

**Measuring Border Delay and Crossing Times
at the U.S. / Mexico Border**

**Task 2.1 Report
TECHNOLOGY ASSESSMENT**

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Introduction

As part of its Freight Performance Measurement (FPM) initiative, the Federal Highway Administration (FHWA) is conducting various projects designed to quantify crossing and delay times at major U.S. land ports of entry (POE). One of these undertakings involves the implementation of a system that uses an appropriate technology to measure crossing times at the Bridge of the Americas (BOTA) in El Paso, TX.

The overall goal of this project is to implement a system that will enable border crossing times for northbound commercial traffic at BOTA to be more easily and precisely measured. The proposed system will be designed to sustain long term data collection, be easily transferable to other POEs along the northern and southern borders of the U.S., and use a technology that may be applicable to also support the measurement of passenger vehicle crossing times.

Two main objectives have been identified in order to meet the goal of this project. The first involves selecting an appropriate technology for the proposed system, while the second is implementing the system itself. This report is designed to cover task 2.1 of the Phase 2 Project Plan. Task 2.1, "Prepare Technology Assessment," builds directly off of task 1.2, "Prepare Current State Analysis."

This report includes an introduction to the project and an outline of previous efforts coordinated by the project team related to technology assessments presented in the next section. The initial technology assessment identified two technologies that are best suited to support border crossing measurements along the U.S. / Mexico border. Building on the previous analysis, the third section of this report will investigate the risks associated with using these two technologies.

The fourth section of this report will expand on the previous sections by identifying border crossing characteristics at BOTA that could influence the selection of one technology over another. It will highlight the results of a stakeholder meeting conducted by the project team in El Paso. The fifth section of the report includes the project team's overall conclusions and recommendations for the technology that will be implemented, as well as the next steps for this project. The sixth and final section of this report contains a brief concept of operations for the selected technology.

Previous Related Efforts

As stated in the introduction section of this report, the project team has been involved with other initiatives aimed at identifying technologies that could be used in order to calculate crossing times for northbound commercial freight at the U.S. / Mexico border. On a previous (Phase 1) study, the project team analyzed six different technologies for the FHWA Office of Freight Management and Operations. This project, also entitled "Measuring Border Delay and Crossing Times at the U.S. / Mexico Border," provided a

comparative analysis of the six selected technologies in its Phase 1 – Tasks 1 and 2 Report. The full report can be found at <http://tti.tamu.edu/documents/TTI-2007-1.pdf>, while a detailed description of the project as well as all other publications related to this study can be found at http://tti.tamu.edu/about_tti/international/cross_border/mobility.htm. The six technologies examined in the Phase 1 – Tasks 1 and 2 Report were:

- Automatic Vehicle Identification (AVI)
 - AVI using Laser Frequency
 - AVI using Radio Frequency (Radio Frequency Identification – RFID)
 - AVI using Infrared Frequency
- Automatic License Plate Recognition (ALPR)
- Vehicle Matching
- Automatic Vehicle Location (AVL)
 - Global Positioning Systems (GPS)
- Mobile Phone Location
- Inductive Loop Detectors

Factors such as cost, accuracy of readings, availability, and reliability were analyzed for each of the technologies listed above. Table 1 summarizes the results of the initial analysis by listing the advantages and disadvantages of the six technologies below.

Table 1 – Summary of Advantages and Disadvantages of Potential Technologies.

Technology	Advantages	Disadvantages
AVI	Can send and/or receive information. Commonly used in POEs for toll collection. Available readers could be used for expanded purpose. Low operating cost. Broad application in metro areas.	Requires investment for roadside infrastructure (transponders and signal readers). Requires operational agreements between the participating countries. Card readers have to be installed in many locations to be able to have a good estimate of the border crossing travel time.
AVL	Can track vehicle location and speed over the predetermined area with very good accuracy. No need of installing any fixed roadside equipment.	Requires some investment on infrastructure (GPS devices). Privacy issues with the vehicle owner. Obtaining truck tracking data from truckers might be difficult.
Mobile Phone Location	No infrastructure required. Can track vehicle location and speed.	Relies on the size of the cell. Especially affected in rural areas. Not as accurate as other in-site technologies.
ALPR	Good identification rate. No on-board equipment is needed.	Negatively affected by slow-moving or turning vehicles (might not be suitable for border crossings). Could require a high investment for infrastructure, especially for equipment. Readers have to be installed in many locations to be able to have a good estimate of the border crossing travel time.

Vehicle Matching	No on-board equipment is needed	Could require a high investment for infrastructure, especially equipment. Readers must be installed in many locations to be able to obtain a good estimated of the border crossing travel time.
Loop Detectors	Relatively low installation cost on a per detector basis	Detector subject to density of traffic. In order to have a general sense of traffic patterns, a large amount of detectors are needed and therefore a large investment is required. Border crossing scenarios are not suitable for this type of technology.

From the initial analysis, the project team concluded that only three of these six technologies could support a system that would sustain long term data collection, be easily transferable to other POEs along the southern and northern borders of the U.S, and utilize a technology that could allow crossing times for passenger vehicles to be measured. AVI (specifically with RFID), AVL (specifically with GPS), and ALPR all have sufficient merits to be considered for a crossing time measurement system.

After reviewing the initial assessment, the FHWA removed ALPR from the finalist list largely because the concerns of using this technology for this type of system far outweighed the benefits. One of the key drawbacks of using ALPR to measure border crossing times was that ALPR presented a high probability of inaccurate readings. Characteristics at land POEs such as high traffic density, dirt and dust in the air (and on license plates themselves), and differing placement of license plates on trailers all contributed to the high probability of inaccurate readings in a border crossing environment.

Unlike ALPR, the benefits of using both RFID and GPS to measure commercial freight border crossing times outweighed the concerns associated with each technology. Some of the important benefits of these technologies include:

RFID

- U.S. Customs and Border Protection (CBP) is currently using RFID transponders in commercial vehicles that could be used to capture data by this proposed system.
- Data collected for the border wait times can easily be shared with CBP and the Texas Department of Public Safety (DPS).
- DPS is planning to install more RFID readers at the entrance to their safety inspection facility at BOTA.

GPS

- The data collected are very precise
- The information received could be used to measure border wait times and locate exactly where delays are occurring.
- Real time information is provided.

Eventually RFID and GPS were identified as the two technologies that are best suited to support a system that measures commercial freight border crossing times. Building on this initial analysis, both RFID and GPS will be examined further in this report.

Concerns / Risks Associated with GPS and RFID

There are certain operational and procedural risks associated with installing a system using either GPS or RFID technologies to measure commercial freight border crossing times. Before selecting one of these two technologies for the proposed system, the project team identified some of the major potential operational and procedural risks for both RFID and GPS.

Because a system using RFID requires the installation of equipment on or near the roadside, the physical equipment is potentially subject to damage or theft. Also, providing power to the installed equipment may be difficult if there are no sources for power available in the area of the proposed measuring site. Communication between the readers and a central computer (especially for readers installed in Mexico) may also prove to be difficult due to the fact that data transfer between two countries is involved. Finally, the installation of equipment on public property will necessitate agreements to be reached between the project team and local public stakeholders.

Because a GPS-based system requires the installation of GPS transponders in individual trucks, the risks associated with GPS mainly involve the private sector. There are two methods for collecting GPS data from carriers in order to calculate border crossing times. The first involves outfitting each test vehicle with a GPS probe that collects latitude, longitude, and time of day information as each of the trucks make its border crossing trip. This information is stored by the probe until it is extracted by a reader and transmitted to a central computer, where crossing times can be calculated. The second method entails simply gathering GPS data collected by a carrier's own locating/Fleet Management System.

In either case, agreements must be reached between the project team and carriers to solicit their participation. A major risk involved with using a GPS-based system is that there is no guarantee a carrier would uphold these agreements and maintain its participation level in the long-term. Also, private carriers may be hesitant to participate in the project due to issues that may arise from the capability of GPS to monitor the exact location of a truck throughout its day-to-day operations (for the carrier, business sensitivities tied to disclosure of operations; and for the carrier's operators, personal privacy concerns). Finally, when looking at installing probes into individual trucks, keeping track of the physical equipment distributed by the project team may be a difficult task in the long run. If a truck changes its day-to-day operations, is sold, or simply goes out of service and the carrier does not inform the project team, it could lead to the loss of GPS equipment.

The findings of the risks associated with using both RFID and GPS technologies are summarized in Table 2 below.

Table 2 – Potential Risks of RFID and GPS-Based Systems

Technology	Potential Risks
RFID	Susceptibility to damage Equipment / component theft Limited power sources for RFID equipment Complexity of data transfer (especially from Mexican readers) Agreements must be reached between public stakeholders
GPS	Privacy issues (installing tracking devices in each truck) Agreements between private stakeholders must be reached Long term participation from carriers cannot be guaranteed

Additional Local Factors Contributing to Technology Selection

During Task 1 of this Phase 2 initiative, the project team concentrated its efforts on collecting background information on BOTA and conducting a stakeholder meeting to assess the local border crossing characteristics in the El Paso region. A full description of the characteristics of BOTA, as well as a summary of the results from the stakeholder meeting can be found in the Task 1.3 Report (Current State Analysis). While undertaking these efforts, two important factors were ascertained that contributed to the selection of one technology over the other.

While gathering background information in Task 1 of this project, the project team learned of an initiative led by the Texas DPS involving the implementation of an RFID-based system at their Border Safety Inspection Facility (BSIF) at BOTA. DPS recently purchased 15,000 RFID tags that they are already distributing to trucks that cross the U.S. / Mexico border into Texas. These RFID tags will communicate with DPS’s Intelligent Transportation System (ITS) located inside each BSIF. From these readers, DPS will be able to pull up truck safety data instantaneously for any truck with a tag that passes through their system (which also illustrates the logistical context that a RFID system can have). DPS expects this system to be fully operational by the end of 2008, and plans on distributing the tags accordingly.

As stated previously, in order to obtain a better understanding of border crossing operations in the El Paso region, the project team hosted a stakeholder meeting in El Paso on February 20th, 2008. At this meeting, the project team presented the background of this project, the results of its initial technology assessment (recommending RFID and GPS), and an implementation plan for a system that would use RFID in order to measure border crossing times for northbound commercial freight. Discussions were led by the project team in order to gauge the acceptance level of an RFID-based system. The general consensus at the stakeholder meeting was that RFID was the best-suited

technology for a commercial freight border crossing measurement system at BOTA. The full results from the stakeholder meeting as well as an attendance list can be found in the Current State Analysis Report from Task 1 of this Phase 1 project.

Recommendations and Next Steps

After a further analysis of both RFID and GPS, the project team is recommending RFID as the technology best suited to measure commercial freight border crossing times at BOTA. Both GPS and RFID technologies are highly capable of sustaining this proposed system; however, several factors at BOTA have contributed to the project team's recommendation. These factors are:

- Both CBP and DPS are currently using RFID in their facilities at BOTA
- A high percentage of carriers are currently outfitted with RFID tags in order to comply with CBP and DPS initiatives at BOTA and the El Paso-Ciudad Juarez region.
- Because of substantial infrastructure investments by CBP and DPS, the project team estimates RFID will continue to be utilized in the long run at land POEs along the U.S. / Mexico border
- Both DPS and the Texas Department of Transportation (TXDOT) are willing to cooperate with the project team, and CBP has expressed interest in the project
- Local private stakeholders in El Paso favored RFID because of its “non-intrusive” capabilities during the stakeholder meeting

In order to give a better understanding of how a system using RFID might work, the project team has designed a top-level Concept of Operations for the proposed system. This Concept of Operations can be found in the next section of this report. Future reports, such as the final design document and written implementation plan, will build off of this Concept of Operations.

Since the project team has received final approval from the FHWA for the selection of RFID as the technology to be used, the project team will proceed with Task 2, during which a Final Design Document will be prepared. This document will include a design and implementation framework for RFID technology and the results of a formal design review with the FHWA.

RFID Top-Level Concept of Operations

This proposed system will be designed to measure northbound commercial freight border crossing times for all commercial vehicles outfitted with RFID tags. Any commercial vehicles outfitted with the RFID tags will display them on their windshields.

The commercial vehicles (trucks) will pass an RFID tag reader at a point sufficiently ahead of the end of any projected queue on the Mexican side. The trucks will have their RFID tags read as they pass the reader station. The reader station will time-stamp the tag read and forward the resulting data record to a central location for further processing via a data communication link. A similar tag reading station will be installed at the exit of the BSIF on the U.S. side of the border. This station will also time-stamp tag reads and forward the data record to the central facility.

The central facility will receive data from all tag reading stations associated with the project (currently projected as 2 stations, although it is desired that there be additional readers to segment the crossing and thus provide better insight into where delays are occurring). The facility will store all inbound raw data and subsequent processed data in an archive for future access and use by regional transportation agencies.

The raw data will be processed to match tag reads of individual trucks from the entrance point on the Mexican side to the exit point on the U.S. side. The difference in time stamps will yield the single truck's travel time through the port of entry. The tag matching process will be executed periodically to obtain a reasonable sample of trucks to produce an average.

The average delay time could be made a shareable resource with the objective of including the information on a regional transportation map or display. Stakeholders have indicated their desire that the data be as near real-time as feasible, both for business decisions as well as port operations. If additional readers can be installed or otherwise used, the additional data that result will allow more informed decisions to be made. In all events, the team will work with carriers to ensure privacy of data they are willing to share, with respect to business operations or other types of identification.

References

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