



*4th IEEE International Symposium on
Wireless Vehicular Communications*

Final Program



5 – 6 September 2011

San Francisco, United States

Welcome from the General Co-Chairs

It is our pleasure to welcome attendees to the Fourth IEEE International Symposium on Wireless Vehicular Communications (IEEE WiVeC2011).

After the successful first, second, and third WiVeC workshops in 2007 (Baltimore), 2008 (Calgary), and 2010 (Taipei), the fourth IEEE WiVeC symposium will be co-located with the 72nd IEEE Vehicular Technology Conference 2011 Fall conference and will take place in San Francisco on the 5th and 6th of September 2011. VTC Fall editions are traditionally located in North America, while VTC Spring editions are located in other areas of the world. Since WiVeC was originally launched co-located with VTC Fall editions, the IEEE Vehicular Technology Society decided that WiVeC would take place every year and a half in order to ensure that the conference is alternatively co-located with VTC Fall and Spring editions. This resulted in there being no WiVeC in 2009.

The papers to be presented at IEEE WiVeC2010 cover the full range of wireless vehicular communications:

physical layer; protocol design; security and applications and systems. As has been a tradition since the first WiVeC edition, IEEE WiVeC2010 will also host a series of wireless vehicular communications demos and invited speakers.

We would like to thank all authors who submitted their work to WiVec, the members of our Technical Program Committee and the external reviewers for providing timely and high quality reviews. We are also grateful to Vinuth Rai our Demo Chair, Tao Zhang our speakers chair and Eric Mai our Local Arrangements and Publicity Chair. We congratulate Frank Kargl and Yaser Fallah for their effective leadership of the TPC. Finally, we express our special appreciation to Javier Gozalvez for his guidance and contribution to WIVEC since its inception. We are grateful for the support of the IEEE Vehicular Technology Society.

Daniel Jiang and Raja Sengupta,
General Co-chairs, WiVeC2011

Welcome from the TPC Chairs

Welcome to WiVeC 2011 in San Francisco! We hope you will enjoy the exciting technical program that the Technical Program Committee has prepared for you. We have selected 23 high quality papers from all submissions for oral and poster presentation. In addition, we also have four demonstrations. Together, papers and demos represent the full range of vehicular wireless communications from physical layer and radio to applications and experiments.

We want to use this opportunity to thank all the authors who submitted papers to IEEE WiVeC 2011. Their contributions, presentations, and attendance are essential for a successful conference. All submissions were carefully reviewed in a blind review by at least three reviewers and this led to the selection of the papers at hand.

So our sincere thanks also go to the 46 members of the Technical Program Committee. We highly appreciate your effort for providing thorough reviews and feedback

to the authors. The same is of course also true for the additional reviewers supporting the TPC. Beyond, we also want to thank the general co-chairs Daniel Jiang and Raja Sengupta for the smooth and enjoyable cooperation. We also thank the speakers chair Tao Zhang, the demos chair Vinuth Rai, and last but not least the publicity and arrangements chair Eric Mai. Finally, our thank would not be complete without thanking our finance chair James Irvine for his invaluable advice and help.

We hope that you will enjoy attending IEEE WiVeC 2011 or reading the proceedings as much as we have enjoyed compiling the program. We look forward to meeting you in San Francisco for thought-provoking presentations and discussions. And of course, we wish you a pleasant and exciting stay in San Francisco, one of the most vibrant cities of the world.

Frank Kargl and Yaser P. Fallah
TPC Chairs, WiVeC2011

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Jeremy Blum	Javier Gozálviz	Robert Lasowski	Dusit Niyato	Christoph Sommer	Lars Wolf
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Lin Cheng	Jérôme Hárii	Victor C. M. Leung	Ravi Puvvala	Marc Torrent-Moreno	
Soumaya Cherkaoui	Mahbub Hassan	Thomas D.C. Little	Jihene Rezgui	Elisabeth Uhlemann	
Carla Fabiana Chiasserini	Behnam Hassanabadi	Thomas Mangel	Matthias Roeckl	Shahrokh Valaee	
Stefan Dietzel	Geert Heijenk	David W. Matolak	Björn Scheuermann	Joel VanderWerf	
Andreas Festag	Ali Honarvar	Martin Mauve	Robert K. Schmidt	Tomotaka Wada	

Opening Plenary

Monday 5 September 2011, 08:30–10:00 (Golden Gate 7&8)

Security and Privacy in V2X: Current Approaches for Deployment

Andre Weimerskirch, President and CEO of encrypt Inc., USA

Vehicle-to-vehicle (V2V) safety applications are actively pushed by the American Department of Transportation for deployment in the mid-term. In a large scaled model deployment, a few thousand vehicles will be equipped with DSRC technology soon. Security and privacy is a major obstacle for successful deployment though. While the IEEE 1609.2 security standard describes details of security in V2V communication, many additional details are currently designed or remain open. In particular, privacy and renewal of security credentials pose a significant challenge.

In this presentation, an overview of the current approaches appropriate for deployment will be given. Privacy will be considered, open issues will be identified, and differences between the American and European approach will be analyzed.

Dr. Andre Weimerskirch is Chief Executive Officer (CEO) and President of American-based ESCRYPT Inc. and is in charge of the international activities of ESCRYPT.

From 2004 to 2007 Dr. Weimerskirch held the position of Chief Technology Officer (CTO) of ESCRYPT GmbH. As CTO he significantly shaped the technological strategy of

ESCRYPT. Previously, Dr. Weimerskirch was with several renowned companies in the areas of research, development, and consulting including Accenture, Deutsche Post, Philips Research, and Sun Labs.

He studied business information technology as well as mathematics at Darmstadt Technical University before

receiving his Master of Science in computer science at Worcester Polytechnic Institute, USA. He then received a Ph.D. of Ruhr-University of Bochum in the area of applied data security. He has led several national and international projects in the area of data security and published numerous articles.

Closing Plenary

Tuesday 6 September 2011, 15:50–16:50 (Golden Gate 8)

Information Assurance for Sensor-based Vehicular Networks

Zygmunt Haas, Cornell University

Information Assurance grew out of the field of computer network security. However, Information Assurance is a much broader term than network security – it relates to the managing of the risks associated with the use, processing, storage, and transmission of information. A basic model of Information Assurance relies on three properties: confidentiality, integrity, and availability, thus it is often referred to as the CIA model.

The wide consensus is that the commonly assumed attributes of sensor nodes, such as limited available energy, relatively small computational power, unattended operation, and wireless connectivity are considered challenges in implementing Information Assurance in sensor networks. Similarly, the broad range of applications, which results in broad range of possibly heterogeneous information modalities and with different quality-of-service requirements, makes the problem even more complex. This is in particular so for sensor-based vehicular networks which require very high degree of reliability. However, one can leverage some of these attributes to our advantage; e.g., a massive deployment of nodes can be exploited in the design of protocols for Information Assurance.

In this talk, I will describe some of the challenges in design and implementation of, as well as a number of approaches to support, Information Assurance for sensor-based vehicular networks.

Part of this work was done during the author's rotational position with the National Science Foundation. The opinions described in this talk are of the author and are not, necessarily, those of the National Science Foundation.

Zygmunt J. Haas received his B.Sc. in 1979, his M.Sc. in 1985, and his Ph.D. in 1988 from Stanford University, all in Electrical and Computer Engineering. In 1988, he joined the AT&T Bell Laboratories in the Network Research Area. There he pursued research in wireless communications, mobility management, fast protocols, optical networks, and optical switching. In August 1995, he joined the faculty of the School of Electrical and Computer Engineering at Cornell University, where he is now a Professor. He heads the Wireless Network Laboratory (wnl.ece.cornell.edu), a research group with extensive contributions in the area of Ad Hoc Networks and Sensor Networks. Dr. Haas is an IEEE Fellow and an author of over 200 technical conference and journal papers and holds eighteen patents in the areas of wireless networks and wireless communications, optical switching and optical networks, and

high-speed networking protocols. Dr. Haas chaired and co-chaired several key conferences in the communications and networking areas, organized many workshops, delivered numerous tutorials at major IEEE and ACM conferences, and has served as editor of many journals and magazines, including the IEEE Transactions on Networking, the IEEE Transactions on Wireless Communications, the IEEE Communications Magazine, and the Springer Wireless Networks journal (WINET). Dr. Haas served as a Chair of the IEEE Technical Committee on Personal Communications and as the Chair of the Steering Committee of the IEEE Pervasive Computing magazine. His interests comprise: mobile and wireless communication and networks, modeling and performance evaluation of large and complex systems, and biologically-inspired networks.

Panel Session

Sunday, 21 September, 17.30 – 16.45 MacLeod A1

Validating VANET Research: Simulation, Emulation and Testbed

Chair: **Raja Sengupta** *UC Berkeley*

Panelists: **Onur Altintas** *Toyota InfoTechnology Center*

Jérôme Härri *EURECOM*

Sateesh Addepalli *Cisco Systems*

Ravi Puvvala *Savari Networks*

Christoph Kirsch *University of Salzburg*

A team of experts spanning academia, government, and industry will convene to seed a discussion including our audience on what could or should be exciting about vehicular wireless networks. We will

explore what killer applications might drive the next generation, revolutionary developments in hardware, algorithms, or the impact of new paradigms like cloud computing.

Dr. Raja Sengupta is Associate Professor in the Systems Engineering program within Civil and Environmental Engineering, University of California at Berkeley. He received his Ph.D from the EECS department, University of Michigan at Ann Arbor. His research interests are in vehicular ad-hoc networks and unmanned air vehicles. He was Associate Editor of the IEEE Control Systems magazine. He was Program Chair of the IEEE Conference on Autonomous Intelligent Networked Systems 2003, Co-General Chair of the first ACM MOBICOM Workshop on Vehicular Ad-hoc Networks 2004 and Co-Program Chair of the second workshop. In 2008 he chaired the First International Symposium on Vehicular Computing Systems.

Dr. Onur Altintas is a senior researcher at the R&D Group of Toyota InfoTechnology Center, Co. Ltd, in Tokyo. From 1999 to 2001 he was with Toyota Motor Corporation and from 2001 to 2004 he was with Toyota InfoTechnology Center USA, and was also a visiting researcher at Telcordia Technologies between 1999 and 2004. Before joining Toyota Motor Corporation in 1999, he was a research scientist at Ultra High Speed Network and Computer Technology Labs (UNCL), Tokyo. He received his B.S. (1987) and M.S. (1990) degrees from Orta Dogu Teknik Universitesi, Ankara, Turkey, and his Ph.D. (1995) degree from the University of Tokyo, Japan; all in electrical engineering. He served as the Co-Chair for Vehicle-to-Vehicle Communications Workshops (V2VCOM 2005 and V2VCOM 2006) co-located with ACM MobiQuitous, and V2VCOM 2007 and V2VCOM 2008 co-located with IEEE Intelligent Vehicles Symposium. He also served as the Co-Chair for the IEEE Workshop on Automotive Networking and Applications (AutoNet 2006, AutoNet 2007 and AutoNet 2008) co-located with IEEE Globecom. He is the co-founder and general co-chair of the IEEE Vehicular Networking Conference (IEEE VNC) held in Tokyo in 2009; in New Jersey in 2010, and in Amsterdam in 2011. He is an IEEE VTS Distinguished Lecturer.

Jérôme Härrri is an Assistant Professor at the Mobile Communication Group at EURECOM, France, and conducting research in wireless vehicular networks. He received a M.Sc. degree and a Dr. ès sc. Degree in telecommunication from the Swiss Institute Technology (EPFL), Lausanne, Switzerland. Previously, he led a Traffic Telematics Junior Research Group at the Institute of Telematics of the Karlsruhe Institute of Technology (KIT), Germany. His research interests are related to the characterization of the mutual relationship between vehicular mobility and inter-vehicular communication on ITS applications.

Jérôme has been Co-Chair of the special session on traffic telematics at IEEE PIMRC'09 and has served as Demo Chair and TPC Co-chair of the IEEE Conference on Wireless Vehicular Communications (WiVeC) 2008 and 2010 respectively. He was also involved in the EU FP7 project iTETRIS with aspects related to mobility and connectivity-based ITS infrastructure deployment. He is now involved in the

French FOT project SCOREF and the smart grid project VELCRI with aspects related to the identification and management of vehicular mobility contexts. He is actively participating to standardization activities of the ETSI TC ITS in a specialist task force on ITS multi-channel operations, and of the CAR 2 CAR Communication Consortium. Jérôme is the author of the chapter on “Vehicular Mobility Modeling for VANET” in the book “VANET: Vehicular Applications and Inter-Networking Technologies”, (Eds. H. Hartenstein and K. Laberteaux) published by Wiley in 2010.

Ravi Puvvala is the CEO of Savari. He is responsible for sales, marketing and providing overall strategic direction for the organization. Savari is an emerging company focused on providing wireless infrastructure to the Intelligent Transportation Systems market and are the chosen supplier for the US DOT's OBE, Here-I-Am, RSE devices.

Previously he served as the founder and CEO of Zazu Networks, which was a design center focused on helping customers build products based on WiFi. A persistent entrepreneur, who is captivated by the power of WiFi and it's proliferation in to various markets. Prior to his entrepreneurial quest, he has worked with several multinational corporations gaining rich experience in engineering, management and global understanding of networking products. He received his B.S. in Computer Science at Bangalore University, 1990 and M.S. in Computer Science at Arizona State University, 1992.

Christoph Kirsch is full professor and holds a chair at the Department of Computer Sciences of the University of Salzburg, Austria. Since 2008 he is also a visiting scholar at the Department of Civil and Environmental Engineering of the University of California, Berkeley. He received his Dr.Ing. degree from Saarland University, Saarbruecken, Germany, in 1999 while at the Max Planck Institute for Computer Science. From 1999 to 2004 he worked as Postdoctoral Researcher at the Department of Electrical Engineering and Computer Sciences of the University of California, Berkeley. His research interests are in concurrent programming and systems, virtual execution environments, and embedded software. Dr. Kirsch co-invented the Giotto and HTL languages, and leads the JAviator UAV project for which he received an IBM faculty award in 2007. He co-founded the International Conference on Embedded Software (EMSOFT) in 2001 and is currently vice-chair of ACM SIGBED and associate editor of TODAES. He has been PC co-chair of EMSOFT 2007, general co-chair of ESWEEK 2008, general chair of LCTES 2009 and EuroSys 2011, topic co-chair at DATE 2010 and 2011, track chair at RTSS 2010, and subcommittee chair at DAC 2011. He has been invited to serve on program committees of CASE, Coordination, DATE, EMSOFT, EUC, EuroSys, HSCC, ICCAD, JTRES, LCTES, MEMOCODE, OOPSLA, RTAS, RTSS, and VEE.

Sateesh Addepalli is Director of Innovation & Research, New Ventures and Business Initiatives, Cisco Systems.

VTC Opening Plenary

WiVeC attendees are invited to the VTC2011-Fall opening plenary on Tuesday, 6 September, from 8.30 – 10.00 in the Plaza Ballroom. Full details can be found on Page 11.

WiVeC Technical Sessions

5 September 2011 8:45-10:00 Golden Gate 7 & 8

WiVeC 2011 Opening Keynote

Welcome and Introduction

Daniel Jiang and Raja Sengupta

2. Security and Privacy in V2X: Current Approaches for Deployment

Andre Weimerskirch, encrypt Inc

5 September 2011 10:30-12:10 Golden Gate 7 & 8

WiVec Radio

Chair: Mahbub Hassan

1 Performance Evaluation of Wiener Filter Designs for Channel Estimation in Vehicular Environments

Jörg Nuckelt, Moritz Schack, Thomas Kürner, Technische Universität Braunschweig

2 Radio Resource Allocation for a High Capacity Vehicular Access Network

Christian Ibars, Centre Tecnologic de Telecomunicacions de Catalunya - CTTC; Rodolfo Milito, Pere Monclus, Cisco Systems Inc.

3 Raptor Codes for Infrastructure-to-Vehicular Broadcast Services

Nor Fadzilah Abdullah, Angela Doufexi, Robert J. Piechocki, University of Bristol

4 Performance of LTE in Vehicle-to-Vehicle Channels

David W. Matolak, Qiong Wu, Ohio University; Juan Jesús Sánchez-Sánchez, David Morales Jiménez, M. Carmen Aguayo-Torres, Universidad de Málaga

5 September 2011 13:40-15:20 Golden Gate Foyer

WiVec Posters

1 An Analytical Packet Error Rate Model for WAVE Receivers

Fabrizio Abrate, Andrea Vesco, Riccardo Scopigno, Istituto Superiore Mario Boella

2 Analysis of Utility-Based Data Dissemination Approaches in VANETs

Ramon S. Schwartz, Anthony E. Ohazulike, Hylke W. van Dijk, Hans Scholten, University of Twente

3 Analytical Design of Inter-vehicular Communications for Collision Avoidance

Mohammad Nekoui, Hossein Pishro-Nik, University of Massachusetts

4 Cooperative Vehicle Positioning via V2V Communications and Onboard Sensors

Sae Fujii, Atsushi Fujita, Takaaki Umedu, Hirozumi Yamaguchi, Teruo Higashino, Osaka University; Shigeru Kaneda, Space-Time Engineering Japan, Inc.; Mineo Takai, University of California, Los Angeles

5 How Severe is the Hidden Terminal Problem in VANETs when Using CSMA and STDMA?

Katrin Sjöberg, Elisabeth Uhlemann, Halmstad University; Erik G. Ström, Chalmers University of Technology

6 Multipath Delay Profile Models for ITS in 700MHz Band

Hisato Iwai, Satoshi Goto, Doshisha University

7 Optimum Capacity of MIMO Systems for High-speed Railway with Spare Antenna Array

Jiayi Zhang, Zhenhui Tan, Haibo Wang, Beijing Jiaotong University

8 RTMB/CTMB: A Collision Avoidance Scheme for VANET Broadcast

Lung-Chih Tung, Mario Gerla, University of California, Los Angeles

9 Throughput of Self-Organizing Time Division Multiple Access MAC Layer for Vehicular Networks based on measured SNR time-series

Arrate Alonso, Technische Universität Wien; Dieter Smely, Kapsch TrafficCom; Christoph F. Mecklenbräuker, Technische Universität Wien

10 WLAN-WiMAX Double-Technology Routing for Vehicular Networks

Kaveh Shafiee, Alireza Attar, Victor C. M. Leung, The University of British Columbia

11 Theoretical Analysis of Broadcast Packet Delivery Rate in ITS V2V Communication with CSMA/CA

Kazuya Minato, Jingze Dai, Yasushi Yamao, University of Electro-Communications, Japan

5 September 2011 13:40-15:20 Golden Gate Foyer

WiVec Demos

1 A Vehicle Group Communication System using IEEE 1609/802.11(p) Radios

Chih-Che Lin, Lo-Chuan Hu, Hsia-hsin Li, Industrial Technology Research Institute

2 CarbonRecorder: A Mobile-Social Vehicular Carbon Emission Tracking Application Suite

Bojin Liu, Dipak Ghosal, Yachao Dong, Chen-Nee Chuah, Michael Zhang, University of California, Davis

3 Demo of "Vis Magna": a Custom and Interactive Tool for the Visualization of VANET Protocols

Daniele Brevi, Qing Xu, Hector Agustin Cozzetti, Riccardo Scopigno, Istituto Superiore Mario Boella

4 Demonstration of Vehicle to Vehicle Communications over TV White Space

Onur Altintas, Mitsuhiro Nishibori, Oshida Takuro, Yutaka Ihara, Masahiro Saito, Rama Vuyyuru, Toyota InfoTechnology Center; Chikara Yoshimura, Youhei Fujii, Kota Nishida, Kazuya Tsukamoto, Masato Tsuru, Yuji Oie, Kyushu Institute of Technology; Abdulrahman Al Abbasi, Masaaki Ohtake, Mai Ohta, Takeo Fujii, The University of Electro-Communications; Si Chen, Srikanth Pagadarai, Alexander M. Wyglinski, Worcester Polytechnic Institute

5 Scalable Cooperative Vehicle Safety Systems: Adaptive Inter-Vehicle Communication

Somak Data Gupta, Yaser P. Fallah, Ching-ling Huang, Raja Sengupta, University of California, Berkeley; Hariharan Krishnan, General Motors

5 September 2011 15:50-17:30 Golden Gate 7 & 8

WiVeC Panel

Moderator: Raja Sengupta, UC Berkeley

Where are we in the research, development, testing and deployment dimension? And what are the 'real' problems?

Onur Altintas, Toyota InfoTechnology Center; Jérôme Härrı, EURECOM; Ravi Puvvala, Savari Networks; Sateesh Addepalli, CISCO; Christoph Kirsch, University of Salzburg

VTC and WiVeC Reception

19:00 – 21:00 Upper Level Restaurant City Scape 6th Floor

VTC Opening Plenary
08:30 – 10:00 Plaza Ballroom

6 September 2011 10:30-12:10 Golden Gate 7

WiVec Networking

Chair: Elisabeth Uhlemann

1 Mathematical Modeling of Channel Load in Vehicle Safety Communications
Qi Chen, Daniel Jiang, Mercedes-Benz Research & Development North America, Inc.; Tessa Tielert, Karlsruhe Institute of Technology; Luca Delgrossi, Mercedes-Benz Research & Development North America Inc.

2 Cross-Validation of DSRC Radio Testbed and NS-2 Simulation Platform for Vehicular Safety Communications
Gaurav Bansal, John Kenney, Toyota InfoTechnology Center, USA; Aaron Weinfield, Denso International America Inc.

3 A Robust Broadcast Scheme for VANET One-hop Emergency Services
Xiaomin Ma, Oral Roberts University; Xiaoyan Yin, Kishor Trivedi, Duke University

4 Efficient Inter-Vehicle Data Dissemination
Fei Ye, Sumit Roy, Haobing Wang, University of Washington

VTC and WiVeC Lunch
12:10 – 13:40 Plaza Ballroom

6 September 2011 13:40-15:20 Golden Gate 7
WiVec Applications, Deployment, and Security

Chair: Onur Altintas

1 Adaptive Cooperative Awareness Messaging for Enhanced Overtaking Assistance on Rural Roads
Annette Böhm, Magnus Jonsson, Elisabeth Uhlemann, Halmstad University

2 Highway Capacity Benefits from Using Vehicle-to-Vehicle Communication and Sensors for Collision Avoidance
Patcharinee Tientrakool, Ya-Chi Ho, N. F. Maxemchuk, University Of Columbia

3 User/Operator Utility-Based Infrastructure Deployment Strategies for Vehicular Networks
Pasquale Cataldi, Eurecom; Jérôme Härrı, EURECOM

4 C2X Communication: Securing the Last Meter
Hendrik Schweppe, Yves Roudier, EURECOM; Benjamin Weyl, BMW Group Research and Technology; Ludovic Apvrille, Telecom Paristech; Dirk Scheuermann, Fraunhofer SIT

6 September 2011 15:50-16:50 Golden Gate 8

WiVec 2011 Closing Keynote

1. Information Assurance for Sensor-based Vehicular Networks
Zigmunt Haas, Cornell University

Program at a Glance : Monday 5 September 2011

	Golden Gate 1 (C)	Golden Gate 2 (D)	Golden Gate 3 (E)	Golden Gate 4 (F)	Golden Gate 6 (G)	Golden Gate 7 & 8 (W)
MONDAY 5 September						
8:00-17:30	Registration (Golden Gate Ballroom Foyer)					
8:30-10:00	T1: Cooperative Wireless Communications	T3: QoS Provisioning in Wireless CR Networks	T5: Order Statistics in Wireless Communications	T7: LTE-Advanced Relay	T9: VANET MACs	WiVeC Opening & Keynote
10:00-10:30	Coffee (by Golden Gate 1)					
10:30-12:00	T1: Cooperative Wireless Communications	T3: QoS Provisioning in Wireless CR Networks	T5: Order Statistics in Wireless Communications	T7: LTE-Advanced Relay	T9: VANET MACs	WiVeC Radio
12:00-13:30	Lunch Break (No lunch provided)					
13:30-15:00	T2: Interference Alignment	T4: Millimeter-wave Mobile Broadband	T6: Internet Access under High Speed Mobility			WiVeC Posters and Demos (in Foyer)
15:00-15:30	Coffee (by Golden Gate 1)					
15:30-17:00	T2: Interference Alignment	T4: Millimeter-wave Mobile Broadband	T6: Internet Access under High Speed Mobility			WiVeC Panel
19:00-21:00	VTC & WiVeC Welcome Reception (Upper Level Restaurant City Scape 6th Floor)					