U.S. Department of Transportation

Federal Motor Carrier Safety Administration

The Motor Carrier Efficiency Study 2007 Annual Report to Congress

A Report Pursuant to Section 5503(d) of the
Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
(P.L. 109-59)

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Executive Summary

Section 5503 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) set aside funding to examine the application of wireless technology to improve the safety and efficiency of trucking operations in the United States. The intent is to enter into a partnership with the motor carrier and wireless technology industries to cooperatively identify and test promising applications and devices in a "real-world" environment, and to promote the adoption and use of successful solutions by a broad array of motor carriers.

The specific objectives of the Motor Carrier Efficiency Study (MCES) include the following:

1. Identify inefficiencies in freight transportation.
2. Evaluate safety and productivity improvements made possible through wireless technologies.
3. Demonstrate wireless technologies in field tests.

In addition to the objectives above, the scope of the MCES also consists of the following five program elements:[1]

1. Fuel monitoring and operations management systems.
2. Radio frequency identification technology.
3. Electronic manifest systems.
4. Cargo theft prevention and security.
5. Roadside safety inspection systems.

The Federal Motor Carrier Safety Administration (FMCSA) was assigned responsibility for administering this program and has completed specific actions pursuant to its provisions. The FMCSA developed and issued a full and open solicitation for contractor teams to conduct Phase I of the program. This phase consists of the completion of activities related to objectives 1 and 2 above, and the recommendation of field tests according to objective 3. The actual field tests will be conducted under Phase II of the program. In September 2006, FMCSA awarded a performance-based contract to a consulting team led by Delcan, Inc., to perform the first phase. Delcan completed Phase I and submitted the *Motor Carrier Efficiency Study Phase I Final Report* to FMCSA in January 2008. The report can be found at www.fmcsa.dot.gov. This 2007 Report to Congress summarizes the key activities and findings from the Phase I Final report.

The Study Team, led by Delcan, organized the Phase I tasks into a work plan that included the following tasks:

- Gathering and analyzing existing literature regarding freight system inefficiencies and the application of wireless technologies.

[1] As discussed in the report, FMCSA updated the minimum set of program elements listed in Section 5503(b) to include the modified Fuel Monitoring and Operations Management Systems and the new Roadside Safety Inspection Systems program element to broaden the wireless safety technology applications under this program.

- Adapting and calibrating an analysis tool that will facilitate the comparative assessment of candidate technologies for benefits and costs.
- Stakeholder outreach sessions to capture information regarding baseline freight performance, user needs, performance measures, and feedback regarding technology options.
- A detailed analysis of current inefficiencies and opportunities for improvement in processes, methods, and tools.
- Identification and preliminary benefit cost analysis of specific wireless technology solution sets.
- Development of conclusions regarding the findings from Phase I and for the conduct of Phase II.

In the above tasks, the Study Team located and reviewed over 200 individual documents and online resources. The team gathered further information on inefficiencies and wireless technology solutions by completing eight stakeholder sessions at seven locations throughout the United States and by setting up expert resource groups to help fill key data gaps in the benefit cost analysis. In all, the Study Team engaged over 1,000 representatives from the motor carrier industry and wireless technology industry during the Phase I effort.

Phase I

The MCES Literature Review revealed that motor carrier operations, specifically profitability and safety, are subject to a broad array of inefficiencies. The Study Team identified a total of 43 separate types of inefficiencies across the following seven categories:

- Equipment/asset utilization.
- Fuel economy and fuel waste.
- Loss and theft.
- Safety losses (i.e., crashes).
- Maintenance inefficiencies.
- Data and information processing.
- Business and driver management.

The results of the detailed inefficiency analysis conducted as part of the study estimated that the motor carrier community incurs financial losses in the tens of billions of dollars per year. The most frequently noted and costly inefficiency identified by motor carriers is "time loading and unloading." This inefficiency is estimated to cost motor carriers over $3 billion annually. The value of this inefficiency doubles to over $6 billion annually when both motor carrier and societal costs such as environmental, safety, and mobility costs are included.

The Study Team, working from suggestions offered by motor carrier stakeholder representatives and with input from FMCSA, formulated several wireless technology solution sets to address the identified inefficiencies. The potential benefits and costs of these proposed wireless solution sets were estimated using the Federal Highway Administration's (FHWA) Freight Technology Assessment Tool (FTAT). The results from the FTAT showed that several of the wireless technology solution sets offer estimated benefit-cost ratio values in excess of 2:1. These solution sets are Border Crossing Tracking, Virtual Queueing, Variable Speed Limiter, Cross-Town Intermodal Interchange, and Untethered Trailer Tracking Systems. These are promising results, particularly when 7 out of the 10 solution sets have an internal rate of return for these applications that exceeds 30 percent. The results for most of the applications improve as the level of deployment increases, and if they are deployed by carriers already using wireless devices (e.g., cellular telephones or satellite tracking systems), for other purposes.

With few exceptions, the common thread running through the priority inefficiencies is delay caused at least in part by the actions (or lack thereof) of a party external to the carrier. Perhaps more evident, however, is that each of these inefficiencies has the potential to be mitigated by improving the quality, accuracy, and timeliness of data held by one or more of the stakeholders (public and private sectors) and the degree to which the data are exchanged and used for decisionmaking.

Under such circumstances, it would appear that wireless technologies, which are primarily mechanisms to accurately capture and exchange information, could offer the means to bring significant relief to the carrier community. Given that an enhanced level of situational awareness is vital to mitigating these inefficiencies, it is logical that wireless systems that promote that enhancement would be of some value to motor carriers that experience these inefficiencies.

Based on the evidence gathered during the identification of industry inefficiencies in Phase I of the MCES, it is reasonable to conclude that ample opportunity exists for applying technology to construct creative solutions to address real, specific needs within the carrier community. The role wireless systems might play seems less clear, but the analysis suggests that the potential exists for measurable positive effects.

Phase II

Phase II of the program will consist of several pilot demonstrations. In these demonstrations, promising wireless technologies will be deployed under realistic operating conditions. During this period, industry and government partners will assess the degree to which the solutions improve safety and operations consistent with the program objectives. The goal for these pilots is to provide sufficient evidence to support investment decisions for the Federal Government, the technology provider, and the user community.

Based on recommendations from the Study Team, FMCSA, along with its multi-modal team with representatives from FHWA, the Department’s Office of the Secretary (OST), and the Research and Innovative Technology Administration’s Bureau of Transportation Statistics (BTS), will focus Phase II pilot demonstrations on applications within the four broad program areas mentioned above. In the remaining years of the program, pilot demonstrations in Phase II will focus on demonstrating wireless capabilities that allow motor carriers to do the following:

- Reduce the amount of time waiting to be loaded or unloaded or to access the facilities where these activities are performed.
- Reduce empty trips, particularly when interchanging loads between intermodal facilities.
- Reduce delays entering the United States at international border crossings.

- Reduce the frequency and duration of delays associated with congestion – particularly congestion associated with traffic incidents.
- Reduce fuel consumption.
- Reduce the risk of having a crash or being placed out of service due to failures of equipment or driver-related factors (hours of service, commercial drivers license, etc.).
- Reduce the risk of having a crash due to excessive speed or other driver errors.
- Reduce empty miles.

Introduction

Genesis of the Program – SAFETEA-LU Legislation

A flexible, responsive, efficient, and cost effective trucking network is essential to the health of any freight system. With very few exceptions, the global supply chains that underpin the United States economy are heavily reliant upon a vital trucking industry to make the system perform. With overall freight volumes projected to continue to increase dramatically, the industry can expect pressures to enhance performance accordingly.

To some degree, advancements in operating methods, such as more tightly integrated supply chain management practices, and the injection of innovative technologies, have helped to improve efficiency. Electronic roadside screening and weigh station bypass initiatives provide cost savings for carriers, as do wireless radio-frequency identification devices (RFID) at international border crossings, satellite-based fleet management and communications systems, and more simple cellular telephone-based applications.

For a portion of the trucking industry – namely the larger common carriers and private fleets – these technologies have helped to streamline operations, leading to higher profitability. Although per-event gains remain modest, the volume of freight these carriers transport allows them to enjoy the benefits of economies of scale. As a result, for these carriers, and their supply chain partners, advanced wireless technologies provide real value.

In addition to offering improvements in efficiency, such technology investments often serve to enhance operational safety and security, both directly and indirectly. Electronic screening applications that incorporate biometric identification capabilities help to ensure that only authorized personnel are granted access to secure facilities and sensitive materials. The electronic screening applications also serve as key components of border crossing applications.

The indirect benefits, particularly to the public, are equally significant. Wireless technologies already play an important role in motor carrier safety enforcement activities, size and weight enforcement activities, as well as for State infrastructure and transportation planning purposes. The result is safer trucks, safer roadways, increased freight mobility, and improvements in the environment, economy, and transportation efficiency. Further, carriers that are making a healthy profit are less inclined to cut corners on safety or security measures.

There are, however, a number of opportunities to dramatically improve the health of the industry as a whole. For instance, a significant fraction of the domestic trucking "fleet" rests in the hands of owner-operators. These small business owners, many of whom are tasked with managing all aspects of their businesses and driving their trucks, historically have not had the resources to invest in sophisticated technologies. As a result, they struggle to remain competitive.

The challenge is to identify and exploit these opportunities to ensure that all segments of the carrier industry can benefit. Larger carriers would then be able to continue to reduce operating costs and smaller carriers – who perform critically important services – could share in the promise of these advancements. This can only happen if they can afford to invest in technologies that allow them to mitigate the negative effects of the challenges they face, and to extract an extra measure of profitability from their operations.

Congress sought to address these needs by incorporating language into SAFETEA-LU that both promotes the application of innovative wireless technologies to trucking operations, and provides seed money to fund pilot demonstrations. Section 5503 of SAFETEA-LU stipulates that funding totaling $1,250,000 per year from Fiscal Year 2006 through Fiscal Year 2009 be utilized to conduct a study to identify these opportunities, and to conduct field tests in cooperation with the motor carrier industry and the wireless technology industry.

Assignment of Responsibility to FMCSA

The primary mission of FMCSA is to reduce crashes, injuries, and fatalities involving large trucks and buses.[2] In carrying out its safety mandate, FMCSA:

- Develops and enforces data-driven regulations that balance motor carrier (truck and bus companies) safety with industry efficiency.
- Harnesses safety information systems to focus on high-risk carriers in enforcing the safety regulations.
- Targets educational messages to carriers, commercial drivers, and the public.
- Partners with stakeholders including Federal, State, and local enforcement agencies, the motor carrier industry, safety groups, and organized labor on efforts to reduce bus and truck-related crashes.[3]

In pursuit of its mission, FMCSA regularly engages in cooperative technology research and development with the motor carrier community. Though care is exercised to maintain the integrity of the Agency's regulatory responsibilities, the Agency routinely collaborates with industry leaders and technology vendors to define and examine innovative solutions to challenges facing the industry.

Since its formation by the Motor Carrier Safety Improvement Act of 1999, FMCSA has sought to reduce the number and severity of commercial motor vehicle (CMV) crashes and enhance the efficiency of CMV operations by doing the following:

- Conducting systematic studies directed toward more thorough scientific discovery, knowledge, or understanding.
- Adopting, testing, and deploying innovative driver, carrier, vehicle, and roadside best practices and technologies.

[2] FMCSA Web site: http://www.fmcsa.dot.gov/about/what-we-do/mission/mission.htm
[3] FMCSA Web site: http://www.fmcsa.dot.gov/about/what-we-do/strategy/strategy.htm

By expanding the knowledge and portfolio of deployable technology, the research and technology program helps FMCSA reduce crashes, injuries, and fatalities and deliver a program that contributes to a safe and secure commercial transportation system.[4] In pursuit of these goals, the FMCSA's Office of Analysis, Research and Technology developed a set of strategic objectives that it relies upon to guide its work. These objectives include the following:

- **Produce Safer Drivers:** Research techniques that help to ensure commercial drivers are physically qualified, trained to perform safely, and mentally alert.
- **Improve Safety of CMVs:** Improve truck and motorcoach performance through vehicle-based safety technologies.
- **Produce Safer Carriers:** Support efforts to improve carrier safety by applying safety management principles, compiling best management practices, communicating best practices, and supporting the Agency's enforcement of carrier-related regulations.
- **Advance Safety Through Information-Based Initiatives:** Improve the safety and productivity of CMV operations through the application of information systems and technologies.
- **Improve Security Through Safety Initiatives:** Develop and implement safety initiatives that also have security benefits for truck and motorcoach operations.
- **Enable and Motivate Internal Excellence:** Improve performance to serve the customers and stakeholders of the Research and Analysis Divisions more effectively and economically.

Consistent with its stated mission, goals, and objectives, and in acknowledgement of its comprehensive knowledge of the motor carrier industry, the FMCSA's Office of Analysis, Research and Technology was assigned the responsibility to administer the requirements set forth in Section 5503.

[4] FMCSA Web site: http://www.fmcsa.dot.gov/facts-research/research-technology/mission/ra.htm

SAFETEA-LU Section 5503 Directives

Specific Language

On August 10, 2005, the President signed the SAFETEA-LU legislation designed to improve the Nation's highway safety, modernize roads, reduce traffic congestion, and create jobs. Title V of the legislation specifies the various research initiatives that are to be undertaken, with a total budget authorization of $196,400,000 for each fiscal year from 2005 through 2009 set aside for the “surface transportation research, development, and deployment program.” In authorizing the provisions of Title V, Congress issued the following findings:[5]

> (1) Research and development are critical to developing and maintaining a transportation system that meets the goals of safety, mobility, economic vitality, efficiency, equity, and environmental protection.
>
> (2) Federally sponsored surface transportation research and development has produced many successes. The development of rumble strips has increased safety; research on materials has increased the lifespan of pavements, saving money and reducing the disruption caused by construction; and Geographic Information Systems have improved the management and efficiency of transit fleets.
>
> (3) Despite these important successes, the Federal surface transportation research and development investment represents less than 1 percent of overall Government spending on surface transportation.
>
> (4) While Congress increased funding for overall transportation programs by about 40 percent in the Transportation Equity Act for the 21st Century, funding for transportation research and development remained relatively flat.
>
> (5) The Federal investment in research and development should be balanced between short-term applied and long-term fundamental research and development. The investment should also cover a wide range of research areas, including research on materials and construction, research on operations, research on transportation trends and human factors, and research addressing the institutional barriers to deployment of new technologies.
>
> (6) That it is in the United States interest to increase the Federal investment in transportation research and development, and to conduct research in critical research gaps, in order to

[5] Excerpted from Section 5103 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, August 2005.

ensure that the transportation system meets the goals of safety, mobility, economic vitality, efficiency, equity, and environmental protection.

This language clearly articulates congressional direction regarding the value of and need for research to improve the safety and efficiency of the transportation system. Among the priorities delineated in SAFETEA-LU is the need for a significant effort towards applying technology to improve freight transportation operations. Section 5503 of the law specifically addresses this need, and directs the efforts of the Executive Branch (and by extension, the U.S. Department of Transportation) in carrying out its provisions. The specific text of Section 5503 is provided herein for reference:

"SEC. 5503. MOTOR CARRIER EFFICIENCY STUDY.

(a) In General.--The Secretary, in coordination with the motor carrier and wireless technology industry, shall conduct a study to--

(1) identify inefficiencies in the transportation of freight;

(2) evaluate the safety, productivity, and reduced cost improvements that may be achieved through the use of wireless technologies to address the inefficiencies identified in paragraph (1); and

(3) conduct, as appropriate, field tests demonstrating the technologies identified in paragraph (2).

(b) Program Elements.--The program shall include, at a minimum, the following:

(1) Fuel monitoring and management systems.

(2) Radio frequency identification technology.

(3) Electronic manifest systems.

(4) Cargo theft prevention.

(c) Federal Share.--The Federal share of the cost of the study under this section shall be 100 percent.

(d) Annual Report.--The Secretary shall prepare and submit to Congress an annual report on the programs and activities carried out under this section.

(e) Funding.--Of the amounts made available under section 5101(a)(1) of this Act, the Secretary shall make available $1,250,000 to the Federal Motor Carrier Safety Administration for each of fiscal years 2006 through 2009 to carry out this section."

Interpretation for Purposes of Program Implementation

The FMCSA is primarily dedicated to the mission of enhancing the safety of motor carrier operations and, by extension, the overall safety of the motoring public. As such, the Agency's core research focus is on the application of technology to further this mission. However, it is important to note that because an efficient freight system that reduces delay and cuts operating costs ultimately delivers a safety benefit, there is a strong tie between the two, reinforcing the logic of assigning responsibility for the MCES to FMCSA.

Consistent with its safety mission, FMCSA evaluated the set of "minimum" program elements defined in the law and determined that it would be both appropriate and advantageous to include an additional element. With an ever-growing population of trucks and a relatively constant level of roadside inspection resources, this element, "Roadside Safety Inspection Systems," focuses on new automated approaches to roadside inspections that would target unsafe motor carriers while not hindering the operations of safe and legal operators. Such an approach could allow public safety agencies and carriers to improve both safety and efficiency. Motor carrier enforcement agencies currently conduct over 3.3 million safety inspections per year, each taking between 30 and 60 minutes.

Additionally, FMCSA has expanded the scope of the "Fuel Monitoring and Management Systems" program element to include fleet management practices that promote safe operations, which can also contribute to more efficient operations. The new program element, entitled "Fuel Monitoring and Operations Management," encompasses opportunities for applying wireless technologies that leverage safety innovations to improve efficiency.

The FMCSA is acutely aware of the challenges that face the commercial trucking community and is a strong partner with its members in the pursuit of operational, institutional, and technical enhancements that will promote a safe, efficient freight delivery system. With that in mind, FMCSA has defined a program to address the Section 5503 language that relies upon a collaborative partnership among government, trucking industry, and the vendor community.

Using rigorous research and technical assessment tools, FMCSA seeks to work with private industry partners to mitigate the risks associated with operational research and development of wireless technology. Conversely, FMCSA recognizes that the purpose of this legislation is not to replace what is typically privately funded research and development of technologies and applications, nor to serve as a promotional platform for specific products or devices. Throughout the program, measures will be taken to ensure that all activities are transparent and open, and that every effort is made to support the identification and evaluation of vendor-independent solutions.

Phase I Results

Because of the broad mandate to evaluate the impact of wireless technologies on safety and productivity in motor carrier freight transportation, FMCSA assembled a program management team. The team includes representatives from OST's freight and policy office, FHWA's offices of freight management and policy, and BTS. This joint program management team led by FMCSA continues to meet regularly with the charge to monitor and guide the program.

In September 2006, FMCSA awarded a performance-based contract to a study team led by Delcan to perform the first phase of the project. Delcan completed Phase I and submitted the *Motor Carrier Efficiency Study Phase I Final Report* to the FMCSA in January 2008. The report can be found at www.fmcsa.dot.gov. This congressional report summarizes the key activities and findings from the Phase I final report.

Phase I of the MCES focused on the application of wireless technologies to overcome common motor carrier inefficiencies. This report summarizes findings in the areas of wireless technologies (in general), motor carrier inefficiencies and potential economic gains in overcoming inefficiencies, proposed wireless applications, and the estimated benefits and costs of applying the proposed technology solutions within the motor carrier industry.

Process

The Phase I effort was divided into the following work tasks:

- Gathering and analyzing existing literature regarding freight system inefficiencies and the potential application of wireless technologies to these inefficiencies.
- Compiling pertinent background information for the analysis of the safety benefits and efficiencies that can be achieved through the use of various wireless technologies.
- Completing stakeholder outreach sessions and individual interviews designed to capture information regarding baseline freight performance, user needs, performance measures, and feedback regarding technology options.
- Isolating the inefficiencies recognized as most pressing by motor carriers and identifying evidence of their effects in order to enable the evaluation of potential solutions.
- Analyzing wireless technology solutions via feedback from industry representatives in the Expert Resource Groups and conducting a benefit-cost analysis using the FTAT.
- Completing task reports and the Phase I final report.

The MCES Literature Review provided an initial examination of common motor carrier inefficiencies extracted from more than 200 individual published sources or offered by several industry experts. Where appropriate, these inefficiencies were examined in the context of the various motor carrier industry segments (i.e., truckload, less-than-truckload, intermodal, etc.). In addition to this inefficiencies overview, the Literature Review provided a wireless technology primer with detailed specifications for wireless technologies available in today's marketplace and for those emerging from technology industry initial research and development.

The Study Team completed eight stakeholder outreach sessions around the United States, and conducted an analysis focused on identifying high-priority inefficiencies. The goal of this portion of the study was to narrow the list of potential challenges to which wireless technology solutions might be applied. Since an in-depth quantitative analysis of every inefficiency identified during the Literature Review was considered too large an undertaking for the scope of this study, the Study Team prioritized inefficiencies based on their relative importance to the carrier community as defined by the stakeholders representing the various segments of the motor carrier community.

The Study Team also examined the degree to which individual inefficiencies could be clearly defined, in both qualitative and quantitative terms, by members of the motor carrier community. Inefficiencies that met these basic conditions, and were cited on multiple occasions by Stakeholder Session participants as being significant issues for their operations (a subjective distinction based on stakeholders' perception of the inefficiencies as described in terminology used in the Literature Review in Task 1), were examined in depth.

Based on suggestions and feedback from the stakeholders, the Study Team was able to formulate concepts for eight different technology applications that might at least partly mitigate the effects of the identified inefficiencies. A ninth option – the expanded evaluation of an Untethered Trailer Tracking solution – constitutes a more thorough examination of existing capability and is included for completeness. In addition to these solutions, the Study Team examined in some depth solutions that are already commercially available to gain a better understanding of the potential benefits of expanded adoption levels. One wireless application reviewed was the use of RFID for weigh-station-bypass programs.

Before the execution of the FTAT analysis, the Study Team undertook a viability analysis to gain useful information regarding the relative opportunities and challenges associated with pursuing pilot demonstrations for each of these concepts. The Study Team constructed a subjective, comparative rating scale based on an initial analysis according to a number of issues. A benefit-cost analysis was developed for these 10 scenarios using FTAT. The FTAT is a decision support tool designed to assist decision-makers in evaluating the potential effects that adoption of emerging technologies could have on the performance of their transportation supply chain from both a qualitative and a quantitative perspective. This is achieved by examining the business processes within certain portions of a supply chain before and after the implementation of these technologies, and evaluating the effects against an array of performance metrics to select the option that will yield the best safety, productivity, cost, and efficiency improvements.

The FTAT is used to provide estimated technology implementation effects using several key financial measures. These measures allow users of FTAT to objectively compare the following financial impacts of the technologies being studied:

Minimum Attractive Rate of Return (MARR) – The rate used to discount future cash flows to determine the present value of those flows. A seven-percent MARR was used for this study based on guidelines in the Office of Management and Budget's circular A-94.3.
Net Present Value – The total discounted benefits minus the total discounted costs.
Internal Rate of Return (IRR) – The rate required to provide a net present value of zero.

Payback Period – The amount of time required to recoup the initial investment based on the anticipated net annual cash flow.
Discounted Payback Period – The amount of time required to recoup the initial investment based on the anticipated net annual cash flow discounted using the MARR.
Benefit Cost Ratio (BCR) – The ratio of the total discounted benefits to the total discounted costs.

Study Findings

The MCES Literature Review revealed that motor carrier operations, specifically profitability and safety, are subject to a broad array of inefficiencies. In all, the Study Team identified 43 separate types of inefficiencies across the following seven categories:

- Equipment/asset utilization.
- Fuel economy and fuel waste.
- Loss and theft.
- Safety losses (i.e., crashes).
- Maintenance inefficiencies.
- Data and information processing.
- Business and driver management.

The Literature Review served as the basis for discussion with motor carriers during the MCES Stakeholder Sessions. Table 1 summarizes the top inefficiencies identified by stakeholder groups as identified in the Stakeholder Sessions.

Table 1: Inefficiencies Identified by MCES Stakeholder Groups

Stakeholders	Priority Inefficiencies
Private Fleets	Hours of Service Fuel waste due to excessive speed
Less than Truckload Carriers	Waiting for unloading Congestion delay
Truckload Carriers	Waiting for unloading Fuel waste due to excessive speed
Pick-up and Delivery	Congestion delays
Cross-Border Carriers	Waiting time—cross-border wait times (processing, paperwork, infrastructure/capacity limitations) Congestion delay
Intermodal Carriers (Rail)	Waiting for loading Lack of backhaul
Intermodal Carriers (Port)	Waiting for loading Chassis roadability
Expedited Carriers	Congestion delays

Public Sector	Safety (crashes, noncompliance) Intelligent Transportation Systems integration (limited applications for motor carriers)
Private-Sector Technology	Waiting for loading/unloading Poor routing, scheduling and out-of-route miles

The results of the detailed inefficiency analysis conducted as part of the study are shown in Table 2. The total effects of these inefficiencies are significant. Based upon high-level calculations performed by the Study Team, it is estimated that the motor carrier community incurs financial losses of tens of billions of dollars per year.

Table 2: Identified Inefficiency Effects

Inefficiency	Potential Gain to Carriers	Potential Gain to Society
Time Loading and Unloading	$3.08 billion annually	$6.59 billion annually
Waiting in Ports	$900 million annually	Unknown
Paperwork Delay at Borders	$23 million annually	$50 million annually
Time in Weigh Stations	$215 million annually	$461 million annually
Incident-Related Delay	Unknown	Unknown
Urban Routing Problems	Unknown	Unknown
Management Tools	Unknown	Unknown
Vehicle Safety	Unknown	$1.55 billion annually
Driver Safety	Unknown	$1.35 billion annually
Compliance Review Inspections	Unknown	$23.1 million annually
Processing Capacity at Borders	$211,000 per Owner/Operator annually	Unknown
Driver Turnover	$8,200 per driver	Unknown
Excessive Speed	$1.6 million annually for one 150-truck carrier	Unknown
Cargo Theft and Pilferage	Unknown	$15-30 billion annually
Empty Intermodal Moves	$21 million annually in Chicago alone	Unknown
Empty Miles	$2.7 billion annually	Unknown
Vehicle Maintenance	$320 million annually	Unknown

Table 2 summarizes the potential gains for overcoming these inefficiencies both for carriers and for society, where societal gains include potential environmental, safety, and traffic congestion benefits (among many others) associated with overcoming the inefficiencies noted. Entries of "unknown" indicate that empirical evidence sufficient to calculate potential benefits was not available.

The wireless technologies examined offer various combinations of performance capabilities, such as range, data transfer rate, and power consumption, and imposed some preconditions on usage in the form of information exchange format and standards. They also have varying levels of technology maturity and user deployment. These characteristics, which are discussed in detail in Section 3.2 of the *Motor Carrier Efficiency Phase I Report*, are summarized in Table 3.

Table 3: Wireless Technology Characteristics

Technology	Characteristics				
	Data Rate	Range	Power Consumption	Maturity	Deployment Level
RFID	Low	Medium	Low	High	High
Digital Cellular	Moderate	Medium	Low	High	High
Bluetooth	Moderate	Short	Low	Moderate	Low
WLAN/WiFi	High	Short	Moderate	High	High
Satellite Tracking	Low	Long	Low	High	High
Satellite Communications	Low	Long	Moderate	Moderate	Moderate
Ultra-Wideband	High	Short	Moderate	Low	Moderate
WiMAX	Moderate	Medium	Moderate	Low	Low
Optical	Moderate	Short	Low	Moderate	Moderate
Zigbee	Low	Short	Low	Low	Low
Two-Way Radio	Low	Long	Moderate	High	High

In addition to the characteristics illustrated in the table, it is important to recognize that the level of supporting infrastructure – and the investment necessary to install and maintain it – can have a profound effect on a technology's usefulness as an enabler for needed capabilities.

The Study Team, working from suggestions offered by motor carrier stakeholder representatives, formulated high-level concepts for eight proposed wireless technology applications. These applications are discussed below, with the addition of the Untethered Trailer Tracking application added at the request of FMCSA:

- **Virtual Queueing –** an application that would reduce waiting for loading and unloading by allowing consignees to monitor and dynamically reschedule dock operations to compensate for delays due to congestion, traffic incidents, or delays in a truck's departure from the shipment origin.

- **Driver Acuity Monitoring** – an application that would permit a carrier to remotely monitor driver behavior characteristics indicative of fatigue (e.g., steering inputs, un-signaled lane departures, head nodding, erratic speeds, etc.), and adjust the remaining hours of service accordingly.

- **Variable Speed Limiter –** an application that would allow the carrier to employ wireless communications to alter the governed maximum speed remotely, based on any combination of factors deemed appropriate by the carrier. Additionally, it could be equipped with a geographic referencing capability tied to a database of posted speed limits, and as a truck passed from one zone to the next, the speed governor would be adjusted automatically.

- **Border Crossing Compliance Notification –** an application that would make information regarding pre-screening status available prior to a driver's arrival at the border, offering the potential to significantly reduce delay and queueing, which would also likely reduce idling and improve safety.

- **Border Crossing Tracking Compliance –** an application that allows motor carriers to comply with emerging shipment tracking requirements from U.S. Customs and Border Protection (CBP) and provides a means for information regarding border crossing travel times to be applied to enhance border operations.

- **Truck-Specific Congestion Avoidance –** an application that would provide a wireless link to existing traffic information, which would allow drivers to receive traffic data that are of particular applicability to their operations, and in the event that alternatives exist, would provide truck-specific alternate routing information.

- **Chassis Roadability Notification –** an application that would provide a means for drivers to wirelessly access chassis maintenance data and inspection history upon entering a storage facility or terminal.

- **Cross-Town Intermodal Interchange –** an application, formulated under a separate research effort within FHWA, that applies a combination of wireless technology and coordinated operating practices among railroads, motor carriers, and public agencies (e.g., Metropolitan Planning Organizations, State Departments of Transportation, first responders, freight economic development entities, etc.) to reduce empty trips, reduce congestion-related delay, and improve safety and the environment.

- **Untethered Trailer Tracking –** an application that allows asset owners and shippers to monitor the integrity and location of goods and equipment, and potentially offers the ability to mitigate theft and pilferage, and enhance security.

Table 4 shows the analysis scenarios run in FTAT based on the findings from the viability analysis. Note that the Driver Acuity Monitoring application did not make the final list of scenarios, because of the limited industry acceptance expressed during stakeholder discussions regarding technologies that monitor driver adeptness.

Table 4: FTAT Analysis Scenarios

Scenario	Supply Chain Segment	Inefficiency	Solution
1	International Border	Paperwork Delay at Border	Border Crossing Compliance Notification
2	International Border	Processing Delay at Border	Border Crossing Tracking Compliance
3	Port to Inland Destination	Waiting Time in Container Ports	Virtual Queueing
4	Port to Inland Destination	Vehicle Safety (Crashes, noncompliance)	Chassis Roadability Notification
5	Closed-Loop Pick-Up and Delivery	Incident-Related Congestion	Truck-Specific Congestion Avoidance
6	Closed-Loop Pick-Up and Delivery	Waiting, Loading, and Unloading	Virtual Queueing
7	Rail Intermodal	Empty Trips	Cross-Town Intermodal Interchange
8	Rail Intermodal	Waiting, Loading, and Unloading	Virtual Queueing
9	Long-Haul Truckload	Fuel Waste due to Excessive Speed	Variable Speed Limiter
10	Long-Haul Truckload	Theft and Pilferage	Untethered Trailer Tracking

The results of the execution of the FTAT calculations offer some interesting insights into the potential benefits of the various proposed applications. As the information in Table 5 shows, the BCR and IRR for the applications span a broad range of values.

Table 5: Combined FTAT Calculation Results

Scenario	Supply Chain Segment	Inefficiency	Solution	BCR	IRR
1	International Border	Paperwork Delay at Border	Border Crossing Compliance Notification	.08	-48.05%
2	International Border	Processing Delay at Border	Border Crossing Tracking Compliance	5.2	73.78%
3	Port to Inland Destination	Waiting Time in Container Ports	Virtual Queueing	2.64	35.85%
4	Port to Inland Destination	Vehicle Safety (Crashes, noncompliance)	Chassis Roadability Notification	0.21	-33.29%

Scenario	Supply Chain Segment	Inefficiency	Solution	BCR	IRR
5	Closed-Loop Pick-Up and Delivery	Incident-Related Congestion	Truck-Specific Congestion Avoidance	1.96	38.5%
6	Closed-Loop Pick-Up and Delivery	Waiting, Loading and Unloading	Virtual Queueing	1.62	18.98%
7	Rail Intermodal	Empty Trips	Cross-Town Intermodal Interchange	8.92	216.76%
8	Rail Intermodal	Waiting, Loading, and Unloading	Virtual Queueing	2.33	30.98%
9	Long-Haul Truckload	Fuel Waste due to Excessive Speed	Variable Speed Limiter	3.86	54.26%
10	Long-Haul Truckload	Theft and Pilferage	Untethered Trailer Tracking	2.47	33.22%

Several of the applications—notably, the Border Crossing Tracking, Virtual Queueing, Variable Speed Limiter, Cross-Town Intermodal Interchange, and Untethered Trailer Tracking Systems—offer estimated BCR values in excess of 2:1. These are promising results, particularly when the lowest IRR for these applications exceeds 30 percent (it is noted that the application of Virtual Queueing to the closed-loop supply chain segment results in a lower value). The results for most of the applications improve as the level of deployment increases, and if they can be deployed by carriers already using wireless devices (e.g., cellular telephones or satellite tracking systems) for other purposes.

However, for a number of reasons, caution is warranted when examining these figures. First, the Study Team assumed in the calculation of the figures that the operating environment would be conducive to the use of application, and that the maximum estimated benefits would be realized. This is not likely to be the case in all scenarios. For instance, because making the necessary staffing changes within international border crossing compounds (namely, the reassignment or increase in the number of staff by CBP to accommodate surges in demand) presents a number of operational challenges, and because a large portion of the border user population would need to be equipped with devices in order for the data to be reliable enough to warrant such measures, it is unlikely that the full benefit will be realized from the deployment of the Border Crossing Tracking Compliance application. Hence, the calculated BCR of 5.2 is very likely higher than might be possible.

Phase II Options and Plans

Based on the results of the research and analysis conducted during Phase I, a number of conclusions can be drawn regarding the potential investment of Phase II research funds. Several viable pilot project candidates emerged as promising. These are discussed below.

New Technology Applications

A review of the wireless technology-based applications endorsed by the motor carriers that participated in the study for analysis using the FTAT benefit/cost tool reveals some important considerations in moving into Phase II. The first is that, with regard to the implementation of new technologies in their operating environment, the carriers demonstrated a bias toward incremental systems enhancement. Even in cases where the financial investment for deploying and operating a system was relatively large, the actual level of technical sophistication of the overall system would not be considered highly advanced beyond what is currently in use. In fact, the carriers expressed a clear preference for the addition of new capabilities to existing technologies, even if these were technologies that they do not currently use in their own fleets.

Further, because their prioritization of inefficiencies reflected their beliefs that the most significant sources of inefficiency are external to their own operations (e.g., traffic congestion, border processing delay, waiting for loading and unloading), the carriers indicated preference for applications that allowed them to overcome the burdens imposed by others. It is unclear, based on the findings from this study, whether they have confidence that they have already optimized their own internal operations, or have resigned themselves to the fact that any further investment in internal improvement would be subject to the law of diminishing returns. Among the wireless applications that do focus on operations within the carriers (Variable Speed Limiter, Untethered Trailer Tracking), there continues to be a preference for applications that manage the behavior of those that use a carrier's assets.

Even within these somewhat limited boundaries, there exist several promising alternatives for examination during Phase II. Seven of the 10 scenarios evaluated using FTAT had estimated IRRs of more than 30 percent. Based on the relatively conservative estimates of potential gain and the use of system implementation and use costs that assumed a carrier would have to purchase all of the necessary hardware (vs. leveraging current systems), each of these seven scenarios warrants further examination through pilot demonstration. Among them, the Cross-Town Intermodal Interchange, Border Crossing Tracking Compliance, and Variable Speed Limiter posted the largest estimated investment returns. The BCRs and IRRs for each of these scenarios suggest that, even if cost and benefit estimates are modestly optimistic, motor carriers would likely find them attractive as pilot test subjects.

Existing Technology Applications

Each of the two systems that demonstrated large potential returns – RFID for weigh station bypass and Untethered Trailer Tracking – has already exhibited empirical proof of its value. From the findings obtained during this study, it is not clear why such systems have not reached greater levels of deployment. In the case of the Untethered Trailer Tracking application, this may be due in part to a combination of a relatively high per-unit price and the historically slow technology adoption rate among all but a relatively few motor carriers. Historical precedent suggests that both available cash for technology investment and a management predisposed to actively pursue technology enhancement are limited to a relatively few large carriers.

As for RFID-based weigh station bypass – again, this study was not focused specifically on determining the conditions under which more expansive deployment might take place – there appears to be sufficient financial incentive for carriers to take part in such systems. Figures published by one of the bypass program management organizations, HELP, Inc., suggest that since 1997, motor carriers enrolled in the organization's PrePass program have accrued reductions in delay of nearly 20 million hours and savings of nearly 120 million gallons of fuel. Based on an operational cost estimated at $5 per stop, it is estimated that PrePass-enrolled carriers have saved more than $1.1 billion since 1997.

Phase II Demonstrations Plans

Phase II of the program will consist of several pilot demonstrations. In these demonstrations, promising wireless technologies will be deployed under realistic operating conditions. During this period, industry and government partners will assess the degree to which the solutions improve safety and operations consistent with the program objectives. The goal for these pilots is to provide sufficient evidence to support investment decisions for the government, and for the technology provider and user community.

Based on recommendations from the Study Team, FMCSA and its multi-modal team with representatives from FHWA, OST, and BTS will focus Phase II pilot demonstrations on applications within the four broad program areas mentioned above. In the remaining years of the program, pilot demonstrations in Phase II will focus on demonstrating wireless capabilities that allow motor carriers to do the following:

- Reduce the amount of time waiting to be loaded or unloaded or to access the facilities where these activities are performed.
- Reduce empty trips, particularly when interchanging loads between intermodal facilities.
- Reduce delays entering the United States at international border crossings.
- Reduce the frequency and duration of delays associated with congestion, particularly congestion associated with traffic incidents.
- Reduce fuel consumption.
- Reduce the risk of having a crash or being put out of service due to failures of equipment or driver-related factors (e.g., hours of service, commercial drivers license, etc.).
- Reduce the risk of having a crash due to excessive speed or other driver errors.
- Reduce empty miles.

The USDOT and Motor Carrier Partnership

From the input received from motor carriers throughout the project – beginning with the industry meeting prior to the start of the Phase I study – it seems clear that there is substantial interest in assisting FMCSA in characterizing systemic inefficiencies and in participating in pilot tests of wireless technologies aimed at addressing them. Evidence of this is in the willingness of motor carrier representatives to participate and offer suggestions regarding where research should be directed. Short of applying it as a marketing investment for a particular vendor's products, the carrier community expressed little apprehension regarding the expenditure of a modest amount of Federal funds on targeted research in this area.

One possible exception was investment in technology applications that required the release of sensitive information or the surrendering of operational control to a government agency. For instance, in the case of the Variable Speed Limiter application, some carriers expressed concern that such an application might be looked upon as a method of speed enforcement. Excluding this and other concerns regarding data security, participating motor carriers generally welcomed the idea of public investment aimed at providing cost-effective solutions to the inefficiencies they encounter.

Conclusion

With few exceptions, the common thread running through the priority inefficiencies is delay caused at least in part by the actions (or lack thereof) of a party external to the carrier. Perhaps more evident, however, is that each of these inefficiencies has the potential to be mitigated by improving the quality, accuracy, and timeliness of data held by one or more of the stakeholders (public and private sectors), and the degree to which the data are exchanged and used for decisionmaking.

Under such circumstances, it would appear that wireless technologies, which are first and foremost mechanisms to accurately capture and exchange information, could offer the means to bring significant relief to the carrier community. Given that an enhanced level of situational awareness is vital to mitigating these inefficiencies, it is logical that wireless systems that promote that enhancement would be of some value to motor carriers that experience these inefficiencies.

In fact, enhanced situational awareness would likely have a profound positive effect on several other inefficiencies—namely, those associated with vehicle and driver safety. Better knowledge about vehicle, operator, and roadway conditions should contribute significantly to reducing driver- and vehicle-caused crashes and reducing the frequency of cases in which drivers operate at speeds in excess of those warranted by roadway conditions.

Better situational awareness can be an important way to counter cargo theft and pilferage and to reduce empty moves, both of which represent significant costs for motor carriers. Simply knowing when and where a shipment has been tampered with or infiltrated would allow carriers to define and implement more effective security solutions. In a similar manner, knowing the locations and delivery requirements of other intermodal loads would likely allow dray haulers to better allocate resources to meet customer needs.

Based on the evidence gathered during the identification of industry inefficiencies in Phase I of the MCES, it is reasonable to conclude that ample opportunity exists for applying technology to construct creative solutions to address real, specific needs within the carrier community. The role wireless systems might play seems less clear, but the analysis suggests that the potential exists for measurable positive effects.