

# **Vehicular Communications: Standards, Protocols, Applications and Technical Challenges**

**Speaker:**

**Rajeev Shorey, Vice-Chancellor, NIIT University, India**

## **Abstract**

Vehicular networks have been the subject of much attention lately. A Vehicular Ad-Hoc Network, or VANET, is a form of mobile ad-hoc network, which provides communications among nearby vehicles and between vehicles and nearby fixed equipment, usually described as roadside equipment. Enabled by short-range to medium-range communication systems (vehicle-to-vehicle or vehicle-to-roadside), the vision of vehicular networks includes real-time and safety applications, sharing the wireless channel with mobile applications from a large, decentralized array of service providers. Vehicular safety applications include collision and other safety warnings. Non-safety applications include real-time traffic congestion and routing information, high-speed tolling, mobile infotainment, and many others.

Several factors have contributed to the surging interest in vehicular networks. In December 2003, the U.S. FCC approved 75 MHz of spectrum for Dedicated Short Range Communications (DSRC), and the resulting DSRC system is expected to be the first wide-scale vehicular network in North America. The IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE) has come out with standards for vehicular communications at all the layers: the MAC (IEEE 1609.4), Networking (IEEE 1609.3), Security (IEEE 1609.2) and Application layer (IEEE 1609.1).

The goal of this tutorial is to discuss detailed developments in the area of vehicular networks - from standards, protocols, government efforts across the world to numerous technical challenges in the area.

**Keywords:** V2V, V2I, Safety, DSRC, WAVE Stack

## **Objectives**

The objective of the tutorial is to bring together leading researchers and practitioners from academia and industry, for an in-depth exchange of ideas in the area of "Vehicular Communications".

Vehicular Networks have attracted a lot of attention in the last few years. Creating high-performance, highly scalable, robust and secure vehicular networking technologies presents an extraordinary challenge to the wireless research community.

In addition to the existing IEEE standards in vehicular networks, the tutorial will describe the efforts of the Vehicular Safety Consortium (VSC), the Crash-Avoidance Metrics Partnership (CAMP) consortium and the Vehicle Infrastructure Initiative (VII).

The tutorial will discuss several technical challenges in creating high-performance, scalable, and secure VANET technologies. The tutorial will cover topics such as VANET protocols, the WAVE (Wireless Access in Vehicular Environment) stack, performance issues, security paradigms, etc.

Topics that remain a huge challenge in vehicular networks such as Security and Scalability of VANETs will be discussed in detail.

At the end of the tutorial, the participants should have an in-depth understanding of business, technical and research challenges in Vehicular Ad Hoc Networks.

## **Syllabus**

1. Introduction to VANETs
2. Differences between VANETs and MANETs
3. Safety and commercial applications of VANETs
4. The WAVE stack and the DSRC protocol
  - 4.1 Multi-channel organization/operation
5. Issues in VANET Protocol design
6. Security and privacy in VANETs
7. Scalability in VANETs
8. Mobility Models of VANETs
9. Detailed discussion of the efforts of various consortia such as VSC-A, CAMP, VII
10. Open research problems in VANETs along with proposed solutions in some of the key areas
  - 10.1 Resource constrained platform
  - 10.2 Cost related issues
11. Conclusion and Scope for Future Work
12. Key References in the area

## **Previous Delivery**

The author has presented talks in the area of "Vehicular Networks" in several universities before. Some of the universities where the tutorial has been presented are:

1. ECE Department, University of Wisconsin at Madison, USA, 2007
2. Computer Science Department, Indian Institute of Technology, Delhi, India, January 2007
3. Computer Science Department, Indian Institute of Technology, Delhi, India, January 2009

In addition, the author has given numerous tutorials in the area of Wireless Networks (e.g., Bluetooth, Wireless LANs) in international conferences and Workshops. The author is an accomplished speaker in several international forums.

### **Audience**

This tutorial is intended for researchers and practitioners who want to track new developments in Vehicular Networks but do not have the time or patience to read relevant papers or specifications. The tutorial will serve extremely useful for research students who are looking for open problems in this space and who are keen to build a deep understanding in the area. Managers and marketers wishing to obtain a better understanding of the VANET space will also benefit from this tutorial.

### **Novelty**

At the end of the tutorial, the participants will have an in-depth understanding of (i) business, (ii) technical and (iii) research challenges in Vehicular Ad Hoc Networks.

The tutorial will present some of the key technical challenges in detail such as "Security" and "Scalability" in VANETs.

Detailed discussion of the objectives of existing consortia (e.g., VSC-A, CAMP, VII) would be extremely useful to delegates from industry and government organizations.

### **References**

1. Select papers from ACM MobiCom's VANET workshop (2005 to 2008)
2. DSRC standard and the WAVE stack
3. Papers from IEEE JSAC special issue on "Vehicular Networks", October 2007, Volume 25, Number 8.
4. Select published papers from GM Research labs in USA and India.
5. Select papers from leading universities in VANETs: CMU, EPFL, UIUC

## **About the Speaker**

Rajeev Shorey is currently the Vice-Chancellor of NIIT University in Nimrana near Delhi. Till August 2009, he was the Lab Group Manager of the Vehicle Communications and Information Management Group of India Science Lab (ISL) at GM Research and Development, Bangalore. Prior to joining GM Research, Rajeev was a Research Staff Member at the IBM Research Laboratory, New Delhi from 1998 to October 2005.

Rajeev received his Ph.D in Electrical Communication Engineering from the Indian Institute of Science, Bangalore, India in 1996. Dr. Shorey's work has resulted in more than 50 publications in international journals and conferences and several US patents, all in the area of wireless and wired networks. He has 10 issued US patents and several pending patents to his credit.

Rajeev serves on the Editorial boards of IEEE Transactions on Mobile Computing and Wireless Networks Journal of Mobile Communication, Computation and Information. He has thrice been the guest editor of IEEE Journal on Selected Areas in Communications, including a special issue on "Vehicular Networks" that was published in October 2007. He is the editor of the book titled "Mobile, Wireless and Sensor Networks: Technology, Applications and Future Directions" published by John Wiley, US in March 2006. Rajeev is the General Chair of the Sixth ACM International Workshop on VehiculAr Inter-NETworking (VANET 2009), a workshop in conjunction with ACM MobiCom 2009. Rajeev has given numerous talks and seminars in industry and academia all over the world and given several Tutorials in International conferences.

For his contributions in the area of Communication Networks, Rajeev was elected Fellow of the Indian National Academy of Engineering in 2007. He is a Fellow of the Institution of Electronics and Telecommunication Engineers, India. He is a Senior Member of IEEE and a Member of ACM.