Testimony of Rafael Aldrete
Texas A&M Transportation Institute
before the
Texas House of Representatives
International Relations & Economic Development Committee
and
Transportation Committee
February 21, 2020

Good morning Chairmen Anchia and Canales and committee members. My name is Dr. Rafael Aldrete and I appear before you today in my capacity as a Senior Research Scientist at the Texas A&M Transportation Institute, and in my specific role as Director of TTI's Center for International Intelligent Transportation Research located in El Paso. I appreciate the opportunity to appear before you today to provide some brief remarks and respond to any questions.

Introduction

The trade relationship between the U.S. and Mexico has continued to grow in recent years, with a very significant amount of goods moving through ports of entry between Texas and Mexico, which has led to increasing traffic congestion issues at the border. While there are a number of natural limitations on cross-border movement, such as existing infrastructure, security measures, and government agency workforce, limitations in reliable cross-border travel data and information also prevent more expedited cross-border movement. To that effect, private-sector manufacturers, companies specializing in logistics, and personal passenger vehicles, have been unable to plan effectively for cross-border movement due to limited real-time data and available information.

Texas A&M Transportation Institute (TTI) is home of the Center for International Intelligent Transportation Research (CIITR), which has researched and developed an enhanced system to monitor border-crossing times that is reliant upon current sources of data - such as Bluetooth/Wi-Fi and Radio Frequency Identification (RFID), but supplemented by Light Detection and Ranging (LiDAR) - as well as artificial intelligence and emerging data sources such as aggregated cell phone/GPS data. This system developed by TTI research builds upon the current system of retroactively reporting travel time for vehicles by transposing it to a real-time reporting system. While we have deployed a prototype on a limited basis in El Paso, the availability of this highly accurate real-time travel information shows great promise in improving our capability to inform numerous decisions, such as route planning by logistics companies, to expedite the movement of goods and people between Texas and Mexico border ports of entry.

Background

According to the office of the U.S. Trade Representative, the U.S. exports more than $265 billion and imports more than $346 billion in goods from Mexico annually, including products such as machinery, mineral fuels, medical equipment and vehicles, as well as produce. While this trade relationship continues to grow, security and trade measures have also increased in recent years. Exacerbated by infrastructure and security agency limitations, border crossing wait-times have spiked.

Lengthy wait-times have implications for numerous involved entities, which has a direct impact to economic development for local communities as well as the state and the nation. Long waits create time and labor constraints for freight companies and law enforcement. They can cause delays in the supply-chain, affecting other companies, and can even render products unusable, such as spoilage of produce. While many factors influence crossing times, technology has emerged which enables us to factor trip planning into the border crossing process. Currently, a system is in place to report travel times across the state's largest ports of entry, but building on this existing technology with new methods could mitigate congestion at ports of entry, expediting crossing times and enhancing efficiency.

Current System

Texas Department of Transportation (TxDOT), along with other border state departments of transportation and federal agencies, currently maintains a system that reports border crossing times; its name is the Border Crossing Information System (BCIS). This has allowed for the public and private sectors to more accurately determine travel-time and adjust some route planning decisions. While this system has been highly beneficial for those purposes, the system is not able to predict crossing-time for vehicles that have not yet entered the line.

The system in use now, BCIS, determines travel-time based on the movement of a particular vehicle. A sensor at the beginning of the crossing process flags a vehicle and the system monitors it through the crossing. When that vehicle reaches a sensor on the other side of the crossing, the elapsed time is reported as current crossing-time. The travel-time reported is extremely valuable, helping to guide route planning and other decisions, but the system does not account for any traffic build-up during the trip of the monitored vehicle. Therefore, the ability to predict crossing-time for vehicles that have not yet entered the line is currently not publicly available. For example, if a vehicle enters the queue when there is no line of vehicles waiting, the travel-time may no longer be accurate if build-up has occurred by the time that vehicle finishes crossing. Under this system, vehicle build-up is not reported and thus can present difficulty for trip planning as well as failure to identify a less congested routes.

Enhanced Cross-Border Travel Information Technology: How Does it Work?

TTI's Center for International Intelligent Transportation Research has researched the application of new technology to enhance the data and information available for travelers to provide more efficient border crossing decision datapoints. The ability of this new system to accurately determine and convey travel times relies on a number of technologies ranging from the existing Bluetooth/Wi-Fi and Radio Frequency Identification (RFID) to Light Detection and Ranging (LiDAR), artificial intelligence, and emerging data sources such as aggregated cell phone/GPS data from companies like INRIX, AirSage or Google. The technology most appropriate varies on the availability of reliable information from certain types of vehicles.

Based on past TTI research studies, the following types of vehicles can best function with each of the listed technologies.

	Crossing/ Wait Times	Crossing Volumes
Commercial Vehicles	RFID	LiDAR
Passenger Vehicles	Bluetooth/Wi-Fi	LiDAR

Figure 1: Technology types and uses for data generation related to border crossing traffic

Use of Bluetooth/Wi-Fi and RFID

The availability of Bluetooth and Wi-Fi connection in vehicles and mobile devices provides manufacturers and other data collectors information with a high degree of reliability and location accuracy, relative to its cost. This source effectively captures the location and movement of passenger vehicles, as currently many vehicles or most of the drivers are equipped with the technology. Conversely, the movement of freight is best measured through a different source – RFID. The fleet of most cross-border freight drayage companies already have an RFID tag for toll or trusted shipper programs, making radio frequency transmissions the most effective tool to identify large trucks. Pinpointing the location and speed of various vehicles, with added means to protect personally identifiable information, can enable agencies and companies to measure the amount of time needed for the crossing of a specific vehicle.

Use of LiDAR

Another necessary element of measuring wait-times, in real-time, is understanding how many vehicles are in the queue. To that effect, our research has shown that a LiDAR detector can provide a highly accurate representation of the volume of vehicles moving through a highly congested, low-speed facility such as a border crossing. LiDAR takes a reading of the slow-moving vehicle with a laser-light and then measures that laser light which is reflected from the vehicle. This collected information can then be used to map objects, so in this case, LiDAR detectors can determine how many vehicles enter and exit a border crossing, and how many inspection booths are open in real time. By knowing the time for a vehicle to cross, measured by the Bluetooth or RFID, and the number of vehicles in the queue measured via LiDAR, this sensor technology can enhance the current border-crossing time reporting system. Predicting travel time for a specific vehicle given the number of vehicles in a queue depends on a third use of technology – artificial intelligence (AI).

Use of Artificial Intelligence and Predictive Capabilities

Artificial intelligence (AI) is increasingly used for an array of purposes, but in the form of machine-learning, it has enabled the prediction of travel-time based on other factors. In this case, the factors in question are data provided by Bluetooth/RFID and the measurements taken by LiDAR. AI can compare location data, from the in-vehicle source, with the volume of traffic provided by LiDAR technology and thus develop an accurate short-term forecast about border-

crossing times. The information generated by AI technology is used to accurately predict the total amount of time which should be planned for a driver to cross at a port of entry when it reaches the queue, within a margin of error of three minutes. This technology can enhance the current border-crossing time system by providing a high degree of reliability for expected wait-times, while accounting for accumulating traffic.

Use of Emerging Data Sources

Most of the traveling public is familiar with navigation applications such as Google, Apple Maps and Waze, which aggregate cell phone data to provide users with point to point navigation and travel time estimates. Several companies, such as INRIX, AirSage and Google also provide aggregate cell phone GPS data in the form of vehicular traffic information to transportation agencies, media and fleet managers. Our research has shown that travel time estimates generated with this data is highly accurate under regular roadway network conditions when compared to vehicle probes and Bluetooth sensor generated information. However, as a result of the unique conditions that exist at border crossings, estimates of cross border travel time generated with this data have proven to be much less accurate than those generated by the existing RFID and Bluetooth Wi-Fi. Specific to international border crossings, many GPS data providers do not collect or share data across Mexico and the United States and estimates of time spent in queued traffic are not accurate. Our research has shown that by integrating the information from a LiDAR-AI enhanced BCIS along with roadway network travel times estimated using emerging data sources from the Mexican travel segment and the separate United States travel segment on both sides of the border crossing queue, we can enable a holistic border crossing time system to provide reliable point-to-point cross-border travel time information for a complete border crossing trip. The enhanced system would allow the traveling public to make better routing decisions earlier on, help balance traffic loads at ports of entry in the same region, and would enable transportation and border agencies to make better informed operational choices.

Application

Figures 2 and 3 on the following page depict the placement of various sensors at the Ysleta-Zaragoza Bridge in El Paso. TTI has sponsored the implementation of these sensors to test the effectiveness and outcomes from the enhanced approach to forecast travel times.

Figure 2 shows the location of RFIDs in the crossing queue. This system is geared toward expediting the movement of freight, as the system employs RFID reader infrastructure on the roadways, which reads the toll or trusted shipper RFID tags of large trucks. These sensors have been placed at each end of the queue, at the exit toll booth in Mexico, and at the Customs and Border Protection (CBP) Inspection location in the U.S. This allows the system to track a vehicle through various stages in the crossing process, reflecting the amount of time needed for each phase of cross-border movement. Not only does this data display wait times for entering the queue, it can also inform various entities of the delays within the queue.

Similarly, Figure 3 also displays sensor placement, but this map shows the location of LiDAR sensors. These pieces have been placed at the toll booth exit in Mexico and the Department of Public Safety (DPS) exit in Texas. Placement of these sensors allows for lasers to survey traffic along each side of the crossing, which then provide volume counts of vehicles within the border-crossing facility. From this point, the data collected from all sensors can be analyzed to estimate travel-time forecasts by artificial intelligence programs developed by TTI/CIITR. This allows software to develop a short-term prediction of travel times for vehicles moving through a queue

with a surveyed number of vehicles with attention to other factors such as the number of open inspection lanes.

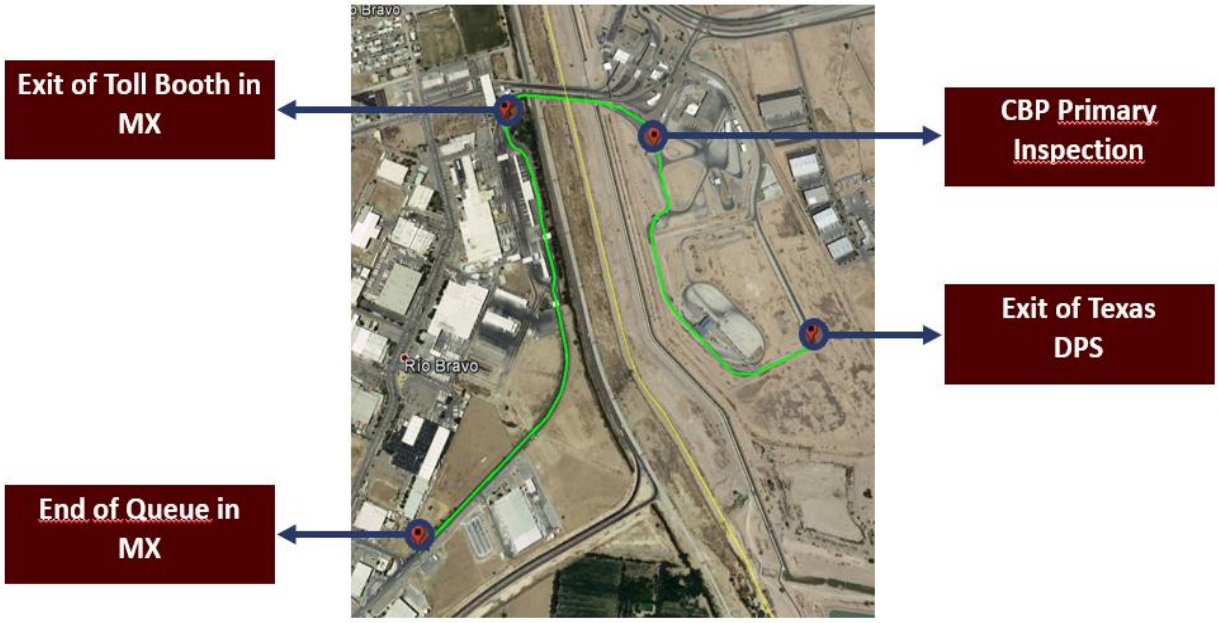

Figure 2: The location of RFID readers at the Ysleta-Zaragoza Bridge

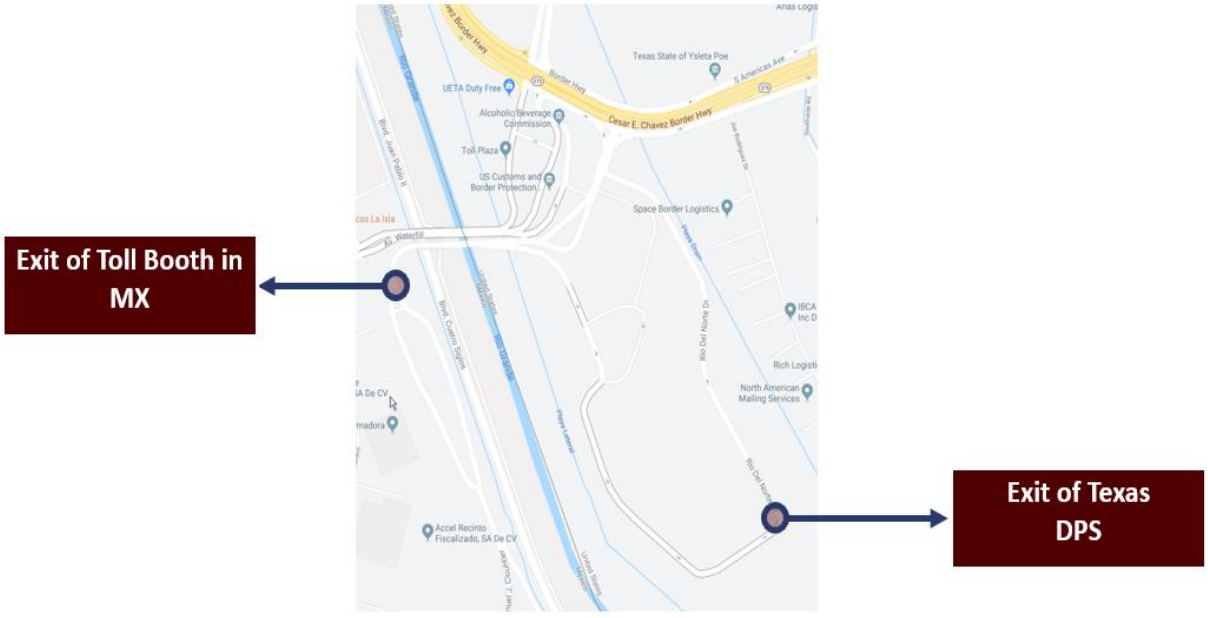

Figure 3: The location of LiDAR sensors at the Ysleta-Zaragoza Bridge

Deployments of Technology

As shown in Figure 4, many ports of entry along the U.S.-Mexico border maintain the vehicle connectivity technology (RFID and Bluetooth) as part of the BCIS. While this BCIS data is helpful, the times reported are dated, as they are reported when vehicles exit the queues, and are sometimes no longer applicable to another vehicle beginning to prepare for its crossing between Texas and Mexico border ports of entry.

CIITR at TTI in El Paso, has sponsored the development and installation of the LiDAR sensors and the development and testing of the AI-based approach at a limited number of border crossing locations in El Paso. Figure 4 also reflects the location of the LiDAR sensors at the Ysleta-Zaragoza bridge and the Bridge of the Americas (BOTA). Since the extent of the deployment of the new technology remains limited, the information produced by the enhanced system is not yet available to the public.

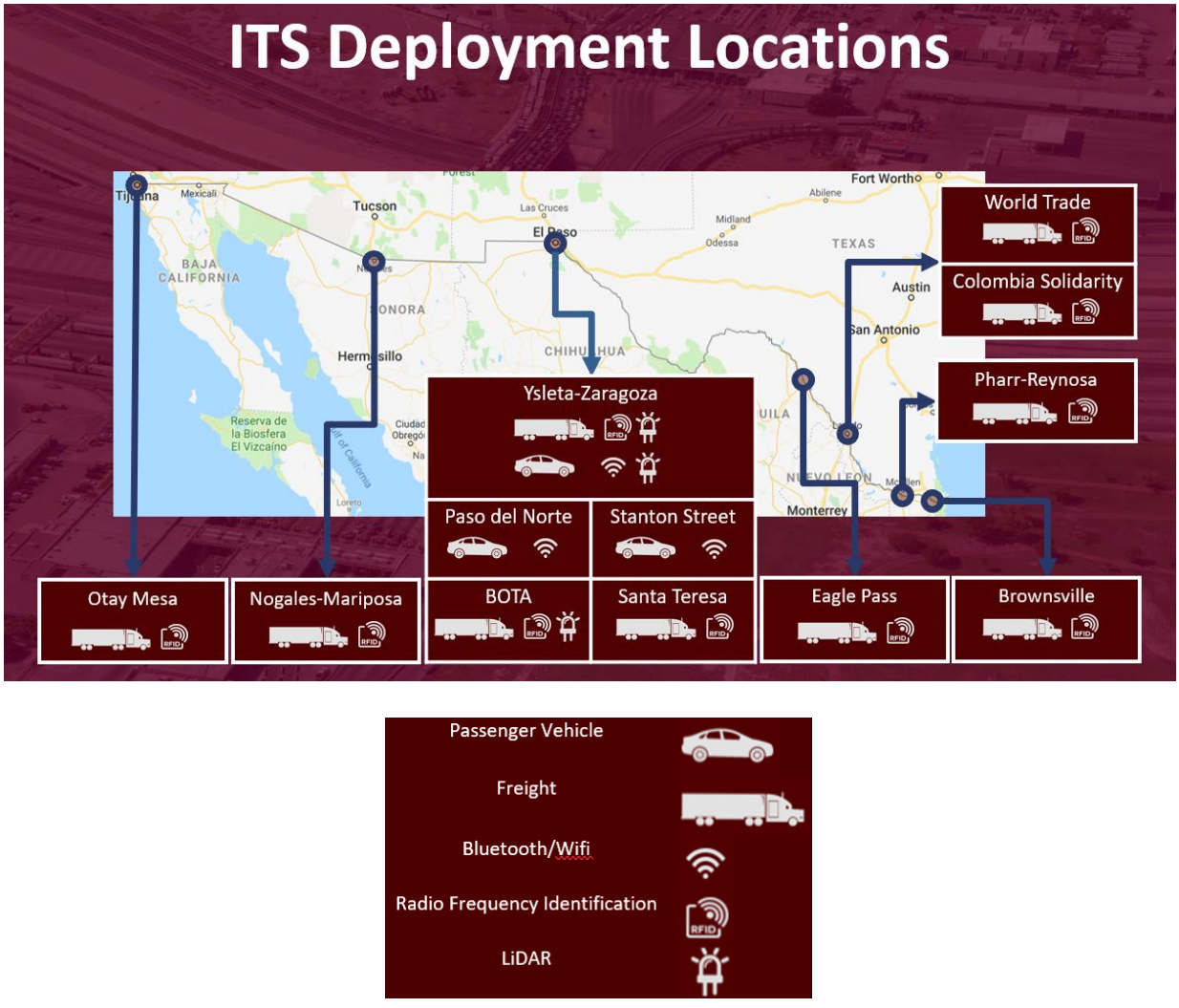

Figure 4: The deployment of RFID, Bluetooth, and LiDAR at ports of entry along the U.S.-Mexico border.

Outcomes and Future Use

While a formal study has not been completed on the impact of the existing TxDOT BCIS border crossing times on routing decisions by freight carriers, agencies and stakeholders regard the available system as a significant improvement over the prior line-of-sight method used by U.S. Customs and Border Protection. Stakeholder feedback has indicated a greater level of trust and usefulness of the crossing times generated by the system.

Enhancing the real-time information capabilities of the BCIS by incorporating the new technology recently developed by TTI will allow individuals, companies, and various stakeholders to more adequately plan routes. Additionally, public agencies will be better able to redirect traffic by placing signage before a vehicle arrives at a queue, shifting traffic to other less congested routes for efficiency.

The accuracy of travel-times is highly beneficial to numerous stakeholders, as this allows logistics companies to better plan routes, redirecting as needed, to ensure timely deliveries. Timeliness and consistency extend benefits down the supply chain, which strengthens the robust trade relationship that bolsters economies of both countries. Public agencies, such as CBP, also stand to benefit from a more efficient crossing process for more balanced distribution of truck volume over various bridges, as this higher level of throughput reduces the burden on limited infrastructure and labor at crossings.