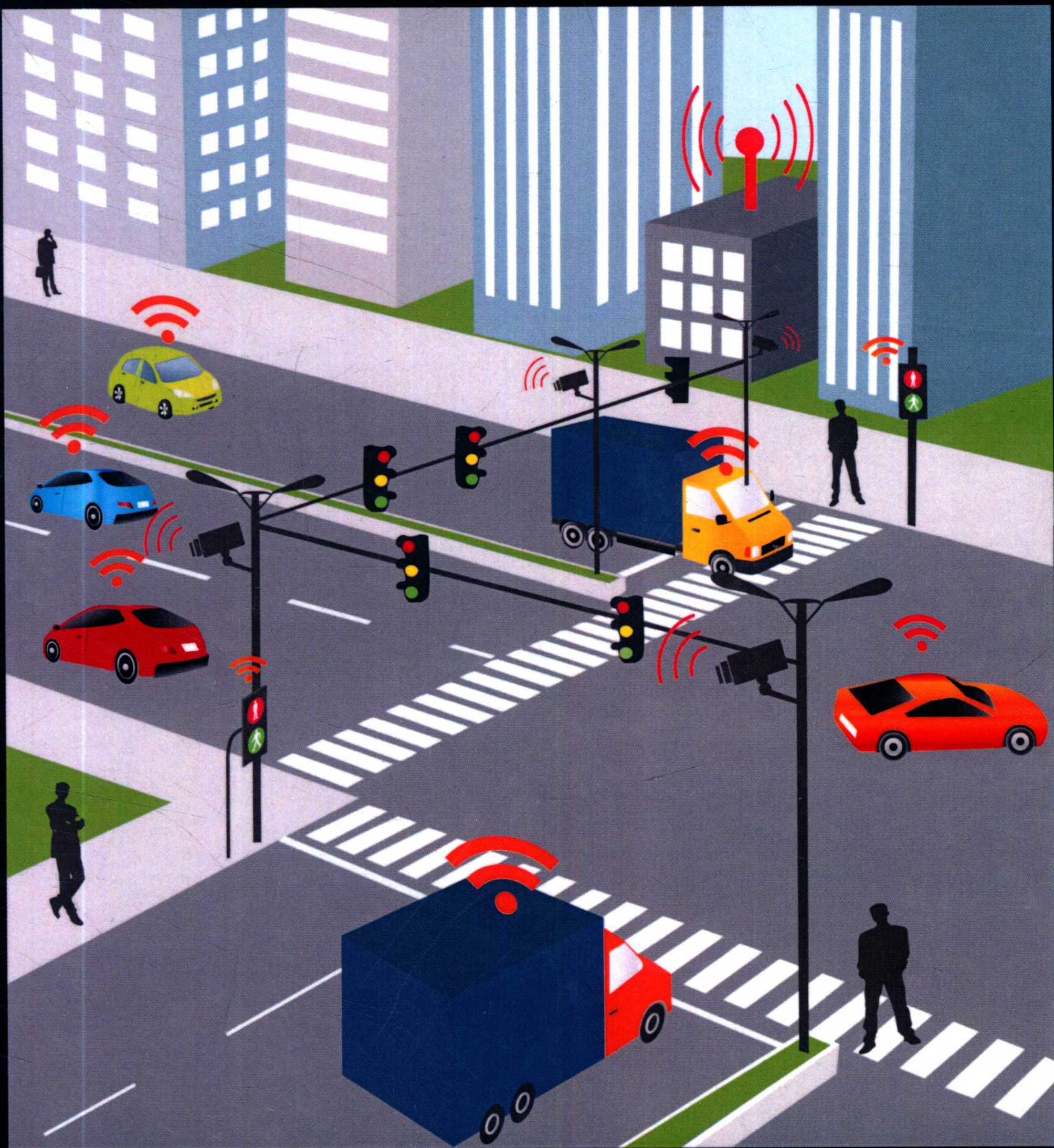
Connected Vehicle Systems

Communications, Data, and Control



Edited by Yunpeng Wang • Daxin Tian
Zhengguo Sheng • Jian Wang

CRC Press
Taylor & Francis Group

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

International Standard Book Number-13: 978-1-138-03587-4 (Hardback)

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

MIX
Paper from responsible sources
FSC® C013056

Printed and bound in Great Britain by
TJ International Ltd, Padstow, Cornwall

Connected Vehicle Systems

Yunpeng Wang, Daxin Tian, Zhengguo Sheng, and Jian Wang

Connected Vehicle Systems: Communications, Data, and Control

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

List of Tables

List of Figures

Preface

In recent years, connected vehicles have attracted the interest of the research community; e.g., wireless communications, intelligent vehicle technology, intelligent transportation systems, mobile computing, sensors, multimedia, etc. The vehicular systems can help improve the efficiency and safety of a system. Some potential applications include emergency warning system for vehicles, automatic driving assistance systems, fleet management, smart road, and dynamic traffic light, just to name a few. These applications have been recognized by governmental organizations and vehicle manufacturers. The U.S. Federal Communications Commission has allocated 75 MHz of spectrum band around 5.9 GHz for Dedicated Short-Range Communications (DSRC), which is used for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications to support vehicular networking applications. Besides standardization efforts such as VSCC in North America, Car-2-Car consortium in Europe, and IEEE 802.11p working group, a number of research projects including NoW, CVIS, Fleetnet, SafeSpot, and SEVECOM have addressed vehicular telematics research around the world. Therefore, there is much interest in better understanding the properties of the related system and developing new application systems.

Connected Vehicle Systems: Communications, Data, and Control is the book to present and discuss the recent advances in theory and practice in connected vehicle systems; it will cover emerging research that aims at dealing with the challenges in designing the essential functional components of connected vehicles. The major topics will cover intra- and intervehicle communications, trace and position data analysis, security and privacy, and mobility control. It starts with (Chapter 1) a summary of automotive applications and provides an outline of the main standards used in the automotive industry, in particular, the networks and their protocols. In-vehicle communications are emerging to play an important role in the continued development of reliable and efficient x-by-wire applications in new vehicles. Chapter 2 presents the advancement of power line communications, which can provide a very low-cost and virtually free platform for in-vehicle communications. The latest Home Plug Green PHY (HPGP) has been promoted by major automotive manufacturers for communications with electric vehicles; Chapter 3 gives the results of its hard delay performance in supporting mission-critical in-vehicle applications. Vehicular ad hoc networks (VANETs) physical channel suffers from serious multipath fading and Doppler spreading; the physical channel behaviors are discussed in Chapter 4. Safety-related applications are geared primarily toward avoiding the risk of car accidents; they include cooperative collision warning, precrash sensing, lane-change warnings, and traffic violation warning—these applications all have real-time constraints. Chapter 5 discusses the short-range communications. Because of the special features of vehicular networks such as mobility, high speed, and self organization, V2V multihop broadcast has become a hot topic in recent years. A high-speed and efficient way to transmit data is discussed in Chapter 6. With the large-scale popularization of GPS equipment, the massive amount of vehicle trajectory data has become an important source for location service, digital map building, and moving trace monitoring. Chapter 7 focuses on road recognition; Chapters 8 and 9 present the DSRC positioning and enhancement methods. VANETs differ from the wired networks and behave in a highly dynamic context; e.g., frequently changing signal-to-noise ratio (SNR) and security risks, which undoubtedly affects the suffered security risk. Chapter 10 presents a lightweight and adaptive security mechanism. Chapter 11 demonstrates a prototype of social-network-enabled transportation system that enables communication between vehicles, monitoring, information gathering, assistant driving, and traffic flow control. Chapter 12 proposes a mobility model to describe the self-organized behavior of the vehicle swarm in VANETs.

MATLAB® is a registered trademark of The MathWorks, Inc. For product information, please contact:

The MathWorks, Inc.
3 Apple Hill Drive
Natick, MA 01760-2098 USA
Tel: 508-647-7000
Fax: 508-647-7001
E-mail: info@mathworks.com
Web: www.mathworks.com

Contributors

Falah Ali
University of Sussex
Brighton, United Kingdom

Roberto P. Antonioli
Federal University of Ceará
Fortaleza, Brazil

Min Chen
Huazhong University of Science and Technology
Wuhan, People's Republic of China

Xuting Duan
Beihang University
Beijing, People's Republic of China

Amir Kenarsari-Anhari
University of British Columbia
Vancouver, British Columbia, Canada

Jia-Liang Lu
Shanghai Jiaotong University
Shanghai, People's Republic of China

Yingrong Lu
Beihang University
Beijing, People's Republic of China

Xiaolei Ma
Beihang University
Beijing, People's Republic of China

Victor Ocheri
University of Sussex
Brighton, United Kingdom

Morgan Roff
Queen's University
Kingston, Ontario, Canada

Zhengguo Sheng
University of Sussex
Brighton, United Kingdom

Wei Shu
University of New Mexico
Albuquerque, New Mexico

Nima Taherinejad
Technical University of Vienna
Vienna, Austria

Daxin Tian
Beihang University
Beijing, People's Republic of China

Jian Wang
Jilin University
Changchun, People's Republic of China

Yunpeng Wang
Beihang University
Beijing, People's Republic of China

Min-You Wu
Shanghai Jiaotong University
Shanghai, People's Republic of China

Yue Yang
Beihang University
Beijing, People's Republic of China

Guohui Zhang
University of Hawaii
Honolulu, Hawaii

Xuejun Zhang
Beihang University
Beijing, People's Republic of China

Jianshan Zhou
Beihang University
Beijing, People's Republic of China

Keyi Zhu
Beihang University
Beijing, People's Republic of China

Contents

INTRAVEHICLE COMMUNICATIONS

I