ESTIMATION OF REAL-TIME ORIGIN-DESTINATION FLOW USING MOBILE SENSOR NETWORK

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Presentation Agenda

- Introduction
- O-D Estimation Techniques Overview
- Proposed Estimation Framework
- Preliminary Results
- Future Study

Introduction

Origin-destination (O-D) demand

- represents the travel demand of people in the transportation network
- is the corner stone of sound transportation planning
- is the vital part of dynamic traffic management

Conventional O-D estimation techniques

- Large scale survey
- Demand modeling based on socioeconomic characteristics

OD estimation technique based on link flow

- Estimation from network traffic flows

$$V_l^k = \sum_i \sum_j D_{ij}^k p_{ij}^{lk} \qquad (0<p_{ij}^{lk}<1)$$

V_l^k -traffic volume on link l at kth time interval

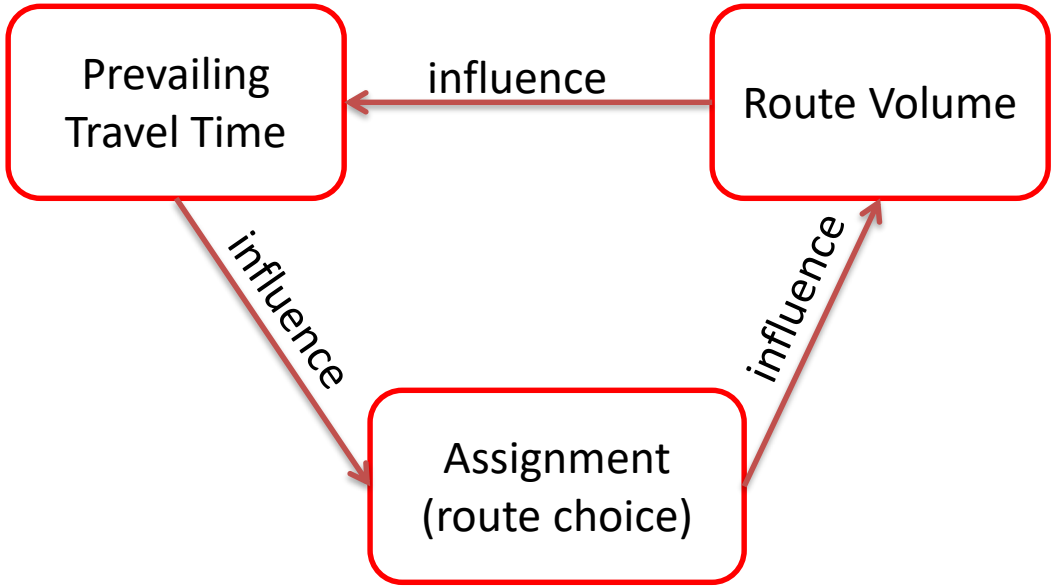
D_{ij}^k -demand fron origin i to destination j at kth time interval

p_{ij}^{lk} -portion of the the demand from i to j assigned to link l at kth time interval

Research Motivation

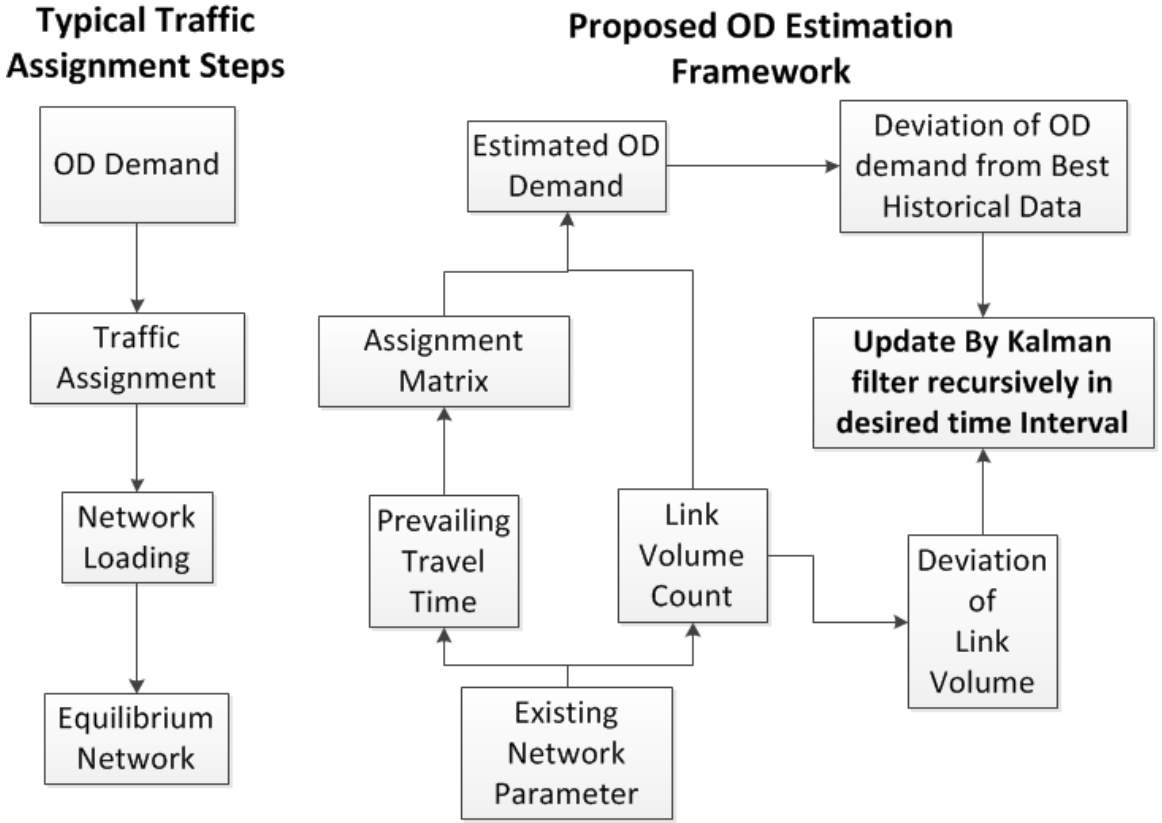
- Dynamic O-D estimations in academic realm typically suffer high computational expenses and therefore are not quite suitable for practical implementation.
- With the emergence of advanced ITS devices(e.g. Bluetooth Readers, RTMS's), a practical analytical framework with reduced calculations could be developed for operation management purpose.
- The ever-increasing needs for a better and more comprehensive work zone monitoring and impact study (e.g. NJDOT I-295 Direct Connect Project).

Module Interaction under Dynamic Traffic Assignment Scheme



- Road user plan their route largely based on travel time.
- The route volume is the result of route choice
- The route volume affect the prevailing travel time
- The recursive updating nature of Kalman Filter is suitable for this framework

Proposed Analytical Framework



- Bluetooth readers provide travel time information
- Route choice is derived from travel time information
- RTMS's provide volume counts

Recursive Kalman Filter

Prediction Step: $$x_{ij}(t+1) - x_{ij}^{H}(t+1) = B_t\left[x_{ij}(t) - x_{ij}^{H}(t)\right] + w(t) \quad (1)$$

Updating Step: $$y_l(\mathrm{t}) - y_l^{H}(\mathrm{t}) = A_t\left[x_{ij}(t) - x_{ij}^{H}(t)\right] + v(t) \quad (2)$$

$x_{ij}(t)$-demand in t time interval from origin i to destination j

$x_{ij}^{H}(t)$-histircal or outdated demand in t time interval from origin i to destination j

$y_l(\mathrm{t})$-real-time link volume counts vector

$y_l^{H}(\mathrm{t})$-historical link volume counts vector

B_t -state transition matrix between two sequential time intervals t and t+1

A_t -assignment matrix at time interval t

w(t)-random error of prediction

v(t)- random error of field measurment

Advantages of the Proposed Framework

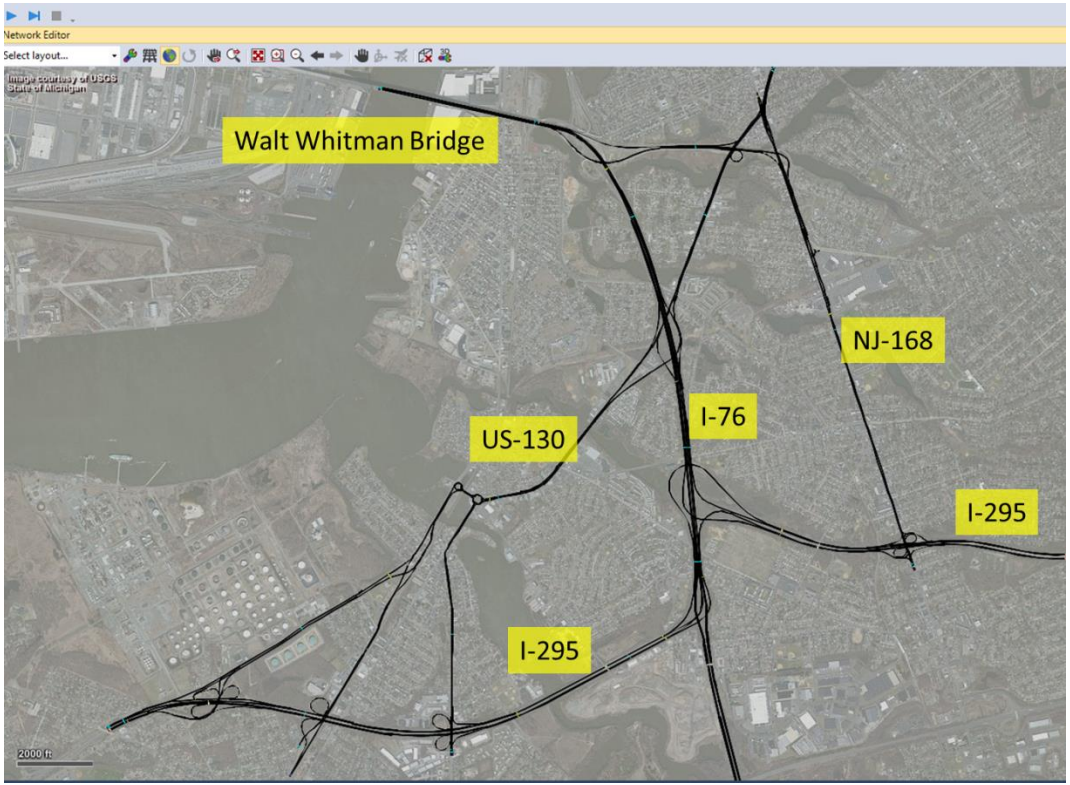
- Different sources of real-time traffic flow information are incorporated and utilized.
- Only the most-travelled routes in the network are considered in order to reduce the computational expenses.
- The estimation result will be evaluated and compare to historical results to ensure the consistency and accuracy of the estimation.
- The three modules are relatively independent, therefore each can be substituted with other assignment modules or data collection modules.

Disadvantage of the Proposed Framework

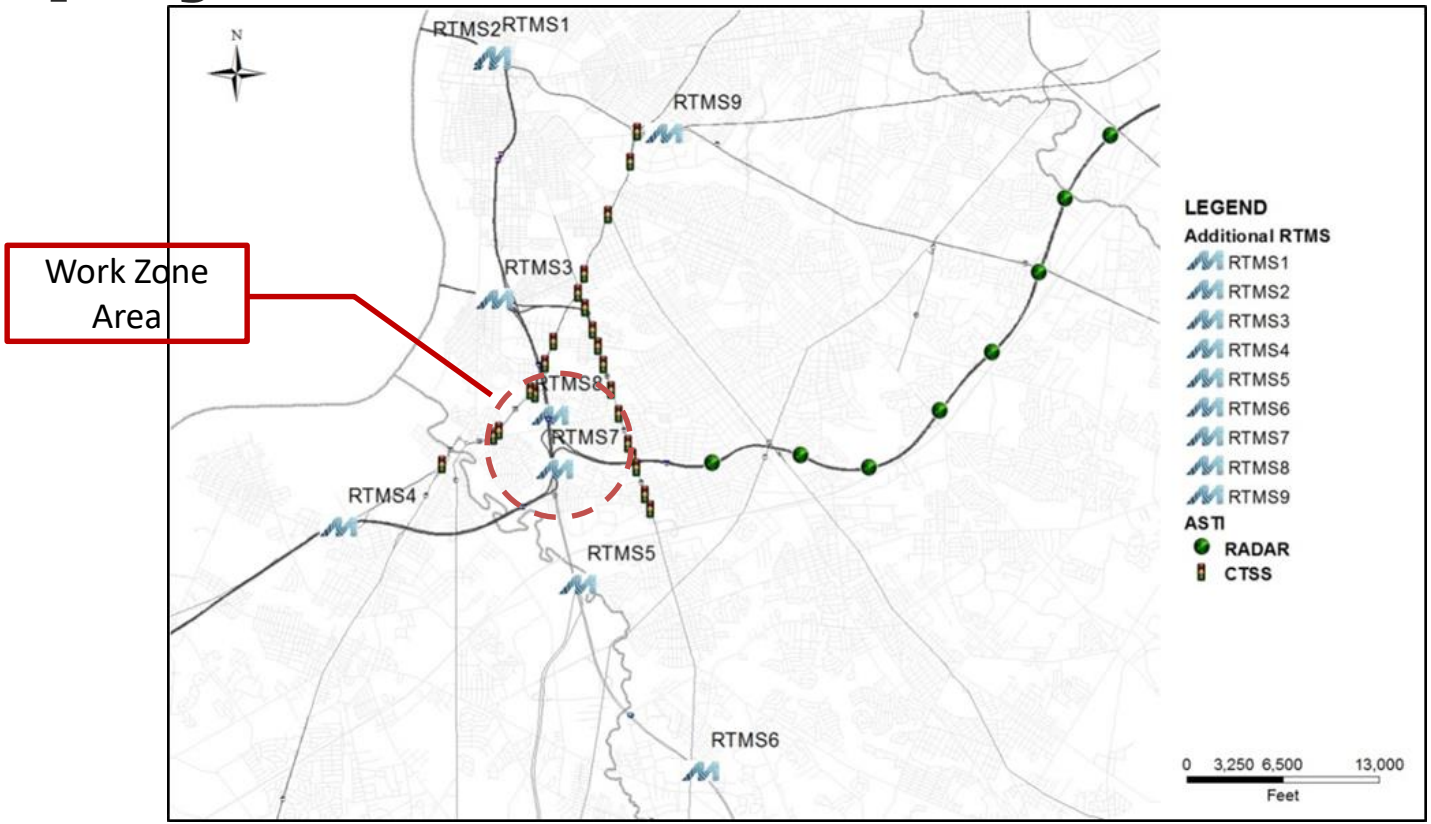
- Errors may occur due to the approximation applied under low market penetrations of Bluetooth devices.
- Need more time and efforts for model calibration due to a case-by-case basis when it comes to implementation.
- Engineering judgment of network travel pattern can affect the accuracy of the model.

Proof-of-Concept Test for I-295 Work Zone Monitoring

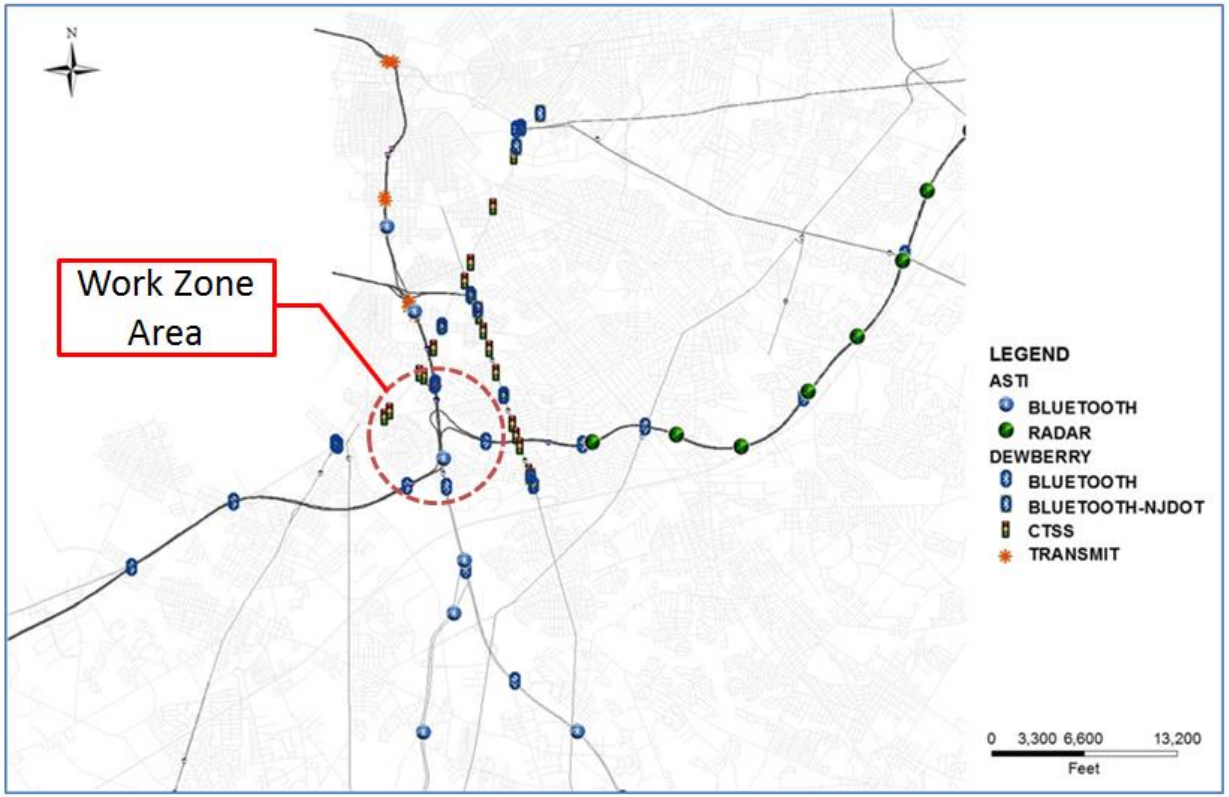
- The proposed framework will be tested for I-295 Direct Connect roadway reconfiguration work zone.
- ITS device installation is currently in progress, while experiencing delays.



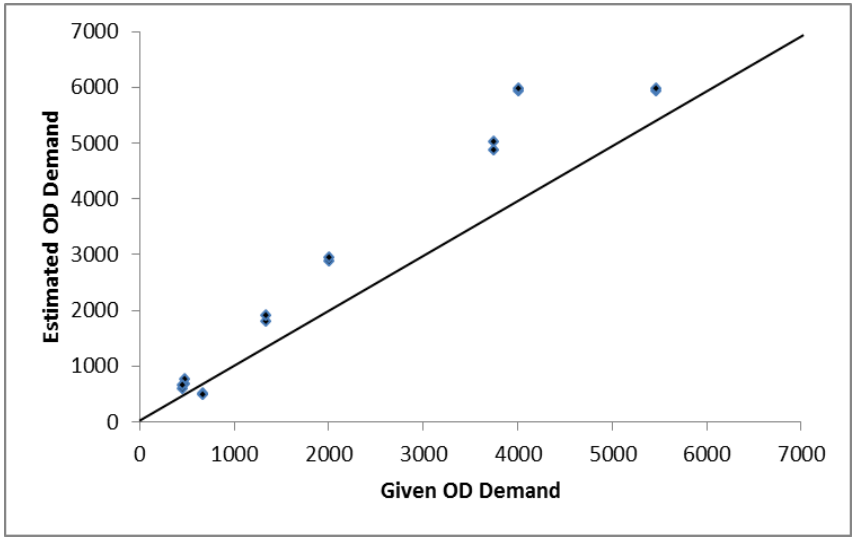
Deployment Plan of RTMS's



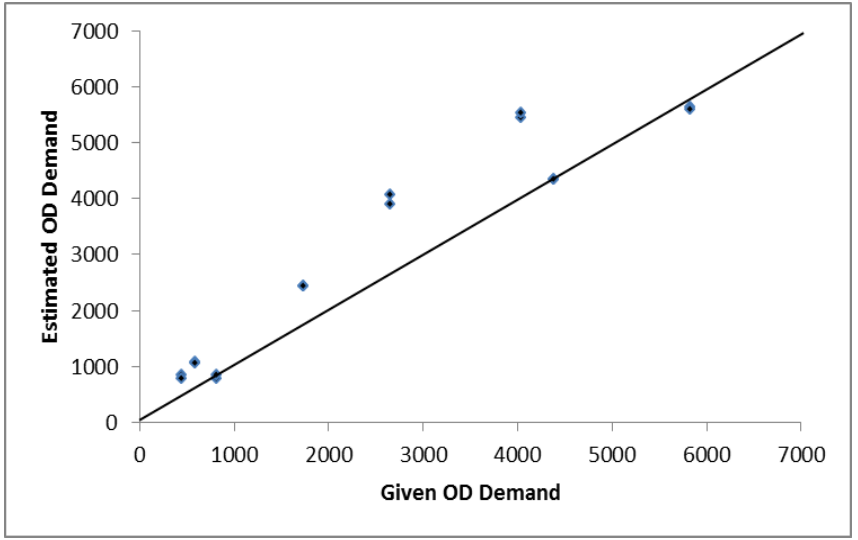
Deployment Plan of Bluetooth Readers



Preliminary Results from Simulation Test Bed



O-D demand estimated for 3:00 to 4:00pm



O-D demand estimated for 4:00 to 5:00pm

- Each point represents one pair of O-D demand
- Kalman Filter was not yet implemented in the test

Future Study

- Modular enhancement (e.g. route travel time estimation based on partly knowledge of the route travel time)
- Application upon receipt of the field data.
- Comprehensive evaluation of the estimation results.
- Investigation its application under congested network.

THANK YOU FOR YOUR ATTENTION

QUESTIONS?