**Opportunities and Challenges with Vehicular Networks**

**Session Chair:** Tim Weil: Principal, SecurityFeeds LLC

**Speakers and Moderators:**
- **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

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<th>Overview of the Vehicular Networks Workshop Program</th>
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<td>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.</td>
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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.

**Contact Information**
- **Tao Zhang**, 247 Harmon Ave, Fort Lee, NJ 07024 - tazhang2@cisco.com
- **Jim Misener**, Qualcomm Technologies, Inc, 5775 Morehouse Drive, San Diego CA 92121-1714 - jmisener@qti.qualcomm.com
- **Tim Weil** – SecurityFeeds LLC, PO Bo 18385 Denver, CO 80218 – trweil@ieee.org
- **Weidong Xiang**, University of Michigan, Dearborn | 126 ELB, 4901 Evergreen Rd. | Dearborn, MI. 48128 - xwd@umich.edu
- **John Kenney** - Toyota InfoTechnology Center, USA | 465 Bernardo Avenue | Mountain View, CA 94043 – jkenney@us.toyota-itc.com

**Comparable VNS Program Experience**

GLOBECOM 2007-09 Designer and Developer Forums – Topics in DSRC, WAVE, Security and Service Architectures and Protocols (Weil, Zhang, Xiang)
Data Communications Topics –

**Dedicated Short Range Communication (DSRC) - Ready for Prime Time (John Kenney)**
This topic will have speakers who can provide a status update on DSRC. This will include some background on the technology and applications/benefits for the non-expert, but would focus on the path to deployment in the US and other regions.

**3GPP/LTE/5G migration to Vehicular Networks (VNS) - (Jim Misener, Tao Zhang)**
The use of mobile communications networks has significant impact on the ‘connected car’ and the future state of intelligent transportation systems (automotive) industry.

**Spectrum Sharing (5.9 GHz) - (John Kenney)**
On January 25 this year, the NTIA issued its initial report on the potential use of up to 195 megahertz of spectrum in the 5GHz band by Unlicensed-National Information Infrastructure (U-NII) devices. The report expressed concern about the potential risks associated with introducing a substantial number of new, unlicensed devices into the 5.9GHz band without proper safeguards. An industry panel discussion will explore the impact of the NTIA initiative and examine the multiple risk factors raised by opening this spectrum for shared access.1

**Security and Privacy Topics**

**PKI solutions (WAVE 1609.2) - (Jim Misener, John Kenney)**
An Intelligent Transportation System (ITS) technical architecture for Service Management has been developed based on IEEE 1609 Wireless Access for Vehicular Environments (WAVE) standards for secure vehicle-to-vehicle and vehicle-to-infrastructure wireless communication. An examination of the working model demonstrates the use of a 1609 Provider Service Identifier (PSID) to provision and secure ITS services using WAVE 1609.2 public key infrastructure (PKI) and applications for the DSRC/WAVE communication stack.

**Vehicular Networks Privacy Requirements and Solutions - (Tao Zhang/John Kenney)**
As vehicles are connected, vehicle communications could be used to breach the privacy of vehicle drivers by identifying and tracking vehicles and their drivers. Driver privacy will become a more serious concern when certain vehicle communication capabilities, such as safety communications, are mandated by the government leaving consumers no choices but to use vehicles with communication capabilities. The ability to adequately protect driver privacy will be an important prerequisite for wide consumer adoption of connected vehicles. Supporting privacy, however, imposes unique challenges. For example, new security credential management mechanisms that can support privacy, such as privacy-preserving digital certificate management mechanisms, will be needed. Supporting privacy also introduces competing requirements with supporting security. For example, making vehicle communications anonymous, for example, will also increase the difficulty in detecting vehicles that have been used to perform security attacks. In this session, we will discuss the

challenges and potential solutions in enabling privacy protection and in balancing privacy protection and other requirements in connected vehicles.

**Research and Innovation Topics -**

**Simulation models for VANETs / DSRC / VNS (Weidong Xiang)**
DSRC builds upon the IEEE 802.11p protocol, which was ratified in 2011. By adopting Orthogonal Frequency-Division Multiplexing (OFDM) modulation scheme, DSRC achieves a data rate of 6-27Mbits/s and a RSU covers a range of 1000 feet. The Federal Communication Commission (FCC) has assigned the 5.850-5.925GHz band for the operation of DSRC systems in the United States. DSRC could be regarded as the outreach of the technically matured and market successful indoor Wi-Fi technology to the roads, which spawns several significant topics in PHY/MAC layers including 1) DSRC channel modeling, 2) advanced baseband algorithms including robust and fast time synchronization, 3) Doppler shift frequency estimate and compensation, 4) fast time-varying channel estimate and 5) the adoption of multiple input multiple output (MIMO) and beamforming technologies for DSRC radios.

**Vehicular Cloud Computing (Tim Weil)**
An overview of mobile cloud computing (MCC) and a recent survey of the Vehicle Cloud Computing applications and networks. Compare and contrast with the evolving systems of VANETs and V2X applications.

**Vehicle Telematics (Tao Zhang)**
Telematics Vehicles are becoming infotainment centers and even our offices on wheels. Vehicles are coming with embedded Web browsers to allow drivers and passengers to enjoy the vast contents and applications on the Internet while they are inside their vehicles. Users will be able to download applications and contents from automakers, automotive application providers, and even the open Internet to in-vehicle infotainment systems. Software on a vehicle can prioritize applications so kids watching videos in the back seats will not interfere with adults having business meetings in the front seats. Users will be able to customize the applications and user-vehicle interfaces in their vehicles by themselves, either inside the vehicles or remotely from their smartphones and computers. The vehicle will become an integral part of the future Internet, or Internet of Things. The vehicle will no longer be just a transportation tool, but will become another platform for extending our connected life style. Providing a rich connected experience to drivers and passengers will be as important as carrying them from one place to another. In this session, we will discuss the changes telematics is bringing and the remaining technical challenges.
Workshop Facilitator Bios

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 Subcommittee 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 Network 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
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.

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).