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Electronic Toll Collection/Electronic Screening Interoperability Pilot Project

Final Report Synthesis

DTFH61-96-C-00098

IPAS I Task 9834

U.S. Department of Transportation

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16. Abstract: In 1998, ITS America established a Blue Ribbon Panel on electronic commerce to study the convergence of transportation and electronic payment systems. Panel members included senior managers from government, toll agencies, motor carrier industry, and service providers. The panel's goal was to achieve national interoperability of Electronic Toll Collection (ETC), electronic screening (E-screening), and other dedicated short-range communication standards (DSRC) applications. The panel provided a successful forum for discussion, while moving toward a solution to the national interoperability problem.

In March 2001, the I-95 Corridor Coalition approved funding for an ETC/E-Screening Interoperability Pilot Project for regional interoperability between ETC and E-screening. The long-term goal was to provide a model for national interoperability of DSRC applications. The project combined testing a single dual-mode DSRC transponder for both ETC and E-screening, and developing administrative and organizational structures to support interoperability beyond the Pilot Project. The Pilot Project's intent was to coordinate the Northeast's interoperable ETC program, E-ZPass, with the CVISN E-screening deployments planned by Maryland and Connecticut. The Pilot Project was designed as a series of five incremental builds to incrementally establish functionality and address institutional and technical challenges that could potentially impact interoperability.

The Pilot Project evaluation structure is based on standard evaluation practices originally developed by USDOT. The following five evaluation goals were identified: 1) Assess the impact of interoperability on motor carrier mobility; 2) Assess the impact of electronic screening on motor carrier safety; 3) Identify industry and government efficiency gains from ETC/ E-screening; 4) Assess the impact of electronic screening on the environment, in particular, reduction in diesel emissions; and 5) Assess overall customer satisfaction, both government and industry.

The Pilot Project successfully demonstrated the following: 1) Interoperable applications using a single transponder are both technically and institutionally feasible; 2) The CVISN model of electronic screening, where motor carriers are issued a transponder but not given a guarantee that simply having the transponder will result in a weigh station bypass, is both technically and operationally feasible; 3) The results of the mobility and efficiency tests demonstrate that interoperable applications do result in quantifiable benefits to the motor carrier industry; and 4) The application of ITS/CVO technologies and systems produces significant environmental benefits through reduced truck idling and emissions.

The resulting lessons learned include: 1) Flexible Approach to Project Management – One of the key successes of the project has been the flexible approach to project management adopted by the project team; and 2) Need for Process Re-Engineering – The ETC/E-screening project has demonstrated the importance of process re-engineering to support the deployment of new technologies and systems.

The resulting recommendations include: 1) Expand Environmental Impact Assessment to conduct a more comprehensive environmental impact analysis using actual emissions data; 2) Conduct an Expanded Safety Analysis when market penetration has reached the point where statistically valid data can be obtained; 3) Expand Interoperability Applications to promote transponder use in commercial vehicles; 4) Identify Additional Opportunities for Expanding Interoperability to aid in congestion mitigation and management at seaports, airports, and intermodal facilities.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

In an effort to demonstrate interoperability between electronic toll collection (ETC) and electronic screening (E-screening), the I-95 Corridor Coalition, in conjunction with the U.S. Department of Transportation (USDOT) and ITS America (ITSA) funded a Pilot Project that would link these applications using a single DSRC transponder. The resulting I-95 Electronic Toll Collection/Electronic Screening Interoperability Pilot Project was designed to build upon the work of the ITS America's E-Commerce Blue Ribbon Panel. Current e-commerce BRP efforts are directed toward establishing the framework and business case for national interoperability of ETC systems for commercial vehicles. Since regional ETC interoperability already exists through the E-ZPass program, this project is focused on linking regional E-screening programs to E-ZPass. The **Electronic Toll Collection/Electronic Screening Interoperability Pilot Project Final Evaluation Report Synthesis** document presents the results of the evaluation sponsored by the Joint Program Office of the US DOT.

To support these efforts, a companion document, the **Attachment 1: Appendices Electronic Toll Collection/Electronic Screening Interoperability Pilot Project Supplement to the Final Report** is being submitted concurrently under separate cover. The Attachment 1 document contains the following seven separate documents used as an attachment to support the ETC/E-Screening Interoperability Pilot Project report published in January 2005. In effect, the documents are being presented as a series of seven unique appendices and are identified as follows:

- Section 1: Evaluation Methodology
- Section 2: ETC/E-Screening Facility Descriptions
- Section 3: Test Results and Findings
- Section 4: Total Truck Counts by Facility
- Section 5: Safety Documents Summary
- Section 6: Motor Carrier Survey
- Section 7: Literature Review – Environmental Assessment

The Abbreviations list compiled for the Attachment 1 document contains abbreviations that are relevant to the seven unique appendices.

ABBREVIATIONS

AAA	The Automobile Club (formerly known as Triple A)
AAMVA	American Association of Motor Vehicles Administration
AAR	American Association of Railroads
AASHTO	American Association of State and Highway Transportation Officials
ABA	American Bus Association
ACS	Affiliated Computer Services, Inc.
ATRI	American Transportation Research Institute
AVC	Automated Vehicle Classification
AVI	Automated Vehicle identification
BRP	Blue Ribbon Panel
CAAA	1990 Clean Air Act Amendments
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CMEM	Comprehensive Modal Emissions Model
CMV	Commercial Motor Vehicle
CO	Carbon Monoxide
Coalition	I-95 Corridor Coalition
CT	Connecticut
CTA	Connecticut Trucking Association
CT DMV	Connecticut Department of Motor Vehicles
CV	Commercial Vehicle
CVIEW	Commercial Vehicle Information Exchange Window
CVISN	Commercial Vehicle Information Systems and Networks
D.C. / District	District of Columbia
DOTs	Departments of Transportation
DSRC	Dedicated Short-Range Communication Standards
e-commerce	Electronic Commerce
EDI	Electronic Data Interchange
EDL	Electronic Documents Library
EIZ	Emission Influence Zone
EPA	Environmental Protection Agency
E-screening	Electronic Screening
ETC	Electronic Toll Collection
ETTM	Electronic Toll Collection and Traffic Management
FMCSA	Federal Motor Carrier Safety Administration

FHWA	Federal Highway Administration
HDDV	Heavy-Duty Diesel Vehicles
HDGV	Heavy-Duty Gasoline Vehicles
I-	Interstate
IAG	Inter-Agency Group
ID	Identifier / Identification Number
IFTA	International Fuel Tax Agreement
IRP	International Registration Plan
ISS	Inspection Selection System
ISTEA	Intermodal Surface Transportation Efficiency Act
IT	Information Technology
ITDS	International Trade Data System
ITS	Intelligent Transportation Systems
ITSA	ITS America – Intelligent Transportation Society of America
JPO	Joint Program Office
LED	Light-emitting diodes
MD	Maryland
MDOT	Maryland Department of Transportation
MdTA	Maryland Transportation Authority
MMTA	Maryland Motor Truck Association
MPOs	Metropolitan Planning Organizations
MSP	Maryland State Police
NAAQS	National Ambient Air Quality Standards
NCAP	National Customs Automation Program
NJ	New Jersey
NJMTA	New Jersey Motor Truck Association
NJTA	New Jersey Turnpike Authority
NORPASS	North American Preclearance and Safety System
NOX	Nitrogen Oxides
NY	New York
NYSMTA	New York State Motor Truck Association
NYSTA	New York State Thruway Authority
RF	Radio Frequency
ROC	Roadside Operations Computer
SAFER	Safety and Fitness Electronic Records
SIPs	State Implementation Plans
SOW	Statement of Work

SPD	Speed Profile Discretization technique
TEA-21	Transportation Equity Act for the 21st Century
TIPs	Transportation Improvement Programs
USDOT	U.S. Department of Transportation
USTRANSCOM	United States Transportation Command
VES	Video Enforcement System
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Carbons
WIM	Weigh-in-Motion
XML	Extensible Mark-up Language

EXECUTIVE SUMMARY

Project Overview

In 1998, ITS America (ITSA) established a Blue Ribbon Panel (BRP) on electronic commerce (e-commerce) to study the convergence of transportation and electronic payment systems.[1] Panel members included senior managers from government, toll agencies, motor carrier industry, and service providers. The panel's goal was to achieve national interoperability of Electronic Toll Collection (ETC), electronic screening (E-screening), and other dedicated short-range communication standards (DSRC) applications. The panel was successful in providing a forum for this diverse group to discuss issues and ideas, while moving toward a solution to the national interoperability problem.[2]

In March 2001, the I-95 Corridor Coalition approved funding for an ETC/E-Screening Interoperability Pilot Project. The primary goal of the Pilot Project was to establish regional interoperability between ETC and E-screening, with the long-term goal of providing a model for national interoperability of DSRC applications. The project combined testing a single dual-mode DSRC transponder (the Mark IV Fusion Transponder) for both ETC and E-screening, and developing administrative and organizational structures that would support interoperability beyond the Pilot Project. The intent of the Pilot Project was to coordinate the Northeast's interoperable ETC program, E-ZPass, with the Commercial Vehicle Information Systems and Networks (CVISN) E-screening deployments planned by Maryland and Connecticut.

The Pilot Project was designed as a series of incremental builds designed to incrementally establish functionality and address institutional and technical challenges that could potentially impact interoperability:

- **Build 1: Pilot ETC/E-Screening Interoperability –** In collaboration with the I-95 Corridor Coalition, the State of Maryland implemented a limited scale interoperability proof-of-concept project between ETC and E-screening applications at the Perryville Weigh Station on southbound I-95 by distributing 50 Mark IV Fusion transponders to Maryland-based interstate vehicles.
- **Build 2: Operational ETC/E-Screening Interoperability –** The initial project plan was for approximately 10,000 of New York State Thruway Authority's (NYSTA's) 250,000 E-ZPass commercial vehicles to be recruited to further test ETC/E-screening interoperability. Build 2 also was to the State of Connecticut's planned deployment of E-screening through the CVISN Pilot Project to test interoperability of E-screening between Maryland and Connecticut.
- **Build 3: Enroll "Foreign" Transponders** – This build was designed for implementation in conjunction with Build 2. The objective was to expand the program along the I-95 Corridor to allow non-Inter-Agency Group (IAG) government agencies to issue the Mark IV Fusion transponders for enrollment in E-ZPass and to participate in E-screening as well. An additional 10,000 transponders were to be issued by Maryland under Build 3.

[1] Accessed from ITS America online newsletter published May 19, 2005: http://www.itsa.org/ITSNEWS.NSF/0/9fa7d2b984e1bd1a852567760049af0b?OpenDocument.
[2] CVO Committee Meeting Minutes, San Antonio, Texas, March 2 – 3, 2000. Accessed from: http://www.itsa.org/committe.nsf/0/91ec1f28b28ceba2852568cc0051d8ec?OpenDocument.

- **Build 4: Motor Carrier Service Bureau** – This build anticipated the establishment of Private Motor Carrier Service Bureaus to perform transponder administration functions for carriers simultaneously participating in E-ZPass and E-screening programs.
- **Build 5: Multi-Application Interoperability** – This build anticipated North American multi-application interoperability to enable program expansion throughout North America.

To encourage motor carrier participation in Builds 2 and 3, the proposed plan offered Mark IV Fusion transponders at the same cost as the E-ZPass flat pack transponders, approximately $22 per transponder, through a project-funded subsidy of approximately $16 per transponder.

A Project Team, comprised of various stakeholder representatives from Connecticut, Maryland, and New York, provided oversight to various aspects of the project. After 2 years of implementation experience, in 2003, the Project Team conducted an assessment of Builds 2 and 3 to determine if changes in the national interoperability environment as well as institutional and technical challenges encountered during the course of the project warranted any change in project scope.

The most significant market change that occurred was the new policy established by the participating toll agencies to allow third parties to establish “super accounts” and take on transponder administrator functions. Under these “super accounts”, third parties established “master” accounts with a toll agency to enable procurements of a large number of transponders. The third parties were then able to market these transponders to the motor carrier industry, and handle all associated administrative functions such as billing and payments. In addition, third party providers were also entitled to receive any available volume discount offered by a state.

Both the Maryland Motor Truck Association (MMTA) and NYSTA established “super accounts” to market transponders to their members. The NYSTA also established a program known as “Best Pass”. The “Best Pass” program is designed to match a motor carrier with the combination of ETC and E-screening programs that best meets the particular carrier’s needs. The New York State Motor Truck Association (NYSMTA) reviews a carrier’s International Registration Plan (IRP) records to determine which programs best match where a carrier runs on a regular basis and then selects the appropriate programs that best match the carrier’s area of operations.

A second significant change in the market involved an agreement between the PrePass Program and the NYSTA to allow interoperability between PrePass-enrolled motor carriers and E-ZPass. The program, known as PrePass Plus,[3] enabled motor carriers to use transponders obtained for the PrePass electronic pre-clearance program for E-ZPass. Affiliated Computer Services, Inc. (ACS), the vendor for E-ZPass, is also the venture capitalist supporting the HELP, Inc., public-private partnership that supports PrePass. This cooperative working relationship enabled ACS to modify the PrePass and E-ZPass systems so that each system would be able to identify a Commercial Motor Vehicle (CMV) transponder in the other ACS program, thus providing in-program interoperability.

As a result of these changes in the market structure, the Project Team determined that several mid-course adjustments in project scope were warranted:

[3] *PrePass Update* online newsletter published July 2002, accessed from: http://www.prepass.com/monthly_updates/jul2002.htm.

- Widespread distribution of transponders with a subsidy provided by the project, as initially planned under Build 2, was not required as a component of the interoperability Pilot Project. Since the project was first initiated, the Mark IV Fusion transponder has become readily available on the market. The Project Team determined that the issue of converting to the Fusion transponder would be a business decision on the part of motor carriers and that the proposed subsidy of the cost difference between the two tags was no longer needed as part of the Pilot Project.
- Build 3 would best promote the project's objectives by making the enrollment process easier for motor carriers and sharing enrollment information with other jurisdictions as designated by the motor carrier. The scope of Build 3 was redefined to be two concurrent efforts:
  - Make improvements to and expand Maryland's motor carrier Web portal to make the screening enrollment process easier for motor carriers by accepting and sharing enrollment information with other jurisdictions.
  - Conduct a feasibility study to determine if it would be practical to interface ETC and E-screening systems. If this did prove feasible, the second part of this effort was to move forward in developing and deploying the interfaces.

The NYSTA also made a business decision to withdraw from transponder distribution activities after the 2,000 units procured were distributed and to rely on market forces, in particular, the super accounts, to encourage industry participation in the program.

Project Deployment

The initial project activities included installing electronic screening infrastructure at the Maryland Transportation Authority's (MdTA's) I-95 southbound weigh station located at Perryville, Maryland, and expanding the E-ZPass system to include motor carriers at all MdTA toll facilities. This expansion, including the facility located on I-95 northbound opposite the weigh station. Johns Hopkins University's Applied Physics Laboratory was selected to oversee the electronic screening system installation, which included:

- Installing a mainline Weigh-in-Motion (WIM) station on I-95 approximately one-half mile before the weigh station. The WIM system selected was the Piezzo Strip system.
- Installing electronic readers at the WIM location and at the weigh station to enable the identification of trucks approaching the weigh station and the verification that a driver had responded appropriately to a "green light/red light" signal as the truck in question passed by the weigh station.
- Developing electronic screening software by the Johns Hopkins University Applied Physics Laboratory.
- Programming and installing two computers at the Perryville Weigh Station – the roadside Operations Computer (ROC) that controlled the electronic screening system components and that operated the E-screening software.

The MdTA authorized its E-ZPass vendor ACS to both enroll motor carriers in the E-ZPass program and to install E-ZPass readers and cameras (used to identify violators who do not pay tolls either through the E-ZPass program or manually) at the "truck only" lanes at the I-95 northbound Perryville, Maryland toll plaza. While this activity was not done as part of the Pilot Project, the equipment deployment and the E-ZPass implementation for commercial motor vehicles did support project objectives.

At the time the project was implemented, MdTA policy stated that all trucks are required to pass through truck-only lanes at the toll plaza, which separates passenger and commercial vehicle traffic. In addition, in 2004 signage was installed along southbound I-95 advising motor carriers of the E-screening capability at the Perryville Weigh Station. Concurrent with the Maryland installations, the State of Connecticut began installing E-screening equipment at the Union Weigh Station located along the Massachusetts – Connecticut border on I-84.

While the physical infrastructure necessary to support ETC and electronic screening was being installed, the project agencies established the following procedures to enable motor carriers to enroll in both the ETC and E-screening programs:

- Motor carriers enrolling in ETC programs in New York and Maryland were offered the option of obtaining either an E-ZPass flat pack transponder or a Mark IV Fusion transponder capable of interoperability between the ETC and E-screening programs. The Mark IV Fusion transponders offered for the dual-mode application contained two separate unique identifiers built in by the manufacturer – one each for the ETC and E-screening applications.
- Motor carriers interested in the Maryland Electronic Screening Program submitted their E-screening enrollment information through the MDOT Motor Carrier Web Portal.[4] Connecticut joined the North American Preclearance and Safety System (NORPASS) electronic screening program and will use NORPASS to enroll motor carriers for E-screening.

The key to the success of the interoperability Pilot Project is the manufacturer's installation of two unique identifier numbers. The AVI readers currently used for ETC and E-screening are not compatible – the readers used for each system are unique for that system. Both systems, however, are able to read the Mark IV Fusion transponder; thus, assigning two unique identifier numbers to a motor carrier for use on a single transponder enables the interoperability between the two systems.

The Coalition developed a brochure describing the Pilot Project, which was distributed by MdTA and NYSTA to all commercial vehicle E-ZPass accounts. In addition, the MMTA, the NYSTA, and the Connecticut Trucking Association (CTA) provided information about the Pilot Project to all their members.

The initial deployment of transponders is still ongoing. A total of 12,000 transponders were initially procured: 2,000 by NYSTA and 10,000 by MDOT, respectively.

Implementation Experience

To date, implementation results have been mixed. One success is the resulting development of the Maryland Motor Carrier Portal, a Web-based portal enabling motor carriers to submit an application to join the Maryland Electronic Screening Program electronically.[5] Motor carriers have successfully used this portal to enroll in the program.

The Maryland Electronic Screening Program tested in the Pilot Project incorporated two significant elements. First, the Maryland Electronic Screening Program did not require that a motor carrier be pre-qualified in order to enroll in the program. Any motor carrier submitting an

[4]Maryland Motor Carrier Portal, accessed from: http://170.93.140.16/mdot/mmcp/escreening/index.html.
[5]Ibid.

application, providing that the motor carrier was a legitimate operation meeting State requirements, was eligible to enroll in the program. If the motor carrier had an outstanding issue or issues that would result in the carrier not meeting the E-screening bypass criteria, the State, to the extent feasible, advised the motor carrier of this so that the motor carrier could address the problem in question. However, motor carriers were not required to meet specific criteria in order to receive a transponder, participate in the program, and be eligible for a weigh station bypass, provided the motor carrier satisfied the bypass criteria.

The Maryland Electronic Screening Program was the first in the United States to test the CVISN concept of E-screening, which is electronic screening on a real-time basis. As snapshot information on motor carriers participating in the Maryland Electronic Screening Program was updated, it was downloaded to the ROC at the Perryville facility using the Maryland Commercial Vehicle Information Exchange Window (CVIEW). Snapshot information was obtained from Safety and Fitness Electronic Records (SAFER) system and from Maryland legacy systems utilizing interfaces developed as part of Maryland's CVISN program. Bypass/no bypass messages were issued to motor carriers based on snapshot information. Though the weigh station personnel maintained the option to signal drivers for a pull-in, the bypass decision was usually based on the most recent information available contained in the snapshot.

The second key element of the Maryland Electronic Screening Program was in establishing an interoperability working relationship with NORPASS[6] partners to work together to deploy mainline screening systems at weigh stations. This partnership allows safe and legal trucks to proceed unimpeded while enforcement resources are focused on high-risk motor carriers.

Through the interoperability working relationship, Maryland and NORPASS exchange data files containing motor carrier enrollment information, transponder identifiers, and other relevant information on each program's members. Members are then able to participate in both programs and receive E-screening benefits. No fee is required to register in either program.

Motor carriers participating in the Maryland program were also able to enroll in the ACS PrePass program and use the Mark IV Fusion transponder obtained from the Maryland program. The Maryland program, however, did not read PrePass transponders or issue bypass/no-bypass messages to motor carriers only enrolled in PrePass but not in Maryland and/or NORPASS. In addition, carriers enrolled in PrePass are not able to use PrePass transponders for other programs and must enroll in those programs separately.

As of June 2004, a total of 281 companies had enrolled in the Maryland Electronic Screening Program and a total of 2,181 transponders had been distributed.

As of December 2004, the NYSMTA Super Account had enrolled 360 companies in New York with a total of 30,000 transponders distributed (Mark IV Fusion and standard E-ZPass flat packs). Similar numbers for Pennsylvania and Maryland were 150 companies/10,000 transponders and 110 companies/2,500 transponders, respectively.

[6] NORPASS members include Connecticut, Georgia, Idaho, Washington, Oregon, Alaska, North Carolina, and the Canadian province of British Columbia.

Evaluation Methodology

The ETC/E-Screening Interoperability Pilot Project evaluation structure is based on standard evaluation practices originally developed by USDOT. The following five evaluation goals were identified:

1. Assess the impact of interoperability on motor carrier mobility.
2. Assess the impact of electronic screening on motor carrier safety.
3. Identify industry and government efficiency gains from ETC/E-screening.
4. Assess the impact of electronic screening on the environment, in particular, reduction in diesel emissions.
5. Assess overall customer satisfaction, both government and industry.

For each evaluation goal, hypotheses were formulated to identify anticipated impacts to the system. One or more measures of effectiveness (MOEs) are associated with each hypothesis to assess the accuracy of the hypothesis. Required data and data sources are identified for each MOE. The goals, hypotheses, MOEs, and data sources identified for each study for the evaluation of the ETC/E-Screening Interoperability Pilot Project are summarized in Table ES-1.

Table ES-1. Evaluation Goals, Hypotheses, and MOEs

Goal	Hypothesis	MOE	Data Sources or Requirements
Improve mobility at weigh stations and toll collection facilities.	ETC and E-screening will improve the mobility of transponder-equipped commercial vehicles at weigh stations and toll collection facilities.	Travel time through facilities. Travel time variability through facilities. Number of commercial vehicles passing through weigh stations per day.	Field measurement of travel times and travel time variability through facilities. Field counts of commercial vehicles. Weigh station records.
Improve safety.	Carriers with transponders will maintain compliance with safety standards. Enforcement personnel will be better able to identify non-compliant or unsafe carriers. Crash rates involving commercial vehicles will be reduced at both weigh stations and toll facilities. Station closings due to ramp backups onto the mainline when station is operating at capacity based on traffic volume will be reduced.	Number of compliant carriers with transponder inspected per day. Out-of-service rates for transponder-equipped and non-transponder-equipped vehicles. Crash rates. Number of times stations must close per day due to ramp backups when stations are operating at capacity based on traffic volume, and duration of closures.	Enforcement records/ out-of-service reports. Weigh station records.
Improve efficiency of motor carrier operations for	Data sharing will improve inter-agency coordination, thereby improving efficiency of motor carrier operations.	Costs associated with reduced fuel consumption and travel time. Costs associated with	Calculations of yearly fuel and travel time savings for industry. Enforcement agency

Goal	Hypothesis	MOE	Data Sources or Requirements
government and industry.	Enforcement agencies will establish standardized criteria for bypass, inspection selection, and other enforcement activities to improve identification of non-compliant carriers.	enforcement activities (number of enforcement officials, hours of operation). Number of inspections on one trip. Agency procedures and policies.	records. Agency documents on enforcement policies and procedures.
Reduce fuel consumption and emissions at toll facilities.	With reduced delays and idle time, fuel consumption and emissions will be reduced.	Vehicle delays. Fuel consumption. Estimated emissions reductions.	Field measurements of delays. Industry records on fuel consumption. Estimation of emissions reductions using typical idle rates.
Improve customer satisfaction.	The use of one transponder for both ETC and E-screening will help promote industry acceptance and use. Drivers will perceive a time savings association with use of the technology. Enforcement officials will benefit from the carriers' use of the technology.	Industry acceptance/ endorsement of technology. Incentives offered by state agencies to encourage use of transponders. Drivers' perceived time savings. Enforcement officials' assessment of technology and perception of benefits.	Surveys/interviews/Focus groups with motor carriers, drivers, and enforcement officials.

Detailed test plans were developed for each of the evaluation components proposed for the evaluation of the ETC/E-Screening Interoperability Pilot Project.[7] Each test plan defined the objective, approach, and work steps for each evaluation component, as summarized below:

- **Mobility Test Plan.** Investigate mobility improvements in terms of travel time through facilities and the volume of trucks processed per day at the weigh stations.
- **Safety Test Plan.** Document the improvements in safety enforcement and carrier compliance with safety standards.
- **Operational Efficiency Test Plan.** Examine the impacts of interagency coordination on motor carrier operational efficiency.
- **Environmental Test Plan.** Examine the environmental impacts from reduced waiting times at toll and weigh station facilities.
- **Customer Satisfaction Test Plan.** Investigate the level of improved customer satisfaction resulting from more convenient payment of tolls and screening process improvements.
- **Institutional and Technical Challenges/Lesson Learned Test Plan.** Identify the lessons learned from both institutional and technical challenges.

[7]ETC/E-Screening Interoperability Pilot Project: Detailed Test Plans, July 2002.

Data collection for the evaluation included two components: quantitative data on CMV travel times at toll facilities and weigh stations, and qualitative data on project impressions and experiences from the state transportation and enforcement personnel, motor carriers, and drivers involved with the project. Table ES-2 presents a summary of field data collection activities.

Table ES-2. Data Collection Sites and Dates for Travel Times and Truck Counts

State	Location	Facility	Collection Dates
NY	Albany: I-90 at Exits 23 & 24	Toll	October 16 – 17, 2002
	NYC: I-95 George Washington Bridge	Toll	Archived data from Port Authority of NY-NJ for 2002 through 2003 inclusive; also from January – August 2004
	NYC: I-87/I-287 Tappan Zee Bridge	Toll	December 14, 2004
MD	Perryville: I-95 near Exit 93	Toll	October 23 – 24, 2002
	Perryville: I-95 near Exit 93	Weigh Station	October 22 – 23, 2002
	Hyattstown: I-270 near Exit 22	Weigh Station	December 2 – 3, 2002
	West Friendship: I-70 near Exit 80	Weigh Station	December 9 – 10, 2002
	New Market: I-70 near Exit 62	Weigh Station	January 21 – 22, 2003
CT	Union: I-84 near Exit 73	Weigh Station	May 19, 2003
	Greenwich: I-95 near Exit 2	Weigh Station	May 21, 2003

Before project qualitative data was collected through industry focus groups conducted in New York and Maryland. A total of four focus groups were conducted, with separate focus groups in each state for drivers and motor carrier company representatives. The results of the focus groups were used to develop industry survey instruments for after project qualitative data collection.

A before project focus group was conducted with enforcement personnel in Maryland, and a before project survey was conducted with Connecticut enforcement personnel. An after project focus group was conducted with the Maryland Transportation Authority Police (MTA). No other after project data was collected from the enforcement community due to the fact that no other weigh stations outside of the Maryland Transportation Authority (MdTA) Perryville facility had deployed E-screening capabilities.

Evaluation Findings

Following are the summary findings resulting from this Pilot Project:

- **Finding #1: The Pilot Project successfully demonstrated that interoperable applications using a single transponder are both technically and institutionally feasible.** Motor carriers have been able to use the Mark IV Fusion transponder for both ETC in New York and Maryland and E-screening in Maryland. In addition, the working relationship established between the Maryland Electronic Screening Program and NORPASS has enabled motor carriers to successfully participate in two separate E-screening programs.
- **Finding #2: The Pilot Project successfully demonstrated that the CVISN model of electronic screening, where motor carriers are issued a transponder but not given a guarantee that simply having the transponder will result in a weigh station bypass, is both technically and operationally feasible.** The Maryland Electronic Screening Program does not pre-screen carriers to determine bypass eligibility, and instead relies on information contained in a motor carrier snapshot downloaded to the electronic screening computer at Perryville. Bypass determinations are made based on the information contained in these snapshots, and these determinations are made on a real-time basis using this data. Both motor carriers and the MdTA enforcement personnel stationed at Perryville confirmed that trucks were being issued electronic bypass messages (green lights) during E-screening operational periods.
- **Finding #3: The results of the mobility and efficiency tests demonstrate that interoperable applications do result in quantifiable benefits to the motor carrier industry.** These results also demonstrate that the greater the number of interoperable applications incorporated into a single transponder, the greater the benefit to industry and the greater the potential incentives for industry to obtain transponders and participate in these programs. The estimated benefits realized by industry through participation in ETC and E-screening, when combined through interoperability, double in value.
- **Finding #4: The application of ITS/CVO technologies and systems produces significant environmental benefits through reduced truck idling and emissions.** The environmental benefits obtained through the deployment of ITS in general, and ITS/CVO in particular, increase the potential sources of funding that a state is eligible to use and also expands the stakeholder community beyond Departments of Transportation (DOTs) and enforcement agencies. This is particularly true for states with significant non-attainment areas – an ITS/CVO deployment that also produces an environmental benefit will be of interest to Metropolitan Planning Organizations (MPOs) and state environmental agencies, and may enable a state to use sources of funding such as from the Congestion Mitigation and Air Quality (CMAQ) Improvement Program.

Lessons Learned

Following are the summary lessons learned:

- **Lesson Learned #1: Flexible Approach to Project Management.** Without question, one of the key successes of the project has been the flexible approach to project management adopted by the project team. This approach supported the mid-term project review that resulted in the re-scoping of the project to eliminate the transponder subsidy for the motor carrier industry and to reallocate funds to support the development of on-line program enrollment capabilities. This flexible approach also enabled the project team to leverage the policy changes that enabled the creation of super accounts, thus enabling the creation of Best Pass, PrePass Plus, and the extensive outreach efforts by MMTA and NYSMTA to promote their super accounts.

- **Lesson Learned #2: Need for Process Re-Engineering.** The ETC/E-screening project has demonstrated the importance of process re-engineering to support the deployment of new technologies and systems. With respect to E-screening, the process re-engineering issues include:
  - Integrating that the new system into existing agency planning, budget, and Information Technology (IT) support processes.
  - Ensuring that the new system is integrated into agency business processes and is not deployed as a stand-alone system.
  - Use established State IT methodologies and project management to support system development. This will also help ensure that the system is integrated with existing systems.
  - Include a human factors assessment that integrates the new system into the daily work processes of staff that will be using the system.

Recommendations

Following are the recommendations suggested for further study:

- **Recommendation #1: Expand the Environmental Impact Assessment.** It is recommended that consideration be given to conducting a more comprehensive environmental impact analysis using actual emissions data. If implemented, this test would be conducted by outfitting commercial vehicles (CV) with equipment that measures actual emissions, and then having these CV pass by weigh stations and toll plazas. The test would measure the difference in emissions from a bypass at a weigh station as compared to entering a weigh station and passing through a sorter ramp or the static scale. The test for ETC would be done in a similar manner by capturing the emissions difference from using ETC as compared to stopping at a plaza and paying cash.
- **Recommendation #2: Conduct Expanded Safety Analysis.** As discussed in the text of the report, the data needed to conduct the Safety Test was not available during the period of performance for the evaluation. It is further recommended that consideration be given to conducting the Safety Test when the degree of market penetration transponders being used for E-screening applications has reached the point where statistically valid data can be obtained. As an alternative, consideration may be given to obtaining data from an existing program to conduct the test.
- **Recommendation #3: Expand Interoperability Applications.** The results of the Efficiency Test indicate that the best way to promote the use of transponders in commercial vehicles is to expand interoperable applications. The economies of scale generated by interoperability offer a strong potential value added service to motor carriers, and it is this added value that will attract industry.
- **Recommendation #4: Identify Additional Opportunities for Expanding Interoperability.** It is recommended that consideration be given to identifying additional opportunities for expanding interoperability. The Eastern Seaboard is home to some of the more congested regions of the country. As freight movement increases, it is vital to identify additional opportunities for using transponders to assist with congestion mitigation and management at seaports, airports, and intermodal facilities. Increased transponder usage, in addition to applications such as ETC and E-screening, offers one option available to the I-95 Corridor Coalition member states to expand interoperability within the region.

1.0 INTRODUCTION

In 1998, ITS America (ITSA) established a Blue Ribbon Panel (BRP) on electronic commerce (e-commerce) to study the convergence of transportation and electronic payment systems.[8] Members of the panel included senior managers from government, toll agencies, motor carrier industry, and service providers. The goal of this panel was to achieve national interoperability of Electronic Toll Collection (ETC), electronic screening (E-screening), and other dedicated short-range communication standards (DSRC) applications. The panel was successful in providing a forum for this diverse group to discuss issues and ideas, while moving toward a solution to the national interoperability problem.[9]

In an effort to develop interoperability between ETC and E-screening, the I-95 Corridor Coalition (Coalition), in conjunction with the U.S. Department of Transportation (USDOT) and ITSA in March 2001 funded a Pilot Project that would link these applications using a single DSRC transponder. The I-95 Electronic Toll Collection/Electronic Screening Interoperability Pilot Project was designed to build upon the work of the ITSA E-Commerce BRP. Current e-commerce BRP efforts are directed toward establishing the framework and business case for national interoperability of ETC systems for commercial vehicles. Since regional ETC interoperability already exists through the E-ZPass program, this project is focused on linking regional E-screening programs to E-ZPass.

To assist in this project, a Project Team was comprised of various stakeholder representatives from Connecticut, Maryland, and New York, to oversee various aspects as needed.

Many I-95 Corridor Coalition agencies have already deployed ETC through the E-ZPass program. Maryland, Connecticut, and Virginia are currently deploying, and other member states have plans to deploy E-screening using a different DSRC transponder. Interoperability between these applications would reduce costs and increase marketability of these programs. The Fusion transponder, a dual-protocol device manufactured by Mark IV Industries, is capable of supporting both ETC Inter-Agency Group (IAG) and E-screening (ASTM v6) functions.

Although E-screening is already being used by a number of states and has been in operation for over 10 years, the program has not obtained a high degree of market penetration among motor carriers. According to the U.S. Census Bureau, in 2002, there were approximately 4.7 million power units greater than 10,000 lbs gross vehicle weight operating in the United States, which represents the total approximate available market for transponders.[10] Currently, there are approximately 340,000 commercial vehicles enrolled in E-screening programs throughout the United States. Thus, even after a decade of operation, the E-screening market penetration is only about 7percent of the total potential population.

Establishing interoperability between ETC and E-screening offers a major opportunity to increase the number of motor carriers using transponders for both applications. Although motor

[8] ITS America online newsletter published May 19, 2005. Accessed from: http://www.itsa.org/ITSNEWS.NSF/0/9fa7d2b984e1bd1a852567760049af0b?OpenDocument
[9] CVO Committee Meeting Minutes, San Antonio, Texas, March 2 – 3, 2000. Accessed from: http://www.itsa.org/committe.nsf/0/91ec1f28b28ceba2852568cc0051d8ec?OpenDocument
[10] U.S. Census Bureau Website, 2002 Vehicle Inventory and Use Survey (VIUS) data releases accessed from: http://www.census.gov/svsd/www/02vehinv.html.

carriers desire a single dedicated short-range communications (DSRC) transponder with multiple applications, interoperability of transponder applications has not yet been achieved.

Under the direction and partial funding of the United States Department of Transportation's (USDOT) Joint Program Office (JPO), Intelligent Transportation System (ITS) evaluations are being conducted on a national basis to accelerate the integration and interoperability of ITS in selected metropolitan and rural areas. The purpose of these evaluations is to:

- Document the institutional and technical challenges encountered.
- Determine how these challenges were resolved.
- Identify, and as feasible, quantify associated costs and benefits.
- Assess the extent to which project goals and objectives were in fact attained.

It is important to emphasize that any and all results from these evaluations are beneficial, and that the evaluations do not represent a "grading" of how well a project did or did not succeed. Rather, the intent is to provide an objective assessment of ITS deployments and document what did or did not work so that other agencies and jurisdictions can use this information to help ensure success in future deployments.

The ETC/E-Screening Interoperability Pilot Project is highly representative of the type of project that is of interest to the ITS community: a project involving multiple agencies and states cooperating on a multi-state deployment; integration of ITS technologies and systems; and the testing of interoperability.

Based on an expression of interest from the State of Maryland, with support from the Federal Highway Administration (FHWA) and the Federal Motor Carrier Safety Administration (FMCSA), an evaluation of the Pilot Project was approved in 2002.[11] This synthesis document presents the Evaluation Team's findings in response to both the original Statement of Work (SOW) and the July 2004 modification.

This Final Report Synthesis is supplemented by the *Attachment I: Appendices Electronic Toll Collection/ Electronic Screening Interoperability Pilot Project Supplement to the Final Report*, under separate cover. The Attachment I Appendices document contains the detailed methodologies, test approaches, and findings from the Pilot Project. The remainder of this Final Report Synthesis document is organized as follows:

- **Section 2.0 Pilot Project Summary:** This section presents an overview of the ETC/ E-Screening Interoperability Pilot Project.
- **Section 3.0 Evaluation Overview:** This section provides a summary overview of the strategy developed for the evaluation.
- **Section 4.0 Evaluation Methodology:** This section provides a summary of the methodologies utilized to complete the evaluation.
- **Section 5.0 Evaluation Findings:** This section discusses the findings from each evaluation test component.
- **Section 6.0 Evaluation Findings:** This section provides evaluation findings.

[11] ETC/E-Screening Interoperability Pilot Project Final Evaluation Plan, SAIC, for the USDOT, April 25, 2002. ITS-JPO Electronic Documents Library (EDL) reference: http://www.itsdocs.fhwa.dot.gov/.

- **Section 7.0 Recommendations for Future Research:** This section presents a discussion of future research topics for consideration by FHWA, FMCSA, and the I-95 Corridor Coalition.

1.1 BACKGROUND

1.1.1 The I-95 Corridor

As shown in Figure 1-1, Interstate-95[12] (I-95) connects the entire Eastern Seaboard of the United States. The I-95 corridor includes some 16 states and the District of Columbia with a combined population of about 103 million people – approximately 37percent of the total U.S. population.[13] One of the most urbanized regions in the United States, this corridor includes such areas as Miami to Fort Lauderdale, Washington, D.C. to Baltimore, New York City, and Boston.

Figure 1-1. I-95 Corridor States.[14]

All available statistics show that the corridor is one of the more heavily traveled corridors in the United States and that congestion is a major issue for corridor states. According to FHWA highway statistics for between 1998 and 2004, a total of 1,064,335 million commercial motor vehicle miles were traveled in the United States.[15] During the same time period, the commercial motor vehicle miles traveled in the Coalition states totaled 309,427million – 29 percent of total commercial motor vehicle miles traveled.

[12] 2002 VIUS data releases accessed from: http://www.census.gov/svsd/www/02vehinv.html.
[13] U.S. Census Bureau Website accessed from: http://quickfacts.census.gov/qfd/states/12000.html.
[14] I-95 Corridor map accessed from: http://www.infoplease.com/atlas/unitedstates.html.
[15] USDOT/FHWA, Highway Statistics (annual series), Tables VM-1 and PS-1.

Congestion costs in the corridor are also among the highest in the country, with six of the 16 most congested urban areas located in the corridor.[16] The corridor is also home to six urban regions that rank among the top 15 urban regions nationally for annual person hours for traffic delay per capita.[17] The corridor is also a major corridor for freight movement. Corridor states are home to 14 of the United States' top 50 water ports, ranked by total tons of cargo.[18]

A presentation by the I-95 Corridor Coalition at the ITS America CVFM Forum's 2004 meeting in Oakland, California, documented expected trends in vehicle miles traveled and freight movement in the I-95 Corridor over the next 20 years. Freight movement is expected to increase by 60 percent by 2020 to approximately 25 billion tons. During the same time period, commercial motor vehicle (CMV) vehicle miles traveled (VMT) are expected to double to approximately 400 million.

The current levels of congestion, coupled with the project increases in CMV VMT and freight, indicate the importance of identifying ITS/CVO solutions that will enable I-95 Corridor states to ensure that future mobility is not adversely compromised.

1.1.2 The I-95 Corridor Coalition

The Coalition began in the early 1990s as an informal group of transportation professionals working together to reduce the operational and institutional barriers to coordinated incident management.[19] Limits on the region's capacity to expand transportation infrastructure made the region an excellent candidate for Intelligent Transportation Systems (ITS). However, the geographical boundaries of 16 states (from Maine to Florida) and the District of Columbia (District) made implementation of ITS difficult without a coordinating body.

Realizing the need to move forward in the region with seamless systems operation and service delivery, the USDOT named the region a Priority Corridor in 1991 in the Intermodal Surface Transportation Efficiency Act (ISTEA). Federal funds were provided to support the Coalition's activities through ISTEA and again in 1996 through the Transportation Equity Act for the 21st Century (TEA-21). This led to the mandate for a partnership of agencies throughout the region to move toward the ideal of having a seamless transportation system. As a result, the Coalition was established in 1993 as a virtual organization to enhance mobility, safety, and efficiency across all modes and transportation facilities that serve the region.

The Coalition's initial membership included the Departments of Transportation (DOTs) from member States and the District. The Coalition has since expanded to include agencies involved with regional passenger and freight movement analyses, long-distance trip planning on public transportation modes, port access, and international border crossing security.

Member agencies now include State and Local DOTs; Transportation Authorities; Transit and Rail Agencies; Port Authorities; Motor Vehicle Agencies; and State Police/Law Enforcement. In addition, the USDOT, and industry and trade associations, such as the American Association of Motor Vehicle Administrators (AAMVA), AMTRAK, American Bus Association (ABA), American

[16] Bureau of Transportation Statistics Web page, accessed from: http://www.bts.gov/publications/national_transportation_statistics/2003/html/table_01_66.html.
[17] Bureau of Transportation Statistics Web page, accessed from: http://www.bts.gov/publications/national_transportation_statistics/2003/html/table_01_63.html.
[18] Ibid.
[19] Information on the I-95 Corridor Coalition was obtained from the Coalition's Website: http://www.i95coalition.com/index.html.

Association of Railroads (AAR); state trucking associations; the American Transportation Research Institute (ATRI); and groups such as ITS America, AAA (Automobile Club), and United States Transportation Command (USTRANSCOM) are also represented in the membership.

The original Coalition member states included Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, and Virginia, and the District of Columbia. In recent years, DOTs representing New York City; the States of North Carolina, South Carolina, Georgia, and Florida; and the Canadian provinces of New Brunswick and Quebec also have joined the Coalition.

During the 1990s, the focus of the Coalition's program evolved from studying and testing ITS technologies to a broader perspective that embraced integrated deployments and coordinated operations. The Coalition's perspective evolved from a concentration on highways to one that encompasses all modes of travel and focuses on the efficient transfer of people and goods between modes. A key part of the Coalition's focus is aimed at facilitating regional incident management in areas such as preplanning, coordination, and communication among transportation and public safety agencies within the corridor. Today, the Coalition emphasizes information management as the underpinning of seamless operations across jurisdictions and modes.

1.2 PROGRAM COMPONENTS

1.2.1 What is CVISN?

In TEA-21, Congress established a goal to complete Commercial Vehicle Information Systems and Networks (CVISN) deployment in a majority of states by September 30, 2003. Through the CVISN Deployment Program, Federal and State government agencies work together with the motor carrier industry to develop and deploy cost- effective information systems and communication networks. These information systems and communications networks provide electronic access to timely and accurate motor carrier safety history and rating, credentials, and other information. CVISN is not a new information system, but rather a collection of information systems and communication networks that together provide a framework for states, the Federal Government, and private stakeholders to electronically collect, process, and exchange motor carrier safety information and commercial vehicle and eventually driver data. To date, over 40 states have completed CVISN top-level designs and project plans.

The CVISN Architecture establishes standards and a technical framework for the deployment and integration of CVISN systems and technologies. The Architecture is based on open standards and interoperability within and between state and Federal legacy systems. Through CVISN, states will deploy new capabilities in three areas:

- Safety Information Exchange – the exchange of safety data to and from roadside enforcement operations and legacy systems, and between legacy systems.
- Credentials Administration – the electronic application, processing and issuance of CMV credentials.
- Electronic Screening – the real-time screening of CMV at weigh and inspection stations using technology.

1.2.2 What is Electronic Screening?

E-screening is the application of technology to the CMV screening process that takes place at weigh and inspection stations. With E-screening, a computer automatically makes an informed decision about whether or not further examination of a CMV is required. Properly implemented, E-screening has the potential to result in improved weigh station traffic flow; CMV inspections that better target non-compliant and potentially unsafe CMV; increased compliance; and ultimately achieves the goals of increased safety and reduced operating costs. [20]

In E-screening system applications:

- States use both electronic data interchange (EDI) and extensible mark-up language (XML) to transmit safety and credentials data (snapshot) to a Roadside Operations Computer (ROC) used in the screening decision.
- Automated Vehicle Identification (AVI) uses DSRC to identify vehicles in motion on the mainline (or on ramps).
- A CMV is equipped with an in-cab transponder mounted on the inside of the windshield. A unique identifier is built into the transponder mounted by the transponder manufacturer. As the CMV approaches a weigh station, the unique identifier information is read by the AVI, which uses this identifier to query a database containing vehicle status information (snapshot) contained in a computer operating an E-screening software system.
- WIM, a scale built into the mainline roadway or on a weigh station sorter ramp, weighs vehicles on the mainline (or on ramps). Over-dimensional detectors may also be used to detect vehicles that exceed legal height and/or width limits.
- Electronic communications transmit information to an electronic screening computer, where a preprogrammed algorithm analyzes roadside weight (and height) and snapshot data to determine if a vehicle should be allowed to bypass a weigh station or requested to enter the weigh station for further processing. An electronic signal is transmitted to the CMV to activate a green light if the vehicle will be permitted to bypass, or a red light, to indicate that the CMV will be required to enter the weigh station.
- The in-cab transponder contains three light-emitting diode (LED) lights. The notification is signaled to this in-cab transponder and is received as a “green light” indicating bypass or a “red-light” indicating pull-in. The in-vehicle transponder is used as a two-way communications device to signal a driver with the pull-in decision using DSRC standards.

Figure 1-2 shows one example of a weigh station equipped with electronic screening infrastructure and the electronic screening process flow. [21]

[20] Commercial Vehicle Information Systems and Networks (CVISN) – Electronic Screening Functional Specification and Conceptual Design, I-70 Westbound West Friendship, Maryland, POR-01-7327 V1.0, The Johns Hopkins University Applied Physics Laboratory, July 2001.

[21] Graphic representation of a weigh station configuration with electronic screening. Source: http://cvisn.fmcsa.dot.gov/Documents/Document_Nav_Frame_Page_documents.shtml.

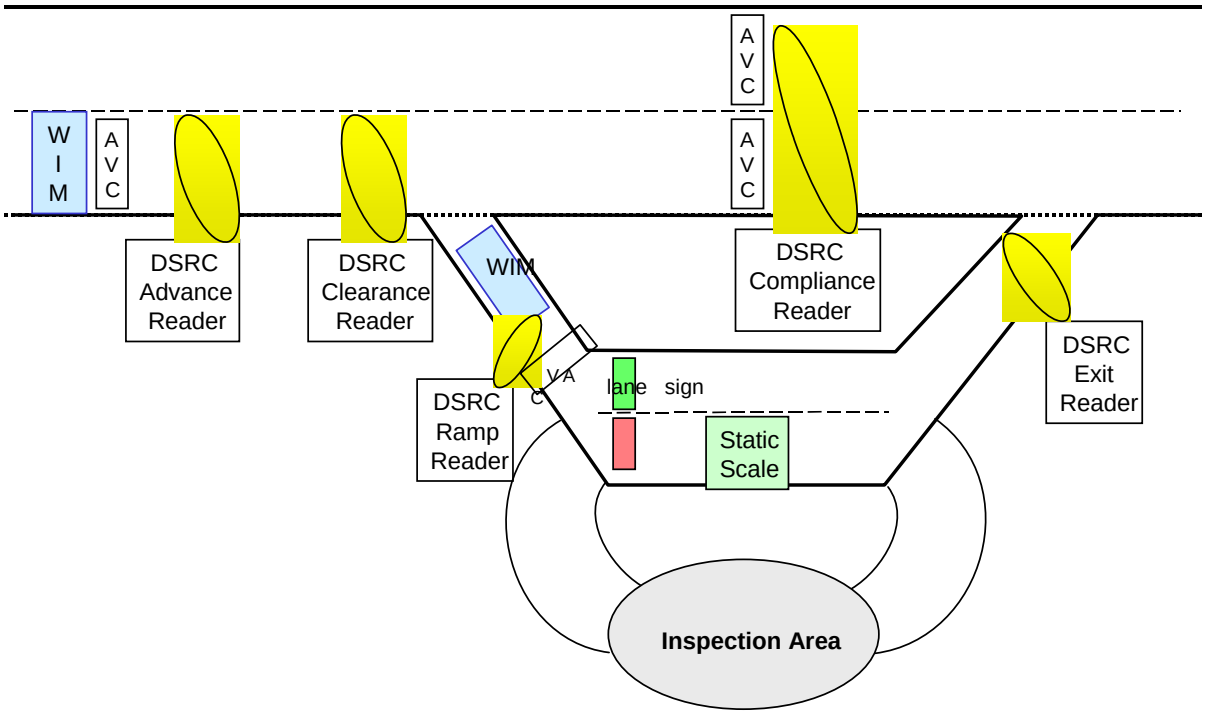

Figure 1-2. Example of Weigh Station Configuration with Electronic Screening.

A CMV equipped with an in-cab mounted transponder approaches a weigh station. Signs located prior to the weigh station direct the CMV into the right lane of the road.

The CMV passes over a mainline WIM and, in some instances, passes an automated vehicle classification (AVC) system that collects height and/or width data. A DSRC Advance Reader reads the transponder identification (ID) number and transmits this data to a computer located in the weigh station.

The computer compares the transponder ID number, and also verifies size and weight information. If the transponder ID number matches a carrier that meets bypass criteria, and size and weight data is within legal tolerances, a bypass message is sent to the CMV via a DSRC Clearance Reader. Weigh station personnel have the option of randomly selecting a certain number of CMV that is eligible for bypass to pull into the weigh station for random checks.

An AVC checks for CMV bypassing the weigh station, and a DSRC Compliance Reader checks if the CMV has a transponder. If a transponder is detected, a message is sent to the ROC. If a CMV does not receive a bypass message, and instead, receives a “red light” that signals the driver to enter the weigh station, the CMV enters the weigh station and passes over a second WIM that is more accurate than the mainline WIM. A DSRC Ramp Reader will check the transponder ID number again, and the electronic check process through the electronic screening computer is repeated.

Overhead signals instruct the CMV driver to either pass over the static scale or return to the highway. When a CMV returns to the highway from the static scale, the message directing the CMV is displayed on the ROC.

1.2.3 What is Electronic Toll Collection?

ETC is the use of various technologies which, when combined, automate the manual in-lane toll collection process so that customers do not have to stop and pay cash at toll booths. For ETC to be effective, reliable, and achieve maximum throughput and customer satisfaction, three major in-lane/roadway components are required:

- **Automatic Vehicle Identification** (AVI) – AVI uses a DSRC device located in the vehicle to uniquely identify the account to the toll equipment.
- **Automatic Vehicle Classification** (AVC) – AVC relies on vehicle classification information contained in a transponder mounted inside the vehicle and the use of various sensors in and around the toll plaza. The sensors verify a match between the transponder data and the vehicle configuration so that the proper toll can be charged.
- **Video Enforcement System** (VES) – VES captures images of the license plates of vehicles that use the facility without a valid transponder so that the owners can be identified and notified that a toll payment is due.[22]

Interoperability for ETC has been established in the Northeast through the IAG and the E-ZPass system. Currently, E-ZPass or E-ZPass interoperable systems are used by the following states that are members both of the I-95 Corridor Coalition and the IAG: Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, and Pennsylvania.

As previously described, each transponder contains a unique identifier built in by the transponder manufacturer. ETC programs permit account holders to move transponders between CMVs, as the unique transponder identifier still enables an ETC program to link the CMV with the appropriate account. This is a significant difference from E-screening programs, which do not permit transponders to be moved between CMVs for E-screening. The unique transponder identifier is used to link a particular CMV to its safety history, and moving transponders between CMVs results in a situation where a CMV would be linked to the wrong safety history.

Following are some of the many benefits associated with ETC:

- Facility throughput can be increased by more than three times without the need to build additional infrastructure.
- The number of staff dedicated to the toll collection process can often be reduced, resulting in lower operating costs.
- Fewer passenger and commercial vehicles idling at toll plazas reduces harmful emissions and fuel consumption.
- ETC improves customer service and satisfaction by allowing customers to quickly pass through toll plazas. Passenger vehicle customers have the flexibility and option of pre-paying their tolls with cash, check, or even credit cards.
- In most states commercial vehicle customers prepay accounts (New York is one state that does not require prepayment of accounts; instead, New York has implemented a post payment based on actual number of transactions). In addition, CMVs receive a toll discount only by using ETC.

[22] Electronic Toll Collection and Traffic Management (ETTM), accessed April 1, 2002: www.ettm.com.

Overall, commercial vehicle drivers will see increased efficiencies as the improvement in less congestion and swifter movement of commercial goods throughout the region, which can enhance the economy and help advance business and industry growth.

2.0 PILOT PROJECT SUMMARY

2.1 PROJECT OVERVIEW

In March 2001, the I-95 Corridor Coalition approved funding for an ETC/E-Screening Interoperability Pilot Project. The primary goal of the Pilot Project was to establish regional interoperability between ETC and E-screening, with the long-term goal of providing a model for national interoperability of DSRC applications. The project combined testing a single dual-mode DSRC transponder (the Mark IV Fusion Transponder) for both ETC and E-screening, and developing administrative and organizational structures that would support interoperability beyond the Pilot Project. The intent of the Pilot Project was to coordinate the Northeast's interoperable ETC program, E-ZPass, with the CVISN E-screening deployments planned by Maryland and Connecticut.

The joint lead agencies for the ETC/E-Screening Interoperability Pilot Project included the Maryland Department of Transportation (MDOT), the New York State Thruway Authority (NYSTA), the New Jersey Turnpike Authority (NJTA), and the Connecticut Department of Motor Vehicles (CT DMV). Within MDOT, the Maryland Transportation Authority (MdTA) provided operational support, with the Office of the Secretary providing initial program management and coordination support.

The FHWA, FMSCA, IAG, and ITSA all provided additional support to the Pilot Project. Maryland Motor Truck Association (MMTA), New York State Motor Truck Association (NYSMTA), and other motor carrier associations also assisted in this project. The NJTA and New Jersey Motor Truck Association (NJMTA) subsequently withdrew from the Pilot Project due to other pressing obligations.

The Pilot Project was designed as a series of incremental builds designed to incrementally establish functionality and address institutional and technical challenges that could potentially impact interoperability. One major objective of the Pilot Project was to address the lack of motor carrier participation, in particular, the lack of multiple, interoperable applications using a single transponder. Additional objectives focused on responding to the concern toll agencies had expressed about multiple transponder applications impacting reliable ETC operations.

2.1.1 Project Builds

Initially, the following five builds were developed for the project:

- **Build 1: Pilot ETC/E-Screening Interoperability –** In collaboration with the I-95 Corridor Coalition, the State of Maryland implemented a limited scale interoperability proof-of-concept project between ETC and E-screening applications at the Perryville Weigh Station on southbound I-95. The State procured 50 Mark IV Fusion transponders, which were assigned to Maryland-based interstate vehicles. The project plan was for these vehicles to be jointly enrolled in Maryland's E-Screening and the E-ZPass ETC Programs and prove the first use of a single dual-mode transponder.
- **Build 2: Operational ETC/E-Screening Interoperability –** Currently, the NYSTA has approximately 250,000 E-ZPass transponders being used by commercial vehicles for ETC. Through Build 2, approximately 10,000 of these E-ZPass commercial vehicles were recruited to further test ETC/E-screening interoperability. The initial project plan projected to

be procured during the course of Build 2, but this did not happen. Build 2 also included the State of Connecticut's planned deployment of E-screening through the CVISN Pilot Project to test interoperability of E-screening between Maryland and Connecticut. The Build 2 objectives included:

  - Demonstrate regional interoperability of ETC and E-screening using the Fusion transponder, and by doing so, act as a model for national ETC/E-screening interoperability.
  - Establish participation in a regional E-screening program, and create a base of transponder-equipped vehicles for further E-screening deployments.
  - Avoid the proliferation of transponders with single program applications that are not compatible with readers used in other programs that may potentially disrupt operations through radio frequency (RF) interference.
  - Deploy the capability to issue and administer additional Fusion transponders enrolled in both programs, and demonstrate the enhanced marketability of E-screening as an interoperable program with ETC.
- **Build 3: Enroll "Foreign" Transponders –** This build was designed for implementation in conjunction with Build 2. The objective was to expand the program along the I-95 Corridor to allow non-IAG government agencies to issue the Mark IV Fusion transponders for enrollment in E-ZPass and to participate in E-screening as well. An additional 10,000 transponders were to be issued by Maryland under Build 3.
- **Build 4: Motor Carrier Service Bureau –** This build anticipated the establishment of Private Motor Carrier Service Bureaus to perform transponder administration functions (e.g., accounting, charges to carriers and reconciliation with toll authorities) for carriers simultaneously participating in E-ZPass and E-screening programs.
- **Build 5: Multi-Application Interoperability –** This build anticipated North American multi-application interoperability to enable program expansion throughout North America.

To encourage motor carrier participation in Builds 2 and 3, the proposed plan offered Mark IV Fusion transponders at the same cost as the E-ZPass flat pack transponders, approximately $22 per transponder, through a project-funded subsidy of approximately $16 per transponder.

After 2 years of implementation experience, in 2003, the Project Team conducted an assessment of Builds 2 and 3 to determine if changes in the national interoperability environment, as well as institutional and technical challenges encountered during the course of the project, warranted any change in project scope.

The most significant market change that occurred was the new policy established by the participating toll agencies to allow third parties to establish "super accounts" and take on transponder administrator functions. Under these "super accounts", third parties established "master" accounts with a toll agency to enable procurements of a large number of transponders. The third parties were then able to market these transponders to the motor carrier industry, and handle all associated administrative functions such as billing and payments. In addition, third party providers were also entitled to receive any available volume discount offered by a state.

Both the MMTA and NYSTA established "super accounts" to market transponders to their members. The NYSTA also established a program known as "Best Pass". The "Best Pass" program is designed to match a motor carrier with the combination of ETC and E-screening programs that best meets the particular carrier's needs. NYSMTA reviews a carrier's International Registration Plan (IRP) records to determine which programs best match where a

carrier runs on a regular basis and then selects the appropriate programs that best match the carrier's area of operations.

"Best Pass" is currently available in the following ETC and E-screening programs and states as depicted inTable 2-1[23] The figure shows the states that are currently participating in each program.

Table 2-1. The "Best Pass" Program Matches Motor Carriers to ETC and E-Screening Programs and States

PrePass	NORPASS	EZ-PASS
Alabama	Connecticut	Delaware
Arizona	Delaware	Illinois
Arkansas	Georgia	Maine
California	Idaho	Maryland
Colorado	Kentucky	Massachusetts
Florida	Maryland	New Jersey
Illinois	Minnesota	New York
Indiana	New York	Pennsylvania
Iowa	North Carolina	Virginia
Kansas	South Dakota	West Virginia
Louisiana	Oregon	
Mississippi	Utah	
Missouri	Virginia	
Montana	Washington	
Nebraska	British Columbia, Canada	
Nevada		
New Mexico		
Ohio		
Oklahoma		
Tennessee		
Virginia		
West Virginia		
Wisconsin		
Wyoming		

[23]Information was derived from the NYSMTA "Best Pass" marketing brochure.

A second significant change in the market involved an agreement between the PrePass Program and the NYSTA to allow interoperability between PrePass-enrolled motor carriers and E-ZPass. The program, known as PrePass Plus,[24] enabled motor carriers to use transponders obtained for the PrePass electronic pre-clearance program for E-ZPass. Affiliated Computer Services, Inc. (ACS), the vendor for E-ZPass, is also the venture capitalist supporting the HELP, Inc., public-private partnership that supports PrePass. This cooperative working relationship enabled ACS to modify the PrePass and E-ZPass systems so that each system would be able to identify a CMV transponder the other ACS program, thus providing in-program interoperability.

As a result of these changes in the structure of the market, the Project Team determined that several mid-course adjustments in project scope were warranted:

- Widespread distribution of transponders with a subsidy provided by the project, as initially planned under Build 2, was not required as a component of the interoperability Pilot Project. Since the project was first initiated, the Mark IV Fusion transponder has become readily available on the market. The Project Team determined that the issue of converting to the Fusion transponder would be a business decision on the part of motor carriers. In addition, the Project Team also concluded that the cost differential between the E-ZPass flat pack transponder and the Fusion transponder was no longer an issue with respect to promoting interoperability, and that motor carriers would choose to enroll in ETC and E-screening systems if the enrollment process was available and not complicated. As mentioned previously, the Project Team concluded that the proposed subsidy of the cost difference between the two tags was no longer needed as part of the Pilot Project.
- Build 3 would best promote the project's objectives by making the enrollment process easier for motor carriers and sharing enrollment information with other jurisdictions as designated by the motor carrier. The scope of Build 3 was redefined to be two concurrent efforts:
  - Make improvements to and expand Maryland's motor carrier Web portal to make the screening enrollment process easier for motor carriers by accepting and sharing enrollment information with other jurisdictions. This joint acceptance and information sharing promotes more efficient screening enrollment possible in the multiple jurisdictions designated by the motor carrier. As part of this effort, the new and expanded service would be promoted through marketing efforts targeting multiple jurisdictions throughout the I-95 corridor.
  - Conduct a feasibility study to determine if it would be practical to interface ETC and E-screening systems. If this did prove feasible, the second part of this effort was to move forward in developing and deploying the interfaces.

The NYSTA also made a business decision to withdraw from transponder distribution activities after the 2,000 units procured were distribute and to rely on market forces, in particular the super accounts, to encourage industry participation in the program.

2.1.2 Project Deployment

The initial project activities included installing electronic screening infrastructure at the MdTA's I-95 southbound weigh station located at Perryville, Maryland, and expanding the E-ZPass system to include motor carriers at all MdTA toll facilities including the facility located on I-95

[24] *PrePass Update* online newsletter, published July 2002. Accessed from: http://www.prepass.com/monthly_updates/jul2002.htm.

northbound opposite the weigh station. Johns Hopkins University's Applied Physics Laboratory was selected to oversee the electronic screening system installation, which included:

- Installing a mainline WIM on I-95 approximately one-half mile before the weigh station. The WIM system selected was the Piezzo Strip system.
- Installing electronic readers at the WIM location and at the weigh station to enable the identification of trucks approaching the weigh station and the verification that a driver had responded appropriately to a "green light/red light" signal as the truck in question passed by the weigh station.
- Developing electronic screening software by the Johns Hopkins University Applied Physics Laboratory.
- Programming and installing two computers at the Perryville Weigh Station – the ROC that controlled the electronic screening system components and that operated the E-screening software.

The MdTA authorized its E-ZPass vendor ACS to both enroll motor carriers in the E-ZPass program and to install E-ZPass readers and cameras (used to identify violators who do not pay tolls either through the E-ZPass program or manually) at the "truck only" lanes at the I-95 northbound Perryville, Maryland toll plaza. While this activity was not done as part of the Pilot Project, the equipment deployment and the E-ZPass implementation for CMV did support project objectives.

At the time the project was implemented, MdTA policy stated that all trucks are required to pass through truck-only lanes at the toll plaza, which separates passenger and commercial vehicle traffic. In addition, in 2004 signage was installed along southbound I-95 advising motor carriers of the E-screening capability at the Perryville Weigh Station. Concurrent with the Maryland installations, the State of Connecticut began installing E-screening equipment at the Union Weigh Station located along the Massachusetts – Connecticut border on I-84.

While the physical infrastructure necessary to support ETC and electronic screening was being installed, the project agencies established the following procedures to enable motor carriers to enroll in both the ETC and E-screening programs:

- Motor carriers enrolling in ETC programs in New York and Maryland were offered the option of obtaining either an E-ZPass flat pack transponder or a Mark IV Fusion transponder capable of interoperability between the ETC and E-screening programs. The Mark IV Fusion transponders offered for the dual-mode application contained two separate unique identifiers built in by the manufacturer – one each for the ETC and E-screening applications.
- Motor carriers interested in the E-Screening Program then had to go through a separate enrollment process. Motor carriers contacted MDOT. Motor carriers then submit their E-screening enrollment information through the MDOT Motor Carrier Web Portal.[25] Connecticut joined the North American Preclearance and Safety System (NORPASS) electronic screening program. NORPASS is a partnership of State agencies and trucking industry representatives who are committed to promoting safe and efficient trucking throughout North America. Connecticut utilizes NORPASS to enroll motor carriers for E-screening. Once the electronic application is received, MDOT personnel enter this information into the E-screening system. This latter function is performed manually, although

[25]Maryland Motor Carrier Portal, accessed from: http://170.93.140.16/mdot/mmcp/escreening/index.html.

a component of the revised Build 3 was to develop an interface between the Web portal enrollment and the E-screening software to fully automate all enrollment activities.

The key to the success of the interoperability Pilot Project is the manufacturer installation of these two unique identifiers. The AVI readers currently used for ETC and E-screening are not compatible – the readers used for each system are unique for that system. Both systems, however, are able to read the Mark IV Fusion transponder; thus, assigning two unique identifier numbers to a motor carrier for use on a single transponder enables the interoperability between the two systems.

The Coalition developed a brochure describing the Pilot Project, which was distributed by MdTA and NYSTA to all commercial vehicle E-ZPass accounts. In addition, the MMTA, the NYSTA, and the Connecticut Trucking Association (CTA) provided information about the Pilot Project to all their members.

The initial deployment of transponders is still ongoing. A total of 12,000 transponders were initially procured: 2,000 by NYSTA and 10,000 by MDOT, respectively.

2.1.3 Implementation Experience

To date, implementation results have been mixed. One success is the resulting development of the Maryland Motor Carrier Portal, a Web-based portal enabling motor carriers to submit an application to join the Maryland Electronic Screening Program electronically.[26] Motor carriers have successfully used this portal to enroll in the program.

A copy of the Motor Carrier Portal E-Screening Enrollment instruction page is shown in Figure 2-1.[27] Figure 2-2 shows the actual E-Screening Application form, which includes information motor carriers are required to provide, such as the business name and address, USDOT number, transponder number and type, and vehicle information.[28] Once this information is received, MDOT updates the E-screening system to include these carriers. The data input needed for the system update is currently performed manually, but an interface that will connect the electronic application directly with the Maryland Commercial Vehicle Information Exchange Window (CVIEW) system and enable real-time processing is under development.

[26]Maryland Motor Carrier Portal, accessed from: http://170.93.140.16/mdot/mmcp/escreening/index.html.

[27]Ibid.

[28]Ibid.

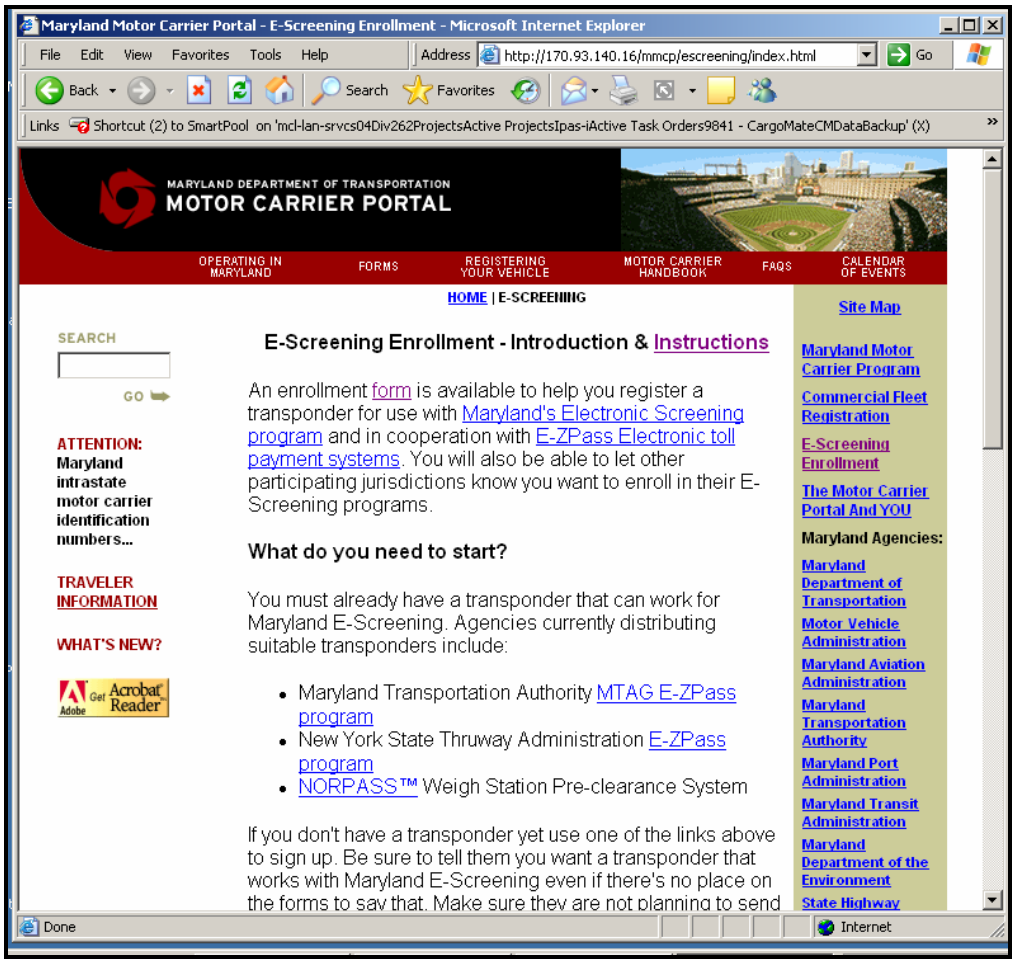

Figure 2-1. Maryland Motor Carrier Portal.

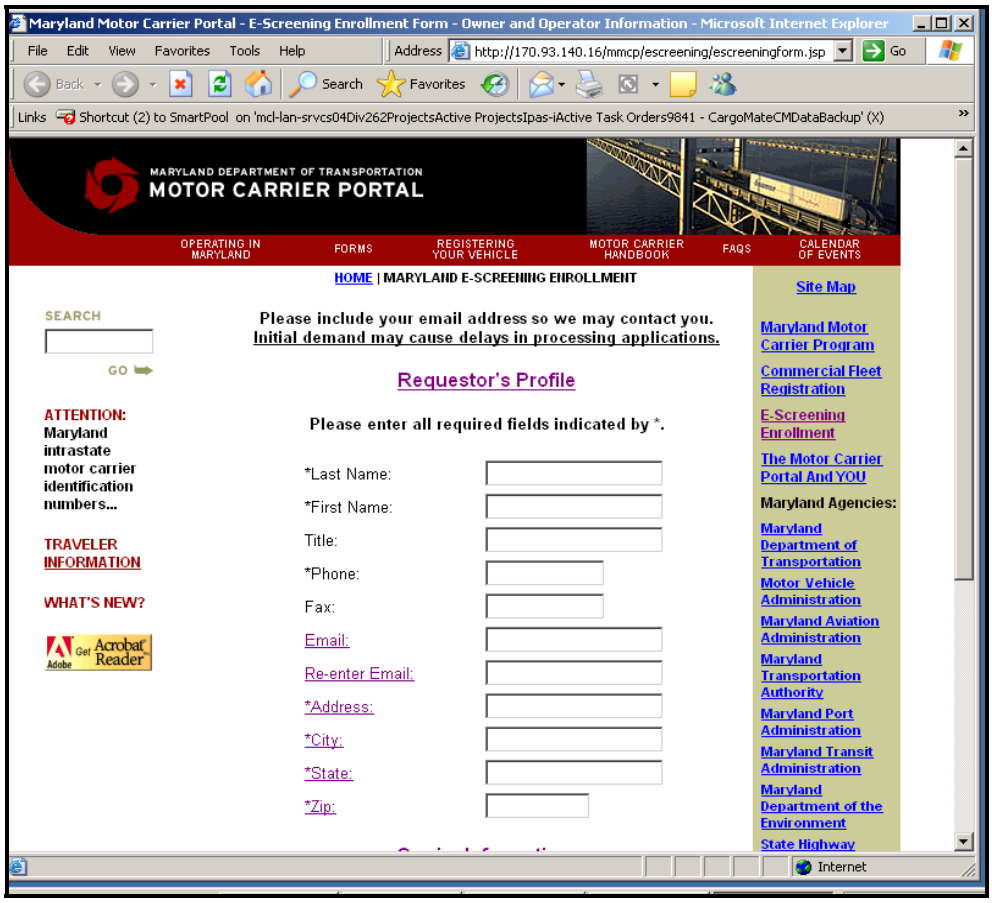

Figure 2-2. Maryland E-Screening Application Form.

The E-screening program tested by Maryland in the Pilot Project incorporated two significant elements. First, the Maryland Electronic Screening Program did not require that a motor carrier be pre-qualified in order to enroll in the program. Any motor carrier submitting an application, providing that the motor carrier was a legitimate operation meeting State requirements, was eligible to enroll in the program. If the motor carrier had an outstanding issue or issues that would result in the carrier not meeting the E-screening bypass criteria, the State, to the extent feasible, advised the motor carrier of this so that the motor carrier could address the problem in question. However, motor carriers were not required to meet specific criteria in order to receive a transponder, participate in the program, and be eligible for a weigh station bypass, provided the motor carriers satisfied bypass criteria.

The Maryland Electronic Screening Program was the first in the United States to test the CVISN concept of E-screening, which is electronic screening on a real-time basis. As snapshot information on motor carriers participating in the Maryland Electronic Screening Program was updated, it was downloaded to the ROC at the Perryville facility using the Maryland CVIEW. Snapshot information was obtained from Safety and Fitness Electronic Records (SAFER) system and from Maryland legacy systems utilizing interfaces developed as part of Maryland's CVISN program. Bypass/no bypass messages were issued to motor carriers based on snapshot information. No list of pre-approved motor carriers was established. Though the weigh station personnel maintained the option to signal drivers for a pull-in, the bypass decision was usually based on the most recent information available contained in the snapshot.

The second key element of the Maryland Electronic Screening Program was in establishing an interoperability working relationship with NORPASS partners to work together to deploy mainline screening systems at weigh stations. This partnership allows safe and legal trucks to proceed unimpeded while enforcement resources are focused on high-risk motor carriers. NORPASS members were previously listed in Figure 2-1.

Through the interoperability working relationship, Maryland and NORPASS exchange data files containing motor carrier enrollment information, transponder identifiers, and other relevant information on each program's members. Members are then able to participate in both programs and receive E-screening benefits. No fee is required to register in either program. Motor carriers participating in the Maryland program were also able to enroll in the ACS PrePass program and use the Mark IV Fusion transponder obtained from the Maryland program. The Maryland program, however, did not read PrePass transponders or issue and bypass/no-bypass messages to motor carriers enrolled in PrePass but not in Maryland and/or NORPASS. In addition, carriers enrolled in PrePass are not able to use PrePass transponders for other programs and must enroll in those programs separately.

As of June 2004, a total of 281 companies had enrolled in the Maryland Electronic Screening Program and a total of 2,181 transponders had been distributed.

As of December 2004, the NYSMTA Super Account had enrolled 360 companies in New York with a total of 30,000 transponders distributed (Mark IV Fusion and standard E-ZPass flat packs). Similar numbers for Pennsylvania and Maryland were 150 companies/10,000 transponders and 110 companies/2,500 transponders, respectively.

3.0 EVALUATION STRATEGY OVERVIEW

This section presents an overview of the evaluation strategy developed for the ETC/ E-Screening Interoperability Pilot Project to reflect the overall goals and objectives established for the Pilot Project by the project participants. The following five evaluation goals were identified:

1. Assess the impact of interoperability on motor carrier mobility.
2. Assess the impact of electronic screening on motor carrier safety.
3. Identify industry and government efficiency gains from ETC/E-screening.
4. Assess the impact of electronic screening on the environment, in particular, reduction in diesel emissions.
5. Assess overall customer satisfaction, both government and industry.

Supporting objectives for the evaluation goals were developed to provide quantitative and qualitative analysis of the system impacts, to document institutional challenges, and to identify lessons learned. The impacts and challenges identified were carefully explored and documented to help provide guidance for other regions considering similar integration projects. The evaluation findings will be used by other agencies to assess the appropriateness of ITS integration as a potential solution to their local problems.

These objectives were derived from the objectives of the project participants. Two types of data were collected: quantitative data on operational performance (e.g., travel time, out-of-service rates) and qualitative data (e.g., customer satisfaction ratings).

The ETC/E-Screening Interoperability Pilot Project evaluation structure is based on standard evaluation practices originally developed by USDOT. For each evaluation goal, hypotheses were formulated to identify anticipated impacts to the system. One or more measures of effectiveness (MOEs) are associated with each hypothesis to assess the accuracy of the hypothesis. Required data and data sources are identified for each MOE. The goals, hypotheses, MOEs, and data sources identified for each study for the evaluation of the ETC/ E-Screening Interoperability Pilot Project are summarized in Table 3-1.

Table 3-1. Evaluation Goals, Hypotheses, and MOEs

Goal	Hypothesis	MOE	Data Sources or Requirements
Improve mobility at weigh stations and toll collection facilities.	ETC and E-screening will improve the mobility of transponder-equipped commercial vehicles at weigh stations and toll collection facilities.	Travel time through facilities. Travel time variability through facilities. Number of commercial vehicles passing through weigh stations per day.	Field measurement of travel times and travel time variability through facilities. Field counts of commercial vehicles. Weigh station records.
Improve safety.	Carriers with transponders will maintain compliance with safety standards. Enforcement personnel will be better able to identify non-compliant or unsafe carriers. Crash rates involving commercial vehicles will be reduced at both weigh stations and toll facilities. Station closings due to ramp backups onto the mainline when station is operating at capacity based on traffic volume will be reduced.	Number of compliant carriers with transponder inspected per day. Out-of-service rates for transponder-equipped and non-transponder-equipped vehicles. Crash rates. Number of times stations must close per day due to ramp back-ups when stations are operating at capacity based on traffic volume, and duration of closures.	Enforcement records/ out-of-service reports. Weigh station records.
Improve efficiency of motor carrier operations for government and industry.	Data sharing will improve inter-agency coordination, thereby improving efficiency of motor carrier operations. Enforcement agencies will establish standardized criteria for bypass, inspection selection, and other enforcement activities to improve identification of non-compliant carriers.	Costs associated with reduced fuel consumption and travel time. Costs associated with enforcement activities (number of enforcement officials, hours of operation). Number of inspections on one trip. Agency procedures and policies.	Calculations of yearly fuel and travel time savings for industry. Enforcement agency records. Agency documents on enforcement policies and procedures.
Reduce fuel consumption and emissions at toll facilities.	With reduced delays and idle time, fuel consumption and emissions will be reduced.	Vehicle delays. Fuel consumption. Estimated emissions reductions.	Field measurements of delays. Industry records on fuel consumption. Estimation of emissions reductions using typical idle rates.

Goal	Hypothesis	MOE	Data Sources or Requirements
Improve customer satisfaction.	The use of one transponder for both ETC and E-screening will help promote industry acceptance and use. Drivers will perceive a time savings association with use of the technology. Enforcement officials will benefit from the carriers' use of the technology.	Industry acceptance/ endorsement of technology. Incentives offered by state agencies to encourage use of transponders. Drivers' perceived time savings. Enforcement officials' assessment of technology and perception of benefits.	Surveys/interviews/focus groups with motor carriers, drivers, and enforcement officials.

In addition to assessing the five goals established for the evaluation, the Evaluation Team also documented the following institutional and technical challenges:

- How participating agencies identified and resolved technical and policy issues related to the use of a single transponder for both ETC and E-screening.
- How industry concerns on such issues as access to and use of ETC and E-screening event data were addressed and the process established for discussing these issues with industry.
- How E-screening enrollment and bypass criteria were established and agreed to.
- Who was responsible for reviewing carrier applications for E-screening and how this was accomplished.
- How transponder administrator services were addressed.
- How participating motor carriers were recruited, and what plans are being developed for larger scale recruitment.
- How E-screening in Maryland and Connecticut will be used as the baseline for expanded deployment of electronic screening capabilities at weigh and inspection stations located elsewhere in each State.
- How the Maryland Electronic Screening Program will operate as a "program neutral" electronic screening program, and what this means for achieving national E-screening interoperability.

Since institutional and technical challenges are identified and addressed throughout the project, documenting institutional and technical challenges was not established as a stand-alone evaluation goal. As particular tests supporting the other objectives were conducted, questions related to or information required for the institutional challenges component were incorporated, as appropriate. To this end, data collection activities for institutional and technical challenges test was designed to complement and be incorporated with the other evaluation activities and detailed tests.

Detailed test plans were developed for each of the evaluation components proposed for the evaluation of the ETC/E-Screening Interoperability Pilot Project.[29] Each test plan defined the objective, approach, and work steps for each evaluation component, as summarized below:

[29]ETC/E-Screening Interoperability Pilot Project Detailed Test Plans, July 2002.

- **Mobility Test Plan –** Investigate mobility improvements in terms of travel time through facilities and the volume of trucks processed per day at the weigh stations.
- **Safety Test Plan –** Document the improvements in safety enforcement and carrier compliance with safety standards.
- **Operational Efficiency Test Plan –** Examine the impacts of interagency coordination on motor carrier operational efficiency.
- **Environmental Test Plan –** Examine the environmental impacts from reduced waiting times at toll and weigh station facilities.
- **Customer Satisfaction Test Plan –** Investigate the level of improved customer satisfaction resulting from more convenient payment of tolls and screening process improvements.
- **Institutional and Technical Challenges/Lesson Learned Test Plan –** Identify the lessons learned from both institutional and technical challenges.

In preparing the test plans for specific evaluation goals, numerous test activities were identified that could be consolidated to ensure efficient use of evaluation resources. For example, one test combined the planned timing of delays at weigh stations and toll facilities. This particular test activity generated data used to complete the mobility, operational efficiency, and environmental tests, and also impacted the customer satisfaction and institutional challenges tests. Prior to conducting field work, all test and design data collection activities were identified to ensure appropriate collection of all necessary data.

The toll facilities and weigh stations used to conduct field tests were selected based on discussions and cooperative efforts with project participants in each respective State. Field measurements at toll facilities required one site visit per facility, which was based on the extensive use of toll tag transponders by the trucking industry. These measurements facilitated the collection of both “Before” (without transponder) and “After” (with transponder) data. Initially, two site visits were planned to collect the Before and After data at weigh stations. This plan was later modified and reduced to one visit given since only the Perryville Weigh Station was operational for E-screening during the evaluation period. There was no need to collect After project data as a result.

As initially proposed, the evaluation assessed the use of the Mark IV Fusion transponder at the Peace Bridge International Border Crossing near Buffalo, New York. Initially, the National Customs Automation Program (NCAP) transponder deployment, with integration to the International Trade Data System (ITDS), was carried out by U.S. Customs and Border Patrol and offered the opportunity to assess an additional interoperable application as an evaluation component. As part of the evaluation, the transponder/ITDS implementation effort was to be assessed as follows:

1. A “case study” assessment of the potential use of a universal transponder as part of this test, consistent with the “universal transponder” deployment effort described in the SOW for the I-95/Northeastern U.S. region.
2. A “case study” assessment of the implementation of the ITDS as part of this border crossing system, including interviews with all major key players to determine the perceived benefits and institutional challenges of deploying these systems.

However, the final test at the Peace Bridge did not use the Mark IV Fusion transponder, and the opportunity to develop the case study did not materialize.

The Peace Bridge "universal transponder" and ITDS deployment was based on "smart card" technology, not transponder-based technology. Since the intended objective of the proposed case study was to measure the expanded interoperability of transponder technology to include border crossing and customs functions, this was not feasible.

During a presentation to FHWA and FMCSA on the preliminary results of data collection, the Evaluation Team was asked if any data collection had been performed to measure the impact of ETC on congestion, mobility, and environmental impacts in urban areas. The Evaluation Team replied that this was not the case, and was then asked to consider expanding the data collection efforts to include urban areas.

Based on this request and the fact that the Peace Bridge case study did not materialize, the SOW for this evaluation was amended to exclude the case study, and instead, to substitute the following items:

> This modification to the Statement of Work requires the following additional tasks:
>
> The collection of data at two additional sites – the Tappan Zee Bridge and the George Washington Bridge. The intent of this additional collection data is to:
>
> - Estimate the mobility, efficiency and environmental impacts resulting from the use of electronic toll collection in an urban setting.
> - Expand the customer satisfaction assessment to include an assessment of the benefits perceived by end users from using ETC in an urban setting.
> - Expand the environmental impact analysis to model the potential emissions reductions resulting from the use of ETC and electronic screening.
> - The period of performance for these two tasks shall be concurrent with the overall period of performance for the current evaluation.
>
> The deliverables for this modification shall be included in the overall report prepared for the evaluation. The deliverables shall include:
>
> - An assessment of the mobility and efficiency benefits of the use of ETC in an urban setting.
> - A statistical assessment of potential emissions reductions resulting from the use of ETC and E-screening technologies.[30]

[30]Electronic Toll Collection/Electronic Screening Interoperability Pilot Project, Statement of Work Modification to DTFH61-96-C-00098, SA9834M2, published July 2004.

4.0 TEST RESULTS AND FINDINGS

4.1 INTRODUCTION

This section provides the test results and subsequent findings for the Electronic Toll Collection/Electronic Screening Interoperability Pilot Project. Supplementary information is contained in the *Attachment I: Electronic Toll Collection/Electronic Screening Interoperability Pilot Project Appendices*, provided under separate cover. The supplementary appendices include the following sections:

- Section 1 – Evaluation Methodology
- Section 2 – ETC/E-Screening Facility Descriptions
- Section 3 – Test Results and Findings
- Section 4 – Total Truck Counts by Facilities
- Section 5 – Safety Documents Summary
- Section 6 – Motor Carrier Survey
- Section 7 – Literature Review – Environmental Assessment

4.2 MOBILITY TEST

To conduct the mobility test, travel times and truck counts were collected in three states: New York (NY); Maryland (MD); and Connecticut (CT).

- In New York, travel times and truck counts were collected on Interstate 90 outside of Albany at the Barrier 23 and 24 toll facilities and at two toll bridges in New York City (George Washington and Tappan Zee bridges). No data from weigh stations were collected in New York.
- In Maryland, travel times and counts were obtained at one toll facility and four weigh stations.
- In Connecticut, travel times and counts were collected at the weigh stations in Union and Greenwich.

Table 4-1summarizes the State, location, facility type, and data collection dates of travel times and truck counts.

Table 4-1. Data Collection Sites and Dates for Travel Times and Truck Counts

State	Location	Facility	Collection Dates
NY	Albany: I-90 at Exits 23 & 24	Toll	October 16 – 17, 2002
	NYC: I-95 George Washington Bridge	Toll	Archived data from Port Authority of NY-NJ for 2002 through 2003 inclusive; also from January – August 2004
	NYC: I-87/I-287 Tappan Zee Bridge	Toll	December 14, 2004
MD	Perryville: I-95 near Exit 93	Toll	October 23 – 24, 2002
	Perryville: I-95 near Exit 93	Weigh Station	October 22 – 23, 2002
	Hyattstown: I-270 near Exit 22	Weigh Station	December 2 – 3, 2002
	West Friendship: I-70 near Exit 80	Weigh Station	December 9 – 10, 2002
	New Market: I-70 near Exit 62	Weigh Station	January 21 – 22, 2003
CT	Union: I-84 near Exit 73	Weigh Station	May 19, 2003
	Greenwich: I-95 near Exit 2	Weigh Station	May 21, 2003

The main goal of the data collection effort was to obtain a sample of travel times and counts for traffic conditions during a typical work week. To minimize the effects of weekend travel, the Evaluation Team collected data at all sites during a standard work week (no holidays), and either on Monday, Tuesday, or Wednesday. With the exception of the George Washington and Tappan Zee bridges, and the Union Weigh Station, data were collected during four time periods (Morning, Noon, Evening, and Night) to obtain a sampling of travel times at various times of the day. The time span for day and times were identified as: Morning (7:30 to 9:30 a.m.); Noon (11:30 a.m. to 1:30 p.m.); Evening (4:30 to 6:30 p.m.); and Night (9:30 to 11:30 p.m.).

Time savings per toll facility are summarized in Figure 4-1. Albany Exits 23 and 24 both show significant time savings from the use of E-ZPass, with thruway exit time savings (actual payment of tolls) being substantially higher than thruway entry times. In general, thruway exits have a higher number of E-ZPass dedicated lanes, which explains the higher time savings. The time savings at Perryville is relatively low compared to the Albany exit time savings. This reflects the initial lack of CMV E-ZPass only lanes, with the result that the time savings realized from the use of E-ZPass was obtained only through the electronic payment transaction.

Time savings per weigh station are summarized in Figure 4-2. Since time savings alone is not meaningful in trying to compare sites, looking at time savings in conjunction with mainline times provides a point of reference for comparing sites and the amount of time savings. For instance, at West Friendship the mainline travel time is 18 seconds, but because of West Friendship-specific conditions (traffic, type of facility, etc.) an E-screening system comparable to a bypassing truck could produce a time savings of 58 seconds per truck. The Greenwich Weigh

Station in Connecticut has the most dramatic time savings, as an E-screening system could result in a savings of 302 seconds per truck.

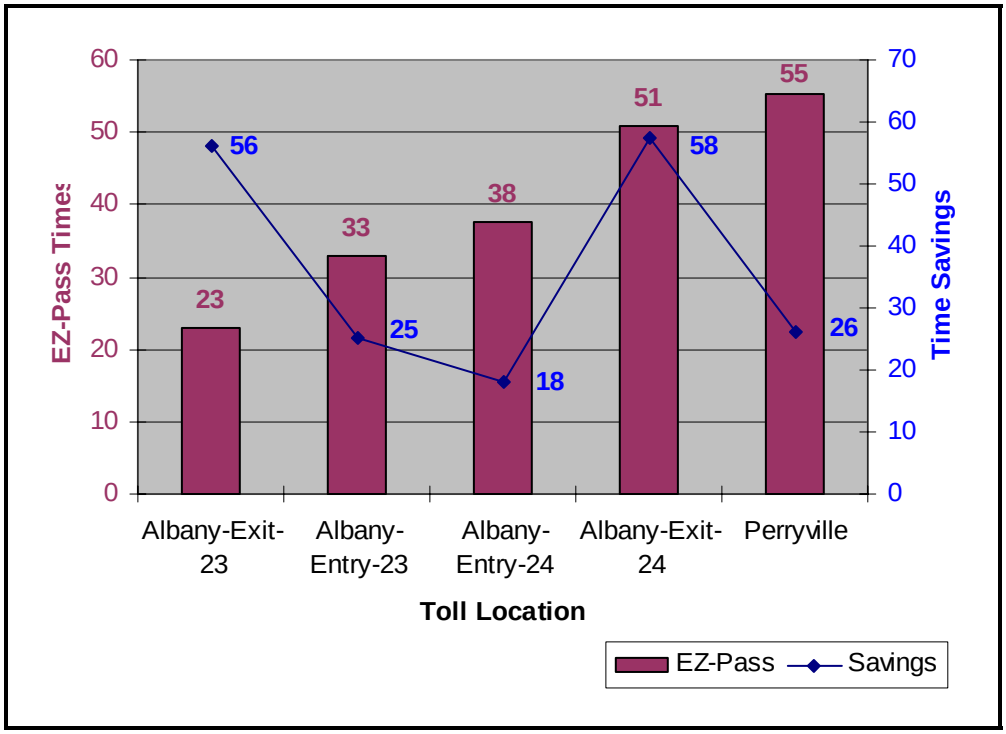

Figure 4-1. Time Savings per Toll Facility in Seconds.

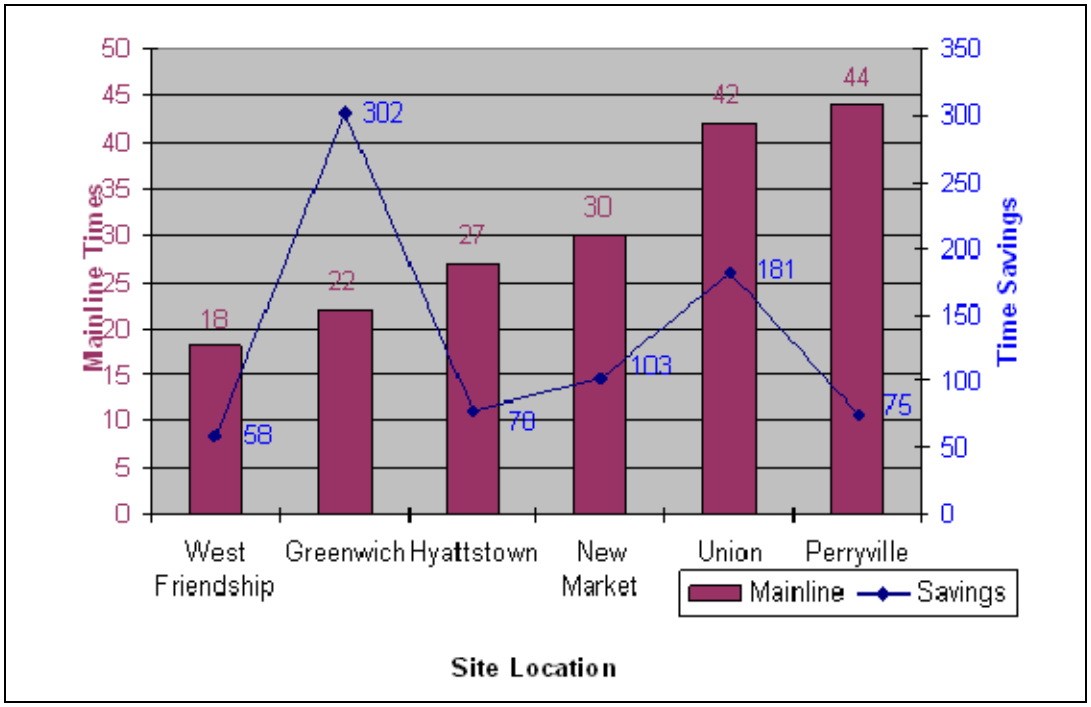

Figure 4-2. Time Savings per Weigh Station in Seconds.

4.2.1 Summary of Travel Time Analyses at Toll Facilities

Compared to manual payment of tolls, electronic toll collection resulted in shorter delays at the toll plaza and reduced travel times for trucks at both the Albany, New York, and Perryville, Maryland, toll facilities. At Barriers 23 and 24 in Albany, New York, trucks using E-ZPass to enter and exit the Thruway experienced shorter travel times through the toll barrier during all four time periods (Morning, Noon, Evening, and Night). In general, the E-ZPass trucks had a larger time savings when exiting the Thruway (and completing the toll payment transaction). The time savings benefit was most pronounced during the Evening period.

Similar results were observed at the toll facility in Perryville, Maryland. Trucks using electronic toll collection consistently had shorter travel times through the toll plaza and on average saved from 24 to 28 seconds compared to those using manual payment.

4.2.2 Summary of Travel Time Analyses at Weigh Stations

Travel times were examined at six locations in Maryland and Connecticut. At the four sites in Maryland (Perryville, Hyattstown, West Friendship, and New Market), travel times for trucks entering the weigh stations and crossing WIM were compared to times for trucks stopping at the static scale. At two sites in Connecticut (Union and Greenwich), the travel times for trucks entering the weigh stations and crossing the WIM were compared to free-flow mainline travel times.

In Perryville, the trucks bypassing the static scale saved on average of about 75 seconds. Depending on the time of day, trucks saved between 70 to 100 seconds, with the largest time savings benefit (100 seconds) occurring during the Noon period. In Hyattstown, during the Noon and Night periods, trucks saved 85 and 70 seconds, respectively. At West Friendship, trucks saved on average about 99 seconds during the Noon period and approximately 46 seconds during the Morning, Evening, and Night periods. In New Market, trucks bypassing the static scales saved an average of 108 seconds during Morning and Noon periods.

In Greenwich, Connecticut, when comparing the travel times for trucks crossing the weigh station WIM to free-flow mainline travel times, the time savings was estimated to be between 57 and 91 seconds, with the largest time savings benefit during the Noon period. In Union, during the Morning and Noon periods, trucks saved 30 and 34 seconds, respectively.

4.2.3 Conclusions of Mobility Impacts at Toll Facilities and Weigh Stations

In most instances, using the E-ZPass resulted in shorter travel times through the toll facilities. Also, using E-ZPass generally resulted in more reliable travel times through toll facilities. As would be expected with a fully integrated E-screening system, bypassing static scales resulted in significantly shorter travel times through weigh stations. If an E-screening system allowed trucks to bypass weigh stations at free-flow mainline speeds, travel times past weigh stations would enable trucks to achieve maximum travel time savings.

4.3 SAFETY TEST

Early in the course of the evaluation it became apparent that the levels of transponder use on the part of industry for E-screening would not be sufficient to yield an adequate number of data points to support a statistically valid analysis of safety impacts. An additional concern was the fact that only one weigh station, the Perryville facility, had an operational system, thus further reducing the size of the potential sample available to conduct the safety test.

Since there was insufficient data available, the Evaluation Team recommended two alternative approaches to FHWA and FMCSA for conducting the safety test:

- **Compare the Before and After safety ratings, out-of-service rates, and number of inspections for those motor carriers using transponders for E-screening.** During follow-up discussions with MDOT, the Evaluation Team learned that MDOT had conducted a similar study and found that there was no significant difference in these metrics for motor carriers participating in E-screening.
- **Model projected traffic volumes, projected growth in transponder market penetration, and use the Volpe model that estimates the safety impacts generated from each inspection to estimate potential safety impacts from E-screening.** The hypothesis that was to be tested is that trucks using transponders are more likely to receive weigh station bypass notification, and this would enable the enforcement community to target the non-transponder using portion of the motor carrier industry. The hypothesis was derived from anecdotal information obtained during focus groups conducted for the project shows that those carriers currently using transponders are carriers with good safety ratings eligible for green lights. However, since this approach had been used for other evaluations, it was not clear that repeating this methodology would produce meaningful results.

Based on discussions with FHWA and FMCSA, a decision was made to not implement a formal Safety Test using either of the above methodologies. The Evaluation Team has included a recommendation for a follow-on study that would examine the safety impacts of E-screening in greater detail, once the level of transponder market penetration has reached a sufficient level to provide a statistically valid sample size. For the purposes of this evaluation activity, the Safety Test was not completed.

4.4 EFFICIENCY TEST

Given the current and projected large volumes of commercial vehicle travel through the I-95 corridor states, private-sector benefits from electronic toll collection and E-screening are and will continue to be realized primarily through travel time savings. These benefits will be realized through reduction in expected en-route delays at the toll facilities and at weigh stations along the corridor.

The benefits were estimated using an identified value of time for a commercial vehicle, defined as $71.05 per hour[31] (or equivalent to $0.0197 per second). Monetized estimates (motor carrier operational efficiency) were developed for the projected time savings by applying the identified value of time to the observed time savings. The result of this value of time was then extrapolated to the larger universe of transactions at the toll facilities and weight inspections in the three target states (Connecticut, Maryland, and New York). Table 4-2 presents the per-event value of time savings, summarized as follows:

- For toll facilities, average travel time savings ranged from 13 to 55 seconds per transaction, with a simple unweighted average of 30 seconds time savings, valued at $0.59 per event.

[31]The 2004 Urban Mobility Report, David Schrank and Tim Lomax, Texas Transportation Institute, The Texas A&M University System, September 2004. Accessed from: http://mobility.tamu.edu.

- At the Maryland weigh stations, average travel time savings ranged from 56 to 109 seconds per transaction, with a simple unweighted average of 76 seconds time savings, valued at $1.56 per event.
- At Connecticut weigh stations, average travel time savings ranged from 32 to 68 seconds per transaction, with a simple unweighted average of 50 seconds time savings, valued at $0.99 per event.
- For all weigh stations observed, a simple unweighted average of 68 seconds time savings, valued at $1.33 per event.

Table 4-2. Per-Event Time Savings and Value to Motor Carriers

Facility:	E-Screening or ETC Average Time Savings	Value of Time Savings
Toll Facilities:		
George Washington Bridge	13	$0.26
Tappan Zee Bridge	39	$0.77
Albany Exit 24 Entry	16	$0.32
Albany Exit 24 Exit	55	$1.09
Perryville	25	$0.49
Weigh Stations:		
Perryville	64	$1.26
Hyattstown	77	$1.52
West Friendship	56	$1.11
New Market	109	$2.15
Union	32	$0.63
Greenwich	68	$1.34

Extrapolating these time savings to a full deployment scenario for the three subject states is proffered to illustrate potential maximum benefits to motor carriers of the ETC/E-screening programs. In terms of E-screening, based on FHWA data, the approximate average annual number of weight inspections conducted is as follows:

- Connecticut: 400,000
- Maryland: 2,900,000
- New York: 200,000

For the three states, the total is approximately 3.5 million trucks weighed per year. At an imputed value of $1.33 per bypass event, and given 100 percent enrollment and clearance at scales, the value to the motor carrier industry would be roughly $5 million per year.

Based on the toll facilities surveyed in this effort, the average annual commercial vehicle volumes and estimated value of the savings are presented in Table 4-3.

Table 4-3. Annual Truck Volumes at Surveyed Toll Facilities and Maximum ETC Benefits

Facility	Average Annual Truck Volume	Estimated Maximum Time Savings Value (100% Subscription)
George Washington Bridge	4.2 million	$1.1 million
Tappan Zee Bridge	0.125 million	$0.1 million
Albany Exit 24 Exit	2.2 million	$2.4 million
Perryville	1.4 million	$0.7 million

Given the current levels of electronic toll collection deployment at the subject facilities and reduced transaction times (cash versus E-ZPass) alone, financial impacts to the industry as a whole are minimal. In terms of participation in electronic toll collection plans, again, motor carrier efficiency benefits will be directly proportional to level of exposure in terms of frequency through toll plazas. What is seen is that commercial vehicle operators, whether cash or E-ZPass customers, are already reaping significant time savings resulting from reduced congestion at toll facilities due to significant subscription rates by the general motoring public.

4.5 ENVIRONMENTAL BENEFITS

Proliferation of ETC mechanisms, such as E-ZPass, has a positive effect in reducing vehicle emissions at toll-plazas due to decreased acceleration, deceleration, and idling events. Speed profiles of vehicles at ETC/E-screening facilities are significantly different for vehicles with and without transponders; vehicles without transponders are required to stop for transaction processing. On-road emission measurement with a sample fleet of instrumented vehicles is perhaps the best way to measure the impacts of ETC/E-screening on heavy-duty truck emissions. Instead, a practical alternative to this costly undertaking is to model ETC/ E-screening activity. However, no such tools exist for modeling emission impacts of ETC/ E-screening facilities on heavy-duty vehicle operations.

Current generation vehicle emission models MOBILE 6.2 and the Comprehensive Modal Emissions Model (CMEM) are limited with respect to their ability to model heavy-duty vehicle emissions. CMEM is incapable of modeling heavy duty vehicle emissions. Emission characteristics of vehicles transiting screening facilities cannot be accurately derived employing traditional modeling methods with MOBILE 6.2. Consequently, few studies have focused on modeling of heavy duty vehicles using ETC/E-screening facilities.

In MOBLE 6.2, modal operations of vehicles are represented as speed bins – collections of uniform speed – at 5-mph increments. Using speed bins enables employment of a speed profile discretization technique (SPD), allocating vehicle miles of travel into various speed bins. By employing an emissions influence zone (EIZ) within which the speed profiles are captured, an estimation of vehicle emissions transiting and ETC/E-Screening facility is possible. Using the SPD technique, emission impacts of heavy-duty trucks were calculated at the toll collection plaza on George Washington Bridge, New York. The following steps describe the methodology using the SPD techniques as previously described to estimate impacts of ETC/E-screening heavy-duty truck emissions:

1. Pre-modeling activities include collecting relevant field data to define/derive the following variables for emissions modeling:
   - Volume of light and heavy duty trucks at various facilities.
   - Processing time for cash, EZ-pass and weighing transactions.
   - VMT distribution of small and large trucks in various speed bins.
2. Develop a spreadsheet-based sketch-planning tool incorporating the SPD technique.
3. Reduce field data to develop input parameters for MOBILE 6.2.
4. Obtain emission factors from MOBILE 6.2.
5. Analyze field data in conjunction with emission factors derived from MOBILE 6.2.
6. Interpret results and report findings.

4.5.1 Travel Time and Truck Count Data Collection

Travel times and truck counts were collected in New York, Maryland, and Connecticut. In New York, travel times and truck counts were collected on I-90 outside of Albany at the Barrier 23 and 24 toll facilities and at two toll bridges in New York City (George Washington and Tappan Zee bridges). No data from weigh stations were collected in New York.

In Maryland, travel times and counts were obtained at one toll facility and four weigh stations. In Connecticut, travel times and counts were collected at the weigh stations in Union and Greenwich. Table 4-4 summarizes the State, location, type of facility, and data collection dates of travel times and truck counts.

Table 4-4. Data Collection Sites and Dates for Travel Times and Truck Counts

State	Location	Facility	Collection Dates
NY	Albany: I-90 at Exits 23 & 24	Toll	October 16 – 17, 2002
	NYC: I-95 George Washington Bridge	Toll	Archived data from Port Authority of NY-NJ for 2002 through 2003 inclusive; also from January – August 2004
	NYC: I-87/I-287 Tappan Zee Bridge	Toll	December 14, 2004
MD	Perryville: I-95 near Exit 93	Toll	October 23 – 24, 2002
	Perryville: I-95 near Exit 93	Weigh Station	October 22 – 23, 2002
	Hyattstown: I-270 near Exit 22	Weigh Station	December 2 – 3, 2002
	West Friendship: I-70 near Exit 80	Weigh Station	December 9 – 10, 2002
	New Market: I-70 near Exit 62	Weigh Station	January 21 – 22, 2003
CT	Union: I-84 near Exit 73	Weigh Station	May 19, 2003
	Greenwich: I-95 near Exit 2	Weigh Station	May 21, 2003

The goal of the data collection effort was to obtain a sample of travel times and counts for traffic conditions during a typical workweek. Further, to minimize the effects of weekend travel, the data at all sites were collected during a normal workweek (no holidays) and either Monday, Tuesday, or Wednesday. With the exception of the George Washington and Tappan Zee bridges and Union Weigh Station, data were collected during four time periods (Morning, Noon, Evening, and Night) to obtain a sampling of travel times at various times of the day. The time of day and times were: Morning (7:30 to 9:30 a.m.); Noon (11:30 a.m. to 1:30 p.m.); Evening (4:30 to 6:30 p.m.); and Night (9:30 to 11:30 p.m.).

The toll authorities in New York and Maryland provided truck counts which were used in our analyses. At weigh stations in Maryland and Connecticut, tubes and vehicle counters were placed across the roadways to obtain counts of trucks entering the weigh stations.

4.5.2 Field Data Reduction

Toll plaza data and the weigh station data were scrutinized for suitability in modeling emission factors using MOBILE 6. Toll plaza data at George Washington Bridge in New York City was used as the test dataset to apply the study methodology. Table 4-5 provides a summary of transaction times for both E-ZPass and cash operations.

Table 4-5. George Washington Bridge Transaction Times Summary

GWB Transaction Time (sec) Statistical Analysis								
Staffed Lane Analysis								
Main	**SPC**	**SPE**	**SOC**	**SOE**	**LPC**	**LPE**	**LOC**	**LOE**
Std Deviation	6.99	4.95	8.66	--	12.66	5.20	10.34	--
Median	17.80	8.18	18.43	--	25.55	12.52	24.33	--
Average	18.69	9.90	20.19	--	29.25	13.28	26.72	--
# of Points	258	43	372	--	178	20	471	--
UCL	39.65	24.76	46.18	--	67.23	28.89	57.74	--
LCL	0	0	0	--	0	0	0	--
95% confidence	19.54	11.38	21.07	--	31.11	15.56	27.66	--
interval	17.84	8.42	19.31	--	27.39	11.00	25.79	--
Average	**17.56**	**9.32**	**19.41**		**26.83**	**13.28**	**25.37**	
# tossed points	15	1	10		12	--	17	

SPC	Small Truck, Peak, Cash	LOE	Large Truck, Off-Peak, E-ZPass
SPE	Small Truck, Peak, E-ZPass	LPC	Large Truck, Peak, Cash
SOC	Small Truck, Off-Peak, Cash	LPE	Large Truck, Peak, E-ZPass
SOE	Small Truck, Off-Peak, E-ZPass	LOC	Large Truck, Off-Peak, Cash

These average transaction times for small truck and large trucks are used to apportion vehicle miles of travel by each of the 12 speed bin classes specified by MOBILE 6. Following are some of the assumptions related to and parameters used in apportioning VMT in various speed bins:

- All approaching vehicles are traveling at the posted 55 mph speed limit.
- Truck traffic is aggregated into two main categories – small and large trucks.
- Stopping sight distance, deceleration, and acceleration criteria specified in the American Association of State and Highway Transportation Officials (AASHTO) manual on Geometric Design of Highways and Streets[32] is applicable. Accordingly, the following parameters are applied:
  - Stopping distance: 325 feet for small trucks and 500 feet for large trucks.
  - Small trucks are assumed to accelerate at 1.3 ft/sec^2 after the transaction.
  - Large trucks are assumed to accelerate at 1.1 ft/sec^2 after the transaction.
- For cash transactions, the vehicles have to stop. However, MOBILE 6 does not model idle emissions. For the duration of the transaction, the travel speed of cash transaction, thus, is assumed as 2.5 mph – which is the minimum speed bin for the model.
- For E-ZPass transactions, vehicles were observed to drive at various speeds ranging from 10 to 30 mph. For test purposes only two E-ZPass speeds, 10 mph and 20 mph, were considered.
- The approach deceleration zone is divided equally into 12 speed bins ranging from 2.5, 5, and 10 through 55 mph (with 5 mph increments).
- The departure acceleration is divided based on transaction type as well as based on the reduced speed for E-ZPass transactions. Consequently, there are 12 speed bins for accelerating from complete stop (cash transaction), 9 speed bins for accelerating from 10 to 55 mph (E-ZPass Case 1) and 7 speed bins for accelerating from 20 to 55 mph (E-ZPass Case 2).
- Speed VMT inputs for small and large trucks do not change by hour of day. (This assumption was necessary because the traffic counts by hour of day are not available).
- Only truck traffic will be modeled in the emission factor modeling process.

The summary in Table 4-6 presents an estimate of percent reductions in emissions (Nitrogen Oxides [NOX], Carbon Monoxide [CO], and volatile organic carbons [(VOC]) in the "emission influence zone" (EIZ) that are attributable to E-ZPass operations. The results indicate that if the E-ZPass allows the vehicles to be processed at 10 mph, the reductions in VOCs due to truck traffic alone could be as high as 50 percent.

Table 4-6. Percent Reduction in EIZ Emissions by Employing E-ZPass

Pollutant	Emissions Due to All Cash Transactions	Emissions Due to Existing Cash – E-ZPass Mix		Emissions Due to All Trucks Using E-ZPass	
		E-ZPass at 10 mph	E-ZPass at 20 mph	at 10 mph	at 20 mph
VOC	10645.30	7366.6	6877.8	6011.0	5320.1
	% Reduction	30.8%	35.4%	43.5%	50.0%
CO	79136.00	60563.5	55877.3	52884.6	46260.9
	% Reduction	23.5%	29.4%	33.2%	41.5%
NOX	45857.46	43175.0	42242.3	42065.9	40747.6
	% Reduction	5.8%	7.9%	8.3%	11.1%

[32] **AASHTO Green Book – A Policy on Geometric Design of Highways and Streets,** January 2001.

4.6 CUSTOMER SATISFACTION

4.6.1 "Before" Project

Background information on the ETC and E-screening programs and interoperability project was obtained through a comprehensive literature review and interviews with project stakeholders. The findings from these activities were used to develop the overall evaluation strategy and specific methodology used to identify both quantitative and qualitative data requirements and sources.

Initially, the Evaluation Team had planned on collecting qualitative data by conducting a series of focus groups with a variety of customers, including enforcement officials, motor carriers, and commercial vehicle drivers. These focus groups were to be followed by a quantitative survey of each customer group.

As the project developed, it became clear that this approach needed modification. For example, the population of enforcement officials in Connecticut and Maryland was so small that it seemed more appropriate to speak with each group of officials in a focus group setting, both before and after the E-screening technology deployment.

Following discussions with industry representatives, it was also determined that administering a driver survey was not a cost-effective means of obtaining data. This decision was based on low market penetration for transponders at the time of the evaluation. Since the evaluation was focused on the interoperability of ETC and E-screening technologies, it is important to be able to identify drivers who had experience with both technologies in order to obtain an accurate assessment of the benefits of interoperability.

It was determined that it would be difficult and costly to identify a large enough sample of drivers to be able to obtain statistically valid results. Due to the low market penetration of the transponders, it was also determined that the results may not be representative of a larger population of drivers. Therefore, the decision was made to survey only the motor carriers for the "After" project assessment. Baseline data for the Customer Satisfaction Test was obtained through a series of "Before" focus groups:

- Maryland motor carriers
- New York motor carriers
- Truck drivers in Baltimore, Maryland
- Truck drivers in Albany, New York
- Maryland enforcement officials

In addition, a survey of enforcement officials in Connecticut was conducted. Though the Evaluation Team attempted to organize a focus group of enforcement officials in Connecticut, the Connecticut Department of Motor Vehicles preferred to participate in a survey rather than a focus group. Therefore, the Evaluation Team developed a survey for the Connecticut enforcement officials.

The purpose of the focus groups and survey was to gain an understanding of the issues important to customers and to use this understanding to design the "After" surveys of enforcement personnel, motor carriers, and commercial vehicle operators.

The MMTA and the NYSMTA recruited participants for the motor carrier and driver focus groups. Both State associations were brought on board as subcontractors to support these activities and the After project motor carrier survey, in particular, the distribution of blank surveys and the collection of completed surveys. The Maryland State Police (MSP) and the MdTA Police identified participants for the law enforcement focus group. For the Connecticut survey, a survey was sent to each enforcement official involved in roadside operations at a weigh station.

4.6.2 "After" Project

Only one "After" project focus group was conducted with the MdTA Police, as this was the only enforcement group that had had experience with E-screening during the course of the evaluation. Due to delays in deploying E-screening capabilities in Connecticut and at the MSP-operated weigh stations, no additional weigh stations were brought online or implemented E-screening during the evaluation's period of performance. The MdTA Police recruited participants for the focus group. This focus group included representatives from motor carrier inspectors, uniformed officers, and information technology staff who had experience with E-screening.

As referenced above, an "After" survey of the motor carrier industry was also conducted to obtain their views on ETC and E-screening. The information gained from the "Before" focus groups and survey was used to develop the post-deployment quantitative surveys. As the preliminary results from the focus groups are qualitative and not representative of the population, the goal of the surveys is to obtain more quantitative information and to survey a sample that will be representative of a particular population of customers, namely those motor carriers belonging to the MMTA and the NYSMTA. The survey was designed to fill information gaps and investigate emerging trends in preliminary data, and included:

- Questions related to industry use and acceptance of the technology.
- Questions related to mobility benefits.
- Questions related to safety benefits (E-screening only).
- Questions related to operational benefits.
- Questions related to cost benefits.
- Questions related to E-ZPass customer service (ETC only).
- Questions related to promotion and registration (E-screening only).

In addition, the After survey was designed to investigate trends that emerged in the preliminary data. For example, with respect to the customers' perceptions of E-screening, the following trends emerged from the data from the focus groups:

- Motor carriers, while less negative than enforcement officials, seem to be "riding the fence" when it comes to the potential benefits of E-screening.
- Although motor carriers reported that they could see the potential advantages of the technology, they had not yet realized the benefits.

Questions were formulated to help investigate whether these trends hold true amongst a larger sample of customers.

Motor carrier survey respondents included members from the MMMTA and NYSMTA. Surveys were distributed to the entire membership of each association, including 910 to the MMTA and 441 to the NYSMTA.

Overall, the results of the motor carrier survey show a reasonable degree of acceptance of ETC on the part of industry. General impressions of E-screening are also favorable, although the results show that the survey respondents do not have extensive experience with E-screening. There is not enough market penetration of E-screening in Maryland to assess motor carriers' perceptions of the technology.

4.6.3 Survey Findings

The Customer Satisfaction Survey findings are summarized as follows:

- **ETC Conclusions:**
  - Motor carriers tend to like ETC.
  - 73 percent of respondents are enrolled.
  - 68 percent disagreed that they preferred their old system of payment.
  - 63 percent were satisfied with their experience with ETC.
  - ETC has positive impacts on travel times through toll facilities.
  - 47 percent reported decreases in travel times of 1 – 10 percent.
  - 42 percent reported decreases in travel times of more than 10 percent.
  - 59 percent of motor carriers are satisfied with the travel time benefits associated with ETC.
  - ETC has positive impacts on operations.
  - 58 percent indicated that ETC has had positive impacts on their operations.
  - 60 percent were satisfied with the impacts of ETC on operational efficiency.
  - ETC, as compared to previous non-cash methods of toll payment (e.g., ticket books), has had both positive and negative impacts on costs.
  - 28 percent of motor carriers reported decreases in fuel usage, while 53 percent reported no impact on fuel usage.
  - 42 percent of motor carriers reported decreases in time/cost of maintaining accounts, while 41 percent reported increases.
  - 35 percent of motor carriers reported decreases in time/cost of record keeping, while 43 percent reported increases.
  - 47 percent of motor carriers disagreed that the costs of participating in ETC outweighed any savings (27 percent agreed).
  - Perceptions of overall impact on costs are divided.
  - 38 percent of motor carriers were satisfied with the eligibility criteria for obtaining toll discounts, and 28 percent are dissatisfied.
  - 44 percent of motor carriers were satisfied with the costs of using ETC, and 20 percent are dissatisfied (31 percent are neutral).

- **E-Screening Conclusions:**

- The general trend of those that use the technology tend to be divided on their perceptions of the benefits of it.
- Those that do not use it tend to agree that they would enroll if E-screening were available on more routes that they run frequently.
- Enforcement officials in Maryland are not accepting of the E-screening technology:
  - They feel it will have adverse long-term impacts on safety.
  - It has not been well introduced into their work environment.
  - It has not functioned well.

4.7 INSTITUTIONAL AND TECHNICAL CHALLENGES

This section of the report presents the institutional and technical challenges identified during the evaluation and lessons learned. This section is intended to present only those issues not previously discussed in the Customer Satisfaction test. Institutional challenges were identified and documented via the following methods:

- **Stakeholder Interviews** – The primary information source for identifying issues and the processes by which they were resolved was accomplished through interviews with project stakeholders on a "Before" and "After" basis.
- **Document Review** – Interviews were supplemented by reviewing selected documents (meeting minutes, correspondence, and project reports) generated through project activities. Document reviews, in particular, meeting minutes, were used to document the processes by which institutional challenges were resolved.
- **Stakeholder Surveys** – To the extent feasible, information was obtained through stakeholder surveys. The primary objective of obtaining information through surveys was to gauge stakeholder satisfaction with how a particular challenge was or was not resolved. In addition, surveys were used to gauge how well the stakeholders felt their views or concerns were incorporated into the process by which an issue was addressed.

Overall, the Pilot Project successfully demonstrated that interoperability is both technical and institutionally feasible. The Project Team has shown a highly flexible and adaptive approach to project management and made a number of mid-project adjustments to reflect changes in the business environment for ETC and E-screening. The Project Team has also worked extremely well with the motor carrier industry and has demonstrated that partnerships with industry can be effectively established. Particular examples of this flexible management approach and the working relationship established with the industry include:

- **Mid-Term Project Scope Adjustments –** The mid-term project assessment and the revision to the Phase 2 and 3 scopes of work made by the Evaluation Team addressed several significant issues identified during project implementation. Based on changes in the business environment, the project team determined that the continued subsidy of the cost of the Mark IV Fusion transponders was not necessary. Rather, the most significant constraint facing the project was the lack of a single registration portal for both ETC and E-screening for motor carriers. Many motor carriers did not understand that enrolling in ETC and obtaining a Mark IV Fusion transponder did not automatically enroll them in E-screening and as a result did not enroll in the Maryland Electronic Screening Program.

Recognizing this, the Project Team made a decision to modify the original project scope and reallocate funds to develop an on-line E-screening enrollment process and explore the feasibility of developing a single enrollment portal that would include both ETC and E-screening. The decision to improve the E-screening enrollment process and to enable the ability of the program to accept enrollment from other programs represent major accomplishments for enhancing interoperability and encouraging motor carriers to enroll in the program. This type of flexible project management, and the willingness to make mid-project adjustments, is a management approach that is critical for the successful deployment of ITS/CVO technologies and systems.

- **NYSMTA and MMTA Super Accounts –** A policy change by the IAGs that took place during the project allowed third party organizations to establish large scale or super accounts and serve a transponder administrator function. Both the NYSMTA and MMTA established super accounts, which have been highly successful in recruiting motor carriers to participate in ETC, and in creating a potential market for E-screening. Using these accounts has also helped smaller carriers and owner-operators who may not qualify for any discount under the ETC system to still obtain a discount by enrolling through each state association's super account, thus offsetting the potential elimination of a significant benefit (toll discounts) of the ETC program, as perceived by the motor carrier industry. In addition, these smaller carriers and owner-operators receive administrative support from each association for enrollment and accounting functions, a significant additional benefit to this segment of the motor carrier industry.
- **Working Relationship with NORPASS –** The establishment of a working relationship with the NORPASS program further expanded the reach of the Pilot Project and also demonstrated interoperability between E-screening programs.
- **Motor Carrier Outreach –** Initially, when motor carriers applied for E-ZPass accounts, they were not provided with adequate information about the Maryland Electronic Screening Program and the option of obtaining a Mark IV Fusion transponder. Vendor representatives have since been provided with training and informational materials, and a more comprehensive marketing and outreach program has been established. To this end, the inclusion of the motor carrier industry, in particular the state trucking associations, in promoting the project has been of significant benefit. Outreach efforts have been targeted to association members as well as to E-ZPass account holders, and the industry has played an active role in promoting the program.

Connecticut has not yet deployed an operational E-screening program, due to a number of challenges beyond the control of the Connecticut evaluation team. These have included state-wide budget reductions, which delayed the project startup, and technical challenges such as the State needing to replace all mast arms used on the highway system. The latter included the mast arms being used for the AVI readers at the Union Weigh Station. The institutional and technical challenges related to E-screening are from the Maryland deployment.

As was noted in Section 4.6, Customer Satisfaction, a policy change made by the IAG, while not directly related to the project, has had an impact on the project. The IAG agencies discontinued the use of the ticket books that motor carriers purchased in bulk to obtain a toll discount, thus requiring motor carriers to either enroll in ETC or pay cash. Motor carriers were also required to register for ETC in one state, a base state system similar to that used for IRP and International Fuel Tax Agreement. Previously, motor carriers would purchase ticket books in each state in which they operated and would obtain the issuing state's discount. Concurrent with this, the IAG also reduced the overall discount available to motor carriers and made discounts contingent on

transaction volume. Thus, from the perspective of the motor carrier industry, the implementation of ETC resulted in a reduced discount and a higher threshold needed to obtain a discount.

4.8 ETC IMPLEMENTATION CHALLENGES

Technical challenges experienced during the deployment of ETC in Maryland included:

- **Placement of cameras used to enforce ETC at the entrance to toll booths –** These were placed to photograph rear license plates of passenger cars to identify the owner for any necessary enforcement action. Given that the extended length of a power unit-trailer combination and that the trailer tag may not identify the actual motor carrier operating the power unit, this rear camera positioning created problems with enforcement. The MdTA has moved cameras to the toll booth exit location for the CMV lanes so that the tag on the power unit can be photographed.
- **Programming particular vehicle configurations into toll tags –** Toll tags were pre-programmed for a particular vehicle configuration. If a power unit with a toll tag did not meet the particular vehicle configuration, either too high a toll (requiring a lengthy process to obtain a refund) or too low a toll (resulting in possible enforcement action) would be assessed. The MdTA has since placed sensors along the access points to toll plazas to identify vehicle configurations and ensure that the system assesses the correct toll for the identified configuration.

4.9 E-SCREENING IMPLEMENTATION CHALLENGES

The two key challenges that have impacted the Maryland Electronic Screening Program are the lack of continuous operational capability of the E-screening system at Perryville and the lack of other weigh stations deploying E-screening systems throughout the northeast. Additional issues identified during the course of the project include:

- **The E-screening system deployed has not proven reliable –** MdTA personnel encountered hardware and software problems that have adversely impacted system performance.
- **Lack of a Configuration Management Process –** Initially, the E-screening system lacked a configuration management process as the project was intended only as a Proof-of Concept project **–**. As a result, adjustments to the system were not adequately documented. As the project evolved to a prototype project, a formal change management process has since been implemented.
- **Incomplete Integration –** The E-screening system was not fully integrated into the ongoing work flow of weigh station operations.

An additional consideration is that the State's Systems Development Life Cycle methodology and MDOT's project management processes were not utilized for the project. Using these methodologies and management processes would help ensure that the project is incorporated into Maryland's motor carrier program as a regular component of program operations.

The project has also identified the importance of supporting transponder administrator functions within a state. At present, one staff person responsible for following up on transponder administration also handles the enrollment for the Maryland Electronic Screening Program in

addition to other duties beyond supporting E-screening enrollment. Applications are received electronically through the Maryland Motor Carrier Website, but an end-to-end interface that will enable the E-screening system to electronically receive this data is still under development. Application information is then manually entered into the E-screening system. The State is working to develop an interface that will link the Maryland Motor Carrier Website and the E-screening system, but this has not yet been deployed.

As with many deployments of new systems and technologies, many of the institutional and technical challenges that most adversely impacted the project were beyond the control of the Project Team. The primary issue encountered was that of the budget problems encountered by the participating states. Both Maryland and Connecticut were required to cut budgets to maintain State constitution-mandated balance budgets. The result was that funds required for the deployment of electronic screening infrastructure were reduced or not available, and staff resources were reduced, which required the remaining staff to absorb increased workloads to maintain current program activities.

In addition, a new governor was elected in Maryland prior to deploying the electronic screening infrastructure at other weigh stations. The new administration requested that MDOT undertake a review of the E-screening program to determine if further deployments would be cost effective under current budget constraints. This study has been completed, and further delayed the E-screening deployment in Maryland.

The net result of these issues was that no other weigh station along the northeastern section of the I-95 Corridor is equipped for electronic screening beyond the Maryland Perryville facility. This offers no incentive to the industry to participate in electronic screening, as there is no perceived benefit from having access to only one facility.

An additional, and rather curious, consequence of the delay in deploying E-screening has been the impact on maintaining the electronic screening software deployed at Perryville. The initial intent was that this same software would be used by all weigh stations in Maryland to operate the electronic screening system. However, as a result of the deployment delays, Perryville is the only weigh station both using and supporting the software. The anticipated economies of scale, where agencies would be able to share operations and maintenance costs, have not been realized and the software now stands as a custom application rather than a production deployment. This has made it somewhat difficult for the MdTA to obtain the resources needed to properly support the application, as other IT needs that support other day-to-day operations have been given priority.

Another complicating factor has been that participating agencies have seen extensive changes in management and senior staff. While this is not uncommon in a state government setting, the end result has been that each time a new manager arrives, technical staff must provide briefings to bring the manager up-to-date on project activities. In some instances, project stakeholders commented that a subsequent result was that new managers sometimes disagreed with existing requirements or added additional requirements, further complicating development and deployment efforts.

The tragic events of September 11, 2001, and the resulting color-coded security alert system adopted by the Department of Homeland Security also adversely impacted the project. Enforcement personnel reported that any time the security alert was elevated to Code Orange, all bypassing of trucks at weigh stations, in particular hazardous materials carriers, was suspended and all trucks were ordered to enter weigh stations. From a national security

viewpoint, this is a very appropriate measure to be taking; however, this action does counter the established CVISN concept of electronic screening and weigh station bypass actions to provide for transport efficiencies.

5.0 EVALUATION FINDINGS AND LESSONS LEARNED

5.1 EVALUATION FINDINGS

Following are the composite findings resulting from this Pilot Project:

- **Finding #1: The Pilot Project successfully demonstrated that interoperable applications using a single transponder are both technically and institutionally feasible** – As a result of the cooperative working relationship established between the IAG and MDOT, motor carriers have been able to use the Mark IV Fusion transponder for both ETC and E-screening, as reported during the Motor Carrier Focus Groups.

  As is noted in this report, the ETC and E-screening systems used different roadside reader systems that are not interoperable. The approach used by the Pilot Project of having the manufacturer assign separate identifier numbers for each application has successfully enabled motor carriers to participate in both the E-ZPass program and the Maryland Electronic Screening Program.

  The working relationship established between the Maryland Electronic Screening Program and NORPASS has enabled motor carriers to successfully participate in two separate E-screening programs.

  As reported during the Maryland Enforcement and Motor Carrier Focus Groups, motor carriers enrolled in the Maryland Electronic Screening Program did receive “green light” signals using the Mark IV Fusion transponder. A “green light” is the E-screening signal that notifies a motor carrier driver that he or she does not have to enter a weigh station and may bypass the facility.

- **Finding #2: The Pilot Project successfully demonstrated that the CVISN model of electronic screening, where motor carriers are issued a transponder but not given a guarantee that simply having the transponder will result in a weigh station bypass, is both technically and operationally feasible** – Both motor carriers and the MdTA enforcement personnel stationed at the Perryville Weigh Station confirmed that trucks were being issued electronic bypass messages (green lights) during E-screening operational periods. The ROC at Perryville maintains a record of all such transactions. In the focus group, motor carriers confirmed that they had enrolled in the Maryland Electronic Screening Program and had been receiving bypass notices at the Perryville Weigh Station.

  The Maryland Electronic Screening Program does not pre-screen carriers to determine bypass eligibility, and instead relies on information contained in a motor carrier snapshot downloaded to the electronic screening computer at Perryville. Bypass determinations are made based on the information contained in these snapshots, and these determinations are made on a real-time basis using this data.

- **Finding #3: The results of the mobility and efficiency tests demonstrate that interoperable applications do result in quantifiable benefits to the motor carrier industry** – These results also demonstrate that the greater the number of interoperable

applications incorporated into a single transponder, the greater the benefit to industry and the greater the potential incentives for industry to obtain transponders and participate in these programs. The estimated benefits realized by industry through participation in ETC and E-screening, when combined through interoperability, double in value. This significant increase in benefits from interoperability is the strongest incentive that can be offered to industry – use of a transponder to save time and money.

- **Finding #4: The application of ITS/CVO technologies and systems produces significant environmental benefits through reduced truck idling and emissions –** The environmental benefits obtained through ITS deployment in general, and ITS/CVO in particular, increase the potential sources of funding that a state is eligible to use and also expands the stakeholder community beyond DOTs and enforcement agencies. This is particularly true for states with significant non-attainment areas – an ITS/CVO deployment that also produces an environmental benefit will be of interest to Metropolitan Planning Organizations (MPOs) and state environmental agencies, and may enable a state to use sources of funding such as from the Congestion Mitigation and Air Quality (CMAQ) Improvement Program.

Table 5-1 summarizes findings by each evaluation goal.

Table 5-1. Evaluation Goals, Hypotheses, MOEs, and Findings

Goal	Hypothesis	MOE	Findings
Improve mobility at weigh stations and toll collection facilities.	ETC and E-screening will improve the mobility of transponder-equipped commercial vehicles at weigh stations and toll collection facilities.	Travel time through facilities. Travel time variability through facilities. Number of commercial vehicles passing through weigh stations per day.	Travel times through weigh stations and toll plazas show statistically significant time savings from the use of a transponder. Unweighted time savings at toll facilities ranged from 13 to 55 seconds. Unweighted time savings at weigh stations averaged 68 seconds. Detailed results showing travel time savings by time of day and by facility are included in Section 4.2
Improve safety.	Carriers with transponders will maintain compliance with safety standards. Enforcement personnel will be better able to identify non-compliant or unsafe carriers. Crash rates involving commercial vehicles will be reduced at both weigh stations and toll facilities. Station closings due to ramp	Number of compliant carriers with transponder inspected per day. Out-of-service rates for transponder-equipped and non-transponder-equipped vehicles. Crash rates. Number of times stations must close per day due to ramp back-ups when	This goal was not met due to the limited market penetration of electronic screening services in the study area and a resulting lack of the data needed to conduct the analysis. See Section 4.3 for a more detailed discussion of this issue.

Goal	Hypothesis	MOE	Findings
	backups onto the mainline when station is operating at capacity based on traffic volume will be reduced.	stations are operating at capacity based on traffic volume, and duration of closures.	
Improve efficiency of motor carrier operations for government and industry.	Data sharing will improve inter-agency coordination, thereby improving efficiency of motor carrier operations. Enforcement agencies will establish standardized criteria for bypass, inspection selection, and other enforcement activities to improve identification of non-compliant carriers.	Costs associated with reduced fuel consumption and travel time. Costs associated with enforcement activities (number of enforcement officials, hours of operation). Number of inspections on one trip. Agency procedures and policies.	Per event savings at toll plazas ranged from $0.26 to $1.09. Per event savings at weigh stations ranged from $0.63 to $2.15. See Section 4.4 for a more detailed presentation of per event savings.
Reduce fuel consumption and emissions at toll facilities.	With reduced delays and idle time, fuel consumption and emissions will be reduced.	Vehicle delays. Fuel consumption. Estimated emissions reductions.	VOC emission reductions ranged from 30.8% to 35.4% at toll plazas, depending on travel speed, and 43.5% to 50% at weigh stations, depending on travel speed. Similar reductions for CO ranged from 23.5% to 29.4% and 33.2% to 41.5%, respectively. Similar reductions for NOX ranged from 5.8% to 7.9% and from 8.3% to 11.1%, respectively. See Section 4.4 for a more detailed discussion of findings.
Improve customer satisfaction.	The use of one transponder for both ETC and E-screening will help promote industry acceptance and use. Drivers will perceive a time savings association with use of the technology. Enforcement officials will benefit from the carriers' use of the technology.	Industry acceptance/ endorsement of technology. Incentives offered by state agencies to encourage use of transponders. Drivers' perceived time savings. Enforcement officials' assessment of technology and perception of benefits.	Overall, the industry perceives ETC to offer significant benefits, although several of the changes made as part of the ETC program implementation (for example, a reduction in volume discounts) were identified as concerns. Drivers also indicated acceptance of ETC. E-Screening acceptance is at best mixed, in part

Goal	Hypothesis	MOE	Findings
			due to the limited market deployment of the program in the study area. Motor carriers perceive a benefit, but the enforcement community still expresses concerns about issuing bypass signals to motor carriers. See Section 4.5 for a more detailed discussion of findings.

5.2 LESSONS LEARNED

Following are the composite lessons learned:

- **Lesson Learned #1: Flexible Approach to Project Management** – Without question, one of the key successes of the project has been the flexible approach to project management adopted by the Project Team. This approach supported the mid-term project review that resulted in the re-scoping of the project to eliminate the transponder subsidy for the motor carrier industry and to reallocate funds to support the development of on-line program enrollment capabilities. This flexible approach also enabled the Project Team to leverage the policy changes that enabled the creation of super accounts, thus enabling the creation of Best Pass, PrePass Plus, and the extensive outreach efforts by MMTA and NYSMTA to promote their super accounts.

- **Lesson Learned #2: Need for Process Re-Engineering** – The management structure established by MDOT to oversee the ETC/E-screening deployment in Maryland included all the appropriate stakeholder groups, was led by a project manager, and included technical staff. Unfortunately, while the deployment was successfully completed, it does not appear that the process re-engineering needed to integrate E-screening into ongoing MdTA and other State agency programs was fully successful. ETC for CMV, however, has been successfully integrated, as evidenced by the significant levels of market penetration and the processes by which MdTA has successfully addressed initial deployment problems.

With respect to E-screening, the process re-engineering challenges include:

- **Systems Engineering** – Given that the project was deployed as a Pilot Project, the E-screening system was not developed within the existing MDOT IT infrastructure and did not utilize the existing systems engineering processes established for the State. Although the intent was to bring on a third-party vendor to provide ongoing maintenance and support, the delays in state-wide deployment of E-screening resulted in this support being provided by MdTA IT staff that did not have adequate familiarity with the system.

  Such systems development should be done using the existing processes and methodologies established for the deploying agency. This approach ensures that the system will be integrated with existing systems, and in turn, be included in technical and budget

processes. This approach will also ensure that the appropriate documentation is developed to support long-term operations.

- **Human Factors** – The system was not fully integrated into the daily work flow of the Perryville Weigh Station, and as a result, did not provide the anticipated level of benefit. It is critical that the deployment of such systems include a human factors assessment that integrates E-screening, or any new system, into the daily work processes of staff that will be using the system. This may include a re-design of consoles or workstations, training, or restructuring of work assignments. An assessment should be done to determine how to integrate a new activity such as E-screening with existing work activities and processes.

- **Business Model** – While MdTA and MDOT provided full support to the project, the project did introduce a new business process (E-screening) to the agency that did not fit with the agency's existing business model. Introducing such a new program, in particular, one that requires an extensive level of budget and technical support, requires much: that senior management buy into the program; necessary resources are allocated; and make necessary operational changes needed to integrate a new program into the existing business model.

6.0 RECOMMENDATIONS FOR FUTURE STUDY

6.1 RECOMMENDATION #1: EXPANDED ENVIRONMENTAL IMPACT ASSESSMENT

The 1990 Clean Air Act Amendments (CAAA) significantly increased the attention paid to the relationship between transportation modes and emissions. The CAAA imposed National Ambient Air Quality Standards (NAAQS) for critical pollutants, and also established schedules to attain these standards linked to the level of severity and type of pollutant. The CAAA also required that states establish State Implementation Plans (SIPs). The SIPs detail the State Action Plan that would be implemented (including the surrounding region, as required) to achieve the standards.

The 1991 ISTEA established a conformity requirement in support of the CAAA. Under ISTEA, states are required to develop annual Transportation Improvement Programs (TIPs) that conform with the SIP. The intent of these plans is to ensure that a State or region does not implement a transportation program that is contrary to the SIP or has the potential to increase rather then decrease emissions.[33]

Under the CAAA, the majority of the northeast and Mid-Atlantic States, as well as the District of Columbia, include metropolitan areas or counties that are classified as non-attainment areas (i.e., that have not met the NAAQS established through the CAAA). These states have implemented a number of strategies for reducing emissions, including the testing of emissions from on-road mobile sources.[34] The Environmental Protection Agency (EPA) has determined that on-road mobile sources

> …collectively are the single greatest contributor in this country to carbon monoxide pollution and to ground-level ozone, the major component of smog. In typical polluted cities, vehicles contribute between 35 and 70 percent of ozone-forming emissions and 90 percent or more of carbon monoxide emissions. Ambient concentrations of one or both of these pollutants exceed national air quality standards in virtually every major urban area of the country.[35]

The environmental analysis conducted for the evaluation demonstrates the potential environmental benefits that can be obtained through the deployment of ITS/CVO technologies and systems. Given this impact, it is recommended that consideration be given to conducting a more comprehensive Environmental Impact Assessment using actual emissions data. If implemented, this test would be conducted by outfitting commercial vehicles (CV) with equipment that measures actual emissions, and then having these CV pass by weigh stations and toll plazas. The test would measure the difference in emissions from a bypass at a weigh

[33]Adapted from FHWA Report No. PD-97-051, "Air Quality Impacts of Intercity Freight, Volume I: Guidebook", Section 4.1.
[34]On-road mobile source emissions are generated by motor vehicle operations on public roads and highways, including passenger/light duty cars and trucks, motorcycles, and heavy duty vehicles (trucks and buses). Heavy-duty vehicles are subdivided into gasoline- (HDGV) and diesel- (HDDV) powered vehicles. Accessed from EPA Web link: http://www.epa.gov/otaq/invntory/overview/examples.htm.
[35]Accessed from EPA Web link: http://www.epa.gov/reg3artd/vehicletran/vehicles/vehicle_emissions_testing.htm.

station as compared to entering a weigh station and passing through a sorter ramp or the static scale. The test for ETC would be done in a similar manner by capturing the emissions difference from using ETC as compared to stopping at a plaza and paying cash.

It is further recommended that this test be done with several different types of commercial vehicles and CV engines so as to accurately model actual commercial vehicle traffic that passes by a particular facility. The test should also be done at different times of day and night and at different times of the year. The suggested testing protocol would enable measuring the impact of varying traffic flows at different times of day and night, as well as enable the ability to estimate seasonal impacts. The rationale for this recommendation is as follows:

- Many states in the I-95 corridor have significant non-attainment areas.
- Capturing environmental benefits available from the deployment of ITS/CVO has the potential to expand the stakeholder base supporting these deployments. If the ETC or E-screening deployment can be shown to have an emissions reduction benefit, MPOs, state environmental agencies, and other interest groups may be brought into the stakeholder community – thus expanding the support for obtaining funding and resources from senior management and elected officials.
- Capturing environmental impacts also expands the potential for obtaining funding from new sources (for example, CMAQ).
- If implemented, it is recommended that the assessment be structured as a 1-year test to enable the complete estimation of environmental impacts with seasonal variations included.

6.2 RECOMMENDATION #2: EXPANDED SAFETY STUDY

As indicated previously, the data needed to conduct the Safety Test was not available during the period of performance for the evaluation. It is recommended that consideration be given to conducting the Safety Test when the degree of market penetration has reached the point where statistically valid data can be obtained. As an alternative, consideration may be given to obtaining data from an existing program to conduct the test.

As part of the project literature review, the Evaluation Team reviewed existing studies on commercial vehicle safety to determine if any previous studies had assessed the safety impacts of electronic screening. While many studies have been conducted to analyze the benefit cost ratios and safety improvements of programs like CVISN and the Inspection Selection System (ISS), it was determined that to date, there are no studies of record that assess the correlation between the use of transponders and impacts on commercial vehicle safety.

The Evaluation Team did identify some studies that have examined certain aspects of transponder use and commercial vehicle safety. In the paper titled *Benefit-Cost Assessment of the Commercial Vehicle Information Systems and Networks (CVISN) in Maryland*,[36] safety is considered a benefit and the implementation of transponders a cost. The analysis concludes that the benefits of CVISN outweigh the costs. However, this presents no real information on the correlation between transponders and safety, only that the study team made the assumption

[36] *Benefit-Cost Assessment of the Commercial Vehicles Information Systems and Networks (CVISN) in Maryland, p*age 16 of 98, accessed from: http://www.eng.morgan.edu/~ntc/Final.pdf.

that "the accident rate due to commercial vehicles will decrease, assuming that carriers who have transponders can be identified for safety enforcement."[37]

In the paper titled *Maryland Motor Carrier Program Safety Profile of Commercial Motor Carriers Traveling in Maryland at the Perryville Scale House Under the Jurisdiction of the Maryland Transportation Authority Police,* [38] there is little or no discussion of transponders. The transponders are only referred to in conjunction with the CVISN project, where they are assumed to improve upon the identification process,[39] thus implying that the use of transponders helps to identify those vehicles posing a safety risk. However, the paper does not show a significant relationship between transponder use and transportation safety.

Future research is needed to assess the relationship between the presence of transponders and increased safety benefits, hence this particular recommendation. If such research is conducted, the safety test developed for this evaluation represents an excellent resource for the development of any experimental design.

6.3 RECOMMENDATION #3: IDENTIFICATION OF OPPORTUNITIES FOR EXPANDING INTEROPERABILITY

The results of the Efficiency Test indicate that the best way to promote the use of transponders in commercial vehicles is to expand interoperable applications. The economies of scale generated by interoperability offer a strong potential value added service to motor carriers, and it is this added value that will attract industry.

It is recommended that consideration be given to identifying additional opportunities for expanding interoperability. As noted in Section 1 of this report, the Eastern Seaboard is home to some of the more congested regions of the country. As freight movement increases, identifying opportunities to use transponders to assist with congestion mitigation and management at seaports, airports, and intermodal facilities, in addition to applications such as ETC and E-screening, offers one option available to the I-95 Corridor Coalition member states to expand interoperability within the region.

If such a study is conducted, it is further recommended that the scope of the study include the following:

- Identify potential interoperable applications and assess the potential market for each particular application.
- Identify potential institutional and technical challenges that may impede deployment.
- Identify, at a high level, the technical requirements that would need to be addressed.
- Identify stakeholder groups who would need to be involved in establishing additional interoperable applications.

[37] *Benefit-Cost Assessment of the Commercial Vehicles Information Systems and Networks (CVISN) in Maryland, p*age 16 of 98, accessed from: http://www.eng.morgan.edu/~ntc/Final.pdf.
[38] *Maryland Motor Carrier Program Safety Profile of Commercial Motor Carriers Traveling in Maryland at the Perryville Scale House Under the Jurisdiction of the Maryland Transportation Authority Police, p*age 66 of 72.
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