Chapter XVII

A Wireless Mesh Network Platform for Vehicle Positioning and Location Tracking

Mohamed EL-Darieby
University of Regina, Canada

Hazem Ahmed
University of Regina, Canada

Mahmoud Halfawy
National Research Council NRC-CSIR, Canada

Ahmed Amer
Zagazig University, Egypt

Baher Abdulhai
Toronto Intelligent Transportation Systems Centre, Dept. of Civil Engineering, Canada

ABSTRACT

Large urban areas in North America as well as many other parts of the world are experiencing unprecedented and soaring congestion problems. It is imperative that modern societies upgrade their transportation systems in order to remain competitive, and maintain the high quality of life and social wellbeing. Current practices in Intelligent Transportation Systems (ITS) data gathering are dominated by the use of point detectors for surveillance, and wire-line communication networks for data transmission. Reliance on point detectors is losing appeal due to detector reliability issues, the cost of building and maintaining detector networks, and potential traffic disruption during construction and maintenance of these networks. This chapter describes a novel wireless mesh network platform for traffic monitoring. The platform uses traveling cars as data collection probes and uses wireless municipal mesh networks to transport sensed data. The platform assumes that cars or drivers' mobile devices are equipped with the
widely adopted low-cost Bluetooth wireless technology. Field trials of the proposed platform demonstrated its capability to track cars traveling at speeds of 0 to 70 km/hour. The platform was able to track cars as they travel and turn on a typical road network. In addition, the platform was used to approximate car speeds through determining the change in position in a time period. The preliminary results indicated an accuracy of ±10%-15%. The chapter describes the architecture, implementation, and field-testing of the proposed platform. It also discusses aspects of large-scale deployment of the proposed platform to cover large geographic areas.

INTRODUCTION

Large urban areas in North America as well as many other parts of the world are experiencing unprecedented and soaring congestion problems. It is imperative that modern societies upgrade their transportation systems in order to remain competitive and to maintain the high quality of life and social well being that we rightly prize so highly. Transportation management agencies are under increasing pressure to adopt more innovative approaches to enhance the efficiency of existing transportation networks. Solutions in the form of building more roads are neither desirable nor feasible in many cases. A more feasible approach would be to maximize the use of the capacity already afforded by existing networks before expansions can be justified.

Over the past two decades, numerous technologies and methods have been developed and deployed to support real-time monitoring of transportation systems (Zheng, Winstanley, Yan, & Fotheringham, 2008). However, the installation and maintenance costs as well as the inherent limitations (e.g., power consumption, telemetry) of existing technologies constitute a major impediment towards implementing continuous real-time monitoring in a cost-effective manner. The efficiency and economic viability of current monitoring practices not only have limited the deployment of such technologies, but many transportation agencies still do not have an effective or systematic strategy for traffic monitoring.

The “heart” of traffic monitoring lies in gathering and using real-time system information to enable proactive management and control of the network. Current practices in monitoring traffic systems are dominated by the use of point detectors for surveillance, and wire-line communication networks for data transmission. In most large metropolitan areas, major freeways and arteries are covered by pavement-embedded induction loop detector stations to measure traffic volumes and speeds. Gathered information are typically aggregated over 20-30 seconds then transmitted over copper or fiber optic wire lines to the nearest operations centre. This approach is losing appeal due to detector reliability issues, the cost of building and maintaining detector networks, and potential traffic disruption during construction and maintenance operations. Modern off-road detector technologies have improved significantly over the past decade, resulting in new and more mature detector types based on radar, ultrasound, infrared, and acoustic technologies. With the inherent limitations of existing technologies, a new technology that allows for cost-effective real-time and continuous monitoring of traffic systems is urgently needed.

In this chapter, we propose a novel wireless and cost-effective platform for ITS monitoring. The novelty of the platform lies in using traveling cars equipped with Bluetooth devices as probes for collecting raw traffic data. The platform employs municipal wireless mesh network (WMN) infrastructure to gather and transport real-time traffic data to a centralized ITS server. The platform does not require installation of infrastructures which results in further cost-effectiveness by exploiting any existing WMN infrastructure and the wide spread use of Bluetooth devices. It is estimated that 80% of the cars