

# EXPLORING THE APPLICABILITY OF COMMERCIALLY AVAILABLE SPEED AND TRAVEL TIME DATA AROUND BORDER CROSSINGS

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## **DISCLAIMER AND ACKNOWLEDGMENTS**

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## EXECUTIVE SUMMARY

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Land ports of entry are important gateways for a variety of cross-border interactions between people and economics of both countries. Every year millions of people cross the United States-Mexico (US-MX) border for social visits, attend educational institutes, work, and for shopping. Commercial vehicle crossings at the US-Mexico border also play an important role in the local, regional, and national economies. The use of Intelligent Transportation Systems (ITS) and other technologies is one way in which capacity at and around border crossings can be increased by providing motorists with information on traffic congestion. However, very few ITS deployments are in place to warn motorists about impending traffic congestion around border crossings on the US-MX border.

In recent years, private companies have started offering real time as well as archived traffic data. Such data include speeds, travel time, delay, and incident information. Private Sector (PS) data comes from variety of technologies and methodologies, including commercial and non-commercial vehicles serving as traffic probes, anonymous cell phone tracking using global positioning systems (GPS), roadside spot speed measurements, and transponder tracking.

Given the fact that very few state or local agencies on the US side of the border currently have capabilities to provide congestion information on arterials and even on major interstates around border crossings, it is highly advisable that agencies purchase and evaluate private sector data. If the concern is congestion heading southbound to MX, then it makes even more sense to deploy private sector data to provide motorists with information on roadways connected to border crossings.

The private sector data are not available on the MX side of the border and hence are not available for motorists entering US to know traffic congestion on roadways headed toward the border crossings. In many border crossings, US bound traffic congestion is much more severe than MX bound traffic.

If agencies do decide to purchase and evaluate private sector data, then they need to be cognizant of a) data accuracy and availability, b) cost, c) network coverage, and d) control of the data stream. In most cases, agencies buying the data will not know the exact cost of private sector data without entering into a negotiation phase. An additional cost that agencies must consider for PS data at the beginning and periodically thereafter is the cost of a verification mechanism. Coverage is a function of the number of probe vehicles in the traffic stream. With PS data, the purchasing agency has little control of the data stream. It is advisable that agencies establish minimum thresholds of acceptability in both accuracy and availability.

Finally, private sector data hold a great promise in filling the void regarding unavailability of traveler information on arterials and major streets around border crossings. Use of private sector data can be a very effective cost saving tool for agencies that cannot afford to deploy expensive vehicle detection equipment but at the same time have a greater need to provide cross border motorists with limited (on the US side) traveler information.

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## **CHAPTER 1: BACKGROUND**

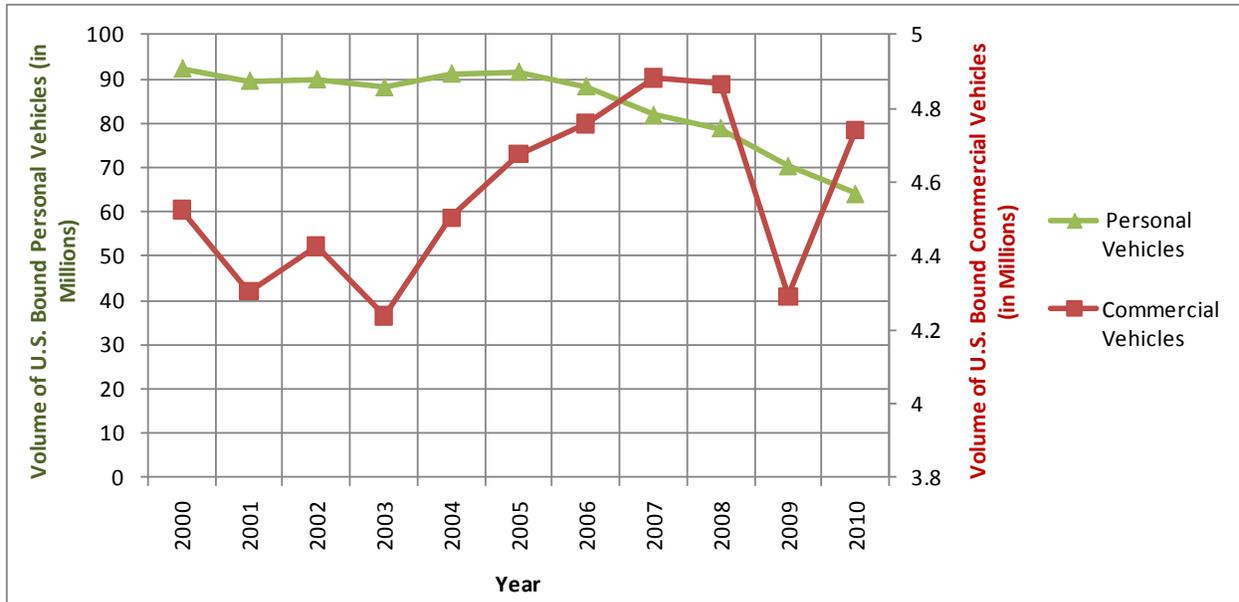
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Cross-border movement of goods and people is an important element of the nation's transportation system. Increasing trends in cross-border traffic present challenges in infrastructure improvements at land border crossings. Adding transportation infrastructure at land border crossings is even more challenging than building transportation infrastructure in our nation's system because of the international dimension and the different stakeholders that interact at an international border crossing.

The use of Intelligent Transportation Systems and other technologies is one way in which capacity at and around border crossings could be increased and also enhance and improve the coordination between stakeholders on both sides of the border. However, one of the lessons learned from the 2001 ITS at International Borders study is that "As with many domestic ITS initiatives, institutional issues represent the most significant hurdle in deploying and using technology as a tool for improving processes at international borders."

### **VEHICLE MOVEMENT AT LAND BORDER CROSSINGS**

Land ports of entry are important gateways for a variety of cross-border interactions between people and economics of both countries. Every year millions of people cross the US-MX border for social visits, attend educational institutes, work, and for shopping. Commercial vehicle crossings at the US-MX border also play an important role in the local, regional, and national economies. Truck trade has been increasing at an annual average growth rate of 7.5 percent for the last decade resulting in increase in volume of commercial vehicles entering the US through various border crossings. However, the number of passenger vehicles entering the US, using ports of entry in El Paso, has been decreasing since 2005 and so is the number of passengers inside the vehicles as shown in Figure 1. Interestingly, the number of pedestrians has been increasing since 2005. Even though no formal studies have been performed to describe this phenomenon, longer wait times at the border experienced by the passenger vehicles could be one of many explanations.



Source: US Bureau of Transportation Statistics

**Figure 1. Annual Volume of Passenger and Commercial Vehicles Entering the US from Mexico between 2000 and 2010.**

In the context of bi-national vehicle movement, time needed to cross the border could constitute a significant portion of the door-to-door travel time. The crossing time of a commercial vehicle (or a passenger vehicle) consists of time to wait to reach the primary inspection after joining the queue (wait time), inspection times at the US and Mexican federal and state facilities. Crossing time of vehicles could span from minutes to several hours and according to anecdotal evidences, it is getting worse, especially for commercial vehicles entering the US from Mexico.

Even though southbound inspection of passenger vehicles and commercial vehicles have not been a priority, with increasing violence in Mexico, the Customs and Border Protection (CBP) and the city officials on the US side have started inspection of vehicles crossing into Mexico. The purpose of the inspection is to seize illegal crossings of contraband. The inspections are performed manually. Due to the inspections of southbound vehicles, the wait times and crossing times have increased exiting US, especially during peak hours in the afternoon. State agencies and the city officials are starting to show concerns that the queues spilled to direct connectors, side streets, exit ramps, and to the freeway main lanes have started to pose traffic management problems around border crossings on both sides of the border.

## PROBLEM STATEMENT

In Texas where land ports of entry are close to downtown central business districts, traffic management on local roadways around these crossings is becoming even more challenging because traffic around border crossings can impact flow of traffic crossing the border and vice

versa. Hence, agencies are now planning to deploy ITS as a tool to manage traffic around border crossings where physical expansion of either ports of entry or roadway network around them is not feasible. ITS is being deployed mainly to warn motorists about traffic conditions around border crossings in addition to wait times and crossing times at the border. Very few ITS deployments are in place to warn motorists about impending traffic congestion around border crossings on the US-MX border. Deployment of ITS devices, such as closed circuit cameras, vehicle detectors, and dynamic message signs to warn motorists about conditions at and around border crossings are very limited.

For example, wait times of vehicles entering and exiting the US is affected by movement of vehicles on the surrounding roadways around the border crossings, especially where border crossings are close to urban centers. Incidents close to border crossings can lead to significant reduction in capacity of roadways, which increases the wait times of vehicles in both directions. One of many strategies available to tackle the problem is to provide advanced traveler information to motorists pre-trip and en-route. This will allow motorists to plan trips to cross the border and avoid incidents, longer wait times, and if possible choose a different border crossing.

However, agencies are rapidly deploying (and planning) ITS to measure traffic conditions around border crossings. On the Mexican side, the federal government is planning several ITS projects to relay traveler information on highways leading to and from border crossings. San Diego Association of Government is planning for deployment of state of the art ITS to measure and relay traffic conditions at and around the new Otay Mesa East border crossing. With funding from the Federal Highway Administration (FHWA), the Texas Transportation Institute (TTI) and Battelle team installed a Radio Frequency Identification (RFID) based system at the Bridge of the Americas in El Paso, Texas, to measure and archive crossing times of commercial vehicles. In addition, Texas Department of Transportation (TxDOT) is a deploying an RFID system to measure crossing times of northbound commercial vehicles in Pharr, Laredo, and Brownsville. Arizona Department of Transportation (ADOT) recently selected a team comprising of TTI and Battelle to install RFID based system to measure crossing times of commercial vehicles at the Mariposa port of entry.

## **GOALS AND OBJECTIVES OF THE PROJECT**

In recent years, private companies have started offering real time as well as archived traffic data. Such data include speeds, travel time, delay, and incident information. PS data come from variety of technologies and methodologies, including commercial and non-commercial vehicles serving as traffic probes, anonymous cell phone tracking using GPS, roadside spot speed measurements, and transponder tracking. The question that research project is trying to answer is whether transportation agencies could and should utilize the data offerings by private sector providers to supplement its own data collection efforts and, if so, how. Specifically, the research determined:

- Transportation operation needs of border regions and potential use of ITS to address those needs.
- Attributes of private sector data including cost, coverage, and accuracy.
- Strength, weakness, and opportunities of using private sector data for border applications.

Results of this project will have immediate value to public agencies and stakeholders at border regions. Data from private providers such as INRIX, TravTeq, and TrafficCast are available today and might add significant value to traffic data already collected by agencies around border crossings, but there needs to be an investigation of the merits of this potential new data source.

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## **CHAPTER 2: TRANSPORTATION OPERATIONS NEEDS AT BORDER CROSSINGS**

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One aspect of the mission of traffic management is incident management. Monitoring the current conditions of the freeway system and reacting to changes in conditions form the basis for any incident management program. In response to incident information, traffic management center operators might alert emergency services, and then proactively manage traffic in the affected area by closing lanes, displaying information on dynamic message signs, considering the implementation of diversion routes and more. Publication of, and utilization of, diversion routes are an accepted element of many response scenarios dealing with larger incidents, such as hurricane evacuation or other natural disasters. The key, however, to taking any of the above steps in management of incidents is having knowledge of the conditions on the surrounding roadway network.

### **INCIDENT MANAGEMENT AROUND BORDER CROSSINGS**

State and local agencies play a significant role in responding to incidents around border crossings. Individual roles of these agencies depend on the presence of state and/or local roadways that lead to and from the border crossings and their current jurisdictions for traffic operation on these roadways. In most cities, because border crossings are in the middle of urban center, local law enforcement agencies are much more involved in incident management on the US-MX border, while state and county agencies play a larger role on the US-Canada border.

Border states operate traffic management centers with significant investments in ITS for incident management. Compared to agencies on the US-Canada border, Mexican counterparts on the US-MX border have deployed ITS only to a very limited degree. Sharing of real-time data between agencies on both sides of the US-MX border has been non-existent so far. None of the cities on the Mexican side of the border have deployed traffic management centers to manage and operate transportation systems including border crossings. There are plans to deploy several such centers in the border region.

### **TRAVELER INFORMATION AROUND BORDER CROSSINGS**

Traveler information is a critical component of traffic management and one of the primary uses for data obtained from the roadway. Through these data, agencies can determine and publicize current conditions such as speeds, travel times, delays, alert motorists of incidents, and more. Traveler information for highway users is typically divided into two categories: pre-trip information and en-route information. The method of disseminating information depends in which category or part of the trip the traveler is involved. These methods include several tools to deliver the information, such as:

- Dynamic message signs.
- Internet/web pages/email.
- Cell phones and other portable devices.
- 511 systems.

- Radio.
- In-vehicle navigation devices.

In the future, additional methods of disseminating traveler information may well come to the forefront beyond the traditional methods above. Industry innovations such as social networking have changed the landscape of how people expect to receive data. These needs could potentially have an impact on the requirements (cleaning, aggregating, formatting, etc.) for any private sector data, so awareness of these technology trends is also an important consideration for this project.

One of the keys to understanding the data requirements for traveler information services is determining exactly what drivers need and want. A number of studies have indicated what specific pieces of information a driver wants. One oft-cited reference states that drivers experienced in traveler information systems want the following:

- Camera views that show road conditions.
- Detailed incident information.
- Direct measures of speed on highway segments.
- Travel time between user-selected origin and destination pairs.
- Coverage of all major roadways, including arterials.
- En-route access.

Another study that was essentially a compilation of literature from the 1990s and early 2000s stated that drivers wanted:

- In-car display of external traffic control signals.
- Information on traffic congestion.
- Indication of the presence of multiple compounding hazards in a driving situation.
- Information about road construction activities.

A critical need for these travelers is advanced traveler information that seamlessly blends information from multiple sources to provide continuous trip information. Agencies on both sides of the border are looking for innovative and sustainable ITS solutions to relay pre-trip traveler information to commuters and truckers through various means such as mobile devices, internet, local media, etc.

Measuring and reporting crossing times are of considerable interest to a wide range of stakeholders that interact at the border between Mexico and US. Crossing time and wait time to cross the border is of high significance motorists. The time it takes to cross the border is an important element in making trip related decisions, including choice of one port of entry over the other.

The stakeholders identified that information required to make “smart” decisions regarding the best departure time, crossing times at border crossings, and selection of one border crossing over the other, would be highly valuable.

Once the trip has started, travelers could use information to modify pre-determined routes to adjust to current and predicted travel conditions, and determine an optimal route that would reduce travel time between origin and destination. Local media outlets can relay the predicted crossing times through traditional means of radio and television.

In addition to travelers, public and private agencies operating at the border also use the information to monitor current conditions at and around border crossings for impromptu modification of resources to increase the efficiency of operation.

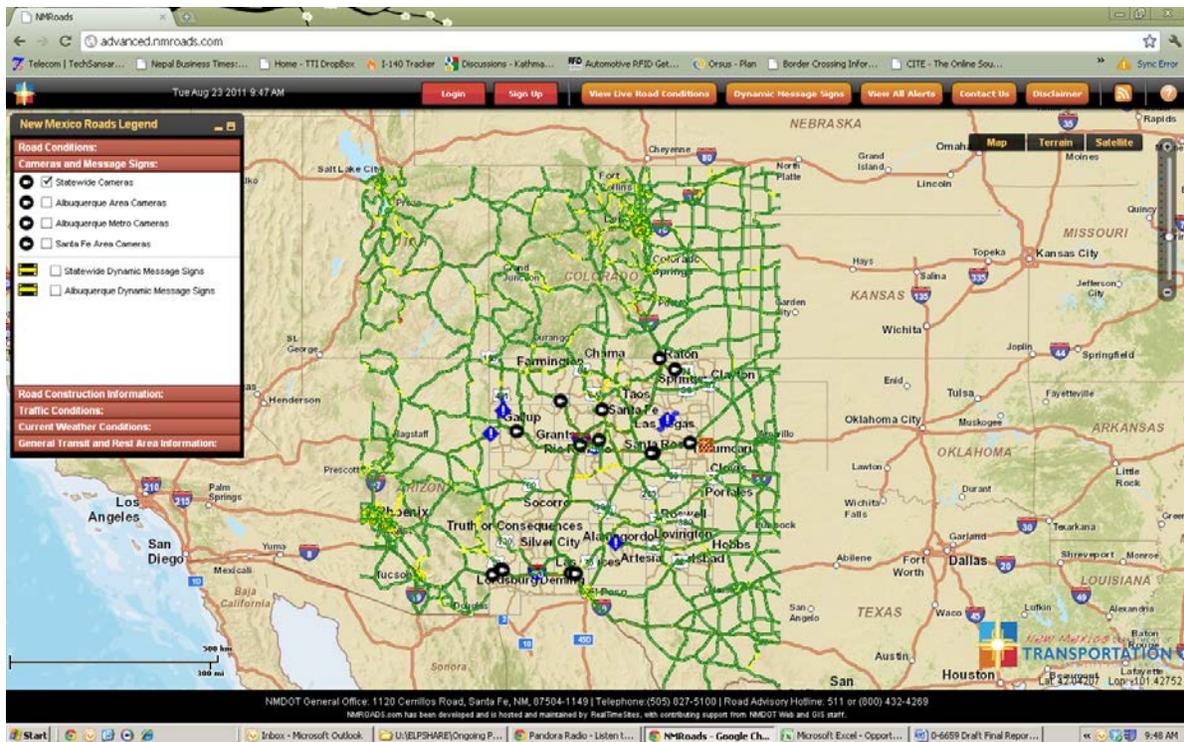
Freight shippers and carriers use the predicted crossing times as part of the pre-trip information to plan a trip from origin to destination. Once the trip has started, travelers could use information to modify pre-determined routes to adjust to current and predicted travel conditions, and determine an optimal route that would reduce travel time between origin and destination. Local media outlets can relay the predicted crossing times through traditional means of radio and television.

## **POTENTIALS OF COMMERCIALY AVAILABLE DATA**

At US-MX border crossings, on the US side, traveler information is widely available for freeways. Local roadways and arterials have limited availability of traveler information both pre-route and en-route. On the Mexican side, traveler information is non-existent on local roadways. However, on federal roadways some information is available. Deployment of ITS field devices such as sensors, dynamic message signs is expensive and may not always be cost effective especially on local roadways and arterials. Availability of funding is another factor that imposes on deployment of ITS.

Commercially available data collected and provided by private entities have strong potentials to provide traveler information and real time data for incident managed on local roadways and arterials. Where public agencies may have difficulty funding ITS deployment on these roadways, obtaining and using commercially available data could be cost effective.

A great example of integration of commercially available data with state's own ITS deployment is available from the New Mexico Department of Transportation recently deployed a statewide 511 system. It includes traffic conditions on state highways, ITS data from urban areas (snapshots from video cameras, dynamic message signs, etc.). The 511 system uses INRIX data to show the state wide highway traffic conditions and is shown in Figure 2.



Source: [www.nmroads.com](http://www.nmroads.com)

**Figure 2. Snapshot of New Mexico’s 511 System Website Showing Integration of Private Sector Data with State’s Own ITS Field Devices.**

Most commercial data providers rely on either fixed sensors or probe-based vehicles or both to provide real-time traffic information. Several providers also enhance the data by performing quality assurance checks before distributing the data to subscribers. A few providers also have the capability to provide both historical and predictive traffic information, taking into account impact factors such as work zones and weather events. Such predictive and historical data can play a significant role in making decisions as to what might happen to the traffic and how to come up with solutions while responding to work zones and weather events. There are number of advantages to the use of commercially available data, including:

- Cost-effectiveness.
- Consistency of the data collection approach.
- Comprehensive coverage.
- Frequency of updates.
- Environmentally sensitive data collection (as compared to in-house efforts such as probes).

However, there are some concerns with commercially available data use, including:

- No influence on the data collection methodology.
- Lack of per-lane data.
- Lack of full ownership of the data due to licensing and cost considerations.

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## CHAPTER 3: PRIVATE SECTOR DATA

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### PRIVATE SECTOR DATA PROVIDERS

Private sector data providers essentially provide some type of location-based services. The information service is the type of location-based service (LBS) applications that the researchers specifically examine in this document. The researchers reviewed four companies that provide some forms of LBS and traffic data service. The information in this document comes from both data provider websites as well as publicly available literature. Most data providers rely on probe-based vehicles to provide real-time traffic information. Several providers also enhance the data by performing quality assurance checks before distributing the data to subscribers.

A few providers also have the capability to provide both historical and predictive traffic information, taking into account impact factors such as work zones and weather events. The private data providers with useful website information were as follows:

- Airsage.
- CellInt.
- INRIX.
- NAVTEQ.

AirSage anonymously collects and analyzes wireless signaling data and then converts the data into meaningful information such as traffic condition and cellular signal quality (<http://www.airsage.com>). Consumers, businesses, government agencies, and other organizations can use this aggregated information to model and analyze the location and movement of people and assets. AirSage product categories include traffic information as well as performance monitoring and analysis of cellular network. AirSage currently provides real-time, historical, and predictive traffic information for 127 cities, which cover approximately 85 percent of the US population.

Cellint is a global provider of traffic information systems based on mobile networks (<http://www.cellint.com>). Cellint's proprietary patented technology utilizes pattern matching analysis on anonymous, real-time data extracted from the signaling links of mobile networks for all active mobile phones. This platform is used by cellular operators to provide road traffic information services and optimize their performance. Cellint's coverage is limited to the agencies/regions that choose to deploy Cellint's system.

INRIX provides traffic information by fusing the data from GPS-enabled vehicles and mobile devices, traditional road sensors, and other sources (<http://www.inrix.com>). The majority of INRIX data come from crowd-sourced GPS-enabled vehicles (currently more than 2 million vehicles). The crowd-sourced traffic network is built on a foundation of commercial fleets—taxi cabs, delivery vans, and long-haul trucks and a growing number of consumer vehicles and mobile devices.

NAVTEQ is a provider of maps, traffic, and location data (digital location content) enabling navigation, location-based services, and mobile advertising around the world. The company is a wholly-owned subsidiary of Nokia but operates independently (<http://www.navteq.com>).

NAVTEQ digital maps provide a representation of the detailed road network including up to 260 attributes such as turn restrictions, physical barriers and gates, one-way streets, restricted access, relative road heights, addresses, signage, and speed restrictions. NAVTEQ database also contains millions of points of interests for routing applications. NAVTEQ Traffic is a traffic solution product offered by the company. NAVTEQ started delivering real-time, personalized traffic linked to the map in a navigation system in 2004 (<http://www.traffic.com>). In North America, NAVTEQ Traffic business models are flexible to support different products and pricing scenarios as application requires.

Table 1 summarizes the information across the data providers. Overall, perhaps the most interesting finding concerning the private-sector data providers was the diversity of data sources in use. Providers are using a combination of GPS data from fleet vehicles, consumer devices, and cell phone applications, as well as data from fixed sensors installed and maintained by other agencies, and fixed sensors installed and maintained by the data provider.

**Table 1. Summary of Historical Data Available from Private Providers.**

<b>Factors</b>	<b>Airsage</b>	<b>INRIX</b>	<b>NAVTEQ</b>
Data Available <sup>(a)</sup>	S, TT, I, Q, V	S, TT, I, Q, V	S, TT, I, Q, V (portion of network)
Services Available <sup>(b)</sup>	D, A, PM	D, A	D, A
Data Source	Cell phone, 911, traffic counts	State installed sensors, commercial fleets, consumer GPS	State installed sensors, commercial fleets, consumer GPS.
Aggregation Levels for Historical Usage	None; as captured	15–60 minutes	15 minutes
Accuracy Checks Performed	Visual camera count, Probe vehicles.	Independently verified in large-scale testing.	Data checks prior to map matching. Comprehensive drive testing.
Documented Quality Levels	None provided. Stated they meet Section 511 requirements.	Accuracy above 95% Availability above 99.9	None provided.
Pricing	Specific pricing information not provided.	Full use open licensing is \$800 per mile per year plus \$200 per mile one-time setup fee. 25% discount on other roads purchased in conjunction.	Specific pricing information not provided.

<sup>a</sup> Data Available: “S”=Speed, “TT”=Travel Time, “I”=Incidents, “Q”=Quality, “V”=Volumes, “GPS”=GPS fleet

<sup>b</sup> Services Available: “D”=Discrete Data (individual data points), “A”=Aggregate Data, “PM”=Performance Measures

## LOCATION REFERENCING

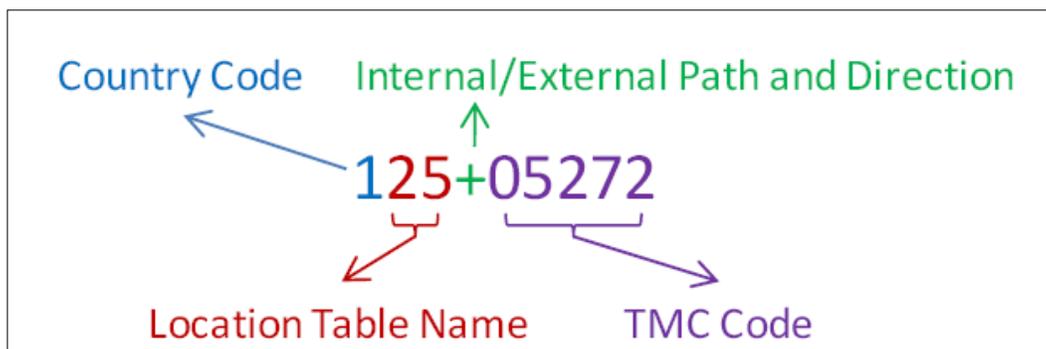
The Traffic Message Channel (TMC) is a specific application of the Radio Data System used for broadcasting real-time traffic and weather information. The development of TMC standards

started in Europe and became available in several areas. TMC location codes were established as a standardized way (independent of map vendor) to report traffic incidents on major roadways in Europe.

TMC codes were originally conceived of as points on the road network, typically assigned at significant decision points, interchanges, or intersections, for the purpose of describing locations of traffic incidents (accidents, construction, traffic slowdowns, etc.) in an unambiguous, vendor independent format. It is possible to report traffic flow data—as INRIX does—by considering the road segments implied by the distance between consecutive TMC codes. These road segments are referred to as “TMC Paths” in this document and are how roadway segments will be defined for this project.

In North America, a consortium of Tele Atlas and NAVTEQ, the nation leading suppliers of commercial map databases, have created and maintained a US/Canada TMC location code table that adheres to the international standard on location referencing (ISO 14819-3:20043). Initially published in fall 2003, the North American Location Code Alliance owns, maintains, and expands the location tables. The version that will be utilized at the outset of this project is version 3.1, containing in excess of 218,000 location codes spanning the US and Canada, and allowing TMC paths to be created for roughly 400,000 centerline miles of roads. Note that the TMC standard mandates that the tables remain backwards compatible as new versions are introduced. Although coverage area and granularity will change, older codes will continue to map to the correct spatial location.

Private data providers have the rights to utilize TMC data and will provide its customers and its partner agencies the information necessary to interpret and geo-reference the TMC paths used in this project. The initial TMC path returned in all of the responses is: <TMC code="125+05272".../>. These nine characters will be referred as the “9-digit TMC,” which defines a unique segment and direction of roadway in North America. Figure 3 decomposes the 9 digits and further explanation follows.



**Figure 3. Traffic Message Channel.**

- **Digit 1** ('1' in this example): Refers to the country code. Country code is "1" for the United States and "C" for Canada. For this project, all TMC paths will start with "1."
- **Digits 2-3** ("25" in this example): Refers to the Location Table Name (see Figure 2). North America is covered with 35 distinct tables, allowing the final six digits to be reused as well as allowing the table coverage to grow in density while still maintaining geographic integrity of the coding scheme.
- **Digit 4** ("+" in this example): Refers to both direction of travel and if the TMC path type is "internal" or "external" (see below and Figure 3).
- **Digit 5-9** ("05272" in this example): Refers to the specific Location ID in the Location table that is tied to a specific interchange, intersection, boundary, or decision point. In most cases there will be 4 distinct TMC paths near one another on the road network that share this same 5 digit Location ID, each preceded by either "+," "-", "P," or "N."

TMC location coding describes two types of paths for every location code: "internal path" and "external path." The internal path refers to the area just past the decision point or intersection at which the TMC code was placed (for example, a freeway off ramp), while the external path refers to the section of the road leading up the decision point. In order to maximize possible data precision, INRIX considers the internal path and external path as individual spatial locations; i.e., speed is reported separately for the two paths. Traffic congestion is often caused by traffic exiting at a decision point. Thus, the external and internal path corresponding to that TMC location might have substantially different speed profiles.

While there are several situations where this does not apply (for example, inner and outer loop road geometry), the typical convention for identifying the direction of travel for the path and whether the path is internal or external is:

- "P" = Northbound or Westbound, internal paths.
- "N" = Southbound or Eastbound, internal paths.
- "+" = Northbound or Westbound, external paths.
- "-" = Southbound or Eastbound, internal paths.

Other TMC configurations include the following:

- TMCs on smaller roads will cross at a point and therefore have only "external" TMC paths.
- Some complex interchanges create situations where "internal" TMC paths overlap.
- Where highways merge, there will often be two sets of TMC paths (one for each highway) over the same stretch of road.

## **DATA AVAILABILITY**

Almost all commercial entities provide speed and travel-time data in both historical and real-time. Associated with those data is the provision of quality or metadata expressing items such as confidence intervals, sample sizes, or other quality indicators. However, there is little consistency in terms of what is actually provided as a quality indicator. This appears to be a negotiable item in contracts.

A number of the data providers use consumer GPS devices to some degree. These data may not arrive in sufficient quantities to include in real-time information but can be added to the existing data sets once they are uploaded at a later date by consumers. Providers spoke of receiving data in this manner that range in age from a few days to several months.

A similar situation exists pertaining to arterial coverage. A number of data models use data from consumer GPS devices to some degree. These data may not arrive in sufficient quantities to include in real-time information but can be added to the existing data sets once they are uploaded at a later date by consumers. Providers spoke of receiving data in this manner that range in age from a few days to several months.

## **DATA ACCURACY AND RELIABILITY**

All respondents indicated the ability to do data filtering or sorting based on typical parameters such as date, time, roadway, region, state, or data source. The provision of these capabilities stands to reason because they are somewhat inherent in any database or archive, although the extent or level of discreteness can vary greatly.

The data providers were very circumspect about discussing any accuracy checks they perform to validate their data offerings. INRIX, in part due to the comparisons performed by the I-95 corridor coalition, stated that large scale client testing has verified its data. NAVTEQ claimed that it does extensive drive testing across all types of roadways in all markets at all times of the day and days of the week. A number of providers also have integration routines employed to merge data from disparate sources into a seamless coverage of their network. However, they did not provide descriptions of these routines.

With the exception of INRIX, data providers were also circumspect about the quality levels they meet. INRIX explicitly claimed an availability of more than 99.9 percent and an accuracy of greater than 95 percent. AirSage also claimed to achieve at least a certain level of quality.

For private sector data, the accuracy is a function of the number of probes in the traffic stream. Data from the largest PS providers has multiple sources, but the primary source is based on GPS devices. These devices are known to generate accurate speeds under almost all conditions. Based on this research, the speed accuracy of PS data is usually within the bounds of  $\pm 5$  to 10 percent and is expected to improve with time since additional probes are being added daily through voluntary incentive programs. Private providers have algorithms that provide the necessary quality control, so the result is an accuracy level with such a modest error that the average driver will not be affected.

In considering the accuracy desired for the various sources of data (fixed or private), one should consider the differences in travel times (prediction errors) that would result from speed errors. The first consideration is that the errors could be random, resulting in errors that tend to cancel each other when considered on an aggregate basis. For example, a speed reading that is 5 percent high would be canceled by another speed reading that is 5 percent low. Obviously, the magnitudes of the errors are not necessarily equal, and if they are not, there would be a resulting error based on the difference. There could be an overall bias in speed readings, which means that all speed detections would be either high or low and there would be no cancelling as in the first example.

With the use of PS data, purchasing agencies have little or no control over the data stream. While this might appear to be an issue at the beginning of some future contract period, purchasing agencies will need to weigh the pros and cons and decide whether the merits are worth the risk. Since agencies such as TxDOT have the denser urban areas covered with fixed sensors, the best approach might be to test PS data in urban fringe or rural areas to see how any apprehensions might play out. One precedent in this decision has been TxDOT's use of toll tag systems in Houston and other urban areas where there are sufficient vehicles with tags to serve as probes. In some cases, the data stream was provided by others.

A number of providers stated they have the ability to impute based on their historical data archives and data-checking routines. Providers also stated that they flag such data as being all or partially composed of historical versus real-time data. INRIX explained in detail how the quality measures associated with any particular data point would change based on the amount of historical data being used. Essentially, the confidence interval expressed for the data point, such as a speed or travel time, would range from very high with no historical data in use to very low with significant historical data in use.

Providers were asked to detail the ways in which they provided data to their customers. For real-time usage, the universal answer was some type of data feed, typically Extensible Markup Language (XML) updated on a 1-minute interval. Providers also stated that they could provide map outputs, but those processes are still fed in the background by a data feed. Smartphone displays were also a standard answer, but they are also powered by a background data feed.

For the historical context, a wider variety of data provision mechanisms is possible. Some providers utilize an Internet-based portal access to the database, and customers can perform and save their own query results. Other providers execute the query for the customer and ship the resulting data file via electronic mail or CD-ROM. Typically, they provide the file in either XML or Comma Separated Variable (CSV) format.

## **DATA ACCESS COST**

In general, the availability of pricing information was minimal. Most providers appear to negotiate each purchase individually. Pricing is tied to the usage of the data. Data that are used for a single application employs one price point. Data used for multiple applications requires a different price point. Providers also make a distinction between uses, such as modeling or origin-destination studies, and derivative products, such as summaries distributed to external sources. While providers did not disclose the various price points, all stated that they exist.

Reduced requirements and uses would result in lower price points. The other advertised cost is from INRIX. It amounts to \$800 per mile per year with an additional first-year cost of \$200 per mile. There are also discounts available for some of the network, but few details are available. An additional up-front cost that purchasing agencies must consider is the cost of its own independent verification of PS data.

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## CHAPTER 4: APPLICATION OF COMMERCIAL DATA FOR BORDER TRANSPORTATION

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### STRENGTH AND WEAKNESSES OF COMMERCIAL DATA

Even though the evaluation of strength and weaknesses of commercial data is entirely subjective, it provides an excellent starting point for border regions to build an understanding of the commercial data. While developing strength and weaknesses of commercial data, researchers considered scope and cost of the data in developing such evaluations and also new opportunities that could provide significant benefit to public agencies due to commercial data. As a cautionary note, researchers believe that the evaluations provided in Table 2 could change over time as commercial data improves in quality and scope.

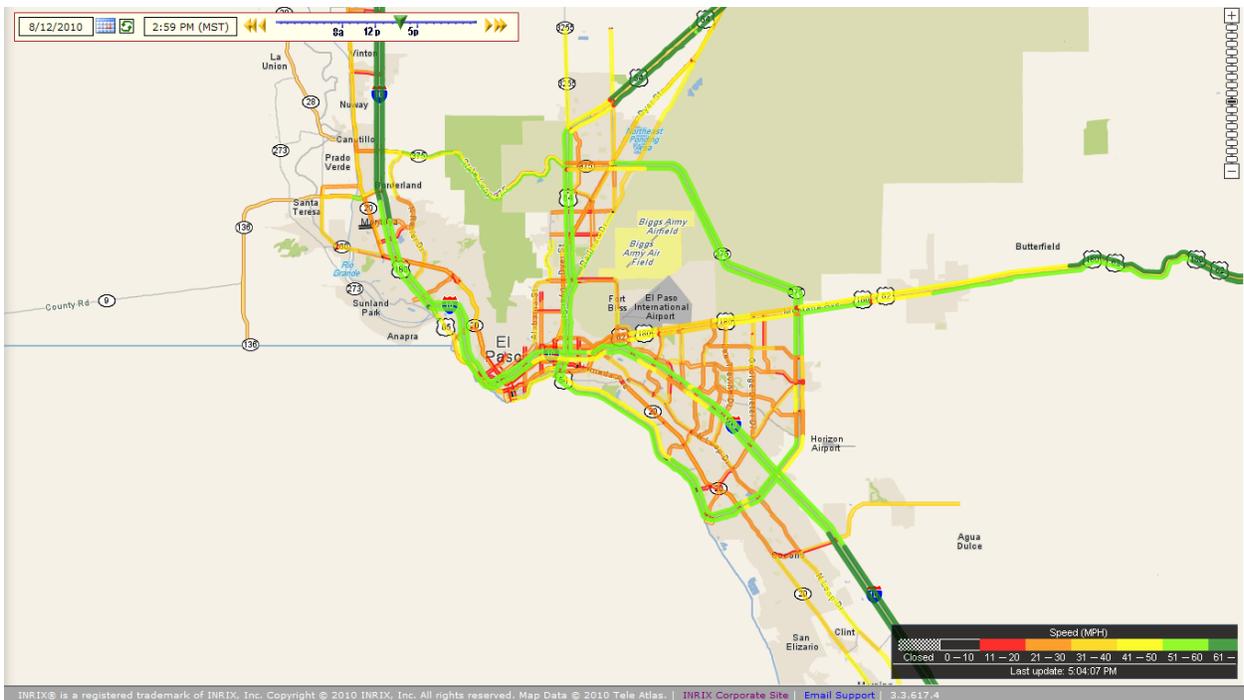
**Table 2. Strength, Weaknesses, and Opportunities of Commercial Data in Relation to ITS Application Areas around Border Crossings.**

Application Area	Strength	Weakness	Opportunities
Enhance coverage of traveler information in urban areas	Where public agencies have ITS deployments, private sector data can be used to improve the information provided to travelers.	Close co-ordination of city and the state is required regarding sustained funding for procurement of data.	Provide traveler information on arterials and state highways around border crossings where there's limited ITS deployment.
Enhance traveler information in rural roadways around border crossings	Acquiring private sector data could be more cost effective than deploying and maintain the fix point sensors on rural roadways leading to and from border crossings.	Complex procurement language may be necessary to cover for data gaps and availability in case enough probe vehicles are not available.	Enhance coverage of rural roadways where ITS is not available and not cost effective to deploy fixed point sensors.
511 system	Border regions can quickly deploy 511 system using the private sector data and show traffic conditions on rural as well as urban roadways around border crossings.	Complex procurement language may be necessary to cover for data gaps, data availability.	The 511 system will show traffic conditions at roadways around border crossings where ITS is not available and not cost effective to deploy.
Emergency evacuation	Private sector data will act as an additional source of traffic information.	Private sector may not be able to report traffic conditions on roadways due to absence of probe vehicles.	Determine alternate routes in dynamic environment and provide that information to traveling public.
Work zone information	Identify alternate routes, proliferation of congested links around work zones around border crossings.	Per lane information is not available, hence private sector data may not be effective for traffic routing within the work zone in a smaller area.	Traffic management operators can however monitor how and where the congestion is moving and expanding around at and around the work zone.

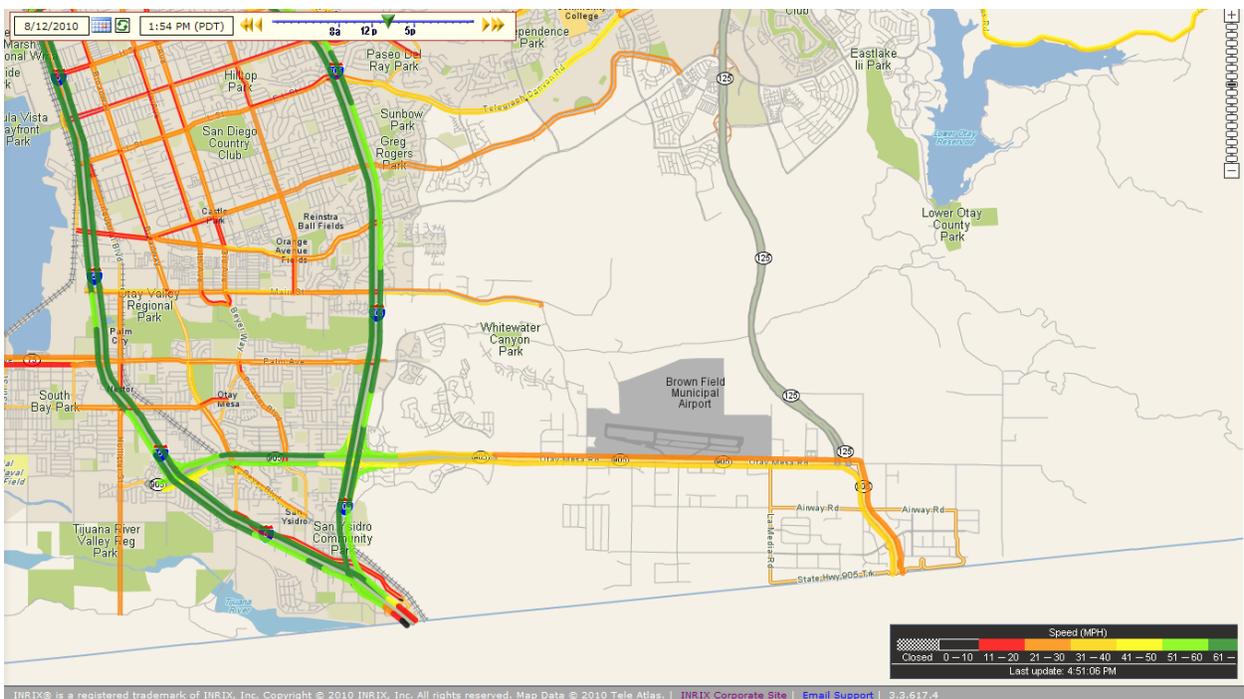
<b>Application Area</b>	<b>Strength</b>	<b>Weakness</b>	<b>Opportunities</b>
Faster identification of congested areas	Private sector data already covers most major urban areas and provides snapshots of traffic conditions in user selected intervals.	Urban areas where there is already wide deployment of ITS to measure traffic conditions, private sector data may be viewed as just another "redundant" data source.	Traffic management operators can be provided with a regional view of traffic conditions, which will allow them to quickly identify where the congestion is building and point surveillance cameras to the area.
Predictive information	Short term prediction of travel time and speed on roadway segments is already provided by many private sector agencies.	Prediction models used by private sector agencies are not transparent to data subscribers and hence its performance is difficult to ascertain.	Traffic management operators can monitor, proactively, where congestion will build up and focus ITS resources in that area.

## **SPATIAL COVERAGE OF COMMERCIAL DATA**

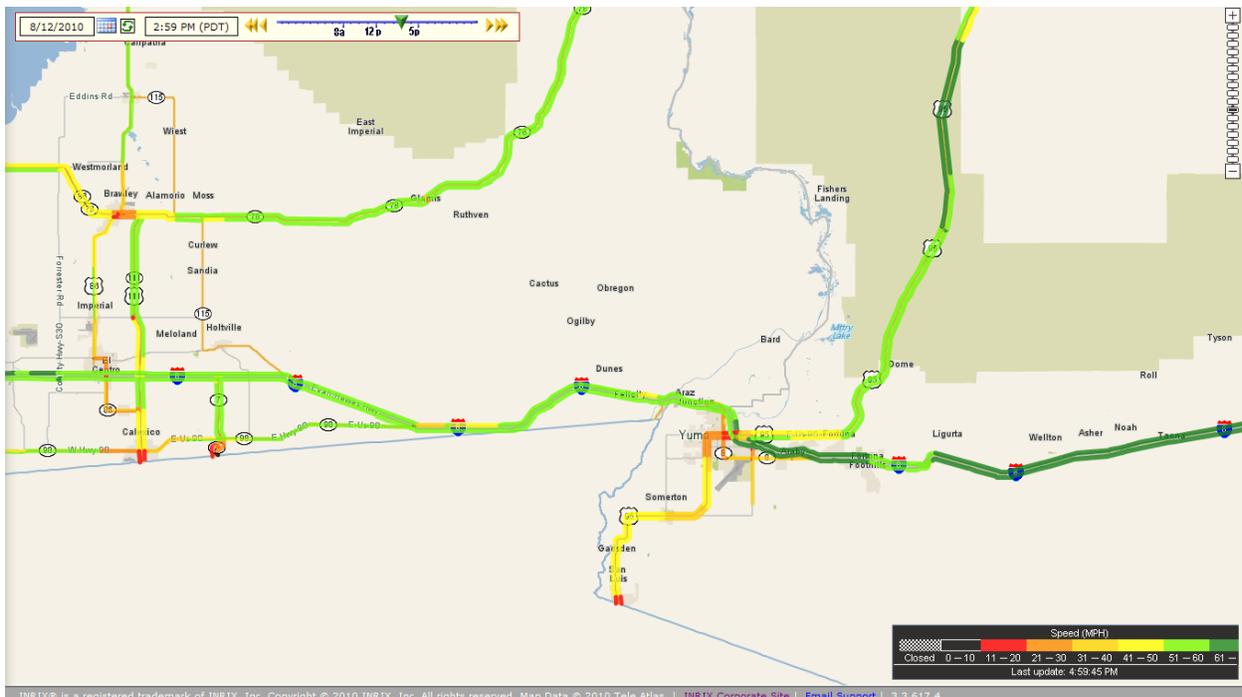
TTI researchers contacted several commercial data providers and were able to obtain snapshot of its data coverage from at least one such provider namely INRIX. All data providers mentioned that they have coverage on the US side of the border, but not on the Mexican side. INRIX did mention that it has plans to provide traffic information on Mexican roadways in the near future. Figure 4 shows snapshots of traffic information coverage available from one of the commercial data provider INRIX at three US-Mexico border regions.



(a) El Paso, Texas



(b) San Ysidro and Otay Mess, California



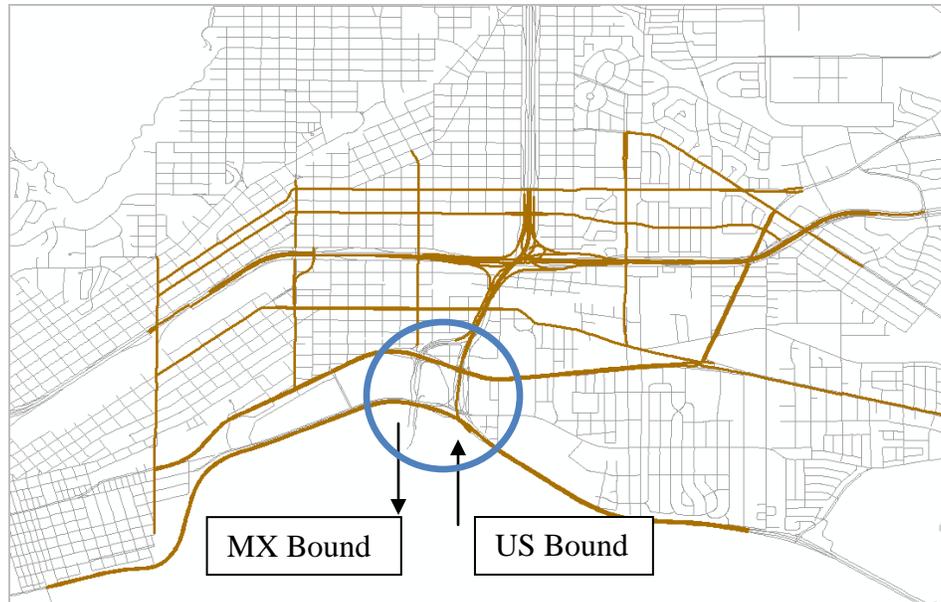
(c) San Luis, Arizona

Source: INRIX

**Figure 4. Coverage of INRIX Data at Three US-Mexico Border Regions.**

Figure 5 shows a snapshot of coverage of INRIX data around Bridge of the Americas in El Paso, Texas. The border crossing is one of the largest passenger vehicle as well as commercial vehicles crossing in Texas. The coverage extends to major arterials around the border crossing on the US side and can show traffic conditions on these roadways. This could be very useful for passenger vehicles and commercial vehicles wanting to know traffic conditions that they will most likely face after crossing the border.

All PS data providers including INRIX stops data relay at the border line however these companies are expanding in MX. Hopefully, in the future data coverage will be available on both sides of the border. This will allow travelers to view congestion on the MX side of the border, which is typically more severe than entering MX from US.



**Figure 5. Converge of INRIX Data around Bridge of the Americas, in El Paso.**

## **RELAYING TRAFFIC CONDITIONS AROUND BORDER CROSSINGS**

Traveler information (if relayed at the right time and at the right location) can contribute significantly toward improving of reliability of the transportation system. If all the border crossings in the region are to be treated as one system, then traveler information should include traffic conditions at all three border crossings on both sides of the border. A question that begs an answer is will all three border crossings have equal level of ITS deployment and on both sides of the border. If there is no information coming from one border crossings about its conditions, then travelers will not be able to choose between the border crossings. Funding wise, this is a tremendous challenge. Key issues and suggestions regarding implementation of traveler information at the border crossing are as following:

- Real-time sharing of traveler information between bi-national agencies is essential. This will allow travelers coming from Mexico to assess traffic conditions on the US side and vice versa. However, agencies on both sides of the border sharing the real-time data should have already established protocols. Internet does provide an efficient and cost effective medium of data sharing but comes with a need to blanket the data for security purpose.
- In the US, Traffic Management Data Dictionary (TMDD) is an established data exchange protocol. Mexico has already produced its own version (in Spanish) of the TMDD. However, translation and interpretation protocols should be agreed upon so that the agency on the US can understand messages from MX and vice versa.

- The Border Wait Time Measurement Project funded by the US-Canada Joint Working Committee is testing several innovative technologies to measure wait times and queue lengths of passenger vehicles. These technologies, if successfully deployed, could be duplicated at the Otay Mesa East border crossing. Prediction of wait times and measurement of queue length is especially interesting since these two parameters have been difficult to measure.
- Similarly, FHWA, TxDOT, and ADOT have deployed and are deploying technologies to measure wait time and crossing times of US-bound commercial vehicles with success. In months to come, several documents regarding step-by-step guidelines to implement similar systems, a guidebook to measure and disseminate wait time and crossing time, and a prototype web tool to disseminate real-time and archived data will be published. Lessons learned from these deployments will be a valuable resource for this project.
- Dynamic message signs are still the most effective means of communicating traveler information to motorists who are already on the road. Traditional media (television and radio) and Internet are more effective in relaying relay traffic conditions to motorists who are planning to take the trip across the border.

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## CHAPTER 5: CONCLUSION

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Given the fact that very few state or local agencies on the US side of the border currently have capabilities to provide congestion information on arterials and even on major interstates around border crossings, it is highly advisable that agencies purchase and evaluate private sector data. If the concern is congestion heading southbound to MX, then it makes even more sense to deploy private sector data to provide motorists with information on roadways connected to border crossings.

The private sector data are not available on the MX side of the border and hence is not available for motorists entering US to know traffic congestion on roadways headed toward the border crossings. In many border crossings, US bound traffic congestion is much more severe than MX bound traffic.

If agencies do decide to purchase and evaluate private sector data, then they need to be cognizant of a) data accuracy and availability, b) cost, c) network coverage, and d) control of the data stream. In most cases, agencies buying the data will not know the exact cost of private sector data without entering into a negotiation phase. An additional cost that agencies must consider for PS data at the beginning and periodically thereafter is the cost of a verification mechanism. Coverage is a function of the number of probe vehicles in the traffic stream. With PS data, purchasing agency has little control of the data stream. It is advisable that agencies establish minimum thresholds of acceptability in both accuracy and availability.

Finally, private sector data holds a great promise in filling the void regarding unavailability of traveler information on arterials and major streets around border crossings. Use of private sector data can be a very effective cost saving tool for agencies that cannot afford to deploy expensive vehicle detection equipment, but at the same have a greater need to provide cross border motorists with limited (on the US side) traveler information.

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