State-of-the-Practice on Use of Intelligent Transportation Systems at US-Mexico Land Border Crossings

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ABSTRACT

A research project was conducted to perform a border-wide assessment of the use of Intelligent Transportation Systems (ITS) technologies and operational concepts at and near United States (US) international land border crossings. The work focused on tolling, traffic management and operations, and safety. The specific objectives of this project were to research, assess and document how ITS technologies can be used in areas of (1) toll collection and management in border regions, identifying technologies used, system components, and any special data sharing arrangements between the United States and its two bordering neighbors; (2) transportation operations and traffic management in US-Mexico border regions; (3) transportation safety policy and operations; (4) traffic management, traffic operation and traffic enforcement on tolled roads/tolled border-crossing roads; and (5) archiving toll and traffic management data. In the interest of brevity, this paper discusses results of the study pertaining to the state-of-the-practice on use of ITS on the US-Mexico border only.

BACKGROUND

Cross-border movement of commercial and passenger vehicles is an important element of the nation’s transportation system. In 2010, more than 90 million personal vehicles entered the United States – 29 million from Canada and 64 million from Mexico; Canada and Mexico are the first and third largest US trading partners, respectively. In that same year, more than 10 million commercial vehicles crossed into the United States through the northern and southern borders, handling trade valued at more than US$556 billion. US merchandise trade with Canada and Mexico by all land modes rose by over 37 percent in the 10 years from 2000 and 2010 (1), and it is expected that the growth rate will increase once the economies of North America recover.

Increasing trends in cross-border traffic present unique challenges in improving operation of border crossings. Making improvements to land border crossings is even more challenging than building transportation infrastructure (e.g., highways, transit) because of the international dimension and wide variety of bi-national stakeholder agencies that seek to fulfill their individual goals and objectives. Factors such as dissimilar funding cycles and environmental regulations make the process of adding capacity and building new border crossings lengthy, difficult, and expensive.

Hence, decision makers from both sides of the border are convinced that the use of ITS is one way in which operation of border crossings could be improved without having to make a substantial investment in adding infrastructure capacity. However, decision makers are also aware that institutional barriers and issues represent the most significant hurdle in deploying ITS at border crossings. ITS deployment at border crossings, especially at the US-Mexico border, is relatively new. There has been significant progress in deploying ITS at border crossings in the last few years, and decision makers would like to see more. However, ITS deployments are often sporadic, and sometimes counterpart agencies from other states and countries do not know about the prior results to learn from them.

As such, decision makers felt that a nationwide assessment was necessary to understand the extent of ITS deployment at border crossings, share lessons learned, and analyze institutional as well as technology barriers that agencies may have faced and solved.
OBJECTIVES OF THE STUDY

The purpose of this study was to assess state of the practice on use of ITS for operations and management of land border crossings on the US-Mexico and US-Canada borders. The study focused on three main applications of ITS at border crossings—border security and enforcement, tolling operation, and transportation operations and management. In addition to documenting ITS applications, the study also assessed institutional issues and barriers to ITS implementation.

However, in the interest of brevity this paper discusses results of the study pertaining to the state-of-the-practice on use of ITS on the US-Mexico border only.

STUDY APPROACH

The state-of-the-practice study was performed through a literature review and interviews with agency officials and private-sector stakeholders, followed by two workshops that were attended by Federal, State, and local agencies from both sides of the border as well as private sector technology providers, to solicit their experiences in planning, funding, and operating ITS projects at the border.

SECURING CROSS-BORDER FLOW OF GOODS AND PEOPLE

Securing Flow of Commercial Vehicles

The process for commercial vehicles crossing into the United States through land border crossings is complicated due to the number of stakeholders that participate, involving two countries, private and public sectors, and agencies from all levels of government. There is a range of activities that take place at land border crossings to secure the flow of commercial vehicles such as electronic filing of import and export declarations, agricultural inspections, drug interdiction, immigration check on the driver, and vehicle safety checks.

US Customs and Border Protection (CBP) is the key agency with respect to securing cargo entering the United States. CBP has implemented several programs that use technology to aid in its mission. CBP’s shipment clearance program called Free and Secure Trade (FAST) uses Radio Frequency Identification (RFID) technology and distributes transponders that are used to provide information through queries about the driver, shipper, and carrier when trucks approach CBP’s primary inspection facility. The FAST program offers expedited clearance to carriers that have demonstrated supply chain security and are enrolled in the Customs-Trade Partnership against Terrorism (C-TPAT). FAST processing exists at all southern border crossings that process commercial cargo [2].

CBP has been heavily promoting the FAST program to trade groups by showing benefits such as dedicated FAST lanes leading to its primary inspection booths, reduced number of inspections, and priority/front-of-the-line processing. However, trade groups are complaining that at some border crossings carriers and shippers do not experience faster processing because their FAST shipments still have to commingle with non-FAST trucks on approaches prior to Mexican Customs and CBP. Despite this, CBP does estimate that at some border crossings up to 80% of trucks entering US are enrolled in FAST program and hence have RFID transponders.
attached with them. This has opened up whole new opportunities to measure wait times of trucks crossing the border and providing that information back to them.

Once trucks leave CBP, they are screened and inspected by the Federal Motor Carrier Safety Administration (FMCSA) for safety-related compliance followed by the State for size and weight and perhaps safety-related compliance. Several border states are implementing technologies to increase efficiency related to screening and inspection of trucks for safety compliance.

The Arizona Department of Transportation (ADOT) recently implemented a commercial vehicle electronic screening program called Expedited Processing at International Crossings (EPIC), which combined proven ITS technologies to expedite truck processing, compliance monitoring, and traffic management at the Mariposa border crossing in Nogales. EPIC’s features included the weigh-in-motion system, Closed Circuit Television (CCTV) monitoring, Automatic Vehicle Identification (AVI), digital imaging equipment, Automated License Plate Recognition (ALPR) scanners, and Optical Character Recognition (OCR) cameras for reading United States Department of Transportation (USDOT) numbers. These sensors send data to the database system for storage and integration of information from all of the technologies, communications systems, and ancillary equipment. The EPIC system is still in an early stage of deployment.

The Texas Department of Public Safety (TxDPS) along with the Texas Department of Transportation (TxDOT) is in the final stage of implementing a commercial vehicle screening system similar to EPIC. The Texas system will expedite screening and inspection of trucks once they approach the State’s safety inspection facility after exiting the CBP compound, using RFID to identify trucks and a database to monitor compliance history of carriers. Texas law is very restrictive about automated visual identification of vehicles on state properties except for tolling purposes. Hence, an ALPR-type system is not being deployed at the state’s inspection facilities.

Commercial vehicles entering Mexico go through a generally similar process to that used by CBP; however, they are subject to less scrutiny than at CBP. Commercial vehicles entering Mexico still need to show necessary paperwork (e.g., visas, import documents). These vehicles are however, inspected by only one federal agency (Mexican Customs) unlike in the United States. The process in Mexico is a red light/green light decision in which a loaded commercial vehicle is selected randomly for a secondary inspection. Empty vehicles cross with no need to stop at a Mexican Customs’ booth.

Securing Flow of Passenger Vehicles

Similar to the FAST program for commercial vehicles, the Secure Electronic Network for Travelers Rapid Inspection (SENTRI) provides expedited processing for pre-approved, low-risk travelers entering the United States via passenger vehicles at southern border crossings (3). At many border crossings, CBP has designated lanes for processing travelers enrolled in SENTRI as well as separate lanes on the Mexican side. This does create a significant wait time advantage for SENTRI-enrolled vehicles over regular vehicles. Even though SENTRI users generally agree that they experience comparatively less wait times, the program is rather expensive for low and average income travelers.
SENTRI uses RFID technology in that CBP issues transponder embedded identification cards that are read automatically at CBP’s primary inspection facility and are quickly granted (or denied) access to enter the United States. For the US-Canada border, a similar trusted-traveler program was established in 2002 and is called NEXUS (not an acronym) (4).

Technology driven programs such as FAST and SENTRI have been successful in reducing processing times at border crossings. But more value can be added, in terms of lower wait times, if separate lanes are available on the MX side at all border crossings. Improvement of this however is the responsibility of the MX government.

CBP recently rolled out READY Lanes (also not an acronym) at a few border crossings; READY lanes are dedicated lanes to enter the United States for travelers who travel with a Western Hemisphere Travel Initiative- (WHTI-) compliant and RFID-enabled travel document (5). The US passport card, the SENTRI card, the NEXUS card, the FAST card, the new enhanced permanent resident “green card,” and the new border-crossing card are all eligible for use in READY lanes. RFID technology allows information contained in a wireless “tag” (i.e., transponder) to be read from a distance, enabling CBP officers to more quickly, reliably, and accurately process travelers. CBP expects use of READY lanes to grow substantially in the future and hence intends to add more READY lanes at border crossings.

CBP recently instrumented a few border crossings with Variable Message Signs (VMSs) over their primary inspection booths, as shown in Figure 1. Depending on the queue of approaching vehicles, CBP officers can change messages on the VMSs to instruct approaching vehicles to use particular lanes (i.e., READY, SENTRI, regular). CBP also implemented 530 AM radio for motorists to tune into to receive wait time information as they approach the primary inspection facility.
Passenger vehicles entering Mexico go through the Mexican Customs inspection station. This is a similar process to that used for commercial vehicles. It uses a red light/green light decision in which passenger vehicles are selected for secondary inspections if they get a red light because of a reason such as atypical weight or more than one passenger. At some border crossings, license plates are automatically read by ALPRs to cross-check against any criminal record associated with the license plate.

**COLLECTING TOLLS TO SUPPORT BORDER INFRASTRUCTURE**

The majority of tolls collected at border crossings are at those where there are bridge structures over a river. On the US-Mexico border, 21 of the 46 border crossings collect tolls and are mostly located in the State of Texas. Tolls from vehicles (commercial and passenger) and pedestrians are collected in the originating country. On the Mexican side, typically private concessionaires on behalf of State governments collect tolls from vehicles and pedestrians entering the US. On the US side, city governments collect tolls from vehicles and pedestrians entering Mexico from the US.

The toll operations at border crossings utilize cash payments, electronic toll collection (ETC) using RFID technology, proximity cards, and bar code technology. Where RFID technology is used, the study did not find interoperability or enforcement agreements between US and Mexican tolling agencies, meaning a motorist/traveler would have to carry two toll transponders—one issued by a Mexican agency and another issued by a US agency.
Of the 21 tolled border crossings on the US-Mexico border, 18 currently have ETC already in place. The border crossings with ETC have various types of technology. Five border crossings use transponder-based ETC technology, five border crossings use proximity cards that are electronically read by card readers with the tolls automatically debited from the customers’ accounts, and eight use barcode technology. On the Mexican side, 14 border crossings have transponder-based ETC. Interviews with selected border crossing operators indicated that they are following 5.9 GHz Dedicated Short Range Communication (DSRC) developments closely but know of no concrete plans in the near future.

All of the tolled border crossings on the US-Mexico border currently have fixed toll rates. There are no schemes to adjust tolls based on congestion levels or toll rate schedules based on the time of the day or day of the week. Carriers and shippers do not view dynamic pricing favorably, since they do not like the idea of not knowing in advance, what the toll rate will be.

Physical barriers (e.g., rotating arm) are commonplace at border crossings to deter toll violators on both sides of the border. Use of ALPR technology to enforce tolling at border crossings would be difficult mainly because of the fact that a large majority of border crossers on the US-Mexico border are from Mexico, and agencies in the US do not have access to vehicle registration information from Mexico and vice versa. Federal agencies share vehicle registration information on commercial vehicles/carriers but not on passenger vehicles. In addition, violators from one country cannot be pursued in the other. Interestingly, tolling violations by drivers appear not to be a concern among toll operators due to the low violation rates.
Table 1. Different Methods of Toll Collection at US-Mexico Border Crossings

<table>
<thead>
<tr>
<th>Border Crossing</th>
<th>US City (all in Texas)</th>
<th>ETC Technology on the US Side</th>
<th>ETC Technology on the Mexico Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterans International Bridge</td>
<td>Brownsville</td>
<td>Barcode AVI (installed in 1999)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Gateway International Bridge</td>
<td>Brownsville</td>
<td>Barcode AVI (installed in 1999)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>B&amp;M Bridge</td>
<td>Brownsville</td>
<td>HID Proximity Card (Xpress Card Plus)</td>
<td>None</td>
</tr>
<tr>
<td>Free Trade Bridge</td>
<td>Los Indios</td>
<td>Barcode AVI (installed in 1999)</td>
<td>None</td>
</tr>
<tr>
<td>Progresso International Bridge</td>
<td>Progresso</td>
<td>None</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Donna International Bridge</td>
<td>Donna</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Pharr-Reynosa International Bridge</td>
<td>Pharr</td>
<td>Transponder (eGo Tag)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>McAllen-Hidalgo-Reynosa Bridge</td>
<td>Hidalgo</td>
<td>HID Prox, Card (EZCrossBridge TollTag)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Anzalduas International Bridge</td>
<td>Mission</td>
<td>HID Prox, Card (EZCrossBridge TollTag)</td>
<td>None</td>
</tr>
<tr>
<td>Rio Grande City-Camargo Bridge</td>
<td>Rio Grande</td>
<td>Barcode AVI</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Roma-Ciudad Miguel Aleman Bridge</td>
<td>Roma</td>
<td>None</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Juarez-Lincoln Bridge</td>
<td>Laredo</td>
<td>Transponder (Laredo Trade Tag, eGo)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Gateway to the Americas Bridge</td>
<td>Laredo</td>
<td>Transponder (Laredo Trade Tag, eGo)</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>World Trade Bridge</td>
<td>Laredo</td>
<td>Transponder (Laredo Trade Tag, eGo)</td>
<td>None</td>
</tr>
<tr>
<td>Laredo-Colombia Solidarity Bridge</td>
<td>Laredo</td>
<td>Transponder (Laredo Trade Tag, eGo)</td>
<td>None</td>
</tr>
<tr>
<td>Camino Real International Bridge</td>
<td>Eagle Pass</td>
<td>HID Proximity Card Reader</td>
<td>None</td>
</tr>
<tr>
<td>Eagle Pass Bridge I</td>
<td>Eagle Pass</td>
<td>HID Proximity Card Reader</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Del Rio-Ciudad Acuna Intl. Bridge</td>
<td>Del Rio</td>
<td>Barcode AVI</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Ysleta-Zaragoza Bridge</td>
<td>El Paso</td>
<td>Barcode AVI</td>
<td>Transponder</td>
</tr>
<tr>
<td>Good Neighbor Bridge</td>
<td>El Paso</td>
<td>Barcode AVI</td>
<td>Transponder (IAVE)</td>
</tr>
<tr>
<td>Paso del Norte Bridge</td>
<td>El Paso</td>
<td>Barcode AVI</td>
<td>Transponder (IAVE)</td>
</tr>
</tbody>
</table>

Note: HID = Hughes Identification Devices Global Inc., IAVE = Identificación Automatica Vehicular

Sources: (6), (7), (8), (9), (10), and (11).

MANAGING TRANSPORTATION AND PROVIDING TRAVELER INFORMATION

Regions along the US-Mexico border need to maximize the efficiency of transportation operations around border crossings using traditional as well as advanced technology, including ITS. Increasing the efficiency of moving vehicles across the border not only depends on how inspection facilities on both sides of the border Mexico operate, but also depend on their movement on approaches leading up to the border crossings. This section describes bi-national coordination and identifies where there are possibilities for coordination between agencies across the border in support of traffic management and operation around the border crossings.
Sharing Real-Time Traffic Data between US and Mexican Partners

Sharing of real-time traffic management data between agencies on both sides of the US-Mexico border is limited. Compared to Canadian agencies on the northern border, Mexican counterparts on the southern border have only to a very limited degree deployed ITS with the specific purpose of traffic and incident management around border crossings. In addition, none of the cities on the Mexican side of the border has deployed Traffic Management Centers (TMCs) around border crossings. TMCs are a crucial platform for sharing information between regions. However, conversations with officials revealed that there has been little or no progress with US agencies sharing their TMC data with agencies in Mexico. In the absence of TMCs at cities on the Mexican side, there is also a lack of protocols for sharing data between the two countries.

This may change in the future. Secretaría de Comunicaciones y Transportes (SCT) is planning to deploy several TMCs in the border regions of Mexico. SCT is going ahead with construction of regional TMCs in the cities of Monterrey and Chihuahua. These TMCs will monitor Mexican federal roadways and toll roads, many of which terminate at border crossings. These TMCs will be able to operate ITS field devices deployed on roadways close to border crossings and provide traveler information, which will include traffic conditions on roadways as well as at border crossings (12). In addition, the ITS system envisioned by SCT includes TMCs to be operated by toll concessionaires that will share real-time data with TMCs on the US side of the border (13).

Interviews with officials revealed that agencies from both sides of the border request assistance from each other when responding to incidents on their side. Officials also call each other to verify incidents to ensure they do not affect flow of traffic on their side of the border. Communication among agencies on both sides of the border is done mostly through mobile phones. Many Mexican agencies often have local US side phone numbers as contact information and/or carry US mobile phones.

It is important to recognize that requests for information/assistance between the United States and Mexico happen at the city level, not county or state level (14). Thus, data sharing among cross-border agencies should happen at the local level because of the immediate need to respond to incidents and emergencies and the fact that local enforcement agencies are the first ones to respond. Exceptions to this include hazardous materials (HAZMAT) incidents and events that affect the flow of vehicles approaching US or Mexican Customs facilities, when communication will occur at the federal level.

Managing Traffic during Special Events at and around Border Crossings

Federal and local agencies play a significant role in planning and managing traffic at and around border crossings due to special events. Special events include visits to the border by high-profile individuals, major cultural and sporting events, and major holidays (e.g., Easter and Christmas) that draw large number of cross-border trips. Agencies from both sides of the border plan proper responses ahead of time using ad hoc meetings (15). Each agency then lays out its subsequent role(s) according to its jurisdictions to assist traffic management at and around the border during the event.
However, none of the border regions has developed a centralized information system through which communication and data sharing could occur between agencies across the border to monitor the progression of traffic during the event.

Real-Time Incident Management around Border Crossings

On both sides of the border, local (i.e., city or municipal) agencies typically play a significant role in responding to incidents around border crossings. Sometimes their roles also depend on the presence of State and/or local roadways (on the US side) and Federal and/or local roadways (on the Mexican side) that lead to and from the border crossings, as well as their current jurisdictions for traffic operation on these roadways. In some urban areas in the US, even if the roadways are State-maintained they may be operated by the cities. In such cases, local law enforcement agencies respond to incidents around border crossings.

Agencies on both sides of the border typically communicate with each other using mobile phones while managing incidents. Incidents at close proximity to border crossings can disrupt operation at the border, resulting in longer-than-expected wait times. Hence, agencies communicate with their counterpart agencies to keep up to date on information such as the scope of incidents, clearance times, and assistance required. However, Mexican agencies do not have direct access to ITS devices that are on the US side and vice versa. For example, Mexican agencies do not have direct access to CCTV installed by TxDOT to monitor incidents around border crossings that might affect the Mexican side of the border. It is not clear whether Mexican agencies would be granted direct access to such devices installed by a state agency in the United States, and the same can be said regarding access by US government agencies to ITS devices deployed by Mexican agencies.

Technology does allow agencies from both countries to access ITS devices and information. But it is not happening at the desired level mostly because there are no governing policies that allows both countries to share ITS functionalities.

Hazardous Material and Other Emergency Response

The US-Mexico border region experiences a large flow of HAZMAT across and at the vicinity of the border. On the Mexican side, 2,600 manufacturing plants use and/or produce an enormous amount of HAZMAT. Under NAFTA requirements, all HAZMAT that is shipped into Mexico or generated during the manufacturing process must be shipped back to its point of origin, typically the United States. The US side has concentrated areas of storage and disposal facilities. Thus, the delivery and return of HAZMAT has created a HAZMAT transportation corridor. For example, fifty percent of the trade that crosses through Laredo involves HAZMAT, and that volume of HAZMAT cargo and commerce is flowing alongside the tourism present on both sides of the border (16). Additionally, Laredo has over 60 million square feet of warehouse space, and at least a quarter of that space contains HAZMAT.

Along the US-Mexico border areas, many cities have signed sister city agreements. The cities of Laredo and Nuevo Laredo developed a cross-border contingency plan in 1998 as part of a sister city agreement to allow either city to utilize resources and work force essential to respond to emergencies and disasters within the two Federal boundaries (17). A similar bi-national
emergency plan (focused on HAZMAT) was signed in 2007 among the City of El Paso, Ciudad Juarez, and the City of Sunland Park, New Mexico under the 14th border sister city agreement (18). The plan calls for police, fire, paramedics, and other emergency response personnel from both sides of the border to respond quickly to large fires, dangerous chemical spills, or other emergencies. However, due to liability issues associated with the risk of responding to a HAZMAT incident on the other side of the border, fire departments on the US side are not allowed to cross into Mexico and directly respond to HAZMAT incidents (19).

Federal and local agencies such as the Environmental Protection Agency (EPA), a city’s fire departments, or the Mexican Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) responding to HAZMAT spills mostly communicate using mobile phones. Agency officials did mention to researchers that they would like to communicate using two-way radio instead of mobile phones since two-way radio would provide reliable communication, because cell phone signals along the border often conflict between US and Mexican carriers.

In discussions with HAZMAT carriers, few of them do monitor of movement of trucks using Geographical Positioning System (GPS) along key corridors. Such information is used solely to monitor the location and report progress to shipper towards timely delivery and is not shared with federal and/or state officials. A recent study did indicate that emergency officials on both sides of the border would like to know in advance shipments of potentially dangerous HAZMATs that are going to cross the border, so that they can be prepared. Until now, only CBP receives such information in advance since carriers have to submit electronic manifest of shipments prior to entering US (19).

Wait Times and Traveler Information

Wait times of commercial and passenger vehicles entering the US are the most crucial piece of information for motorists as well as agencies operating border crossings. This is because wait times are typically much longer for vehicles entering the US than while entering Mexico. CBP measures and disseminates wait times of border crossings using the visual method and through random surveys of drivers. There is a consensus among stakeholders that CBP-relayed wait times are not uniform and systematic throughout the border.

With objectives to address this need, Federal Highway Administration (FHWA) and state departments of transportation (e.g., Texas and Arizona) have deployed ITS at several border crossings to measure wait times of US-bound commercial vehicles. These deployments use RFID technology to measure and relay highly accurate and reliable wait times and crossing times of commercial vehicles. These RFID technology-based systems have been deployed at five border crossings in Texas. Table 2 includes a list of border crossings that are equipped with ITS to collect and relay wait and crossing times of US-bound vehicles. These agencies are coordinating with CBP to install RFID equipment inside its primary inspection facility and in return CBP has requested for access to the wait time data to replace the ones it currently relays. These agencies also plan to deploy ITS to measure wait times of passenger vehicles.
Table 2. Technology Implementations to Measure Wait and Crossing Times at US-Mexico Border Crossings

<table>
<thead>
<tr>
<th>Location</th>
<th>Technology</th>
<th>Direction</th>
<th>Vehicles</th>
<th>Factors Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge of the Americas, El Paso, Texas</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
<tr>
<td>Pharr-Reynosa International Bridge, Pharr, Texas</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
<tr>
<td>Mariposa Port of Entry, Nogales, Arizona</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
<tr>
<td>World Trade and Camino Colombia International Bridges, Laredo, Texas</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
<tr>
<td>Otay Mesa, California-Mexico</td>
<td>GPS</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times</td>
</tr>
<tr>
<td>Veterans International Bridge, Brownsville, Texas</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
<tr>
<td>Zaragoza-Ysleta International Bridge, El Paso, Texas (in design)</td>
<td>RFID</td>
<td>US-bound only</td>
<td>Trucks only</td>
<td>Crossing times and wait times</td>
</tr>
</tbody>
</table>

Adapted from: (20)

Regarding measurement of wait times of passenger vehicles on the US-Mexico border, agencies are closely following deployment of Bluetooth technology at several border crossings on the US-Canada border. Researchers are aware of several efforts to collect, for a short period, wait times of passenger vehicles using Bluetooth technology. Agencies from both sides of the US-Mexico border have developed a high level of confidence in the use of Bluetooth technology. However, obtaining funding remains an issue.

Once the wait time data is collected, disseminating the information effectively to motorists on the MX side of the border is a challenge. In the absence of variable message signs on the MX side of roadways, wait times to motorists are related mostly through agency Web sites, which are then relayed by local media outlets such as radio and television stations. Few agencies in California have integrated the wait-time information into their regional 5-1-1 systems and relayed a digitally prerecorded message. Researchers also found only two agencies that use social networking Web sites such as Twitter to relay wait time information. Table 3 lists agencies’ use of social networking sites, e-mail, and mobile devices to relay border wait times. However, all of these agencies relay wait times produced only by CBP. Because many agencies re-relay CBP-published wait-time information, the frequency of relay is the same as the one used by the CBP, which is hourly.
Table 3. Use of Social Networking Sites, E-mail, and Mobile Devices by Agencies to Relay Border Wait Times

<table>
<thead>
<tr>
<th>Agency</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Email</th>
<th>RSS</th>
<th>5-1-1 System</th>
<th>Web Site</th>
<th>Mobile Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBP (21)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SCT (13)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No**</td>
<td>No**</td>
<td>No**</td>
<td>No**</td>
</tr>
<tr>
<td>TxDOT (22), (23)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No**</td>
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<tr>
<td>NMBA (24)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
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<tr>
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<td>No</td>
<td>No</td>
<td>Yes*</td>
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<tr>
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<td>No</td>
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<td>Yes*</td>
<td>Yes*</td>
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<tr>
<td>SANDAG and Caltrans (27)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>Yes*</td>
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Note: * Same as CBP wait times; ** Planned, NMBA = New Mexico Border Authority, NMDOT = New Mexico Department of Transportation, SANDAG = San Diego Association of Governments, Caltrans = California Department of Transportation

A review of agency Web sites and the literature review revealed that none of the agencies on the US-Mexico border currently displays wait time information on VMSs. Several agencies on the US-Canada border provide such information through VMS deployed on approaches leading to border crossings. Agencies planning to deploy VMSs for border crossings need to be aware that the efficiency of such deployment depends upon whether travelers understand the information correctly, how they value the usefulness of information, and whether they follow the suggested alternatives. Studies have shown that the preferences on route switching increase with the information contents provided by the VMSs (28). Whether a similar conclusion can be drawn for border crossings is a topic of future research—mainly because motorists do not have many choices when it comes to border crossings.

A motorist’s response to wait time information is at best subjective and anecdotal. There do not appear to be studies that have documented users’ responses to wait times. How users react to en route wait time information relayed by field ITS devices such as VMSs and local media is still unknown. In freeway operation and management, researchers have used focus group studies, interviews, and visual simulations to understand motorists’ behaviors in real-time traffic conditions. Similar studies might be helpful to understand users’ behavior to real-time information at border crossings.

OVERCOMING INSTITUTIONAL BARRIERS

Several agencies from both sides of the border constantly remind each other that institutional barriers are more difficult to overcome than technological. Given the fact that myriad of Federal, State, and local agencies from two countries as well as private-sector stakeholders operate at the border, institutional barriers are additionally complex. Not to mention that all these agencies from both countries have varying needs. Coordination among these stakeholders is an important element in deploying ITS. US-Mexico Joint Working Committee (JWC) is a step towards improved coordination between the two countries and its numerous stakeholders and thereby
addressing ways to break down institutional barriers. The JWC is led by Federal from US and Mexico and includes members from State DOTs, cities, MPOs, and private sector. The committee meets semi-annually and discusses border crossing related projects including planning, funding, programming, and implementation. Both Federal governments have been using JWC as a conduit to allocate federal monies to fund border related infrastructure improvement programs, monitor project’s progress, and ensure project’s success and acceptance by stakeholders.

Because of funding constraints, the JWC and its members are increasingly going out and advocating for projects that are not cost-prohibitive such as ITS. In addition, they are emphasizing on a need to continuously monitor performance of border crossings, which will facilitate improved decision-making. At the same time, some agencies are attempting innovative ways to fund large infrastructure development at the border. For example, San Diego Association of Government and Caltrans are planning a new publicly financed border crossing, which will be funded fully by tolls collected on both sides of the border. The new border crossing will have among other facilities state of the art ITS to monitor wait times of traffic on both sides of the border.

Also, a joint ITS architecture geared towards US-Mexico border would be greatly benefit ITS implementation by allowing stakeholders to plan and program ITS projects at the border. A similar document exists for the northern border and was created with initiations from both US and Canadian governments.

In general, there needs to be an elevated level of knowledge about ITS among decision and policy makers on both sides of the border.

CONCLUSION

Dissimilar funding and technical capabilities between Mexican and US partners is an issue that has resulted in dissimilar levels of ITS deployments on the US side compared to the Mexican side. For example, all border-states in the United States have TMCs in urban areas in close proximity to the border. On the Mexican side, there is none although there are plans to develop a few.

The study revealed that sharing of real-time traffic management data between agencies from both sides of the US-Mexico border has been limited mostly due to funding constraints on the Mexican side of the border and to some extent on the US side too. There has not been significant progress made in developing bi-national data exchange standards/protocols that could lead to an integrated, interoperable system capable of sharing resources and perhaps information between systems in two countries.

At tolled border crossings, both the United States and Mexico have been quite forefront in using ETC to expedite toll collection. However, the study did not find interoperability or enforcement agreements between US and Mexican tolling agencies. In addition, the use of ALPR to reduce toll violation and enforcement is limited mostly because of the fact that Mexican
agencies do not have access to vehicle registration information from the United States and vice versa.

One surprising fact is that Mexican toll operators, which are typically private concessionaires, are becoming quite innovative in managing and keeping track of the queue of US-bound vehicles. This is mainly because Mexican toll operators get some of the blame for long wait times of US-bound vehicles since they collect tolls from commercial and private vehicles before they head to CBP facilities. Mexican toll operators have expressed a desire to deploy ITS to measure wait times and volume automatically. Unfortunately, even with significant cash flow available to them, ITS deployment has been limited mostly because State government and owners of the company puts higher priority on toll collection than queue and wait time monitoring.

With regard to measurement and dissemination of wait times, the FHWA or state DOTs have implemented ITS technologies to measure border wait and crossing times for commercial vehicles at several US-Mexico border crossings. These deployments are based primarily on RFID technology. Their next goal is measurement of passenger vehicle wait and crossing times for which Bluetooth seems to be a viable technology.

The scan revealed that television and radio are the most common methods by which motorists prefer to receive disseminated wait and crossing times. Use of mobile devices to obtain wait times seems to be becoming popular, especially among drivers of passenger vehicles. Truck drivers, on the other hand, prefer to use radio and communication from their dispatchers. MX government is however planning to deploy variable message signs and 511 systems on its roadways leading to border crossings.

With regard to future technologies, implementation of technologies that are part of the USDOT Connected Vehicle Program that have bi-directional communication capability between the vehicles and border crossing systems have potential to improve border operations.

Needless to say, use of ITS to improve operation of border crossings has substantially increased in recent years. However, more is necessary to improve experiences of traveling public and freight crossing the border. Institutions such as the JWC should continue to lead the efforts in framing policies, prioritizing projects, and allocating funds to deploy ITS. CBP and other federal, state, and local agencies in US and Mexico as well as the private sector should continue to implement ITS to improve border crossing operations. Failure to do so would greatly reduce the efficiency of these freight and passenger gateways, which are essential to regional and national economy.

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