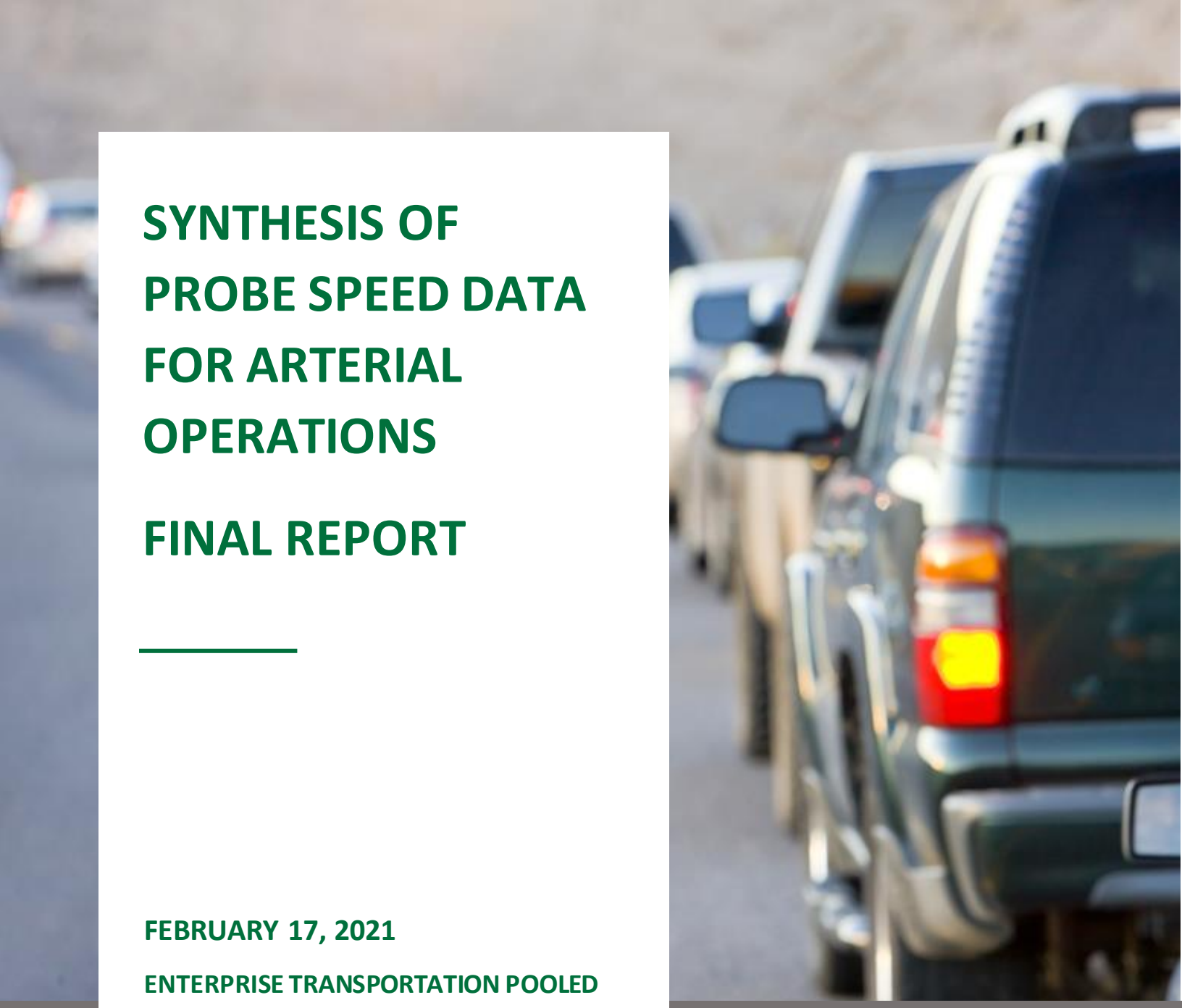

SYNTHESIS OF PROBE SPEED DATA FOR ARTERIAL OPERATIONS

FINAL REPORT

FEBRUARY 17, 2021

ENTERPRISE TRANSPORTATION POOLED FUND STUDY TPF-5(359)

Prepared by:
Athey Creek Consultants

ENTERPRISE

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16. Abstract Several third-party data providers offer traffic data for a variety of transportation purposes. Many agencies use third-party probe data for freeway operations and some agencies also use this data on arterials to assist in overall operations. For this effort, ENTERPRISE members were interested in understanding the uses and suitability of probe speed data on arterials to support deploying or expanding operational uses. The purpose of this research was to assist ENTERPRISE members in understanding the overall status and key uses of arterial probe speed data for operations (real-time or post analyses) from a select number of agencies. This project focused on vehicle probe speed data without the need for deploying and maintaining equipment in the right-of-way. It excludes probe speed data that requires additional roadside infrastructure (e.g. Bluetooth, non-intrusive detectors).			
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Project Champion

Steve Gault, Pennsylvania Department of Transportation, was the ENTERPRISE Project Champion for this effort. The Project Champion serves as the overall lead for the project.

ENTERPRISE Members

The ENTERPRISE Board consists of a representative from each of the following member entities of the program:

- Illinois Department of Transportation
- Iowa Department of Transportation
- Kansas Department of Transportation
- Michigan Department of Transportation
- Minnesota Department of Transportation
- Ontario Ministry of Transportation
- Pennsylvania Department of Transportation
- Texas Department of Transportation
- Wisconsin Department of Transportation

Project Participants

ENTERPRISE would like to acknowledge and thank the following transportation agencies and third-party probe data providers who offered input and participated in phone interviews for the project:

Transportation Agencies

- Georgia Department of Transportation
- Indiana Department of Transportation
- New Jersey Department of Transportation
- North Carolina Department of Transportation
- Ohio Department of Transportation
- Pennsylvania Department of Transportation
- Regional Transportation Commission of Southern Nevada
- Wisconsin Department of Transportation

Third-Party Probe Data Providers

- HERE Technologies
- INRIX
- TomTom

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1.0 Introduction

Several third-party data providers offer traffic data for a variety of transportation purposes. Many transportation agencies use third-party probe speed data for freeway operations, and there are multiple documented resources on the uses and accuracies of freeway probe speed data. For example, the Eastern Transportation Coalition began a Vehicle Probe Project in 2008, and the data has been subjected to rigorous validation for reliability. For this effort, as probe penetration has increased from freeways to arterials, the ENTERPRISE members were interested in understanding more about probe speed data on arterials to support deploying or expanding operational uses.

The purpose of this research was to assist ENTERPRISE members in understanding the uses and suitability of probe speed data for arterial operations (real-time or post analyses).

Research Purpose

To assist ENTERPRISE members in understanding the overall uses and suitability of probe speed for arterial operations (real-time or post analyses).

This project focused on vehicle probe speed data without the need for deploying and maintaining equipment in the right-of-way. It excludes probe speed data that requires additional roadside infrastructure (e.g. Bluetooth, non-intrusive detectors).

This report is not meant to be comprehensive, but rather highlight some uses of probe speed data for arterial operations. To gather information, phone interviews were conducted with the following selected transportation agencies and third-party data providers:

- Transportation Agencies
  - Georgia DOT (GDOT)
  - Indiana DOT (INDOT)
  - New Jersey DOT (NJDOT)
  - North Carolina DOT (NCDOT)
  - Ohio DOT (ODOT)
  - Pennsylvania DOT (PennDOT)
  - Regional Transportation Commission of Southern Nevada (RTC of Southern Nevada)
  - Wisconsin DOT (WisDOT)
- Third-Party Data Providers
  - HERE Technologies
  - INRIX
  - TomTom

The sections of the report include:

- 2.0 Project Approach – Describes the steps taken to complete this project.
- 3.0 Literature Search – Summarizes the research reports or evaluations of arterial probe data gathered through an online and Transportation Research International Documentation (TRID) database search, including previous ENTERPRISE related efforts.
- 4.0 Probe Speed Data for Arterial Operations: Transportation Agencies – Highlights information gathered from phone interviews with eight transportation agencies.

- 5.0 Probe Speed Data for Arterial Operations: Third-Party Probe Data Providers – Highlights information documented from phone interviews with three third-party data providers.
- 6.0 Summary – Summarizes overall findings of the use of probe speed data for arterial operations.
- Appendix A: Interview Notes - Transportation Agencies – Provides notes from phone interviews with transportation agencies.
- Appendix B: Interview Notes - Third-Party Probe Data Providers – Provides notes from phone interviews with third-party data providers.

2.0 Project Approach

The project first conducted initial research to identify transportation agencies using probe data for speeds on arterials. This included performing an online and TRID database search to highlight key findings from any recent research reports or evaluations of arterial probe speed data.

An online search also identified agencies using probe data for speeds on arterials and findings related to accuracy and uses of the data as well as third-party data providers that provide probe-based speed data on arterials.

The Transportation Management Center (TMC) Pooled Fund Study members were also contacted to identify additional transportation agencies using arterial probe speed data.

Next, the project conducted phone interviews with eight transportation agencies and three third-party probe data providers to gather information on arterial probe speed data identified through the online search and outreach to the TMC Pooled Fund Study.

The project conducted phone interviews with eight transportation agencies and three third-party probe data providers to gather information on arterial probe speed data.

Input from agencies aimed to understand:

- Reasons for procuring arterial probe speed data.
- Analytics platforms and uses of arterial probe speed data.
- Changes to transportation agency practices.
- Potential future uses with arterial probe speed data.
- Challenges with arterial probe speed data.

Input from third-party probe data providers aimed to understand:

- Availability and data sources of speed data on arterials.
- Data validation.
- Factors that might impact data accuracies.
- Data delivery and platforms.

To help ENTERPRISE members understand the overall status and uses of probe speed data for arterial operations, the last step of the project produced this document that summarizes the information gathered through the online search and phone interviews with transportation agencies and third-party probe data providers.

3.0 Literature Search

This section provides a summary of the research reports or evaluations of arterial probe data gathered through an online and TRID database search. Table 1 identifies the source and describes the focus of the study, analysis, or project, then highlights the result.

Following are selected findings from published resources summarized in the literature search. See Table 1 for additional details and a link to each publication.

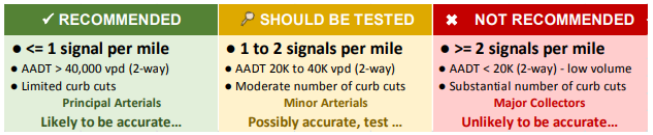
- Agency implementation of probe speed data for arterials:
    - Seven agencies were found that utilized third-party speed data for arterials: New Jersey DOT, Pennsylvania DOT, Maryland DOT, Virginia DOT, North Carolina DOT, Colorado DOT, and Minnesota DOT.
- Third-party providers of arterial probe speed data used by agencies:
    - Three third-party vendors were identified as providing probe speed data for arterials: HERE Technologies, INRIX, and TomTom.
- Performance and agency application:
    - Probe data performance on arterials has improved over time, and data from three vendors (HERE Technologies, INRIX, and TomTom) evaluated through the Eastern Transportation Coalition has performed at a level suitable for planning and operational applications. (Vander Laan and Sharifi, 2019)
    - In Virginia, a proof of concept study that used probe vehicle speeds and annual average daily traffic (AADT) to develop and evaluate a method to rank arterial congestion bottlenecks was validated by an expert panel with field observations. (Zhau and Venkatanaravana, 2019)
- Conditions when arterial probe speed data works best:
    - Probe data works best on high-volume arterials that do not have super-dense access points and do not have over-saturated conditions. (Athey Creek Consultants, 2017)
    - Increased volume, as measured by AADT, will increase accuracy or probe data all other factors being equal. (Young et al, 2015)
- Arterial roads present certain challenges for probe speed data:
    - Third-party probe data may be inconsistent on low-volume rural facilities. (Athey Creek Consultants, 2017)
    - Low-volume road are difficult to validate. (Vander Laan and Sharifi, 2019)
    - In some cases, cellular coverage by no or only one carrier in remote areas leaves gaps in the speed data. Areas of cellular dead zones with only one or two carriers providing coverage can also increase latency. (Athey Creek Consultants, 2017)

Table 1: Arterial Probe Speed Data Research Report, Study or Evaluation, Focus of the Source, and Result

Research Report, Study, or Evaluation	**Focus of Arterial Probe Speed Data Study/Analysis/Project** *Described in Source Reviewed*	**Result** *Described in Source Reviewed*
Source #1: Arterial Real-Time Traveler Information (Commercial Probe Data) (Short Elliott Hendrickson Inc., 2012)	**Minnesota DOT (MnDOT)** • Used a non-infrastructure-based approach to collect real-time traffic data on metro area arterials to provide real-time traffic information to motorists. • Real-time traffic data was collected on three additional, non-instrumented arterial routes for a period of up to 6 months. • Data was also collected on a major county arterial, since many of the major arterials in the metro area are county roads, and a rural interstate construction zone.	• Confirmed the accuracy and reliability of data collected by collecting data for 5 months on TH 100 to compare to existing traffic data collected from the in-place instrumentation by MnDOT's Regional Transportation Management Center (RTMC). • Demonstrated the accuracy and reliability of traffic non-infrastructure-based data collection on a major state arterial. • Showed INRIX can provide cost-effective travel time data for arterial routes that is comparable to data currently collected by MnDOT.
Source #2: Travel Time on Arterials and Rural Highways: State-of-the-Practice Synthesis on Arterial Data Collection Technology (Singer et al, 2013)	• Identified, reviewed, and synthesized information on current and potential future efforts in real-time travel time on arterials. • Discusses available and emerging arterial travel time (ATT) data sources as well as implementation considerations, advantages, and limitations of each including Bluetooth detectors, toll tag readers, in-pavement magnetic detectors, automatic license plate readers (ALPR), machine vision, connected vehicle, radar/microwave/LIDAR, inductive loops, crowdsourcing, and cell phone signal monitoring. Several implementations of ATT data collection are also discussed. • Reviews case studies in Chandler, AZ and St. Louis, MO in detail. • Provides information on current and emerging technologies available for ATT data collection. Summarizes current practice and provides a set of key considerations and questions to ask when planning and operating an ATT program.	• Although ATT data collection is a relatively new and rapidly evolving area, ATT can be successfully implemented when a project is properly planned and executed. Successful implementers have carefully considered project objectives and have provided detailed implementation plans. • Practitioners who focus on asking the right questions and heed lessons learned by colleagues will greatly increase the chances of a successful implementation.

Research Report, Study, or Evaluation	Focus of Arterial Probe Speed Data Study/Analysis/Project *Described in Source Reviewed*	Result *Described in Source Reviewed*
Source #3: Probe Vehicle Data Comparative Validation Study (Spasovic et al, 2013)	• Summarizes validation results of probe-vehicle speed data for a three week period in 2011 from INRIX, NAVTEQ, and TraffiCast DynamFlow™.	• All three technologies were within the acceptance limits for the average absolute speed error (AASE ≤ 10 mph) and the speed error bias (|SEB| ≤ 5 mph), with two exceptions. • It was observed that all of the studied technologies consistently overestimated the speed in the lowest speed bin (0-30 mph), and consistently underestimated the speed in the highest speed bin (> 60 mph). In the case of NAVTEQ, the speed bias in the [>60] mph speed bin was largely due to capped maximum reported speeds on the LIE and NSP (which were capped at the speed limit of 55 mph). • It was observed that all three evaluated technologies provided inaccurate (and therefore unreliable) estimates of speeds during incidents, especially on the weekends. This can be explained by an insufficient number of probes on weekends and during off-peak time periods (especially night time), as all three evaluated vendors obtain speed data largely from commercial vehicle fleets (which operate mostly on weekdays, during regular business hours).
Source #4: Arterial Speed Studies Based on Data from GPS Equipped Probe Vehicle (Puangprakhon and Narupiti, 2015)	**Journal of the Eastern Asia Society for Transportation Studies, Vol. 11** • Describes the implementation of Running Speed and Stopped Delay (RSSD) for investigating urban travel speed and discusses the limitation of error in speed associated from each GPS device to maintain advantages in travel speed estimation.	• Results from real observation traffic data on urban roadway confirm the accuracy of travel speed estimation is significantly improved when RSSD was employed as the estimation technique compared to baseline approach, particularly in highly congested areas.

Research Report, Study, or Evaluation	Focus of Arterial Probe Speed Data Study/Analysis/Project *Described in Source Reviewed*	Result *Described in Source Reviewed*

Source #5: I-95 Corridor Coalition Vehicle Probe Project: Validation of Arterial Probe Data (Young et al, 2015)	**New Jersey DOT, Pennsylvania DOT, Maryland DOT, Virginia DOT, and North Carolina DOT**
	• Collected traffic data and compared it to vehicle probe data on arterials from April 2013 to June 2014. Nine collection activities were carried out on 14 corridors encompassing 320 miles and included principal arterials, minor arterials, and major collectors.
	• Compared outsourced probe data to field collected Bluetooth Traffic Monitoring in 5-minute intervals.
	• Performed slowdown analysis to determine how accurate the probe data captured speed reductions of at least 10 to 15 miles/hour for 30 minutes or longer.
	• Assessed probe data's ability to accurately portray recurring congestion and reviewed daily probe and Bluetooth data on each segment.
		• Probe data performance correlated best with signal density.
		• Increased volume, as measured by AADT, will increase accuracy of probe data all other factors being equal.
		• Volume of traffic alone does not overcome the challenges of reporting accurate speed and travel time as a result of the complex stop and go motion of vehicles on arterials with dense signal spacing.
		• Issues:
		  ○ Probe data consistency errored toward faster speeds during congested periods.
		  ○ Whenever platoons of vehicles were consistently split by a red light resulting in two distinct speed profiles, probe data reported the faster of the two modes.
		  ○ Complex flow patterns common on signalized roadways cannot be observed in vehicle probe data.
		• Recommendations on the use of outsourced probe data for operations and performance measure purposes, considerations for future use, and future validation emphasis for probe data on arterial roadways:
		 

Source #6: Quality of Private Sector Travel Time Data on Arterials (Hu et al, 2016)	**Virginia DOT**
	• Evaluated the quality of private sector data on arterials using Bluetooth travel-time data as the ground truth. Conducted the evaluation from 2 perspectives:
	  ○ The ability to track real-time conditions.
	  ○ The ability to identify long-term traffic state changes.
		• The private sector data that was evaluated at 3 signalized arterials in Virginia was not suitable for real-time applications but could be used to measure long-term traffic state changes for performance measurement programs.

Research Report, Study, or Evaluation	Focus of Arterial Probe Speed Data Study/Analysis/Project *Described in Source Reviewed*	Result *Described in Source Reviewed*

Source #7: Implementation of Probe Data Performance Measures (Mathew et al, 2017)	**Pennsylvania DOT**
	• A 12-month Purdue University research study of 5 arterials and 2 incidents to evaluate and monitor traffic conditions by developing, implementing, and assessing three web dashboards and a data system that uses the commercial probe data licensed by Pennsylvania to produce arterial performance measures.
	• Traffic speed data was downloaded in real-time as well as historic data from INRIX to populate roadway speeds nominally at 1-mile spatial resolution. The dashboards mapped the speeds to 138 "super-critical" corridors in the five-county region of District 6 where investments were made including signal retiming and deployments of adaptive control, in various combinations.
	• Three tools were developed:
	  ○ An arterial travel time comparison tool, showing superimposed Cumulative Frequency Diagrams (CFDs) for a "before" period and an "after" period for the same corridor to facilitate before/after comparisons of travel time and travel time reliability.
	  ○ An arterial ranking tool, where travel times for several different corridors can be ranked according to travel time metrics that are normalized to account for differences in posted speed limits, as well as varying corridor lengths.
	  ○ An interactive arterial congestion ticker showing the distribution of speeds over time for a given corridor.
		• The travel times along the corridors were tabulated for before and after periods, and used to estimate changes in user costs, based on traffic volumes from corridor AADTs and heavy vehicle proportions, using basic assumptions of the value of time and other related factors. The data showed a user benefit in four of the five corridors, with a total user savings of $32 million.
		• The report provides further discussion of use of the tools for incidents where traffic is diverted from a parallel Interstate highway to the arterial. The resulting increases in travel time can be visualized using CFDs and the congestion ticker.
		• The use of the Interquartile Ratio (IQR), considering the variation between the 25th percentile and 75th percentile travel times, was proposed to account for variations in travel time due to signal timing and whether vehicles are arriving on red or green.

Research Report, Study, or Evaluation	Focus of Arterial Probe Speed Data Study/Analysis/Project *Described in Source Reviewed*	Result *Described in Source Reviewed*
Source #8: ENTERPRISE Assess Speed Data for Traffic Management Athey Creek Consultants, 2017)	**New Jersey DOT** • Transcom conducted an independent analysis of both HERE and INRIX data for the New Jersey DOT.	• It can take several days for the third-party data to re-calibrate after agencies adjust traffic signal timings.
	Virginia DOT • Conducted a significant number of studies to validate third-party data beginning in 2010, verifying data accuracy for all interstates, including at night and on rural interstates, and specific arterial routes. • WiFi and Bluetooth sensors were deployed to improve data comparisons and better consistency.	• Arterial characteristics that negatively impact the data: super-dense access points and over-saturated conditions.
	Colorado DOT • Conducted an online search and contacted agencies to gather information on the use of real-time third-party speed data in operations. • Analyzed findings to document and share common practices, challenges, and solutions. • Looked at how speed data could be combined with sensor data to address a more limited deployment of sensors.	• Third-party data is inconsistent on low-volume rural facilities. • In some cases, cellular coverage by only one carrier in remote areas leaves gaps in the speed data. • Areas of cellular dead zones with only one or two carriers providing coverage can increase latency.
Source #9: Improving the Identification and Characterization of Arterial Congestion Bottlenecks (Zhau and Venkatanaravana, 2019)	**Virginia DOT** • Proof of concept study that used widely available datasets such as probe vehicle speeds and (AADT to develop and evaluate one method for identifying and ranking traffic bottlenecks by studying impacts of different congestion threshold speeds and queue estimation methodologies. Conducted a case study on a Northern Virginia urban arterial network with 245 nodes. An expert panel validated the study results with field observations.	• Proposed a new sketch planning bottleneck analysis and ranking method for arterial intersections using a node-link approach that examines all intersection approaches. • Expert panel comments and feedback showed high confidence in the results. • Additional feedback from VDOT, the Virginia Office of Intermodal Planning and Investment (OIPI), and localities indicated their high interest in using this methodology because of the quantitative performance measures and the ability to support data-driven decision making.

Research Report, Study, or Evaluation	Focus of Arterial Probe Speed Data Study/Analysis/Project *Described in Source Reviewed*	Result *Described in Source Reviewed*
		• The intended use cases include improved planning, funding, and evaluation of bottleneck mitigation solutions across the region and state.

Source #10: I-95 Corridor Coalition Vehicle Probe Project: Update on Validation of Arterial Probe Data (Vander Laan and Sharifi, 2019)	**New Jersey DOT, Pennsylvania DOT, Maryland DOT, Virginia DOT, and North Carolina DOT**
	• Vendors: HERE, INRIX, and TomTom
	• Update to the original arterial report (Source #2: I-95 Corridor Coalition Vehicle Probe Project: Validation of Arterial Probe Data (Jul 2015)). 13 additional data collection activities from the initial analysis were carried out on 23 corridors between 2014-2018. The original arterial report conducted 9 data collection activities on 13 corridors.
		• Probe data performance on arterials has improved since the original analysis.
		• Operational performance on arterials improved dramatically and is less linked to AADT and signal density since the initial report.
		• All 3 vendors (HERE, INRIX, and TomTom) performed at a level suitable for planning and operational applications.
		• Signalized arterials have complex traffic patterns that cannot be fully captured the way vendors report the data. This has not changed since initial report.
		• Arterial roads still present certain challenges:
		  ○ Probe data consistently errors toward faster speeds during congested periods.
		  ○ Complex flow patterns common on signalized roadways cannot be observed with vehicle probe data.
		  ○ Low volume roads are difficult to validate.

4.0 Probe Speed Data for Arterial Operations: Transportation Agencies

Eight transportation agencies were interviewed between June and August 2020 to provide information on procurement of arterial probe speed data, arterial probe speed data and analytics platforms, use of probe speed data, challenges, and changed practices.

There were a few agencies interviewed that use **HERE** probe speed data, 1 agency that uses **TomTom** probe speed data, and 4 agencies that use **INRIX** probe speed data for arterials. The **RTC of Southern Nevada** does not purchase probe speed data from a third-party data provider for arterials. Probe data is gathered through GeoTab® that tracks their fleet vehicles (e.g. paratransit, vehicles used by staff daily) and via a mobile app used by RTC staff that provides GPS data/breadcrumbs. See Table 2.

The RTC of Southern Nevada does not purchase probe speed data from a third-party provider for arterials. Probe speed data is gathered through GeoTab® that tracks their fleet vehicles and via a mobile app used by RTC staff that provides GPS data/ breadcrumbs.

Table 2: Arterial Probe Speed Data Provider

Transportation Agency Interviewed	Arterial Probe Speed Data Provider			
	HERE	INIRX	TomTom	Agency-Generated
GDOT	✓			
NCDOT	✓			
INDOT		✓		
NJDOT	✓	✓		
ODOT		✓		
PennDOT		✓		
WisDOT			✓	
RTC of Southern Nevada				✓

4.1 Procuring Probe Speed Data for Arterials

There are many transportation agencies that have procured third-party speed probe data for freeway uses, however some agencies have expanded the use of probe speed data to arterials for a variety of reasons. A couple transportation agencies have been procuring probe speed data for nearly 10 years on arterials, while others are new to incorporating probe speed data into transportation uses. See Table 3.

Table 3: Year Started Using Probe Speed Data on Arterials

Transportation Agency Interviewed	Year
GDOT	2017
WisDOT	2016
RTC of Southern Nevada	2016
PennDOT	2015
ODOT	2014
NCDOT	2011
INDOT	2011
NJDOT	2010

Arterial probe speed data was purchased statewide by most of the agencies interviewed. However, in rural areas or where there are not many probes, arterial speed data may not be available. **WisDOT** pays by the mile for third-party arterial speed probe data (not statewide) and has the option to expand or delete routes throughout the contract duration.

NCDOT, **PennDOT**, and **GDOT** procure probe data through their membership in the Eastern Transportation Coalition. The Eastern Transportation Coalition maintains the contracts with the third-party data providers. Other agencies procured third-party data through sole source contracts or through a Request for Proposal (RFP) process.

The following table highlights the initial reasons that arterial probe speed data was procured by transportation agencies. It is important to note that since the initial procurement, many of these agencies have expanded to other uses and will continue to do so as third-party arterial probe data availability and accuracy continues to improve over time.

Table 4: Use Cases Agencies Initially Procured Probe Speed Data for Arterials

Use Cases	Description (Agencies Interviewed)
Construction Project	• To provide alternate arterial route travel times versus the work zone route for a major construction project (WisDOT).
Expanding Third-Party Probe Data	• Obtained probe data for all interstate routes, US routes, and state routes in the state which allowed ODOT to offer the data to local agencies and provide the districts with additional data to analyze (ODOT).
Congestion Locations and Reliability Issues	• For network screening to identify bottleneck locations and issues with reliability (PennDOT).
Signal Retiming Before and After Studies	• To replace floating car studies for before/after signal re-timings (INDOT). • To assist in before and after signal retiming studies over a longer period compared to driving corridors and recording travel times which only provided a snapshot of information (PennDOT).
Signal Prioritization	• To assist in prioritizing signal retiming (PennDOT).
Cost Effectiveness	• Found the cost to add arterials to the freeway probe contract was not significant (INDOT, NJDOT, and NCDOT). • Found that third-party probe data is more cost effective than deploying field devices (GDOT).
Collect Data Using Agency Resources	• To learn about arterial probe data gathered from agency-operated fleet vehicles (RTC of Southern Nevada).

4.2 Arterial Probe Speed Data and Analytics Platforms

Each arterial probe speed data provider provides data in 1-minute increments. However, most of the agencies interviewed use the data in larger increments, depending on each specific use. See Table 5.

Other data sources (e.g. connected traffic signals, travel time runs) are used by some of the transportation agencies interviewed to supplement arterial probe speed data. **INDOT** uses high-resolution millisecond data from connected traffic signals to supplement arterial probe speed data. **INDOT** is in the process of connecting all signals, with a goal to have all 2,500 signals connected in 2-3 years. **NCDOT** uses travel time runs collected by staff or firms as wells as controller data such as detector logs and split monitor logs to supplement the arterial probe speed data.

Each of the transportation agencies that purchase probe speed data from a third-party data provider also procure the raw speed data from that provider. In addition, most of the agencies utilize one or more analytics platforms to analyze probe speed data. See Table 5.

- Six of the agencies interviewed use the Regional Integrated Transportation Information System (RITIS) platform to analyze data. RITIS provides a situational awareness, data archiving, and analytics platform. Using RITIS, **ODOT** can monitor arterial corridors using more granular data provided by INRIX XD Segments (XDS). INRIX XDS are provided for a specific geographic area or route. As noted in Section 3.0, the Implementation of Probe Data Performance Measures (April 2017) study completed by Purdue University provides additional information on the proof of concept and reliability measures for arterials. The proof of concept was incorporated by the University of Maryland CATT Lab into RITIS and allows PennDOT to customize selected corridors for comparison using INRIX XD segment. **PennDOT** is also using this methodology in District 6 (Philadelphia & suburbs) to identify and prioritize corridors for retiming.
- Iteris Clearguide is used by **NCDOT** to provide transportation analytic solutions.
- Analytic platforms provided by the third-party data provider are also used by **INDOT, NCDOT**, and **PennDOT**.
- **WisDOT** does not use an analytics platform, however arterial probe speed data is imported into WisDOT's Advanced Traffic Management System (ATMS) through an Application Programming Interface (API) provided by their third-party data provider. There is a global setting in **WisDOT's** ATMS that allows users to configure which data source (e.g. Bluetooth, Remote Traffic Microwave Sensor (RTMS), probe speed data) is used to calculate travel times in priority order. If the designated priority 1 data source is not available, it will go to the next source to calculate travel times.
- **ODOT, INDOT,** and the **RTC of Southern Nevada** can analyze individual signals using probe speed data. **GDOT, NJDOT, INDOT, NCDOT,** and the **RTC of Southern Nevada** can analyze probe speed data at a corridor level.

Most of the agencies use both real-time and historical arterial probe speed data. For example, **NJDOT** uses real-time arterial probe speed data for posting travel times on dynamic message signs (DMS) and historical arterial probe speed data to conduct data checks when complaints are received from the public on delays.

Each third-party data provider archives arterial probe data and RITIS also stores archived data. **NCDOT** uses historical data to analyze changes over time (e.g. compare to last year, compare to last month) for a wholistic view of arterial corridors over time. See Table 5.

As agencies have utilized and analyzed the arterial probe speed data over the years, following are improvements noted by those interviewed.

- *Smaller segmentation* – Segments are provided for a specific geographic area or route and the distance of the segments have decreased to provide more granular data to analyze.
- *Map updates* – Overall segment map updates are conducted by third-party data providers more frequently (e.g. twice a year) which has improved the usability of the arterial probe speed data.
- *Data availability* – Third-party providers have made it easier to integrate the data into transportation agencies' platforms (e.g. by providing the data through an API). In addition, the amount of downtime has decreased over the years.
- *Increased number of probes and probe types* – Each year the number of probes increases and has tremendously increased in the last few years due to additional data from connected and automated vehicle sources.
- *Accuracy* – With increased probe penetration, spatial, temporal, and incident detection accuracy has increased.

Table 5: Arterial Probe Data and Analytics Platforms

Agency Interviewed	Data Provider	Temporal Granularity Used *(Note: Data is provided in 1-min increments by data providers)*	Analytics Platform					Historical	Real-Time
			RITIS	Iteris Clearguide	Data Provider	In-house	Other		
GDOT	HERE	5-min to 15-min	✓					✓	✓
NCDOT	HERE	5-min	✓	✓	✓	✓		✓	✓
INDOT	INRIX	Downloaded in 1-min increments	✓		✓	✓			✓
NJDOT	INRIX and HERE	15-min	✓				Transcom SPATEL	✓	✓
ODOT	INRIX	15-min	✓			✓		✓	✓
PennDOT	INRIX	Larger bins (e.g. 2-hour peak period, average by weekdays).	✓		✓			✓	
WisDOT	TomTom	1 minute, with travel time smoothing.					Integrated into ATMS		✓
RTC of Southern Nevada	Agency-Generated	1-sec to 5-sec				✓		✓	

A few of the agencies noted in Table 5 have developed or use in-house or other analytics tools to view and analyze the third-party arterial probe data as described below.

NCDOT

- ***Signal Retiming Prioritization Tool*** – NCDOT developed this tool in conjunction with North Carolina University's Institute for Transportation Research and Education (ITRE) in 2017. The underlying data is HERE probe data. The tool was used in 2018 to assist in the development of a 2019 Statewide Retiming Project Program.
- ***Before/After Signal Retiming Excel Analysis Tool*** – To assess the operational efficiency gained during a signal retiming project, arterial probe data is entered into this before/after spreadsheet tool.

ODOT

- ***Speed Limit Study Tool*** – In 2014, ODOT created a spreadsheet to analyze speed studies using probe data (including arterials) to determine whether speed limits should be modified.
- ***Before/After Signal Retiming Spreadsheets*** – ODOT uses raw 15-minute speed probe data from INRIX (e.g. 3 months before/after signal re-timing), then uses spreadsheets developed in-house to calculate, for example, fuel savings and delay savings.
- ***Ad-Hoc Before/After Signal Retiming Analysis Techniques*** – ODOT uses built-in tools through the RITIS PDA Suite, utilizing visualizations and maps to perform arterial before/after studies and other requests as needed.
- ***The Snow and Ice Performance Evaluator*** – Tool that combines probe-based speed data and weather data to determine how quickly routes recover drivability after a snow or ice event.
- ***Traffic Operations Assessment System Tool (TOAST)*** – TOAST is an analysis tool utilized by ODOT Districts to rank operationally sensitive corridors and apply for Transportation Systems Management and Operations (TSMO) funding. TOAST combines probe-based speed data (bottlenecks data and travel time performance) with safety and volume data to determine the overall operational condition of each route segment. See Figure 1.

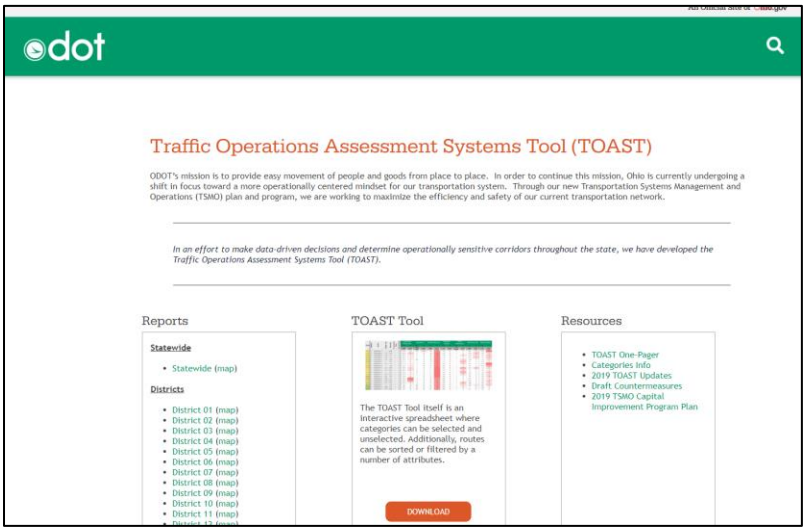


Figure 1: 11/11/20 Screenshot of Ohio DOT TOAST

NJDOT

- ***Selected Priorities Applied to Evaluated Links (SPATEL) Tool*** – NJDOT as a member of the Transportation Operations Coordinating Committee (Transcom) uses the SPATEL tool for data fusion and extraction.

INDOT

- ***Miscellaneous Tools and Dashboards*** – Initially tools were built in conjunction with Purdue University out of a necessity since dashboards were not available from third-party providers. Currently these tools developed in-house are being integrated into the agency's TMC software.

4.3 Arterial Speed Probe Data Use

The transportation agencies interviewed indicated that arterial probe speed data has worked best in free-flow conditions, where there are higher volumes and probe penetration. Accuracy challenges are observed with several conflicting movements (e.g. driveways), times of day with very low traffic volume (e.g. overnight), and where signals are densely spaced.

This section provides details on how the transportation agencies interviewed are currently using arterial probe speed data, changes to agency practices, potential future uses, and challenges with arterial probe speed data.

Arterial probe speed data has worked best in free-flow conditions, where there are higher volumes and probe penetration.

Accuracy challenges are observed with several conflicting movements (e.g. driveways), times of day with very low traffic volumes (e.g. overnight), and where signals are densely spaced.

4.3.1 Current Uses

There are a variety of ways transportation agencies interviewed for this project utilize probe speed data on arterials as shown in Table 6 and as described following the table. The most common agency uses are calculating travel times, performance monitoring for arterials, and signal retiming prioritization.

Table 6: Arterial Probe Speed Data Use

Arterial Probe Speed Data Use	Transportation Agencies Interviewed							
	GDOT	NCDOT	INDOT	NJDOT	ODOT	PennDOT	WisDOT	RTC of Southern Nevada
Signal Retiming Prioritization	✓	✓	✓		✓	✓		✓
Performance Monitoring	✓	✓	✓		✓	✓		✓
Travel Times	✓		✓	✓	✓		✓	
Before and After Studies	✓	✓	✓		✓	✓		
Incident Detection	✓	✓		✓				
Identify Problem Areas (Bottleneck Locations, Reliability Issues, High Speed Areas)	✓					✓		
Traveler Information		✓					✓	
Detour Route Monitoring	✓		✓					
Evacuation Route Speed Monitoring		✓						
Flooding Detection		✓						

Selected highlights describing how agencies are using arterial probe speed data are summarized below.

Signal Retiming Prioritization

- Purdue University normalized probe speed data for **PennDOT** using the corridor length and speed limit to rank corridors for signal retiming.
- **GDOT** has used arterial probe speed data at a programmatic level monthly to identify areas in need of modifications. **GDOT** also uses the data to identify recurring problems for programming signal retiming projects instead of waiting for complaints from the public.
- **NCDOT** uses a data downloader to feed a Signal System Retiming Prioritization Tool on an annual basis described in Section 4.2.
- **ODOT** uses the probe speed data with RITIS to determine signal retiming prioritization.
- The **RTC of Southern Nevada** ranks intersections by various performance measures (e.g. best/worst green light performance).

Performance Monitoring

- **ODOT** monitors arterial segments to determine operational performance and uses rankings to prioritize TSMO funding through the TOAST application described in Section 4.2. The Snow and Performance Evaluator Tool also described in Section 4.2 combines probe speed data with weather data to determine how soon speeds recover following a weather event. Probe speed data is also used to determine a travel time performance rating (how often motorists were able to travel near free flow speeds. In 2018-19, **ODOT** began using arterial probe speed data to look at performance on arterials on a case by case basis, for example to verify traffic backing up at a ramp during holidays.
- **RTC of Southern Nevada** uses probe data to analyze conditions at signalized intersections such as the length of delay, percent green, distance from stop bar (to identify queues), and multiple stops. In addition, intersections are ranked by various performance measures (e.g. best/worst green light performance). Intersections are also analyzed to understand the cause and effects of traffic signals and performance changes due to various events.

Travel Times

- **GDOT**, **NJDOT**, and **INDOT** occasionally post travel times on arterial DMS using probe speed data, however it is not often as there are a limited number of DMS on arterials.
- **ODOT** and **WisDOT** have posted the travel time for an alternate arterial route for travelers along a freeway providing information if they want to divert.

Before and After Studies

- **NCDOT, PennDOT, ODOT,** and **GDOT** utilize arterial probe speed data for before and after signal retiming studies to measure congestion improvements. **ODOT and GDOT** have eliminated the floating car method with the use of the arterial probe speed data.

Incident Detection

- **GDOT** and **NJDOT** actively monitor the arterial probe data to identify issues on arterials. **NCDOT** TMC operators monitor Google maps to identify incidents and then uses the HERE Traffic Viewer for confirmation.

Identify Problem Areas (Bottleneck Locations, Reliability Issues, High Speed Areas)

- **GDOT** uses the probe speed data to identify which corridors have a bad buffer index/bad progression and bottlenecks. **PennDOT** uses the probe speed data on arterials to identify reliability issues. Both **PennDOT** and **GDOT** use the probe speed data to determine high speed areas where vehicles are traveling over the speed limit.

Traveler Information

- Most of the agencies interviewed do not post arterial probe speed data on their traveler information platforms. However, at **WisDOT** since the probe speed data comes through their ATMS, the data is used to populate traveler information (e.g. WisDOT 511 website) for selected routes. **NCDOT** congestion levels (red, yellow, green) from third-party probe data are available on the DriveNC traveler information website and the traveler information map is used by 511 phone operators to view and convey traffic conditions.

Detour Route Monitoring

- **INDOT** monitors the arterial probe speed data to monitor detour routes.

Evacuation Route Speed Monitoring

- Before and after speed reports are generated by **NCDOT** every few hours to help with evacuation management during hurricanes.

Flooding Detection

- Probe speed data (and Waze data) is monitored by **NCDOT** to identify congestion or locations where no speeds are showing, which can indicate a road that is impassible due to flooding.

4.3.2 Changes to Agency Practices

As transportation agencies have used arterial probe speed data there are a variety of practices that have changed.

- Revised Process for Speed Studies
  - **ODOT** recently revised their speed limit study tool and is using it to understand actual speeds in the field from arterial probe data (e.g. changes due to the pandemic), rather than physically driving to sites to conduct speed studies.
- Reduced Use of Floating Car Method and Resource Savings
  - **ODOT** has achieved savings (and is obtaining better data) for travel time studies and signal timing contracts, as less time and effort is dedicated to the floating car method for these studies.
  - **GDOT** is no longer using the floating car method to verify travel times.
  - Staffing for travel time runs has been reduced at **INDOT**. Previously there were 7 positions conducting travel time runs and over time these positions were reassigned to ITS/data analysis positions.
  - **RTC of Southern Nevada** has seen cost savings with a reduction in travel time runs conducted by staff or contractors.

- Improved Signal Prioritization
    - Arterial probe speed data for **PennDOT** has provided the ability to evaluate the impacts and benefits over a longer period of time to assist in signal prioritization.
- Supplemental Data in Work Zones
    - Arterial probe data is used in **WisDOT** work zones to supplement data where physical detection and communications can be disrupted unexpectedly due to lane shifts, crossovers, damage, and disconnections.
- More Proactive Arterial Management
    - The probe speed data has allowed **GDOT** to be more proactive with arterial management as there is more coverage of speed data, compared to physical field detection devices.
- Data-Driven Project Prioritization
    - **GDOT** now takes a more data-driven approach to identify congestion reduction projects.
    - Provided **NCDOT** with a data-driven approach for selecting which corridors to retime each year as opposed to the previously very subjective process.
- Less Field Detection Devices
    - **NJDOT** is phasing out field detection such as Bluetooth devices and using third-party probe data.
    - **RTC of Southern Nevada** has less need for field detection equipment, with more data available from probe vehicles.

Changes to Agency Practices

- Revised process for speed studies
- Reduced use of floating car method and resource savings
- Improved signal prioritization
- Supplemental data in work zones
- More proactive arterial management
- Data-driven project prioritization
- Less field detection devices

4.3.3 Challenges

Transportation agencies interviewed described a few challenges with arterial probe speed data.

- In order to fully utilize the analytics tools for probe speed data, staffing time and resources are needed, and some agencies are not able to dedicate staff.
- Staff needs to be trained and educated on the use of arterial probe speed data. This should include learning from signal timing staff to apply their expertise to the potential uses of the data. However, some agencies are unable to dedicate the time to training of arterial probe speed data.
- There is a challenge with probe penetration in rural areas. Additional probes are desired to increase reliability in these areas.

Challenges

- Staff resources and training
- Need for more granular segmentation of data
- Need for improved accuracy with low volumes (e.g. rural areas) and at locations with conflicting movements or dense signal spacing
- Determining 85th percentile speeds

- It can be challenging to identify a true 85th percentile speed with probe speed data, since the data does not represent a profile of individual vehicles and is typically an average. This information would be beneficial to identify if speeding is occurring during off peak hours on a corridor to implement safety measures (e.g. enforcement efforts).
- In some cases, segmentation available for probe speed data on arterials is not granular enough to pinpoint which signal is causing congestion, especially when multiple signals are included in a segment. Arterials operate as interrupted flow facilities by design, which makes it more challenging to differentiate whether changes in travel times are the result of traffic control devices regulating flow or congestion.
- Arterial probe speed data has challenges with accuracy when there are a lot of conflicting movements (e.g. driveways), times of day when there is very low volume (e.g. overnight), and when signals are spaced very close.

4.3.4 Potential Future Uses

As arterial probe speed data continues to expand with increased probe penetration, there are a number of future uses that transportation agencies interviewed are considering.

Potential Future Uses

- Monitor signals and provide automated alerts
- Assess speed changes
- Identify bottlenecks
- Ramp metering operations
- Identify field detection needs
- Agency performance measures
- Speed dashboard to assist with winter operations

- Real-time arterial probe speed data dashboard
  - **ODOT** is aiming to implement a Real-Time Snow and Ice Monitoring Program. Currently, this performance measure is run after the end of storms based on historical data. In the future it is desired to develop a dashboard to display real-time arterial probe speed data. The live dashboard would provide county managers information to help with routing drivers during a storm and send resources where they are most needed at the time.
- Monitor signals and provide automated alerts
  - The **RTC of Southern Nevada**, **ODOT**, and **PennDOT** are interested in using real-time probe speed data to automatically monitor signals, detect an issue, and provide an automated alert to potentially make signal adjustments.
- Assess speed changes
  - **NJDOT** is interested in enhanced analytics tools to assist in determining changes in different scenarios (e.g. before and after the COVID-19 Pandemic).
- Improvements in spatial granularity
  - As finer granularity arterial probe speed data is available, it will be useful to **GDOT** to identify bottlenecks, for ramp metering, and to identify where field detection is needed.
  - Once the probe speed data is granular enough, there is a potential for **NCDOT** to use the data for some internal agency performance measures that are currently only possible to generate using high resolution signal controller data.

  Half mile segmentation currently is used by **PennDOT**; if this could be further segmented, it would be helpful especially in urban areas where signal spacing may be every 400 feet.

5.0 Probe Speed Data for Arterial Operations: Third-Party Probe Data Providers

This section provides information gathered from phone interviews conducted with the following three third-party data providers. Information documented includes availability of arterial probe speed data, data sources, data validation, and data delivery and platforms.

- HERE Technologies
- INRIX
- TomTom

Arterial Probe Speed Data and Availability

Probe data is provided by most third-party probe data providers for the Traffic Message Channel (TMC)-coded network (uniquely identifies standardized roadway segments for the purpose of conveying traffic information). INRIX also provides XD Segments (XDS). INRIX XD segments are provided for a specific geographic area or route. HERE Technologies provides probe speed data for the TMC-coded network and offers some coverage outside of the TMC-coded network. TomTom provides probe data referenced to either TMC or with map-agnostic Open Location referencing and also offers live route monitoring services enabling selection of any route including segments at any level of the road network. .

The arterial probe data is available from each of the third-party providers in 1-minute increments. When there are situations where probe speed data is not available, each third-party provider utilizes historical data.

- HERE Real Time data is available continuously on the TMC coded road network. When probe data is not directly available, interpolation based on a historical dataset is used to generate speed data. Real time data is also available outside the TMC coded network when sufficient probe data is available. A Confidence Value is provided to identify whether data sourced from live probe data or from the HERE historical traffic dataset. HERE also offers historical probe data products at higher granularity resolution (HERE Traffic Analytics) and as a generalized aggregate "average" speed product called Traffic Patterns.
- INRIX continuously looks at whether the source data is consistent enough for real-time reporting. If not, historical data is used to publish a speed value. INRIX publishes a number (score) reflecting whether sufficient data is available.
- TomTom provides live speed data beyond the TMC network, down to interconnecting municipal roads known as functional road classes 0-5. Live observed speeds are supplied within the feed wherever GPS probe data exists. If there is not sufficient recent GPS probe data available, then TomTom falls back on historic speed profiles. This historic speed profile data product is produced from aggregated averaged speed information collected over a 2-year period, updated quarterly. The degree of availability of live speed observations is captured within the quality statistic called "Confidence Value" provided within the live traffic feeds.

Data Sources

There are a mix of GPS data sources utilized by third-party data providers.

- HERE uses a robust mix of GPS-probe data sourced from over 120 aggregators of GPS probes. Sources include connected devices (e.g. cell phones), personal navigation devices, and connected vehicles.
- INRIX uses GPS point source data from connected vehicles including automobiles, trucks (with data binned in 3 weight classes), and mobile devices.
- TomTom sources GPS probe data from in-vehicle systems (in-dashboard and on-dashboard navigation systems) and from mobile navigation applications (TomTom's own, handset manufacturer, and third-party apps). This data is anonymized, map-matched, processed, and aggregated for each road segment or incident to provide live traffic services as described in this document.

Data Validation Practices

The Eastern Transportation Coalition has evaluated freeway probe data from HERE Technologies, INRIX, and TomTom data for several years. The coalition transitioned to focusing on arterial probe data a few years ago. In addition, TomTom uses the Traveler Information Services Association's (TISA's) Q-Bench quality methodology and has used drive testing to confirm observed speeds. The HERE data is tested internally on a routine basis, the results of which are not published. INRIX uses Bluetooth data and floating cars to measure against the published probe data. All three providers service the automobile industry, which has industry-wide agreed high standards for data quality and accuracy.

Data Delivery and Platforms

Speed data is provided by HERE as an API or as a URL-based XML feed. The data is presented on various analytics approaches and platforms. For instance, agencies can use the HERE map platform to merge HERE data with other data sources for combined viewing. An analytics historical database that can be queried is also available. HERE does not directly offer analytics tools, with the exception of a simple viewing tool. Rather, HERE partners with two major traffic analytics platforms: RITIS and Iteris ClearGuide. These platforms integrate and display HERE data, for users to view and perform analytics functions. HERE has recently begun to offer an "Arterial Turn Lanes" service that captures and reports delays associated with vehicles turning at intersections. This service has not been used by agencies yet but could be valuable for performing signal timings.

INRIX provides speed data directly via APIs and as a comprehensive service with analytic tools. See docs.inrix.com for API documentation and visit inrix.com for general information on analytics. Through the RITIS platform there are modules specific to arterials (signal analytics that provide individual trip observations/floating car and trip analytics). Both modules are powered when data is mined out of the trip records. All metrics are based on observed trips, no modeling is involved in either module.

TomTom has different delivery methods to best suit different customers:

- TomTom Live Traffic feeds: A server-2-server bulk delivery of Live Traffic Speeds and Live Traffic Incidents data delivered to Datex II v.3 standards with TMC or Open Location Referencing.
- TomTom Live Traffic APIs provide compact tile and non-tile services via REST API.
- TomTom Move: The TomTom Move portal provides a suite of historic speed, Origin-Destination Analysis and live route monitoring products for traffic planners, operators or contractors working on-road.

6.0 Summary

This section summarizes probe speed data for arterial operations from an online literature search and interviews with eight transportations (GDOT, NCDOT, INDOT, NJDOT, ODOT, PennDOT, WisDOT, and the RTC of Southern Nevada) and three third-party data providers (HERE Technologies, INRIX, and TomTom).

Arterial Probe Speed Data, Uses, and Analytics Platforms

There were two agencies interviewed that use HERE probe speed data, one agency that uses TomTom probe speed data, and four agencies that use INRIX probe speed data for arterials. The RTC of Southern Nevada does not purchase probe speed data from a third-party data provider for arterials. Rather, probe data is gathered through GeoTab® that tracks their fleet vehicles (e.g. paratransit, vehicles used by staff daily) and via a mobile app used by RTC staff that provides GPS data/breadcrumbs.

Table 7 on page 27 summarizes selected information from the agencies interviewed, including the data providers each agency utilizes, the year each agency started using probe speed data on arterials, analytics platforms used to review and analyze the data, whether historical and/or real-time data is used, and overall probe speed data use. Common uses of arterial probe speed data by agencies include arterial performance monitoring, travel times, signal retiming prioritization, and before and after studies to determine the effectiveness of signal timing improvements. Other uses include traveler information displays, detour route monitoring, incident detection, evacuation route monitoring, flooding detection, and identifying problem areas such as bottlenecks, reliability issues, and high-speed areas.

Changed Practices

As transportation agencies have used arterial probe speed data, there are a variety of practices that have changed including:

- Revised process for speed studies
- Reduced use of floating car method and resource savings
- Improved signal prioritization
- Supplemental data in work zones
- More proactive arterial management
- Data-driven project prioritization

Improvements in Arterial Probe Speed Data Over the Years

As agencies have utilized and analyzed the arterial probe speed data over the years, the following improvements were noted by those interviewed.

- *Smaller segmentation* – Segments are provided for a specific geographic area or route and the distance of the segments have decreased to provide more granular data to analyze.
- *Map updates* – Overall map updates are conducted by third-party data providers more frequently (e.g. twice a year) which has improved the usability of the arterial probe speed data.

- *Data availability* – Third-party providers have made it easier to integrate the data into transportation agencies' platforms (e.g. by providing the data through an API). In addition, the amount of downtime has decreased and improved over the years.
- *Increased number of probes and probe types* – Each year the number of probes increases and has tremendously increased in the last few years due to additional data from connected and automated vehicle sources.
- *Accuracy* – With increased probe penetration, spatial, temporal, and incident detection accuracy has increased.

Potential Future Uses

As arterial probe speed data continues to expand with increased probe penetration, there are a number of future uses that transportation agencies interviewed are considering including:

- Monitor signals and provide automated alerts
- Assess speed changes for various scenarios
- Identify bottlenecks
- Ramp metering operations
- Identify field detection needs
- Agency performance measures
- Speed dashboard to assist with winter operations

Challenges

Though the accuracy and usability of arterial probe speed data has improved over time, arterial roads present certain challenges for probe speed data:

- Additional agency resources and staff training is needed to become familiar with and analyze arterial probe speed data.
- Need for more granular segmentation of data.
- Need for improved accuracy with low volumes (e.g. rural areas) and at locations with conflicting movements or dense signal spacing.
- Third-party probe data may be inconsistent and difficult to validate on low-volume rural facilities.
- In some cases, cellular coverage by no or only one carrier in remote areas leaves gaps in the speed data. Areas of cellular dead zones with only one or two carriers providing coverage can also increase latency.
- Arterials operate as interrupted flow facilities by design, which makes it more challenging to differentiate whether changes in travel times are the result of traffic control devices regulating flow or congestion.

Third-Party Data Providers

There are a mix of GPS data sources utilized by third-party data providers.

- HERE uses a robust mix of GPS-probe data sourced from over 120 aggregators of GPS probes. Sources include connected devices (e.g. cell phones), personal navigation devices, and connected vehicles.
- INRIX uses GPS point source data from connected vehicles including automobiles, trucks (with data binned in 3 weight classes), and mobile devices.
- TomTom sources GPS probe data from in-vehicle systems (in-dashboard and on-dashboard navigation systems) and from mobile navigation applications (TomTom's own, handset manufacturer, and third-party apps). This data is anonymized, map-matched, processed, and aggregated for each road segment or incident to provide live traffic services as described in this document.

Probe data from third-party probe data providers on arterials is available in 1-minute increments. When there are situations where probe speed data is not available, each third-party provider interviewed for this project utilizes historical data. Typically, a score or confidence value is provided with the data to understand if the data is using historical data.

Overall Performance and Trends

The Eastern Transportation Coalition has evaluated freeway probe data from HERE Technologies, INRIX, and TomTom data for several years. The coalition transitioned to focusing on arterial probe data a few years ago and has documented that arterial probe speed data has performed at a level suitable for planning and operational applications.

Overall, arterial probe data, as described by the transportation agencies interviewed and through the online search, works best in free-flow conditions, where there are higher volumes and probe penetration.

Each transportation agency interviewed indicated that their needs have been met with arterial probe speed data. Use of the arterial probe speed data is an ongoing, iterative process. As penetration of probes increases on arterials and finer segmentation is available, agencies' needs will be better met.

Table 7: Agencies Interviewed: Arterial Probe Speed Data Providers, Year Started Using Probe Data on Arterials, Analytics Platform, and Use

Agency Interviewed	Data Provider				Year Started Using Probe Speed Data on Arterials	Analytics Platform					Historical	Real-Time	Arterial Probe Speed Data Use									
	HERE	INRIX	TomTom	Agency Generated		RITIS	Iteris Clearguide	Data Provider	In-house	Other			Travel Times	Traveler Information	Performance Monitoring	Signal Retiming Prioritization	Before and After Studies	Detour Route Monitoring	Incident Detection	Evacuation Route Speed Monitoring	Flooding Detection	Identify Problem Areas
GDOT	✓				2017	✓					✓	✓	✓			✓			✓			✓
NCDOT	✓				2011	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓	✓	✓	
INDOT		✓			2011	✓		✓	✓			✓	✓		✓	✓	✓	✓				
NJDOT	✓	✓			2010	✓				Transcom SPATEL	✓	✓	✓						✓			
ODOT		✓			2014	✓			✓		✓	✓	✓		✓	✓	✓					
PennDOT		✓			2015	✓		✓			✓				✓	✓	✓					✓
WisDOT			✓		2016					Integrated into ATMS		✓	✓	✓								
RTC of Southern Nevada				✓	2016				✓		✓				✓	✓						

Appendix A: Interview Notes – Transportation Agencies

- Georgia DOT
- Indiana DOT
- New Jersey DOT
- North Carolina DOT
- Ohio DOT
- Pennsylvania DOT
- RTC of Southern Nevada
- Wisconsin DOT

Synthesis of Probe Speed Data for Arterial Operations

Matt Glasser
Georgia DOT
August 13, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- There was a bridge collapse on I-85 in 2017. Blue Toad devices were used at that time. However, there were challenges with the data, if for example there were 10 nodes for 10 miles and one node broke there would be no travel time data reported for that day and therefore no information to report to management.
- Georgia DOT (GDOT) then started exploring third-party probe data for arterials and reviewed studies completed by the Eastern Transportation Coalition. Cost was also reviewed, and third-party probe data was much more cost effective then field devices.

Who is the third-party data provider?

- HERE data is procured through the Eastern Transportation Coalition

How long has your agency been using probe speed data for arterials?

- 2017, 3 years to 3 ½ years

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- GDOT uses raw speed data and analytics platform (RITIS and direct links to HERE data).

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Travel times
  - Travel times are occasionally posted on DMS, however there are a limited number of DMS on arterials.
- Signal retiming prioritization
  - Use arterial speed data to identify which corridors have a bad buffer index/bad progression and bottlenecks.
  - Use for before and after analysis to measure congestion improvements.
  - Use at a programmatic level each month to identify areas in need of changes or modifications.
- Incident detection
  - Active monitoring by operators, to identify issues on arterials.
- Traveler information
  - Congestion levels for freeways (red, yellow, green) are available on the Eastern Transportation Coalition website.

- Other
    - The operations improvement team uses speed data to identify recurring problems for programming projects instead of waiting for complaints from the public.
    - The safety group has reviewed the data to identify high speed areas and where safety strategies could be implemented.

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- 1- minute granularity is provided, however typically 5-minute to 15-minute increments are used.
- Both real time and historic arterial probe data are used.

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- Typically signal analysis is done at a corridor level, due to the TMC lengths that are available.

Are other data sources used on arterials to supplement the speed probe data?

- GDOT uses an open source platform that was created by Utah DOT (Automated Traffic Signal Performance Measures (ATSPM)).
- HERE dataset provides access to a layer for speed limits.
- Exploring other datasets (not necessarily for arterials), such as INRIX trip data, StreetLight trip data, and HERE hazard warning data.

Can origin/destination information on arterials be derived? In what settings/cases?

- GDOT is not currently obtaining origin/destination data but is exploring with StreetLight for trip data.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- As finer granularity data is available, it will be useful to identify bottlenecks, for ramp metering, and to identify where field detection is needed.
- For larger projects, can use congestion scans to identify weak sections and the impacts.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Yes, this data has allowed the agency to be more proactive with arterial management.
- There is a need for higher granularity in terms of TMC lengths. This is more a function of the analysis tools than the actual probe data.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- The probe speed data has allowed GDOT to be more proactive with arterial management.
- There is more coverage of speed data, compared to physical field detection devices.

- Probe speed data on arterials has enabled GDOT to take a more data-driven approach to identifying congestion reduction projects.
- No longer use floating car method to verify travel times.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- GDOT contributes and reviews the Eastern Transportation Coaltion evaluation studies.
    - Vehicle Probe Project (VPP) Marketplace: https://tetcoalition.org/projects/vpp-marketplace/

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Probe data on arterials works best when volumes are higher.
- Probe data is least favorable during times of day when there is very low volume. This generally occurs overnight and can stretch from 10PM to 6AM for corridors that already have a lower AADT.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- There have been improvements in the data over time with the increase in the number of probes. However, it's not necessarily just the speed data improving, but the providers are also including other datasets (e.g. trip data, hazard warning, back of queue) that complement the speed data, which provides additional information for agency operations.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- The Eastern Transportation Coaltion has developed perfomance templates.
- GDOT maintains monthly a performance tracking website: https://tetcoalition.org/projects/vpp-marketplace/.
- RITS and PDA Suite: https://tetcoalition.org/projects/ritis-pda-suite/
- RITS Use Cases: https://www.ritis.org/usecases
- Files sent via email on 8/13/2020
    - Travel-Advisory-Template.pptx (Example of a graphic (Predicting Holiday Travel) created using the PDA Suite and RITIS apps)
    - GDOT_HolidayTravel_ROUTES.pptx (Thanksgiving Week 2018 travel forceast summary of areas around Atlanta)
    - GDOT Brochure 11 X 17 PPT Template.pptx (Project Assessment Summary)
    - New Jersey DOT Project Assessment Summary (July 2012)
    - GDOT Statewide Data Research_April2020.pdf

Synthesis of Probe Speed Data for Arterial Operations

Ed Cox
Indiana DOT
August 11, 2020 DRAFT Interview Notes

Procurement

1. ***What was the reason(s) for procuring probe speed data for arterials?***
   - In 2011-2012, Indiana DOT (INDOT) procured freeway probe data due to a major closure of bridge and needed a way to manage traffic. 200 miles of arterial probe data was included in the agreement. The intent for use of arterial speed probe data was to conduct before/after studies for signal re-timings to replace floating car studies.

2. ***Who is the third-party data provider?***
   - INRIX

3. ***How long has your agency been using probe speed data for arterials?***
   - Since 2011-2012.

4. ***Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?***
   - 2011-2019: Raw data only
   - 2019: Procured some of the INRIX analytics tools for arterial group at INDOT to utilize.
   - INDOT has built several in-house tools in conjunction with Purdue University and is now integrating all tools into TMC software.
     - INDOT initially built its tools out of necessity since dashboards weren't available from the third-party vendor at the time. However as noted some INRIX analytics tools have now been purchased.
     - INDOT will likely continue to invest in research/tools/ITS staff with a good relationship with Purdue University for research.

Speed Probe Data Use

5. ***How is your agency currently using speed data on arterials?***
   - Travel times
     - Not on arterials. Use for before and after internal analysis, not for traveler information.
   - Performance monitoring
     - Analysis on multiple signals along an arterial corridor
   - Signal retiming prioritization
   - Traveler information
     - Minimal, but some speed displays on arterials.
     - Use to monitor arterials on detour routes

- Before and after studies
    - When rebuilding a corridor, look at before, during, and after construction conditions

6. ***What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?***
    - Download every 1-minute because of freeway use
    - INDOT has access to all probe speed data provided for the corridor, but only uses real-time data. The derived/backfilled data (i.e. where the vendor doesn't have probes) is not used.
    - INDOT does not use anything form the vendor's historical data access site.

7. ***Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?***
    - Only use data where it is available, some rural areas don't have probes.
    - Can analyze an individual traffic signal or aggregate at a corridor level depending on the corridor and number of probes available.

8. ***Are other data sources used on arterials to supplement the speed probe data?***
    - High-resolution millisecond data from traffic signals that are connected.
        - INDOT is in the process of connecting all signals, with a goal to have all 2500 connected in 2-3 years.

9. ***Can origin/destination information on arterials be derived? In what settings/cases?***
    - No, not based on the dataset INDOT is currently purchasing.
    - INDOT is doing some research that could provide origin-destination information in the future.

10. ***How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?***
    - INDOT's goal is to bring in a second probe data source to provide a backup in rural areas. In urban areas, some field sensors are in place as a backup. This second data source would also allow the two sources to be compared head-to-head, with longer-term testing.

Needs Being Met

11. ***Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?***
    - The datasets are very useful, but more probes are needed in rural areas; this is the biggest challenge.

12. ***Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?***
    - Reduced the number of roadside field devices along the freeway, resulting in significant cost savings.
    - Staffing has been reduced. There previously were 7 positions conducting travel time runs and over time these positions were reassigned to ITS/data analysis positions.

Evaluation Results

13. ***Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?***
    - INDOT has worked with Purdue University on testing roadside sensors against probe data.
        - The probe data was proven to be very accurate. In addition, probe data was proven to be better than radar, because of occlusions (can't see further lanes on multi-lane highways) with radar.
        - INDOT tested how long it would take for speed data to show on the map. Latency was 3-4 minutes.

14. ***Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?***
    - A challenge exists with very close/dense signal spacing and not having the segmentation broken down to a level to indicate signal locations.
    - Data users need to understand that probe data provides an average speed between signals.

15. ***Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?***
    - Huge improvements in the data since 2011-2012.
    - In 2011-12, segmentation was 10-15 miles long. With this larger segmentation, average speeds didn't indicate queues and didn't provide good real-time data. Now smaller segmentation of data is available from the provider, which is an improvement.
    - The number of probes have improved significantly. In the early years, INRIX was heavy on freight data and now the data is much more representative of other vehicle types.
    - Data downtimes have decreased and improved.

Other

16. ***Do you have anything else to share about your experience with use of probe speed data for arterials?***
    - Probe data for arterials has the most opportunity to keep improving.
    - INDOT is working with researchers at Purdue University and Iowa State University (overlaying data and improving signal performance).

Synthesis of Probe Speed Data for Arterial Operations

Michael Pilsbury
New Jersey DOT
August 25, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- 10 years ago, New Jersey DOT (NJDOT) started looking into Bluetooth and probe data. INRIX at that time provided a statewide package that covered all state highways in New Jersey.

Who is the third-party data provider?

- INRIX

How long has your agency been using probe speed data for arterials?

- Almost 10 years using probe data for all state highways including interstates.

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- Purchase raw data
- Analysis tools used include SPATEL (TRANSCOM tool) and RITIS. RITIS uses INRIX data.

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Travel times
  - Post arterial travel times on DMS.
- Incident detection
  - Utilize the INRIX colored coded map of speeds to identify incidents on arterials.
- Traveler information
  - Travel times posted in 511 for freeways, not arterials.

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- Probe data is available in 1-minute increments. However, mostly using the data in 15- minute increments.
- Both real-time (e.g. DMS on freeways) and historical (e.g. data checks when public complains of delays) data is used.

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- SPATEL does segments down to about 1 mile, but not individual signals.

Are other data sources used on arterials to supplement the speed probe data?

- There are some field detection Bluetooth devices used, however these are being phased out and the agency will use third-party probe data.

Can origin/destination information on arterials be derived? In what settings/cases?

- No.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- NJDOT is interested in analytics tools (e.g. that can be used to determine changes in different scenarios such as before and after the COVID-19 Pandemic). However, there are still challenges with staffing time and resources to fully utilize the analytic tools.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Overall, needs have been met.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- NJDOT will no longer be installing Bluetooth readers or installing readers through the TRANSCOM consortium and will only use third-party probe data.
- It provides data to verify conditions, but access to the data hasn't changed a lot of practices.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- The NJ Institute of Technology conducted a study for NJDOT checking the accuracy of the probe data and found it to be reasonably accurate.
    - Probe Vehicle Data Comparative Validation Study (2013)

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Probe data vendors continue to refine algorithms. Several years ago, probe data was used for a construction travel time system. There were lots of exits on the route, and the agency noticed that probe data was picking up vehicles getting off and back on the highway, which skewed the data. Over the years as the third-party provider has refined its algorithms, the agency saw much better results with the probe data.
- SPATEL provides speeds. However, NJDOT only uses time.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- The price for procuring probe data has come down over the years.
- The data has become incrementally better and is now quite accurate.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- NJDOT has installed some Blue Toother readers and has used "Transmit" (through the TRANSCOM consortium) which reads license plates and can be used as probes.
- Recently started looking at Streetlight data and capabilities. However, this is more geared toward transportation planning applications, as opposed to traffic operations.

Synthesis of Probe Speed Data for Arterial Operations

Kelly Wells and Matthew Carlisle
North Carolina DOT
August 11, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- North Carolina DOT (NCDOT) procured probe speed data through the Eastern Transportation Coalition in 2008 for freeways.
- In 2011, all covered roadways were added to the contract through the Eastern Transportation Coalition since the cost to expand to all roadways wasn't significant.

Who is the third-party data provider?

- HERE
- Through the Eastern Transportation Coalition there have been a few probe project efforts.
  - Vehicle Probe Project (VPP) 1 in 2008 used INRIX data
  - VPP2 in 2014 included INRIX, TomTom and HERE data
  - In 2016, NCDOT switched to HERE data, because of HERE's mapping capabilities and our desire to conflate TMC data to NCDOT's Linear Referencing System and HERE provided sub-TMC (smaller segments within a TMC) data and an analysis and visualization platform for this data.
  - VPP3 will be in place in Summer of 2020 and will include adding in volumes and origin/destination data.

How long has your agency been using probe speed data for arterials?

- Since 2011.

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- Raw data.
  - This includes 18,000 miles of centerline road data and some fraction of this is arterials.
- RITIS/PDA Suite
  - NCDOT has been using this for 10 years.
- Iteris Clearguide (https://www.iteris.com/clearguide)
- Signal Retiming Prioritization Tool
  - This tool developed in conjunction with North Carolina University's Institute for Transportation Research and Education (ITRE) in 2017. The underlying data is HERE probe data. The tool was used in 2018 to assist in the development of a 2019 Statewide Retiming Project Program. NCDOT plans to use the tool for future signal retiming prioritizations (once a

year or every 6 months), but due to budget issues has not yet had the opportunity to implement this frequency.

- Corridor Travel Time Analysis Tool (arterials)
- Probe data is also used to assess the operational efficiency gained during a signal retiming project using a before/after Excel analysis tool.
    - Probe data is used in conjunction with the travel time runs. Both methods will be continued to be used to compare results. Results have been mixed, with the probe data showing much less of a benefit then actual travel time runs. However, at some point probe data might replace travel time runs.

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Incident Detection
    - Currently there is not any automated incident detection. However, TMC operators monitor Google maps to identify incidents and then use the HERE Traffic Viewer for confirmation.
- Performance Monitoring
    - Before/after signal timing results using the Corridor Travel Time Analysis Tool.
- Signal Retiming Prioritization
    - A data downloader is used to feed the Signal System Retiming Prioritization Tool on an annual basis.
- Traveler Information
    - Used to show red, yellow, green congestion levels on the Drive NC traveler information website and used by 511 phone operators to view and convey traffic conditions.
- Evacuation Route Speed Monitoring and Flooding Detection
    - Before and after speed reports are generated every few hours to help with evacuation management during hurricanes as shown in Figure 1.
    - For flooding, probe speed data is monitored as well as Waze data to identify congestion or locations where no speeds are showing, which can indicate a road that is impassible due to flooding.

Hurricane Evacuation Speed Report				
Routes	Direction	Current	Historic	Differential
I-95	North	69	69	0
I-95	South	72	69	3
I-77	North	69	62	7
I-77	South	68	63	5
I-26	West	60	60	0
I-26	East	63	62	1
I-85	North	64	66	-2
I-85	South	70	66	4
I-40	West	72	71	1
I-40	East	70	71	-1
US-74	East	69	63	6
US-74	West	67	63	4
US-70	West	50	49	1
US-70	East	50	48	2
US-421	North	50	49	1
US-421	South	49	47	2
US-264	West	54	53	1
US-264	East	55	53	2
US-64	East	60	59	1
US-64	West	60	59	1
US-158/US-168	North	53	49	4
US-158/US-169	South	53	49	4

Figure 1: Example NCDOT Hurricane Evacuation Speed Report

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- Probe speed data is available in 1-minute increments, however for arterial use 5-minute granularity is used.

- Real time and historical data are both used. Historical data is useful to analyze changes over time (e.g. comparing to last year, compare to last month) for a wholistic view of arterial corridors over time.

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- Cannot effectively analyze a single signal – only used for corridor-level analysis.

Are other data sources used on arterials to supplement the speed probe data?

- Yes – travel time runs collected by staff or firms and controller data such as detector logs and split monitor logs.

Can origin/destination information on arterials be derived? In what settings/cases?

- Origin/destination information is not available from the HERE data that NCDOT has access to.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- NCDOT would like to use arterial speed probe data for project prioritization, for example to identify interchange modifications or other improvement projects. However, using the probe speed data when compared to a more traditional ranking method produced different results. NCDOT plans to assess why the results were so different.
- Once the probe speed data is granular enough, there is a potential for it to be used for some internal agency performance measures that are currently only possible to generate using high resolution signal controller data. INRIX XD data is granular enough in some states that, for example, split failures can be discerned which would be tremendously beneficial.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Yes, largely the probe data on arterials is meeting NCDOT's needs.
- Once the segments are smaller and penetration is higher (especially outside of urban areas), the data should be much more reliable and can be used for additional agency uses.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- So far, the most significant impact on agency practices for arterials is that it has provided data-driven approach for selecting which corridors to retime each year as opposed to the previously very subjective process.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- The Eastern Transportation Coalition's VPP data validation by University of Maryland (UMD) was conducted approximately 3 years ago on NC 55 in Wake County.
- The Transportation Mobility and Safety Division (TMSD) within NCDOT validated some arterial travel time runs data against the probe data in 2016, prior to the development of the Signal System Retiming Prioritization Tool. A wide range of results were seen, but generally they were in the ballpark of one another. NCDOT signal system timing staff have also been comparing travel time runs against HERE data.
- Overall arterial probe data results are taken with a grain of salt. Arterial probe data is useful and can give a good general sense of operations, but the agency still doesn't have a complete level of confidence with the data on arterials, especially due to limited probe penetration in rural areas.

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Probe speed data is better for higher volume roadways, longer sections.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- On freeways, TMC operators report reduced latency with data delivery over time.
- NCDOT will continue to look at how many probe data points are reported, to determine the optimum penetration rate NCDOT is comfortable with, to use the data for detailed analysis on arterials.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- No

Synthesis of Probe Speed Data for Arterial Operations

Charlie Fisher and Stephanie Marik
Ohio DOT
August 3, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- Initially Ohio DOT (ODOT) procured speed data for real-time TMC operations along mainly freeways and freeway look-alikes. When the agency switched to probe-based data, data was obtained for all interstate routes, US routes, and state routes throughout the state. This allowed ODOT to offer the data to local agencies and provide the Districts with more data to analyze.
- ODOT recently procured new analysis tools through RITIS (e.g. obtain more granular data (XD segment tool) for monitoring along corridors).

Who is the third-party data provider?

- INRIX

How long has your agency been using probe speed data for arterials?

- In 2014, ODOT created a spreadsheet to analyze speed studies using probe data (which can include arterials) to determine whether speed limits should be modified. This process replaced going out into the field and using laser guns to obtain vehicle speeds.
- In 2018-19, ODOT began using the data to look at performance on arterials on a case by case basis, for example to verify traffic backing up at a ramp during holidays.

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- ODOT uses both the raw speed data and RITIS Analytics platform (https://pda.ritis.org/suite/)
- ODOT has built some in-house tools:
  - The Snow & Ice Performance Evaluator tool is used to combine probe-based speed data and weather data to determine how quickly routes recover drivability after a snow or ice event.
  - Traffic Operations Assessment System Tool (TOAST) is an analysis tool utilized by Districts to rank operationally sensitive corridors and apply for TSMO funding. TOAST combines probe-based speed data (Bottlenecks data and Travel Time Performance) with safety and volume data to determine the overall operational condition of each route segment.
- ODOT uses raw 15-minute speed data from INRIX (e.g. 3 months before/after signal re-timing), then uses spreadsheets developed in-house to calculate for example fuel savings and delay savings.
- ODOT uses ad-hoc analysis techniques by using built-in tools through a contract with the RITIS PDA Suite. ODOT utilizes visualizations and maps to perform arterial before/after studies and other requests as needed.

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Travel Times and Traveler Information
  - ODOT initiated a pilot project/research (Traveler Information Traveler Time Corridor Study) with the University of Cincinnati for arterial travel time alternatives to freeway travel times. The project is using real-time speed probe data to display alternate travel times on DMS boards, to determine how many vehicles would divert.
- Performance Monitoring
  - ODOT monitors all state-maintained routes, including arterial segments, for their operational performance and uses the rankings to prioritize TSMO funding through the TOAST application.
  - The Snow & Ice Performance Evaluator tool combines speed data with weather data to determine how soon after the end of an event speeds recovered to within 10 mph of "normal." Recovery time goals are set based on the maintenance priority set by the Districts.
  - Probe speed data is used for the Travel Time Performance rating, which determines how often motorists were able to travel near free flow speeds.
  - Using the travel times and speeds from probe data, ODOT is able to eliminate its use of the floating car method to gather travel time data. The travel time delta from RITIS is used to analyze corridors and how they rank against each other.
- Signal retiming prioritization
  - Probe speed data along with the RITIS re-timing tool, is used for signal retiming prioritization.

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- 1-minute granularity and 15-minute granularity
- Using both real-time and historical speed data

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- Speed probe data is available statewide from INRIX. However, speed data for some county routes and some state routes in very rural areas are not available through INRIX.
- Depends on the corridor, but for most segments on the primary routes, ODOT can analyze individual signals using INRIX XD segmentation.

Are other data sources used on arterials to supplement the speed probe data?

- Weather data is used for the Snow & Ice Performance Evaluator
- Bluetooth data is sometimes used to supplement the probe data

Can origin/destination information on arterials be derived? In what settings/cases?

- ODOT procures origin-destination data through a separate contract with Streetlight

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- Real-time Snow and Ice Monitoring

    - ODOT is aiming to implement a real-time Snow & Ice monitoring program. Currently, this performance measure is run after the end of storms based on historical data. It would be nice to get the data in real time, process it, and create a live dashboard that County managers can use in routing their drivers during a storm send resources where they are most needed at the time. The probe speed data is available in real-time, but a real-time dashboard tool would need to be built.
- Real-time Monitoring of Signals on Corridors
    - The probe speed data could be used to automatically detect an issue in real-time and generate an alert to the signal engineer to review the issue and consider making adjustments.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Yes, ODOT's needs for arterial probe speed data have been met, for the most part.
- This data and related tools have been very helpful for signal performance monitoring.
- Earlier, there were some issues with arterial-based speeds, because of the stop and go nature of vehicles at traffic signals or stopped at a right-hand turn lane waiting to turn. The probe-generated speeds are an average and they may not have been reflective of actual speeds in these cases. This has been better in INRIX XD, with better segmentation.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- ODOT recently revised the speed limit study tool and is using it to understand actual speeds in the field (i.e. changes due to the pandemic), rather than physically driving to sites to conduct speed studies.
- ODOT has achieved savings (and is obtaining better data) for travel time studies and signal timing contracts, as less time/effort is dedicated to floating car method for these studies.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- The data has only been field-tested by ODOT on freeway routes, not on arterials. For the freeway testing, ODOT uses the floating car method and records travel times and speeds based on certain locations. This is then compared to the current readings back in the TMC to compare the two data points (after-the-fact) for accuracy. Travel times are also checked per the traveler information website/app.
- The probe speed data is more accurate in free-flow conditions, compared to congested conditions. INRIX has made some improvements based on feedback from ODOT, based on accuracy testing during congested conditions.

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- The speed data is typically better at locations with more vehicles and probe penetration.
- Rural corridors with less traffic, larger segments may not be as accurate/favorable.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- With the most recent contract, ODOT required "high density" data (INRIX XD) which is more granular on segment lengths and believed to be more accurate than the traditional TMC level data.
- INRIX performs map updates approximately twice per year, which results in continuous improvements in data quality.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- NCHRP Synthesis: State DOT Use of Vehicle Probe and Cellular GPS Data
  - Principal Investigator is Michael Pack, University of Maryland
  - Draft report is out for review, likely to be published in October 2020

Synthesis of Probe Speed Data for Arterial Operations

Steve Gault, Ted Lucas, and Ashwin Patel
Pennsylvania DOT
July 23, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- In Pennsylvania signals are owned and maintained by the local municipalities. Pennsylvania DOT (PennDOT) is responsible for the signal timing plans. The infrastructure varies greatly among the municipalities, with very few field detection devices along the arterials.
- In the past consultants would drive along corridors to record travel times before and after a signal was retimed. However, this only provided a snapshot of information.
- Probe data was procured:
  - To assist in before and after signal retiming studies. With speed probe data you can evaluate the impacts and benefits over a longer period of time;
  - For network screening to identify bottleneck locations and issues with reliability; and
  - Prioritize signal retiming.

Who is the third-party data provider?

- INRIX
- Arterial probe data was purchased as a package with freeway probe speed data statewide through the Eastern Transportation Coalition. PennDOT is a member of the coalition.

How long has your agency been using probe speed data for arterials?

- Approximately 5 years, started utilizing the data in 2015-2016

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- Primarily utilize the analytics plattorm provided by a third-party provider.
- Through the INRIX contract with the Eastern Transportation Coaltion, PennDOT has access to raw INRIX data as well as the analytics tools.
- The Implementation of Probe Data Performance Measures (April 2017) study completed by Purdue University provides additional information on the proof of concept and reliability measures for arterials.
- The proof of concept from the Purdue University study was incorporated by the University of Maryland CATT Lab into the Regional Integrated Transportation Information System (RITIS) analytics platform used by PennDOT.

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Performance monitoring to evaluate before and after data.
- Signal retiming prioritization to rank corridors using a very basic weighting factor.
    - It is difficult to compare corridors against each other using just travel times since corridors vary in length. Purdue University normalized the data using the corridor length and speed limit.
    - Identifying and prioritizing corridors that need re-timing has been completed once by PennDOT. Ideally this will be completed every 3 years in the future.

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- INRIX data can be reported once per minute, however minute by minute is not as useful on arterials with vehicles stopped at signals. The data can be aggregated into larger bins (e.g. 2 hours during the peak period, average by weekdays, days of the week, etc.). PennDOT has not been using real-time INRIX data for arterial performance.
- PennDOT uses mostly historical data.
    - Historical INRIX XD data is available as well as historical data accessed using RITIS. INRIX stores the data and PennDOT has the ability to access it. RITIS uses the INRIX data and stores it separately.

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- Probe speed data procured from INRIX includes all data available from INRIX statewide. PennDOT, Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs) plus consultants working with these entities have access to the data.
- The PennDOT Philadelphia region (District 6) is using the data most extensively. Some other districts have used the data occasionally.

Are other data sources used on arterials to supplement the speed probe data?

- The INRIX data is the main source of PennDOT's speed data for network screening.

Can origin/destination information on arterials be derived? In what settings/cases?

- PennDOT is unaware if this functionality is provided by INRIX, but it would be beneficial.
- Other providers (e.g. Streetlight) provide origin/destination data including for multiple modes (e.g. peds, bikes, etc.). PennDOT may purchase Streetlight data on occasion for a project.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- Before/after analysis to determine how effective a signal re-timing project has been.
- There are challenges with the capability of the data on arterials. For example, there are so many variables on arterials that it can't be used as the only source for generating and posting travel times.
- Automated alerts for signals timing issues:
    - Establish trends over time, automatically identify issues on a corridor/signals, and alert signal staff to potentially make adjustments.

- Before RITIS, a corridor was built in GIS and then imported it into the analytics tools, with RITIS this is a bit easier. This could help with identifying trends/issues automatically. Could potentially be a dashboard in RITIS in the future.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Overall, PennDOT's needs have been met.
- As noted above, if would be beneficial to build in monitoring/trends over time to trigger potential signal timing updates.
- If during off peak hours speeding is occurring on a corridor, then look at crash data to identify where to implement safety initiatives (e.g. enforcement efforts). However, the challenge is obtaining a true 85 percentile with INRIX data since it's already an average and not really representing a profile of individual vehicles.
- There are challenges with segmentation – even with INRIX XD segments that are more granular, this still sometimes not granular enough. It can be difficult to pinpoint which signal is causing the congestion with multiple signals on the segment.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- Speed data has provided the ability to evaluate the impacts and benefits over a longer period of time to assist in signal prioritization.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- PennDOT has not verified the accuracy independently, for arterials.
- PennDOT plans to evaluate whether there are reliable travel times from INRIX vs. Bluetooth readers. This could help to establish ground truth.
- The Eastern Transportation Coaltion conducts an accuracy evaluation on a regular basis. PennDOT monitors this.

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Depends on traffic volumes. On lower volume roads, there are fewer probes and the data is less accurate. Many probes are from fleet vehicles (tractor/trailers) that aren't driving on arterials as much.
- The data quality seems to be improving with more probe penetration.
- On some roadway sections, PennDOT has needed to supplement/subsitute with field sensors (e.g. lower volume roads).

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- Accuracy has improved over time.
- Half mile segmentation currently is used; if this could be further segmented, it would be helpful especially in urban areas where signal spacing may be every 400 feet.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- No

Synthesis of Probe Speed Data for Arterial Operations

Brian Hoeft
Regional Transportation Commission (RTC) of Southern Nevada
September 2, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- RTC wanted to learn about probe data and began gathering probe data from internal tools.
  - In 2016-2017 RTC internally developed an app that provided GPS data/breadcrumbs when the app was in use. Initially 20 to 30 internal staff used the app. A dashboard that was developed for freeways was expanded to arterials to track app users.
  - RTC uses GeoTab for fleet tracking and in late 2018 the tracking information available from the agencies fleet vehicles (e.g. paratransit vehicles, vehicles used by staff daily) was ingested into the RTC dashboard. There are approximately 300 fleet vehicles which expanded the dataset to 500,000 data points per month.

Who is the third-party data provider?

- RTC is not currently procuring third-party probe data. Probe data is gathered internally from RTC staff use of the app and through GeoTab tracking of fleet vehicles.
- RTC is exploring expanding their analytics platform with GeoTab and collaborating with Waycare (cloud based platform for proactive traffic management).

How long has your agency been using probe speed data for arterials?

- Prior to October 2018 – started to obtain small samples of probe speed data
- October 2018 – began obtaining larger sample size of probe speed data from agency fleet vehicles

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- Using in-house tools (dashboard)

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Performance monitoring
  - To conduct analysis at a signalized intersection, for example:
- Data is granular enough to analyze through traffic and turns
- From the probe data the length of delay, percent green, distance from stop bar (to identify queues) and multiple stops can be determined.
  - To conduct analysis of a corridor, for example:
    - Estimate signal delay

- Rank intersections, for example RTC has 1500 signalized intersections, has identified 10 different categories of intersection types, and ranks the intersections by various performance measures (e.g. best/worst green light performance)
- Understand cause and effects due to traffic signals
- Understand performance changes due to events

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- Granularity is at 1 second to 5 second increments, which is helpful for signal analytics and performance measures.
- Mostly using historical data.
- Real-time data could be used in the future, for example Waycare uses traffic data for incident detection on freeways. This could potentially be adapted for incident detection on arterials.

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- The probe speed data is used at an intersection level, to look at each specific intersection approach and for counting movements.
- The data is also used to link to upstream signals, to review corridor level measures.

Are other data sources used on arterials to supplement the speed probe data?

- Non currently.
- In the future, RTC would like to have data about incidents, construction, signal pre-emption, adaptive signal systems, and the number of pedestrian calls signalized intersections receive, to better understand signal performance.

Can origin/destination information on arterials be derived? In what settings/cases?

- Origin/destination information can be derived, but the current sample size may not be large enough for transportation planning uses. With a larger data sample, certain origin/destination estimations could be derived.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- Future uses:
  - In the future, RTC would like to have data about incidents, construction, signal pre-emption, adaptive signal systems, and the number of pedestrian calls signalized intersections receive, to better understand signal performance.
  - Real-time data could be used in the future, for example Waycare uses traffic data for incident detection on freeways. This could potentially be adapted for incident detection on arterials.
- Challenges:
  - Learning how to best use the data.
  - Training and educating staff on use of the data.
  - Learning from signal timing staff to apply their expertise to potential uses of the data.

- Overall data processing, management, and displays (e.g. performance metrics, how to display to different audiences such as elected officials).

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- It is an ongoing, iterative process. The first wave of needs has begun to be understood, and the agency's needs will be better met if datasets are increased.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- The agency now has more complete datasets, with usable granularities.
- Cost savings, as the agency doesn't spend as much for travel time runs conducted by staff or contractors.
- Less need for field detection equipment, with more data available from the probe vehicles.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- Users of the data have a good sense for accuracy. Sometimes outlier data points may be deleted to improve accuracy.
- Visual inspection using the analytics tools will show accuracy, and analysis by the agency's signal staff can also determine accuracy.
- The data is accurate enough for the agency's current uses.

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Reporting of speed data works well, for example to report average speeds.
- It is easy to convert the speed data into travel times.
- The speed data works well to convey information to the general public, as speeds are understandable to them.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- Speed probe data has improved with larger datasets collected using additional agency fleet vehicles as probes.
- The source data has very strong granularity, at 1-2 second intervals.
- Finer granularity of the speed data could be explored for safety applications at intersections, such as connected vehicle applications.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- It is important to formalize interactions with other agencies using probe data, to learn from one another.
- This agency-gathered vehicle-based speed probe data appears to be fairly unique.
- It will be beneficial to pair the expertise of signal professionals with the big data expertise with third-party data providers.

Synthesis of Probe Speed Data for Arterial Operations

Liz Schneider
Wisconsin DOT
August 12, 2020 Interview Notes

Procurement

What was the reason(s) for procuring probe speed data for arterials?

- Wisconsin DOT (WisDOT) initially purchased to provide alternate route travel times.
  - During 2014 and 2015 there were two major construction projects preparing for long term closures and WisDOT wanted to provide travel times for alternate routes versus the work zone routes.
- One project conducted an RFI (responses were received from Bluetooth and third-party providers) and then an RFP. TomTom was selected to provide arterial speed probe data on the alternate arterial routes (e.g. state routes, county low volume roads).
- The second project utilized Bluetooth detection to inform drivers of travel times on a parallel route to the construction location.
- WisDOT pays by the mile for GPS based third-party arterial speed probe data (not statewide) and has the option to expand data throughout the contract duration. There is a lot of flexibility with the third- party provider's service, as WisDOT can add or delete routes.

Who is the third-party data provider?

- TomTom

How long has your agency been using probe speed data for arterials?

- Bluetooth based 2014
- GPS based probe 2016

Are you procuring just raw speed data or also an analytics platform provided by a third-party provider? Have you built your own tool(s) to analyze the data?

- Procuring raw data only
- Provider has archived data
- WisDOT's ATMS uses the data:
  - The ATMS imports the data from the TomTom Application Programming Interface (API) in addition to other traffic data sources.
  - The ATMS allows users to turn on/off various data displays (Bluetooth, Remote Traffic Microwave Sensor (RTMS), TomTom probe speed data). Note that RTMS are not used on arterials.
  - There is a global setting in the ATMS that allows users to configure which data sources will be used, in priority order. If the designated priority 1 data source is not available, then it will go to the next source to calculate travel times.

Speed Probe Data Use

How is your agency currently using speed data on arterials?

- Travel Times
  - Display travel times from arterial probe speed data on freeway message signs and hybrid signs and arterial DMS
  - For construction projects, if travel time from arterial probe speed data on alternate routes was faster than the freeway route the DMS would change the travel time message display to the driver. If the travel time on the freeway is less than the alternate it would not be shown on the DMS.
- Traveler Information
  - Arterial probe speed data is used to populating 511 for specific or selected routes. The probe speed data comes through the ATMS to the 511 provider.
- Performance Monitoring
  - WisDOT has used archived TomTom data for freeways, not on arterials.

What is the granularity of the data provided (e.g. 15-minutes, hourly, AADT)? Are you using speed probe data in real time, historical, or both?

- 1-minute intervals
  - DMS are capable of updating every minute. However, the ATMS performs smoothing so the travel time message doesn't display one minute changes too frequently.
- WisDOT uses arterial probe speed data in real time. Detailed Bluetooth data is archived

Where is it used? Are you able to analyze an individual traffic signal or only aggregate at a corridor level?

- N/A. Arterial probe speed data is procured only for selected routes, not statewide.

Are other data sources used on arterials to supplement the speed probe data?

- Hardware based data (e.g. some loop detectors and some Bluetooth). Each data source is treated separately and prioritized in the ATMS.

Can origin/destination information on arterials be derived? In what settings/cases?

- Through Bluetooth, yes. Not through probe speed data.

How might your agency use the speed probe data in the future, beyond current uses? What barriers or challenges prevent these uses currently?

- Incident detection
  - WisDOT is proposing to use probe data for incident detection on freeways, not arterials.
- Challenges:
  - Staffing challenge: Probe data is managed by the operations group which does not include GIS staff. GIS staff are involved in many other projects and it is not yet a priority to dedicate staff to integrate third-party probe data into operational systems.
  - Software development and storage for a database to process the geo/GIS based formats is not currently underway.

Needs Being Met

Have your agency needs been met with arterial probe speed data? If not, what is needed from probe speed data?

- Needs have been met using probe speed data on arterials.
- WisDOT has not verified TomTom data on arterials against the Bluetooth data that is also used.

Has speed probe data changed your practices (e.g. more complete datasets, reduced sensor deployments, cost savings)? In what ways?

- Yes, can supplement with probe data in work zones where physical detection and communications can be disrupted unexpectedly due to lane shifts, crossovers, damage, disconnections.

Evaluation Results

Has your agency evaluated the third-party data for accuracy? How was the accuracy determined (e.g. compared to sensor data)? What accuracy levels have you seen? Is it accurate enough?

- Yes, WisDOT partnered with the University of Wisconsin – Madison to evaluate probe data, comparing it to multiple sources on different highway classes. TomTom data was accurate on freeways.
- Analysis not conducted for probe data on arterials.

Are there situations or conditions where speed data works best for arterials? What conditions are least favorable?

- Probe speed data is more reliable with more consistent traffic (more samples/probes).
- Arterials have a lot of conflicting movements (e.g. driveways, signals) which affects the accuracy of probe data.

Have there been improvements in the data over time (e.g. has the granularity of the data progressed over time, has the accuracy of the data improved)? Have you adapted your use of the data based on changes to the granularity of the data?

- GPS based probe data was reviewed in early 2000's, and it's better now. The probe providers have made it easier to use interfaces to map routes and receive the data via an API.

Other

Do you have anything else to share about your experience with use of probe speed data for arterials?

- Probe data is received every minute. WisDOT has additional flexibility to configure Bluetooth data outside of the ATMS system. Bluetooth data can be configured to average travel times over different times. This improves responsiveness to changing congestion conditions

Appendix B: Interview Notes – Third-Party Probe Data Providers

- HERE Technologies
- INRIX
- TomTom

ENTERPRISE

Synthesis of Probe Speed Data for Arterial Operations

Finn Swingley and Frank Corsaro, HERE Technologies

October 5, 2020 Interview Notes

Availability/Accuracy Speed Data

Where is arterial speed data available (e.g. probe locations)? What is the granularity of the speed data provided (e.g. 15-minutes, hourly, AADT)?

- Coverage:
  - HERE traffic data uses the Traffic Message Channel (TMC)-coded network. This covers all major roads, including U.S. and state roads. Within metro areas, the data covers road classifications 1-4, covering all roads except local streets.
  - HERE also offers some coverage outside the TMC-coded network.
- Temporal Granularity: Real-time speed data is provided on a 1-minute update cycle.
- Spatial Granularity: Spatial granularity depends on the network. Spatial granularity is more dense in metro areas, compared to rural areas. The sub-TMC network provides higher granularity when changes in speeds are present.

What sources of data are used to determine arterial speeds?

- HERE uses a robust mix of GPS-probe data sourced from over 120 aggregators of GPS probes. Sources include connected devices (e.g. cell phones), personal navigation devices, and connected vehicles.

Are there thresholds or conditions when arterial speed data is provided (e.g. probe saturation rates)? If so, what are these thresholds, situations, or conditions?

- TMC Network:
  - HERE provides a continuous data feed at 1-min intervals for the entire TMC network.
  - HERE Real Time data is available continuously on the TMC coded road network. When probe data is not directly available, interpolation based on a historical dataset is used to generate speed data. Real time data is also available outside the TMC coded network when sufficient probe data is available. A Confidence Value is provided to identify whether data sourced from live probe data or from the HERE historical traffic dataset. HERE also offers historical probe data products at higher granularity resolution (HERE Traffic Analytics) and as a generalized aggregate "average" speed product called Traffic Patterns.
- Off-TMC Network:
  - Speeds are provided only when probe data is available.

Are there situations or conditions where arterial speed data is not available? Please describe.

- TMC Network:
  - The data is continuous. When probe data is not directly available, interpolation based on a historical dataset is used to generate speed data.

- Off-TMC Network:
    - Speeds are not provided when probe data is not available.

Has the arterial speed data provided by your company been evaluated for accuracy? What detection sources were used to validate the data? What were the results?

- The HERE data is tested internally on a routine basis. HERE services the automobile industry, which has high standards for data quality and accuracy. However, the results of this internal testing are not typically published publicly.
- The Eastern Transportation Coalition has conducted and published several evaluations testing the accuracy of probe speed data – both HERE freeway data and arterial data. In addition, individual state DOTs have evaluated the data for accuracy.
- It is difficult to test accuracy on arterials since vehicle speeds vary so much, with numerous stops and starts.
- Data on arterials has improved over time (especially over the last 2-3 years) based on significant increases in probe penetration rates. HERE has also fine-tuned their algorithms based on ongoing testing.

How is the data provided or delivered to transportation agencies? Do you offer any analytics tools for use of the data? Are any modules specific to arterial data? Can origin/destination information from the arterial probe data be derived and to what level of accuracy?

- Data delivery to agencies:
    - The speed data is provided as an API or as a URL-based XML feed.
    - The data is presented on various analytics approaches and platforms. For instance, agencies can use the HERE map platform to merge HERE data with other data sources for combined viewing.
    - An analytics historical database that can be queried is also available.
- Analytics tools:
    - HERE does not directly offer analytics tools, with the exception of a simple viewing tool. Rather, HERE partners with two major traffic analytics platforms: RITIS and Iteris ClearGuide. These platforms integrate and display HERE data, for users to view and perform analytics functions.
    - Arterial Turn Lanes Service: HERE has recently begun to offer an "Arterial Turn Lanes" service which captures and reports delays associated with vehicles turning at intersections. This service has not been used by agencies yet but could be valuable for performing signal timings.
- Origin/destination (O/D) information:
    - HERE doesn't currently generate or offer origin-destination information.
    - HERE can offer the ability to access the data directly, so users could build O/D analytics, based on the data. Alternatively, HERE can work with their third-party partners to generate O/D information as a complete solution.

- Accuracy of origin/destination information is a challenge, to put a bound around what this includes (e.g. what are the zones? how many trips apply to population level?) Privacy limitations will also limit the amount of origin/destination information that can be shared.

Other

Do you offer any other data sets that would be beneficial to arterials, and if so what types of data?

- HERE is a premium map data provider. HERE maps include the locations of several attributes such as stop signs, traffic lights, lane counts, and lane configurations – all within the mapping file. This type of information is likely valuable to transportation agencies.

Do you have anything else to share about probe speed data for arterials?

- N/A

ENTERPRISE

Synthesis of Probe Speed Data for Arterial Operations

Ted Trepanier, INRIX

September 3, 2020 Interview Notes

Availability/Accuracy Speed Data

Where is arterial speed data available (e.g. probe locations)? What is the granularity of the speed data provided (e.g. 15-minutes, hourly, AADT)?

- At some level, probe data is provided everywhere, however there are different ways the data is processed.
  - Primary sources for INRIX speed data services are GPS points that provide location, direction heading, and speed from cars, trucks (fleets) and mobile devices.
  - Real-time speeds are provided on every segment, every minute.
  - INRIX archives the data. In addition, RITIS also archives the data provided by INRIX every minute to query and visualize.
  - INRIX Trip Paths data (not real-time data) provides the GPS path/chain to show what segments a vehicle traveled (origin and destination) on any route (including arterials). This data is similar to information collected in a floating car survey that provides speed distribution for every segment on the observed route.
  - INRIX has developed a signal analytics platform (historical data) that provides performance measures based on observed trips at the movement level. Metrics include: approach speed, travel time, control delay, percent arrival on green, and split failures in addition to turning movement percentages.
- INRIX has been providing probe data for 15 years. However, the amount of source data available has grown tremendously since 2019 with an increase in communications for connected vehicles. This has increased GPS source data to INRIX across the US by more than tenfold, improving coverage on all class of roadways with the biggest impact being on the arterial and local road coverage.

What sources of data are used to determine arterial speeds?

- GPS point source data from connected vehicles including automobiles, trucks (with data binned in 3 weight classes) and mobile devices

Are there thresholds or conditions when arterial speed data is provided (e.g. probe saturation rates)? If so, what are these thresholds, situations, or conditions?

- Every minute INRIX processes data to calculate real-time speeds by segment. Density is assessed as part of a continuous process. There is no single published threshold as required density has several variables.
- The Trip Path data provides observed speed samples on all routes that is transparent as to the number of observed samples.

Are there situations or conditions where arterial speed data is not available? Please describe.

- Data is available pretty much everywhere. There are low volume segments where data density does not provide for quality real-time speed data. And many where overnight volumes do not support real-time reporting. Low volume routes are not included in real-time coverage while historical data is available on most all roads above the level of local collector. For segments included in the real-time coverage maps, INRIX looks at whether or not the source data consistent enough for real-time reporting as a continuous operation. If not, historical data is used to publish a speed value. INRIX publishes a number (score) reflecting whether sufficient data is available.

Has the arterial speed data provided by your company been evaluated for accuracy? What detection sources were used to validate the data? What were the results?

- The Eastern Transportation Coalition has evaluated INRIX data for several years. The freeway data has been accurate, so they transitioned to focusing on arterial probe data a few years ago. The results are published on the coalition web site.
- INRIX uses Bluetooth data and floating cars to measure against the published probe data. One recent evaluation in Florida found that INRIX penetration is double (10%) over Bluetooth data (5%).

How is the data provided or delivered to transportation agencies? Do you offer any analytics tools for use of the data? Are any modules specific to arterial data? Can origin/destination information from the arterial probe data be derived and to what level of accuracy?

- INRIX provides speed data directly via APIs and as a comprehensive service with analytic tools. See docs.inrix.com for API documentation and visit inrix.com for general information on analytics.
- Through the RITIS platform there are modules specific to arterials (signal analytics which provides individual trip observations/floating car and trip analytics). Both modules are powered with data that is mined out of the trip records. All metrics are based on observed trips, no modeling is involved in either module.
- The INRIX analytics tools are transparent in terms of what the sample size is.

Other

Do you have anything else to share about probe speed data for arterials?

- Source data is growing rapidly and information/conclusions shared has a short shelf life. If an agency is considering probe data it is critical to contact vendors for demonstration and to learn what is new to meet the agency's needs.

ENTERPRISE

Synthesis of Probe Speed Data for Arterial Operations

John Auble and Douglas Gilmour, TomTom

September 10, 2020 Interview Notes

Availability/Accuracy Speed Data

Where is arterial speed data available (e.g. probe locations)? What is the granularity of the speed data provided (e.g. 15-minutes, hourly, AADT)?

- TomTom can provide both live and historic road traffic speed data for Arterials. These speeds relate to passenger car speeds only.
- In general, TomTom Live Traffic Flow and Incident Feeds are available for all roads in Functional Road Classes 0 to 5 (from Federal Highway through Secondary Interconnecting roads). In addition to Live Feeds, we provide ready visualization of the data via Live Traffic API services.
- Our Live Traffic services and Live Traffic API services are updated every minute.

What sources of data are used to determine arterial speeds?

- TomTom sources GPS probe data from in-vehicle systems (in-dashboard and on-dashboard navigation systems) and from mobile navigation applications (TomTom's own, handset manufacturer and third-party apps). This data is anonymized, map-matched, processed and aggregated to provide live traffic services as described in this document.

Are there thresholds or conditions when arterial speed data is provided (e.g. probe saturation rates)? If so, what are these thresholds, situations, or conditions?

- No. We provide live speed data on arterials whether sufficient live GPS probe data exists to calculate speeds or detect incidents. In the rare instance that there is not sufficient GPS probe data available, then TomTom falls back on historic speed data. This historic speed data product is produced from aggregated averaged speed information collected over a 2-year period, updated quarterly.
- The availability or otherwise of live speed observations is captured within the quality statistic called "Confidence Value" provided within our live traffic feeds.
- In addition, TomTom filters out GPS observations that are not related to vehicular traffic on the road network, in real time, for example bikes or pedestrians.

Are there situations or conditions where arterial speed data is not available? Please describe.

- See answer above.
- Even during Covid19 lockdown, we have had sufficient data to measure live observed speeds on arterials in the US.

Has the arterial speed data provided by your company been evaluated for accuracy? What detection sources were used to validate the data? What were the results?

- TomTom Live Traffic Flow coverage (QBench) and Incident Detection quality (QKZ) is monitored continuously (24/7), automatically, internally (in our Azure server environment) and using industry standard measures.
- TomTom uses the TISA's QBench quality methodology to ensure the good quality service. More information on QBench can be found here:
  - https://tisa.org/wp-content/uploads/SP16002_TISA_QBench_Guidelines_v1.0.pdf
  - https://tisa.org/wp-content/uploads/SP16001_TISA_QBench_Calculations_v1.0.pdf
- In the past we have also used drive testing to confirm observed speeds

How is the data provided or delivered to transportation agencies? Do you offer any analytics tools for use of the data? Are any modules specific to arterial data? Can origin/destination information from the arterial probe data be derived and to what level of accuracy?

- TomTom has different delivery methods which best suit different customers:
  - TomTom Intermediate Traffic – a server-2-server bulk delivery of the whole Traffic Flow and Traffic Incidents feeds. The Intermediate Traffic requires decoding knowledge of either TMC or OpenLR location referencing methods.
  - TomTom Traffic APIs – developer REST APIs part of our Developer Portal offer.
  - TomTom Move – the TomTom Traffic Analytics suite of products, including TomTom Origin-Destination Analysis.

Other

Do you offer any other data sets that would be beneficial to arterials, and if so what types of data?

- By way of a summary, we provide the following data for Arterials:

Product	Description
Live Traffic Flow	Live observed speeds for every directional road segment for most major and minor roads (functional road classes 0-5 where 0 is freeway, and 5 is a minor interconnecting road)
Live Traffic Incidents	Live speeds through congestion, incidents, unscheduled delays, roadworks and due to accidents.
Traffic Stats	Historic fully observed speeds (and sample volumes) for every directional road segment on routes or in areas selected by you, for date ranges and time periods selected by you.
Junction Analytics (Beta)	Live speed, delay, red time, cycle time and queue length at intersections selected by you.

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