DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Hybrid Data Implementation

Discover an integrated data fusion methodology for Daily Vehicle Hours of Delay (DVHD) that can be estimated in multiple ways with a flexible mix of data, including both traditional sensor data as well as third-party, probe-based data.

Traffic Operations

MARCH 2021

Project Title:
Alternate Data Detections

Task Number: 3643

Start Date: September 18, 2018

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WHAT WAS THE NEED?

California Department of Transportation (Caltrans) relies on over 40,000 individual vehicle detection zones to provide information on vehicle data such as volume, occupancy, and speed. This information is in turn used for various system operations and management activities. Gigabytes of data every day is collected and used to provide support for traffic management, real-time traveler information, and system performance monitoring. These functions are vital in supporting Caltrans mission, vision, and goals – Goal 1: Safety and Health, Goal 2: Stewardship and Efficiency, Goal 3: Sustainability, Livability and Economy, and Goal 4: System Performance.

Operating this vast detection system requires extensive resources in the form of engineering and maintenance support along with millions in capital funds to keep them running. Recently, Caltrans programmed over $150 million in State Highway Operation and Protection Program funds to address failed or failing detection stations across the state.

With the increased availability of third-party, probe-based data to provide some of the same data currently obtained through existing detection systems, there should be a renewed effort to look at how those data sources may be able to supplant or augment existing data collection methods. Most third-party data providers can now provide detailed travel time or speed data on any route. In addition, data samples will continue to grow as more cellular devices are used.

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To properly integrate this data into the existing reporting platform and into deliverables such as the Mobility Performance Report (MPR), research is needed to determine how to incorporate the third-party data to provide both real-time and historical performance metrics. This will require evaluating and modifying algorithms currently used in the Caltrans Performance Measurement System (PeMS).

WHAT WAS OUR GOAL?

One objective of this project is to develop a new reporting methodology for Daily Vehicle Hours of Delay (DVHD) that can be estimated in multiple ways with a flexible mix of data, including both traditional sensor data as well as third-party, probe-based data. In addition, this project will determine required data levels to achieve satisfactory DVHD reports and propose a strategy for including DVHD in PeMS.

WHAT DID WE DO?

- Assemble a survey of commercial forms of third-party data and work with Caltrans to identify what is most relevant to the needs of the existing Caltrans data pipeline and PeMS. Investigate existing methods for data fusion, standards for mobile data, and the panoply of available products.
- Define a reporting methodology for DVHD and algorithms to estimate it using a flexible mix of third-party probe data and standard vehicle detection.
- Review the key roles and usage of physical, point-based data (such as that from loops, radar, etc.) in the Caltrans data pipeline including PeMS, and propose a strategy for more efficient collection of point-based data.
- Evaluate emerging opportunities for using third-party data to improve coverage of existing Caltrans infrastructure.
- Propose a strategy for incorporating third-party data into the Caltrans data pipeline including PeMS, identifying key challenges, and alternative solutions. Highlight key considerations for a future procurement strategy when defining data requirements, data quality and data ownership.

WHAT WAS THE OUTCOME?

Based on the analysis in this report, the recommended Vehicle Hour Delay (VHD) estimation method depends on the infrastructure type and the data available. Recommendations are summarized in below table. For freeway mainlines, the best performance was achieved with the hybrid calculation. For HOV lanes, traditional traffic sensing methods must be used until third-party data become available that offer precision to reliably distinguish High Occupancy Vehicle (HOV) lanes from mainline lanes. For connectors, good performance was obtained using third-party data combined with the traditional calculation. For ramps and arterials, further work is required.

There are four main methods that were compared for estimating VHD:

- Traditional data and calculation
  - Uses point-sensor data only
  - Calculates delay over long freeway segments
- 3rd party + traditional calculation
  - Only possible when spatial reference systems match
  - Uses point-sensor data for flows and third-party data for travel times
  - Calculates delay over one connector, or a long freeway segment
- Hybrid calculation
  - Required when spatial reference systems do not match
  - Uses point-sensor data for flows and third-party data for travel times
  - Divides long freeway segments into cells for greater accuracy
  - Applies traffic theory to accommodate the distance between point-sensors

- Adjustments for limited instrumentation
  - Uses rough estimates for flows and third-party data for travel times

WHAT IS THE BENEFIT?

A benefit of this project is to reduce the use of traditional vehicle detection systems thereby reducing maintenance cost, addressing sustainability and stewardship goals, while also limiting exposure of construction, maintenance, and operations personnel to traffic, thereby improving worker safety.

Additionally, third-party detection will provide broader coverage of the state routes to include those areas not currently monitored.

This will mean that performance measurement will be more comprehensive, and highlight needs in areas not previously captured. Overall, an integrated data fusion method will provide a more reliable and more complete data set that will enable more efficient and effective system performance monitoring and evaluation.

LEARN MORE

The final report will be posted to this website when available:

https://dot.ca.gov/programs/research-innovation-system-information/research-final-reports

IMAGES

Recommended Delay Calculation Method for Each Facility

	ML	HOV	Connectors	Ramps	Arterials
Traditional data and calculation		3rd party data not widely available			
3rd party + traditional calculation			Obtained good performance		
Hybrid calculation	Obtained best performance	Potential for the future			
No recommendation				Needs further work	Needs further work

Image 1: Based on the above table Caltrans and other DOTS can view their needs for purchasing 3rd party data or continue with their current infrastructure development, if the data is unavailable or inconclusive.

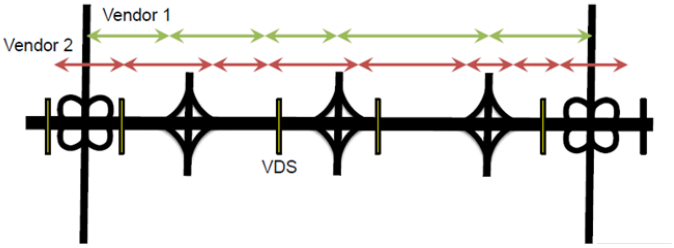

Image 2: Sample of Existing Point Sources and potential third-party data vendors.

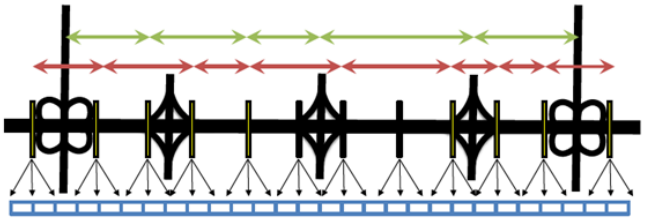

Image 3: Vector segments containing both existing Point Sources and potential third-party data vendors.

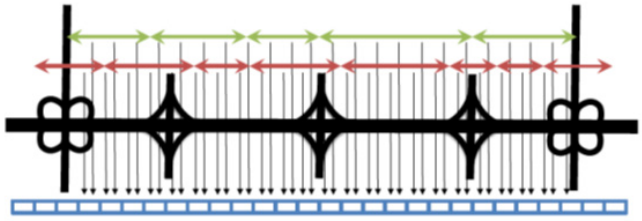

Image 4: Sample of hybrid data segmented distributions of all sources.

Image 5: Point Detector Placement Strategy. Select point detectors representing a single Fully Accounted Traffic Volume (FATV) group. Study impacts on performance measures of each detector group by removing the group

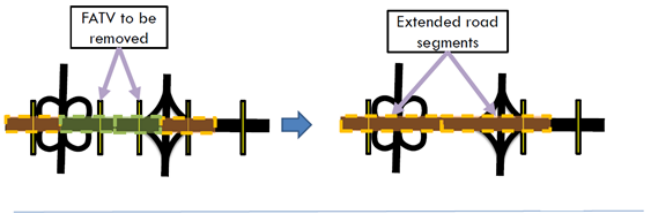

Image 6: Evaluation of Traditional Method: When detectors are removed, remaining VDS become responsible for longer road segments. use of flow and speed from available VDS

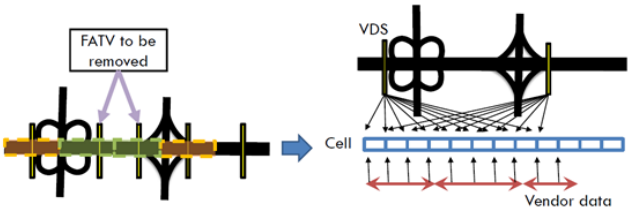

Image 7: Evaluation of Hybrid Method: Flow conflation from the available upstream and downstream VDS. Use of flow from VDS, and speed from third-party vendors