



U.S. Department of Transportation

Intermodal Freight

ITS Benefits, Costs, and Lessons Learned: 2017 Update Report

Intermodal Freight

- Freight Tracking
- Asset Tracking
- Freight Terminal Processes
- Drayage Operations
- Freight-Highway Connector System
- International Border Crossing Process
- Freight Travel Planning

Highlights

- Drayage optimization can have positive impacts on fleet miles traveled, number of vehicles required, and bobtail miles.
- Using wireless communications with GPS vehicle positioning systems can improve commercial vehicle utilization by reducing empty container miles.



Introduction

This factsheet is based on past evaluation data contained in the ITS Knowledge Resources database at: www.itskrs.its.dot.gov. The database is maintained by the U.S. DOT's ITS JPO Evaluation Program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The factsheet presents benefits, costs and lessons learned from past evaluations of ITS projects.

While the United States economy has been affected by an economic downturn in recent years, it is expected to recover and continue to grow. Long-term economic growth should result in even greater demand for freight transportation.

The freight industry and its customers are increasingly turning to information technologies and telecommunications to improve freight system efficiency and productivity, increase global connectivity, and enhance freight system security against common threats and terrorism. In short, these technologies help freight operators use the transportation system more intelligently. Most importantly, they do so in ways that improve safety, whether related to hazardous materials transport, heavy truck operation and maintenance, or load limit compliance.

Intelligent freight technologies are currently deployed in several areas including the following:

- **Asset tracking:** Mobile communications and global positioning systems, bar codes, and radio frequency identification (RFID) tags track the location of trucks, containers, and cargo to improve efficiency and to ensure the safety and security of shipments.
- **On-board status monitoring:** Sensors record vehicle operating conditions, check the condition of cargo, and detect tampering or intrusion.
- **Gateway facilitation:** Non-intrusive inspection technologies, such as scanners and RFID tags, are used at terminals, inspection stations, and border crossings to search for contraband and enhance national security.
- **Freight status information:** Web-based technologies facilitate the exchange of information on freight shipments and improve data flows.
- **Network status information:** Cameras, road-sensors, and display technologies monitor congestion, weather conditions, and incidents.

The ITS Knowledge Resources provides information about the state of the art development and adoption of effective technologies by the freight industry and its customers. This information includes private, public, and network-based benefits, costs and lessons learned.

Benefits

Efficiency Benefits Assessment

In 2013, the Federal Highway Administration finalized an assessment of a drayage optimization application sponsored under the Cross-Town Improvement Project (C-TIP) in Memphis, Tennessee. The purpose of this project was to test methods for leveraging technology to improve drayage operations. The evaluation of this application quantified benefits resulting from improved algorithms that optimize intermodal shipments from origin to destination. The U.S. DOT team partnered with a local drayage company in order to develop and deploy the algorithm.

To effectively handle the complexity of the drayage problem inherent in the Memphis C-TIP and ensure that the algorithm was working properly, the team developed the algorithm in several iterations and anchored performance testing to well-established benchmarks, while utilizing real-world data collected from the daily operations of the drayage company.

A pre and post-deployment analysis of 31 data points revealed the following benefits ([2014-00919](#)):

- Required fleet reduced by 21 percent
- Total miles reduced by 9 percent
- Average miles per truck increased by 14 percent
- Total bobtail miles reduced by 13 percent

In a separate study, a U.S. DOT HAZMAT Field Operational Test (FOT) was conducted to test methods for leveraging technology and operations to improve HAZMAT transport security and operational efficiency. The evaluation of this FOT quantified benefits resulting from technology deployments that improve the security and operational efficiency of HAZMAT shipments from origin to destination.

Regardless of technology configuration in the FOT, two technologies created the enabling platform on which the other test technologies operated – **wireless communications** and **asset positioning/tracking**. Through discussions with the participating motor carriers, these two capabilities provided the majority of measurable operational benefits. Without these two capabilities, potential operational, as well as safety and security benefits of the other test technologies could not be realized.

The inputs used in calculating per truck monthly benefits of Wireless Communications with GPS tracking are presented in *HAZMAT FOT Volume III* report, Section 2. [1] The return-on-investment (ROI) model essentially equates downtime savings associated with eliminated driver call-in stops and unscheduled en-route maintenance/repairs with increased asset capacity. The ability to know where assets are, the state of conditions vis-à-vis maintaining schedule, and knowing driver availability for hours of service allows dispatchers/load planners to assess the feasibility for picking up potential backhaul loads (applicable to the operation). The model also estimates the value of freed up phone call time for dispatchers talking with drivers, thus allowing them to focus on other duties, or have the time to manage more drivers if necessary. Other benefits include lower communications costs and less idling time (associated with driver call-in stops), resulting in reduced fuel and engine wear costs. These benefits are displayed below in Table 1 ([2013-00880](#)).

Analyses in the HAZMAT FOT Final Synthesis show that using wireless communications and GPS tracking can save from \$80 to \$309 per month by reducing empty freight miles.

Table 1: Estimated and Minimum Estimated Monthly Per Truck Benefits Derived Using Wireless Communications with GPS Vehicle Positioning System.

Benefits	LTL* High Hazard	Bulk Chemicals	Truckload Explosives
Improved vehicle utilization by reducing empty miles (Estimated)	\$309	\$199	\$270
Improved vehicle utilization by reducing empty miles (Minimum)	\$124	\$80	\$108

* Less than Truckload (LTL) shipping

It is recognized that all operations are not able to realize many of the estimated benefits as modeled for the FOT participants. The proportion and degree to which carriers realize benefits of technologies has been examined in numerous case studies and industry benefit-cost analyses. To explore low-end benefits of the Wireless Communications with GPS vehicle positioning system, this effort draws upon the results of a 1999 American Trucking Association (ATA) Foundation study that examined the benefits and costs of technology systems across a wide-range of carrier operations for over 900 surveyed motor carriers. Among the findings, carriers using Wireless Communications and vehicle tracking technologies, 33 to 47 percent increased loads; 22 to 35 percent reduced non-revenue miles; and 12 percent lowered driver to dispatcher ratios. By focusing only on these three areas of operational efficiency improvements (using the midpoint values) and ignoring the other modeled benefits, the results of a “minimum” benefit analysis are presented in Table 1 as well.

Costs

The benefits presented in Section 6 of the HAZMAT FOT Volume II synthesis report were compared to the generally, more high-end costs of the satellite and terrestrial-based product/service offerings to estimate benefit-cost ratios and expected payback periods. Per the synthesis report, Table 2 presents the costs by industry segment (capital costs are amortized over three years). Using the costs from Table 2 and benefits developed in the synthesis document, benefit-cost ratios were calculated, with the results shown per segment/fleet size in Table 3 ([2013-00290](#)).

Table 2: Per Truck-Specific Technology Costs (Wireless Communications with GPS Tracking Capabilities).

Item	Purchase Cost Truck Terrestrial/Satellite	Annual Cost Truck Terrestrial/Satellite
Mobile Communications with GPS Tracking Units (Hardware Costs)	\$1,000 / \$2,000	\$336 / \$672
Installation	\$200	\$72
Basic Monthly Service (per truck)		\$600
Monthly Maintenance Agreement		\$180
Total Per Truck Costs	\$1,200 / \$2,200	\$1,188 / \$1,524

Table 3: Costs, Benefits, Benefit-Cost Ratios, and Payback Periods by Industry Segment (Wireless Communications with GPS Tracking Capabilities).

Segment/Fleet Size	Annual Cost/Truck	Annual Benefit/Truck	Benefit-Cost Ratio	Payback on Purchase in Months
Bulk Fuel (Terrestrial)	\$1,188	\$5,832	4.9:1	3
LTL-High Hazard (Satellite)	\$1,524	\$2,352 to \$9,840	1.5:1 to 6.5:1	3 to 17
LTL Non-Bulk (Terrestrial)	\$1,188	\$1,920	1.6:1	13
Bulk Chemicals (Satellite)	\$1,524	\$1,560 to \$7,116	1.0:1 to 4.7:1	5 to 34
Truckload Explosives (Satellite)	\$1,524	\$1,824 to \$11,004	1.2:1 to 7.2:1	3 to 25

Lessons Learned

Implementing a National Freight Data Architecture

In practice, the value of a national freight data architecture is a function of the costs associated with its implementation. Quantifiable data about expected benefits and costs are currently not available and were not part of the Guidance for Developing a Freight Transportation Data Architecture survey. However, it is clear from the documentation and information gathered during the research that the “do-nothing” alternative (i.e., not implementing the national freight data architecture) is costly, ineffective, and unsustainable. Therefore, the research teams recommended to pursue the national freight data architecture following a scalable implementation path in which the national freight data architecture starts with one application at one or two levels of decision making and then adds applications and levels of decision making as needed or according to a predetermined implementation plan until, eventually, reaching the maximum net value.

The research team for this guidance conducted a planner and analyst survey, a shipper survey, and a motor carrier survey (as well as follow-up interviews) to gather information about freight data uses and needs. The research team also conducted interviews with subject matter experts to address specific items of interest to the research. The purpose of the planner and analyst survey was to gather information from government planners, analysts, and other similar freight-related stakeholders. Respondents were involved in all modes of transportation, including air, rail, truck, pipelines, and water. Respondents indicated that they use freight data to support the production of a wide range of public-sector transportation planning documents, adding weight to the notion that the national freight data architecture should support a variety of freight-related processes. Respondents reported using and/or needing data at various levels of geographic coverage and resolution. The feedback on unmet data needs complement similar findings in the literature.

Below are lessons learned through surveys conducted during the preparation of Guidance for Developing a Freight Transportation Data Architecture ([2013-00655](#)).

- Understand the different business processes that affect freight transportation at different levels of coverage and resolution.
- Understand the supply chain, which should help transportation planners to identify strategies for improving freight transportation infrastructure.
- Recognize the role that different public-sector and private-sector stakeholders play on freight transportation.


Source: Thinkstock

- Recognize the need for standards to assist in data exchange.
- Coordinate systematic development of reference datasets (e.g., comprehensive commodity code crosswalk tables).
- Develop systematic inventory of freight transportation data sources.
- Develop systematic inventory of user and data needs that are prerequisites for the development of freight data management systems.
- Use as a reference for the identification of locations where there may be freight data redundancy and inefficiencies.
- Use as a reference for requesting funding allocations in the public and private sectors.
- Use as a reference for the development of outreach, professional development, and training materials.

Using Information Systems for Intermodal Ports

Pacific Gateway Portal (PGP) is a port user information system in a web-based form, operated by the Port of Vancouver. [2] The information available on PGP includes container status, vessel activity, and real time video images from both the port terminal side and also truck and driver identification. This system also has an option of an appointment system for trucks and dangerous goods applications. A truck appointment system is in use at all three terminals within the Port of Vancouver, and is very successful. In order to make appointments truck companies use the terminal's web page. Appointments are matched with transactions determined by the terminal on the basis of capacities of terminal. Dedicated lanes are in use for trucks with an appointment. An approved Truck Licensing System (TLS) License is required by any party wishing to access Port of Vancouver's property for the purposes of draying marine containers to or from any of the terminals under the jurisdiction of Port Metro Vancouver. Trucks without a TLS license are not allowed to access Port Metro Vancouver property. Truckers also have to be in line at the gate entrance at least 15 minutes before expiration of their reservation time. If trucks arrive late they are required to go to the line for trucks with no reservation, or they will need a new reservation. There is no fee to use the reservation system, but there is a fee to use the web portal.

One of the major problems at marine container terminals is that the terminal gates, where trucks enter and exit the terminal to deliver or pick-up a container, are only open during certain hours on weekdays; due in part to union agreements, although operations within the terminal carry on 24/7. Consequently, trucks are forced to pick-up and deliver containers during specific hours of the day, resulting in high demand over certain periods. This phenomenon has led to inefficient gate operations that can spill traffic over to the surrounding roadway network causing serious safety and congestion problems. The problem of congestion also extends to the yard of the terminals where coupled with capacity issues, it can degrade the reliability and performance of carriers, shippers, and terminal operators. In addition to the deterioration of the performance of terminal and drayage operations, the environmental effects from idling trucks has also been starting to emerge as a serious problem as truck emissions have been linked to health conditions including asthma, cancer and heart disease [3].

Since intermodal freight terminals tend to be located in or near major cities, where right of way is limited and very expensive, implementing operational strategies to reduce the effect of the terminals' truck related traffic on the surrounding roadway network and the terminal operations becomes more important and more viable than physical capacity expansions. Because of this, there is much research focusing on improving efficiency in the operations of intermodal marine container terminals without having to expand physical capacity. Below are a few of the lessons learned through implementation of the types of systems used at the Port of Vancouver ([2013-00652](#)):

- **Coordinate between trucking companies and port intermodal terminals for efficient terminal operations.** Gates that are clogged can worsen terminal capacity and this creates not only an operational but also an environmental problem. For a tactical/operational level gate strategy system to be effective, a large percentage of trucks will have to use it, and there has to be some priority or benefit for trucks with appointments. Incentives are necessary to get trucking companies to buy into appointment systems and actually make appointments (and keep them). Incentives may also be needed for the terminals to use the systems effectively. Gate appointments are a more favored alternative than extended gate hours, since the cost is lower.
- **Deploy and expand gate appointment systems.** Gate appointment systems have the potential to dramatically improve operations inside the terminal as well as at the gate, and as a secondary result, reduce congestion on the roadway system, and therefore reduce harmful emissions in the neighboring communities. Of course, as freight shipping increases, there will be a point that limits the amount of trucks and containers that can physically be processed within the constraints of terminal boundaries, but there is certainly room for improvement now, before reaching that point. For extended gate hours, additional workers are required at off-peak times, but this is a viable option to increase throughput at terminals. It will require that additional workers be added, hours and pay

contracts be adjusted and associated businesses buy-in, but there is potential for greater amounts of container movement without the need to expand terminals.

Increased efficiency at intermodal port terminals due to any or all of the strategies discussed in this paper can affect the overall transportation community and all other types of intermodal transportation by allowing more containers to be shipped, and moved more quickly away from the ports, onto the other forms of transportation, and to their final destinations. Appointment systems and extended hours, as well as the managing technologies can be used by other modes experiencing congestion and air quality concerns to increase efficiency, thereby lowering congestion and emissions. The key to developing effective gate appointment systems is to ensure participation from all key stakeholders.

References

- [1] Federal Motor Carrier Safety Administration, *Hazardous Materials Safety and Security Technology Field Operational Test Volume III*. U.S. DOT. December 2004.
- [2] Pacific Gateway Portal. 2008. <http://www.pacificgatewayportal.com/>
- [3] Solomon, D., Bailey G., "Pollution Prevention at Ports: Cleaning the Air." *Environmental Assessment Review*, Vol. 24, pp. 749-774, 2004.

All other data referenced is available through the ITS Knowledge Resources Database, which can be found at <http://www.itsknowledgeresources.its.dot.gov/>.