
# I-95 Corridor Coalition

## Vehicle Probe Project

# Guide for Posting Travel Times on Changeable Message Signs

Report Update – June 2012

I-95 CORRIDOR COALITION

*June 2012*

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## *Report Update*


*Sponsored by:*

I-95 Corridor Coalition

*Prepared by:*

Center for Advanced Transportation Technology

University of Maryland



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June 2012

## *Abstract*

This report incorporates the information from the original report on travel times on changeable message signs (TTCMS) dating from 2011, as well as updates and new material on recent topics and issues. Several coalition members provided updated information on the status of their TTCMS systems. Additional topics covered in this report include posting travel time across state borders and jurisdictional boundaries, use of predictive algorithms for travel time, and validation policies. Where content has been substantially added or updated, the text is demarked in blue-gray for ease of identification. Coalition members are encouraged to forward any updates or comments on the material in this report to the University of Maryland, as the material will be updated on a periodic basis.

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Posting travel times on changeable message signs (CMS) is a traveler information service of growing interest throughout the I-95 Corridor. With the success of the I-95 Vehicle Probe Project (I-95VPP), many states now have an affordable and accurate data source to drive this application. As a result, several inquiries for guidance on the use of I-95VPP data for this purpose have been made to the Coalition. Travel time on changeable message signs (TTCMS) requires higher quality and more immediate real-time data than many other traveler information services, due to its high visibility and direct impact on driver behavior. In addition to data quality concerns, consistent and effective program and message display policies have proven critical for successful deployments.

This guide was assembled to provide recommendations for the appropriate use of the I-95VPP data as the source of posting travel times on signs and to provide recommendations for program policies related to the display of travel time messages. This guide reviews existing practice within the I-95 Corridor, explores technical best practices for aggregating, smoothing, and filtering sensor data, and overviews policy considerations for items such as segment length, message priority and content, and frequency of update. Case studies and lessons learned are drawn from states with existing TTCMS programs.

# Contents

## *List of Figures*



## *List of Tables*

# Introduction

Posting travel time on changeable message signs (CMS) arguably has greater potential to influence driver behavior than other conduits of traveler information. Radio traffic updates, given at most once every ten minutes, provide drivers a geographically broad view of congestion. Telephone-based 511 systems provide audio updates of specific routes, but are designed to be accessed prior to departure, and may cause a driver distraction if accessed while in route. Internet-based 511 systems and other electronic maps typically display congestion in three to five color-coded regimes rather than provide link specific travel times. Similar to telephone counterparts, these Internet-based systems are designed to be accessed prior to departure. Travel time on CMS provides the most current, detailed, and route specific reporting of traffic conditions directly applicable to drivers, in the safest, most easily accessible form. For these reasons, travel time on CMS is arguably the most effective method to inform and impact driver behavior.

The technology to support posting travel time on signs has been evolving for two decades. Hardware and communications for modern CMS matured during the 1990s when central operations software, communications, and flexible LED based CMS began proliferating. Much of the initial content for CMS was event-based, such as notifications of incidents, road closures, or major construction. Research during 1990s indicated that clear, objective flow measures such as speed and travel time were preferred by motorists over general information such as 'congestion ahead', or 'expect slowdowns.' Technical advances in sensing and increased demand for traffic flow data led to the investments in sensor networks. Though costly to install and maintain, several metro areas estimate and post travel time based on an extensive network of point sensors. The cost of point-sensor networks limited deployment to high impact areas. The process of turning point-sensor data into travel time information further increased complexity of systems.

Between 2000 and 2010 travel time emerged as the preferred metric to report traffic flow both for traveler information and traffic performance measures. With CMS infrastructure in place and expanding, the demand for travel time on changeable signs (TTCMS) continued to grow. The emergence of outsourced data, exemplified by the I-95 Vehicle Probe Project (I-95VPP), provided a ubiquitous, cost-effective data source to enable TTCMS. The cost to implement travel time on CMS was subsequently reduced by eliminating the need for a dedicated sensor network, thus allowing state departments of transportation (DOTs) to adopt and/or accelerate TTCMS programs. Some states within the I-95 Corridor Coalition have already initiated TTCMS based on I-95VPP data, while others are considering similar programs, or considering expanding legacy systems to include the use of this new data source. The need for sharing best practices, both technically and programmatically, led to the development of this guide.

This guide is organized into three sections. The first is a review of the status of TTCMS systems within the Coalition. The information is intended to give Coalition members knowledge of adjoining states systems, data sources, and critical design and operations considerations, as well as contact information for additional questions. The second part of the guide is dedicated to technical processing of the base-level data from the Vehicle Probe Project into meaningful travel time information for posting to signs. It encompasses such topics as methods for aggregating data from individual segments into longer routes, filtering and smoothing of data, and placing limits on travel time. These processing guidelines are tailored to the I-95VPP, although concepts are applicable to a number of data sources. The third section deals with the programmatic policy of TTCMS that impact the effectiveness of systems. It includes discussions on such topics as selection of routes and end destinations, times of day to display travel time messages and their relative priority to other types of messages, proper formatting to maximize readability and utility, guidelines for phasing and updating messages, use of travel time ranges, and display of distance to the destination.

Technical and policy guidelines are based on literature review, analysis of I-95VPP data sponsored by the Coalition, survey of Coalition members, and interviews with national experts in the field. This guide is intended for I-95 Corridor Coalition members planning to implement or expand programs for posting travel time on CMS based on VPP data.

# Section 1: Existing and Planned Travel Time Systems in the I-95 Corridor

Systems for the display of travel time on changeable message signs (TTCMS) are in various stages of implementation throughout the I-95 Corridor. In 2011, and again in 2012, Coalition members were surveyed to ascertain the following:

- the status of any existing or planned TTCMS systems,
- the data sources used in the system, and
- any operating policies and procedure in active use.

This section summarizes the status of TTCMS systems based on the survey, and provides a synopsis for each state. The map at the right, in Figure 1.1, charts the status of TTCMS systems as provided by the survey. Ten states currently have active TTCMS systems. Of those, six are based on traditional speed sensor or toll tag data, and four use the VPP data. Three states are in various stages of developing travel time systems for use on changeable message signs (CMS), two states responded indicating no TTCMS systems are currently planned, and one state did not respond to the survey.

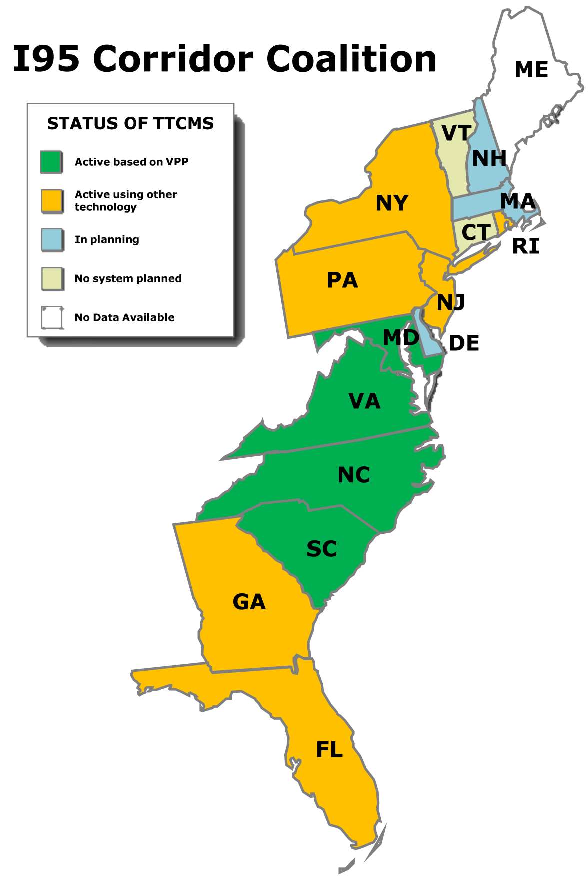


Figure 1.1 Status of Travel Time on Signs within the Coalition

When reviewing the survey data, the reader should keep in mind that the administration of travel time programs varies from state to state. Some states have a centrally managed TTCMS system such as Maryland and New Jersey in which central data systems facilitate statewide implementation, and thus induce uniformity. Other states are decentralized such as Florida and Pennsylvania in which independent TTCMS systems exist in different districts and/or metropolitan areas.

## *1.2 Existing TTCMS Systems in the Coalition*

A summary of the status of TTCMS system are provided for the states in the Coalition in geographical order from north to south. The primary goal of the survey was to determine the status, critical issues and/or decision points for each member. For members with existing systems, additional detail is provided related to the technical data processing and program policies. A summary is provided only for those states who responded to the survey.

***New Hampshire****- New Hampshire (NH) began building its intelligent transportation system (ITS) infrastructure in 2007. Since then infrastructure investments have yielded 20 portable CMS permanently mounted along major highways, 19 cantilever or bridge mounted CMS boards, and another 30 portable CMS for use in construction zones, in addition to a central TMC and a network of closed circuit television (CCTV) cameras.*

*NH is developing software integration efforts so travel time on CMS can be posted, and anticipates that an outsourced data feed such as the VPP can provide quality travel time data for portions of the freeway system starting at Concord and going south where 90 percent of the state's population resides. Acquiring accurate travel time information north of Concord is a concern due to the rural nature where freeway annual average daily traffic (AADT) can be 6000 or less. Policy development for TTCMS will be addressed as well.*

*NH has active smart work zone systems utilizing 30 portable DMS that are linked with construction projects and controlled via the state TMC. These CMS post travel time based on temporarily deployed point speed sensors within the work zone.*

***Vermont*** *- Vermont has not implemented, nor has any immediate plans to implement travel times on CMS. Due to the rural nature of the state, traveler information systems are more focused on weather events rather than congestion.*

***Massachusetts*** *- MassDOT is prepared to implement travel time information on their system of permanent CMS. Their current vision is to implement based on a network of point sensors. However, significant issues with maintaining traffic monitoring equipment and overall data quality have prevented full implementation. Written guidelines have not been developed for posting travel times, and they are awaiting resolution of data issues.*

*MassDOT currently outsources the state 511 traveler information system. INRIX is a subcontractor to the 511 service provider, and INRIX data is the basis for travel time estimates to the public. In the future MassDOT is evaluating the development of a "minimum" sensor-based traffic monitoring program for speed (to serve ITS) and volume/vehicle class (for Federal Highway Administration (FHWA) Highway Performance Monitoring System (HPMS)) requirements and supplementing this data with private global positioning system (GPS)/cellular-*

*based data. This system of sensors is planned to serve as statistical control points in the event that private data is purchased.*

*MassDOT is soliciting proposals to provide a Real Time Traffic Management (RTTM) system in 2012. The goal of this system is to monitor traffic conditions on the Interstate 93 (I-93) Corridor and disseminate real-time information to MassDOT Highway Operations Center and the traveling public. The I-93 corridor extends 45 miles from the New Hampshire border to the end of I-93 in Canton. The scope of the RTTM system shall include installation of portable CMS equipment on I-93 for the purpose of providing distance-based travel time for travel to and from the City of Boston as well as select points of destination along the route. This will be a two year contract and it is anticipated that the system will be operational for the July 4th, 2012 holiday. During the contract period, independent evaluations will be conducted to estimate the benefits of providing travel time information to the public using CMS as well as the cost tradeoffs of using the private sector for all aspects of deployment, quality control, operations and maintenance.*

***Rhode Island*** *- The initial travel time pilot program in Rhode Island was rolled out in early August 2011 consisting of two overhead signs in the Metro Providence area, both displaying the travel time to TF Green Airport (PVD). The remaining signs were turned on in September 2011. The travel time program currently utilizes seven overhead DMS and three portable VMS, providing coverage for all of I-95 in Rhode Island. The major destinations include Downtown Providence, PVD, major interchanges (I-195 and Rt. 4) and the CT and MA state lines. All signs are multi-purpose signs, so at any time the travel time may be overwritten to display accident information or detour instructions. There are three additional overhead DMS on I-95 that are currently displaying detour messages 24/7 due to a bridge replacement. After bridge work is completed, these signs will be switched over to travel times service as well. A technical memorandum issued by the Rhode Island DOT in July of 2010 provides programmatic guidance, see bibliographic reference 3.*

*In the Rhode Island, system data is collected from approximately 30 radar detectors (Wavetronix brand) previously deployed by the state. In order to post travel times on additional corridors it will require deploying new detectors, integrating partner's sensor data (such as Navteq/Traffic.com), integrating vehicle probe data, or a combination of two or more of these options. Rhode Island is currently evaluating the best way to move forward.*

*In the initial phase emphasis was placed on lowering cost by utilizing equipment originally purchased and deployed for other reasons. The sensors were originally installed primarily for data collection under several different contracts including the Iway (I-195 realignment). DMS have been deployed in the state for years to disseminate travel information to the public. The communication infrastructure (mostly T1 connections) were already installed and used to transmit camera images from the same locations as the sensors and signs. The bandwidth* *required for the travel time system is extremely low compared to a camera, so no additional communication investment was needed. The travel time system was therefore a relatively low investment to tie together these existing systems.*

*Rhode Island would like to extend the coverage to I-295, which is the beltway around the city. This would allow travelers to make an informed choice to take I-295 as an alternative to I-95 based on current conditions. Plans are currently being drawn up to extend the sensor and DMS network onto I-295, but these are subject to availability of funding. Other corridors under consideration for deployment include I-195, Rt. 6 / Rt. 10, Rt. 146, and Rt. 4 / Rt. 138 (especially for summer beach traffic).*

***Connecticut** - Connecticut Department of Transportation (ConnDOT) has yet to begin posting travel times on CMS due to lack of travel time information for input into the central management software. Their central management software is capable of delivering travel time messages on the state's CMS infrastructure, though integration would be needed for the specific travel time data feed and protocol. ConnDOT was prevented from participating in the VPP project due to issues with executing the data use agreement, but continues to search for a means to obtain appropriate travel timed data for display on CMS.*

***New York** - The New York State Department of Transportation (NYSDOT) has an expanding system of TTCMS and supporting detectors as part of its Intelligent Transportation Systems (ITS) program. Information is provided to the traveling public to alert them of roadway conditions, incidents ahead or on adjacent roadways, anticipated travel times, congestion, detour recommendations, and advance notice of future roadway condition changes anticipated as a result of special events or roadway construction activities. Accordingly, the Department shares the data with media and traveler information service providers for the purpose of distributing information to the widest audience possible. A fuller description of the NYSDOT's use of TTCMS within the New York Metropolitan Area (District 10) using it's INFORM system is available in bibliographic reference 7.*

*NYDOT has an extensive published policy on TTCMS, last updated in January 2011, for the placement of signs, public education, formatting and content, and data security to protect individual privacy. Protecting individual privacy is unique in the TTCMS policy statements owing to the use of TRANSMIT data, which is based partially on the use of travel time derived from automated toll-tags. A copy of the NYDOT policy is included in Appendix C.*

*In addition to fully configurable CMS, NYDOT utilizes what is termed as Hybrid Message Signs (HMS). HMS are static signs with CMS inserts that allow travel time information to be continuously conveyed to motorists. HMS are complimentary to traditional CMS, giving motorists information on road condition/status and travel time to a destination. The HMS use Route/Facility shields in order to minimize the amount of text needed to convey the information,* *and making it easier for motorist to interpret the sign quickly. Additionally, because of the use of Route/Facility shields, the travel time to multiple destinations can be more easily displayed on one sign whereas the use of traditional CMS to display travel times for multiple destinations is restricted due to the complexity of the text message required. Examples of HMS in use in NY are provided in Figure 1.2. HMS signs have proven cost effective when compared to overhead CMS and their associated structure.*


**Figure 1.2 Examples of Hybrid Message Sign in use in New York**

***New Jersey*** *- Currently the New Jersey Department of Transportation (NJDOT) posts travel time along a couple of corridors where data is available from toll-tag information. The data is made available to NJ through participation in TRANSMIT, a regional traffic monitoring consortium supported by New York, New Jersey and Connecticut. All current posting of travel time in NJ is hardware and sensor specific. NJDOT is upgrading software that will provide the capability to post travel times from the newly developed data fusion engine. The data fusion engine is a processing engine that combines data from multiple sources (such as the VPP, point sensors, toll-tag data from TRANSMIT, and Bluetooth) into a single comprehensive traffic monitoring system. The new software will allow for more robust, expandable command and control within their transportation management centers allowing NJDOT to take advantage of the best data available to post travel time. Expected to be available by the end of 2011, the system will provide and post travel times to CMS statewide.*

*One key technical hurdle to enable statewide coverage was increasing the granularity of the Traffic Message Channel (TMC) codes used in the VPP. TMCs as used in the VPP encompass about 8800 base level segments for the entire freeway system in New Jersey. To enable the data fusion engine to utilize the VPP data, NJDOT converted to a system with higher granularity, using approximately 88,000 base level segments for New Jersey. This allowed more thorough travel time calculations and placement of DMS locations. NJDOT also anticipates providing cross-border travel times, such as Newark to Yankee Stadium. NJDOT also posts travel time in some work zones. They are experimenting with VPP data for such applications, and finding it more stable than point sensors in some areas.*

***Pennsylvania*** *-Travel times are posted by the Pennsylvania Department of Transportation (PennDOT) in Pittsburgh and Philadelphia metro areas. These efforts are initiated by PennDOT engineering districts 6 & 11 respectively. Currently PA does not have an existing statewide policy that addresses TTCMS.*

*Philadelphia Metropolitan Area (District 6)*
*The effort was initiated in November 2009 with a system of nine signs on US 202, US 30 and PA 100. In September 2010, 13 more signs were added on I-76 and I-476. Travel time data are calculated through a system of EZ Pass tag readers and RTMS detectors. Presently, the system has grown to 53 total DMS that display travel time throughout the region.*

*District personnel noted increased costs for DMS when used for posting travel time. This included both monthly power consumption and increased routine and preventative maintenance. A one-time response to a DMS taking into account manpower, equipment, parts, and materials could run in excess of $3000. The cost of preventative and response maintenance of devices (sensors) is also notable, as well as routine maintenance of servers and software. Some of this can only be performed by experienced engineers familiar with the operation of the system and placement of devices.*

*District 6 advises other agencies to be prepared for a significant increase in operating and maintenance costs, to anticipate more sign failures from using the sign more intensively than before posting travel times. Regular routine maintenance of signs and devices is necessary to ensure dependable system operation.*

*Pittsburgh Metropolitan Area (District 11)*
*Travel times are posted on two DMS along I-376 WB between the PA Turnpike and downtown Pittsburgh. Point speed detection is currently used to determine travel time. Bluetooth™ traffic monitoring technology is also being tested.*

*Initial deployment was based on legacy RTMS devices. The required refurbishment and reconfiguration prior to implementing travel times was a substantial cost. The software system was designed so that travel times in other areas could be configured by the transportation management center (TMC) Manager or Information Technology (IT) department, without relying on the developers to add routes as the system grows.*

*Travel time data is validated by comparison with data from Traffic.com who also provides travel time in the area, as well as the INRIX probe data used by PA's 511 vendor. The system was tested for several months prior to implementation. TMC Operators perform accuracy checks at least once a day since deployment commenced.*

***Delaware*** *- Delaware is currently developing centralized travel time based on a network of point sensors deployed and being deployed as part of the statewide Integrated Transportation Management System (ITMS). A statewide system of Bluetooth based sensors is planned to be deployed beginning in the 2013 fiscal year to supplement the point detection. Delaware is also reviewing other probe based technology. Delaware 511 will be implemented in the 2013 fiscal year. Travel time information is currently available at www.DelDOT.gov. A smart phone application is under development with a planned release in the 2013 fiscal year. As part of the Delaware 511 project, automated travel time information is planned for release on DelDOT's primary licensed radio station WTMC 1380 AM. Plans to post to CMS are still under review.*

***Maryland*** *- The Maryland State Highway Administration's (MdSHA) Coordinated Highways Action Response Team (CHART) program gained access to real-time travel-time information via the VPP in 2008, enabling them to accelerate plans to disseminate travel time information to traveling motorists through its dynamic message sign (DMS) infrastructure. The ability to post travel time on DMS required upgrades in the CHART system software. These upgrades were originally planned for future releases of CHART software, coinciding with the deployment of a point sensor network budgeted to begin in 2012. MdSHA's sister organization, the Maryland Transportation Authority (MdTA) also owns DMS infrastructure that would display travel time information using the CHART system.*

*Software upgrades were initiated in 2009 ahead of the original schedule so that if the VPP data was of sufficient quality for posting travel times, then the CHART system would be poised to deploy TTCMS utilizing the VPP data. With the software upgrade completed in 2009 and the positive results of the Coalition's validation program, CHART posted the first travel time to a DMS in January of 2010. Since then the program has grown steadily. VPP coverage was expanded to the entire state and now supports statewide TTCMS.*

*In 2009, CHART initiated a study to develop a set of procedural guidelines for the travel time implementation. The guidelines provided procedural recommendations for launching the DMS travel time capability using the CHART software, and were developed specifically targeting VPP as the base data for travel time. (See bibliographic reference 6)*

*In short, Maryland was able to leverage the Vehicle Probe Data to deliver statewide TTCMS two years ahead of schedule, while avoiding a large capital investment in upgrading their sensor infrastructure. Much of the technical and policy work is fully documented. See bibliographic references 5 and 6.*

*In 2012 MdSHA is now considering using arterial data supplied in the VPP to augment traveler information services.*

***Virginia*** *- Virginia Department of Transportation (VDOT) has an active TTCMS system in Northern Virginia, and plans are in place to initiate two more systems in the Hampton Roads area in the upcoming months. The Department is also looking to incorporate travel times along other major corridors around the state in the upcoming year. In October 2011, travel times were displayed on four signs in Northern Virginia along the I-66 corridor using the I-95 VPP data. This was expanded to further deployments on I-95 and I-395 in Northern Virginia within the last few months. The Department is planning on implementing travel times in the Hampton Roads Region of the state as part of a "Reach the Beach" campaign by Labor Day of 2012. These travel times will give drivers the opportunity to look at drive times along different routes for a desired location. Drivers will be able to make route based decisions based upon travel time duration. These travel times will be displayed on newly installed combined Static / VMS signs, Welcome Centers and VDOT's 511 web site. VDOT is also in the process of validating a Hampton Roads Detector System for implementing travel times in the Hampton Roads Region along other major corridors. This travel time effort is looking to become operational in the October 2012 timeframe. This system is being verified using Bluetooth™ traffic monitoring technology. These systems are currently being deployed as independent initiatives, but each will follow statewide policies currently being updated.*

***North Carolina*** *– North Carolina Department of Transportation (NCDOT) has two TTCMS systems in operation, one automated and one manual. NCDOT developed Standard Operating Procedures (SOPs) to insure consistent practice between the two programs. (North Carolina SOPs for TTCMS are included in Appendix A). The automated system in Raleigh is based on point sensors. It was implemented as part of a capital improvement anticipated to increase traffic volume, and thus induce congestion on older sections of the network. The TTCMS is intended to inform drivers of anticipated travel times, and encourage alternate routes when appropriate. The system in Raleigh is fully automated, using point sensors as the basis to calculate travel times. Sensor reliability has been an issue, particularly during rain. NCDOT is considering the use of VPP going forward.*

*The other TTCMS system provides travel time based on VPP data for defined routes through a central server accessed via the internet. The calculation of travel time is automated, however operators must manually post travel time information to the state's CMS, requiring nine additional operator positions. Development efforts are currently underway to automate this process. The new process will create a single system that combines data from multiple sources to maximize travel time accuracy. The current system based on VPP data includes defined routes through the mountains. The accuracy of travel time on mountainous routes has been problematic, related to the differing speeds between private automobiles commercial trucking in such areas. NCDOT has also had challenges obtaining VPP data on new roadways. For example, a new section of freeway completed in 2008 currently does not have coverage through the VPP due to issues related to the unavailability of Traffic Message Codes (TMCs). TeleAtlas has not created TMC codes for this section, so even through INRIX collects data on the freeway,* *no traffic data appears in the VPP due to the lack of TMC codes. NCDOT is currently working with INRIX on a way to report non-TMC coded areas.*

***South Carolina*** *– Within South Carolina, the program to display travel on signs program began in 2008 and currently incorporates 33 signs statewide. Data to estimate travel times is obtained from the I-95 Vehicle Probe Project. Travel times are displayed whenever travel time is greater than normal, and updated once per minute. Travel times are validated periodically by staff through ride checks.*

*South Carolina noted increased power costs should be considered. It is estimated that it costs $13.00 per day per sign to run 24/7.*

***Georgia*** *– Only metropolitan Atlanta has travel time posted on signs. The system consists of about 100 CMS, the earliest of which dates to the Olympic Games (1996). The original system was primarily internal to the Atlanta beltway and constitutes about 25 percent of the current system, but has since grown to cover a large portion of the Atlanta metro, both inside and outside the beltway. Destinations are typically chosen 5-12 miles downstream, and travel times are displayed from 5AM to 10PM every day.*

*Owned and maintained by the GeorgiaDOT, the system is based exclusively on approximately 2800 point sensors, of which 80 percent are video-based, and the remaining 20 percent are radar (RTMS). Sensors are typically on 1/3 mile spacing. Filtering of data is based on point sensor data availability. If 50 percent or more of the sensors report, the system post travel times, otherwise the system reverts to the next lowest message in the CMS message queue.*

*Validation of travel time is performed whenever a new sign or route is activated or in response to a user complaints. Validation is performed using video and a stop watch. A unique vehicle is identified at the upstream camera, and then timed until it arrives at the downstream camera.*

***Florida*** *– Florida Department of Transportation (FDOT) ITS Operations are decentralized, with each major metropolitan area hosting its own system. Florida as a whole has invested heavily in ITS infrastructure, and over the last ten years has deployed DMS and active TTCMS systems in the state's metropolitan areas. Practices and procedures for each district differ slightly. Florida is currently establishing central policy and practices for TTCMS. A statewide policy for the display of messages on dynamic messages signs is included in Appendix B. Most metro areas use a network of point sensors to estimate travel time with some exceptions. Orlando has invested heavily in toll tag sensors, and the toll tag data is a major contributor to their travel time system. Others areas are considering the use of probe data such as the VPP for use/integration in existing TTCMS systems.*

*Update in 2012: Florida continues to add miles of ITS in the urban areas and within five years will be completely built out, barring any unforeseen loss of funding. In addition to the system previously described, FDOT has a License Plate reader system in the Tallahassee metropolitan area that provides travel times for posting on two DMS on I-10 east and west of the Tallahassee metro limits.*

**Table 1.1 Status of Each State in the Coalition.**

| | Active TTCMS System/s | Utilizes VPP Data | Utilizes Point Sensor Data | Plans for implementation/upgrade | Published policies and procedures | Validation program | Notes |
|---|---|---|---|---|---|---|---|
| Maine | | | | | | | -- No survey data -- |
| New Hampshire | | | | ✓ | | | |
| Vermont | | | | | | | No Plans due to rural nature of state |
| Massachusetts | | | | ✓ | | | Data Quality issues of point sensor has inhibited progress |
| Rhode Island | ✓ | | ✓ | | ✓ | ✓ | Rolled out initial phase on I95 in through Providence in 2011 |
| Connecticut | | | | | | | Lack of data has inhibited progress |
| New York | ✓ | | ✓ | | ✓ | ? | Primary data is toll RFID tags, strong central policies |
| New Jersey | ✓ | | ✓ | ✓ | | ? | Moving toward centralized system with data fusion engine |
| Pennsylvania | ✓ | | ✓ | | | ✓ | Pittsburgh and Philadelphia hosts separate systems |
| Delaware | | | | | | | Currently completing sensor infrastructure |
| Maryland | ✓ | ✓ | | | ✓ | ✓ | Statewide implementation based on VPP data |
| Virginia | ✓ | ✓ | ✓ | ✓ | | ✓ | NOVA and Hampton Roads into production in 2012 |
| North Carolina | ✓ | ✓ | ✓ | ✓ | ✓ | | Moving toward centralized, VPP-driven system |
| South Carolina | ✓ | ✓ | | | | ✓ | Statewide implementation based on VPP data |
| Georgia | ✓ | | ✓ | | | ✓ | System is in Atlanta metro area |
| Florida | ✓ | | ✓ | | | ? | Multiple systems in metro areas |

**Table 1.2 State Contacts for Additional Information**

| | Name | Phone | Email |
|---|---|---|---|
| Maine | | | |
| New Hampshire | Denise Markow | 603-271-6862 | dmarkow@dot.state.nh.us |
| Vermont | Robert White | 802-828-2781 | robertt.white@state.vt.us |
| Massachusetts | Russ Bond | 617-973-7358 | russ.bond@state.ma.us |
| Rhode Island | Michael Wreh | 401-222-5826 ext. 4200 | mwreh@dot.ri.gov |
| Connecticut | Harold Decker | 860-594-2636 | harold.decker@ct.gov |
| New York | John Bassett | 518-457-2384 | jbassett@dot.state.ny.us |
| New Jersey | Dhanesh Motiani | 856-486-6610 | Dhanesh.Motiani@dot.state.nj.us |
| Pennsylvania | Jay Sengoz | 717-265-7557 | csengoz@state.pa.us |
| Delaware | Gene Donaldson | 302-659-4601 | gene.donaldson@state.de.us |
| Maryland | Richard Dye | 410-582-5619 | rdye@sha.state.md.us |
| Virginia | Scott Silva | 804-786-0186 | Scott.Silva@VDOT.Virginia.gov |
| North Carolina | Jennifer Portanova | 919-696-8857 | jportanova@ncdot.gov |
| South Carolina | Dan Campbell | 803-737-1459 | campbellde@scdot.org |
| Georgia | Mark Demidovich | 404-635-8014 | mark.demidovich@dot.state.ga.us |
| Florida | Gene Glotzbach | 850-410-5616 | gene.glotzbach@dot.state.fl.us |

# Section 2:  Data Processing

In this section, the steps and processes of transforming the I-95 Vehicle Probe Data (VPP) into meaningful travel time information for selected routes and destinations are explained.  These steps include processes that aggregate, filter, smooth, and place limits on travel time information with the end result of travel time information, as illustrated in the block diagram of Figure 2.1.

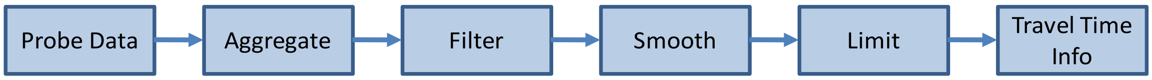


**Figure 2.1    Block Diagram of Travel Time Processing**

Data from the Vehicle Probe Project comes primarily from the vehicles operating as anonymous probes.  INRIX Inc. provides the VPP data feed to the Coalition by combining instantaneous speed and trajectory information from various sources to estimate traffic conditions.  The primary source of data comes from fleet vehicles equipped with Global Positioning System (GPS) equipment that periodically report location, speed and direction.  Although other sources of data are used in the process, the majority of base data comes from these GPS equipped fleets.  The fidelity of the resulting traffic data is largely dependent on the number and frequency of reporting vehicles.  As volume of traffic increases and as the percentage of commercial fleets increase, the density of probe data increases, improving the accuracy of the resulting traffic data.

Traffic data is at the heart of the VPP system.  Some data items in the VPP were explicitly specified in the contract, while INRIX provides other items as value added, and others have been added in collaboration with INRIX in order to improve the usability of the VPP data.  All data items can be viewed from the project monitoring website at www.i95.inrix.com, and are also available in the XML data feed used to support real-time travel time calculations for specified routes and destinations.  The VPP data items include:

- *Speed* - the current space mean speed for the roadway segment in miles per hour.
- *Travel Time* - the current travel time it takes to traverse the roadway segment in minutes.
- *Reference Speed* –the calculated "free flow" mean speed for the roadway segment in miles per hour (capped at 65 miles per hour). This attribute is calculated based upon the 85th-percentile of the observed speeds on that segment for all time periods, which establishes a reliable proxy for the speed of traffic at free-flow for that segment.
- *Average Speed* - the historical average mean speed for the roadway segment for that hour of the day and day of the week in miles per hour.

- *Score*- three discrete values are defined:
  - "30" – Real-time time data for that specific segment
  - "20" – Estimate of speed relies heavily on historical data, specifically the average speed. May have some real-time data.
  - "10" – Estimate of speed is based on historical data, specifically the reference speed.

- *Confidence Value* (C-Value) - in December 2009, INRIX began publishing a confidence value separate from the score attribute to provide supplemental information on the fidelity of real-time data. C-Value ranges from 0 to 100 and is provided only when the Score = "30". A C-Value equal to 100 represents the combination of (1) high data density, (2) the current data is very consistent with the data over the past 45 minutes, and the (3) current data is very consistent with the historical data. As each of the three criteria degrade, the C-Value will decrease until it reaches a minimum value of 0, corresponding to the lowest possible confidence in the estimate of traffic conditions. See the project interface guide for additional details.
- *Date and Time* - the UTC timestamp at which the response was generated.
- *TMC Segment* - the Traffic Message Channel (TMC) code that defines the beginning and ending point of the roadway segment being reported. TMC codes are maintained by an industry consortium of electronic map providers. Generally TMC segments begin and end at breaks in access, typically ramps for freeways and major intersections for arterial roadways.

Data from the XML feed is updated every minute, but the data may be requested at less frequent intervals.

For purpose of illustrating the various processing steps in this section, a sample route is defined on the outer-loop of the Washington DC I-495 beltway (counter-clockwise travel direction) of roughly 6.1 miles in length as shown in Figure 2.2. At point A is an overhead changeable message sign (CMS). At point B is a major interchange between the Beltway and I-95 heading north to Baltimore. The route from A to B represents a typical route of interest to post on the CMS at point A, and which requires the calculation of travel time based on the data provided by the VPP.

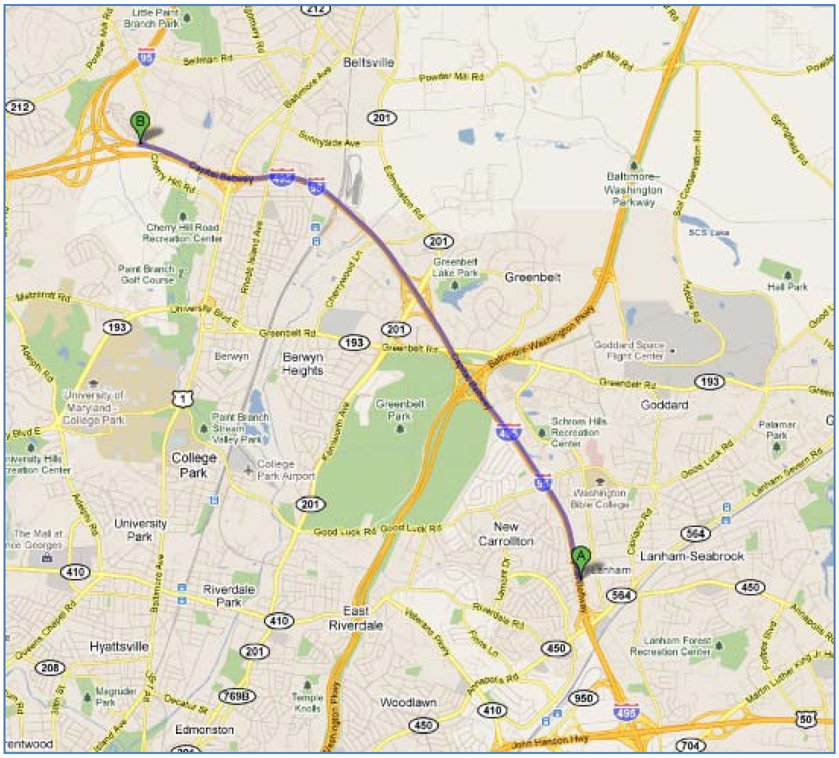


**Figure 2.2 Sample Route for Illustrating Processing Steps**

## *2.1 Aggregating Segments into Routes*

Routes of interest are typically a combination of several base level segments. Within the VPP, the base level segments are reported using a convention from the electronic mapping industry called Traffic Message Channel (TMC) codes. The code scheme is explained in detail in the Project Interface Guide available from the project web site at http://www.i95coalition.org/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx. In most cases traffic information from several TMC segments must be aggregated to form travel time information for a route of interest.

Table 2.1 provides a precise naming convention for data items used in the processing of VPP data. A *route* refers to a roadway path for which travel time is needed. It is typically several miles in length, possibly spanning multiple interchanges as in our example. A *segment* refers specifically to TMC segments which are short sections of roadway between highway entrances/exits. Multiple *segments* are typically combined to form a *route* of interest for travel time calculation.

**Table 2.1 Naming Conventions**

| | |
|---|---|
| $TTroute_i$ | Travel time in minutes for the route of interest at time period *i* |
| $TTsegment^n_i$ | Travel time in minutes for TMC segment *n* at time period *i* |
| $Sroute_i$ | Speed in mph for the route of interest at time period *i* |
| $Ssegment^n_i$ | Speed in mph for TMC segment *n* at time period *i* |
| *Droute* | Distance in miles for the route of interest |
| $Dsegment^n$ | Distance in miles for TMC segment *n* |
| $SCOREroute_i$ | Score for the route of interest at time period *i* |
| $SCOREsegment^n_i$ | Score for TMC segment *n* at time period *i* |
| $CVroute_i$ | C-Value for the route of interest at time period *i* |
| $CVsegment^n_i$ | C-Value for TMC segment *n* at time period *i* |
| *N* | Number of TMC segments comprising the route |

Note that the time period, *i*, represents the current time period of interest. This time period may be may be as short as 1 minute, reflecting the maximum update frequency supported by the VPP. The maximum recommended time period is 5 minutes.

The relationship between segment and route data items are defined mathematically in Equations 2.1.1 through 2.1.6. Travel time ($TTsegment^n_i$) and speed data ($Ssegment^n_i$) for TMC segments are available directly from the VPP data feed. Segment travel time can also be calculated from segment speed divided by segment length as shown in EQ 2.1.2.

$$TTsegment_i^n = \left[Dsegment^n / Ssegment_i^n\right] * 60$$ EQ 2.1.1

Route distance and travel time are obtained by accumulation of distance and travel time of the individual TMC segments comprising the route. These equations are given in EQ 2.1.2 and EQ 2.1.3 respectively.

$$Droute = \sum_{n=1}^{N} Dsegment^n$$ EQ 2.1.2

$$TTroute_i = \sum_{n=1}^{N} TTsegment_i^n$$ EQ 2.1.3

Route speed is obtained from the route distance divided by the route travel time as given in EQ 2.1.4.

$$Sroute_i = 60 * Droute / TTroute_i \qquad \text{EQ 2.1.4}$$

Score and C-Value for routes are produced using a weighting scheme based on the distance of the individual segments. The Score for each segment in the route is multiplied by its distance. The sum of these values is then divided by the total distance of the route to obtain a Score value for the route. The same process is used to obtain C-Value for a route. See EQ 2.1.5 and 2.1.6 respectively for corresponding mathematical equations. Note that C-Value is only reported if Score = 30. If C-Value is not reported for a specific segment because the corresponding Score is less than 30, set C-Value equal 0 in equation 2.1.6.

$$SCOREroute_i = \frac{\sum_{n=1}^{N} \left( SCOREsegment_i^n \bullet Dsegment^n \right)}{Droute} \qquad \text{EQ 2.1.5}$$

$$CVroute_i = \frac{\sum_{n=1}^{N} \left( CVsegment_i^n \bullet Dsegment^n \right)}{Droute} \qquad \text{EQ 2.1.6}$$

Note: C-Value is reported only if Score = 30. If C-Value is not reported for segment *n* for time period *i* in EQ 2.1.6, set it equal to 0.

The sample route on the DC Beltway as shown in Figure 2.2 is used to illustrate the processing. The sample route is comprised of nine TMC segments. The 6.1 mile route traverses three full interchanges including the Baltimore-Washington Parkway (Route 295), Kenilworth Avenue (Route 201), and US Route 1. The route also includes an entrance ramp from a DC metro station between Kenilworth Avenue and US Route 1. The listing of the individual TMC segments beginning at the changeable message sign (location A on the map) is given in Table 2.2.

Table 2.2 TMC Segments Comprising the Sample Travel Time Route

| | TMC Code | Route | Associated Interchange | State | Length Miles | Diagram Label |
|---|---|---|---|---|---|---|
| CMS location → | 110-04631 | I-495 | MD-295/MD-193/Exit 22 | MD | 2.00 | -31 |
| | 110N04631 | I-495 | MD-295/MD-193/Exit 22 | MD | 0.61 | N31 |
| | 110-04630 | I-495 | MD-201/Kenilworth Ave/Exit 23 | MD | 0.26 | -30 |
| | 110N04630 | I-495 | MD-201/Kenilworth Ave/Exit 23 | MD | 0.60 | N30 |
| | 110-04629 | I-495 | Greenbelt Metro Dr/Exit 24 | MD | 0.47 | -29 |
| | 110N04629 | I-495 | Greenbelt Metro Dr/Exit 24 | MD | 0.34 | N29 |
| | 110-04628 | I-495 | US-1/Baltimore Ave/Exit 25 | MD | 1.04 | -28 |
| | 110N04628 | I-495 | US-1/Baltimore Ave/Exit 25 | MD | 0.22 | N28 |
| End of route → | 110-04627 | I-495 | I-95/Exit 27 | MD | 0.63 | -27 |
| | | | | | 6.18 | |

A strip-map diagram of the sample route is shown in Figure 2.3. The strip map reads from left to right beginning at the CMS location and ending at the exit to I95 NB. The major interchange ramps mark the beginning/ending of each TMC segment as shown above in Table 2.2.

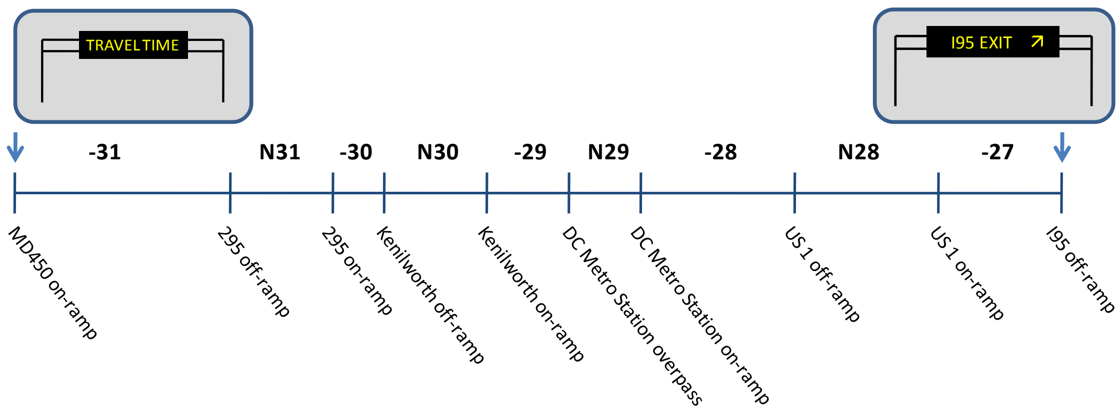


Figure 2.3 Logical Diagram of Sample Route Showing Corresponding Segments

Table 2.3 provides sample minute-by-minute VPP data for the nine TMC segments for a 15 minute period beginning May 3, 2011 at 3:30 PM. The calculation of route travel time is illustrated based on individual segment travel times, and then converted to its equivalent speed based on equations 2.1.2 through 2.1.4.The first matrix provides speeds for each segment as reported by the VPP. The speed data is color coded to highlight congested flow. The second matrix shows the corresponding travel times for each segment. The last row of the second matrix, labeled 'route', is the sum of the segment travel times. The route speed data shown in the third matrix (containing only a single row) is calculated by the route travel times divided by the route distance. It is color coded to highlight congested flow similar to the first matrix.

**Table 2.3 Calculation of Travel Time and Speed for Sample Route**

5/3/2011 - 3:30 PM to 3:45 PM

Minutes Past the Hour

| TMC Segment | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | Length Miles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED - MPH | | | | | | | | | | | | | | | | |
| 110-04631 | 68 | 68 | 68 | 67 | 67 | 67 | 67 | 67 | 65 | 64 | 62 | 62 | 62 | 61 | 62 | 62 | 2.00 |
| 110N04631 | 61 | 61 | 61 | 61 | 61 | 60 | 62 | 62 | 59 | 59 | 59 | 59 | 57 | 56 | 56 | 56 | 0.61 |
| 110-04630 | 65 | 63 | 63 | 61 | 61 | 61 | 62 | 62 | 60 | 60 | 59 | 59 | 53 | 53 | 52 | 52 | 0.26 |
| 110N04630 | 63 | 64 | 64 | 62 | 62 | 61 | 62 | 61 | 49 | 46 | 44 | 43 | 43 | 43 | 31 | 29 | 0.60 |
| 110-04629 | 63 | 63 | 63 | 40 | 40 | 39 | 39 | 33 | 28 | 27 | 29 | 27 | 27 | 27 | 26 | 31 | 0.47 |
| 110N04629 | 61 | 61 | 61 | 45 | 45 | 36 | 36 | 31 | 29 | 31 | 31 | 31 | 31 | 31 | 31 | 40 | 0.34 |
| 110-04628 | 45 | 45 | 45 | 29 | 29 | 25 | 32 | 32 | 32 | 36 | 43 | 49 | 49 | 49 | 50 | 56 | 1.04 |
| 110N04628 | 32 | 23 | 23 | 24 | 24 | 24 | 31 | 31 | 30 | 35 | 38 | 55 | 55 | 55 | 55 | 55 | 0.22 |
| 110-04627 | 34 | 32 | 32 | 32 | 32 | 32 | 34 | 34 | 37 | 42 | 44 | 56 | 56 | 56 | 51 | 52 | 0.63 |
| | TRAVEL TIME - MINUTES | | | | | | | | | | | | | | | | |
| 110-04631 | 1.76 | 1.76 | 1.76 | 1.79 | 1.79 | 1.79 | 1.79 | 1.79 | 1.85 | 1.87 | 1.94 | 1.94 | 1.94 | 1.97 | 1.94 | 1.94 | |
| 110N04631 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.61 | 0.59 | 0.59 | 0.62 | 0.62 | 0.62 | 0.62 | 0.64 | 0.65 | 0.65 | 0.65 | |
| 110-04630 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.26 | 0.26 | 0.26 | 0.26 | 0.29 | 0.29 | 0.30 | 0.30 | |
| 110N04630 | 0.58 | 0.57 | 0.57 | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 | 0.74 | 0.79 | 0.82 | 0.84 | 0.84 | 0.84 | 1.17 | 1.25 | |
| 110-04629 | 0.45 | 0.45 | 0.45 | 0.71 | 0.71 | 0.73 | 0.73 | 0.86 | 1.02 | 1.05 | 0.98 | 1.05 | 1.05 | 1.05 | 1.09 | 0.92 | |
| 110N04629 | 0.33 | 0.33 | 0.33 | 0.45 | 0.45 | 0.56 | 0.56 | 0.65 | 0.70 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.51 | |
| 110-04628 | 1.39 | 1.39 | 1.39 | 2.16 | 2.16 | 2.51 | 1.96 | 1.96 | 1.96 | 1.74 | 1.46 | 1.28 | 1.28 | 1.28 | 1.25 | 1.12 | |
| 110N04628 | 0.42 | 0.59 | 0.59 | 0.56 | 0.56 | 0.56 | 0.44 | 0.44 | 0.45 | 0.39 | 0.36 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | |
| 110-04627 | 1.11 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.11 | 1.11 | 1.02 | 0.90 | 0.86 | 0.67 | 0.67 | 0.67 | 0.74 | 0.73 | |
| **Route** | 6.88 | 7.12 | 7.12 | 8.29 | 8.29 | 8.79 | 8.01 | 8.24 | 8.61 | 8.27 | 7.95 | 7.57 | 7.62 | 7.66 | 8.04 | 7.65 | |
| | SPEED - MPH | | | | | | | | | | | | | | | | |
| **Route** | 53.86 | 52.1 | 52.1 | 44.72 | 44.72 | 42.19 | 46.29 | 44.99 | 43.09 | 44.83 | 46.67 | 49.02 | 48.68 | 48.41 | 46.11 | 48.47 | 6.18 |

The Score and C-Value are useful for filtering as discussed in the next section. The distance weighted calculation of the Score and C-value are illustrated for the sample route based on EQ 2.1.5 and EQ 2.1.6 in Table 2.4.The last row in each matrix provides the distance weighted Score and C-Value for the sample route, respectively. In each table simple color highlights are used to identify below optimal Scores and C-Value (Recall optimum Score is 30 and optimum C-Value is 100.) The use of Score and C-Value for filtering poor quality data are addressed in the next section.

**Table 2.4 Calculation of Score and C-Value for the Sample Route**

5/3/2011 - 3:30 PM to 3:45 PM

Minutes Past the Hour

| | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SCORE** | | | | | | | | | | | | | | | | |
| 110-04631 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 110N04631 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 110-04630 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 110N04630 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 110-04629 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 20 | 30 | 30 | 30 | 20 | 30 |
| 110N04629 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 |
| 110-04628 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 20 | 30 | 20 | 30 | 30 |
| 110N04628 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 110-04627 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| **Route** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 28.69 | 27.76 | 30 | 27.76 | 28.69 | 30 |
| **CONFIDENCE VALUE** | | | | | | | | | | | | | | | | |
| 110-04631 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 70 | 40 | 40 |
| 110N04631 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 70 | 60 | 50 | 40 | 40 | 80 |
| 110-04630 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 50 | 40 | 30 | 20 | 0 | 20 |
| 110N04630 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 50 | 70 | 20 | 20 | 80 |
| 110-04629 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 70 | 80 | 0 | 50 | 30 | 60 | 0 |
| 110N04629 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 70 | 90 | 0 | 0 | 10 | 0 | 0 |
| 110-04628 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 50 | 70 | 20 | 0 | 20 | 0 | 60 |
| 110N04628 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 70 | 60 | 40 | 30 | 30 | 30 | 40 |
| 110-04627 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 80 | 70 | 50 | 30 | 30 |
| **Route** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 84.54 | 84.36 | 57.8 | 54.19 | 41.79 | 27.6 | 44.15 |

## *2.2 Filtering*

Filtering and smoothing are tools to identify and minimize the impact of random errors that can occur in the VPP data. These techniques can be applied by agencies to the VPP data, and they are recommended for agencies that use the data for real-time applications. To be clear, these techniques are NOT completed before agencies receive the data, but are applied by agencies to the data prior to use in applications.

The VPP data acquired by the I-95 Corridor Coalition from INRIX is intended to provide samples of travel time and speeds as frequently as every minute along selected roadways within the I-95 corridor. The accuracy of this data is continuously validated by the University of Maryland (UMD) to verify that it correctly reflects travel conditions along these roadways. The UMD validation is conducted to verify that the INRIX data satisfies the following contractual requirements:

1) Average Absolute Speed Error (AASE): Speed data shall have a maximum average absolute error of 10 mph in each of the following speed ranges: 0-30 mph, 30-45 mph, 45-60 mph and >60 mph. This is the primary accuracy metric, measuring the average deviation from ground truth.

2) Speed Error Bias (SEB): Speed data shall have a maximum error of +/- 5 mph in each of the same speed ranges as those that are specified for the average absolute speed error. The SEB indicates whether the speed data provided from the project is consistently higher or lower than ground truth.

These specifications have served the Coalition well, providing its members with confidence that the VPP data is of adequate accuracy for use in a variety of applications. It is important to recognize however, that both the AASE and the SEB are long term averages of the data that is collected during the evaluation period. As such, they do not capture significant short term deviations that might be present in the VPP data. These types of errors could be the result of anomalies such as data captured from a vehicle whose speed is not representative of the overall traffic stream. It is these short-term deviations that filtering and smoothing tools address.

Filtering relies on two data quality measures that are reported with each record within the VPP data feed. These are the Score and the Confidence Value (or C-Value).

From the onset, the VPP has provided (and continues to provide) a data parameter known as the “Score” along with the speed and travel time information on every segment and for every time period. Score reflects the level of base data available from which traffic conditions are estimated. Three discrete Score values are defined. Additional details on the three discrete levels are discussed below:

- “30” – Real-time base data is sufficient to estimate travel time and speed for the segment at the specific time period. Estimate of speed and travel time does not rely on historical data.
- “20” – Real-time data is insufficient to estimate traffic conditions. The method used to estimate travel time and speed data relies heavily on historical data by time of day and day of week. This method is typically used during daytime hours from 5AM to 10PM when real-time base data is insufficient.
- “10” – Real-time data is insufficient to estimate traffic conditions. Estimates of speed are based on historical data, specifically the reference speed. This method for estimating speed and travel time is typically used during overnight hours from 10PM to 5AM when real-time base data is insufficient.

The Confidence Value (C-Value) was initiated in December 2009 in order to supplement the Score, providing additional data on the fidelity of real-time data. The C-Value provides an added degree of detail to the real-time data and is only available to speed and travel time estimates that have a score of 30.The C-Value is based on a number of additional factors including the degree to which the current traffic matches historic conditions, the rate of change of the speed data, and the length of time that the same speeds are being reported. A detailed discussion of the C-Value is presented in the Project Interface Guide. C-Value ranges from 0 to 100 and is provided only when the Score = “30”. When Score < “30”, the C-Value is assumed equal to 0 for mathematical processes.

Figure 2.4 is a conceptual flow diagram of the filtering process that should be considered as a guide for agencies as they utilize the VPP data. The input to the filtering process is route data that has been aggregated from segments as described in Section 2.1. Filter criteria includes thresholds placed on Score and/or C-Value.

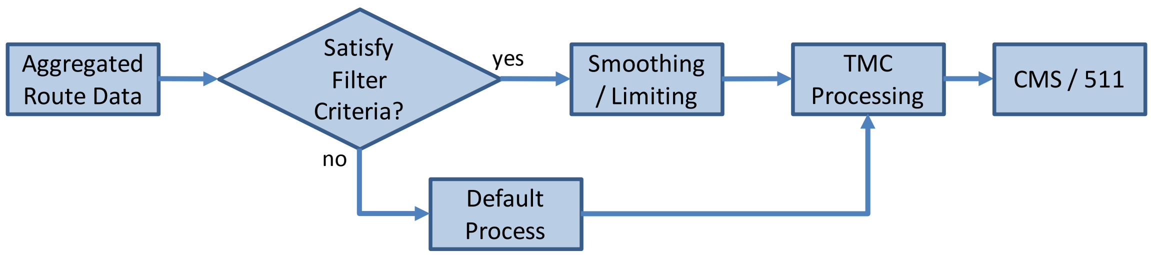


**Figure 2.4 Conceptual Flow Diagram of the Filtering Process**

Aggregated Score and/or C-Value route data should be continuously monitored as speed data is received from the VPP. If the aggregated Score and/or C-Value passes the filter criteria, route speed and travel time data are processed without interruption, proceeding onto the smoothing and limiting functions. If the Score and/or C-Value fail the filter criteria, a default mode of operation should be activated within the Traffic Management Center (TMC). This default process should be defined by the user, and may include actions such as:

- Blanking travel time displays on CMS and Websites
- Inserting default travel times on these displays
- Requiring manual operator intervention

The challenge faced by the user is to select an appropriate threshold for Score and C-Value to use in their applications. Proposed threshold filter criteria are outlined below. The Coalition recommends at a minimum, criteria one should be applied. The effect of using C-Value at various thresholds is still under study.

Filtering Criteria:

1) Score of the aggregated route data should equal or exceed 27.0 for use in posting travel time to CMS. A Score of 27.0 or more indicates that real-time data is sufficient to report

travel time and speed on at least 70 percent of the route.

2) C-Value of the aggregated route data should exceed 30.0 for use in posting travel time to CMS.

A paper titled *Analysis of Quality Metrics in VPP* [1] characterizing the effectiveness of filtering by Score and C-Value was presented at ITSWC in 2011 and is available in the VPP literature archive on the project web site (http://www.i95coalition.org/). Supporting analysis for the above criteria is beyond the scope of this guide.

In summary, the implementation of the filtering requires users to (1) select the aggregated Score and Confidence Value thresholds to be used, and (2) determine a default operation to be activated in the event that the aggregated Score or Confidence Value falls below the selected threshold.

Using the sample data from Table 2.3, all aggregated route Score data pass Criteria #1. Although Scores of "20" are reported for a few of the segments, the aggregate Score for the route remains greater than or equal to 27.0. If Criteria #2 is applied, the aggregate data from minute 44 would not pass, requiring a default action to be taken.

## 2.3 Smoothing

Smoothing can be used in conjunction with filtering, and is intended to prevent sudden deviations in the data from a sudden jump in speed. As with filtering, smoothing is NOT completed before agencies receive the data, but is applied by agencies to the data prior to use in applications. Smoothing transforms sudden changes to a more gradual transition. The theory of the smoothing is based on the fact that sudden deviations between two distinctly different speeds for the overall traffic stream rarely occur in practice.

The input into the smoothing algorithm is the aggregated route speed ($Sroute_i$ as given in Eq. 2.1.4), and the previous output of the smoothing algorithm, designated as $SV_{i-1}$. The output of the algorithm is the smoothed speed route data ($SV_i$) to be used as the basis for posting travel time on signs. (Note, if smoothing is not implemented, then *Sroute* serves as the basis to post travel time on signs.) The smoothing process is giving by the following equation:

$$SV_i = SV_{i-1} + K * (Sroute_i - SV_{i-1})$$

[1] Analysis of Quality Metrics in the I-95 Vehicle Probe Project, University of Maryland

Where:

| | | |
|---|---|---|
| $SV_i$ | = | Smoothed Value of route speed calculated for the current time period, *i*. |
| $SV_{i-1}$ | = | Smoothed value of speed calculated for the previous time period, *i-1*. (this could be two minutes ago for example) |
| $Sroute_i$ | = | The value of speed that has just been received from VPP (aggregated route speed data for current time period *i*. |
| K | = | Smoothing constant (a value of 0.5 is recommended) |

This is a very simple equation. Its function is to update the value of the smoothed speed that was previously calculated with the difference between that value and the current unsmoothed speed measurement (received from the VPP) multiplied by the factor "K." If the recommended value of 0.5 is used for K, the updated value of smoothed speed will then be influenced by ½ the difference between the current INRIX speed measurement and the previous value of smoothed speed.

Table 2.5 and Figure 2.5 illustrates the impact of applying the smoothing algorithm on the sample data set.

**Table 2.5 Smoothed Speed Data from Sample Route.**

| | Minutes Past the Hour | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Route Speed | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| | SPEED - MPH | | | | | | | | | | | | | | | |
| **Unsmoothed** | 53.86 | 52.1 | 52.1 | 44.72 | 44.72 | 42.19 | 46.29 | 44.99 | 43.09 | 44.83 | 46.67 | 49.02 | 48.68 | 48.41 | 46.11 | 48.47 |
| **Smoothed** | 53.86 | 52.98 | 52.54 | 48.63 | 46.67 | 44.43 | 45.36 | 45.17 | 44.13 | 44.48 | 45.57 | 47.3 | 47.99 | 48.2 | 47.16 | 47.81 |

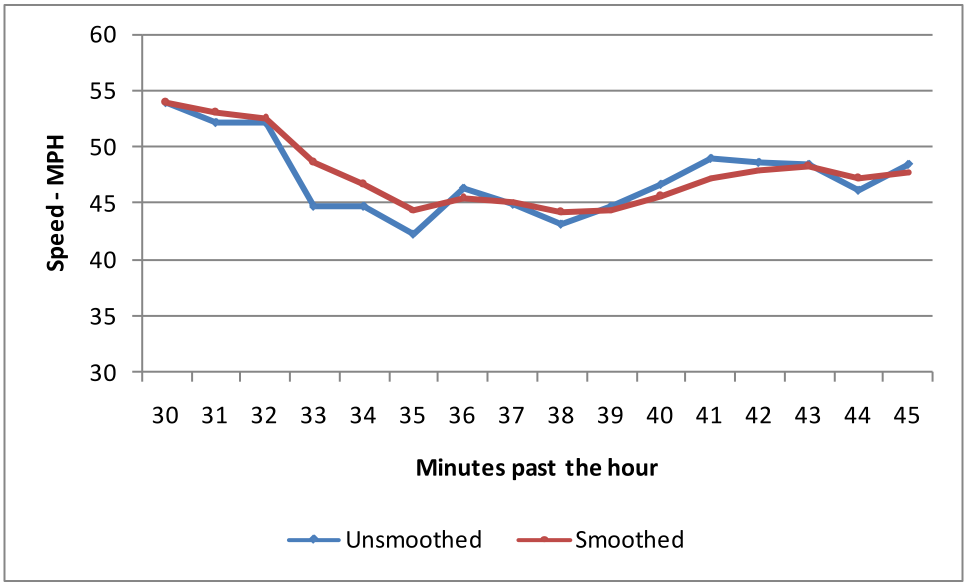


**Figure 2.5 Graph of Smoothed Versus Unsmoothed Data from Sample Route.**

Implementation Notes:

On startup, or immediately after a void caused by the filter mechanism, the previous smoothed values ($SV_{i-1}$) will not be available. In these instances, ($SV_{i-1}$) can be assumed equal to $Sroute_i$.

The equation and the recommended K value of 0.5 are based on an evaluation of the relative effectiveness of a number of alternative smoothing techniques and K values, which concluded that they produced the most effective techniques. Details of these analyses are available from the literature archive on the project page of the Coalition web site.

The smoothing function is inserted in the processing stream after filtering, and prior to the applications of travel-time or speed limitations.

## *2.4 Limiting*

In order to avoid posting travel times that may appear to violate speed limits, speed is typically limited to posted speed along the route. Even though traffic may be flowing at 70 to 75 mph, the output of the smoothing function may be capped at prevailing speed limits, typically 60 to 65 mph in much of the I-95 Corridor. If the speed is capped, the corresponding travel time for use on CMS signs reflects the minimum travel time if obeying speed limits. All active systems surveyed place limits on the posted travel time based either on posted speed limit, or a maximum speed of 55, 60, or 65 mph.

# Section 3: Policy and Display Issues

Program policy encompasses selection of routes and end destinations, times of day to display travel time messages, the priority of travel time messages relative to other types of messages, and policies for media and public interaction to promote its use and educate drivers. Display issues include the proper organization of message content to maximize utility and minimize driver confusion. These guidelines encompass such items as formatting of the message, phasing and updating guidelines, use of travel time ranges, and display of distance to the destination.

The discussion in this section is a synthesis of practice based on standards (such as the Manual on Uniform Traffic Control Devices (MUTCD), national guidance, prevailing practice as reported by Coalition states, and input from national experts. Terms 'shall', 'should', and 'may' reflect the relative level of guidance provided in decreasing order from mandatory to suggested practice.

## *3.1 Location of Changeable Message Signs*

TTCMS systems typically take advantage of existing CMS erected for other traveler information services. As the TTCMS system grows and expands, the locations of new CMS's will increasingly be influenced by travel time concerns. The effectiveness of travel time information is maximized if signs are placed in areas with significant destinations, on sections of roadway within minimal visual activity (that is existence of other messages critical to the driver), and in advance of major decision points that give the driver alternative routes. Guidelines for placement prior to diversion opportunities are generally 0.5 to 2.0 miles in advance of major interchanges, providing the driver the opportunity to change lanes appropriate to the diversion maneuver.

## *3.2 Selection of Routes and End Destinations*

Significant destinations include intersecting freeways, major state routes, major landmarks such as bridges and tunnels and venues for special events such as sports stadiums and civic centers. Destinations typically remain constant, but may be changed based on the time of day to accommodate destinations whose demand is time sensitive such as sports stadiums and special event venues.

Survey results indicate that travel times are typically reported for destinations between 5 to 20 miles upstream. Destinations less than five miles ahead may be reported but diversion opportunities and lack of granularity in reporting travel time (if reporting to the nearest minute) impacts effectiveness. Reporting travel time for routes greater than 20 miles upstream are less common, but provides even greater opportunities for diversion to avoid congestion. Prevailing practice uses the current travel time as an estimate of future travel time.  At distances greater than 20 miles, more sophisticated prediction algorithms may be warranted.

Routes less than 20 miles typically identify a precise roadway or landmark, such as a major interchange.  As route distance increases, the landmarks may be to a region, city or area.  Travel time to a city or region 30 miles ahead may need to only identify the area by name.  For example, "Travel Time to Newark, DE 45-55 minutes", is sufficient.   Exact exits or crossroads are not required in these cases.

## *3.3 Priority of Travel Time Messages*

The hierarchy of travel time among all CMS messages is typically medium to low relative to other types of messages.  It is difficult to classify priority in a format that is common to all systems, because each Traffic Management Center uses varying nomenclature for various message types.  Examples from several of the states that responded to the survey are given below.

Maryland message priority is as follows:

1. Urgent Messages – any message given top priority
2. Incident Messages
3. Planned Roadway Closure Messages
4. Toll Rate Messages
5. Travel Time Messages
6. Congestion Messages
7. Shazam Messages – type of message with simulated flashing lights
8. Weather Messages
9. Special Messages – such as sporting or special events
10. Action Messages – such as "Debris in Roadway"
11. Safety Messages – such as "Ozone Alert"

Within PA District 6, all travel time messages are replaced by messages for incidents/roadwork/lane restrictions and delays.  Those messages take priority over anything.

In Florida, travel time messages are pre-empted by other messages as needed in the following order: (1) Conditions that require motorists to take action or alter their driving, such as emergency events including evacuations or road closures, (2) Traffic incidents, hazardous and/or uncommon road conditions, work zone activities, and severe weather conditions, (3) Law enforcement alerts (such as Amber alerts), and (4) Traveler information related to special events, emergencies, and incidents impacting mobility and safety.

In South Carolina travel time messages are second to lowest priority. Ozone alerts is the only message lower in priority.

In Rhode Island, travel times messages are configured as the lowest priority. If they are pre-empted by another traffic message, the travel time returns automatically after the priority message is blanked.

New York State DOT does not explicitly list message priority, but their use of Hybrid Message Signs (HMS) allows the continual posting of travel time, reserving CMS for posting more critical accident and emergency information when needed.

## *3.4 When to Display Travel Time Messages*

The prevailing practice indicated by majority of Coalition member's survey is to display travel time messages throughout the day, as indicated below.

- Rhode Island – 6AM to 7PM
- PA District 6 – 6AM to 10PM
- PA District 11 – All Day
- Maryland – 5AM to 9PM
- North Carolina – 6AM to 9AM, and 4PM to 7PM
- South Carolina – throughout the day whenever travel time is longer than normal
- Georgia, Atlanta – 5AM to 10PM (previously 6AM to 9PM)

A notable exception is the state of New York whose policy states, 'Travel times shall only be displayed during the hours of heaviest congestion, typically the weekday a.m. and p.m. peak periods.' Exceptions for off-peak times are warranted if volumes have reached a level where the display of travel times would be beneficial to motorists, such as during special events, poor driving conditions, major road construction or road closures, major incidents, or seasonal traffic such as beach traffic.

At a minimum, travel time messages should be displayed during times of expected congestion such as the morning and evening commuter peak hours. Once implemented, customer expectations (and positive customer response) tend to expand the service from early morning until nighttime hours.

## *3.5 Publicity and Driver Education*

Responses to the Coalition member survey indicated that at most, standard press releases were issued when the system was first implemented, and after expansions to include additional highways and/or signs. No ongoing advertisements or driver education was indicated.

The Maryland implementation that began in 2010 followed a similar path. Media attention was drawn to the system shortly after implementation due to observed slowdowns at the CMS's. Commentary attributed the slowdowns to the display of travel time, though no objective measurements were able to confirm the phenomenon in terms of extent or duration of slowdown. The Maryland travel time program was the first in its region, so driver education may have been an issue. In response, Maryland CHART deactivated travel time on a couple of signs in the region that appeared to exhibit (or was reported to exhibit) this phenomenon to a greater degree. The slowdown effect was transitory and is no longer an issue. Driver education through repeated exposure and use of the system appears to have eliminated any such concerns.

The New York State policy provides the most thorough description of required driver notification. A public information campaign prior to a new system startup or significant expansion should inform the public:

- How the travel time information is collected and utilized
- How personal information is processed (relevant to automated toll tags)
- Locations of signs
- Destinations used on the signs and why they were chosen
- Sign text and its meaning (including symbols and the meaning of blank signs)
- Hours of operation

## *3.6 Travel Time Display Format*

The predominant display format is the direct posting of the travel time in minutes. FHWA has no specific policy for the posting of travel time on CMS [6], but encourages following any pertinent guidance in the MUTCD. The MUTCD provides the following guidance:

- Shall's
    - Messages shall be centered within each line either as
        - Text fully centered
        - Left element - left justified and right element - right justified (within a line)
    - No more than two messages shall be displayed on a 3-line sign
    - Display techniques such as fading text, exploding graphics, animation, or other dynamic elements shall not be used.
- Should's
    - No more than two phases in one message cycle
    - One thought per display
    - Avoid simple, vague messages such as 'CONGESTION AHEAD'
    - Limit to 3 lines, 20 characters per line
    - Letter size 18" (desired), 10.6" minimum

- o Readable at least twice by motorist on approach

A pooled fund study dating to 2007 indicates FHWA encourages each state to develop their own standards.  Results from the survey of Coalition members reinforces that any standards set are maintained either at the state or district level.  Although no national standards are in effect, the states or districts attempt to remain consistent with neighboring jurisdictions, for the most part, and attempt to implement best practices at the time the system was developed.

Suggested message format for a single destination based on a 3 line and 21 characters per line sign includes:

- First line - Message heading (i.e., TRAVEL TIME TO)
- Second line - Destination, distance (if there is space for it, see section 3.10)
- Third line - Travel time.

Suggested message format for a multiple destination based on a 3 line and 21 characters per line sign includes:

- First line - Message heading (i.e., TRAVEL TIME TO)
- Second line - Destination 1 and corresponding travel time
- Second line - Destination 2 and corresponding travel time

Figure 3.1 illustrates a multi-destination sign using left element left justified and right element right justified (meeting MUTCD guidelines).  Note in this example a range of travel times is displayed, as discussed in 3.9.

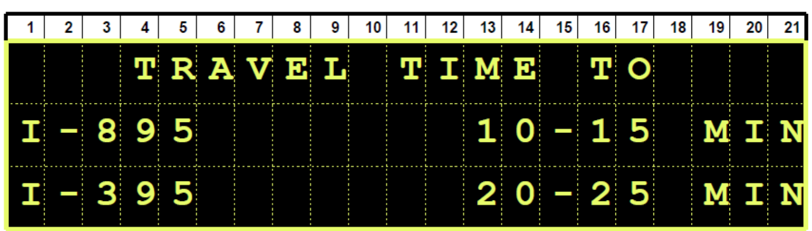


**Figure 3.1 Left Element - Left Justified and Right Element - Right Justified Travel Time Display [5]**

## *3.7 Phasing and Updating Messages*

Although MUTCD allows for multiple phasing of messages, it is recommended that two phase travel time messages be avoided if possible. While being displayed, the travel time message should remain up on a continuous basis. For a single-phase message, the text should be continuously displayed,  If a two-phase message is used (though discouraged), the full cycle should be displayed continuously, with each phase displayed long enough for motorists to read the text twice, while traveling at the posted speed limit.

The frequency for travel time updates on CMS depends on the frequency of the travel time data update in the system. Nominally, a five-minute minimum update cycle should be provided to keep travel times accurate.  Travel time display should be fully automated and must be dynamic.

## *3.8 Maximum and Minimum Travel Times*

All Coalition members surveyed post a minimum travel time consistent with either the posted speed limit, or a constant maximum speed of 55, 60, or 65 mph.

Policies for maximum or excessive travel time vary for Coalition members.  For example in Maryland, at a travel time 4x (where x is the travel time corresponding to the posted speed limit), the TMC software alerts the operator, but continues to display travel time.  At a travel time 10x, the display automated switches to "Blank" or other appropriate messages, such as "Stop and Go" or "Congestion Ahead".   South Carolina does not display any travel time over 40 minutes or less than 5 minutes.  In New York, maximum travel times are segments specific.

## *3.9 Travel Time Ranges*

A range may be used for travel time display instead of a single number. The range may vary on a graduated scale, i.e., narrower range at a lower value and wider range at a higher value. The range maybe capped at a higher value (30 minutes and above). Table 3.1 presents suggested travel time ranges based on distance as used in the Maryland implementation.

**Table 3.1 Suggested Travel Time Ranges from Maryland Implementation**

| **Travel Time Display Range Reported Travel Time, Min** | **Suggested Range** | **Example** |
|---|---|---|
| **0-10** | +/- 1 | 5 will be shown as 4-6 |
| **11-20** | +/- 2 | 15 will be shown as 13-17 |
| **>20** | +/- 3 | 25 will be shown as 22-28 |

## 3.10 Displaying Distance to Destination

If space is available on the sign, distance may be displayed along with location and travel time. Distance, in association with travel time, offers a sense of level of congestion to the motorists. [5]


**Figure 3.2 Example of displaying distance to destination, Georgia DOT**

## 3.11 Validation of Travel Time on Changeable Message Signs

Validation of travel time may be applied on the data used to develop travel time information and on the accuracy of the posted travel time relative to the travel time experienced by motorists viewing the sign – referred to as forecast accuracy. Responses to the Coalition member survey indicate that the majority of jurisdictions perform some type of validation of the accuracy of the data used to post travel times. Validation of the accuracy of the posted travel time as a forecast of the travel time that the motorist will experience is much less common; examples of which are, for the most part, are informal methods or in research. For example an operator may time a notable vehicle between the CMS and the destination via the center's remote video feeds and compare the observed time with that posted on the sign. Most jurisdictions rely on the validation of the underlying data, such as the monthly validation of the I-95VPP, or the quality control procedures for sensors on installation, or periodic maintenance schedules. A sample of the validation activities and policies performed in relation to TTCMS program gleaned from the coalition surveys is provided in Table 3.2.

**Table 3.2 TTCMS Validation Activities within the Coalition**

| State | Jurisdiction / Agency | Type of System | Type 1 - Data Accuracy | Type 2 - Forecast Accuracy | Notes |
|---|---|---|---|---|---|
| Pennsylvania | District 11 Pittsburgh Metro Area | RTMS Sensors | ✓ | | Comparison with commercial data sources (Traffic.com and INRIX) Operators perform periodic accuracy checks. |
| Maryland | Maryland SHA | VPP Data | ✓ | ✓ | Relies on VPP for validation of data<br>Univ. of Maryland is investigating forecast accuracy of TTCMS. Anticipated report in 2012 |
| South Carolina | South Carolina DOT | VPP Data | ✓ | | Periodically by staff through ride checks |
| Georgia | GDOT in Metro Atlants | Point Sensors | ✓ | | Performed by operators using video feed and stopwatch. A unique vehicle is identified at the upstream camera, and then timed until it arrives at the downstream camera. The process is Initiated whenever a new sign or route is activated or in response to a user complaints. |
| Florida | Orlando County Expressway Authority | Toll Tag Readers | ✓ | | Extensive system acceptance test, as well as ongoing monitoring for accuracy of travel time data |
| | District 1 Southwest Florida | Point speed sensors | ✓ | | Installation tests, and ongoing testing (3 times per year) of all sensors in the system |
| | District 2 Northeast Florida | Point speed sensors | ✓ | | On installation, and periodic testing every 6 months. |
| | District 4 Southeast Florida | Point speed sensors | ✓ | | Construction Phase Testing |

## *3.12 Displaying Cross-Border Travel Times*

Many metropolitan areas cross state boundaries or jurisdictional boundaries, and require data sharing in order to develop a comprehensive TTCMS for the region. Sensor data can be problematic for cross-border travel times. Not only are data sharing agreements needed between jurisdictions, sensor data may need to be translated and/or transformed into a format usable in the host TTCMS. The I-95VPP provides unique capability to enable cross-border travel time. Any data acquired through the I-99VPP is available to all subscribing members. Traffic data for an entire metropolitan area spanning one or more states, or one or more jurisdictions (such as a toll facilities or federally owned facilities) is available to all in a common format.

When surveyed in the spring of 2012, no examples of active cross-border travel times were identified, though more than one jurisdiction indicated interest and/or intent to do so. The Maryland State Highway Administration (SHA) was studying the use of VPP data in order to post travel times of the Maryland portion of I-495 (the Washington, DC Beltway) that reflected major landmarks and interchanges on the Virginia side of the beltway. Specifically Maryland SHA is investigating posting travel times near the interchange of I-95 on the north side of the

DC Beltway, reflecting alternative routes (clockwise and counter-clockwise) to the I-95 interchange on the south side of the beltway in Virginia. This would allow through travelers to avoid major incidents. NJDOT is considering use of data to provide travel times to major landmarks within New York City, requiring travel time on New York State roadways.

No major policy issues were identified, particularly for state borders, though the need for coordination was stressed. Jurisdictional boundaries between tolled and non-tolled facilities may be more problematic, as posting of travel time may impact demand, and thus impact revenue.

## *3.13 Displaying Predicted verses Measured Travel Times*

TTCMS systems within the Coalition display currently measured travel time on signs, rather than a prediction of future travel time that motorists will experience. If the current measured travel time is 100 percent accurate at the moment when a motorist passes a changeable message sign, congestion may escalate or abate while a vehicle travels the route. As a result, the travel time the motorist experiences can be less than or greater than the travel time that was posted. Algorithms that predict future travel times, rather than post existing travel time, may increase accuracy of the system. When surveyed in 2012, New Jersey was the only state to indicate ongoing research and development in this area. The NJ Turnpike is working with IBM on one such project. The adequacy of currently measured travel time as a predictor of future travel time is part of ongoing research at the University of Maryland in cooperation with the Maryland SHA.

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## **APPENDIX A** - North Carolina SOP's for Posting Travel Time on Changeable Message Signs

### Travel Time Guidelines

1. WHEN:
   a. Travel times shall be posted on weekdays (Monday through Friday) between morning rush (6am – 9am) and evening rush (4pm – 7pm) on pre-determined DMS'.
   b. Travel Time messages shall not take precedent over "real" incident messages notifying of roadway conditions, incident locations, AMBER or SILVER Alert messages, or any other messages related to situational awareness of the motorists.
   c. Travel times shall be updated on each of the specified signs during peak times every 10 minutes.

2. WHERE:
   a. On the DMS corresponding to the predetermined segments as outlined in the Link View website (http://64.79.136.88/linkviewBeta/linkview.aspx).
   b. Identify which DMS will be associated with each segment and what link is associated with that travel time (examples below);

      i. Evening Rush Hour: DMS Locations as follows
         1. CMS0-0I0077SB0011.97
            a. Link 14
               Segment: I-77 SB, mm 12 to mm 0
               Travel Time shall not be less than the
               **MINIMUM TRAVEL TIME** is 12 minutes
               (Speed Limit TT value is 11.06 min, so round up to nearest whole number - 12 min)
         2. CMS0-0I0077NB0016.87
            a. Link 15
               Segment: I-77 NB, mm 17 to mm 30
               Travel Time shall not be less than the
               **MINIMUM TRAVEL TIME** is 13 minutes
               (Speed Limit TT value is 12.01 min, so round up to nearest whole number - 13 min)
         3. CMS0-0I0085SB0033.64
            a. Link 16
               Segment: I-85 SB, mm 33 to mm 17
               Travel Time shall not be less than the
               **MINIMUM TRAVEL TIME** is 14 minutes
               (Speed Limit TT value is 13.63 min, so round up to nearest whole number - 14 min)

3. INFORMATION PROVIDED:
   a. Travel Time speeds are provided at http://64.79.136.88/linkviewBeta/linkview.aspx (shown below);
      i. Users should navigate to the area for which they will be providing travel times by selecting their area from one of the drop down menus located in the upper left-hand corner of the page.
   b. Discrepancies should be accounted for and, if present, augmented appropriately by the trained Operator.

| Link | Link Description | Travel Time | Speed Limit TT | Update Time |
|---|---|---|---|---|
| 10 | I-77 SB from mm 22 to mm 14<br>MM22 <-> MM14 | 5.31 | 7.36 | 03/29 13:35:02 |
| 11 | I-77 NB, mm 0 to mm 14<br>MM0 <-> MM14 | 14.99 | 12.92 | 03/29 13:35:02 |
| 12 | I-85 SB, mm 52 to mm 39<br>MM52 <-> MM39 | 12.83 | 12.92 | 03/29 13:36:32 |
| 13 | I-85 NB, mm 28 to mm 39<br>MM28 <-> MM39 | 9.30 | 8.86 | 03/29 13:36:32 |
| 14 | I-77 SB, mm 12 to mm 0<br>MM12 <-> MM0 | 17.26 | 11.06 | 03/29 13:35:02 |
| 15 | I-77 NB, mm 17 to mm 30<br>MM17 <-> MM30 | 10.89 | 12.01 | 03/29 13:35:02 |
| 16 | I-85 SB, mm 33 to mm 17<br>MM33 <-> MM17 | 14.73 | 13.63 | 03/29 13:36:32 |
| 17 | I-85 NB, mm 40 to mm 54<br>MM40 <-> MM54 | 12.30 | 12.92 | 03/29 13:36:32 |

4. WHO:
   a. A designated Operator shall be the responsible party for displaying travel times on DMS' and for accurately recording Travel Time activity within the appropriate day's Travel Time Log.
   b. All Operators are responsible for assisting with the workload during peak hours – no breaks are to be taken during Peak Travel Times.

5. FORMAT:
    a. The following format shall be used on all signs to display Travel Times

**TRAVEL TIME MESSAGE FOR TRAVELING ALONG A ROUTE:**

| | |
|---|---|
| **EST TIME TO**<br>**“ROUTE NAME”**<br>**## MINUTES** | **EST TIME TO**<br>**“ROUTE NAME” ## MIN**<br>**“ROUTE NAME” ## MIN** |
| **EST TIME TO**<br>**AVIATION PKWY**<br>**16 MINUTES** | **EST TIME TO**<br>**CITY BLVD 10 MIN**<br>**BRUTON SMITH 26 MIN** |

**TRAVEL TIME MESSAGE FOR TRAVELING TO A ROUTE:**

| |
|---|
| **TIME TO XXXX VIA**<br>**“ROUTE NAME” ## MIN**<br>**“ROUTE NAME” ## MIN** |
| **TIME TO 85 VIA**<br>**485 EAST 24 MIN**<br>**485 WEST 28 MIN** |

    b. Travel Times shall **ALWAYS** be rounded “up” to the next whole minute (i.e. – A travel time of 9.30 minutes will be given as 10 minutes).
    c. Travel Time posted shall not be below the Speed Limit Travel Time (i.e. – If the value listed within the “Travel Time” column is less than the value provided in the “Speed Limit TT” column, then the Operator will display the “Speed Limit TT” value on the DMS).

6. DOCUMENTATION:
    a. A Travel Time Log shall be filled out daily and turned in to the Supervisor at the end of each shift.

7. TRAINING

a. Training will be provided upon request.

**APPENDIX B** - Florida Policy for Displaying Messages on Dynamic Message Signs

**Florida Department of Transportation**

CHARLIE CRIST
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STEPHANIE C. KOPELOUSCS
SECRETARY

**POLICY**

Effective: September 17, 2009
Office: Traffic Engineering & Operations
Topic No.: 000-750-015-c

# DISPLAYING MESSAGES ON DYNAMIC MESSAGE SIGNS PERMANENTLY MOUNTED ON THE STATE HIGHWAY SYSTEM

## PURPOSE:

The main purpose of dynamic message signs (DMS) is to convey timely and important en-route and roadside information to motorists and travelers. The Florida Department of Transportation's guiding principles on posting DMS messages shall conform to the Federal Highway Administration's ***Manual on Uniform Traffic Control Devices (MUTCD)***.

## DEFINITION:

Dynamic Message Sign — Refers to dynamic, changeable or variable message signs, defined as programmable traffic control devices that display messages composed of letters, symbols/graphics or both. They are used to provide information about changing highway conditions in order to improve operations, reduce accidents, and inform travelers. These signs may inform drivers to change travel speed, change lanes, divert to a different route, or simply to be aware of a change in current or future traffic conditions.

## POLICY STATEMENT

It is the policy of the Florida Department of Transportation (FDOT) to designate the use of DMS on the State Highway System for managing travel, controlling and diverting traffic, identifying current and anticipated roadway and environmental conditions, or regulating access to specific lanes or the entire roadway.

**The default display on dynamic message signs shall be travel time display.**

www.dot.state.fl.us

Travel time messages can be preempted with other messages as needed in the following order:

1) Conditions which require motorists to take action or alter their driving, such as emergency events including evacuations or closures required by FDOT, the State Emergency Operations Center, state and local law enforcement, the military, or the Department of Homeland Security.

2) Traffic incidents, hazardous and/or uncommon road conditions, work zone activities, and severe weather conditions.

3) Florida Department of Law Enforcement Alerts such as America's Missing: Broadcast Emergency Response (AMBER) Alerts, Law Enforcement Officer (LEO) Alerts and Silver Alerts.

4) Traveler information related to special events, emergencies, and incidents impacting mobility and safety.

**In the absence of accurate travel time information, at locations where travel time information would not be useful, or when not being preempted with other messages listed above, the default display shall be a blank sign.**

The use of DMS for the display of general public information, advertisements, and non-essential messages is prohibited. However, public information messages that assist the Department in improving highway safety and reducing congestion may be used. These messages shall only be displayed when any of the following conditions are met:

a. Display of the message will have a positive effect on highway safety and congestion in the area.

b. The message is a supplement to a specific national or statewide highway safety media campaign on the same topic.

The total duration of any such highway safety campaign message shall not exceed two hours per day, shall not be displayed during peak hour travel periods, shall not last more than two weeks in duration, and shall not exceed six events per year.

The message display must be approved by the State Traffic Engineer prior to displaying the message. A library of acceptable standard messages is included in the ***Traffic Engineering Manual (TEM), Topic No. 750-000-005***.

SCKopelousos
Stephanie C. Kopelousos
Secretary

**APPENDIX C** – State of New York – Travel Time Systems Policy, January 2011

State of New York
Department of Transportation
Office of Traffic Safety and Mobility

NYSDOT.GOV

**January 2011**

# Travel Time Systems Policy

## I. Introduction.

The New York State Department of Transportation ("Department") has and is installing traffic detectors and message signs along certain state roadways as a part of its Intelligent Transportation Systems ("ITS") program. The ITS program utilizes technology to address transportation system needs. The traffic detectors and message signs are elements of Advanced Traffic Management Systems ("ATM Systems") that allow the Department to manage its roadway system in a manner that maximizes the efficiency of the existing facilities. This is critically important in congested urban areas where it may not be possible or desirable to add roadway capacity. The traffic detectors and message signs also give the Department the ability to post travel times to the traveling public. In addition to being displayed on signs, data associated with travel times may also be made available in real-time or through historical databases.

ATM Systems use technologies such as traffic detectors, electronic message signs and closed-circuit television (CCTV) systems to monitor and collect information on traffic conditions, manage traffic, quickly detect incidents, dispatch proper response and provide motorists advance notice of congestion. Thus, reducing the possibility of secondary accidents and allowing motorists to consider alternate routes or modes of travel or adjust schedules to avoid congestion. These systems are run from Transportation Management Centers ("TMCs") where managers and operators analyze the data from the field devices, manage traffic via the ATM system elements and coordinate the fastest and best response to incidents.

Information is provided to the traveling public to alert them of roadway conditions, incidents ahead or on adjacent roadways, anticipated travel times, congestion, detour recommendations, and advance notice of future roadway condition changes anticipated as a result of special events or roadway construction activities. Accordingly, the Department shares the data with media and traveler information service providers for the purpose of distributing information to the widest audience possible.

## II. Applicability.

This policy establishes the manner in which travel times shall be collected, the format to be used to present travel times to the public and general guidelines for establishing travel time systems in specific corridors.

## III. Definitions.

A. “Advanced Traffic Management Systems (“ATM Systems”)” shall mean technologies such as traffic detectors, electronic message signs and CCTV to collect information, manage traffic, quickly detect incidents, dispatch the proper response and provide motorists advanced notice of congestion.

B. “Transportation Management Center (“TMC) shall mean the central station site for monitoring, analyzing and using the data collected by the Advanced Traffic Management System.

C. “Data” shall mean information collected by the traffic detectors, including vehicle speed, vehicle type and vehicle location.

D. “Incident” shall mean an activity that occurs on the road, roadway, right-of-way or in proximity to it, such as a vehicular accident, flat tire, fire, or similar situation that has or could have a roadway safety or congestion impact on travel conditions on such roadway.

E. "Entity” shall mean a private corporation or other private organization, including media or other information service provider, which is duly authorized under an agreement with the Department consistent with this policy to receive Advanced Traffic Management System data.

F. “Personal Identifier Information” shall mean

i. Identifies an individual, drivers or passengers
ii. Tracks the individual travel pattern of a specific vehicle

G. “Public Partner” shall mean any public agency, government, municipality, authority, accredited academic institution or coalition of such bodies that enters into an agreement with the Department for the use of traffic detector data consistent with the provisions set forth in this policy.

H. “Mine/Mining” shall mean any process wherein data containing personal identifier information is collected, manipulated, enlarged, enhanced, analyzed, and/or otherwise used.

I. “Travel Time System” shall refer to a deployment of traffic detectors and message signs for the purpose of providing travel times and alternate route times to the traveling public.

J. “Detectors” shall mean any device used for the purpose of gathering speed or vehicle data to determine highway congestion.

K. “Changeable Message Signs” shall refer to fully dynamic electronic traffic signs capable of displaying various messages to the traveling public.

L. “Hybrid Message Signs” shall refer to motorist information type static signs fitted with changeable message sign inserts where the travel times are dynamic and the location information is constant. These signs shall be green background and white lettering.

M. “Message Signs” shall refer to signs used for relaying messages to the driving public. These may include permanent overhead or side-mounted changeable message signs, permanent overhead or side-mounted hybrid message signs or portable side-mounted changeable message signs.

## IV. Principles

The planning, design, deployment, operation and maintenance of all travel time systems deployed by the Department, as elements of ATM System shall conform to the following principles:

### A. Privacy

The Department shall consider the protection of personal privacy in all aspects of system planning, design, deployment, operation and maintenance and shall not disseminate any personal identifier information.

### B. Public Involvement and Education

The public shall be made aware of projects to initially deploy or significantly expand travel time systems on a facility, in a corridor or throughout a region except where such advisement is not practical. Such as in the case of a temporary installation for purposes such as short term traffic management, construction or data collection, or where the installations are an element of routine-type maintenance activities. The Department shall provide timely public notice and consider public input in the planning and design of each of the systems in accordance with the State Environmental Quality Review Act (“SEQRA”) process and this policy.

A public information campaign shall be implemented to educate drivers about how the travel time systems work. The content of this campaign shall include how information is collected, how the information will be utilized, how such information shall be distributed, the degree of accuracy of the information (nearest minute, five minutes...), expected hours system will be in operation, location of message signs and the destinations to be included on the signs. Furthermore, the media and public (where practical) should be invited to observe the functioning of the travel time systems from within the TMC, or other central gathering site for traffic information.

**C. Security/Integrity**

Data security shall be designed into each travel time system at the system architecture level. For the purpose of protecting personal identifier information, travel time systems shall make use of hardware and software security technology, and audit procedures. Security software and hardware will be consistent with the state of the art within the industry, as feasible for upholding the principles set forth in this policy. ATM Systems shall use operational, technological and administrative safeguards consistent with Department policy to assure that access to personal identifier information is restricted to duly authorized individuals. Data shall be protected from improper alteration, manipulation or improper destruction.

**D. Extent/Use**

Travel time messaging should be used in cities or corridors that experience traffic congestion or traffic variability. However, conditions should be dynamic enough so that travel time messages are not viewed as static messages, which may result in credibility problems.

The Department may share travel time data with other public partners to achieve common transportation objectives in improving transportation planning, traffic management and traveler information. The Department may also distribute travel time data directly to the public via the internet or other means for the purpose of providing traveler information.

**E. Access and Accountability**

Access to travel time data and ATM systems shall be controlled by pre-determined administrative and supervisory policies based on design and operational considerations and shall be tracked for adherence to procedures. Disciplinary procedures shall be established to address improper access, data manipulation, mining or data disclosure, as well as for assessment of procedural security. Procedures shall be developed to ensure appropriate training of personnel with access to travel time systems and other instrumentation with respect to the requirements of this policy.

## F. Commercial Use

Travel time data may be shared with other entities for commercial use in order to provide for the widest distribution of the information to allow travelers to make informed travel decisions. For this purpose, the entity shall be regularly involved with the distribution of traveler information for commercial purposes and provide significant value to the Department in providing for widespread dissemination of traveler information to the public.

Travel time data may be shared with the trucking industry and other transportation related entities for fleet management and facilitating the movement of goods and services through important corridors.

## G. Enforcement

Travel time systems shall be designed and used primarily for the traffic management and traveler information purpose for which they were installed and for which the public would reasonably expect. Enforcement agencies play an important public safety role in incident management activities. Accordingly, the Department partners, and sometimes co-locates at TMCs, with enforcement agencies to provide for the best incident management services to the public. As a result, enforcement agencies may have access to travel time data directly or remotely through TMCs for the purpose of coordinating incident management and incident-related public safety activities. Travel time data shall not be provided for routine or regular monitoring of traffic for enforcement purposes. The ongoing sharing of data with enforcement agencies shall be in accordance with the privacy and security provisions of this policy as well as existing data sharing agreements, policies and guidelines of the Department. Enforcement agencies shall be responsible for ensuring that any use of the travel time systems is done in accordance with statutory authority, appropriate legal process, or emergency circumstances as defined by law.

# V. Design Guidelines

The following design guidelines shall be followed when deploying travel time systems along with current MUTCD requirements. The Department's "Travel Time Systems Requirements" should be referred to for more specific information regarding system deployment, equipment locations and public outreach.

## A. Deployment of Travel Time Information

1. The public shall be made aware of projects to initially deploy or significantly expand travel time systems on a facility, in a corridor or throughout a region in accordance with applicable requirements of this policy.

2. Travel time system equipment should generally be installed in areas of traffic congestion.

3. Travel time systems shall have the ability to archive the calculated data (travel times) for future planning and performance measuring.

**B. Location of Detectors for Travel Times**

1. Locations of detectors shall be determined based on the type of detector, the nature of the roadway and the spacing of interchanges in order to provide the most accurate travel times.
2. Detectors shall be installed in conjunction with other ATM System elements.

3. Power sources shall be considered during design.

4. Appropriate communication facilities shall be available or installed as part of the project. Planning of detector placement shall include an analysis of existing and proposed communication infrastructure.

**C. Location of Travel Time Message Signs**

1. Signs shall be installed in locations that provide ample distance for drivers to read, understand, make a decision and execute the appropriate maneuver.

2. Key decision points within major travel corridors shall be considered in all deployments.

3. Sign placement shall be in accordance with the travel time guidelines and adhere to the regulations and recommendations of the MUTCD.

4. Public concern for roadside aesthetics should be considered.

5. Power sources shall be considered during design.

6. Appropriate communication facilities shall be available or installed as part of the project. Planning of sign placement shall include an analysis of existing and proposed communication infrastructure.

7. The use of existing message signs for travel times should be encouraged where practical.

## VI. Operation of Travel Time Systems

The following operations guidelines shall be followed when deploying travel time systems. The Department's "Travel Time Systems Requirements" should be referred to for more specific information regarding system operations and the display of travel time messages.

**A. Travel Time System Operations**

1. Before initial deployment to the public, the system shall undergo extensive testing and field verification to ensure acceptable functionality and reliability. The extent and procedure of the testing shall be determined during design of the system. In addition to the initial testing, the system shall undergo regularly scheduled testing and field verification to ensure continuous system reliability.

2. In the event of a public health danger or safety emergency, the Department may provide personal identifier information, when available, to such other public partner and/or entities as may be necessary to prevent, limit or mitigate such emergency.

**B. Display of Travel Times on Message Signs**

1. At no time shall a travel time be displayed that would result from traffic traveling faster than the posted speed limit. Systems shall be configured so that default times (minimum time required to travel segment at posted speed limit) are displayed in those instances when traffic is traveling faster than the posted speed limit.

2. Default messages shall also be available and utilized for special situations including but not limited to instances when the travel time information is unavailable or the travel time is greater than a pre-determined maximum time for that particular segment.

3. Message formats shall be uniform. Standard abbreviations should be used when possible. The use of static signs will be permitted but must conform to the MUTCD.

## VII. Agreements

Existing data sharing agreements with public partners, agencies, etc. that comply with the data privacy requirements outlined in this policy, shall be considered in effect for this policy and no separate agreement will be required specific to this policy.

The Department shall not provide data containing personal identifier to any public partner or private entity except for the purposes set forth in this policy, provided, however, that the Department may provide such data, consistent with this policy, to consultants retained by the Department in the performance of Department functions. The sole purpose of providing such data shall be for the dissemination of transportation information to facilitate traffic management and the efficient use of the transportation infrastructure and all such uses and dissemination shall be consistent with this policy.

Any agreements entered into by the Department with any public partner or entity shall expressly provide that the party to such agreement shall no longer receive data if the entity fails to adhere to the privacy protections set forth in this policy. The Department may terminate any agreement or execution of such agreement that does not conform with the provisions of this regulation.

**Related documents:**

Travel Time Systems Requirements
Policy and Guidelines for Variable Message Signs (VMS)
Information Security Policy
Information Security Roles and Responsibilities
New York State Information Security Policy