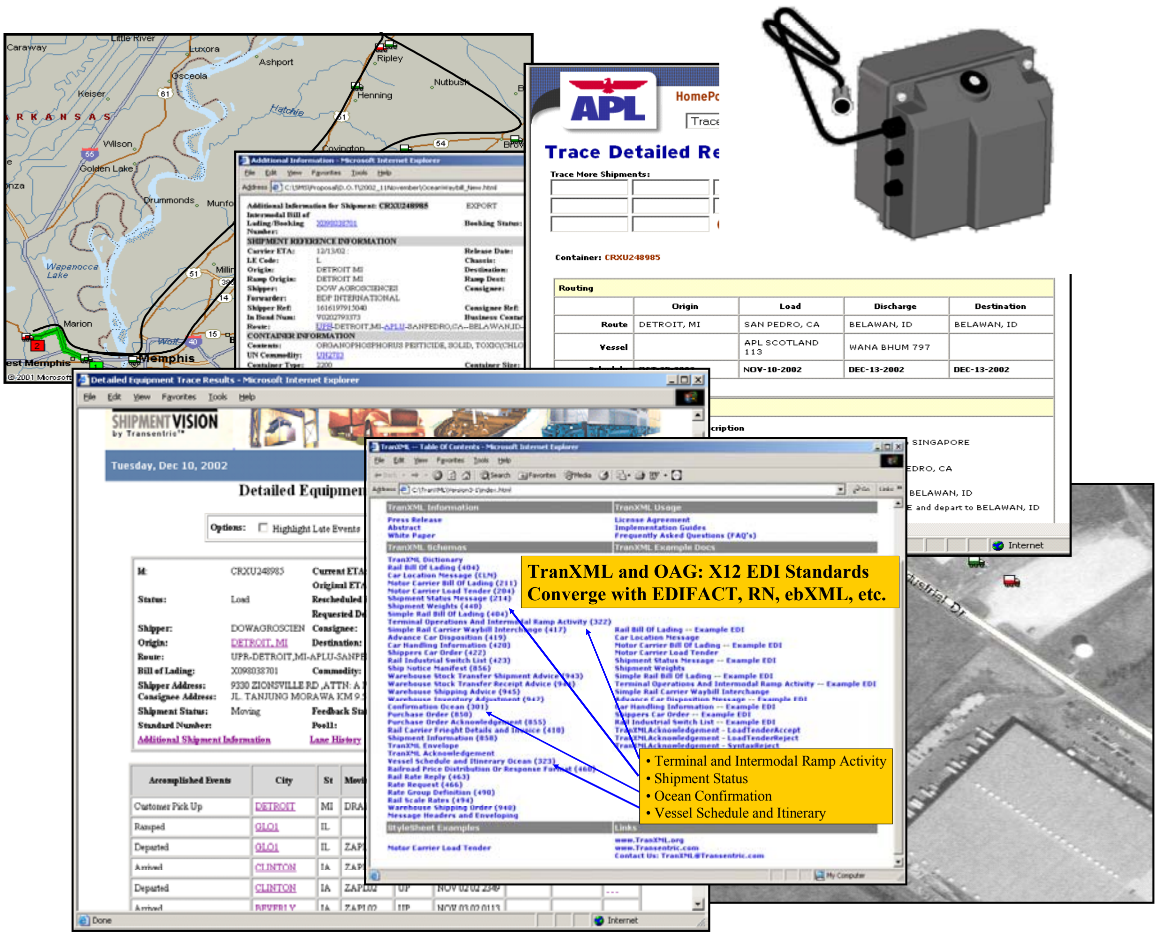
September 2003

Intermodal Freight Technology Working Group Asset Tracking and "Freight Information Highway" Field Operational Test Evaluation

Final Report – Executive Summary



U.S. Department
of Transportation

QUALITY ASSURANCE STATEMENT

The Federal Highway Administration provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

NOTICE

Comments on this final report should be provided to SAIC by email, fax, or mail, addressed to:

Mark A. Jensen
Science Applications International Corporation
2715 Southview Avenue
Arroyo Grande, CA 93420
Phone: 805-473-2471
Fax: 805-456-3961
E-mail: jensenm@saic.com

THIS PAGE INTENTIONALLY LEFT BLANK.

EXECUTIVE SUMMARY

INTRODUCTION

In January 2001, the Federal Highway Administration (FHWA) released a solicitation requesting "Cost Sharing Cooperative Agreements" to conduct operational tests to improve efficiencies in the intermodal freight operations and to establish the foundation for an intermodal freight ITS architecture. The solicitation, developed through the recommendations of four action groups established under the auspices of the Intermodal Freight Technology Working Group (IFTWG), and with key support provided by the FHWA Office of Freight Management and Operations, the U.S. Department of Transportation (USDOT) Office of Intermodalism, Booz Allen Hamilton, and ITS America, requested operational test proposal(s) covering three areas:

1. **Cargo Visibility – Making the Business Case:** reconciling system-level returns on investment with those of the individual stakeholders.
2. **Terminal Dray – Advancing Deployments:** focusing on ports and terminal dray operations and on technology solutions that bridge the gaps between the modes.
3. **Development of the Freight Information Highway (FIH):** focusing on integrating data from diverse intermodal freight systems and activities. The intention is to promote standards that allow development of open freight information systems that would propagate throughout the freight industry similar to what happened with protocol standardization for e-mail and the Internet (SMTP and HTTP).

In response to the solicitation, a team led by American Presidents Line (APL), which included the Union Pacific Railroad, PAR LMS (a manufacturer and overseer of the Cargo*Mate® Logistics Information Management System) and Transentric (software developers and integrators), submitted a successful cost-sharing bid to conduct an operational prototype deployment test that addresses both the Cargo Visibility and Freight Information Highway components of the USDOT solicitation. The two components of this operational test were:

- **Asset Tracking.** This portion of the operational test examined the technical and operational feasibility of using tracking technologies to better manage assets through near real-time visibility (location) and status (covered/uncovered chassis). Fifty-nine PAR LMS Version 3 Chassis DataGate Units were installed and monitored with associated Web-based Cargo*Mate® asset tracking system software in two distinct regions and operational environments:
  - *Oakland.* The chassis in this region were primarily used to dray military hazardous material (HazMat) shipments from Northern California military facilities to APL Oakland for export. These chassis were managed to maintain asset visibility and shipment alignment within the bounds of the deployment. This test site was selected to serve as the primary site for understanding the effect of Cargo*Mate® technologies on HazMat shipment processes.
  - *Memphis.* These chassis were used to dray a variety of commodities including commercial HazMat shipments to and from the Union Pacific (UP) Marion Ramp from/to shippers within the region. The Memphis deployment, secondary to the

Oakland deployment, was selected to provide data concerning regional dray movements in combination with the accuracy and benefits of asset tracking.

- **Freight Information Highway.** This portion of the project facilitated a method of communication between transportation modes (i.e., marine, truck, and rail) through a mix of "open source" message architecture from Transentric LLC and Internet communications software designed around interoperability standards. The FIH was designed to allow transportation providers and customers to communicate without changes to their proprietary systems. This project provided the opportunity to monitor intermodal data exchange via TranXML.

TECHNICAL OVERVIEW

Freight Information Highway

The FIH served to integrate the third-generation Cargo*Mate® chassis tracking system with Web-based intermodal freight logistics applications to provide end-to-end cargo visibility over the defined life cycle of a cargo shipment. The primary goal of the FIH deployment was to consolidate mode-specific data exchange technologies and standards. Transentric accomplished this goal by developing a Transportation Extensible Mark-Up Language (TranXML) that facilitates Internet-based information exchange in the intermodal freight industry. TranXML supports application development advantages offered by XML without requiring significant changes in existing legacy systems by using existing data transfer standards and XML Data Dictionaries that permit data transformation between EDI and TranXML. In addition, TranXML is attempting to collapse certain modal-specific message sets into a common, intermodal message that would reduce transportation-related applications maintenance.

The FIH provided standardized information via the Transentric's ShipmentVision and Business Integration products. Figure ES-1 illustrates the project's architecture.

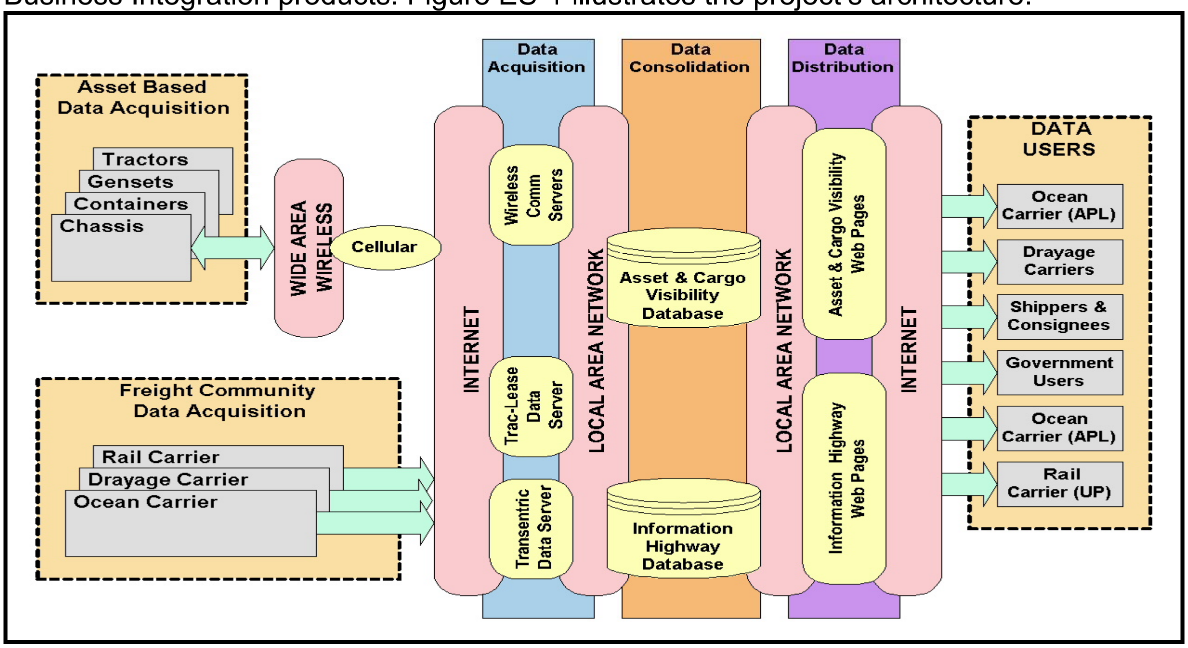


Illustration courtesy of Transentric

Figure ES-1. Freight Information Highway System Architecture.

This architecture is compatible with the Cargo*Mate® chassis tracking system. Using XML and simple Web services gives users access to a wide variety of data acquisition and distribution technologies without requiring changes in the data consolidation and display. This architecture allows a container to be associated with its chassis during a move to support "end-to-end" visibility. The architecture is scaleable and supports future intermodal freight technologies. The overall system is divided into three related subsystems: Data Acquisition; Data Consolidation; and Data Distribution.

Figure ES-2 combines both the user interface (on the left) and the data sources and Web services (on the right). The FIH Test supported two separate access points linked via common data exchange using a communication tool, *Agilink*® as a central communications and data translation hub and Web hyperlinks from one system to the other. The FIH test also used *Agilink*® *Connector* (*Connector*)**,** Java-based software installed on a trading partner's local system to send and/or receive data across the Internet. The two interfaces included PAR's Cargo*Mate® Website (chassis tracking) and Transentric's *ShipmentVision* based Freight Information Highway demonstration site (intermodal container visibility).

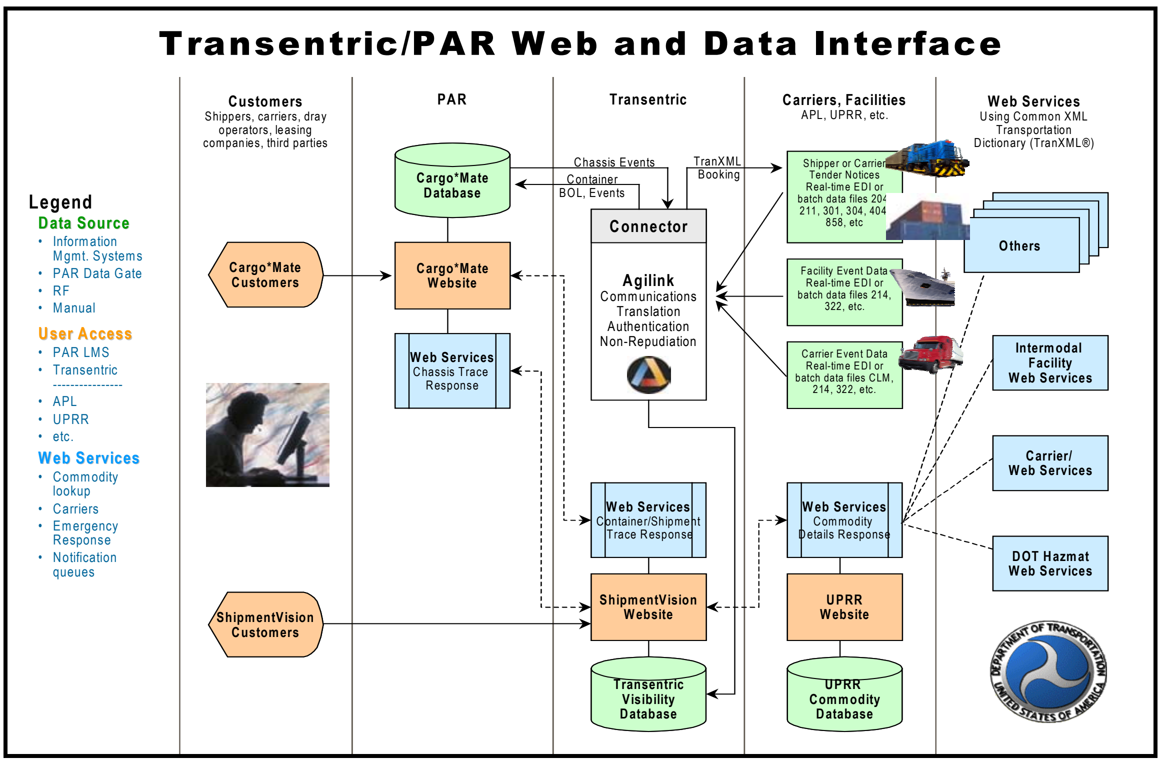


Figure ES-2. PAR LMS Cargo*Mate® Logistics Information Management System.

Data from PAR's global positioning system (GPS) devices on the chassis was sent to Transentric using *Connector***.** Conversely, ocean and rail events collected by Transentric were translated into PAR's preferred format and transmitted to PAR using *Connector* as well. This allowed chassis and container visibility from either Web interface. Multiple communication methods are supported to collect and disseminate data including e-mail, Internet FTP, SNA host-to-host communications, asynchronous dial-up, Internet secure socket communications (*Agilink*® *Connector*), and secure Web forms.

The stakeholders teamed together to create a transportation network with end-to-end cargo visibility. PAR LMS developed the Cargo*Mate® chassis-tracking device that functions with GPS, acoustic sensors, motion sensors, and cellular communication. Under an USDOT-funded cost-sharing agreement, APL purchased and PAR LMS installed 59 of these units (29 units in Oakland and 30 units in Memphis). Details of the deployments at each location are provided in the subsections below.

Deployments

Oakland

In May 2002, PAR LMS personnel installed 29 DataGates on chassis at the Port of Oakland APL facility. After several months of operation, gross reporting errors were noted, including: erroneous bare/covered status reporting; inaccurate location reports; and poor power management (i.e., unusually high rates of battery failure). Despite these flaws, the old technology was allowed to operate unconstrained on the 29-outfitted chassis in the port and surrounding geography of Oakland, California. Although the original intention was to match the DataGate-equipped chassis with HazMat loads, in practice, such an attempt proved unfeasible.

Memphis

In April 2002, PAR LMS personnel installed 30 DataGates on chassis at the UP Marion Rail Facility. As in Oakland, after several months of operation, reporting errors were noted, including: erroneous bare/covered status reporting; inaccurate location reports; and poor power management (i.e., unusually high rates of battery failure). Unlike Oakland, the IFTWG Asset Tracking team and APL decided to re-engineer the Memphis based DataGates and re-deploy with newer technology. In August 2002, the original 30 chassis outfitted in Memphis were recalled and upgraded. Subsequently, the chassis were allowed to operate as part of the normal chassis pool unconstrained until the end of the test in March 2003.

Evaluation Approach

Based on the initial goals of the effort, and on significant inputs from USDOT and stakeholders, the evaluation focused on the following major objectives/study areas:

- Broadcast Data Analysis.
- Data Exchange Processes Assessment.
- Business Model and Cost Benefit Assessment.
- Process Engineering Assessment – Lessons Learned.
- Deployment Potential-Opportunities and Issues Assessment.

The evaluation emphasized significant interaction with the project deployers, sponsors, and relevant stakeholders to develop an institutional framework with which to view the technical findings. Information developed through these assessments provided valuable insight to industry for integrating data exchange into the FIH, and will also provide guidance to the USDOT on the need and acceptance of an open source transportation management system. The following summarize the findings.

Broadcast Data Analysis

In evaluating the feasibility of linking a real-time data source to an interoperable freight information system, key assessments were made regarding the timeliness, accuracy, and quantity of the real-time data broadcast from the DataGates. Two detailed analyses were conducted of the broadcast data received from the DataGates. The first compared the data from the old DataGates versus the upgraded DataGates (i.e., Oakland data versus Memphis data). The second analysis used measures derived from the DataGate broadcast data in comparison to existing APL data to ascertain a level of data integrity. The measures examined are: rates of data inaccuracy; miles traveled; loads transported; broadcast data delay; and amount of data broadcast. Key findings of these examinations are as follows:

- *Comparison of Memphis and Oakland DataGates*: The upgraded/ Memphis chassis DataGates proved to be considerably more reliable than the old DataGates deployed in Oakland. This was demonstrated by through significantly reduced false reports (3/chassis versus .03 per chassis) and failure rates (83 percent versus 0 percent) for the Oakland and Memphis deployments, respectively.

- *Dataset Inaccuracy Rates*: Comparison of APL and Cargo*Mate® data showed that on average, 18 percent of the records in the APL data were inaccurate. This level of inaccuracy results from 1) human failure to accurately record chassis activities during gate processing or 2) the EDI transactions occurring within the rail ramp. The system at the UP Marion Railport is set up such that when it out-gates a container it enters an additional in-gate transaction prior to the out-gate transaction in an effort to tie the chassis to the container. Additionally, if a chassis and container arrive into the terminal and subsequently move out on the train, the next load to be put into the container and onto the chassis triggers a chassis/container association which prompts the system to create an additional transaction prior to the in-gate event, recording the chassis as bare. Whether the result of human error or system-generated errors, the level of error creates a “visibility gap” that can impede effective and optimal asset utilization.

- *Broadcast Data Delays*: On average, 22 percent of the records for the 30 Memphis chassis from September 1 through November 1, 2002 were entered into the APL system on a 1, 2, 3, or 4+-day delay. It is opined that this level of delay in the system contributes to lost efficiency and equipment abuse.

- *Number of Container Drops per Chassis*: According to the APL data, the difference in containers transported is not significantly different from the number reported by the Cargo*Mate® data. This indicates that chassis abuse is most likely occurring from the use of an empty container and chassis as a combination.

- *Miles Traveled per Chassis*: The difference in miles traveled as reported by the APL data versus the Cargo*Mate® data is not significantly different. The Evaluation Team observed anomalies in the data and believe that a more robust data set would suggest a significant difference, thus supporting the use of real-time asset tracking in the detection of equipment abuse.

- *Amount of Broadcast Data:* The level of data broadcast during this deployment resulted in costs much greater than those originally estimated by PAR LMS. An average cost of $9.92/chassis/month was calculated for the current test configuration, though an average cost of $4.25/chassis/month could be realized based on only reporting event driven data. Shippers identified that a lower level of data may be sufficient, and thus the original PAR LMS estimate of $5.71/chassis/month may be realized.

Data Exchange Processes

Intermodal operations data exchange process charts were developed to document and outline the data exchanged during the operational process of the intermodal equipment cycle. These charts provided existing or standard data exchanges process charts as well as an FIH Information Highway" and Asset Tracking data exchange model.

The information flows and means of data exchange occurring between entities in the intermodal supply chain are numerous, complex, and can often involve interruption of information flows between parties. This complexity of current data exchanges between ocean carrier, terminal operators, dray companies, and rail carriers is demonstrated in Figure ES-3.

As shown in Figure ES-3, many members of the freight transportation industry send and receive data using EDI as the established technology in the freight community. Adding new trading partners can be prohibitive, as the receiving company must be standardized on the same version of EDI for the transaction to work properly. The FIH uses a version of XML, called TranXML (developed by Transentric) readily translates different electronic data exchange formats into one universal format that can be viewed by authorized users via the Internet.

Figure ES-4 represents, in its most basic format, the means by which the asset tracking technology and the FIH facilitate end-to-end visibility and information exchange. The two technology solutions are depicted in yellow. Currently, there is a new flat-file transfer of asset location and status data along with ocean carrier and rail carrier information into the FIH. The FIH then assembles (error checks) and translates the various data streams into a variety of formats as required to maintain an error-free Equipment Inventory List and to provide required information to all intermodal supply chain stakeholders. The diagram presented in Figure ES-4 demonstrates how information flows and processes described in Figure ES-3 are integrated creating a seamless and simplified data exchange environment for FIH users.

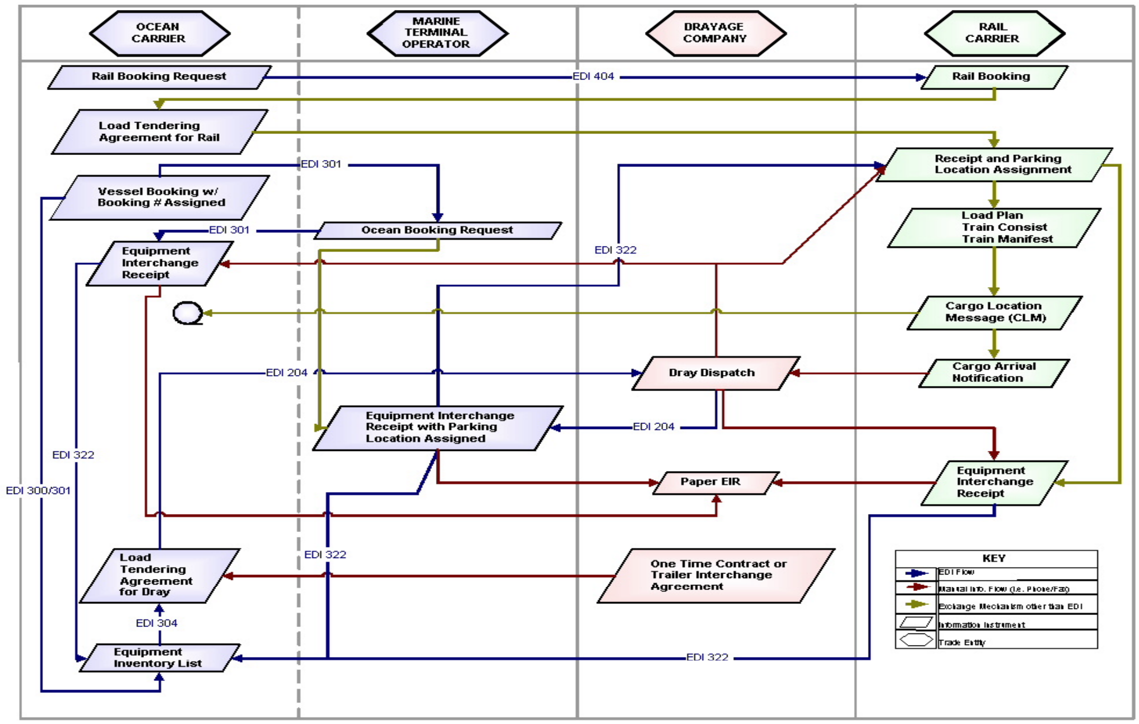


Figure ES-3. Intermodal Data Exchange Processes.

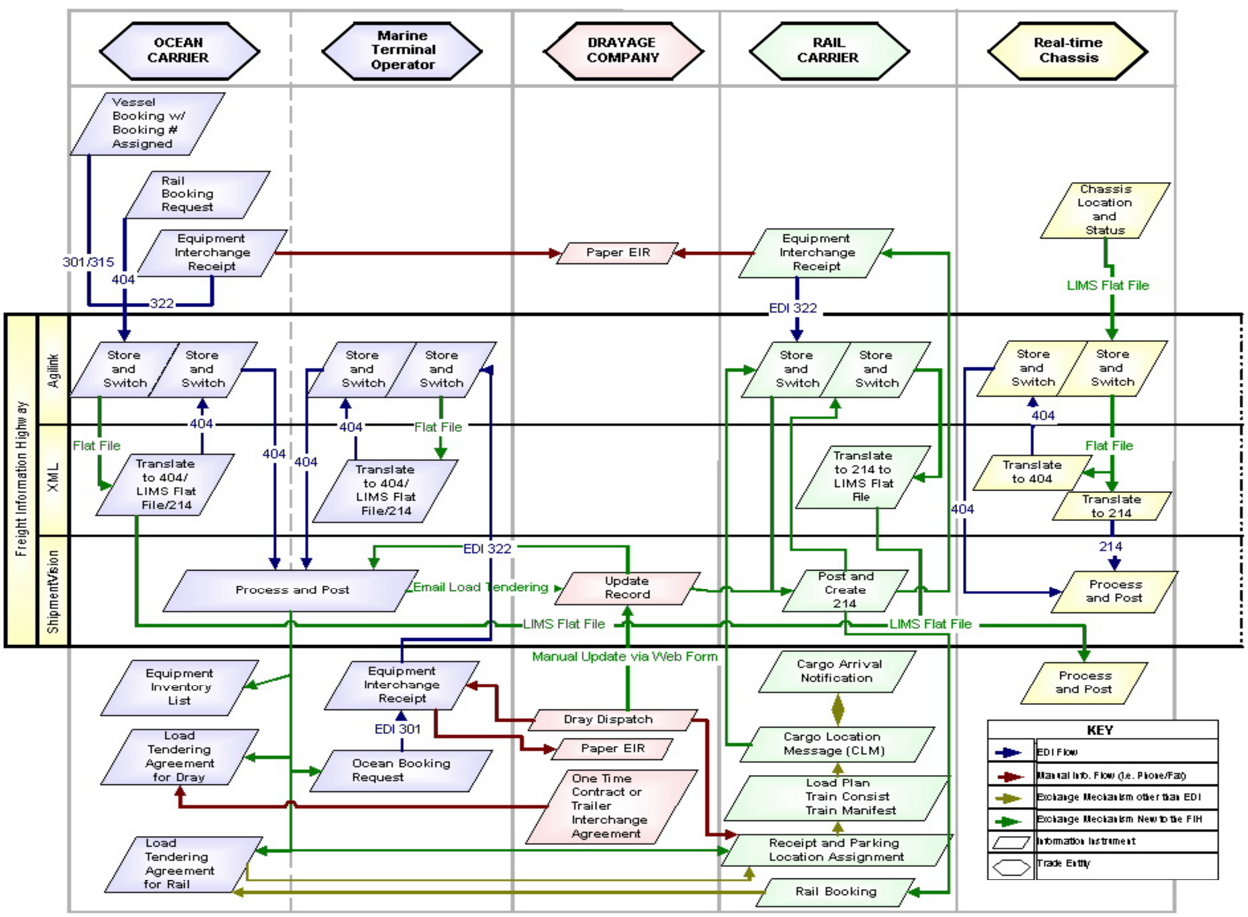


Figure ES-4. Intermodal Data Exchange Processes Through the FIH.

Business Model and Cost Benefit Assessment

The Evaluation Team worked with APL and the IFTWG to further develop and validate the asset tracking business model and cost benefit assessment, while concurrently working with Transentric and the IFTWG to develop a FIH business model.

The evaluation reviewed the Cargo*Mate® and FIH benefits models prepared in association with Par LMS. This was accomplished through a synthesis of the analyses of the field data collected during the testing of the data gates; interviews with key industry stakeholders, analysis of internal return on investment (ROI) models developed by a large commercial ocean carrier and one developed by a large rail carrier to assess the financial viability of Cargo*Mate units in their operations and a review of literature specific to technology impacts on transportation operations. The factors used in the Cargo*Mate® and FIH benefits models were adjusted to reflect the consensus of information developed through the synthesis.

*Cargo*Mate Model*

The Cargo*Mate® ROI models[1] primarily focus on cost avoidance benefits derived through full chassis location and status knowledge impacting a firm's ability to improve asset utilization. Deployment costs examined include: acquisition of the data gate units; installation; unit activation; messaging costs; and, back-office integration costs. The results of the ROI review are summarized in Table ES-2 and as follows:

- Both the evaluator-adjusted and the PAR ROI models estimate that net benefits exceed the daily costs of the Datagates. The range of estimated net benefits is $0.19 to $0.38 per chassis versus the PAR figure of $0.39. The estimated daily chassis operational cost savings are approximately 90 percent of those proffered by the PAR ROI model.

- A key sensitivity factor in the analysis is the level of messaging required to realize the benefits. Given this sensitivity, the potential range of net benefits over costs is estimated at 48 percent (low) and 97 percent (high) of net benefits proffered by the PAR ROI models.

- Payback for the data gates is expected to occur within 3 years of full deployment in a chassis fleet. Interviews with industry representatives indicated that a likely deployment scenario would involve the incremental equipping of a chassis fleet over 3 to 4 years.

- The level of benefits derived by a firm would be directly proportional and possibly time-lagged to the proportion of chassis equipped with the data gates. The payback period per unit will be inversely proportional to the aggressiveness of deployment within a chassis fleet.

[1] IFTWG Program – Business Case Evaluation Report, PAR Logistics Management Systems, CMDoc204.IFTWGBusCaseEval.Rev.1.6; Interim Business Case – Ocean Carrier Chassis and Interim Business Case—Ocean Carrier Rail Chassis*, Aspen/Vail Institute, December 2001.

Table ES-2. Comparison of Evaluation ROI and PAR ROI Models

Benefits and Costs	Evaluation Estimated Savings per Chassis per Shipment	PAR ROI Savings per Chassis per Day
Projected Total Daily Savings per Chassis (Benefits)	$0.74	$0.83
Data Gate Costs[2]	$0.22	$0.25
Communications Costs[3]	$0.14 to $0.33	$0.19
Total Visibility Costs	$0.36 to $0.55	$0.44
Net Daily Benefit per Chassis	$0.19 to $0.38	$0.39
Data Gate Costs[4]	$0.22	$0.25

Freight Information Highway Model

The model developed for the FIH examined the potential benefits of an integrated shipment, equipment, and status information system to enable users to make more informed transportation decisions, reduce shipping documentation errors, reduce labor involved in tracking shipments, avoid shipping penalties, and reducing back office integration costs. The benefits were estimated for a very large shipper or a small class of shippers representing 2.2 million shipments per year. As presented, the benefits equate to a 6.2 percent reduction in shipment costs and are comprised of the following factors: increased modal shift (truck to rail); reduced emergency transloads (shifting to a more expensive transport mode to meet customer needs); reduced inventory carrying costs and outages; improved collaboration; reduced data entry and shipment mishandling; reduced customer service and tracking costs; and reduced penalties and delays.

Discussions with industry representatives led to adjustment of the estimated FIH benefits. The adjusted factors ("Evaluation ROI") and the FIH ROI factors are compared in Table ES-3.

The Evaluation Team's adjustment of FIH benefits reflects the rejection of two of the assumed benefit areas – R*educed Emergency Transloads and Reduced Inventory Carrying Costs and Outages* based on the infrequent and spurious nature of the events and the reduction in possible modal shifts from truck to rail – based on industry perception derived through interviews. It is not to say that these benefits may not exist, but only that they were not substantiated through this effort.

---

2 Cost of data gate units, installation, activation, and back-office integration.

3 Based on observed messaging during FOT.

4 Cost of data gate units, installation, activation, and back-office integration.

Table ES-3. Comparison of Evaluation ROI and PAR ROI Models

Benefit Component	Evaluation Estimated Benefit per Shipment	FIH ROI Benefit per Shipment
Increased Modal Shift – Truck to Rail	$17.05[5]	$40.91
Reduced Emergency Transloads	$0.00	$10.66
Reduced Inventory Carrying Costs and Outages	$0.00	$29.25
Improved Collaboration, Reduced Data Entry and Shipment Mishandling	$9.00	$9.00
Reduced Customer Service and Tracking Costs	$1.20	$1.20
Reduced Systems Integration Costs	$1.16	$1.16
Reduced Penalties and Delays	$0.25	$0.25
Total Benefits	$28.66	$92.43

Although significantly reduced, the level of potential benefits can still be considered favorable for the FIH.

Process Engineering Assessment – Lessons Learned

The process evaluation focused on the major role players involved in deploying new intermodal information technology on a large scale. The overarching goal is to assess lessons learned at each stage of the deployment process; these stages are as follows:

<u>Cargo*Mate®</u>

The Cargo*Mate® system operated, for the most part, smoothly through out the duration of the deployment, though two technical issues were identified: DataGate redesign and geolocation issues.

- *DataGate Redesign*: The original DataGates broadcast a high level of erroneous reports as well as experienced a high failure rate. The source of the failure was the acoustic sensor, designed to detect when a container is placed on or taken off a chassis.

- *Geolocation Issues*: The primary trouble with geofencing and mapping of a GPS read to a specific yard or terminal stems from the "drift" commonly experienced by GPS. The points at which this reporting shortcoming posed a problem were upon the transition out of "heartbeat" mode and the occurrence of geofenced yards or

[5] The rail carrier benefits model examined in this review estimates a shift from truck to rail of a maximum of 2.5 percent of shipments (versus 6 percent proffered by the FIH business model). This shift estimate, if applied to the FIH benefits model, shows the benefit of truck to rail shifts reduced from $40.91 to $17.05 per shipment.

terminals in close proximity of major roads or each other. Unfortunately, this problem remains open; PAR LMS was unable to correct these discrepancies within the scope of this test.

Building the Freight Information Highway

Designing and building the FIH was a major undertaking. Most significant was the need to coordinate many different information processes (a reflection of the many different modal stakeholders) into one standard data format. There were two distinct challenges affiliated with this endeavor: Data translation/encoding and data sharing.

- *Data Translation and Encoding:* One of the largest challenges encountered in developing the FIH was the variety of message formats and requirements. Several specific problems with some message sets make a universal standard in intermodal freight data exchange difficult.

- *Data Sharing:* In an effort to protect shippers' privacy (and maintain a competitive advantage) carriers require signed written letters of authorization from the shipper to release shipment status information to a third party. According to FIH personnel, the most universal approach is one that adds a new participant classification on each bill-of-lading that identifies a particular FIH provider as a trading partner with authorization to shipment and/or carrier data.

System Integration

The assessment found that the level of difficulty, integration, and feasibility of using real-time asset tracking technology to broadcast data to a larger intelligent messaging service and link multiple intermodal freight trading partners varied greatly, depending on the trade entity. System integration included: PAR LMS; APL; and dray carrier.

- *PAR LMS Integration:* From the perspective of the PAR LMS team connecting to the Freight Information Highway via the *Agilink Connector* tool was very easy. PAR LMS attributes this integration success to the outstanding level of communication between PAR and Transentric. In particular, the coordination of the appropriate levels of technical personnel from both companies made the integration procedure efficient and effective.
- *APL Integration:* The integration between the participating ocean carrier (APL) and the FIH was also a successful.
- *Dray Carrier Integration:* The integration of drayage carrier freight activity into the FIH proved to be difficult – primarily for reasons of institutional issues. This is in part due to the decision of APL to change dray providers mid-deployment, requiring Transentric personnel to expend additional effort rendering a method of access agreeable to the new dray carrier.

Deployment Potential – Opportunities and Issues

The deployment potential of the Cargo*Mate® tracking system and the FIH was assessed through extensive interaction with stakeholders and leaders in industry and through a review of key issues of security and economics that may impact the adoption of new technologies.

An unstable U.S. economy since the end of 2000, the terrorist attacks of September 11, 2001, the West Coast port shutdown in late 2002 (in part driven by issues of technology threatening jobs), and recent air-quality legislation requiring reductions in truck waiting time at facilities[6], have had destabilizing financial effects that are still being felt today by most companies involved in freight transportation. Industry representatives are of the opinion that at least another 2 years will be required for the economic health of the freight industry to be restored to "pre-shock" levels.

Notwithstanding, the use of technology, specifically information sharing and asset tracking and management technologies, are being considered as a method to improve business operations and meet new freight-related security challenges and documentation requirements.

PAR LMS' Cargo*Mate® asset tracking system and the FIH have the ability to track fleets of chassis and provide key operational information back to the users in a timely and reliable fashion, allowing for improved visibility resulting in chassis inventory reductions, reduced maintenance, reduced equipment abuse, reduced grounding and repositioning costs. The ROI reviews conducted as part of this overall evaluation showed the potential for estimated net operational savings of $0.19 to $0.38 per chassis per day and up to $28 per shipment are possible. If extrapolated to the universe of domestic intermodal shipping, an estimated $52 to $104 million per year net reductions in chassis operating costs and $160 million per year reduction in intermodal shipping costs are a possibility, providing a combined estimated industry savings of $212 to $262 million per year.

As previously noted, many factors will drive the level of benefits of real-time asset tracking and information exchange systems and the timeframes in which they could be realized. These include: current levels of technological capabilities of intermodal firms, management approaches and objectives, economic conditions impacting willingness to invest in new technologies, or the potential for cost shifting from one firm or industry segment to another which could potentially constrain or negate many of the potential benefits.

Findings and Recommendations

The following provides a summary of findings from the IFTWG Asset Tracking and Freight Information Highway Deployment Evaluation recommendations for consideration by all IFTWG FOT public and private sector participants.

<u>Findings</u>

- Due to the diverse participant mix in the intermodal supply chain, effective collaboration and interoperability between modes, competitors, and industries, is an awesome challenge. Complications arise from conflicting data standards within

[6] The California State Assembly enacted Assembly Bill 2650 in the fall of 2002 to help reduce diesel emissions from idling trucks at terminals. As of July 1, 2003, all terminals located in California ports are required to reduce truck queues so that no truck will idle more than 30 minutes and to provide the state with the final plans for reducing congestion at their gates. State assemblies in Washington and Oregon both have drafted similar legislation.

specific industries, as well as limited information system capabilities for smaller carriers and shippers. Additionally, asset visibility is limited.

- This lack of freight equipment visibility information and of effective information sharing can lead to an increase in inefficiency, operating costs, and congestion and a decrease in economic competitiveness.The chassis tracking technology demonstrated a high level of accuracy (after a successful mid-deployment software and hardware upgrade). The device was able to send reports directly to the Freight Information Highway. The reports were accurate and included the ability to detect abuse moves. In comparison to legacy systems, the DataGates have the potential to eliminate high levels of manual entry and system-generated data errors (currently 18 percent), as well as excessive data entry delay (greater than 4 days in some instances). Based on increased visibility and chassis status data, savings per chassis per day are estimated at $0.74. DataGate costs are estimated at $0.36 to $0.55 per chassis per day; hence, the Evaluation Team found net benefits to range from $0.19 to $0.38 per chassis per day. Feedback from industry suggests that the lower bounds of chassis polling can provide sufficient tracking capabilities to meet operational goals; therefore, the upper bound of net benefits is attainable.

- The FIH technology demonstrated the ability to capture and standardize data from multiple sources and in multiple formats. This robust flow of data has the ability to rationalize data flowing through out the intermodal supply chain as demonstrated by the data exchange process charts developed in this evaluation. The benefits of this intelligent data consolidation and distribution manifest themselves in the form of potential savings of $28.66 per shipment. Even if this significant component of these savings (modal shifts-$17.05 savings per shipment) were considered “benefit-neutral” across the intermodal supply chain, significant benefits are still attainable via the FIH.

- While increased data access via the FIH has the potential to provide a number of benefits, significant institutional challenges need to be addressed for the potential to be fully realized. Challenges regarding stakeholder cooperation, regulatory reform, data privacy, national security, business enhancement, and technological compatibility will require continued informed discussion and negotiation for satisfactory solutions to be found.

- The analytical methods developed through this evaluation effort enable the measurement and forecast of asset tracking technologies in a variety of settings, thus enabling their ready use in a wider evaluation of the Cargo*Mate® DataGates currently underway.

<u>Recommendations</u>

Although significant potential exists for the technologies pilot tested, continued support for these efforts will be required to fully develop the technical capabilities and market critical mass necessary to encourage their adoption by the industry. The Evaluation Team’s significant interaction with the project deployers, sponsors, and relevant stakeholders identified the following suggestions to promote participation and support in advancing the technologies to realize the potential benefits:

- **Federal investment in an open-standards effort (perhaps via NAS).** Data standards are one of the greatest things hampering the widespread data translation. Such an investment in a federal standards program would rapidly consolidate efforts and encourage broad participation. One such area of standards development that would directly benefit the FIH is that regarding FIH portal standards. A standardized portal based model would encourage competition while promoting a distribution infrastructure that encourages innovation. This architecture does not eliminate the possibility for a national Homeland Security database; it simply promotes the growth of electronic portals to support feeding such a database, once again using standardized data structures. These FIH portals become data collection funnels that promote connectivity and make it easier to support national security efforts if legislation dictates such an approach.

- **Financial incentives**. These incentives will encourage adoption and participation in both asset tracking and freight data exchange via state/federal subsidies or tax rebates to all participants, including terminal operators, carriers, third-party services providers, shippers, etc. A major hindrance to widespread adoption of chassis tracking is that foreign companies that care little about security on American soil own many of the chassis in America. Perhaps financial incentive to promote asset tracking may promote homeland security.

- **Local, state, or federal regulations.** Imposing such regulations will encourage intermodal participants to look at the bigger picture. For example, establishing truck idle time limits at facility gates and border crossings may help. Another alternative is to provide incentives to terminal operators to keep wait times below a certain threshold or penalize terminals that do not meet certain performance levels. Again, such legislation not only serves to improve terminal congestion and air quality problems, but also serves to promote enhanced equipment visibility and data exchange.

- **Increased education and marketing.** Overcoming fears that advanced technologies could eliminate jobs would improve participation and increase current employee job skills, thus adding value to the participating company. Increased market penetration by using the advanced technologies would most likely increase the profitability of the participating company.

- **Provision of a federal funding model to mirror highway funding to each state.** This funding model is based on some portion of highway funds being dispersed to states if they invested in programs to promote, educate, and invest in FIH standards and systems. Due to the ability of Asset Tracking and the Freight information Highway to promote intelligent, efficient, and safe use of the national highway infrastructure, such a funding model would be reasonable and effective toward encouraging electronic connectivity.