

**NSF unit of consideration: CISE**

**Title: network public transportation**

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## **1. Background**

### **Public transportation**

Public transportation briefly serves the general public, and the notion includes railway, bus, airline, taxi services etc. Although in US the private cars dominate in most areas, public transportation does have the advantage of efficiency over private transportation in terms of physical and environmental cost for each passenger. In areas with denser population, or more fixed routines, this advantage would be even larger. And due to the increasing cost for fuel and economical concerns, there has been growing interest in the public transportation service in recent years.

Comparing to European countries and Eastern Asia, US has relatively low experience in public transportation, and due to the different living modes, it is important to investigate how to run the public transportation more efficiently. A few Problems may include, but are not limited to: whether to run in fixed routine and stop at fixed stops, at what interval should the carriers run, how to dispatch all the carriers, and how many carriers are needed. And the desired optimized schedule should be tunable via feedbacks the system gets. Modern information technology breakthrough in networks and sensors provides a perfect opportunity to tackle with such problems.

### **Sensor network**

Since around 2002, there has been a breakthrough in the field sensor networks. Because the mature of smart sensor devices, it is now feasible to deploy large, distributed networks with such sensor works. This notion differs from other wireless, battery powered environments in that they consist of thousands of autonomous nodes which operate without human interaction. So they do not need network routes configuration, recharging batteries and tuning parameters once deployed, and can run weeks of time. These sensor networks are often embedded into some remote physical environment from which they will monitor the environment and collect data. For the network, there are two kinds of key elements: nodes and access points. Nodes can be active, which collect the data, and send the data out via the network path formed, or can be inactive, and not included in the network path. While access point collect the data from all nodes, and report the data to out world. Thus with this kind of network, we can monitor the environment for the information we are interested in.

### **Sensor network and public transportation**

There have been several studies utilizing sensor networks for transportation, and in these researches, sensors are deployed on the road, to collect data such as speed, road condition, number of passing by cars for traffic surveillance either on road or at parking lot. However, there have been few researches relating sensor network with public transportation, which is of great importance and merits.

## **2. Merits of sensor network for public transportation**

## **Help managing public transport system**

With data collected by sensor networks, we expect to monitor real time information such as the location of the carrier, the number of people on board, the number of people waiting, the time to arrive from stop to stop, the distance between the previous and next carrier. With this information and backend software support, a real time feedback routine is created. Based on the feedback, the system may decide if there is congestion, movement is needed to add the carriers, or there is enough vacancy so we the carriers can be reduced. If the interval is too long and too many people waiting at certain stops, the system may decide to shorten the path. The hope is with real time feedback, the system will be built to be able to response much quicker, and more efficient.

A more aggressive approach would be, with real-time feedback, bus and railway systems can run without fixed schedule, and taxi can find the optimized distribution, and different public transport systems will share the information, run efficiently together.

Overall, under the help of the study, the expectation is that public transportation can be run more economically, efficiently, and human friendly, performs better services, and expands to areas where public transport thought to be not suit in.

## **Help understand insights of public transport and urban planning**

People tend to go to work/school/home via public transport. With the sensor network deployed, we will get large data base for the flow of people from time to time. Collecting and studying this data will help building the model of people travelling, which will be helpful for planning the location of companies, factories, and houses, and new public transport service between them.

### **Low risk**

Sensor networks have been well studied in recent years for different applications in different environments, and it is relatively easy to set up the network in public transport environment. It can first be tested on bus service, and then expanded to other services. The nodes will be set both on buses and at bus stops, and the access points will be set at bus stops. And it is straight forward to get started and collect the first group of data.

### **3. Outline of plan**

#### **Phase 1. Test the sensor, and simulate the network.**

As the first step, what device/system/sensors would best suited for the network will be decided. Experiments start with testing one simple node and its sensor on one bus. Then based on the test results, the model for the network will be set up, and simulated, so the design can be verified.

#### **Phase 2. Set up experimental network, collect the data, and develop algorithms.**

Set up the sensor network on a short bus routine, and test the system for a period of time. Decision include, where to put the access point, how to network sensors at different locations. Fix the problem when testing the network, meanwhile collect the data. Based on the data, we continue to modify the simulation and develop the system, and develop the algorithm to manage the routine.

### **Phase 3. Manage one routine with developed system, and collect the data.**

Tries to manage one routine with the developed system (at least let the system proposes), and observes the network and system behavior, and collect the data.

### **Phase 4. Simulate larger systems**

Based on the experiment, expand the simulation to several routines, or all routines for the same city, study the simulation outcome, and compare it with the real situation. Other services (e.g. railway, taxi ...) which have very different systems will also be studied at this stage. And the goal includes running railway and bus services without fixed schedule, coming out with the optimized taxi distribution, and combining several systems seamlessly together.

## **4. Resources**

Sensor platforms (INTEL motes, MIT mAMPS ...);

University of Rochester computing facilities;

University of Rochester Shuttle Service;

Rochester Regional Transit Service;