EXPLORING MULTI-SOURCE TRAFFIC SENSOR DATA FOR MULTI-MODAL ARTERIAL PERFORMANCE MEASUREMENT

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Smart Transportation Lab
Shaping the future of ITS

ABSTRACT

With the emerging development of Intelligent Transportation System (ITS) technologies, surface-transportation data can now be collected by a wide variety of ITS traffic detectors, including Bluetooth detectors, automatic vehicle location (AVL) devices, inductive loop detectors, and radar-based detectors. It has been challenging to take full advantage of multi-source ITS data by enabling them to exchange information with each other to compensate for their various disadvantages. This poster is focused on big data applications of multi-source traffic data in Tucson, Arizona. The City of Tucson is a dedicated traffic research living lab for the University of Arizona to develop data-driven applications to improve arterial performance (e.g. traffic signal timing optimization), transit system, and pedestrian and bicyclist environments.

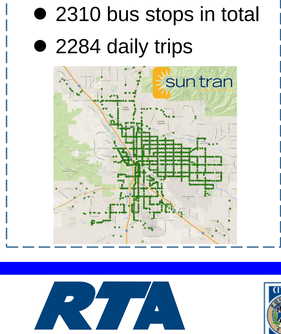
Data Source and Collection

Integrated Data

- Open Big Data / Open Research
- Integrated Solutions for the Region

Video-based Sensors

- Around 1,000 sensors in Tucson



Probe Vehicle Data

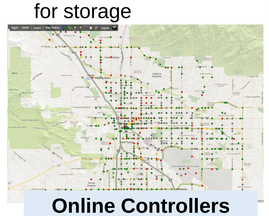
- Provide through and turning movement trajectories
- Use trajectories to estimate travel times


Through

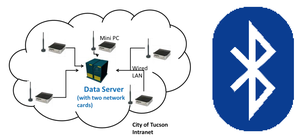

Turning

Event-based Data

- About 1.5 GB per day for storage


Online Controllers

Bluetooth Data



GTFS Data

General Transit Feed Specification (GTFS)

- 49 routes in total
- 2310 bus stops in total
- 2284 daily trips

Data Quality and Visualization

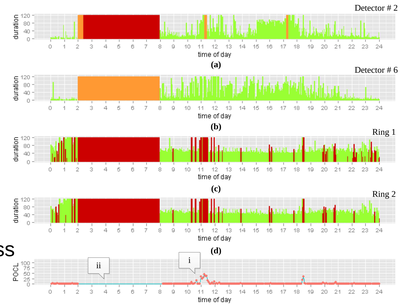
Diagnosing Event-based Data

Data quality control criteria includes:

- Phase always-on
- Unpaired on and off
- Long duration

Two-step procedure is proposed to diagnose missing data:

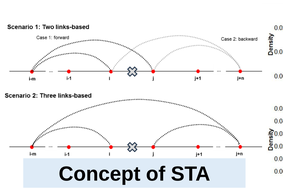
- Check data archiving statues
- Check data completeness for each interaction



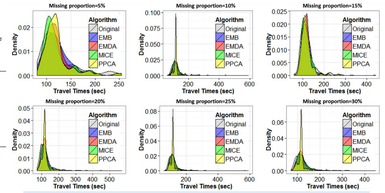
Mitigating Missing Data of Bluetooth

An innovative two-step approach is proposed:

- A spatial traversal algorithm (STA) is introduced to maximize the travel time sample size.
- Four different missing data imputation algorithms are used to obtain a complete dataset for aggregated link travel times.

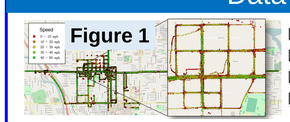


Concept of STA

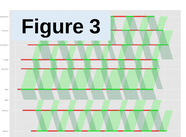


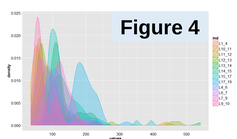
Density Distribution Validation

Data Visualization



- Fig. 1 Probe Vehicle Trajectories
- Fig. 2 Scheduled & Actual Bus Arrival Time
- Fig. 3 Real-time signal Timing Bandwidth
- Fig. 4 Distribution of BT-based Travel Time



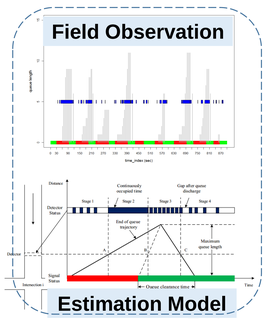


Multi-Source Data Applications

Real-Time Signal Timing Data & Video-based Sensors

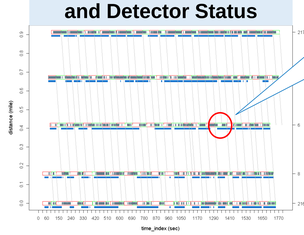
➢ Real-Time Queue Length Estimation

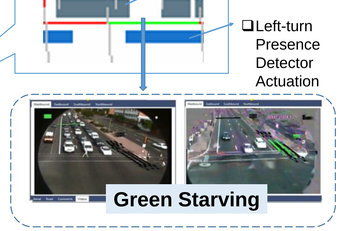
- The vehicular queue lengths and delay can estimated using the proposed methods with combining advance signal channel detectors with the information from upstream intersections.

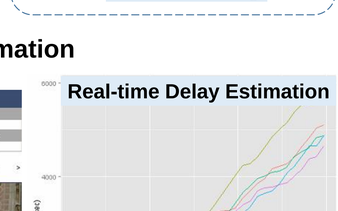


➢ Bandwidth Utilization

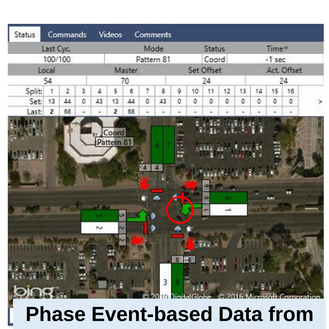
Real-time Signal Timing and Detector Status







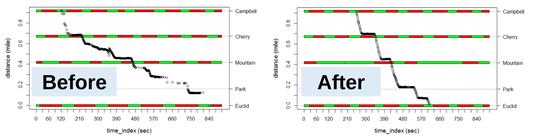
➢ Real-Time Delay Estimation



Real-Time Signal Timing Data & Video-based Sensors & Bluetooth Readers

➢ Signal Timing Optimization

- After optimizing signal timing in Speedway(Campbell-Euclid) based on multi-source data, travel time was reduced by 51%, speed was increased by 102% and the number of stops was decreased by 41%.



➢ Benefit Analysis

Assumptions:
- Time value = **$10**/hour
- Vehicle occupancy = **1.2** person/vehicle

Segment traffic throughput:
- Average through volume = **1457** veh/h

Cost per hour = volume * vehicle occupancy * time value * travel time improvement

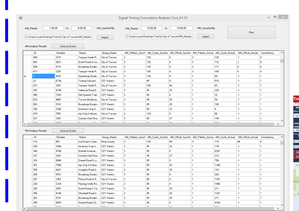
✓ One Peak-Hour Cost Saving:
$ 1,224

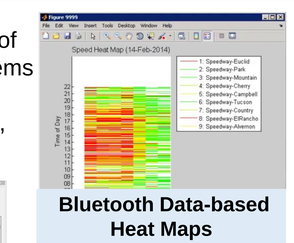
✓ Monthly Cost Saving (20 weekdays):
$ 24,480

✓ Annual Cost Saving (251 work days in 2015):
$ 307,22

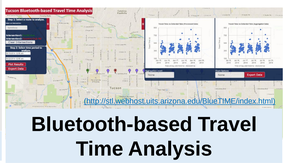
System Development

- We developed a series of practical tools and systems to collect, analyze and utilize multi-source data, including:


Traffic Signal Diagnosis



Bluetooth Data-based Heat Maps



Bluetooth-based Travel Time Analysis

Acknowledgment: the authors are thankful for the support of Arizona Department of Transportation (ADOT), Pima Association of Governments (PAG), Regional Transportation Authority (RTA), the City of Tucson, Metropia and other local partners. We would also like to thank the contribution from the Smart Transportation Lab members, especially Chengchuan An, Shu Yang and Ming Chen.