

# Real-time Volume and Turning Movements from Probe Data

A proposal to the I-95 Corridor Coalition

2015 August 31

## Introduction

This proposal to the I-95 Corridor Coalition outlines an initiative to ...

*---To accelerate the timeframe to a viable real-time volume and turning movement data feed, and to make every effort to insure that initial data products meet Coalition members' information needs for operations, performance measurement, and planning---*

The proposal is a cooperative initiative between the University of Maryland Center for Advanced Transportation Technology (UMD CATT), the three leading outsourced probe data companies: INRIX, HERE, and TomTom, and the National Renewable Energy Laboratory (NREL).

The objectives by the end of the project are to:

- Define a practical and logistical framework for the delivery of probe-based volume and turning movement data, and how it will be formatted, transmitted, and integrated into applications
- Create a testbed for calibrating and validating vendors' initial development efforts
- Provide representative volume and turning moving data products to the coalition along with an accuracy and feasibility assessment to support Coalition applications
- Estimate the resources needed to maintain/operate a national calibration/validation testbed

The I-95 Corridor Coalition was the first to put forth the proposition of providing traffic volumes through outsourced probe data as part of a 2013 **Multistate Corridor Operations and Management Program (MCOMP)** proposal, foreseeing that probe data will ultimately drive many of the operations and planning business processes.

Traffic volumes and turning movement counts are critical dimensions to traffic data not currently available in probe data, and are needed in many applications. Probe data, with its ever evolving capability as more and more vehicles act as probe vehicles, is poised to deliver such information. Three vendors: INRIX, HERE, and TomTom have each expressed the desire to participate in this project. Since 2013 when the Coalition first introduced the idea, other jurisdictions have inquired as to the viability of such a product, and some vendors have already taken internal efforts to explore product feasibility. Some vendors have introduced initial volume products which are archive products, not real-time data feeds.

UMD and NREL recognize that the success of this project is critical to broader national initiatives which require quality data to operate and model the transportation system with the goal to optimize for safety, mobility and energy efficiency.

The objective of the proposal is to accelerate the timeline in which volume and turning movement data from probe sources may be effectively offered to Coalition members (transportation agencies and their partners) to enhance operations, performance measure, and planning activities. Specifically the joint team led by UMD CATT proposes to:

- ***Define a practical and logistical framework*** to provide traffic volume and turning movement data in an efficient and comprehensive manner. This includes establishing precision, accuracy and data format guidelines based on input from Coalition and other transportation interests to guide the development of vendor data products. A structure of committees/working groups within the Coalition will be established to oversee and inform the process. The framework will also identify the attributes of a viable product for real-time volume and turning movements to guide vendor development;
- ***Develop a calibration and validation testbed*** drawn from sensor volume data with established accuracy already collected by state DOT's, MPOs and other public agencies. The testbed will provide reference data which vendors can use to develop and tune their products, as well as a validation data set to assess accuracy and fidelity. Based on early discussions, it is anticipated that some form of a national calibration/validation testbed will be needed on an ongoing basis to account for regional variability in probe data sources. The process of establishing a testbed for the Coalition effort will provide the information needed to scope the extent and level of resources required for a national testbed system;
- ***Develop consensus formats, standards, and testing protocols*** in cooperation with industry partners for delivering volume and turning movement data based on probe sources. As with the original VPP, the Coalition will attempt to establish best practice with respect to understanding and communicating the fidelity of volume and turning movements in close collaboration with industry;
- ***Along with industry, demonstrate the availability of volume and turning movement data*** from vendor supplied data feeds for a representative network within the I-95 Vehicle Probe Project (VPP), and;
- If fully successful, by the end of the project, vendors may be able to provide volume and turning movement data products in conformance with the specifications identified, or have a development path that anticipates such products as probe data technology continues to increase in capability<sup>1</sup>.

This proposal, now in 2015, carries out the vision originally put forward in the **MCOMP** research program, and provides a systematic, cooperative research approach to enable these capabilities within 12 to 18 months.

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<sup>1</sup> Note, it is not the goal or expectation that real-time volume and turning movement data to be included with existing data feeds within the I-95 Vehicle Probe Project. If viable, such products may (or may not) be included in future solicitations or renewals of the VPP procurement contracts.

## Background

*Real-time volume data remains the key missing dimension* in operations data that would greatly improve the accuracy of assessing transportation system performance.

Although agencies have invested in fixed sensors, volume data remains relatively sparse and of varying quality on the majority of the freeway and major arterial networks. *Anticipated volume*, a by-product of factoring of Highway Performance Monitoring System (HPMS) data, is currently the state-of-the-practice in assessing performance measures involving user cost, emissions, and energy efficiency. However, anticipated volume does not reflect traffic volume fluctuations during weather events, major incidents, or even normal day to day fluctuations in traffic.

Quality volume data is required to effectively assess user costs, assess extent of delay and congestion, detect real-time perturbations to the network, understand traffic density during major weather events such as blizzards and hurricanes, and to estimate congestion impact in terms of travel time and delay and their corresponding economic, environmental, and energy impacts.

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*Similar to volume data, turning movement counts which reflect the patterns of vehicle distribution through interchanges and intersections, (the first step in basic origin-destination assessment) is also of key interest.* Increases in probe density combined with more refined processing techniques (referred to as point-pair processing) provides the basis to assess the split of traffic at intersections and interchanges, assessing the quantity of turning vehicles from each approach to each leg. With such information, Coalition members will be able to assess the effectiveness of traveler information in response to incidents or to recognize unusual demand patterns that may result from a special event.

The UMD CATT initiated work in this area by authoring a white paper that explores uses that broad-based volume and origin-destination data could enable. Consultation with Coalition members and industry partners helped narrow the focus to what appears technically viable in the near future which included volume and turning movement counts.

## Mission and Objectives

The UMD proposes a joint initiative with transportation agencies, university and national lab researchers, and outsourced probe data providers to cooperatively develop and mature the underlying technology to provide accurate broad-based volume data and turning movement data usable by agencies and researchers.

The specific mission of this initiative is both to advance the timeline in which such data can be delivered, and provide a common framework to assess and communicate the accuracy and fidelity of the data. The latter is *critical* to communicate clearly the utility of such data, set reasonable expectations, and effectively integrate the data into a number of prevailing transportation areas. The data is envisioned to support both operations, as well as critical modeling and performance measure initiatives.

In concert with probe data providers (participating industry partners) and the National Renewable Energy Laboratory, the challenges of delivering a quality product were discussed and a method to accelerate that process in a cooperative, public-private research forum was formulated. This resulted in the following detailed objectives:

- 1) **Coordinate with the Coalition members and other national partners interested in real-time volume and turning movement data to articulate specifications and requirements that address accuracy, format, and delivery methods necessary to utilize an outsourced data feed of this nature.** Technical items include such items as segment length for reporting, update rate for data feed (five minute, fifteen minutes, etc.), parameters reported (density, through-vehicles, etc.), needed accuracy to support various applications and uses, and delivery format.
  - a) This effort will be facilitated through a use survey as well as a focus group. The survey will be structured to elicit needs of current and future uses. Interested Coalition members and other national research interests will be invited to join the focus group to guide the efforts.
  - b) This framework will be communicated nationally through technical exchanges such as NATMEC, ITE, ITS and performance measurement venues.
  
- 2) **Create a test bed for vendors to develop and test their product** - the test bed will include a network of existing volume and occupancy sensors to be used for calibration and validation of volume and turning movement data from probe vendors. This is envisioned as approximately fifty sites in which high quality volume reference data is obtained from a broad range of roadway types, though the size and scope will be based on technical assessment and consultation with vendors and available resources.

Verified volume data will be made available to cooperating vendors for their development efforts. A set of reserved validation sites will be utilized for blind testing. Outsourced data collection (such as from video data) will be considered as a secondary source for the calibration test bed data based on need and budget:

- a) Size, extent, and geographic representation of the testbed will be determined in cooperation with industry partners. Deliverables will include a report with testbed concept and plan that contains a breadth of items needed by vendors for testing;
- b) Validation methodology: The original I-95 Corridor Coalition's VPP validation program was instrumental in ushering in speed and travel time data for everyday use in public agencies. Similarly, a validation plan for volume and turning movement that is fair and transparent is needed to accelerate this effort. As with the VPP, the intent is to encourage vendors to improve the product whenever problems are encountered as well as set realistic expectations for users of the data in terms of timeliness and accuracy;
- c) A data format standard for communicating testbed information among project participants will be established. This data format standard (possibly a variant of products from task 1) will ease the validation and calibration integration task.

Note that the structure of the testbed, and development is yet to be determined. Early suggestions included a two-phase approach. During the initial phase (Phase I), the emphasis will be placed on

archived data comparison. The development, calibration and validation will not stress real-time delivery, but rather rely on batched historical data sets. The results would be shared with each vendor, the agency team, and used to inform on the best method/s for real-time.

The second phase would progress to 'real-time', repeating the first stage, but with the expectation that data is provided from the vendor in real-time for comparison. This may be months down the line and informed by Phase I.

- 3) **Assess the viability of Volume and Turning movement data.** After a 6 to 12 month development/calibration phase, the output from the vendor development effort will be characterized in terms output and fidelity. This will form the basis of determining when a viable product may be available. The overall result would be better informed vendors and jurisdictions, as well as recommendations from UMD/NREL on the minimum viable product requirements and specifications for initial products in the area.

This final objective, delivering a viable industry product, presents the greatest risk – and the collaborative approach seeks to minimize risk to all parties. Although each vendor has expressed enthusiasm, and expect that probe data can support value-added information in terms of volume and turning movement counts; no such product is currently on the market. See the individual vendor proposals for individual expected outcomes/deliverables.

## Tasks and Deliverables

### Task 1 Project Management

The University of Maryland (UMD) Center for Advanced Transportation Technology (CATT) will have primary responsibility for project management, with additional support provided by NREL. This includes periodic reporting to the Coalition of project status, organizing and providing resources for coalition collaboration including meetings, webinars and conference calls, and insuring overall project delivery.

**Deliverables:** The UMD CATT-led research team will provide monthly status reports on activities in the project, quarterly status reports on overall project status to include conformance to anticipated timeline, activities, tasks and objectives met, and any disruptions to the proposed project timelines, and updates to the I-95 Vehicle Probe Project steering committee during periodic webinars.

### Task 2 Specifications and Requirements

#### Task 2-1 Use Survey

UMD CATT in consultation with the I-95 Corridor Coalition and industry partners will create, administer, and analyze a survey to the I-95 Corridor Coalition members, as well as invite input from outside the Coalition. The survey will ask participants to describe their needs and desired format for volume data based on specific uses of the volume data. The survey will also solicit participation in the validation testbed.

**Deliverable:** The results of the survey will be summarized in a report that will be made available to the Coalition and industry partners. A webinar hosted by CATT will also go over the results.

## Task 2-2 Recommended Specifications

Based on the results of the survey, the research team in consultation with the Coalition and industry partners will create specifications for accuracy, format and delivery of volume and turning movement data. Technical issues will also be brought up during this task. A task force of interested parties will be invited to collaborate, provide input, and review the results of the recommended specifications.

**Deliverable:** The specifications and technical issues developed from this task will be included in a technical memorandum to the Coalition.

## Task 2-3 Freight (Origin & Destination) Data and Practices

Although real-time Origin and Destination (OD) was determined not ready for real-time implementation, probe data OD data sets and experimental uses have emerged, particularly for freight. To compliment volume efforts, a white paper that explores initial applications of archive OD datasets currently available to Coalition members through the VPPII contract will be developed. The white paper targets the different options within the data set including vehicle-types, temporal coverage, spatial coverage, and data format. Use cases including initial freight specific applications will follow. The whitepaper and findings will be presented within the Coalition's freight community.

**Deliverable:** A white paper and presentation covering the characteristics and applications of OD data currently available to the Coalition are the deliverables for this task.

## Task 3 Testbed Initialization

The testbed forms the heart of the mechanism to accelerate data product development, and must be approached in a full collaborative manner with project participants. The Coalition contacts and interested parties identified in Task 2 will be invited to contribute to the design and construction of the testbed, as well as the members of research team (UMD, vendors, NREL).

### Task 3-1 Validation Methodology

The research team will review possible validation methodologies that could be used to evaluate the quality of participating industry partners' volume and turning movement data. Potential data formats that will convey both validation and vendor-provided data will also be identified increasing efficiency of analysis on the project. The validation methodology will be guided by the same principles used in developing the I-95 VPP validation for travel time, in that it will be open, fair, and account for known variance.

**Deliverable:** The candidate validation methodologies, standard data formats will be published in a report and discussed through a webinar.

### Task 3-2 Testbed Preplanning

In collaboration with the industry partners, the research team will partner with Coalition agencies willing to contribute to a testbed. Based on the sites available, the research team will select calibration sites in accordance with the methodology and data formats identified in Task 3-1, anticipating up to 100 sites,

spanning up to 200 miles of roadway. The actual number of sites and miles will be based on appropriate representation of the roadway type, AADT, speed, and other roadway characteristics.

If outsourced volume and turning movement data is necessary, procurement for such data will be scoped and budgeted at this stage. The pre-planning will include identifying the location and resources for the volume and turning movement data clearing house to be used during the calibration and validation stage. Jurisdictions outside the Coalition will also be invited to participate. The validation methodology(s) and data format(s) identified from Task 3-1 will be down-selected as needed to complete the testbed pre-planning.

**Deliverable:** The locations and time periods that the testbeds will be active, participating jurisdictional members, outline of data warehousing activities to promote the testbed, refined timeline of testbed activities, and agreed methodologies and data formats will be consolidated in a technical memo.

### Task 3-3 Initialize Testbed

The research team will gather sample volume and or turning movement data using the technique and architecture identified in Task 3-2, as well as any data from each of the participating industry partners during the times and at the sites specified. The resulting data will be consistently formatted according to the proposed specifications and shared among participants.

**Deliverable:** A technical memo/summary report will be issued detailing the construction, use, and participation in the calibration test bed. Reference data from the testbed clearing house will be made available to the industry partners. Vendors will provide overview of approach to utilizing testbed, framework for calibrating and delivering volume data, and initial test results.

The findings and deliverables up to this point form phase I of the project. A go/no-go/scope adjustment decision will be made after Phase one, before proceeding to phase II.

## Task 4 Product Development and Refinement

Based on phase preparation, vendors will actively engage with the testbed in phase II, with the goal of developing and providing a standards-compliant volume and/or turning movement product offerings for Coalition members, for possible inclusion into the VPP at a future date (see vendor sub-proposals/letters of support for further vendor specific details). Phase II will proceed upon successful completion of Phase, and showing feasibility of approach. At a minimum, each vendor commits to providing data for the calibration testbed for a continuous period of time as long as the Coalition continues maintenance of the test bed, but not to exceed 24 months from the initiation of the project.

### Task 4-1 Testbed Production

To be carried out by UMD and NREL as well as cooperating Coalition members. The research team will collect and populate the test bed from verified volume and turning movement sources identified in section 3-2 from Coalition and other members volunteering data, compile into standard formats, and

make available calibration data to participating vendors. The research team will log estimated volume data provided by vendors (both Historical and Real-time feeds as explained below), and compare with validation sensor data archived in the testbed, provide accuracy analysis in agreement with Task 3-1, which involves comparing each of the participating industry partners' data to the reference data. Validation tests will be shared with project participants confidentially. The overall results will be shared with Coalition as representative of industry capabilities. Vendor specific results will be released only with concurrence of vendor.

#### Task 4-2 Historical Archive Approach (Vendor Responsibility)

Initial approach will incorporate an offline analysis to determine approach / product feasibility. Data sets from the testbed are made available to the vendors to be utilized in their technical approach to delivering volume and turning movements. Based on archive data sets, vendors will develop algorithms, refine product, and provide volume estimate data sets for validation in the testbed.

#### Task 4-3 Real-Time Approach (Vendor Responsibility)

Phase II will proceed with developing and testing a real-time data feed (not offline or historical estimates), delivering the volume data from the real-time feed to the testbed for a variety of roadway types and conditions.

**Deliverable/s:** Task 4-1 will run in parallel with Tasks 4-2 and 4-3. Monthly project updates and period technical memorandum, and presentations will be issued summarizing activity, accomplishments, and results. A summary memo from after completion of Task 4-2 will be issued with results of archive approach. Similarly a technical memo conveying the results of Task 4-3 of the real-time approach will be issued. A full project report will be issued at the end of the project which summarizes all tasks, activities and results.

Although Task 4 is subject to the success of the calibration and validation, at a minimum, the results of Task 4 will be incorporated into a description of a minimum specification for use in procurement documentation.

#### **Risks:**

Theoretical calculations and industry feedback indicate products for volume and turning movement are feasible and foreseeable. As with the original VPP project, this is a high-risk / high-reward proposition. Proper calibration, validation and testing are needed to effectively commercialize a real-time volume and turning movement data product. This joint effort with the Coalition, UMD, NREL and industry partners is intended to minimize risks, and maximize opportunity for success by establishing realistic industry expectations, and avoid potential market confusion. Approaching the research in a joint fashion minimizes risk exposure to the industry, to any individual vendor, and initial adopters. An initial early failure (by a vendor, or a jurisdiction) can stifle future product development. The proposed approach accelerates adoption through education, establishing realistic expectations, and creating a reasonable validation methodology.

**Furthermore, the project is proposed in two phases, with a 'go' / 'no-go' / 're-scoping' decision to be made at the end of Phase I, before proceeding to Phase II.** Phase I encompasses all tasks and

deliverables up to and including Task 3. If preliminary analysis and initial testbed activity indicate that proceeding with the full production testbed is warranted, the project will continue to Phase II. This will also provide the opportunity to recalibrate the scope, objectives, tasks, and deliverables of Phase II prior to commencing. Phase II will begin by activating the testbed for continuous operation and proceeding with the remainder of the project.

**Potential Rewards:**

If successful, the addition of volume and turning movement data will save substantial time and money for operations and planning activities; improve the quality of data provided to the traveling public; and increase the accuracy of performance measures used to determine the investment of funds in public infrastructure.

Current volume estimates are costly, limiting data collection to only candidate infrastructure improvement projects on a portion of the network:

- Real-time 24x7x365 volume and turning movement data will provide full observability of the status of the network, including inclement weather or special events to better manage and assess their impact;
- Volume data will greatly increase the accuracy of performance measures, which currently rely primarily on nominal volumes from the Highway Performance Monitoring System (HPMS), thus increasing the precision of operations planning;
- Broad based volume and turning movement data will increase both the efficiency and accuracy of planning models attempting to assess not only current conditions (calibration of models), but also better understanding the impact of ITS technologies as they are implemented in the future;
- Volume data on specific roadways will allow better construction and maintenance scheduling by identifying roadway specific volume profiles indicated beginning and ending of peak periods;
- Real-time volume and turning movement data can also be used to observe the impact of Advanced Traveler Information Systems, particularly travel time on signs directing travelers to divert to avoid delays due to either congestion or incidents.

**Timeline:**

