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Hongzi Zhu · Minglu Li

Studies on Urban Vehicular Ad-hoc Networks

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Hongzi Zhu
Minglu Li
Department of Computer Science and Engineering
Shanghai Jiao Tong University
Shanghai
People's Republic of China

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Preface

Vehicular Ad hoc Networks (VANETs) are emerging as a new technology to provide a wide spectrum of safety, efficiency, and comfort applications to the public and governments. It has been immensely successful and naturally attracted considerable attention from both academia and industry since its introduction about one decade ago. Numerous publications and projects have been devoted to this topic. However, the realistic behavior of the network at a large scale is still unavailable today, due to the initial stage of VANET deployments. The goal of this book is to offer some fundamental observations of node and network behavior when the network scale reaches over 10,000 vehicles and demonstrates mobile sensing applications based on VANETs in urban scenarios. The target audiences are researchers interested in getting to know VANETs, in particular graduate students. It is also our hope that this book can be useful to experts as quick reference.

This book starts with an introduction on VANETs and representative experimental work in the world such as the MIT CarTel project, the UMASS DieselNet project, and the GM DSRC Fleet. We then introduce the empirical studies conducted in SJTU, which are based on three realistic GPS data sets collected from taxies and buses in Shanghai and Shenzhen, two metropolises in China.

In Chap. 2, we describe the characteristics of the trace data and main challenges and issues in data analysis. In Chap. 3, we extensively study the distribution of inter-contact time (ICT) between a pair of vehicles and establish a general vehicular mobility model in urban settings which follows the observed ICT distribution. Some of the proofs are involved and can be safely skipped at first reading. Nevertheless, we decided to include them because they either illustrate useful analytical skills or provide details that are missing in the original papers. Due to the limited time, space, and of course our knowledge and ability, the content of this book is far from extensive.

Chapter 4 covers two opportunistic data forwarding strategies in VANETs. In this chapter, first, the temporal correlations between pairwise contacts are analyzed and further utilized to predict future contact information between vehicles. As data are relayed in VANETs in a store-carry-forward fashion, such estimated future contact information can be leveraged to improve routing performance. Moreover, the sociality of vehicular networks is also examined and we have the observation

that vehicles do have clear social relationships that can further stimulate the routing performance. We describe two proposed opportunistic routing schemes in VANETs which utilize such knowledge and gain better performance in terms of end-to-end delay and network traffic cost.

Chapter 5 introduces a distributed online vehicle tracking scheme in large cities. RFID systems are deployed to capture vehicles and location information about vehicles is locally stored among a large number of nodes distributed in the city. The main challenge is to guarantee that the response time of a query issued from anywhere in the city meets a given real-time requirement and meanwhile to minimize the network cost for location updating and query forwarding in the network. We describe a scheme which organizes the nodes into different regions. With this organization, location information updating is restricted within a small scale and still keeps the whole network updated. In addition, the query can be forwarded to the most up-to-date node within the given time requirement.

Chapter 6 covers a mobile sensing application which uses commuting vehicles as mobile sensors to sample the traffic condition on surface roads and analyzes these sensory data to infer the traffic condition on those roads with insufficient sample data. The main challenge is to remove noise embedded in the data and recover the traffic condition information from lossy sensory data.

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Shanghai, People's Republic of China, Hongzi Zhu
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