The Electronic Freight
Management Initiative

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Executive Summary

The Electronic Freight Management (EFM) initiative is a U.S. Department of Transportation (DOT) sponsored research effort that partners with freight-related industries to improve the operating efficiency, safety, and security of goods movement. Web technologies that improve data and message transmissions and facilitate business transactions from one end of the freight management supply chain to the other play a prominent role. A service-oriented architecture (SOA) leverages these Web technologies and supports them by setting standards, and the EFM program packages them so that both government and commercial users could use them to support their needs. Potential benefits of using Web services technologies include improved shipment visibility throughout the entire supply chain, a reduction of redundant data entry, improved tracking, simplified interfaces with government authorities, and enhanced security.

This paper provides the context for developing the EFM initiative and describes the program's approach, components, and products. It also discusses the benefits of using EFM concepts and the importance of adopting data standards to improve communication among supply chain partners and government agencies. The paper identifies opportunities for implementation in both the private and public sectors and ends with a discussion of approaches to achieve broad adoption.

Introduction

The economy is growing and with it international trade that helps fuel our standard of living. International trade is now 25 percent of U.S. gross domestic product and is expected to continue to grow. Economic forecasts indicate that by 2020 domestic freight volumes will grow as well, increasing by 70 percent over 1998 totals, Freight volumes through our primary gateway ports could more than double. Given our existing and predicted physical

capacity constraints, finding ways to improve the operational efficiency of moving this freight into, out of, and throughout the United States is critical to our economic vitality. Freight movement, particularly international freight movement, involves a complex set of parallel processes related to the exchange of information between multiple entities (governmental and commercial) and the concomitant transfer of goods within and between modes of transportation.

To better understand these exchanges and where potential opportunities exist for improvement, DOT worked extensively with its private sector partners in the Intermodal Freight Technology Working Group (IFTWG) to create a freight process map that illustrates the physical movement of a container through a domestic supply chain along with its attendant information flow. Evaluation of this freight process map with industry partners helped DOT determine that the information transfer of a freight exchange is an area where improvements in speed, accuracy, and visibility could result in large rewards for the freight transportation industry. The EFM initiative directly targets that information exchange.

INTERNATIONAL TRADE GROWTH FACTS AND FIGURES:

- U.S. foreign trade rose from $1.2 trillion to $2.6 trillion between 1990 and 2003
- Over the past two decades, U.S. foreign trade in goods by value has quadrupled
- The volume of trade moved on the U.S. transportation system is projected to increase 65 to 70 percent by 2020 from 1998 levels

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Freight Facts and Figures 2005*, Washington, DC:2005.

Information processing is key to business operations. Most large carriers and shippers use electronic technologies to catalog and track cargo within their systems and to transmit cargo information outside their systems to U.S. and foreign government agencies. Some shippers also establish electronic inventory management systems with their largest suppliers and supply chain partners. However, not all businesses transfer shipment information electronically to each other across an open supply chain. In fact, the majority does not communicate electronically with all of their supply chain partners. In recent years, increasing competition and disruptions to the transportation network, such as the 2004 labor strike at the Ports of Los Angeles and Long Beach and Hurricane Katrina, cause companies to revisit their approaches to supply chain management, including the productivity of the transportation system on which they rely.

FedEx and UPS are two U.S. companies that use the electronic transfer of information to improve the productivity of their supply chains. Because overall system productivity is a major concern for these two companies, the transfer of information from origin to destination across modes is tightly scripted and very efficient, and each transaction is viewed as an origin-to-destination pair.

EFM seeks to provide this same level of efficiency to a broader user community by way of an open system that provides information transfer opportunities similar to a closed system. The EFM team works directly with the freight transportation industry to identify opportunities for implementing the EFM initiative.

The EFM initiative expects to demonstrate electronic information exchange by conducting an international supply chain test of the technology and related business case elements. From a system perspective, EFM has the potential to push paper out of the system of information transfers among supply chain partners (for example, manufacturer, shipper, freight forwarder to air carriers). So far, work has focused on the truck-air freight interface. Pending the results of this work, supply chains involving other modes, such as truck-rail and truck-ship could be evaluated and tested.

The EFM initiative also works with national and international standards organizations to ensure harmonization of data elements used in business and reported to governmental agencies. This ensures coordination with key programs such as 1) CBP's next generation trade processing system, the Automated Commercial Environment (ACE); 2) the International Trade Data System (ITDS), a multiagency component of ACE; 3) other related government programs such as the World Customs Organization's (WCO) security framework; and 4) commercial initiatives such as the International Air Transport Association's (IATA) eFreight and Cargo 2000.

Background

The EFM initiative evolved from recommendations to improve the operational efficiency and productivity of the U.S. transportation system, as well as from concerns about security. The EFM traces its roots to an initial study sanctioned by the White House Commission on Aviation in 1996. The Commission, headed by then Vice President Gore, studied issues and opportunities for improving aviation security. The final report included some recommendations for cargo transported by trucks for loading on airplanes, but these recommendations were limited to the physical control of the trucks.

Air Cargo is the fastest growing segment of the freight industry.

The EFM initiative is shaped by two previous projects. The first, a 1997 grant by the Federal Aviation Administration (FAA), was aimed at designing and testing a system for improving truck-air security. The project, named the O'Hare Air Cargo Security System, integrated smart cards, fingerprint biometrics, and some company and cargo data into an automated system for approving truck-delivered air cargo. The automated system, which was evaluated against manual processing times for the same transactions, was found to be two-to-four times faster than paper-based transactions. Final results of the system testing and evaluation were submitted to the FAA in June 2000.

The second project expanded the O'Hare project by leveraging the same security technologies to create a secure multimodal electronic cargo manifest and provide for automated data transfer across transportation modes and political jurisdictions. This project, called the Electronic Supply Chain Manifest,[1] was sponsored by DOT's Intelligent Transportation Systems (ITS) Joint Program Office and managed by the Federal Highway Administration (FHWA). The ITS Joint Program Office supports the overall advancement of ITS through strategic investments in promising initiatives. Although the test demonstrated some system integration issues, it did show estimated cost savings per transaction, based on a comparison of processing time and costs between manual processing and test-specific transactions. In complete end-to-end transactions, cost savings were shown to exceed $16.20 per transaction.[2] Additional information regarding this project is described in the sidebar.

The EFM initiative further expands the use of electronic data exchange through an ongoing joint partnership with industry. Sponsored by DOT's ITS Joint Program Office, the initiative demonstrates the sharing of complete end-to-end transaction information for Limited Brands, a U.S.- based apparel and personal care items retailer, based in Columbus, Ohio, with its international supply chain members. The initiative focuses on truck-air-truck supply chains. A demonstration test will be designed in 2006 and conducted and evaluated in 2007. The goal is to design and evaluate a more complete system built on an SOA platform that incorporates Web services and data exchange standards. Using a single manufacturer's supply chain, the research team manages and evaluates system inputs and outputs and incorporates freight data transaction standards to support international efforts to standardize freight information and support national freight policy.

PHASE II ELECTRONIC SUPPLY CHAIN MANIFEST (ESCM) PROJECT FACTS AND FIGURES:

- $2.0 billion—potential annual ESCM savings to industry
- 32—number of ESCM participants
- 3—types of supply chain participants— manufacturers, motor carriers, and airlines
- 81.8—percentage of participants who said ESCM improved on their current methods and could save time and effort
- 91—percentage of participants who said ESCM could allow for better or easier scheduling of shipments under a wide-scale deployment scenario
- 54—percentage of participants who recommended developing a "critical mass" of ESCM users to reduce or eliminate the need for duplicate efforts
- 100—percentage of participants who indicated ESCM met or exceeded their expectations

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations.

EFM Definition

The EFM initiative, whose goal is to extend mature technologies and standards to industry and government, is not an entirely new concept. Many other organizations are involved in similar activities, and various elements of what constitutes EFM are in development, demonstration, or production elsewhere. EFM is trying to accelerate and help organize the e-business environment in transportation by:

- Developing a specification for the use of Web services technologies and a true SOA as the means for exchanging information.

[1]U.S. Department of Transportation, *Electronic Intermodal Supply Chain Manifest, Freight ITS Operational Test Evaluation, Final Report*, December 2002 (http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13769.html).
[2]This figure comprises two components: 1) *measured* cost savings based on data collected for the pick-up side of the supply chain ($11.77), and 2) *estimated* cost savings for the delivery side of the supply chain ($4.43).

- Demonstrating a platform for commercial interests in hopes that the private sector will want to implement similar technologies for its information exchanges, as well as for potential government users.

- Extending and applying emerging efforts within international standards development and implementing organizations to use data-level standards that are applicable globally and in many different contexts of freight movement (most significantly, modally, geographically, and by industry).

- Demonstrating the packaging of the standards with the technology architecture by conducting various tests.

Among several concepts EFM is advancing is the idea of promoting electronic data exchanges along a supply chain in an "end-to-end" manner more robustly than is currently being done. Typically, freight movements are supported by point-to-point communications, either paper-based or electronic, between parties that have agreed to such communications. Using the Internet to make data broadly available to any authorized and authenticated user in real-time is key to improving the exchange of information along a given supply chain and to ultimately making freight transportation networks more efficient and secure. EFM defines "end-to-end" as from point of original consignment to final delivery at the shipper's warehouse. This type of data exchange provides buyers with various types of visibility into their supply chains.

Given the nature of freight movement, it is useful to consider supply chains in an international context. International supply chains tend to be more complex, have more partners exchanging information, and involve greater business-to-government data exchanges. These characteristics increase opportunities for EFM to create value.

The SOA, discussed in the EFM Technology Approach section, is an important component of the EFM initiative. Data standards that support this architecture enable disparate companies in a particular supply chain to share data with definitions and syntaxes that are commonly understood.

To date, all EFM development efforts center on transport, distribution, and delivery functions and, to some degree, ordering and security functions. Other functions, such as billing, payment, auditing, and insuring, have not been addressed. EFM's architectural contribution, however, should be sufficiently robust to enable its expansion to address a full functional range of process areas regarding freight movement.

Value Proposition

In the demonstration test of the EFM concept, which will be conducted using an actual end-to-end supply chain of Limited Brands, benefits will be quantified primarily through time-on-task comparisons between legacy manual processes and an automated equivalent. These comparisons will show where automation improved efficiencies and saved money.

The EFM must provide specific benefits for companies to be willing to adopt it. Given the fast-paced nature of supply chain management practices and the disparate nature of automated capabilities, it is unlikely that all potential adopters of EFM would see the same level of cost savings. It is important to discuss other types of potential benefits and, even more important, whether these benefits will attract future adopters of EFM.

> "The pressure is always on reducing rates. Everyone is looking for increased efficiency to get lower costs per unit. The only way you can stay profitable is to reduce costs. One way to do that is to minimize the huge manual input of information."
>
> Jorge Estevez, Vice President of Pricing and Yield Management, Crowley Liner Services, "Oceans Away," Kathleen Reidy, Line 56, December 2003.

Potential benefits of adopting the EFM include:

- Improved efficiency in the supply chain, and potential cost savings
- Reduced paperwork associated with the movement of goods and related services
- Improved cycle times
- Reduced complexity to access information by authorized parties
- A view across the supply chain that provides full cargo and asset visibility and the ability to identify opportunities for increased efficiencies and improved security.

Because these benefits are not exclusive to EFM, the value proposition must identify the unique contributions of EFM. Commercial entities already have created and implemented tools similar in concept to EFM. FedEx and UPS, for example, have long deployed EFM-like capabilities for their internal supply chain management functions as well as for their customers. In fact, these automated capabilities provide data to the government on international transactions and provide end users with a "single window" portal. However, as discussed earlier, these are proprietary systems, and when UPS or FedEx go outside their system to communicate with potential partners they may also need EFM capabilities.

In addition, EFM is based on an open architecture and is intended for use by all industries, whereas some commercially available products are industry specific, or specific to components of the supply chain. EFM is being designed and developed as an industry and technology tool that can be used by all members of a given supply chain. Instead of the point-to-point, well-defined information interactions between specific supply chain partners that are the norm in today's environment, an SOA approach fosters interactions among multiple partners. The SOA approach also eliminates batch information exchanges and allows for real-time information exchange.

The extent to which partners along various supply chains can take advantage of EFM varies according to their level of technological sophistication. Small- and medium-sized enterprises (SME) with rudimentary computing access (for example, those companies with little more than personal computing platforms and browser access to the World Wide Web) should be able to use EFM.

Source: Science Applications International Corporation

Air Cargo consolidation center at Chicago O'Hare Airport

EFM also offers opportunities for multiple adaptations within a given supply chain. For large companies with sophisticated installations, the degree to which labor savings are realized may be less. However, as larger companies are more likely to do business with many supply chain partners, and do so in broad geographical relationships, other EFM benefits should be realized (for example, increased visibility into and across transactions, diminished dependencies on external entities for status notifications).

Finally, the EFM value proposition is bolstered in a less tangible way through the promotion and adoption of standards. One of the hurdles to increasing collaboration among nonintegrated partners in the global supply chain community is the lack of agreed-on standards. The global supply chain community will benefit from standards that are fully accepted across all industries, geographic areas, and organizations that are stakeholders in supply chains. Outside the EFM initiative, there is a nexus of activity to develop and promote such global standards. Therefore, the EFM approach is to contribute to the developmental effort and also to demonstrate, through the aforementioned demonstration test, the advantage of a truly harmonized data element and messaging standard.

EFM Technology Approach

As previously discussed, freight supply chain partners are likely to have a broad mix of technology infrastructures and application platforms that are usually incompatible and unable to share data. To help solve this problem, EFM will use an SOA that includes Web services and data standards to enable partners to seamlessly and dynamically exchange needed information. SOA comprises standard IT components that are used successfully in a variety of industries. In addition, SOA offers uniform access to existing, customized database formats, computing platform independence, and customizable services. Scalable Web services also could be run in-house or outsourced to a value-added network (for larger-sized companies) and can provide SMEs the electronic interoperability they may need to grow.

The openness of Web services lends itself to the constantly changing business environments of supply chain transactions. By deploying Web services in a SOA environment, supply chain partners can automate daily business

interactions and streamline business processes. Web services are not hard-wired connections, thus allowing supply chain partners to implement a robust business service environment. SOA environments also provide businesses with an infrastructure that will be the building blocks for the development and integration of multiple supply chain applications. This feature will allow supply chain partners to react to dynamic business conditions and relationships and not experience a break in interaction. Even diverse technology assets can communicate with one another in an SOA environment. Furthermore, Web services can be implemented incrementally and can leverage existing information technology (IT) assets to attain both flexibility for a quick build of new applications and reusability of technology investments. These applications work together to allow information to flow up and down a specified supply chain, providing not only visibility of goods (either in transit or in stock) but also timely communications and proactive notification of the status of exceptions.

Figure 1 shows the Publish–Subscribe–Discover model that is at the core of SOA. Other important features of SOA technology include:

• Reusable technology and information that streamline operations

• Platform independent and standards-based services that can communicate with one another

• Loosely coupled services that minimize dependencies existing between systems

• Real-time data accessibility to increase business agility.

Figure 1. Publish/Subscribe/Discover Model of a Service-Oriental Architecture
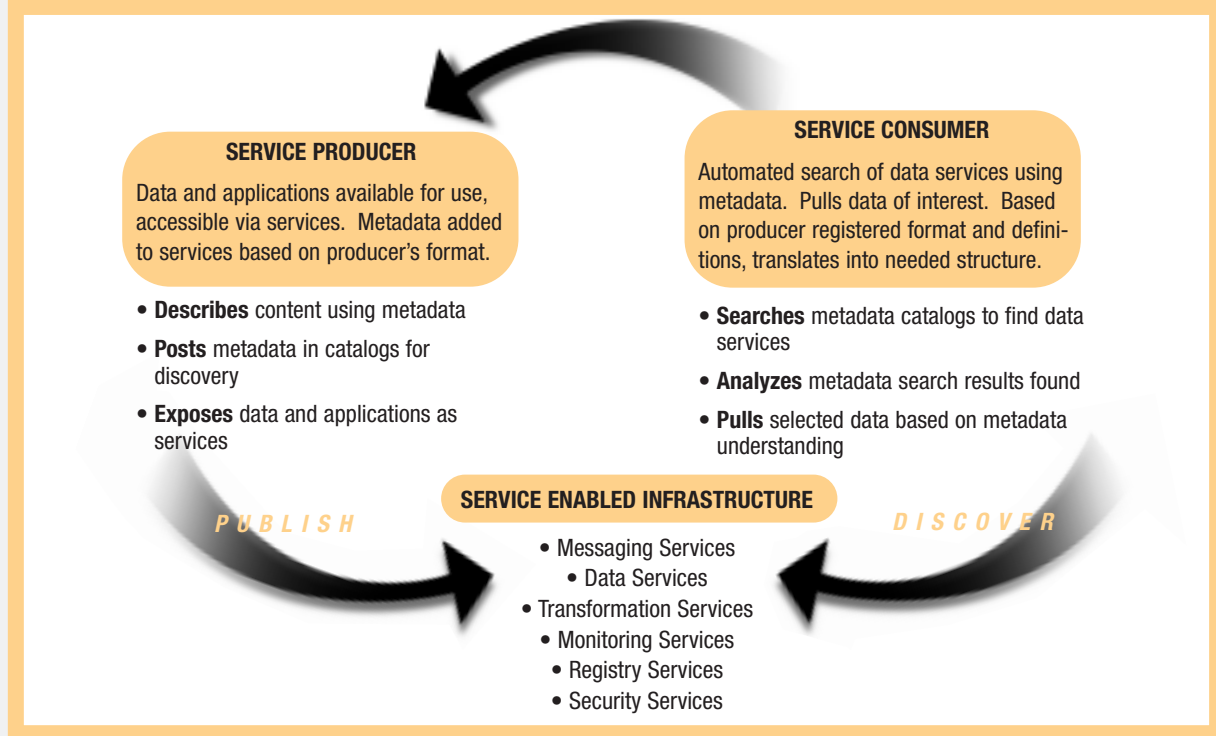
It is important to note that no central data repository must be deployed as part of the EFM concept. Data that compose the EFM domain must be maintained in some form (for example, in a database, XML structure, or file system), in a distributed manner by the constituent partners' systems and interfaces defined in the EFM rules. Cross-enterprise messaging is accomplished on demand and in real time.

To facilitate the implementation and use of Web services, EFM will contain a "Yellow Pages"-like portal function known as a Universal Description Discovery and Integration (UDDI) registry. The UDDI standardizes the directories of information on Web services, listing their capabilities, location, input requirements, and expected output or service performed. Supply chain partners will use the UDDI entries to learn the specifics of communicating with other partners' Web services.

Current partners' IT systems are not compromised by the EFM concept. A migratory, phased path toward SOA is feasible and practical. Initially, an operational system can be augmented with a Web-facing, read-only SOA frontend to the existing database or flat-file system. The new software will translate Web services requests to the appropriate database queries (or file parsing rules) and return the requested data as an XML document. This operation will require additional key components:

• User authentication and authorization modules to ensure that the requestor is permitted to receive the data

• A security mechanism to encrypt the data in transit

• A uniform data dictionary so that the requestor can use the same terms to retrieve the same data types from each supply chain partner.

These components will enable each organization to deploy tools, at its own pace, for retrieving data from other supply chain partners and automatically populate needed forms.

A Business Process Perspective

DOT and its partners are not focused on business process changes in the EFM demonstration test. Ultimately, it is up to the business community to change and standardize their business processes. However, as a subset of EFM activity, process changes may need to be addressed as part of replacing paper with electronic information. In a paper environment, human and other resources are dedicated to manually processing paper between entities. In an electronic environment, humans and other resources are also dedicated to processing data, but the task is done electronically between entities. This eliminates manual data entry. Instead of processing in a one-to-one environment, the task can be done in a one-to-many environments. Data captured once can be shared by many entities.

Thus, in the EFM environment, business process changes may be minimal, involving adjustments in procedures to accommodate the replacement of paper with electrons. Or, it may be more complex, involving changes in business operating procedures that may be outmoded as a result of using a new technology.

> "The main barrier to digital supply chain collaboration is complexity and high costs associated with extensibility of business processes throughout the network of suppliers and customers. Business process extensibility is the ability of an enterprise to conduct digital collaboration with its partners, by extending processes throughout the supply chain to increase visibility and streamline the information flow."
>
> "Successful Application of Service-Oriented Architecture Across the Enterprise and Beyond," *Intel Technology Journal,* November 17, 2004.

Standards Development

The success of global supply chain partner communities (beyond regulated government environments) in implementing EFM concepts hinges on the successful definition and adoption of various standards published in open and accessible forums. The EFM concept will leverage and influence several types of standards that are evolving under different imperatives, such as data, message syntax, IT architecture, and technology (discussed in the Technology Approach section). Because growth in EFM deployment will likely be incremental, supply chain partners must have defined standards to provide a common "language" to connect with other partners. Standards are needed to guide the EFM initiative.

To illustrate this need, a hypothetical example of a supply chain, which involves a foreign consumer products manufacturer selling its product in the U.S. market, is presented in the sidebar on page 15. This example also demonstrates that the state of data standardization is best described as individual groups of partners, individual geograph-

ic regions, and industrial segments that have standardized within their own supply chain segments. Adoption of standards across each of these constituencies is needed to provide interoperability between the various segments. Efforts independent of EFM are moving in this direction by organizations such as the International Organization for Standardization, the United Nations Centre for Trade Facilitation and Electronic Business, WCO, and the Organization for the Advancement of Structured Information Standards, as well as within the U.S. Government where there are many data standardization initiatives underway. EFM wishes to endorse, support, and demonstrate the use of these emerging global standards. Where standards are lacking, EFM developmental activities include building such standards, with the intent of delivering them to standards institutions.

HYPOTHETICAL SCENARIO

The manufacturer uses a local forwarder to tender freight to an air carrier for delivery to a U.S. gateway for subsequent trucking to a retailer's distribution center. At origin, unstructured e-mail messages might combine with Electronic Data Interchange for Administration, Commerce, and Transport (EDIFACT) shipment status messaging. Perhaps a U.S.-based representative makes entries into U.S. CBP's Air Automated Manifest System (AMS), while a broker enters data into CBP's Automated Commercial System (ACS) system. The airline might use an airline industry-specific format of EDI messaging to communicate with the forwarder and with U.S. government agencies. The U.S. trucking company might use the American National Standards Institute's (ANSI) format of EDI messaging, along with custom applications, to communicate with the import broker, forwarder, and delivery party or may, depending on the level of technical sophistication, communicate by cell phone or fax. In this mix of different message types, there is no consistency in the meaning of data elements, how they are represented, how they are packaged into messages, and how they are represented on paper forms. But this is the very kind of supply chain that EFM is attempting to assist by creating a single means for partners to read or contribute data elements that can be read and understood by other partners. This requires the introduction of standards into the EFM concept—whether those standards are adopted by the partners in their applications and systems, or whether the introduction of standards is accomplished with an additional layer of software that might be added between existing systems (or human interfaces) and the Internet conduit.

"Doing international business is rarely simple. For a seller to find a buyer, for a sales contract to be signed, for the goods to be shipped by the producer and received by the consumer, for the payment to be made within the contractual deadline, each phase of the transaction must take place within a pre-established system, based on specific rules for trade. The UN/ECE has learned that the best results are gained through basing trade facilitation on a combination of business-process facilitation and the opportunities offered by the information technologies. By harmonizing and standardizing procedures and information flows, this combination of techniques simplifies and integrates the trading process. The results: reduced trade-cycle time, simpler 'paperwork,' incentives to harmonize national standards to international ones, substantive cost savings."

Memorandum of Understanding on Standardization in the Field of Electronic Business, 2000, between the United Nations Economic Commission for Europe, International Electrotechnical Commission, International Organization for Standardization, and International Telecommunication Union.

EFM Demonstration Test

As previously mentioned, the EFM initiative is launching a demonstration test of component capabilities in 2007. The U.S.-based retailer Limited Brands, a Fortune 250 company, is participating in the test on some of its air shipments from China to its distribution centers in Ohio. Figure 2 shows how this test contributes to the overall advancement of the EFM concept.

The demonstration test, and the positive results achieved from it, will contribute to EFM's overall vision. The test, however, should not be expected to serve as the only source for constructing the vision nor should it limit the potential scope of the vision. In addition, the test should not lose sight of overall EFM objectives, including stimulating freight productivity, developing international standards, enhancing transportation efficiency, and promoting supply chain security. Focusing on these objectives, supported by performance metrics demonstrating achievement of these objectives, will also provide data to estimate investment returns.

Figure 2. Components of the EFM Test
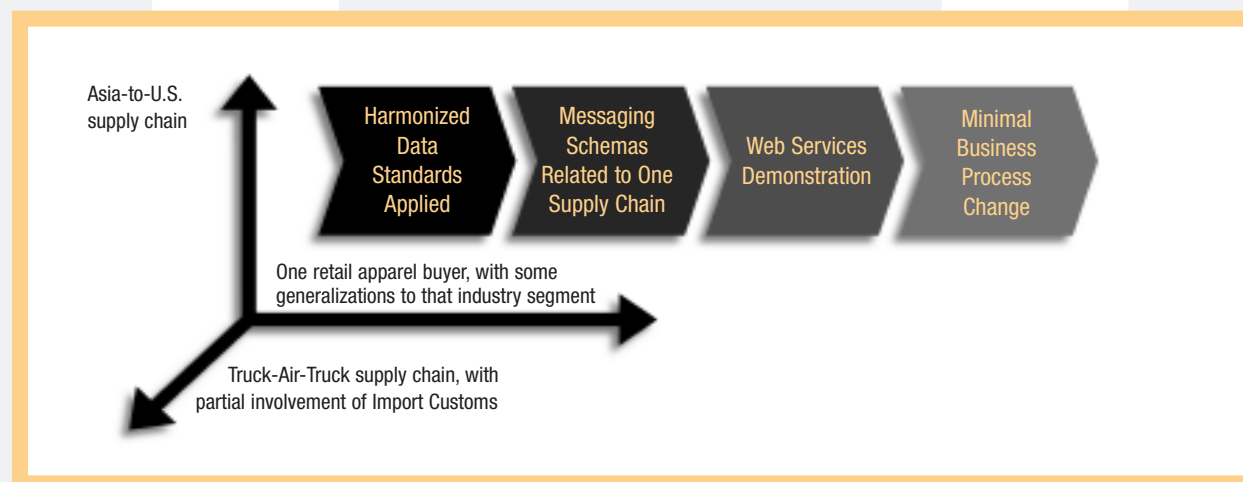
The test will demonstrate that Web services technologies built in an SOA environment will allow common sharing of information between supply chain and government partners. For the demonstration test, the Web services SOA will be referred to as the freight information highway (FIH), a mechanism for sharing supply chain freight information. The FIH will validate that XML translations used in the test will benefit users in the same manner as the data they were using before the test. It will also alleviate any concerns about the security of shared data.

Additional testing needs to focus on system capacity and the ability to handle ever-increasing amounts of data. The relatively small number of transactions that will move through the system should allow the test to be operated in a controlled state. In an uncontrolled industry-wide operation, the volume and flow of information will be more difficult to predict; thus, the system must demonstrate flexibility in processing information without disruptive effects.

Because the EFM plan calls for widespread deployment, providing various benefits for multiple stakeholders across different industries and government agencies, the test needs to consider issues that go beyond the boundaries and interests of the Limited Brands supply chain segment. It should not be assumed that this test, as designed for Limited Brands and its related stakeholders, will test and validate all aspects of a system that will be of interest to other potential industry participants. The selected supply chain provides an opportunity to cover a wide range of issues that may confront or be of interest to future participants. However, because it focuses only on selected modes of transportation in specific geographic regions, the test will not validate all areas of interest to many potential participants.

Market Overview: Government Sector

Following the EFM demonstration test, FHWA must articulate the government's role in EFM. Its ability to do so is a critical measure of success. The demonstration test will include development, a trial implementation, and test evaluation activities. During the test, the role of FHWA and other government agencies will be considered. A clear statement of the roles and impact of the project is important to ensure that EFM stands out from other federal initiatives for data standardization and collection, such as ACE Automated Truck Manifest, ACE Advanced Trade Data Initiative, Data Management Improvement Act, and US-VISIT that are competing for the attention of potential EFM partners.

As a conduit, EFM will provide the capability for filing existing data sets in various message syntaxes to the government. For example, an Automated Broker Interface (ABI) filer with the CBP could file the ABI transaction via EFM as securely as filing directly via ABI. The advantage of using EFM is its ability to allow data to be sent once, and through the use of business rules, determine who receives the information (including subsets of the data being transmitted). In this way, government stakeholders may choose to use EFM as a window for the trade community's interactions with U.S. and foreign governments as well as with commercial members along proscribed supply chains.

The security features and functional design of the EFM offer users the ability to tailor, on a transaction-by-transaction basis, who views their data and where their data go. This includes the ability to have EFM parse data streams in real time and send only authorized information to authorized recipients. This feature, while essential among programs by which transactional information is sent to government agencies, is one that requires the greatest preci-
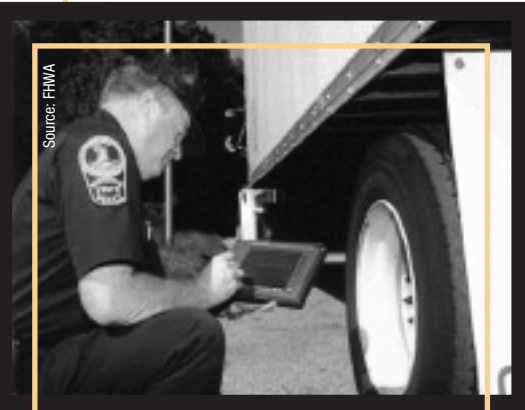
CVISN inspector conducts a safety Inspection using a wireless hand-held technology.

sion and clarity. Through basic business rules, the filer responsible for sending currently required information to government agencies can establish what entities receive the data and specify precisely what data are sent. Response messages (for example, edit and validation messages) from government entities also could be routed back to the appropriate recipients as designated by the filer.

A lack of effective information sharing leads to inefficiency, increased operating costs, congestion at cargo transfer points, errors in data transfer, and a decrease in economic competitiveness. The federal role is clearing institutional barriers and demonstrating the way ahead through standardizing datasets, building public-private partnerships that showcase operational improvements, identifying criteria that move the industry toward implementation of freight technologies employed in EFM, and developing associated operational best practices. Although it is through the private sector that the EFM will be implemented, governmental barriers must also be addressed, such as replacing paperwork now required of the trucking industry with electronic data exchange when transferring freight to an airline, through bills of lading, and so forth.

DOT perceives EFM as an initiative that could help advance its mission. For example, the Federal Motor Carrier Safety Administration (FMCSA) as a government stakeholder could use the Web services feature of EFM or the FIH to facilitate paperless compliance with federal motor carrier safety regulations. With connectivity to FMCSA's Commercial Vehicle Information Systems and Networks (CVISN), EFM could be used not only to track freight movement but also to determine whether a vehicle assigned to move freight is unsafe. In particular, EFM could be used to check a vehicle against a list of out-of-service vehicles or a list of vehicles cited for equipment violations. Checking would be performed before the freight is moved, saving time and effort on the part of commercial vehicle enforcement officers as well as the carrier and shipper. Dispatchers may have privileges to view such lists, be alerted to updates, and request changes, but not to change the list. Removing a vehicle from service for safety reasons delays freight movement for hours, if not days.

There is also a disconnect between private transportation data and FHWA infrastructure planning that places the government at a disadvantage in getting needed information to appropriately plan for infrastructure investments. FHWA is responsible for ensuring that the nation's highway network is adequate to handle current as well as

"This is a daunting challenge given the number of traders in the global supply chain, not to mention the number of regulatory authorities with an interest in the solution— each, perhaps, with their own point of view. I believe shippers, carriers, and other supply chain partners want to do everything necessary to be secure and compliant, but they will not invest in a solution unless they are certain it will satisfy the future requirements of regulatory agencies. A consensus view on requirements from U.S. Customs, TSA, Homeland Security (and perhaps international authorities, since this should be addressed with a global perspective) will be an important element of commercializing EFM as a long term solution."

Michael Sherman, VP Logistics, Limited Brands, DOT Air-Surface Cargo Security and Productivity Forum, September 2003.

future traffic loads. With the deployment of EFM, the collection and use of "scrubbed data" from private industry would be very helpful in making better infrastructure investment decisions and planning for the future.

Market Overview: Commercial Sector

A majority of supply chain partners operate in the commercial sector. Buyers and sellers of goods may be government entities, but the majority of transactions involve commercial concerns. In addition, most transport providers are commercial entities.

For the commercial sector, DOT acts as a facilitator, trying to reduce barriers that prevent supply chain partners from achieving operating efficiencies that have positive effects on transportation networks. Both industry and government have concerns about the capacities of ports and terminals and the highways, rail lines, air lanes, and waterways that are central to supply chain operations.

The transportation component of a supply chain comprises shippers, forwarders, line-haul operators, local transporters, drayage operators, and brokers. There are many secondary parties that have responsibilities for processing data used by parties in the chain. These include other government authorities, ground-handling agents, intermediate consignees, and terminal operators. Among commercial entities, the shippers and line-haul transportation operators drive the requirements for what and how information will be exchanged.

> "The real problem with EDI is that it's not real time. EDI is still a batch process, and it still takes too long to receive the information."
>
> Michael Bittner,
> Research Director,
> AMR Research, "The Next Step in e-Logistics,"
> Kristine Grow, Exec Online.

Shippers represent a broad range of companies, including forwarders, manufacturers, and distributors. Together, these companies and customers largely control data related to orders and the status of shipment. Large shippers and buyers customize, to some extent, their technologies, procedures, and standards used in information exchanges. For large supply chains, customization is generally governed by Electronic Data Interchange (EDI) standards and technologies, although often modified within the degrees of freedom that EDI permits.

Many commercial companies in a supply chain develop, deploy, and successfully use various Internet technologies to promote inter-enterprise structured communications. For example, Menlo Logistics (a division of UPS) developed applications to provide connectivity and visibility to customers and their supply chain partners. EFM differs from most other transportation management systems with its use of an SOA that provides a flexible, loosely coupled, and reusable application environment that leverages Web services to the fullest extent.

Although EFM is being engineered to be robustly useful in intermodal supply chains and for organizations with cross-modal activities, initial efforts are focused on line-haul segments involving air cargo movement. The air cargo industry has invested significantly in electronic capabilities to support operations management functions with its partners along its supply chains. These investments have been sponsored by individual carriers; ad hoc groups of industry stakeholders, including carriers, asset-based integrators, and non-asset based forwarders; and formal working groups through the IATA (see sidebar). The initiatives featured use information technologies and supporting process definitions to make the operations more efficient, particularly those of airlines and their primary operations partners, including forwarders and government authorities with which data is exchanged. These industry initiatives are generally adopted for competitive positioning, cost reduction, revenue enhancement, and/or customer service.

For EFM concepts to be successfully adopted by the commercial sector, they must harmonize with, and not disrupt, existing programs and initiatives (such as those described in this section for the airfreight industry). There are several ways EFM can do this for industry:

- Industry can bolster existing initiatives by adopting best practices that have been derived from the EFM demonstration test.

- Industry can take advantage of the standards being developed within EFM, given that all efforts are being conducted in the open domain, and in conjunction with open, public standards development and implementing organizations.

- Industry can choose to internalize portions or all of the EFM deployment test, perhaps testing or piloting initiatives in conjunction with internal development efforts.

- Industry can leverage EFM as a rallying point and demonstrate that the industry-wide benefits are possible.

EFM overcomes implementation barriers by not adversely affecting investments in proprietary or other legacy systems that commercial concerns use to operate their businesses. There are some unknowns as to the connection methods, but the test should help identify the various ways that businesses can interact with web services and other business partners.

> "Communicating with airlines is a challenge. The underlying problem is that no single system or third-party portal allows us to communicate with all our airline partners."
>
> Chris Coppersmith, President and CEO Target Logistics Services, quoted in *CargoVision*, December 2004.

A number of industry-led efforts to commercialize elements of the same business domain are addressed by EFM. DOT hopes to partner with stakeholders of such efforts with the objective that the industry will adopt and commercialize EFM. For example, in the air cargo industry, relevant initiatives include—

1. Consortia of air carriers have created web portals initially intended for cargo booking, but which have expanded to other functions, such as tracking. Forwarders have clearly stated they would prefer a single, universal portal solution. Existing portals include—

    • Cargo Portal Services

    • Global Freight Exchange

    • Ezycargo

2. Cargo 2000, an International Air Transport Association (IATA) interest group, defines and certifies implementation of process standards, particularly in the movement of freight between forwarders and air cargo carriers; defines a quality measurement system; and measures and reports on performance. As of 2004, 38,000 Master Air Waybills per month and 80,000 House Air Waybills per month were being measured under the Cargo 2000 program.

3. eFreight, an IATA industry action group, specifically targets the reduction of paper requirements that hamper the success of electronic communications in making measurable savings in supply chains (such as by reducing cycle time). The initiative is planning to run pilot tests in 2007. The project team recognizes that keys to success include expanding beyond the air carrier industry and has actively engaged the World Customs Organization. eFreight also embraces the instruments of standardization being developed by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT).

4. Initiatives are creating XML schemas supporting air cargo messaging between supply chain partners. These schemas are harmonized at some level with the international standards instruments, such as the UN Trade Data Element Directory. For example, the government-endorsed Hong Kong regional Digital Trade and Transportation Network has a series of such schemas covering messages, such as the Air Waybill.

5. Individual companies are moving forward by adopting technology solutions that support a standardized, global view of supply chain information exchanges. Examples include the following:

    • German-based forwarder and integrated logistics provider Schenker has announced a $30 million investment to integrate the data and messaging environments of its air and ocean forwarding businesses to create a cross-modal environment.

    • Air cargo IT services provider CHAMP Cargosystems has reengineered its legacy systems onto a web services platform available over the Internet to support customer operations worldwide.

Moving Toward EFM Adoption

The EFM test is an important component of the EFM deployment strategy. It is anticipated that this test will demonstrate positive value with manageable risks, consistent with the results of earlier testing, and that supply chain parties will be interested in adopting EFM.

FHWA believes the EFM initiative could significantly increase freight movement efficiency by improving information transfer and sharing techniques among supply chain partners. This initiative uses a Web services environment and focuses on developing and implementing international standards for data elements to improve information transfer efficiency. A demonstration test of the EFM initiative will be completed in 2007.

Success of this initiative is defined as the adoption of the information transfer method demonstrated in the test. To prepare for ready adoption of this information transfer and sharing method beyond test participants, FHWA's Office of Freight Management and Operations seeks to build awareness of the EFM initiative with industries that will benefit from improved information transfer.

Therefore, in parallel with the EFM demonstration test, FHWA will develop a phased plan to promote adoption of EFM candidate best practices. Finding industry members who are seeking productivity gains by using information transfer and sharing techniques will be accomplished through joint presentations with project partner champions at key conferences and meetings throughout 2006 and 2007. In addition, articles on key features and best practices of EFM will be written and made available for publication in trade journals with strong industry readership. Awareness is a critical

element in the process of preparing business plans and budgets. Part of the awareness process will include sharing documentation on the EFM concept of operation and detail design. Following the awareness activity, FHWA will share implementation guidance documentation, developed as part of the demonstration test, to facilitate the roll-out of EFM. Industries with a strong interest in reviewing implementation guidance in other air cargo supply chains are likely candidates for adoption of EFM's best practices. FHWA is also willing to support industry as it moves forward to adopt best practices. This collaboration between government and industry could enable the ready adoption of EFM information transfer techniques and could signify a fundamental change in how intermodal freight would be handled domestically and globally in the future.

Successful adoption of EFM best practices in air cargo supply chains may be a catalyst for their adoption in other modes of transportation, such as water and rail. FHWA will use assessment measures, such as industry focus groups, to determine the practicality of expanding demonstration tests to other modes. These assessments will be done in 2007 and 2008. •
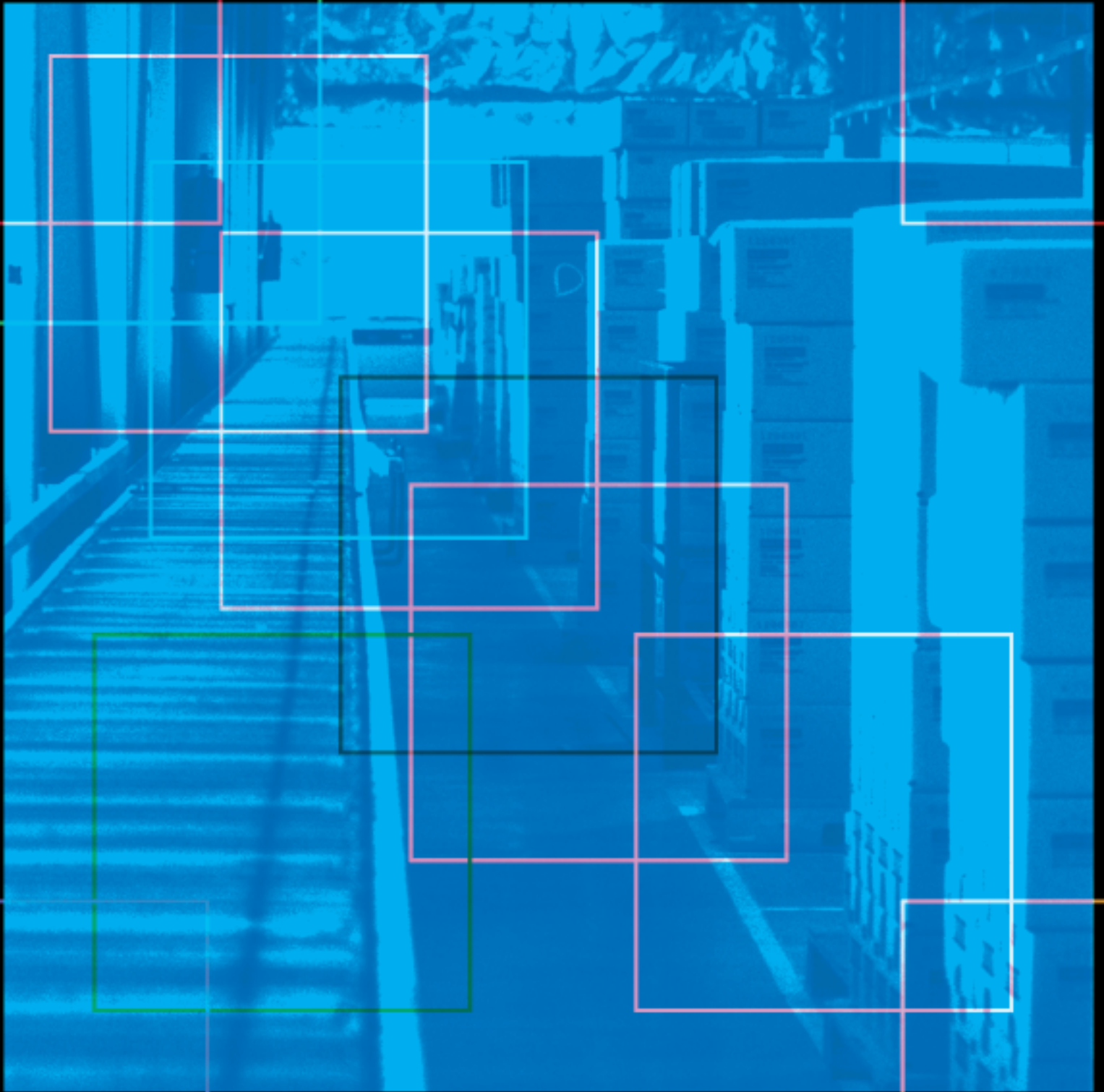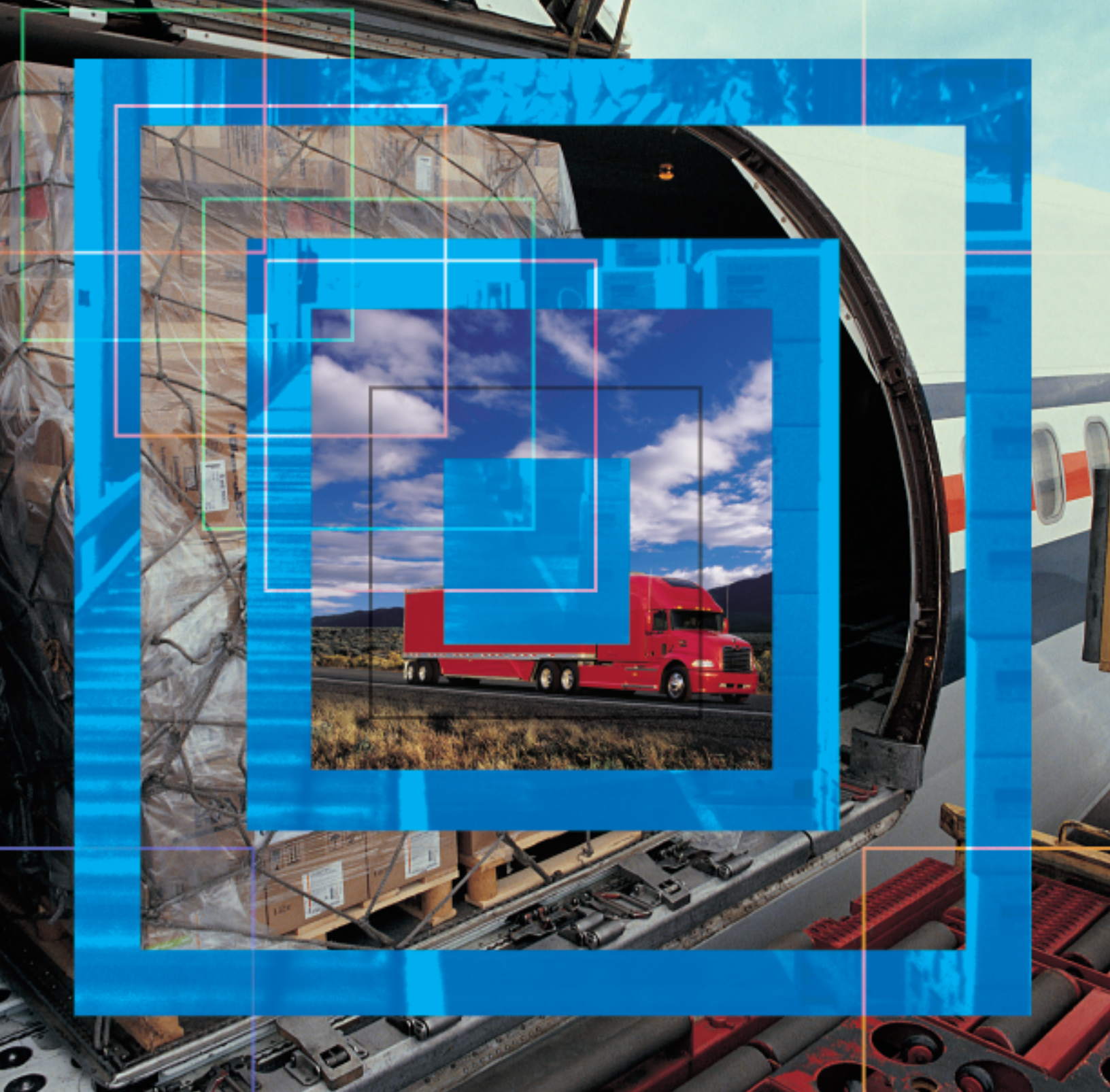
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16. Abstract
This report discusses the Electronic Freight Management initiative, a U.S. Department of Transportation (DOT) sponsored research effort that partners with industry to improve the operating efficiencies, safety, and security of goods movement. The EFM initiative uses Web technologies to improve data and message transmissions and facilitate business transactions among supply chain partners. A service-oriented architecture leverages the Web technologies and supports them by setting data standards.

The potential benefits of using Web technologies include 1) improving shipment visibility throughout the supply chain, 2) reducing the amount of repetitive data entry required, 3) augmenting the diagnostic tracking abilities that come from greater supply chain visibility, 4) simplifying interfaces with government agencies, and 5) providing additional data on shipment status that can make supply chains more secure. A service-oriented architecture leverages Web technologies

The paper provides the context for developing the EFM initiative and describes its approach, components, and products. It also discusses the benefits of using EFM concepts and the importance of adopting data standards to improve communication among supply chain partners. The paper identifies opportunities for implementation in both the private and public sectors and discusses approaches to achieve broad adoption.

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