

Data Validation Plan

I95 Vehicle Probe Project

June 6, 2008

I-95 Vehicle Probe Validation

Critical aspects of the validation of the vehicle probe data

1. Spatial sampling should reflect various types of roadways across the corridor including:
 - Freeways
 - Arterials
 - Rural Interstate
 - Urban Freeways
 - Commute Routes
 - Recreational Routes
2. Time sampling should attempt to maximize the likelihood of observing congestion:
 - Rush hours for commuter routes
 - Weekends and holidays for recreational routes
 - Major events such as sporting and concerts
3. Ground truth data should be of sufficient quality and quantity.
 - Higher density, higher quality data sampled less frequently is of more value than sparse, low quality data recorded more frequently.
 - Ground truth data should be direct measures of travel time – not inferred from speed measurement.
4. Ground truth data will be compared directly against vendor data using established statistical tests.
 - Travel time accuracy will be assessed in all speed categories as per the RFP.
 - Latency will be assessed based on measured data obtained during congested periods.
5. The validation will consist of two components, an initial validation (or systems acceptance test) and an ongoing validation to monitor the quality and health of the system.
 - The initial validation portion will run for the first three months, concurrently with the start of the data from Inrix. A report is due the first of October.
 - The ongoing validation will generate monthly reports based on sampling. In addition to a sampling routine, the ongoing validation will also be flexible to test areas with unusual or suspect data.

Not only is the I95 Vehicle Probe project unprecedented in terms of extent of coverage, the validation scheme will likewise break new ground in terms of being able to monitor and verify the quality of the data on such a vast system. Traditional methods of validation have primarily relied on floating car methods to obtain ground truth data.

Although the floating car method is well established, the expense would place severe limits on the scope of validation. Even in established programs, the density of floating cars is typically 8-10 vehicles during the peak period. Such data density would provide only representative or top level indication of data accuracy, rather than a rigorous validation of the probe data that is sought. This relative sparsity of data would not be able to validate latency to any relevant degree.

In order to achieve the desired thoroughness of calibration, the University of Maryland (UMD) has identified and developed a new technology based on deployable sensors that provides both high quantity and high quality travel time data. The technology is based on using the radio emissions of consumer electronic devices in a method directly analogous to automated toll tag data. Specifically this targets the Bluetooth point-to-point networking signatures as anonymous probes. This approach provides both quantity and quality travel time data combined with an unprecedented level of flexibility (in terms of deployment). The technology has been in development since late 2007, so there is some risk related to the use and deployment of relatively new technology. In order to buffer this risk, the initial validation plans a combination of both floating car data and Bluetooth anonymous probes during the initial three month test. If the Bluetooth probe approach proves as effective as it has shown to date, the remainder of the validation will be based primarily on the Bluetooth probes.

In addition to the floating car runs and Bluetooth probe technology, existing sensor data will be used where available. UMD of Maryland requests the cooperation of the coalition members in providing such data, identifying locations for high probability of congestion, and coordination while collecting data. If Bluetooth probes are employed, assistance is requested from the respective coalition members in deploying and collecting sensors in a safe and efficient manner.

Proposed Validation Scheme:

A stratified sampling strategy is used to determine the number of freeway and arterial segments in each state for data collection. The core area of coverage is divided into systems of freeways and arterial streets with low, moderate and high levels of recurrent congestion. The preliminary results of our analysis indicate that 40 segments of 4 miles length on average on the freeway system and 40 segments of 2 miles length on average on the arterial street system will provide a representative area coverage in each validation period.

In the first month we will collect data using both Bluetooth sensors and probe vehicle runs. If the vehicle probe runs verify the travel times obtained by the installed Bluetooth sensors then in the ensuing months only Bluetooth sensors will be utilized in the validation process.

In July, we will concentrate the validation efforts in Maryland and Virginia. In August, the core coverage area in New Jersey, Delaware and Pennsylvania will be subject to the validation effort. Finally, in September we plan to have sampling and data collection

performed in the North Carolina. In each case, samples from the second and third weeks of the corresponding month will be used in the validation process.

- Initial three month Validation:
 - The initial validation will encompass about 160 miles of the freeway network and about 80 miles of the arterial network.
 - Data will be collected from July 1 through September 19.
 - UMD will work with each state to identify portions of the network with high probability to observe congestion, as well as locations, if any, where data quality validation is a high priority (relative to other portions of the network.)
 - UMD will coordinate with each respective coalition member during data collection to insure safe and efficient operations. Preferable this would be through road operations personnel of the respective authority to provide authorization and escort to place and retrieve sensors.
 - Initial Validation report due on Oct 1 for initial validation
- Ongoing Validation
 - The location and mileage of freeways and arterials on which ongoing validation will be performed will be determined later. It is expected that the total mileage for the ongoing validation efforts will reasonably represent the coverage area.
 - Validation report due two weeks after the month of validation
 - First monthly validation report due November 1 for data collected in October 2008
 - As with initial validation, coalition cooperation is essential
 - Geographic samples will be located similar to initial validation, but also be flexible to check unusual or suspect areas. As practical and to minimize cost, coalition members will be requested to deploy and retrieve sensors, or install sensors for longer duration.
- Sampling Methodology
 - Test sections will be chosen and rotated through the core network to provide representative sampling of:
 - Type of facility
 - Volumes
 - Urban vs. Rural
 - Times of data collection will be chosen to reflect maximum probability of congestion periods. For example:
 - Tuesday through Thursday for heavy commuter routes
 - Weekends for recreational routes
 - Targeted data collection for major events
 - Sections will be identified in coordination with the respective road authority and Coalition project team.
 - Test section lengths will reflect interchange to interchange movement on freeways, and major intersection to major intersection on arterials consistent with the descriptions in the RFP.

- Sensor locations will be chosen to coincide as closely as possible with the beginning and ending of TMC sections as delivered by Inrix. Multiple TMC segments will be combined as necessary to obtain segment lengths as described above.
 - Travel times, and space mean speed derived from travel times will be used for comparison with vendor supplied data
 - Volumes will be either recorded through existing permanent count stations, estimated from HPMS data, or estimated from sensors.
 - Speed and travel time data from existing detector data will be used where available. Spot-speed based data will be used for qualitative (rather than quantitative) comparisons.
 - Travel time data from existing automated toll facilities (where available / if available) will be incorporated into the validation
- Method of Comparison
 - Travel Time / Space Mean Speed Accuracy
 - Accuracy will be assessed in each speed category defined in the contract (0-30 mph, 30-45 mph, 45-60 mph, >60 mph)
 - Ground truth will be established using the methods previously described.
 - The space mean speed determined from average travel time as observed by the probes.
 - The average travel time will be assessed in 5 minute sample intervals, and converted to a corresponding speed.
 - The ground truth speed for each 5 minute sample will determine the speed bin category. (0-30 mph, 30-45 mph, 45-60 mph, >60 mph)
 - For each observation in a speed bin category will be matched with the corresponding speed reported by the Vendor.
 - The Absolute Average Speed Error and the Speed Error Bias will be calculated for each speed bin as per section 3.1 item 6 and 7 respectively in the RFP.
 - All data, statistics, and summary error calculations will be reported periodically.
 - Data Latency Validation
 - Ground truth data will be determined as described under Travel Time / Space Mean Speed Accuracy with the following exceptions.
 - Time bins will be a maximum of 5 minutes. Shorter duration time bins will be used if the density of Ground Truth data allows, and if Vendor supplied data is recorded appropriately at such time intervals.
 - Latency will be determined by determining the time offset needed to achieve maximum correlation. In practice, the Ground Truth and Vendor supplied data will be plotted on the same graph, and the Vendor data shifted in time until the basic congestion signature

matches that of the Ground truth data. The time shift will determine latency.