February 2026 | Prepared by: Athey Creek Consultants

ENTERPRISE

Alternative Methods of Traffic Data Analysis

ENTERPRISE TRANSPORTATION POOLED FUND STUDY TPF-5(490)

FINAL REPORT

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Transportation agencies are familiar with traditional traffic data (e.g., speed, volume) produced from traditional data collection methods (e.g., tube counts) and the traditional methods to analyze the data to produce origin-destination tables, segment speed delay etc. However, there are new and emerging traffic data sets (e.g., ubiquitous speed, vehicle specific data) collected from new and emerging data sets (e.g., third-party probe data, sensors) and corresponding alternate methods to analyze the data to understand, for example harsh braking, delays, or level of service/return to normal. The new and emerging traffic data collection methods produce a lot of data (often referred to as Big Data), and some transportation agencies have hired data scientists and Artificial Intelligence (AI) specialists to conduct data analysis. The analyses and processing of these large sets of data often require additional skills and tools beyond traditional data analysis methods. This is not only due to the large volumes of data, but also because of additional factors such as the conflation of multiple data sets together. The objective of this project was to understand and document different transportation agency examples of new and emerging alternate methods of traffic data analysis through a literature review, interviews, and related webinars.</td></tr>
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The cover page image is provided courtesy Benjamin Wiens from Pixabay.

ENTERPRISE Members

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

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

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List of Abbreviations

AASHTO	American Association of State Highway Transportation Officials
AI	Artificial Intelligence
API	Application Programming Interface
ArcGIS	Arc Geographical Information System
ATSPM	Automated Traffic Signal Performance Measures
BTS	Bureau of Transportation Statistics
CAV	Connected and Autonomous Vehicle
CCS	Continuous Count Stations
CFI	Continuous Flow Intersection
CV	Connected Vehicle
CV PFS	Connected Vehicle Pooled Fund Study
DLT	Displaced Left Turn
DMS	Dynamic Message Sign
DOT	Department of Transportation
ENTERPRISE	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency
ESRI	Environmental Systems Research Institute
FDOT	Florida DOT
FHWA	Federal Highway Administration
FME	Feature Manipulation Engine
GIS	Geographic Information System
GIS-T	GIS for Transportation
GPS	Global Positioning System
IRIS	Intelligent Roadway Information System
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
ITS America	Intelligent Transportation Society of America

IVHS	Intelligent Vehicle Highway Systems
IWZ	Intelligent Work Zone
JPO	Joint Program Office
JTRP	Joint Transportation Research Program
LBS	Location-based Services
MnDOT	Minnesota DOT
NCDOT	North Carolina DOT
NCHRP	National Cooperative Highway Research Program
NCITE	North Central Institute of Transportation Engineers
NDW	Nationaal Dataportaal Wegverkeer
NOCoE	National Operations Center of Excellence
PBSPM	Probe-based Signal Performance Measures
PNT	Position, Navigating, and Timing
PPD	Purdue Probe Diagram
RITIS	Regional Integrated Transportation Information System
ROW	Right-of-way
TDA	Transportation Data & Analytics
TETC	The Eastern Transportation Coalition
TMAS	Travel Monitoring Analysis System
TMSO	Transportation System Management and Operations
TTAP	Tennessee Transportation Assistance Program
TVT	Traffic Volume Trends
USDOT	United States Department of Transportation
VMT	Vehicle Miles Traveled

Executive Summary

The objective of this project, *ENTERPRISE Alternative Methods of Traffic Data Analysis*, was to gather information and document different transportation agency examples of new and emerging alternate methods of traffic data analysis. Specifically, a series of outreach efforts were conducted, including a literature review, interviews, and related webinars. This report documents the findings of those efforts to help practitioners understand the state of the practice regarding new and emerging alternate methods of traffic data analysis. In the past decade, increased connectivity between vehicles and the infrastructure enabled a rapid expansion of individual vehicle data being recorded and stored for use. As a result, there is now an extensive amount of information about various vehicle classes (e.g., commercial vehicles, passenger vehicles) that has added considerable additional data sources. Advancements in traffic data analysis are largely driven by advancements in traffic data collection and availability of richer data to analyze.

The research in this report reflects the findings of a literature review supplemented with key interviews, when available, and related webinars. Literature review, interview, and webinar findings include the following observations:

- **Increased data sources**
  - There is an increasing number of vehicles that are connected and able to report data describing their movement which has increased data available for traffic analysis.
  - Additionally, increased monitoring of the roadways through cameras supplemented with artificial intelligence (AI) or other processing and analyses adds to the data now available.
- **Transition of ownership of data**
  - In the 1980s era, state and local Departments of Transportation (DOTs) typically owned all detectors and were responsible for maintenance and calibration. They had a good understanding of the performance of these collection devices, but all costs of ownership and operations were borne by the DOTs, and this limited the areas where data could be collected by the number of devices.
  - In 2026, there are considerably more data sources. Some are increased data collected and owned by DOTs, but other data sources are available for purchase for either the data collectors or consolidators. This enables DOTs to purchase data sets without ramping up considerable equipment costs. However, as the DOT is not responsible for collection of the data, there may be less information available about the accuracy of the data (e.g., during low traffic periods, the number of vehicles contributing to average speeds may be limited).
- **Increased data users**
  - With the increased data that is now available, there are examples of new groups or individual users within the DOT now benefiting from the data. One example cited in this report is new data sources that provide information on the availability of truck dwell times at rest areas, which are of possible use for multiple groups within the DOT.

- With additional users of the data, there is expected to be additional needs for data processing and data analyses to meet the specific needs of the additional users.
- **Observed changes in data analysis and display**
  - One area that was identified repeatedly in the research was the current use of data conflation (i.e., merging multiple data sets from multiple data sources and possibly different geographic and temporal attributes together). Data conflation is essential to make use of all the new data sources. This is a role that traditional traffic engineering positions may be less comfortable and familiar with and is a candidate for data scientists (either within the DOT or as outside consultants), research universities, or companies that perform the role of data assembly and delivery.
  - The examples described in this project also indicate a movement towards increased use of visualization to display data and information in usable mediums all that can be learned from the data. Specific examples described below include:
    - Visual displays to articulate truck dwell times at rest areas.
    - Visual time lapse displays showing the impacts of a hurricane on traffic volumes displayed in conjunction with the arrival and departure of the hurricane.

  In summary, the use of visualization and visualization tools appears to be a key mechanism to enable engineers, planners, and other operations personnel to understand key messages from the massive volumes of data that have been conflated and analyzed by data scientists or other specialists that analyze the data.

The use of visualization and visualization tools appears to be a key mechanism to enable engineers, planners, and other operations personnel to understand key messages from the massive volumes of data that have been conflated and analyzed by data scientists or other specialists that analyze the data.

Overall, this project provided ENTERPRISE members with examples of new and emerging alternative methods of traffic data analysis and key things to consider with new traffic data analysis methods.

Chapter 1: Introduction

Transportation agencies are familiar with traditional traffic data (e.g., speed, volume, occupancy) produced from traditional data collection methods (e.g., temporary pneumatic road tube counts, in-road sensors, non-intrusive sensors) and the traditional methods to analyze the data to support activities such as transportation planning, transportation management, and incident and event response. However, there are new and emerging traffic data and data sources that are now available, either for transportation agencies to collect directly or to procure from private vendors.

Technology and the new and emerging traffic data and data sources have created paradigm shifts in traffic data collection and analysis over the years across the following three generations of traffic data collection devices:

- **Early Traffic Data Collection Devices.** Traffic data analyses prior to the late 1980s or early 1990s used well established traffic data collection devices such as piezoelectric tubes and loop detectors (i.e., inductance loops that generate electromagnetic fields to detect the presence of vehicles) to detect the presence of vehicles. Through the use of multiple tubes or loops, detection devices could detect volume, occupancy, and speed as the primary data sources. As one example during this time, traffic volumes were collected on representative roadways and travel diaries helped to supplement the information to better understand travel demand through origin-destination tables.
- **Introduction of Advanced Technology.** With the introduction of technology solutions, initially known as Intelligent Vehicle Highway Systems (IVHS) and later referred to as Intelligent Transportation Systems (ITS), new technologies included non-intrusive detection devices that included radar, video and camera systems, and ultrasonic and infrared sensors.
- **Increased Vehicle Connectivity and Supporting Systems**. Around 2015, increased connectivity between vehicles and the infrastructure enabled a rapid expansion of individual vehicle data being reported that is stored and combined. As a result, there is now extensive information about various vehicle classes (e.g., commercial vehicles, passenger vehicles) that has added a considerable number of data sources.

In the 1980s, state and local DOTs typically owned all detectors and were responsible for maintenance and calibration. They had a good understanding of the performance of these collection devices, but all costs of ownership and operations were borne by the DOTs, and this limited the areas where data could be collected by a number of devices.

In 2026, there are considerably more data sources. Some increased the data collected and owned by DOTs, but other data sources supply data that is available for purchase for either the data collectors or consolidators. This enables DOTs to purchase data sets without ramping up considerable equipment costs. However, as the DOT is not responsible for collection of the data, there may be less information available about the accuracy of the data (e.g., during low traffic periods, the number of vehicles contributing to average speeds may be limited).

Research has shown that transportation agencies have actively been procuring and using this new and emerging data for several years. A 2021 survey conducted through a National Cooperative Highway Research Program (NCHRP) effort, *NCHRP Synthesis 561: Use of Vehicle Probe and Cellular GPS Data by State Departments of Transportation*, gathered information from 45 state DOTs plus the District of Columbia about the current state of practice for Global Positioning System (GPS)-based probe data sources. These findings indicated that:

- *Speed data* was used or purchased by all 46 (100%) of the agency respondents, including real-time or historical average speed data on one or more road segments.
- *Origin-destination data* was used or purchased by 26 (57%) of agency respondents (i.e., data that describes the origin and destination of a trip).
- *Location-based services data* was used or purchased by 20 (43%) of agency respondents (i.e., data obtained from private vendor applications on smartphones that periodically report the location of users).
- *Route/trajectory data* was used or purchased by 10 (22%) of agency respondents (i.e., data describing the path and routes of a trip from an origin to a destination).

The new and emerging traffic data enables agencies to access considerable amounts of data, and some transportation agencies have hired data scientists and AI specialists to conduct data analysis. The analyses and processing of these large sets of data often require additional skills and tools beyond traditional data analysis methods. This is not only due to the large volumes of data, but also because of additional factors such as the conflation of multiple data sets together.

Project Objective

To understand and document different transportation agency examples of new and emerging alternate methods of traffic data analysis.

The objective of this Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) project, *Alternative Methods of Traffic Data Analysis*, was to understand and document different transportation agency examples of new and emerging alternate methods of traffic data analysis. The project objective was accomplished through a literature review, interviews, and participation by ENTERPRISE members in related webinars.

Report Organization

This report includes the following sections.

- Chapter 2: Literature Review and Industry Outreach – Summarizes the resources reviewed as well as interviews conducted and webinars attended related to alternative traffic data analysis methods.
- Chapter 3: Key Takeaways and Implementation – Summarizes overall key takeaways found through the literature review, interviews, and webinars including a suggested implementation plan.

Chapter 2: Literature Review and Industry Outreach

This section summarizes the resources reviewed and key takeaways noted from the literature review to assist ENTERPRISE members in understanding different aspects to consider with alternate traffic data analysis methods. Throughout this project, the research team also attempted to identify individuals from multiple local transportation agencies to discuss their experiences with integration of private data sources identified in the literature review. There were two interviews conducted to learn additional aspects and details of alternate methods of traffic data analysis. Information on alternative methods of traffic data analysis was also documented through participation in related webinars. It is important to note that most of the efforts reviewed occurred in the last two years, highlighting the “new and emerging” aspect to this project.

The results from the literature review and industry outreach were not meant to provide an exhaustive list of all transportation agency examples with alternative traffic data analysis methods, but to identify overall traffic data analysis efforts of new and emerging data sources.

2.1 Forida DOT Datalytics Examples

Florida DOT’s (FDOT’s) Transportation Data & Analytics (TDA) Office identified a need to educate and inform their internal and external customers of the services and products they provide to the public. Their mission is to provide leadership for informed transportation decisions through data collection, analysis, integration, and dissemination.

FDOT is utilizing their data and performing analytics to provide examples of how the data can be used to further their mission and educate their customers. The web page FDOT Datalytics includes links to the end results of 14 efforts. The following summarize two related projects.

2.1.1 Traffic Impacts of Hurricane Milton

Key Takeaways

- **Combined Data Sets**
- **Data Visualization**

Combined datasets to create an animated video to illustrate traffic before, during, and after Hurricane Milton in Florida.

A few efforts on the FDOT Datalytics web page were focused on providing traffic impact time lapses due to hurricanes. The most recent traffic timelapse was conducted from Hurricane Milton in 2024.

FDOT collected and analyzed both real-time and historical traffic data for October 5–13, 2024 from Hurricane Milton that forced mass evacuation from a large majority of Florida. There were nearly 120,000 traffic counts in 1-hour intervals along major roadways, power outage data in 3-hour intervals, and similar traffic data from the Georgia DOT. All datasets had associated time and date stamps. Using Environmental Systems Research Institute’s (ESRI’s) Arc Geographical Information System (ArcGIS) Online Experience builder, ArcGIS Pro, and some digital animation software, FDOT developed an interactive application and a compelling animated video (Datalytics: Hurricane Milton Traffic Behavior) that showed the traffic behavior before, during, and after the hurricane. The visualization that is accomplished by the simultaneous display of the traffic volumes, location of the hurricane, power outages, and timestamps is a very effective display of the overall impacts of the storm. The end product tells the story of how the public responded to an emergency event and provides insight to improve future preparedness and response activities.

Source: FDOT Datalytics – Hurricane Milton Landfall Traffic Impact Time Lapse

2.1.2 Truck Parking Dwell Time Visualization

Truck parking is nationally recognized as a top issue for truck drivers. It is anecdotally understood to be a statewide issue based on surveys and interviews. However, prior to the analysis that inspired FDOT Datalytics it had not been quantified or understood well enough to take appropriate action. As with other strategic planning and investment decisions, a data-driven approach can effectively help alleviate this issue in locations experiencing the greatest over-utilization at designated truck parking locations or where unauthorized parking is most severe. Anecdotal examples suggest that truckers park for a multitude of reasons (e.g., homestays (after multiple days on the road), overnight parking) and each reason is associated with different dwell times.

> ***Key Takeaway***
>
> **New Data Analysis**
>
> Analyzed truck GPS data in Florida to:
>
> - Identify where trucks were stopped greater than an hour.
> - Determined when trucks are parked in unauthorized locations.
> - Conduct a statistical analysis to find areas of greatest concern.

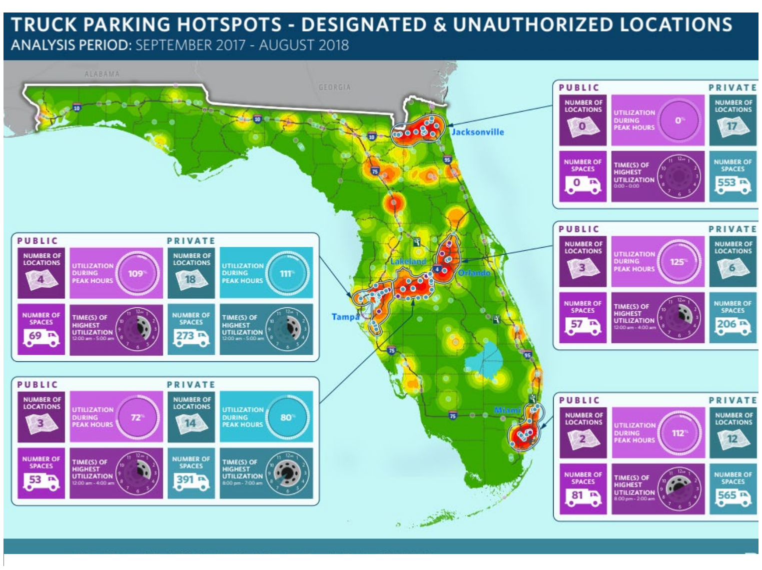

Figure 2.1 FDOT Truck Parking Hotspots - Designated & Unauthorized Locations

Statewide truck GPS analyses were further analyzed by FDOT to identify where and when trucks were stopped for the period of September 2017 through August 2018. An inventory of known (designated) truck parking locations, both public and private, was conducted and is considered the supply (or capacity). The demand (or volume) is the number, and location, of stopped trucks. These statistics can help transportation planners better understand where volume exceeds capacity, resulting in an over-utilized truck parking location. The data can also identify where trucks are stopped in an unauthorized fashion, namely within public right-of-way (ROW). This insight can then be used to identify where and why truck parking is of the greatest concern. Then appropriate solutions (projects, partnerships, policy updates, etc.) can be identified and tailored to each unique problem area. See Figure 2.1.

Source: FDOT Datalytics – Statewide GPS Truck Parking Dwell Times

2.2 Purdue University Examples of Traffic Data Analyses

Purdue University is an example of an industry recognized leader in traffic data analyses. Two examples of research activities related to alternative methods of traffic data analysis with an emphasis on CV data analysis are briefly summarized below.

2.2.1 Converting Connected and Autonomous Vehicle Data

Purdue University's Joint Transportation Research Program (JTRP) is using BigQuery and Google Cloud to convert Connected and Autonomous Vehicle (CAV) data. The converted data will include information that can be used to study, learn from, and inform innovation in transportation technology.

BigQuery is replacing on-site servers and software, and the data can be accessed by researchers and used for example by transportation agencies to adjust traffic signal timings and deploy warnings to drivers.

An online summary of Purdue University's use of BigQuery included the following:

"There's no question that BigQuery is more cost-effective than buying servers. With $10 worth of queries, we can do what would cost $20,000 of engineering and labor in the field. This is a real game-changer for using CAV data to provide agencies with actionable information for improving the safety and efficiency of their transportation systems." —Darcy Bullock, Director, Joint Transportation Research Program, Purdue University

Key Takeaways

- **Data Accessibility**
- **Cost Effectiveness**

Replacing on-site servers and software with BigQuery for researchers to access.

BigQuery is more cost-effective than buying servers by reducing engineering costs and labor in the field costs.

Source: Purdue University Traffic Research Program Cuts Data Analysis and Batching from Hours to Minutes with BigQuery

2.2.2 Continuous Flow Intersection Performance Measures

Another example of Purdue University research involving data analyses is their research into continuous flow intersection performance measures using connected vehicle (CV) data. In this research, Purdue University researched the performance of continuous flow intersections (CFIs) that are also referred to as displaced left turns (DLTs). CFIs are intersections where left-turn movements are relocated to the left side of opposing traffic to improve flow at intersections with heavy left-turn movements. In this study, CV trajectory data was collected in West Valley City, Utah. Over 4,500 trajectories and 105,000 GPS points were analyzed. The study documented three CV-based techniques that were used to evaluate CFI performance, as follows:

- Conventional and extended Purdue Probe Diagrams (PPDs) – A CV-based tool that provides insights into the experiences of vehicles traveling through intersections.
- Performance Summaries – An approach of using heatmaps to assess all movements at various intersections simultaneously by time of day.
- First Stop Distribution – The use of linear referenced histograms that visually show the distribution of where vehicles first come to a full stop.

This research is one example of the use of CV data, data analytics, and data visualization to assess performance measures and visually display results.

Source: *Continuous Flow Intersection Performance Measures Using Connected Vehicle Data*

2.3 Netherlands National Road Traffic Data Portal

In the Netherlands, the Nationaal Dataportaal Wegverkeer, abbreviated NDW (National Road Traffic Data Portal) is a partnership that serves as a collaborative hub for traffic information. Rijkswaterstaat, a national agency dedicated to enhancing the safety, mobility, and quality of life in the Netherlands, is a key partner in this. The National Road Traffic Data Portal from the NDW stores and makes data available to road authorities and other service providers. Additionally, the Data Portal also monitors data quality and enriches the data.

Key Takeaway

Data Warehouse

Stores data from and about road traffic by collecting data, monitoring data quality, enriching data, storing the data, and making it available to road authorities.

According to the NDW website, *"NDW collects, combines, and distributes real-time data about the road situation and has set up a big data environment in the cloud to make it easier to consult large data sets."*

Source: *National Road Traffic Data Portal*

2.4 USDOT: Post-event Connected Vehicle Data Exploration – Lessons Learned

The Federal Highway Administration (FHWA) Office of Highway Policy Information conducted a study on the use of CV data. In this study, data from a private data provider, as well as data from the United States Department of Transportation (USDOT) Joint Program Office (JPO) CV pilot project were sources for the data. The study describes the valuable data sets that were able to be extracted from the CV data, including hard vehicle acceleration and deceleration data, vehicle speeds, seat belt usage, and windshield wiper status. The study found that the geolocation data that is tied to each of the datasets were particularly significant as they were able to support analyses to identify areas where potential geometric and pavement inadequacies may exist.

The study also described how a suitable platform for data storage, access, and analytics must be acquired based on the programming language it supports and the expertise of an organization's analysts in order to effectively use post-CV data. The study suggested that the focus should be on accessing and utilizing the data since from a cost perspective, accessing the data is more economical than owning it.

The study went on to acknowledge that while the CV data is mainly machine-generated, it may still have quality issues and advised agencies to consider performing data quality checks on the data.

Source: Post-event Connected Vehicle Data Exploration – Lessons Learned

Key Takeaways

- **New Data Sets**
- **Effectively Using the Data (not owning the data)**

CV data offers valuable data sets that are otherwise not currently available.

Georeferencing data to known locations supports advanced analytics.

Data storage, access, quality checks, and analytics are critical to effectively using the data.

The study suggests accessing and utilizing the data is more economical than owning it.

2.5 Transportation Agency Examples of Data Analyses and Uses

The Connected Vehicle Pooled Fund Study (CV PFS) developed a Connected Vehicle Data Architecture. As part of this effort, outreach interviews were conducted to understand how DOTs are using CV data and the data analytics involved in the use of the data. These findings are summarized at a high level below, and can be found in the CV PFS document at the CV PFS Connected Vehicle Data Architecture Report.

- The Maricopa Association of Governments described that they receive individual vehicle data from a vendor and store the data to conduct queries that generate data to replicate floating car surveys, supporting corridor-wide signal retiming.
- Maryland DOT works with a private CV data provider that equips Maryland DOT fleet vehicles with applications that communicate their position. This allows Maryland DOT to access the positions and movements of their fleet vehicles in near real-time and also allows Maryland DOT to provide access of their data to the HAAS Alert system (using a direct feed from the CV data vendor to HAAS Alerts).
- Minnesota DOT (MnDOT) procures segment travel time data from a private vendor. Minnesota DOT's Intelligent Roadway Information System (IRIS) accesses the data immediately and generates messages for display on Dynamic Message Signs (DMS) located throughout the metro

area. The IRIS software communicates the travel times to DMS for display. No storage or access to the data is needed beyond this immediate use.

- The city of Montreal described their use of private vendor data. They access the data through the vendor's Application Programming Interface (API) and use incident, speed, and travel time data in near real-time.
- Maryland DOT and Georgia DOT users access historical data through the Regional Integrated Transportation Information System (RITIS) data portal. This eliminates their need to store data and provides a readily available query for any authorized user to access the data.

Source: CV PFS Connected Vehicle Data Architecture Report

2.6 USDOT: Travel Monitoring Analyses System

The Travel Monitoring Analysis System (TMAS) is an internal FHWA data program that assists in the collection and analysis of data on traffic volumes, vehicle classification, truck weights for traffic statistics, and analysis. TMAS is used for development of policies and regulations. The monthly data are published in the Traffic Volume Trends (TVT) report that estimates the percentage of change in traffic for the current month from the same month in previous years and

- Is based on hourly traffic count data from 5,000 continuous monitoring stations nationwide.
- Includes quality-controlled Vehicle Miles Traveled (VMT) for each state for all roadways.
- Uses experimental generative AI.

> ***Key Takeaway***
>
> **Data Consistency**
>
> State DOTs upload data (e.g., traffic volumes, vehicle classification) to create a monthly traffic volume trends report.

TMAS provides online data-submitting capabilities to enable State traffic offices to upload their Continuous Count Stations (CCS) data to FHWA. Access to TMAS is obtained through the FHWA Division office in each State.

Source: FHWA's TMAS Data Program

2.7 Summary of The Eastern Transportation Coalition Vehicle Telematics Proof of Concept

The Eastern Transportation Coalition (TETC) conducted a pilot proof of concept by considering the question "Could CV data be used as a real-time data source to estimate volumes, and if so, what would be needed to make this possible?"

In 2020, TETC conducted a pilot study on the use of data from a private sector data source to estimate traffic patterns during a hurricane. Six southeastern states (Georgia, Virginia, North Carolina, Florida, Tennessee, Alabama) participated in the pilot. The volume of data was extensive, with over 75 billion data points per month, resulting in 230 billion data points in the 3-month pilot study period for the states involved. *The project report summarized the impacts of the data size as follows: "It showed that managing CV data at scale is challenging for the industry and that sheer size and velocity of the data will require efficient processing architecture, as well as streamlined calibration, calculation and conflation techniques."*

The validation process included simple scaling factors based on roadway class, time-of-day, day-of-week, and state were demonstrated to provide a workable and sufficiently accurate traffic volume estimate. Including additional factors and leveraging more advanced machine learning may improve accuracy. Overall, the pilot points to a viable path toward real-time traffic volume estimates based on CV data."

> ***Key Takeaway***
>
> **Data Challenges**
>
> As noted in the TETC report: *"CV data at scale is challenging for the industry and that sheer size and velocity of the data will require efficient processing architecture, as well as streamlined calibration, calculation and conflation techniques."*

Other observations from the pilot included that traffic volumes are most demanded, but hard to get with small sample sizes, integration of these new data types into existing agency operational workflows is very difficult, and since this was for hurricane assessments, lack of information from trucks was challenging and speaks to a "narrow band" of vehicles reporting.

Source: Hurricane Proof of Concept Results: States' Experiences with Real-time Connected Vehicle Data

2.8 Industry Provided Position Summary for a Traffic Data Scientist/Statistician

The position of a Traffic Data Scientist within a state or local DOT is a relatively new position and one that many DOTs either do not staff or have only staffed in recent years. The National Operations Center of Excellence (NOCoE) is a collaborative effort of the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITS America). Recognizing the increasing need for DOTs to hire and staff positions with experience in traffic data science and statistical analyses, NOCoE has defined a description for use by transportation agencies that are considering hiring a traffic data scientist/statistician as follows:

> ***Key Takeaway***
>
> **Need for Data Analysts**
>
> To enable new approaches to solving traffic/transportation problems to improve safety, system efficiency, and quality of life in our community.

"The Traffic Data Scientist/Statistician is responsible for extracting, organizing, integrating, analyzing, and communicating information obtained from a variety of traffic and/or toll data sources. The purpose of this role is to develop predictive analytics and performance measures, to enhance the planning process, and to enable data driven decision-making for the Transportation System Management and Operations (TSMO)

Office. The successful candidate will possess strong technical skills for grappling with big data, the ability to communicate with diverse groups of stakeholders to share information and provide guidance for technical decisions, and the curiosity to examine current practices and push the department toward new and better ways of thinking. The overall vision is that the Traffic Data Scientist/Statistician will enable new approaches to solving traffic/transportation problems to improve safety, system efficiency and quality of life in our community."

Source: NOCoE Traffic Data Scientist/Statistician

2.9 University of Maryland's Data Analytics Program

The University of Maryland's RITIS is a platform for transportation data analysis, monitoring, and visualization. CV data and location-based services data (LBS) is consumed by RITIS. Agencies can purchase data from vendors and have RITIS ingest the data or the data can be purchased through the University of Maryland. There is a cost to use the RITIS platform, and there are 50 different analytics tools available.

Key Takeaway

Combine Data Sources

RITIS can ingest a variety of data (e.g., ITS sensor data, incident management plans, real time weather data) to be used for many different analyses including real-time situational awareness, safety analytics, historical analysis, and trip analytics.

RITIS can ingest a variety of data (e.g., ITS sensor data, incident management plans, real time weather data) to be used for many different analyses including real-time situational awareness, safety analytics, historical analysis, and trip analytics. CV high frequency data streams (location every 5 to 15 seconds) are used by Maryland DOT for signal performance measures. Maryland DOT also uses these data streams in rural areas to identify issues to avoid sending out technicians.

There are variety of RITIS Resources that provide additional information: RITIS Report Templates page, RITIS Tool Catalog, RITIS Tutorials, and RITIS Support.

Sources: Login - RITIS and North/West Passage: Purchasing Data from Vendors of Connected Vehicle Data

2.10 Iowa DOT Input on Data Warehouse and Data Mart

Iowa DOT utilizes a data warehouse/data mart as a central repository for information and provides a storage backup for Iowa DOT to analyze data. The traffic data has transitioned over the years from .csv files to data provided through APIs.

There are a variety of tools used by the Iowa DOT to analyze or process the data including Power BI, Feature Manipulation Engine (FME), Excel, ArcGIS, ESRI, and RITIS.

Visualization tools and dashboards have then provided a way to see and interpret the data. For example, RITIS is used by Iowa DOT staff to analyze and view data. A lane closure planning tool calculates average volumes from sensors to determine when to close lanes. In addition, staff use an Intelligent Work Zone (IWZ) dashboard that provides performance measures for IWZ to view how each work zone is performing.

The Institute for Transportation at Iowa State University Operations & Safety Dashboards website provides a list of dashboards that have been developed at the Iowa State University – Institute for Transportation to support traffic operations and traffic safety research at the Iowa DOT. This page includes links to internal (available for DOT staff only) and external (publicly available) dashboards that can be used for data analysis.

It is a challenge for Iowa DOT to continually inform staff of the data sources, dashboards, and available data analytic options. There is now more data available that has been used to guide TSMO plans, identify field device deployment locations, and provide data driven decisions. With more data there have been efficiencies, but there is even more data available.

Key Takeaways

- **Data Warehouse**
- **Data Visualization**

Iowa DOT utilizes a data warehouse/ data mart as a central repository for information and provides a storage backup for Iowa DOT to analyze data.

Visualization tools and dashboards have provided a way to see and interpret the data.

Data analysis is conducted by consultants and in some cases by Iowa DOT themselves. Iowa DOT has an annual support contract with Iowa University. Iowa DOT staff reach out with specific issues and Iowa State has the data knowledge to determine the best data source and analysis for the issue. For example, probe data is a good data source for travel time reliability data. Sensor data may be used for updating speed limits and connected vehicle data for queue warnings.

The figure below highlights the overall data sources and how the data is accessed by Iowa DOT.

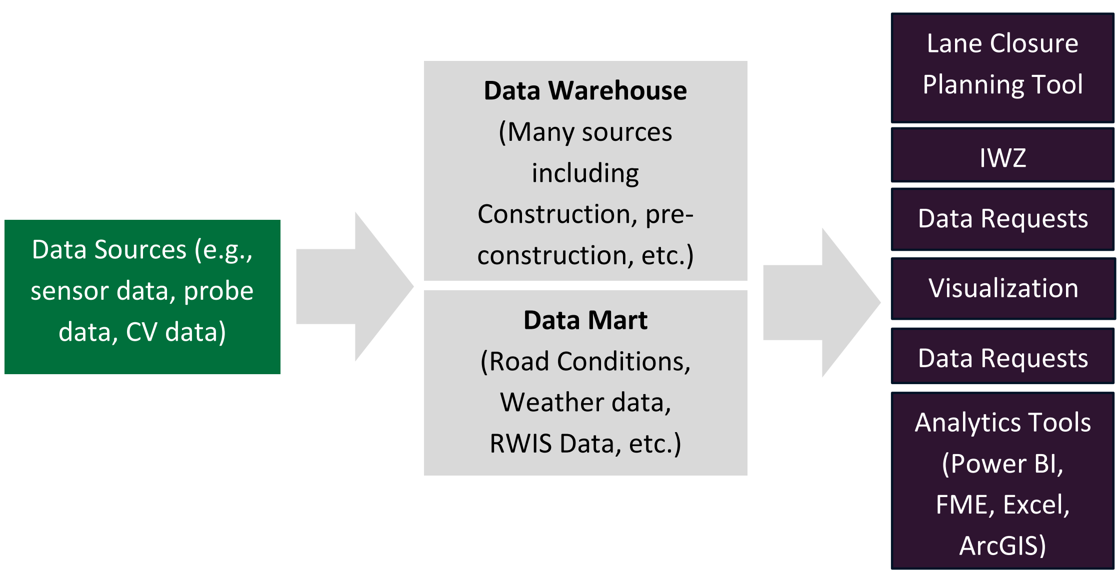

Figure 2.2 Illustration of Iowa DOT Data Sources and Access

Source: Iowa DOT webinar interview, August 2025

2.11 FHWA Bureau of Transportation Statistics Input on Data Analytics

A telephone interview was conducted with a representative from the FHWA Bureau of Transportation Statistics (BTS) in April 2025 to understand examples of data analyses approaches used by BTS. From discussions with FHWA BTS, the following were noted to be considered with data analysis.

Define Outcomes Needed from Data

It is important to understand what data is being collected, the analysis being conducted, and outcomes needed from the data. If the ultimate outcome is not known, the best approach is to collect the data for routing support, corridor analysis, or origin/destination tables. Ultimately, data needs to fit into some type of tool or analysis to make it useful.

Key Takeaways

- **Define Data Outcomes**
- **Data Visualization**

It is important to understand what data is being collected, the analysis being conducted, and the outcomes needed from the data.

Spatial visualization of analyzed data can present the data to show an area of impact, relational mapping, and relational calculation of impacts.

Data Elements

Critical data elements gathered include position, navigation, and timing (PNT). Position refers to the geographic location, navigation refers to the current movement, and timing refers to the precise time of data collection. With these elements present in the data set, the data has many uses, such as for alternate routing, navigation, or traffic analyses.

Expertise Needed for Data Analyses

There are different areas of expertise needed with data analysis. Transportation engineers will focus on defining why the data is being collected and how it is being analyzed to solve the project objective as well as documenting validation of the data. Cartographers, Geographic Information System (GIS) experts, and data scientists will bring the solutions to the desired analysis approaches.

Connections to Other Data Teams

There are many user groups of data that are collected, including asset management, traffic engineering, and traveler information. Asset management is a key resource and shares many use cases with other groups. GIS for Transportation (GIS-T) shares many similarities to operations and ITS groups.

Spatial Visualization

Spatial visualization of analyzed data can present the data to show an area of impact, relational mapping (e.g., DMS signs related to a closure), and relational calculation of impacts (e.g., impacts of a bridge failure).

Source: FHWA Bureau of Transportation Statistics phone interview, April 2025

2.12 Minnesota DOT Input on Leveraging Big Data and Data Analytics in Signal Optimization

On September 30, 2025, ITS Minnesota and the North Central Section Institute of Transportation Engineers (NCITE) hosted a webinar that shared a case study on the Minnesota DOT leveraging big data analytics in signal optimization. The case study was also presented on September 29, 2025, to the Tennessee Transportation Assistance Program. A recording of the presentation is available at: https://www.youtube.com/watch?v=7V827o9X9RA.

Key Takeaways

- **Combine Data sources (not replacing typical data sources or engineers)**
- **Data Validation**
- **Data Visualization**
- **Reduced Staff Time**
- **Increased Data Trends**

PBSPMs and high-resolution ATSPMs were integrated.

Local calibration (spot checks via MnDOT cameras) determined that the turning movement counts were accurate enough for signal optimization.

With the increased data from the project, visualization of the data was key through useful trends shown in charts and graphs.

With the use of the turning movement counts provided by the probe data, it has reduced staff needed to conduct field counts.

This project focused on 16 intersections in the south metro of the Twin Cities in Minnesota where tried and true signal optimization methodologies were combined with big data and analytics. The big data and analytics were not to be a replacement for traditional signal optimization methodologies and engineering but to add another layer to plan, for example, for incidents and special events. Probe-based Signal Performance Measures (PBSPMs) and high-resolution Automated Traffic Signal Performance Measures (ATSPMs) were integrated for the project. Because split timing is important with signal optimization, the probe-based movement data was converted into signal phase data.

The probe data was provided by Flow Labs that uses TomTom data as its primary data source. The data provides many metrics on a corridor, intersection, and movement level (e.g., turning movement counts, control delay). With the use of the turning movement counts provided by the probe data, it has reduced staff needed to conduct field counts. It was also determined through local calibration (spot checks via MnDOT cameras) that the turning movement counts were accurate enough for signal optimization. Flow Labs has completed a number of efforts to improve traffic signal operations and management as well as mobility and roadway safety management. Use Cases are available on the Flow Labs website.

With the increased data from the project (instead of 1 day, there are weeks, days, months of data), visualization of the data was key through useful trends shown in charts and graphs to see trends.

Source: *Leveraging Big Data and Data Analytics in Signal Optimization: A Case Study with MnDOT*

Chapter 3: Key Takeaways, Resources, and Implementation Plan

This section provides an overall summary of key takeaways with alternative methods of traffic data analysis, key resources, and a suggested implementation plan.

3.1 Key Takeaways

Most of the sources reviewed for this project have occurred in the last few years, highlighting the fact that data analysis is evolving quickly. Overall key takeaways from the literature review, interviews, and webinars participated in as part of this project related to alternative methods of traffic data analysis include the following. See Figure 3.1.

- **Goals of Data Analyses.** Ideally, the intended uses of the information resulting from data analyses are known and can be factored into the entire data collection and analysis process. But, if all intended uses of data are not known, there are steps to increase usefulness of the data and results.
- **Data Understanding.** It is important to understand what data is available, a complete description of the data (e.g., metadata describing the data), as well as the accuracy and quality control of the data. Data consistency is also critical to compare data analyses among transportation agencies. Data validation is critical to compare and understand as well as ensure confidence in new data sources that may be included in data analysis.
- **Data Access and Storage.** Experiences documented in this report describe advantages of not owning and storing data but having access to data. Additionally, cloud-based applications provide easier data access for transportation professionals and are more cost-effective than buying hardware or installing devices. A data warehouse can be beneficial to provide one central location for multiple users to access the data as well as in some situations store and monitor the data quality.
- **Data Conflation.** New methods of analyzing data include conflation of data. For example, data from existing detection devices combined with new data sets. Conflation of data is not simple and often is performed by data scientists. The combined data sets provide another layer to established data sources and are not intended to replace typical data sources or engineers.

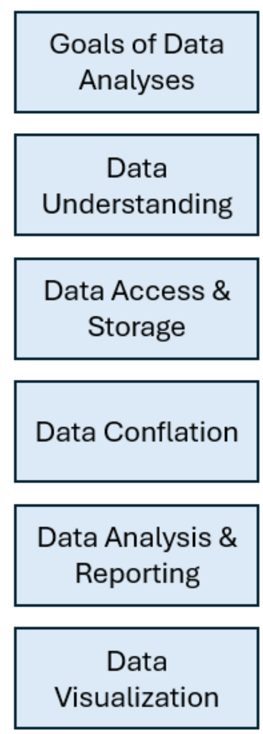

Figure 3.1 Key Takeaways Related to Alternative Methods of Traffic Data Analysis

- **Data Analysis and Reporting.** There is increased data analysis with new data sets (e.g., instead of analyzing data from one day, the analyses now may include weeks, days, or months of data). Data analysts or data scientists may be needed to understand new data sources, to determine the best approach for each analysis, and to execute the data analysis.

- **Data Visualization.** With the large amount of data used in new traffic data analysis methods, data visualization is a key tool to assist in illustrating analysis results.

3.2 Key Resources

The table below includes a list of the key resources found for this project related to alternative traffic data analysis.

Table 3.1 Alternative Traffic Data Analysis Resources Reviewed

Resource #	Agency/ Organization	Alternative Traffic Data Analysis Effort Title	Year
1	FDOT	TDA Datalytics: Hurricane Milton Landfall Traffic Impact Time Lapse	2024
2	FDOT	TDA Datalytics: Statewide GPS Truck Parking Dwell Times	2019
3	Purdue University	Purdue University Traffic Research Program Cuts Data Analysis and Batching from Hours to Minutes with BigQuery	Web page
4	Journal of Transportation Technologies	Continuous Flow Intersection Performance Measures Using Connected Vehicle Data	2022
5	NDW	National Road Traffic Data Portal	Web page
6	FHWA	Post-event Connected Vehicle (CV) Data Exploration – Lessons Learned	2024
7	CV PFS	Model Connected Vehicle Data Architecture	2023
8	USDOT	FHWA's Travel Monitoring Analysis System (TMAS) Data Program	Web page
9	TETC	States' Experience with Real-time Connected Vehicle Data	2021
10	NOCoE	Traffic Data Scientist/Statistician Position Summary	Web page
11	RITIS	A data-driven platform for transportation analysis, monitoring, and data visualization	Website
12	North/West Passage PFS	Purchasing Data from Vendors of Connected Vehicle (CV) Data	2024
13	Iowa DOT	Institute for Transportation at Iowa State University Operations & Safety Dashboards	Web page
14	TTAP	Webinar video: Leveraging Big Data and Data Analytics in Signal Optimization: A Case Study with MnDOT	2025

3.3 Implementation Plan

Transportation agencies can implement the results of this research in several ways. Implementation steps could include the following actions.

1. Distribute the report to agency staff that are responsible for data collection and analysis. This may include traffic data staff, traffic planning staff, ITS staff, CAV staff, and arterial and freeway management staff.
2. Review the resources list documented in this section and the summary of interviews and webinars to identify what alternative methods of traffic data analysis may be of interest.

Overall, this project provided ENTERPRISE members with examples of new and emerging alternative methods of traffic data analysis and key things to consider with new traffic data analysis methods.

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