



# SPR RESEARCH PROGRAM SECOND-STAGE PROBLEM STATEMENT FY 2009-10

ODOT Research Unit  
200 Hawthorne Ave. SE  
Suite B-240  
Salem OR 97301-5192

Phone (503) 986-2700  
Fax (503) 986-2844

## I. PROBLEM NUMBER

TS-10-05

## II. PROBLEM TITLE

Performance Monitoring for Transportation System Management and Operations

## III. RESEARCH PROBLEM STATEMENT

To improve mobility and the efficiency of the transportation system we must improve operations and the management of the existing transportation infrastructure. The 2006 Oregon Transportation Plan calls for using technology to optimize system capacity and safety. We cannot effectively manage the transportation system without monitoring its performance.

Without a reliable means to estimate travel times, ODOT cannot effectively manage the transportation system. Travel time estimation is a necessary step for the evaluation of proposed highway or transit facilities to serve present and future land uses [1]. In addition, with the progressive implementation of advanced traveler information systems (ATIS) and advanced traffic management systems (ATMS), it is increasingly important that accurate estimation of link and route travel times be provided to traffic managers as well as drivers and travelers. [2].

A common approach to estimate travel times is using speed data provided by inductive loop detectors or other point-based sensors [3]. These are expensive to install and maintain and not widely available on different types of travel corridors in Oregon. Additionally, speed detectors are often not accurately calibrated, and even if they are, speed distribution in congestion is not uniform, and simple travel time extrapolations of speed are known to be invalid [4]. Other approaches that have been used in the past include cell phone, toll tag, license plate tracking, and floating car runs.

A novel method for travel time estimation which is based on the collection of media access control (MAC) addresses from Bluetooth-enabled devices has recently appeared in the literature [5]. This new approach to estimate travel times offers a number of advantages over more conventional methods, including lower costs of hardware and software, greater volume of data that can be collected over time, and the ease of implementation. The latter advantage makes this data collection method suitable for quick deployment along different types of travel corridors, including interstate highways, freeways, and other principal and minor arterial systems.

## IV. RESEARCH OBJECTIVES

This project will build on previous preliminary research done by Indiana, California, and Maryland demonstrating the use of MAC addresses from Bluetooth-enabled devices. By combining the elements of research and development, this project will advance the state-of-the-art in travel time estimation. The three main objectives are:

1. **Design, develop, and test an integrated wireless data collection unit (DCU) for capturing time-stamped MAC addresses.**
2. **Design, develop, and implement a database management system (DBMS).** The DBMS will be used for filtering, sorting, matching, and storing the MAC addresses collected by the DCU.
3. **Develop a robust real-time data analysis methodology.** An improvement over prior Bluetooth-based data collection trials will be performing data processing and analysis in real time to produce travel time estimates.

## V. WORK TASKS, COST ESTIMATE AND DURATION

Successful completion of the proposed research will include the following tasks:

1. **Literature Review.** Analyze travel time estimation models that have used data collected via wireless technology (e.g., cell phone, GPS). A report will be prepared for the TAC. **Estimated cost: \$12,000.**
2. **Develop functional and technical requirements for the design and development of the DCU and the DBMS.** Establish critical parameters associated with the operation of the DCU (e.g., transceiver architecture, antenna type, etc.) and the DBMS. **Estimated cost: \$24,000.**
3. **Design, develop and implement the DCU and DBMS.** Assemble the transceiver architecture using different antenna

configurations. Develop DMBS's structure and data processing procedures. **Estimated cost:** \$96,000.

4. **Integrate and test the DCUs and DBMS.** Perform baseline laboratory testing of an integrated system (i.e., multiple DCUs and DBMS). Collect GPS-based test data with the use of a floating car. This task will include determination of the appropriate sensor density placement. **Estimated cost:** \$60,000.
5. **Develop real-time data analysis methodology.** Apply analysis methodology to data collected during the testing period with an integrated system. **Estimated cost:** \$21,000.
6. **Develop procedures for data collection, data processing and data storage to protect citizens' privacy.** Main goal is to minimize the amount of time MAC addresses are kept for travel time estimation. **Estimated cost:** \$17,000.
7. **Develop documentation of system components and prepare draft and final reports.** **Estimated cost:** \$10,000.
8. **Project coordination and management.** ODOT staff time to coordinate TAC meetings, manage project, and prepare final report for publication. **Estimated cost:** \$7,000.

The project cost estimate is **\$247,000** with an estimated duration of **15 months**.

## VI. IMPLEMENTATION

The performance of an integrated system (i.e., multiple DCUs connected to the DBMS) will most likely be tested on a corridor in Eugene. Data collected during the testing period will be compared to travel time estimates derived from GPS-based data collected with floating vehicles. Alternatively, the results of the performance testing (i.e., accurately collecting data and producing valid travel estimates) may be compared to probe data to be collected by private sector carriers conducting a project<sup>1</sup> in the Eugene area or to data collected on Portland's US 26-Powell Blvd project. We intend to compare both data sources to identify advantages and disadvantages of estimating travel times with these techniques as well as to develop a perspective on how to improve the efficiency of our approach. Results of the design, development and testing of the integrated system comprised of several DCUs and the DMBS will be documented in the final report for ODOT Research. The results of the research may also be presented at relevant transportation related conferences and submitted in the form of journal articles to appropriate transportation journals.

## VII. POTENTIAL BENEFITS

The execution of the proposed research will result in a number of benefits to both ODOT and users of the highway and arterial systems. ODOT will be able to use the data to improve the efficiency of the transportation system. Additionally, this technology could easily be applied to evaluate the impact of different types of road improvement projects on travel time. For example, delays through construction zones could be estimated more accurately, thus providing ODOT with the ability to enforce contractual agreements with service providers. Drivers and travelers will benefit from having more accurate and timely travel time data.

## VIII. SUBMITTED BY

<i>Stage 1 Submitter</i>	<i>Stage 2 Submitter</i>	<i>ODOT champion</i>
David Porter & David Kim Associate Professors Oregon State University 204 Rogers Hall Corvallis, OR 97331	David Porter*, David Kim* & Mario Magaña+ Associate Professors Oregon State University *204 Rogers Hall +1148 Kelley Engineering Center Corvallis, OR 97331	Galen McGill Oregon Department of Transportation ITS Manager 800 Airport Rd SE Salem, Oregon 97301-3871

## IX. REFERENCES

- [1] Nam, H. & Drew, D.R. (1996). Traffic Dynamics: Method for Estimating Freeway Travel Times in Real Time from Flow Measurements. *Journal of Transportation Engineering*, 122(3), 185-191.
- [2] Cheu, R.L., Xie, C., Lee, D. (2002). Probe Vehicle Population and Sample Size for Arterial Speed Estimation. *Computer-Aided Civil and Infrastructure Engineering*, 17, 53-60.
- [3] Li, R., Rose, G., Sarvi, M. (2006). Evaluation of Speed-Based Travel Time Estimation Models. *Journal of Transportation Engineering*, 132(7), 540-547.
- [4] Caltrans (2008). Press Release.
- [5] Wasson, J.S., Sturdevant, J.R., Bullock, D.M. (2008). Real-Time Travel Time Estimates Using Media Access Control Address Matching. *ITE Journal*, 78(6), 20-23.

<sup>1</sup> The name of the project is *Probe Data for Traveler Information*.