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

Research Results

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

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Traffic Operations

March 2026

Project Title: Traffic Signal Systems Operations and Management

Task Number: 3272

Start Date: January 1, 2018

Completion Date: June 30, 2023

Task Manager:

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WHAT WAS THE NEED?

This is pooled fund study (PFS) led by Indiana DOT and with participation from FHWA and State Department of Transportations 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 logged 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 WAS OUR GOAL?

The goal was to enhance and expand the Traffic Signal Performance Measures that were developed under Pooled Fund Project TPF-5(258) and adopted under EDC-4. There was 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 complemented the past work the multi-state team has done in the area of traffic signal performance measures.

WHAT DID WE DO?

The following papers have been published as a result of this

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system.

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#:~:text=departments%20of%20transportation%20(DOTs,at%20a%20lower%20cost
- 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. doi: 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. doi: 10.4236/jtts.2022.124042
- Mathew, J. , Li, H. , Saldivar-Carranza, 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. doi: 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://www.scirp.org/journal/paperinformation?paperid=120684
- Saldivar-Carranza, E. D., Li, H., Mathew, J. K., Gayen, S., Malackowski, H., & Bullock, D. M. (2023). Reporting framework for arterial-level traffic signal performance measures estimated from connected vehicle trajectory data. West Lafayette, IN: Purdue University. https://doi.org/10.5703/1288284317617

WHAT WAS THE OUTCOME?

- Traffic signal vendors begin deploying the new enumerations in 2020.
- Inrix has now implemented the Purdue Probe Diagram developed in this project in their commercial signal analytic
- Deployment of trajectory-based performance measures, based upon techniques described in TRBAM 21-01472, in several states.

WHAT IS THE BENEFIT?

The benefit was to 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 delays and emissions.

Enhanced Traffic Signal Performance Measures pooled fund study develop a consensus on operational standards of performance, define a central management model, and provide management principles for using a central system to identify when and where resources are most needed to maximize return on investment. The development of successful performance measures decrease the incorrect usage of traffic signals and increases the overall system reliability.

LEARN MORE

You can view the pooled fund website here:

https://pooledfund.org/Details/Study/629

IMAGES

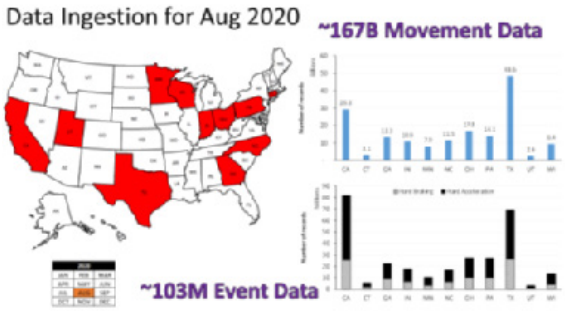

Image 1: Data ingestion map of 167 billion vehicle records from 11 states from August 2020

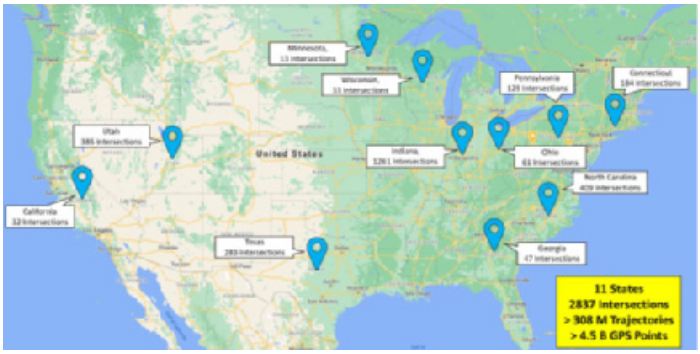

Image 2: Map summarizing the corridor analyses completed by the research team