Enhanced Traffic Signal Performance Measures

Background

The Pooled Fund Project TPF-5(258) led by Indiana and with participation from FHWA, California, Georgia, Minnesota, Mississippi, New Hampshire, Pennsylvania, Texas, Utah, Wisconsin, and City of Chicago has produced the following technical reports:

- Performance Measures for Traffic Signal Systems: An Outcome-Oriented Approach. http://dx.doi.org/10.5703/1288284315333 [1]
- Integrating Traffic Signal Performance Measures into Agency Business Processes. http://dx.doi.org/10.5703/1288284316063 [2]

The current project end date is December 31, 2017. During the April team telecom, participating states expressed interest in developing a second phase of the project to address two needs that have emerged:

1. **Traffic Signal Data Logger Update**: Update the data logger specification to provide secure file transfer, incorporate new enumerations that have emerged, and logging new connected vehicle messages.
2. **Probe Data**: Current probe data tools are focused on freeway data. There is a need to build upon the work of Indiana and Pennsylvania DOTs to develop methodologies and tools for using high resolution vehicle trajectory data to compute traffic signal performance measures.

Both of these initiatives would complement the past work the multi-state team has done in the area of traffic signal performance measures.

Research Needs -Traffic Signal Data Logger Update

The current generation of traffic signal performance measures are based upon enumerations defined in

- Indiana Traffic Signal Hi Resolution Data Logger Enumerations. http://dx.doi.org/10.4231/K4RN35SH [3]

Those enumerations were published in 2012 in collaboration with representatives from Econolite, Peek and Siemens. Since their initial publication, several additional vendors have embraced this concept. With participation from additional vendors, many good suggestions have been submitted for additional event enumerations, updating the transport protocol security, and providing a mechanism for logging SPAT, and other connected vehicle messages. It is anticipated that a similar process will be used again where all vendors (there is a larger pool of interested participants in 2017) will be invited to participate in workshops. The initial workshop will focus on identifying new enumerations needed, as well as identifying enumerations that may be candidates to sunset. Incorporating SPAT and other connected vehicle data elements in this discussion will provide an opportunity ensure there is consistency in connected data elements from DSRC through the traffic signal data logger.

Indiana will take the lead in preparing draft documents, vendors and participating agencies will have opportunities to provide feedback, and the participating states will finalize the updated specification. A key component of this process is ensuring the specification is acceptable to multiple states on the team and they are committed to procuring controllers with the updated data logger specification. It is anticipated that the first year of the pooled fund study would be devoted to updating the specification, and the second and third years would be focused on developing and documenting use cases that exercise the updated specification.

Research Needs -Probe Data

Private sector probe data has been used extensively for characterizing freeway conditions [4] and with improved penetration rates can be applied to busy signalized arterials (Figure 1) [5]. However, private sector probe data has relatively large segment lengths (about 1 mile) that often span multiple signals. Furthermore, segment breaks typically occur at signalized intersections.

Indiana and Utah have explored a technique where the raw GPS trajectory data can be analyzed to directly compute control delay (Figure 2). However, due to the huge volume of raw GPS data and potential privacy issues, it is important to develop a method for agency interfaces with private sector data providers that avoids massive database requirements and does not introduce privacy concerns associated with capturing raw GPS points that may include origin at residences, work destination, or other intermediate stops. Initial concepts explored by Indiana and Utah found that virtual detection zones (Figure 3) could be defined as the interface mechanism for agencies to request travel time records. There is a need to extend this methodology into a formal framework for government agency specifications to commercial probe data vendors for a method of providing true intersection control delay, without encountering privacy issues or large data management issues, because no actual trajectory data would need to be transferred to agency computers.

Funding Request

$90,000 per state ($30,000 per year for three years) from participating states.

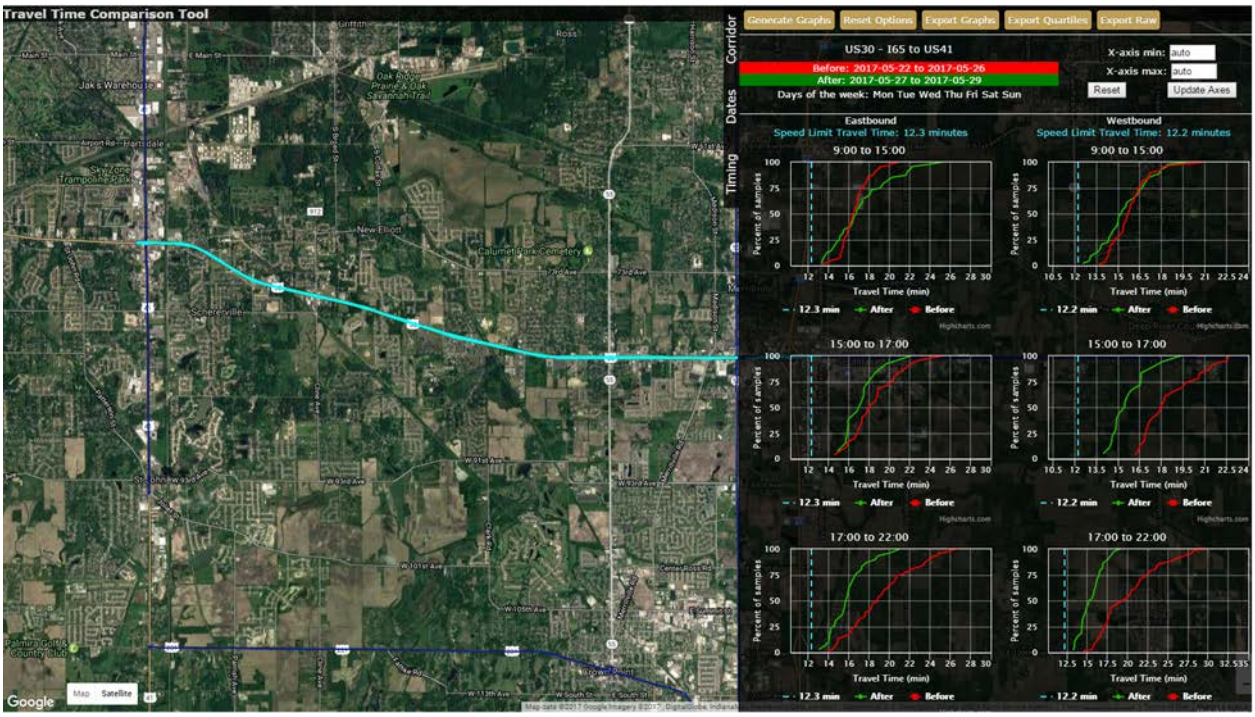

Figure 1. Arterial travel time dashboard comparing two date ranges using segment speeds.

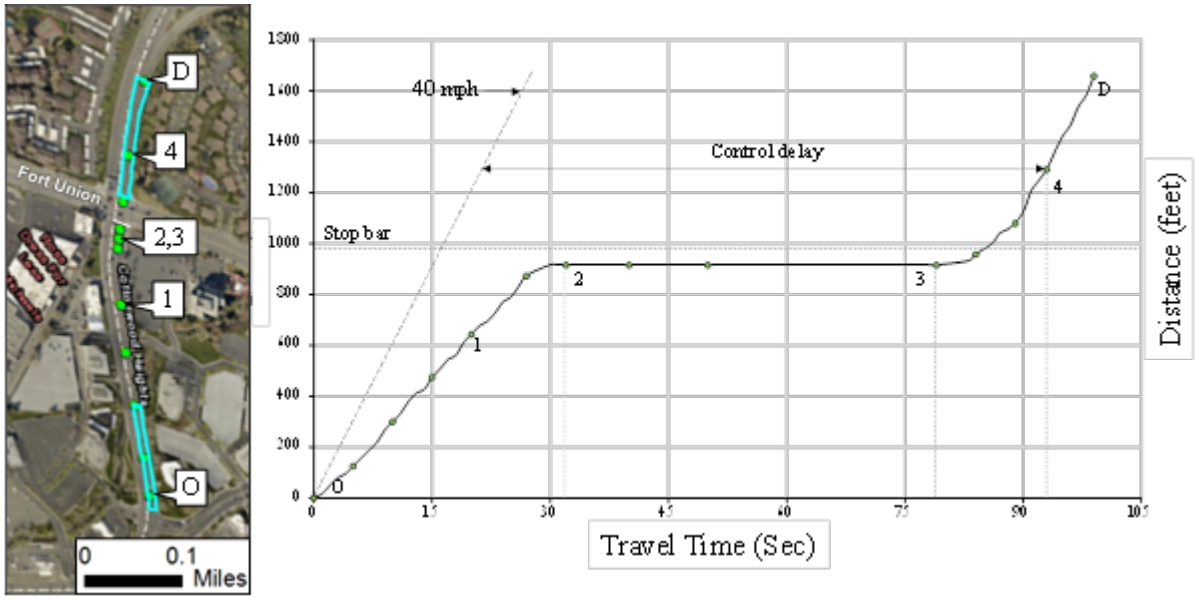

Figure 3. Computing control delay using vehicle trajectory data.

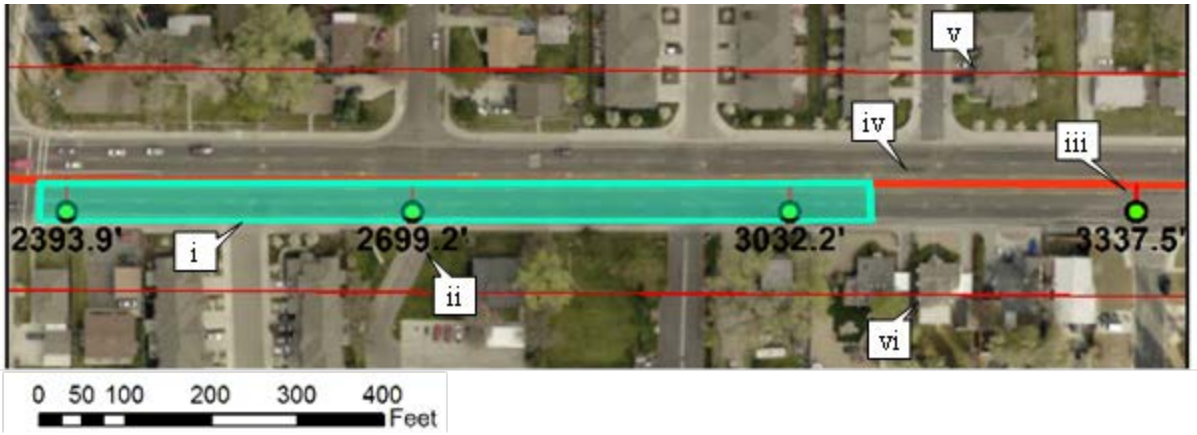

Figure 2. Selection and linear referencing of probe data waypoints.

References

1. Day, C. M., D. M. Bullock, H. Li, S. M. Remias, A. M. Hainen, R. S. Freije, A. L. Stevens, J. R. Sturdevant, and T. M. Brennan. Performance Measures for Traffic Signal Systems: An Outcome-Oriented Approach. Purdue University, West Lafayette, Indiana, 2014. http://dx.doi.org/10.5703/1288284315333
2. Day, C. M., D. M. Bullock, H. Li, S. Lavrenz, W. B. Smith, and J. R. Sturdevant. Integrating Traffic Signal Performance Measures into Agency Business Processes. Purdue University, West Lafayette, Indiana, 2015. http://dx.doi.org/10.5703/1288284316063
3. Sturdevant, J. R., T. Overman, E. Raamot, R. Deer, D. Miller, D. M. Bullock, C. M. Day, T. M. Brennan, H. Li, A. Hainen, and S. M. Remias. Indiana Traffic Signal Hi Resolution Data Logger Enumerations. , Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2012. http://dx.doi.org/10.4231/K4RN35SH
4. Day, C., Remias, S., Li, H., Mekker, M., McNamara, M., Cox, E., Horton, D., & Bullock, D. (2014). 2013–2014 Indiana Mobility Report: Full Version (Joint Transportation Research Program Indiana Mobility Reports). West Lafayette, IN: Purdue University. http://dx.doi.org/10.5703/1288284315508
5. Krohn, Drake W., L. Rymarcsuk, J.K. Mathew, C.M. Day, H. Li, A. Patel, D. Farley, and D.M. Bullock, “Outcome Assessment using Connected Vehicle Data to Justify Signal Investments to Decision Makers,” Transportation Research Board, August 1, 2016, Paper No. 17-00314.
6. Li., H., R. Sakhare, J.K. Mathew, J. Mackey, D.M. Bullock, “Estimating Intersection Control Delay using High Fidelity Commercial Probe Vehicle Trajectory Data, ” Submitted to Transportation Research Board, August 1, 2017, Paper No. 18-00345