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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Traffic Operations

MAY 2023

Project Title:
Traffic Signal Systems Operations and Management

Task Number: 3272

Start Date: January 1, 2018

Completion Date: June 30, 2023

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Enhanced Traffic Signal Performance Measures - Pooled Fund Study- TPF-5(377)

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WHAT IS THE NEED?

This is pooled fund study (PFS) led by Indiana Department of Transportation (DOT) and with participation from Federal Highway Administration and State DOTs from California, Georgia, Minnesota, Mississippi, New Hampshire, Pennsylvania, Texas, Utah, and Wisconsin. This group expressed interest in developing the project to address two needs that had 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 initiatives would complement the previous work the multi-state team had done in traffic signal performance measures.

WHAT ARE WE DOING?

This is a PFS oriented toward traffic signal operations and management that would engage a broad cross section of agencies on the leading edge of active traffic signal management. This study is a multi-agency team charged with developing modern management practices for traffic signal operations. All participating agencies provide feedback and participate in finalizing the updated specification. A key component of this process is ensuring the specification is acceptable to multiple states and they are committed to procuring controllers with the updated data logger specification.

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WHAT IS OUR GOAL?

The project will address the following initiatives that complement and expand on the past work the multi-state team has done around traffic signal performance measures:

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.

WHAT IS THE BENEFIT?

The benefit is that this will provide guidelines for Caltrans and other agencies to use to improve signal system operations. The intent is that agencies adopting the resulting recommendations will achieve a 10-15% reduction on motorist delay and emissions.

WHAT IS THE PROGRESS TO DATE?

Pooled Fund Study Solicitation to expand Enhanced Traffic Signal Performance Measures was posted on November 15, 2022. This will continue the work of the current pooled fund project: https://www.pooledfund.org/Details/Solicitation/1589

As of March 2023, the following papers have been published as a results of this Pooled Fund Effort:

- The enhanced enumerations document has been published: https://docs.lib.purdue.edu/jtrpdata/4/
- Li, H., A. M. Hainen, J. R. Sturdevant, T. Atkison, S. Talukder, J. K. Mathew, D. M. Bullock, D. Nelson, D. M. Maas, Jr., J. Fink, and T. Stiles. Indiana Traffic Signal Hi Resolution Data Logger Enumerations. Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2019. https://doi.org/10.5703/1288284316998
- Mathew, Jijo, H. Li, and D.M. Bullock, "Using Stochastic Variation of Cyclic Green Distributions to Populate SAE J2735 Message Confidence Values along a Signalized Corridor", Transportation Research Record: Journal of the Transportation Research Board, Transportation Research Board of the National Academies, Washington, D.C., 2020. https://doi.org/10.1177/0361198120929337
- Desai, J., H. Li, J.K. Mathew, Y. Cheng, A. Habib, and D.M. Bullock, "Correlating Hard-Braking Activity with Crash Occurrences on Interstate Construction Projects in Indiana." Journal of Big Data Analytics in Transportation, October 2020. https://doi.org/10.1007/s42421-020-00024-x
- Mathew, J.K., J.C. Desai, R.S. Sakhare, W. Kim, H. Li, and D.M. Bullock, "Big Data Applications for Managing Roadways," ITE Journal, Institute of Transportation Engineers, February 2021. https://www.researchgate.net/publication/348945735_Big_Data_Applications_for_Managing_Roadways
- Sakhare, R. , Desai, J. , Mathew, J. , McGregor, J. and Bullock, D. (2021) Evaluation of the Impact of Presence Lighting and Digital Speed Limit Trailers on Interstate Speeds in Indiana Work Zones. Journal of Transportation Technologies, 11, 157-167. https://doi.org/10.4236/jtts.2021.112010
- Hunter, M., Saldivar-Carranza, E., Desai, Mathew, J.K., Li, H., and Bullock, D. "A Proactive Approach to Evaluating Intersection Safety Using Hard-Braking Data," Journal of Big Data Analytics in Transportation. (2021). https://doi.org/10.1007/s42421-021-00039-y
- Saldivar-Carranza E., H. Li, J. Mathew, M. Hunter, J. Sturdevant, D.M. Bullock, "Deriving Operational Traffic Signal Performance Measures from Vehicle Trajectory Data," Transportation Research Record: Journal of the Transportation Research Board, Transportation Research Board of the National Academies, Washington, D.C., 2020. https://doi.org/10.1177%2F03611981211006725
- Hunter, Margaret; Mathew, Jijo K.; Cox, Ed;

Blackwell, Matthew; and Bullock, Darcy M., "Estimation of Connected Vehicle Penetration Rate on Indiana Roadways" (2021). JTRP Affiliated Reports. Paper 37. https://doi.org/10.5703/1288284317343

Saldivar-Carranza, E.D., Hunter, M., Li, H., Mathew, J., and Bullock, D.M. "Longitudinal Performance Assessment of Traffic Signal System Impacted by Long-term Interstate Construction Diversion using Connected Vehicle Data." Journal of Transportation Technologies, 11, 644-659. (2021) https://doi.org/10.4236/jtts.2021.114040

Saldivar-Carranza, E.D., Li, H. and Bullock, D.M. "Diverging Diamond Interchange Performance Measures using Connected Vehicle Data." Journal of Transportation Technologies, 11, 628-643. (2021) https://doi.org/10.4236/jtts.2021.114039

Hunter, M., Mathew, J.K., Li, H. and Bullock, D.M. "Estimation of Connected Vehicle Penetration on US Roads in Indiana, Ohio, and Pennsylvania." Journal of Transportation Technologies, 11, 597-610. (2021) https://doi.org/10.4236/jtts.2021.114037

Saldivar-Carranza, E., Mathew, J.K., Li, H. and Bullock, D.M. (2022) Roundabout Performance Analysis Using Connected Vehicle Data. Journal of Transportation Technologies, 12, 42-58. https://doi.org/10.4236/jtts.2022.121003

Saldivar-Carranza, E. , Li, H. , Mathew, J. , Fisher, C. and Bullock, D. (2022) Signalized Corridor Timing Plan Change Assessment Using Connected Vehicle Data. Journal of Transportation Technologies, 12, 310-322. https://doi.org/10.4236/jtts.2022.123019

Sakhare, R. , Hunter, M. , Mukai, J. , Li, H. and Bullock, D. (2022) Truck and Passenger Car Connected Vehicle Penetration on Indiana Roadways. Journal of Transportation Technologies, 12, 578-599. https://doi.org/10.4236/jtts.2022.124034

Nafakh, A. , Bullock, D. and Fricker, J. (2022) A Quantitative Approach for Timing the Pedestrian Walk Interval. Journal of Transportation Technologies, 12, 732-743. https://doi.org/10.4236/jtts.2022.124042

Mathew, J. , Li, H. , Saldivar-Carrranza, E. , Duffy, M. and Bullock, D. (2022) Integrated Performance Measures for Bus Rapid Transit System and Traffic Signal Systems Using Trajectory Data. Journal of Transportation Technologies, 12, 833-860. https://doi.org/10.4236/jtts.2022.124046

Saldivar-Carranza, E. , Li, H. , Taylor, M. and Bullock, D. (2022) Continuous Flow Intersection Performance Measures Using Connected Vehicle Data. Journal of Transportation Technologies, 12, 861-875. https://doi.org/10.4236/jtts.2022.124047
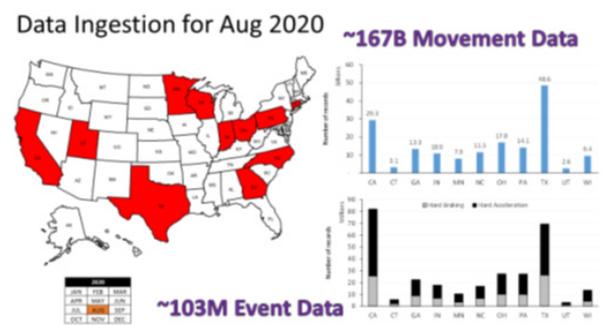
IMAGES

Image 1: Data ingestion map of 167 billion vehicle records from 11 states from August 2020
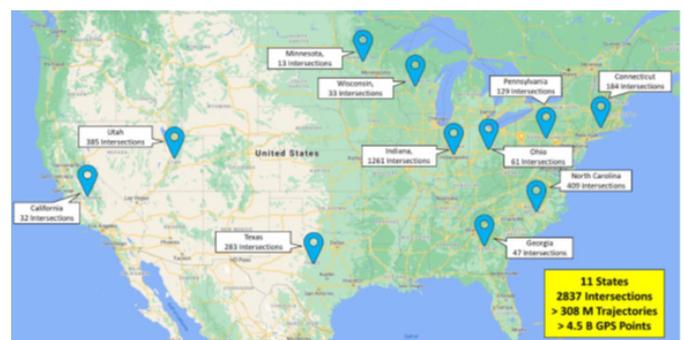
Image 2: Map summarizing the corridor analyses completed by the research team

Image 3: Day 1 of Panel Meeting held in Columbus, Ohio on April 26-28, 2022

Image 4: Tour of Ohio Transportation Research Center (TRC)