A Wireless-Based Approach for Transit Analytics

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1. INTRODUCTION

Public transit systems carry millions of users in their daily activities throughout the year and are, sometimes, an important part of public infrastructure provided by local governments. Like all systems, public transit has always looked for mechanisms that allow them to improve their services for people in terms of, say, what new routes or stops should be introduced, how do peak and off-peak behaviors be handled, and much more. Traditionally, these decisions are often based on limited surveys — the local Madison Metro Transit would use infrequent volunteers ask people about their transit preferences.

In this paper, we propose Trellis, a low-cost in-vehicle wireless monitoring system that passively observes mobile devices and provides various analytics for transit operators. Trellis takes advantage of widely available mobile devices and the popular notion of crowdsourcing from many passengers to quickly gather such information at a significantly larger scale.

Trellis uses a low-end Wi-Fi monitoring unit mounted on the vehicle to determine when a certain passenger gets on and off the vehicle. The approach relies on the fact that when a vehicle is moving, typically the signal strength of a passenger's mobile device observed by a vehicle-mounted observer will stay somewhat stable, while that of a pedestrian will fluctuate and eventually disappear (Fig. 1). Hence, by observing device signal strengths coupled with either vehicle location changes or speed of movement, one can easily discern who is inside the vehicle and who is not. This capability is a key building block in the Trellis system.

2. TRELLIS SYSTEM DESIGN AND IMPLEMENTATION

Our system uses a front-end sniffing module to collect Wi-Fi devices' signals and transit GPS information, and uses a back-end modeling module to reconstruct transit schedules and human mobility patterns. The sniffing module collects the data from mobile devices and stores the data into local database. Meanwhile, the sniffing module can send calculated passenger number

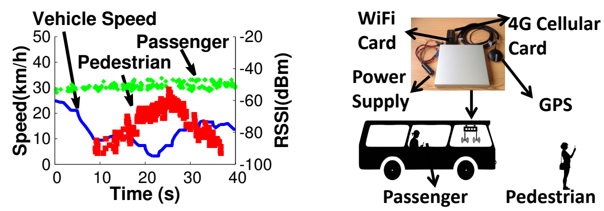

Figure 1: Different RSSI patterns between passenger and pedestrian, and the Wi-Fi monitor installed on vehicle.

to remote server in real-time through cellular link, i.e., for the purpose of real time monitoring. Although our system supports real-time communication, we use separated program to send the data from databases to remote back-end server. The back-end server reconstruct public transit schedules and human mobility patterns from the collected data. It further aggregates the data from multiple transit sniffing system instances to provide a more complete view of the transit schedules and human mobility patterns.

3. DEMO DESCRIPTION

In this demo, we will use Trellis to track station-to-station passenger movements in real time. We implement the Trellis system using off-the-shelf embedded platforms equipped with Wi-Fi interfaces and have deployed it to operate on two city buses in Madison, WI (in collaboration with our partners — Madison Metro Transit). In particular, our functionality is built into an existing system that provides a free Wi-Fi service, called WiRover [1], that is available on these city buses. We will provide a web page to show passengers getting on and off the bus, and a heatmap rendering on the map indicates number of pedestrians on the street.

4. REFERENCES

[1] Joshua Hare, Lance Hartung, and Suman Banerjee. Beyond deployments and testbeds: experiences with public usage on vehicular wifi hotspots. In *Proceedings of the 10th international conference on Mobile systems, applications, and services*. ACM, 2012.