooperative ITS). Prior to joining Qualcomm in 2014, Mr. Misener was an independent consultant, with public sector clients that included US Department of Transportation and private sector clients, primarily in the Silicon Valley. From 2010 – 2013, he was Executive Advisor to Booz Allen Hamilton, where he led the Federally-focused Intelligent Transportation Systems and highways business for the firm. From 2008 – 2010, he served as Executive Director of the California Partners for Advanced Transit and Highways (PATH) at UC Berkeley. He was with PATH from 1995 – 2010, with focus on wireless applications for the automotive sector. Mr. Misener was a pioneer in vehicle-highway automation, car-to-car safety communications and infrastructure-based testbeds. He is widely published and speaks frequently at conferences, panels and with industry groups. Jim holds BS and MS degrees from UCLA and USC.

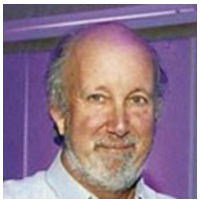
Weidong Xiang received his M.S. and Ph.D. degrees from Tsinghua University, Beijing, China, in 1996 and 1999, respectively. From 1999 to 2004, he worked as a Postdoctoral Fellow/Research Scientist in the Software Radio Laboratory (SRL) at Georgia Institute of Technology, Atlanta, USA. In 2004, he joined the ECE Department, University of Michigan, Dearborn (UMD) where he currently is an Associate Professor. His research interest includes vehicular communications and networks, ultra-wideband (UWB), wireless networked control systems, Internet of Things and wireless positioning. He established and leads the Center for Vehicular Communications and Net- work Laboratory at UMD focusing on dedicate short range communications (DSRC), machine type communications (MTC), LTE for high mobility applications and UWB positioning. He serves as an

Associate Editor/Editor for *IEEE Communications Magazine, EURASIP Journal on Wireless Communications and Networking* and others. He has published 75+ technical papers in relevant international journals and conferences. His current research is widely supported by NSF, DoE, CISCO Research and other companies. He also found and operates the *Vehicom LLC*.

Dr. John B. Kenney: John is Network Division Director and Principal Researcher at the Toyota InfoTechnology Center in Mountain View, CA. He leads a team researching vehicular communication, including DSRC, Automated Driving, and Smart Grid. His personal research focuses on performance and standardization of DSRC, especially channel congestion control and spectrum sharing. He has represented Toyota in the automakers' Vehicle Safety Communication consortium. He also represents the industry in the investigation of potential sharing of spectrum between DSRC and unlicensed devices, including recent testimony before a US Congressional committee. He is active in IEEE and European standards, and serves as an elected officer of the SAE DSRC Technical Committee. He is Associate Editor (Connected Vehicles) for the IEEE Vehicular Technology Magazine. He co-chaired the 2011 and 2012 ACM VANET Workshops, and the IEEE SmartVehicles 2014 and 2015 Workshops. He co-authored a Best Paper at the 2013 IEEE WiVec Symposium, and he also authored an invited Proceedings of the IEEE paper on DSRC Standards in the US (2011). He holds electrical engineering degrees from Stanford and Notre Dame, where he also served as Adjunct Professor.

Falko Dressler is a Full Professor for Computer Science and head of the Distributed Embedded Systems Group at the Dept. of Computer Science, University of Paderborn. Dr. Dressler received his M.Sc. and Ph.D. degrees from the Dept. of Computer Science, University of Erlangen in 1998 and 2003, respectively. He is an editor for journals such as IEEE Trans. on Mobile Computing, Elsevier Ad Hoc Network s, Elsevier Computer Communications, and Elsevier Nano Communication Networks. He was guest editor of special issues on self-organization, autonomic networking, vehicular networks, and bio-inspired communication for IEEE Journal on Selected Areas in Communications (JSAC), Elsevier Ad Hoc Networks, and others. He regularly serves in the program committee of leading IEEE and ACM conferences. Dr. Dressler authored the textbooks Self-Organization in Sensor and Actor Networks published by Wiley in 2007 and Vehicular Networking published by Cambridge University Press in 2014. Dr. Dressler has been an IEEE Distinguished Lecturer as well as an ACM Distinguished Speaker in the fields of inter-vehicular communication, self-organization, and bio-inspired and nano-networking. He is actively participating in the IETF standardization. His research objectives include adaptive wireless networking, self-organization techniques, and embedded system design with applications in ad hoc and sensor networks, vehicular networks, industrial wireless networks, and nano-networking.

Walton Fehr is an engineering professional with extensive experience in a wide variety of engineering and marketing roles in the automotive industry, including electronic component design, technology introduction, and business development. Specialties: Lead multi-discipline engineering teams, designed products for rigorous automotive applications, transferred technology from Internet and telecom into automotive.



Tim Weil is a Security Architect/IT Security Manager with over twenty five years of IT management, consulting and engineering experience in the U.S. Government and Information Technology and Communications industries. Mr. Weil's technical areas of expertise include IT Security Management, Enterprise Security Architecture, IT Audit and Compliance, Identity Management, and Network Engineering. Mr. Weil is a Senior Member of the IEEE and Security Editor for IT Professional magazine. In the areas of Vehicular Networks his work includes the IEEE 1609 (WAVE) standards, US DOT VII/Intellidrive and Connected Vehicle programs, author and speaker on topics in Security for Vehicular Networks. His interests include '*Service Management for Vehicular Networks Using WAVE (IEEE 1609) Protocols*' and topics related to the PKI models for implementing IEEE 1609.2 (WAVE Security).

His degrees include an M.S. in Computer Science from Johns Hopkins University, and a B.A. in Sociology from Immaculate Heart College. Currently he is an industry-certified Security and Privacy professional (CISSP), Project Management Professional (PMP), IT Auditor (CISA) and Risk and IS Control (CRISC). He works for the Coalfire as a Senior IT Auditor (contractor) specializing in ISO 27001 compliance for SMB companies (Denver, Colorado).