Columbus Electronic Freight Management Evaluation Final Report

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16. Abstract

This document provides the independent evaluation of the USDOT-sponsored Columbus Electronic Freight Management (CEFM) Operational Test, which occurred from late May 2007 until December 2007. The Evaluation report includes descriptions of the CEFM system and defines quantitative and qualitative benefits in the following four primary study areas:

(1) CEFM system usefulness in terms of participants' perceptions regarding the system's ability to improve their daily operations and whether CEFM represents an improvement in their Information Technology (IT) environment (improved information quality and flow).

(2) The ability of CEFM to improve cargo visibility in terms of more actionable (complete, accurate, and timely) cargo location and status information for public and private sector participants.

(3) CEFM's ability to improve supply chain and logistics performance by reducing supply chain costs, shipping delays, cargo clearance times, or to improve overall levels of partner coordination and ultimate customer satisfaction.

(4) Assessment of deployment scalability through participant willingness to integrate the Electronic Freight Management concept into their overall IT environments, and establishment of a business case demonstrating the public and private sector value propositions.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS LIST

ABI	Automated Broker Interface
ANC	Anchorage, Alaska
ASN	Advanced Ship Notice
Deployment Team	Battelle/Transentric
BIM	Booking Information Management system
CBM	Cubic Meter
CBP	U.S. Customs and Border Protection
CEFM	Columbus Electronic Freight Management
CFS	Container Freight Station
ConOps	Concept of Operations
COTM	Contracting Officer's Task Order Manager
COTR	Contracting Officer's Technical Representative
CSV	Comma Separated Value
DC	Distribution Center
Design Document	Detailed Design Document version 3.0
DSR	Daily Status Report
EDI	Electronic Data Interchange
EFM	Electronic Freight Management
ESB	Enterprise Service Bus
EST	Eastern Standard Time
FedEx	Federal Express
FHWA	Federal Highway Administration
FIH	Freight Information Highway
FOT	Field Operational Test
FTAT	Freight Technology Assessment Tool
GAC	Goods At Consolidator
GOH	Goods on Hand
HACTL	Hong Kong Air Cargo Terminals Limited
HAWB	House Air Waybill number
HKG	Hong Kong Airport
HTTP	Hypertext Transfer Protocol
HWL	Hellmann Worldwide Logistics
IFTWG	Intermodal Freight Technology Working Group
IT	Information Technology

ITS	Intelligent Transportation Systems
JFK	John F. Kennedy International Airport
JPO	Joint Program Office
KC SmartPort	Kansas City SmartPort, Inc.
LB	The Limited Brands
LCK	Rickenbacker Airport
MAWB	Master Air Waybill number
MOCC	Measuring Outcomes of Clinical Connectivity
MOE	Measure of Effectiveness
MPO	MAST Purchase Order
NDC	iN Distribution Center
North River	North River Consulting Group
NTB	Notice to Broker
OCR	Open Consignment Report
ODW	ODW Logistics
PDF	Portable Document Format
PO	Purchase Order
ROI	Return On Investment
SAIC/Evaluation Team	Science Applications International Corporation
Star	StarTrans International Ltd.
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SSL	Secure Socket Layer
TDE	Trade Data Exchange
TMS	Transportation Management System
UBL	Uniform Business Language
UCR	Unique Consignment Reference number
UDDI	Universal Description, Discover, and Integration
ULD	Unit Load Device number
UPS	United Parcel Service
USD	US Dollars
USDOT	United States Department of Transportation
UTC	Coordinated Universal Time
VB	Visual Basic
WSDL	Web Services Description Language
WCO	World Customs Organization
XML	Extensible Markup Language

EXECUTIVE SUMMARY

PROJECT BACKGROUND AND CONTEXT

The Columbus Electronic Freight Management (CEFM) project is a Deployment Test of an implementation of the Freight Information Highway (FIH). The CEFM project is sponsored by the U.S. Department of Transportation (USDOT) as part of the Intelligent Transportation Systems (ITS) program's Electronic Freight Management (EFM) research initiative. The official definitions of these three efforts are:

- **EFM:** An ITS research and development initiative led by USDOT that promotes and evaluates innovative e-business concepts, enabling process coordination and information sharing for supply chain freight partners through public-private collaboration.
- **FIH:** An innovative non-proprietary standards-based architectural specification that defines a Service-Oriented Architecture (SOA) to support business process coordination and secure real-time data exchange. FIH utilizes standard processes, schemas, and definitions that are specific to the freight transportation industry.
- **CEFM:** A deployment test within the EFM program, which implements all components of the FIH necessary to support a select Limited Brands international truck-air-truck supply chain.

The CEFM project encompasses the entire air cargo supply chain, from overseas suppliers in China to The Limited Brand's (LB) distribution centers in Columbus, Ohio. Design and development of CEFM were completed during 2006 and early 2007, and the Deployment Test was conducted from May 29, 2008 to December 4, 2007.

In support of the USDOT ITS Joint Program Office (JPO), an Evaluation Team led by Science Applications International Corporation (SAIC, Evaluation Team), supported by the North River Consulting Group (North River), performed an independent evaluation of the CEFM test implemented by Battelle and Transentric (Deployment Team). The CEFM Evaluation Plan was completed in January 2007,[1] and the corresponding evaluation occurred throughout the test and in the several months that led up to this evaluation report.

The Evaluation Team prepared and followed a series of Detailed Test Plans[2] to conduct the evaluation for each of the four main study areas and associated individual hypotheses as described in the Evaluation Plan: System Usefulness; Cargo Visibility; Supply Chain and Logistics Performance; and Deployment Scalability.

[1] U.S. Department of Transportation, Federal Highway Administration (FHWA), *Columbus Electronic Freight Management Final Evaluation Plan,* (Washington, DC: January 2007).
[2] USDOT, FHWA, *Columbus Electronic Freight Management Detailed Test Plans* (Washington, DC: October 4, 2007).

CEFM SYSTEM AND TEST OVERVIEW

The CEFM system is a freight data exchange and information management concept, which relies on the Web-based FIH. CEFM obtains data from each supply chain partner, stores the data separately (for most partners), and then exchanges the data with other trading partners via Web services using Extensible Markup Language (XML) data standards. Web services in CEFM automatically send and receive shipment status information among supply chain partners. Using the FIH as an SOA or gateway for automated interfaces within the CEFM provides software capabilities designed to support computer-to-computer interactions over the Internet. The ultimate goal of the FIH (the SOA in CEFM) is to facilitate this status information exchange.

CEFM used 21 Web services as described in the CEFM Detailed Design Document.[3] The supply chain event data used by CEFM is stored in individual partner shadow databases that acted as an interface between the partners' existing logistics management systems and the FIH. As a separate data storage file, shadow database contained each partner's exclusive data within the CEFM deployment test, thereby protecting the partner's production data from the deployment test. The shadow database was mainly populated automatically through either CEFM Web services message content, or from the partner's existing Information Technology (IT) system. Although manual entry input was allowed via the user Web interface for the manufacturer, or by the CEFM Deployment Team, this method only was used when automatic population was not feasible. Since the data population was automatic in most cases, CEFM provided near real-time data to the supply chain partners. CEFM was designed such that only the manufacturer needed to enter data, yet all partners could access the CEFM Website to view consignment status within the supply chain. The CEFM Website was known as the user interface, and each partner had a separate user interface.

For the deployment test, most partners' existing logistics systems that provided the data were not integrated with the CEFM, where integration means there was no shadow database or user interface. ODW Logistics, the container freight station (CFS), modified its existing system to include the CEFM Web services and FIH-supplied data. Where existing logistics systems were not integrated, shadow databases acted as the interface between the existing systems and the FIH.

CEFM DATA FLOWS AND EVALUATION FINDINGS

The evaluation included an analysis of the consignment supply chain data that was received and exchanged by CEFM and stored for each partner. A total of 871 consignments were completed during the test. The System Usefulness evaluation confirmed that the system met its functional specifications and requirements in an operational setting and gauged the usefulness of the new system to its users. The evaluation report discusses each Measure of Effectiveness (MOE) and the potential benefits from use of the types of automated information available from CEFM.

Figure 1 presents the LB supply chain process flow from origin at the manufacturer's factory in southern China through delivery to LB's distribution center (DC) in Columbus, Ohio. Sections of the diagram show current data flows, CEFM data flows, and anticipated benefits from CEFM. For the current data flows, the six boxes show data transferred during a shipment's departure from the origin

[3]USDOT, FHWA, *Draft Detailed Design Document for the Columbus Electronic Freight Manifest (CEFM) Deployment Test* (Washington, DC: November 21, 2006).

to the destination at the DC. The six boxes are located along the timeline to show the approximate data transfer times. This graphic also identifies each piece of data as manual (phone, email, or fax) or automated (Electronic Data Interchange [EDI] or legacy Information Technology [IT] system). Below the existing data flows, the diagram comparatively illustrates how and when the CEFM data flows occur. The diagram also compares the LB's 96-hour transit time standard and the timings between respective supply chain events, as calculated using archived CEFM data.

The CEFM portion of the diagram is overlaid with annotations of the benefits found during the evaluation. Each major benefit area is shown with a "$" and is discussed later in section 4. The primary message of the diagram is that CEFM data is very often available earlier in the supply chain than current data, which translates to benefits to the various partners on the supply chain. Table 1 defines the acronyms used in the timeline diagram.

The benefits noted in the timeline diagram are:

- **Manufacturer Reduced Data Entry:** Refer to the quantitative benefits in section 4.4.2, MOE 5.
- **Advance Preparation of Customs and Border Protection Documents:** Refer to the qualitative benefits in section 4.3.1, MOE 4, and section 4.4.1, MOE 5.
- **Air Status Research Savings:** Refer to the qualitative benefits in section 4.3.1, MOE 3, and quantitative benefits in section 4.4.2, MOE 5.
- **Daily Status Report Daily Savings:** Refer to the qualitative benefits in section 4.3.1, MOE 2 and quantitative benefits in section 4.4.2, MOE 5.
- **Pre-Alert Time Savings:** Refer to the quantitative benefits in section 4.4.2, MOE 5.
- **Improved Data Quality at CFS:** Refer to the qualitative benefits in section 4.3.1, MOE 4B, and quantitative benefits in section 4.4.2, MOE 2:
  - Improved EDI Accuracy.
  - Improved EDI Availability.

Table 1. Timeline Diagram Acronyms and Definitions

Acronym	Definition	Acronym	Definition
ASN	Advance Ship Notice	HACTL	Hong Kong Air Cargo Terminals Limited
CB	Customs Broker	HAWB #	House Air Waybill number
CFS	Container Freight Station	HK	Hong Kong
CMH	Airport Code for Columbus	LB	The Limited Brands
DSR	Daily Status Report	MAWB #	Master Air Waybill number
ecVision	Product lifecycle management system	MFG	Manufacturer
EDI	Electronic Data Interchange	NTO	Notice to Broker
FA	Forward Air	OCR	Open Consignment Report
FF	Freight Forwarder	PO	Purchase Order
GAC	Goods At Consolidator		

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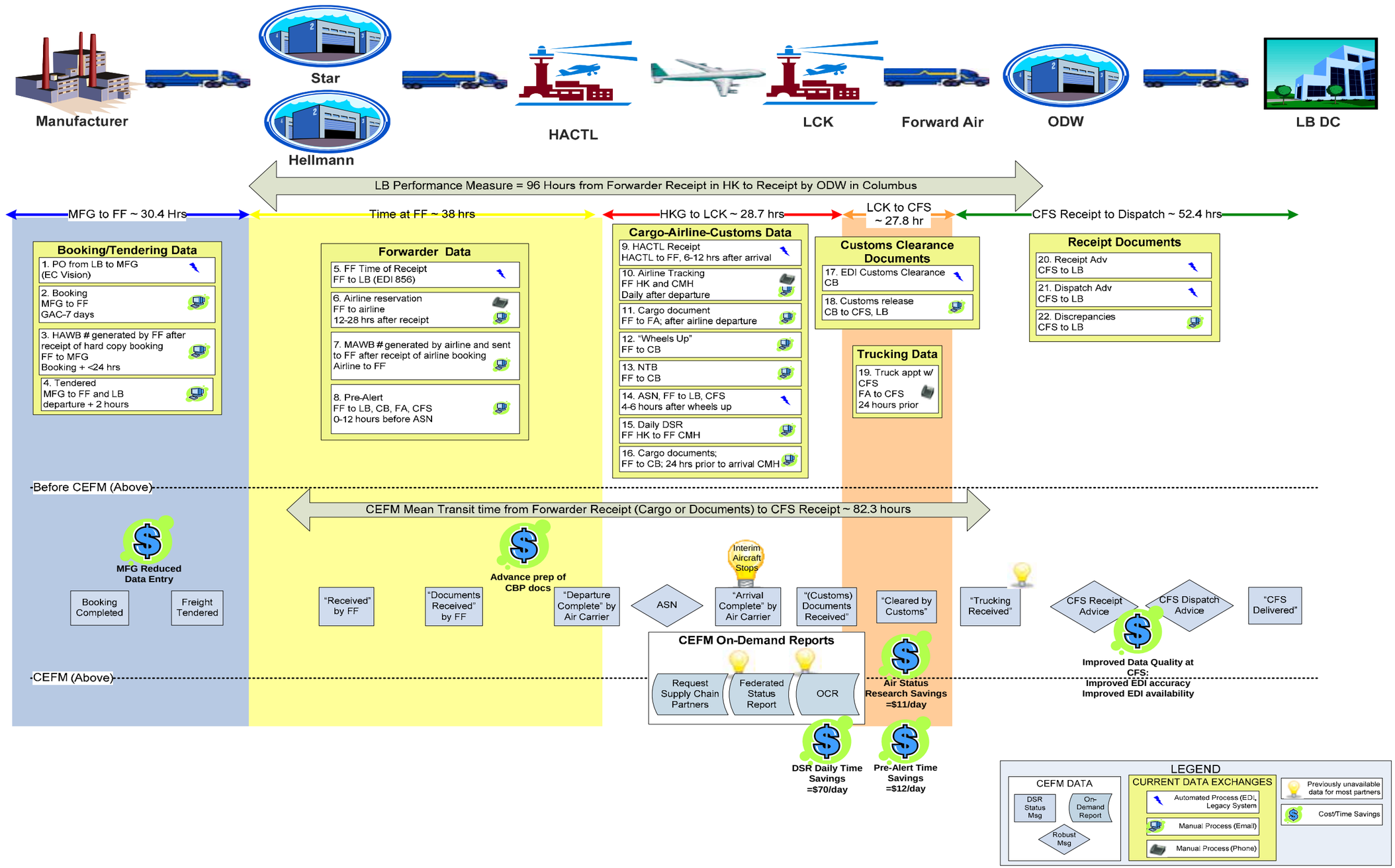

Figure 1. CEFM Timeline Diagram with Benefits.

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As originally defined in the Evaluation Plan, the CEFM evaluation addressed four study areas:

1. System Usefulness.
2. Cargo Visibility.
3. Supply Chain and Logistics Performance.
4. Deployment and Scalability.

Each study area had two or more hypotheses, and each hypothesis had several MOEs. The hypotheses and MOEs defined the detailed work steps that the Evaluation Team followed in the overall CEFM evaluation. For the purpose of this evaluation report, the evaluation findings are organized by hypothesis.

Since the fourth study area applies to the likelihood of future deployment, it is not included in this phase of the evaluation. The Deployment and Scalability at study area will be discussed in a second report to be produced by September 2008, the CEFM Deployment and Scalability Evaluation Report.

The following Tables 2 through 8 present the various hypotheses, MOEs, and analysis methods used to conduct the evaluation. The "stop light" icons indicate whether the evaluation has a positive (green) or negative (red) rating. Summary comments about each hypothesis are contained in the right-hand column. To account for overall content completeness, and as a reference to the CEFM Evaluation Deployment and Scalability Report that will be completed in September 2008, Table 8 contains similar information about Scalability and Deployment. Since these elements will be evaluated and documented in the future CEFM Evaluation Deployment and Scalability Report, the applicable stop light icons are colored gray.

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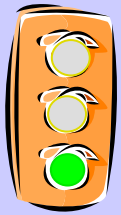
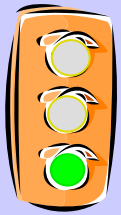
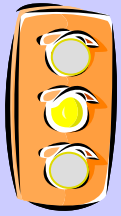
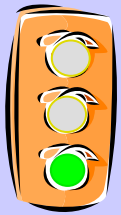
Table 2. Results of Private Sector System Usefulness CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. CEFM technologies will be accepted by system users as valuable new tools to support their daily operations.	1. Meets system specifications in Detailed Design Document and use cases.	• System screens and user interfaces including the CEFM Website. • Observations of test shipment data during test. • Participant interviews in person, via telephone, or follow up via email. • Current DSRs. • Consignment status information for test shipments.	• Analyzed CEFM screens and test data including observation of test data moving between and among partners. • Compared test data and screens with specifications and use case definitions. • Conducted interviews with all partners. Obtained follow-up information by telephone and email.	 Green	• The Evaluation Team reviewed the specifications during and after the test and found that the specifications were met (see section 4.2.1, MOE 1). • Users, as well as the Evaluation Team, found the screens straightforward and useful, perhaps with less flexibility or ability to customize than they wanted (see section 4.2.1). • The ability to export the OCR to Excel was a very important feature and widely used (see section 4.2.1).
	2. Usefulness of CEFM data and reports in daily operations as compared with current operations.		• All users were interviewed either in person (both Hong Kong and Columbus) or via email (LB and follow up with all users). • Samples of user reports and documents were obtained and compared with CEFM data.	 Green	• Content of screens and reports was as designed. Users were impressed with the quality and content of the reports (see section 4.2.1, MOE 2). • Users seemed to want and expect transportation management system (TMS) capabilities from CEFM. By design, CEFM is a data exchange system, and not a TMS, and therefore, has limited reporting capability, and is not as flexible in its analysis capabilities as one would find in a typical TMS (see section 4.2.1, MOE 2).

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
	3. Modified business process to conduct daily operations.	• Observations of test shipment data during test. • Participant interviews in person, via telephone, or follow up via email.	• A decision was made early in the project to not have any business processes change as a result of CEFM. • Conducted interviews with all partners, and Obtained follow-up information by telephone and email.	 Yellow	• Integrating ODW data into CEFM ODW system showed the promise of modifying business processes. By agreement prior to the test, no partner business processes were changed during or as a result of the test because CEFM represented only about 10 percent of the total shipments, and partners had to continue to perform their work. Partners discussed the potential use of CEFM-type data if it applied to all shipments. The Evaluation Team would expect process changes in full adoption of CEFM (see section 4.2.1, MOE 3).
2. The CEFM participant experience in using FIH information exchange technologies will illustrate the advantages of integrating existing and disparate freight Information Technology (IT) systems into a common XML-based environment.	1. Improved system user ease, timeliness, and accuracy of obtaining/ sharing information. 2. Reduction in time required to retrieve data using FIH compared with like data exchanges with current systems. 3. Reduced effort in establishing data exchanges with a new supply chain partner. 4. Ability of each partner to send or receive and correctly interpret messages from other partners.	• Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • On-site observation/ process timings. • On-site visits to measure the "before" (or without) condition: – At LB's DC in Columbus. – At ODW and other partners in Columbus. • Current DSRs.	• Performed qualitative analysis of before and after (or with or without) daily operations based on participant interviews/ surveys and stakeholder observations. • ODW provided very useful anecdotes about EDI use. The Evaluation Team was not able to meet with LB. No operating statistics were obtained, nor any historical performance reports. LB did provide a file of data from its DSRs for the CEFM shipments.	 Green	• The SOA, FIH, and Web services performed well. The Web services did manage the data exchanges as was planned (see section 4.2.2). Where there were data errors or gaps, they tended to occur due to design issues or integration problems with existing systems, and not because of FIH (see sections 3.2.3 and 4.2.2). • The technical partners, including representatives from ODW, perceived improvements resulting from using the FIH for data exchange. For most users, the FIH was transparent, and the users did not really interact directly with the FIH. • ODW, the one partner who integrated, thought there would be

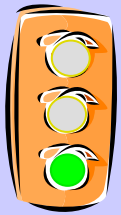
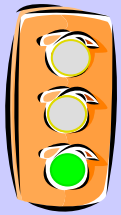
Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
		• CEFM standardized and unstructured messages including consignment status report data.	• ODW's experiences are likely to be the basis for primarily qualitative benefits compared with EDI. The Evaluation Team will try to determine if there is other industry experience of XML implementation versus EDI. • Some EDI statistics were reviewed; the Evaluation Team generally relied on the users' perceptions about their existing EDI.		reduced implementation barriers. This was never proven during the test because additional partners were not added. Industry representatives familiar with EDI and Web services concurred that implementation would be easier. • The information sharing as a result of Web services worked extremely well. The Evaluation Team is not aware of any data errors that resulted from using the Web services.
3. System security features and protection of proprietary information in the CEFM test will demonstrate the ability of EFM technologies to protect sensitive data and restrict access to existing systems.	1. Legacy systems and data are protected from unauthorized partner access. 2. Ability to restrict data to particular users. 3. Improved security against unauthorized accesses to the system.	• CEFM partners' files and authorizations to data. • Digital certificates within CEFM related to data exchanges. • Data exchanged on test shipments during the deployment test.	• Observing unsuccessful efforts to gain unauthorized access to data during the test. • Examining partner privileges and ability to restrict access to data for each type of CEFM user. • Identifying discrepancies or differences and assess significance.	 Green	• Through test observation and their own use of CEFM, the Evaluation Team determined that the existing systems were protected from access by other partners. Password-protected user authorizations were observed and understood by all partner participants. • Users thought the password for accessing CEFM was too hard to use and remember, perhaps a testament to CEFM's system security features. • The Evaluation Team reviewed XML message formats of some test data and found that the digital certificates functioned as designed.

Table 3. Results of Private and Public Sector Cargo Visibility CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. Implementation of the CEFM on LB supply chains will yield improved supply chain visibility. (Defined as accuracy, timeliness, and usefulness of information not currently being provided.)	1. Improved tracking information and ability to trace shipments. 2. Improved cargo status information. 3. Improved air mode information. 4. Increased timeliness and quality of visibility information.	• Baseline types of information. • DSRs. • Shipment information from ODW. • Test data from CEFM • Pre-alerts from forwarders. • CEFM-generated consignment status reports.	• Comparative analysis of baseline versus CEFM types of information. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements.	 Green	• Partners agreed that CEFM information provides better visibility. They agreed that if CEFM were integrated with existing systems and applied to all shipments, there would be measurable benefits (see all MOEs). • CEFM provided significantly improved status information along the entire supply chain, including the ASN and air mode data. The Federated Status Report of all supply chain events in CEFM was not previously available to any partner (see MOEs 2 and 3). • CEFM improved data timeliness at forwarders and at other partners including earlier access to overseas supply chain events and status reports. Earlier access to data allows Barthco to process customs clearance documents earlier (see MOE 4A). • CEFM improved data quality because it eliminated data entry after the manufacturer's booking. This reduced data entry errors, improved accuracy of XML data

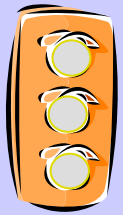
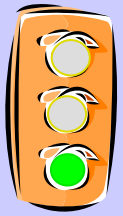
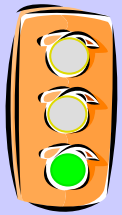
Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
					compared with EDI, and made it easier for all partners to respond to errors or discrepancies (see MOE 4B).
2. State and/or Federal Government agencies will find greater value in the improved cargo visibility information demonstrated by the CEFM such that the data can be utilized by applications such as governmental transportation planning, safety, and security.	1. Improved information transfer to government agencies. 2. Enhanced safety and security information.	• Public sector interviews in person or by telephone. • Public sector surveys via email or standard mail.	• Qualitative analysis of agency perceptions regarding the adequacy/applicability of CEFM information to meeting the agencies' transportation planning, safety, and security needs.	 Gray	• The public sector and industry-wide benefits and impacts will be covered in the second evaluation report. • The analysis will examine visibility improvements in industry and additional analysis of cost of quality and efforts to quantify the improvement in data quality in CEFM. • The CEFM Deployment and Scalability Evaluation Report will include lessons learned in cargo visibility efforts throughout the industry and government from the industry-wide supply chain research.

Table 4. Results of Private Sector Supply Chain and Logistics Performance CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. Implementation of the CEFM on LB supply chains will indicate the potential for improved supply chain logistics performance. (Defined as benchmarking the performance of the overall supply chain. The Limited Brands and its customers are the beneficiaries.)	1. Reduction in lost cargo via more accurate information. 2. Increased schedule adherence. 3. Reduced end-to-end transit times. 4. Reduced dwell time at nodes. 5. Improved timeliness of freight release process.	• Participant records. • CEFM system outputs. • Current DSR data as well as consignment status reports generated by CEFM. • Measurements of time to prepare DSR before and after CEFM. • Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • End-user customer interviews. • Design/Deployment Teams' and participants' estimates of costs to map across data sources and implement interfaces with CEFM system.	• Compared available baseline supply chain data from each supply chain participant with CEFM data. This included the DSR and the time it takes to create the DSR before and after CEFM. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements. • Factor in interviews/ surveys results and anecdotal information from participants. • Estimate qualitative and quantitative (as data permits) improvement.	 Green	• LB has a number of performance reports that it issues to its partners, including a 96-hour transit time standard. The users believed that if CEFM applied to all shipments there would be performance improvements (see MOEs 2 and 3). • CEFM measured both dwell time at nodes and overall transit time; none of the partners thought that the schedules or transit time of CEFM test shipments were affected, primarily because test shipments were a relatively small percentage of the total, and no partner made an effort to separately manage those shipments (see MOEs 3 and 4). • Data from CEFM could relieve a backlog in the processing of customs clearances by Barthco, which could improve the timely release of shipments from ODW to LB (see MOE 5). • Air AMS was implemented October 16, but isn't being used operationally by the partners. ODW and Barthco

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
					expect significant improvement in the timeliness of the release process from Air AMS (see MOE 5).
2. Implementation of the CEFM supply chains will indicate the potential for increased productivity for logistics services. (Defined as improved business efficiency and information from the freight forwarders and third-party logistics providers. The supply chain participants are the beneficiaries.)	1. Reduced erroneous billings. 2. Reduced labor applied to solving shipment errors or problems, such as misroutings. 3. Reduced delays in transferring custody from one intermodal partner to another through improved information exchange. 4. Increased schedule adherence/avoidance of penalties/detention fees. 5. Reduced data entry and staff time from automatically generated status reports. 6. Improved accuracy of information transfer from brokerage houses to CBP.	• Participant records. • On-site observations and timings. • CEFM system outputs. • Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • Design/Deployment Teams' and participants' costs to map across data sources and implement interfaces with CEFM system.	• Compare before and after data (or with or without) regarding information from each supply chain participant. • On-site time and motion studies. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements. • Model and/or forecast improvements where test data is limited, including technology descriptions, and operations and implementation costs. • Factor in interviews/ surveys results and anecdotal information from participants.	 Green	• CEFM eliminated manual data entry errors for supply chain events. No data entry was required by any partner after manufacturer tendering of the freight. CEFM also eliminated re-keying along the supply chain if system is integrated with legacy transportation management applications (see all MOEs). • There are quantified labor savings attributed to the improved data available from CEFM and the reduced data entry (see MOEs 2 and 5). These include reductions in time to: – Enter shipment data at the manufacturer. – Prepare Daily Status Report and other status reports at all partners. – Resolve data errors at the CFS. – Monitor hot shipments at LB. • LB maintains visibility on hot shipments and LB and

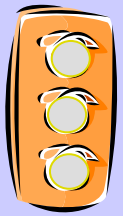
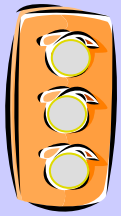
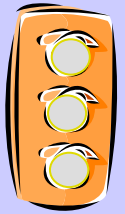
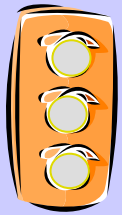
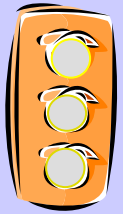
Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
					the partners would be able to manage such shipments better with CEFM data (see MOE 2).
3. For performance benefits successfully realized or indicated in the two private sector hypotheses, derived public sector transportation system and environ-mental benefits can be measured or forecasted	1. Reduced traffic congestion through reductions in erroneous moves and reductions in dwell times at nodes. 2. Reduced air pollution associated with congestion reduction (see above). 3. Enhanced safety and security.	• Results from the assessment of the two private sector hypotheses. • Environmental Protection Agency Air Quality tables. • Public sector stakeholder interviews in person or via telephone.	• Application of environmental cost factors to the data. • Other public sector benefits estimation techniques. • Model and/or forecast benefits where test data may be limited.	 Gray	• Most of the analysis will be conducted during the spring and summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report • The analysis will include logistics performance and productivity improvements in industry and additional analysis of cost of supply chain improvements in industry, particularly those related to better information for decision making.

Table 5. Results of Private and Public Sector Deployment and Scalability (CEFM to EFM) CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. The information exchange technologies tested in CEFM will be considered for operational use.	1. Successful integration by one or more supply chain partners of CEFM technology with legacy system. 2. Deployment of the EFM components and technologies beyond the Deployment Test into a production environment by any participants or other industry supply chains. 3. Integration of EFM technologies into the companies' evolving IT systems. 4. Positive efforts by partners and others to expand the use of EFM technologies.	• On-site observation and participant interviews from test participants and other organizations who implement EFM. • EFM adoption strategies and advocacy presentations by partners. • Observations and results from Kansas City EFM Adoption Effort. • Industry surveys and literature searches of supply chain enhancement trends in industry. • Definition of EFM components and implementation issues.	• Analysis of industry survey results and of supply chain trends in other industries. • Observation of and participation in industry meetings where EFM adoption is discussed. • Analysis of Kansas City EFM Adoption Effort results, interviews, and identified benefits. • Use of Cost-Benefits Analysis. • Analysis of industry studies to estimate or calculate industry-wide benefits of supply chain visibility improvements. • Review of other industry studies or implementations of Web services and SOA. • Review of lessons learned from the supply chain research	 Gray	• EFM and CEFM technologies have been discussed with industry at IFTWG meetings. USDOT also has conducted small group discussions with potential adopters. There is a favorable view toward the use of EFM technologies. An adoption strategy has been published and materials for potential adopters have been prepared and included on an EFM-FIH publicly available Website. • Most of the analysis will be conducted during the spring and summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report.

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
2. A benefit-cost case can be developed from the CEFM test data and evaluation assessments that can illustrate EFM system scalability and deployment benefits at a national level..	1. Private sector net benefits of CEFM over costs and other benefit-cost measures. Public sector net benefits of CEFM over costs and other benefit-cost measures. 2. Continued growth in supply chain industry of the use of EFM technologies including SOA, FIH, and Web services-based data exchanges. Continued progress toward objectives of EFM adoption strategy to deploy EFM technologies throughout industry.	• Data and results from the earlier CEFM hypotheses assessments and from other industry implementation of EFM. • Industry/supply chain demographics and trends. • Industry supply chain analyses and plans for implementing technologies. • Interviews with industry supply chain leaders. • Interviews and results from Kansas City EFM Adoption Effort.	• Use of cost-benefit models including DOT's FTAT. • Analysis of trends in supply chain technology in industry including adoption of SOA. • Review industry studies to estimate or calculate industry-wide benefits of supply chain visibility improvements. • Analysis and observation of Kansas City EFM Adoption Effort.	 Gray	• Kansas City SmartPort is planning to implement EFM capabilities and have been involved in EFM team conference calls since the fall of 2007. Anticipated cost benefit estimates were completed for the likely Kansas City operational scenario. • The analysis will be conducted spring/ summer |of 2008 and included in the CEFM Deployment and Scalability Evaluation Report
3. Those working in the transfer of freight information will deem the CEFM freight information standards appropriate.	1. Use of UBL standards within CEFM. 2. Ability to submit non-standard CEFM messages (such as Open Consignment Report) for UBL certification. 3. Increased use of XML messages compared with EDI.	• CEFM data structures and message formats. • UBL and other data standards. • Industry trends in implementation and approval of data standards.	• Review and comparison of current automated message flow among partners versus schemas and standards in CEFM. • Examine lessons learned from the CEFM and industry use of UBL data standards.	 Gray	• CEFM successfully used UBL standards and created a transportation status message for submittal to UBL certification See the discussion in section 4.2, System Usefulness. • The analysis will be conducted spring/summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
4. Benefits to industry productivity highlighted by the CEFM test can lead to improvements in U.S. economic competitiveness under a national-scale EFM deployment.	1. Reduced resources required by industry as measured in many of the efficiency benefits measured in this independent evaluation.	• Evaluation of efficiency-related results and benefit-cost assessment results.	• Macro-economic assessment methodologies to estimate national factors such as employment, added productivity, net profit. • Use of cost-benefit models including DOT's FTAT.	 Gray	• The analysis will be conducted spring/summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report.

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QUANTITATIVE BENEFITS SUMMARY

The quantitative benefits of CEFM data identified in this study area accrued primarily to the other partners in the supply chain rather than to the shipper, LB. There may be a derivative benefit to the shipper of savings for other partners; for example, a more efficient forwarder may be able to reduce its rates to the shipper. It is also possible that improved data quality at the partners could translate into fewer errors or exception shipments, with a resulting improvement in on-time performance at the shipper or a reduction in labor to use automated reports from the partners or to research errors or data problems. It is also possible that existing systems (such as the Access database used at LB for managing the DSRs) could be turned off if CEFM/FIH were implemented.

It should be emphasized that shipper benefits of improved data quality from CEFM-type data can only accrue if the data is integrated into the operations and existing systems at the company. Some of the partners, as well as LB, told the Evaluation Team that CEFM would be good for small- to medium-sized shippers who have less supply chain sophistication. Large firms that already have sophisticated visibility technologies in place might show some benefit from improved data quality, but as a portion of revenues, those savings might be fairly small. A small company with largely manual processes could enjoy a significant improvement in data accuracy, but its magnitude of benefit would be less because its business volume is so much less than the larger firms. A company that has primarily manual processes could achieve a substantial improvement over an 8 percent error rate for manual data entry that has been found in earlier USDOT Field Operational Tests (FOTs).

The following quantitative savings were identified and calculated by the Evaluation Team for the CEFM supply chain:

- **Manufacturer data entry savings** of 5 minutes per PO from only having to enter two data elements instead of eight to book a shipment. Hourly rates cited are for Chinese labor.
- **Hong Kong forwarder data entry savings for automating portions of the pre-alert** (76 minutes per day). Hourly rates cited are for Hong Kong labor.
- **Columbus forwarder labor savings for reducing research to obtain airline data** (28 minutes per day). Hourly rates cited are for Columbus labor.
- **Columbus forwarder labor savings for eliminating manual work on the daily status report (DSR)** (178 minutes per day). Hourly rates cited are for Columbus labor.
- **Columbus container freight station (CFS) warehouse labor savings** of $4 per error for less time spent researching missing data. Hourly rates cited are for Columbus labor.
- **Columbus CFS logistics staff labor savings** of $3 per error for correcting EDI data. Hourly rates cited are for Columbus labor.
- **Columbus shipper savings for reduced effort in monitoring hot shipments** (27 minutes a day). Hourly rates cited are for Columbus labor.

Table 6 further breaks these savings out by shipment. In reviewing the shipments involved in the deployment test, the Evaluation Team found there were 871 consignments completed. Various partners had indicated that CEFM represented approximately 10 percent of the shipments from the four manufacturers for the two LB brands handled by the two forwarders in the deployment test. This scaled to 48.3 consignments per day for all shipments. Dividing $259 per day by the daily total

shipments of 48.3 yields a per shipment savings of $5.94., which is summarized in the last row of Table 6.

Table 6. Estimated Daily Savings per Shipment

Partner	Partner Labor Function	Calculation for Daily Cost Savings	Daily Labor Savings	Per Shipment Labor Savings
Manufacturer	Data entry activities to book consignment.	$6.70 x 4 manufacturers (216 minutes saved).	$27	**= $0.61**
Forwarder	Data entry for pre-alert.	$12.32 x 2 forwarders (76 minutes saved).	$25	**= $4.16**
	Time for researching airline status.	$11.20 x 2 forwarders (28.5 minutes saved).	$22	
	Time to prepare DSR.	$70 x 2 forwarders (178 minutes saved).	$140	
CFS	Warehouse staff time to research data errors.	60 minutes saved.	$24	**=$0.92**
	Management staff time to correct missing or incorrect EDI data.	20 minutes saved.	$16	
Shipper	Staff time to research and process priority shipments.	28 minutes saved.	$11	**= $0.25**
		TOTAL:	**$259**	**$5.94**

QUALITATIVE BENEFITS SUMMARY

The Evaluation Team found important benefits to LB and its partners that could not be quantified, and are summarized as follows:

- **Improved timeliness of freight release process:**
  - CEFM could allow the broker to prepare documentation on Sundays, thereby reducing its backlog of Monday shipments, which would potentially help the broker to better spread out its labor force throughout the week.
  - CEFM data means that the broker can process the current paperwork and the Customs clearance can be processed earlier.
- **Improved cargo status information:**
  - CEFM improved data availability for freight forwarders and for other partners. The ASN was not previously available to one forwarder.
  - CEFM provided near real-time automated status reports containing all supply chain events that either were not available before, or required significant manual effort to prepare.
- **Improved timeliness of supply chain data:**
  - CEFM provides downstream partners earlier access to PO manufacturer booking and tendering data.

  - Users can access status data on demand that is currently available only from manually prepared daily pre-alerts and status reports.
  - The CEFM ASN is available at least 6 hours up to 1 day earlier than current EDI versions of the ASN.
  - Shipment status information is available to the broker at least 4-6 hours earlier.
- **Improved data quality, especially for less automated supply chains:**
  - There would be a reduction in data entry errors when using CEFM because of less data entry and no need to re-key data on the supply chain.
  - Improved quality data from CEFM would make it easier for forwarders to respond to discrepancies from the shipper.
  - XML data is more accurate than EDI, requiring less error correction.
  - While CEFM data accuracy was consistent with the EDI and DSR accuracy rates tracked by LB, for supply chains that rely heavily on manual data entry and re-keying information, data accuracy could potentially have greatly improved data accuracy rates.

EVALUATION FINDINGS

The key evaluation findings that are in addition to the quantitative and qualitative benefits above are summarized as follows:

- The Federated Status Report is a new report not previously available to users before CEFM, and is generally not available today in any logistics system. In particular, the real-time polling of partners external to a company is rare, even in the SOA sphere.
- The Open Consignment Report and improved airline data were well received by users from the various partners.
- All of the LB's partners said that if CEFM was applied to all shipments, they would use the system more, and indicated that using the system would be beneficial.
- ODW, the one partner who integrated, perceived far more benefit from CEFM than did the partners who did not integrate. This was because CEFM provided ODW with more accurate and more timely data to its existing system than was available without CEFM.
- ODW, the one partner who integrated, expected that there would be reduced implementation barriers at lower cost; however, this was not proven during the test since additional partners were not added.
- A recent analysis by members of the broader EFM project team estimated the cost of EFM implementation to be $125,000 for a medium-sized company. This estimated cost includes labor; hardware and software; and an FIH node that includes integration with the company's existing systems.

The CEFM Concept of Operations and other program documents defined seven objectives of the deployment test of FIH capabilities in CEFM, which are below with references to specific sections in the full report. In addition, CEFM met the Business Requirements and System Specifications for the system included in the Detailed Design Document and Design Foundation document (see detailed tables included in sections 3.6 and 4.2).

1. **Provide comprehensive visibility of shipment information to appropriate LB supply chain partners.** This was achieved (see the qualitative benefits listed above and section 4.3).
2. **Provide the ability and platform for LB supply chain partners to communicate electronically.** This was achieved through the implementation of the FIH platform and the receipt of OCRs and Federated Status Reports by users (see the discussion about the CEFM architecture and data flows in sections 2, 3, and 4.2).
3. **Improve the ability for consignees within the supply chain to schedule/plan for receipt of shipments.** ODW, the only partner that integrated CEFM with its existing system, thought CEFM could help staff to better plan ODW's operations. ODW's logistics staff used the exported OCR to forecast anticipated shipments (see section 4.3).
4. **Provide carriers with real-time lading and cargo management information.** These items were not specifically addressed in CEFM since the "presence" of the three airlines was provided via a third-party airline data firm. However, separate shadow databases were implemented in CEFM for each airline, and were the airlines to use that information, it could provide them with real-time data about booked cargo in Hong Kong (see section 3 and sections 4.2 and 4.3).
5. **Provide a means for manifest data to be electronically delivered to its intended receivers securely and on a near real-time basis.** These items were achieved by transmission of the ASN to LB, ODW, and other partners, some of whom did not receive the ASN before (see sections 4.3 and 4.4).
6. **Increase the ability of LB supply chain partners to collaborate with each other to improve service.** This was achieved (see sections 4.3 and 4.4).
7. **Enable the deployment of universal and distributed applications among LB supply chain partners.** This was achieved. Each partner had a shadow database, integrated the system, or used the CEFM Web portal. All data used UBL international data standards.

LESSONS LEARNED SUMMARY FOR ADOPTION STRATEGY

Following are the lessons learned that were derived from the three study areas evaluated that can be valuable for the Adoption Strategy effort:

- For future implementations, it is important for users to understand that CEFM is a supplement to existing systems, not a separate or replacement transportation management system.
- As much as supply chain professional and Government officials want to reduce transit time, improve shipment reliability, and reduce dwell time, live tests cannot be expected to address these measures. Tests that are part of existing operations as occurred with CEFM are generally only a subset of the shipments and the users and managers must first move the freight and second provide support to the test. While these measures are appropriate goals for the supply chain and something that could be used if the participating companies implemented the system in operation, they should not be used in the test itself.
- Integrating CEFM system capabilities into an existing system is critical to obtain the benefits of reduced data entry and increased data quality.

- Partners who integrate are better able to benefit from data quality because they do not have to re-key the data.
- Future versions of CEFM/FIH need to have logic that detects double flight arrivals or completely illogical dates and flags such errors for users to investigate and correct as needed.
- For the system to be truly effective and usable by the supply chain partners, it needs to be flexible enough to accept and provide data about any partner that may be involved in the supply chain. Consideration should be given in future implementations to the tradeoffs involved in meeting the complex partner requirements in the supply chain.
- The OCR should be expanded to include all data elements needed by the users for the various status reports.
- The airline data capability should be examined carefully to improve its flexibility to address multiple airlines moving freight on the supply chain.
- Labor savings are the easiest to quantify when looking at the benefits of improved information. Care needs to be taken in selecting measures of effectiveness—fewer is better—to ensure that they are achievable and relate to what is happening in the supply chain and in the test.
- Even though labor savings were the most quantifiable, the partners had a difficult time providing estimates of errors and time to conduct various work tasks.

CONCLUSION AND INTRODUCTION TO THE FUTURE REPORT ON DEPLOYMENT AND SUPPLY CHAIN SCALABILITY

The CEFM deployment test was narrowly focused on a single supply chain. However, the EFM project and the USDOT interests in improving supply chain performance and visibility both deal with potential Government impacts and wider industry impacts. Building on the quantitative and qualitative benefits cited above and included in this report, as well as the lessons learned compiled from the CEFM evaluation, the Evaluation Team's second report will include analysis of the potential benefits from expansion and further deployment of CEFM technologies, both among the CEFM supply chain partners and the wider manufacturing and distribution industries.

This part of the evaluation is particularly important to the USDOT, since it will attempt to quantify the national benefits of the kind of automated data exchange included in CEFM. In the second report, the CEFM Deployment and Scalability Evaluation Report, the Evaluation Team will document wider industry improvements in supply chain technologies, which will be completed in September 2008.

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1. INTRODUCTION

1.1. CEFM EVALUATION REPORT OVERVIEW

The Columbus Electronic Freight Management (CEFM) project is a Deployment Test of an implementation of the Freight Information Highway (FIH). The CEFM project is sponsored by the U.S. Department of Transportation (USDOT) as part of the Intelligent Transportation Systems (ITS) program's Electronic Freight Management (EFM) research initiative. The official definitions of these three efforts are:

- **EFM:** An ITS research and development initiative led by USDOT that promotes and evaluates innovative e-business concepts, enabling process coordination and information sharing for supply chain freight partners through public-private collaboration.
- **FIH:** An innovative non-proprietary standards-based architectural specification that defines a Service-Oriented Architecture (SOA) to support business process coordination and secure real-time data exchange. FIH utilizes standard processes, schemas, and definitions that are specific to the freight transportation industry.
- **CEFM:** A deployment test within the EFM program, which implements all components of the FIH necessary to support a select Limited Brands international truck-air-truck supply chain.

The CEFM project encompasses the entire air cargo supply chain, from overseas suppliers in China to The Limited Brands' (LB) distribution centers in Columbus, Ohio. Design and development of CEFM were completed during 2006 and early 2007, and the Deployment Test was conducted from May 29, 2007 to December 4, 2007.

In support of the USDOT ITS Joint Program Office (JPO), an Evaluation Team led by Science Applications International Corporation (SAIC, Evaluation Team), supported by the North River Consulting Group (North River), performed an independent evaluation of the CEFM test implemented by Battelle and Transentric (Deployment Team). The CEFM Evaluation Plan was completed in January 2007,[4] and the corresponding evaluation occurred throughout the test and in the several months that led up to this evaluation report.

The EFM initiative partners with freight-related industries to improve the operating efficiency, safety, and security of goods movements. The EFM effort packages Web services technologies and an SOA so that both Government and commercial users can use them to support their needs.[5]

As part of the CEFM effort, a detailed process flow analysis of the "As-Is" and "To-Be" physical freight movement has been performed.[6] In addition, documents have been prepared that detail a concept of operations (ConOps), an initial system design, and the detailed design that includes descriptions of the Web services and SOA used in the CEFM system.[7]

[4]USDOT, FHWA, *Columbus Electronic Freight Management Final Evaluation Plan,* (Washington, DC: January 2007).
[5]USDOT, FHWA, *Electronic Freight Management Initiative* (FHWA-HOP-05-085, Washington, DC: April 2006).
[6]USDOT, FHWA, *EFM Deployment Test As-Is Process Documentation* (Washington, DC: July 21, 2005).
[7]USDOT, FHWA, *Draft Concept of Operations for the Columbus Electronic Freight Management (CEFM) Deployment Test* (Washington, DC: June 12, 2006). Also see USDOT, FHWA, *Draft Detailed Design Document for the Columbus Electronic Freight Manifest (CEFM) Deployment Test* (Washington, DC: November 21, 2006).

A key aspect of CEFM involved the Evaluation Team participating in the project early in the design effort so that appropriate test data and appropriate quantities of such data could be targeted and collected through cooperation with the Deployment Team, their project partners, and USDOT.[8] This cooperative effort is discussed in more detail in section 3.4.

The Evaluation Team prepared and used a series of Detailed Test Plans[9] to conduct the evaluation for the four main study areas and associated individual hypotheses as described in the Evaluation Plan:

1. System Usefulness.
2. Cargo Visibility.
3. Supply Chain and Logistics Performance.
4. Deployment Scalability.

The evaluation involved analyzing test data collected during the deployment test, as well as perceptions from the various supply chain partners. This evaluation final report includes both quantitative and qualitative benefits.

1.2. CEFM SCALABILITY AND DEPLOYMENT REPORT OVERVIEW

The Columbus deployment test focused on the pilot test of a portion of a single supply chain. The EFM project and the USDOT interests in improving supply chain performance and visibility deal both with potential Government impacts and with wider industry impacts. To meet this need, the Evaluation Team will prepare a second report, the CEFM Deployment and Scalability Evaluation Report. This second report will focus on the scalability and deployment of EFM technologies in industry to include the expected public benefits of such improvements. Building on the evaluations in section 4 and the overall lessons learned in the CEFM evaluation, the analysis for the CEFM Deployment and Scalability Evaluation Report will involve the rest of the industry and the potential benefits from expansion and further deployment of CEFM technologies, both among the CEFM supply chain partners and the wider manufacturing and distribution industries. The CEFM Deployment and Scalability Evaluation Report will document wider industry improvements in supply chain technologies, and will be completed September 2008.

The deployment portion of the evaluation is particularly important to the USDOT since it will attempt to quantify the national benefits of the kind of automated data exchange included in CEFM. The Evaluation Team will review information and confer with experts in the supply chain industry for other uses of SOA and Web services, and for other efforts underway to improve global supply chain performance. In addition to reviews and interviews, the CEFM deployment and scalability evaluation will include computer-based modeling of costs and benefits of supply chain improvements. The Evaluation Team will collaborate with other EFM project team members involved in developing an EFM Adoption Strategy to include the CEFM deployment results and findings from the industry analyses in the Adoption Strategy efforts. The Evaluation Team will assess potential improvements in logistics performance in supply chains beyond those tested with CEFM. The scalability analysis results also will be incorporated into the CEFM Deployment and Scalability Evaluation Report to be completed in September 2008.

[8]USDOT, FHWA, *Columbus Electronic Freight Management Final Evaluation Plan* (Washington , DC: January 2007) and *Columbus Electronic Freight Management Detailed Test Plans* (Washington, DC: October 4, 2007).
[9]USDOT, FHWA, *Columbus Electronic Freight Management Detailed Test Plans* (Washington, DC: October 4, 2007).

1.3. DOCUMENT OVERVIEW

The remainder of this CEFM Evaluation Final Report document is organized as follows:

- **Section 2: Overview of CEFM and LB Supply Chain Data Flows –** This section describes the CEFM information flows from origination of a shipment in China to delivery in Columbus. Current data flows are described, along with the automated data included in CEFM.
- **Section 3: CEFM Deployment Test Overview –** This section describes the CEFM architecture and technical approaches, and details the deployment test activities conducted from May 29 through December 4, 2007.
- **Section 4: CEFM Evaluation Study Area Results –** This section describes the four evaluation study areas, and details the qualitative and quantitative benefits derived from CEFM type data.
- **Section 5: Summary of Observations, Findings, and Lessons Learned –** This section summarizes the key benefits identified in section 4, and identifies the lessons learned from the CEFM deployment test.

The following supporting documents described here are contained under separate cover as *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report* document:

- **Appendix A: Hong Kong and Columbus Participant Interview Results –** This appendix presents the various interview results from September through December 2007 interviews the Evaluation Team conducted with deployment test participants. The interviews cover current data flows and operations, perceptions of CEFM, and anticipated benefits from CEFM data.
- **Appendix B: Battelle Data Anomalies and Quantitative Analysis –** This appendix presents the analysis by the Development and Deployment Teams of data collected during the test and categorizes data anomalies.
- **Appendix C: Summary of CEFM Data Analysis –** This appendix presents reports of CEFM data analysis completed by the Evaluation Team during the conduct of the test. The appendix also discusses the final pivot table prepared by the Deployment Team as used by the Evaluation Team in completing the Final Evaluation Report.
- **Appendix D: CEFM Outage Log and System Transaction Logs –** This appendix presents the log maintained by the Evaluation Team during the test to record CEFM outages and their duration and the daily logs created by the Deployment Team to show timing statistics about the various CEFM transactions.
- **Appendix E: LLS Scorecard Report June 2007 –** This appendix presents a monthly performance report that The Limited Brands provided to one of its forwarders. The report typically has embedded spreadsheet files that show specific performance parameters. A sample of the form is shown in this appendix.

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2. OVERVIEW OF CEFM AND LB SUPPLY CHAIN DATA FLOWS

2.1. INTRODUCTION

CEFM is designed to provide visibility over key supply chain events in the Limited Brands' (LB) movement of Victoria's Secret and Express Brand items from Hong Kong, China, to Columbus, Ohio. The CEFM "As-Is" analysis and other industry research indicates that it is difficult to obtain visibility data from multiple partners along a complex, international supply chain. CEFM collects information on these events from each partners' operational databases, which are linked to CEFM through a "shadow" database. A shadow database is a separate data storage file that contained each partner's exclusive data within the CEFM deployment test, thereby protecting the partner's production data from the deployment test. The shadow database was largely populated automatically through either CEFM Web services message content, or from the partner's existing IT system. Although manual entry input was allowed via the user Web interface for the manufacturer, or by the CEFM Deployment Team, this method only was used when automatic population was not feasible. Since the data population was automatic in most cases, CEFM provided near real-time data to the supply chain partners.

CEFM then makes this information available to all supply chain partners using Web services. The current LB supply chain is described in detail within this section, in particular, the information that accompanies each physical event. This also section provides a comparison of the means by which these events were completed before CEFM and during the CEFM deployment test.

2.2. LB SUPPLY CHAIN DATA FLOWS

Figure 2 presents an overview diagram of the LB 11 supply chain events that occurred prior to using CEFM. The six boxes contain all the data information that is transferred during the shipment's departure from the origin at the manufacturer's factory in southern China to the destination at the LB's distribution center (DC) in Columbus, Ohio. These six boxes are categorized by the data "owner," in this case, LB, the party that creates and transfers the data to the other partners. This diagram identifies each piece of data as manual (phone, email, or fax) or automated (Electronic Data Interchange [EDI] or legacy Information Technology [IT] systems).

Although section 3.5 discusses performance measures in more detail, Figure 2 includes the LB's most critical performance measure: the transit time standard. The transit time standard states that there will be no more than 96 hours between the forwarder's cargo receipt in Hong Kong (the later of "Cargo Received" or "Documents Received") and delivery to the container freight station (CFS) in Columbus. Table 9 defines the acronyms used in the timeline diagram.

Table 7. Timeline Diagram Acronyms and Definitions

Acronym	Definition	Acronym	Definition
ASN	Advance Ship Notice	HACTL	Hong Kong Air Cargo Terminals Limited
CB	Customs Broker	HAWB #	House Air Waybill number
CFS	Container Freight Station	HK	Hong Kong
CMH	Airport Code for Columbus	LB	The Limited Brands
DSR	Daily Status Report	MAWB #	Master Air Waybill number
ecVision	Product lifecycle management system	MFG	Manufacturer
EDI	Electronic Data Interchange	NTO	Notice to Broker
FA	Forward Air	OCR	Open Consignment Report
FF	Freight Forwarder	PO	Purchase Order
GAC	Goods At Consolidator		

During 2005-2006, the CEFM Evaluation Team conducted in-depth interviews with the supply chain partners, including personnel from the LB, StarTrans (Star), Hellmann Worldwide (Hellmann), ODW Logistics, and Barthco in Hong Kong, China, and Columbus, Ohio, to assess the existing data flows that support the supply chain operation. These interviews supplemented interviews by other project team members used in preparing "As -Is" and "To Be" analyses, as well as the CEFM Concept of Operations (ConOps). Some supply chain partners had existing systems that contain pre-CEFM shipment information, while others maintained manual records, such as Excel spreadsheets. The majority of the supply chain partner interviews focused on the pieces of information that were shared; the methods by which they were shared (manual or automatic); and the partners that were sharing the information. In addition, the interviews focused on the performance measures used by each partner, which are reported in section 3.5.

To compare the process of sharing and distributing supply chain visibility information with and without CEFM, the Evaluation Team analyzed the partner interviews to determine the actual supply chain events, the data that is shared between partners, and the means through which it is shared. As the diagram in Figure 2 shows, although some of the information exchanges are automated within the supply chain, many rely on manual data entry to a spreadsheet or email. Information exchanges associated with the 11 LB supply chain events are described as follows.

- **Supply Chain Event #1: The Manufacturer receives a Purchase Order (PO) from The Limited Brands and creates one or more consignments for that shipment.**

LB sends PO to manufacturer for booking:

The Manufacturer receives Purchase Orders (POs) through EDI or ecVision (the LB's off-the-shelf PO system), schedules production, and assembles the items to be included in the shipment.

When the Manufacturer is ready to ship, the consignment is booked, which may include all or part of the items listed in a PO.

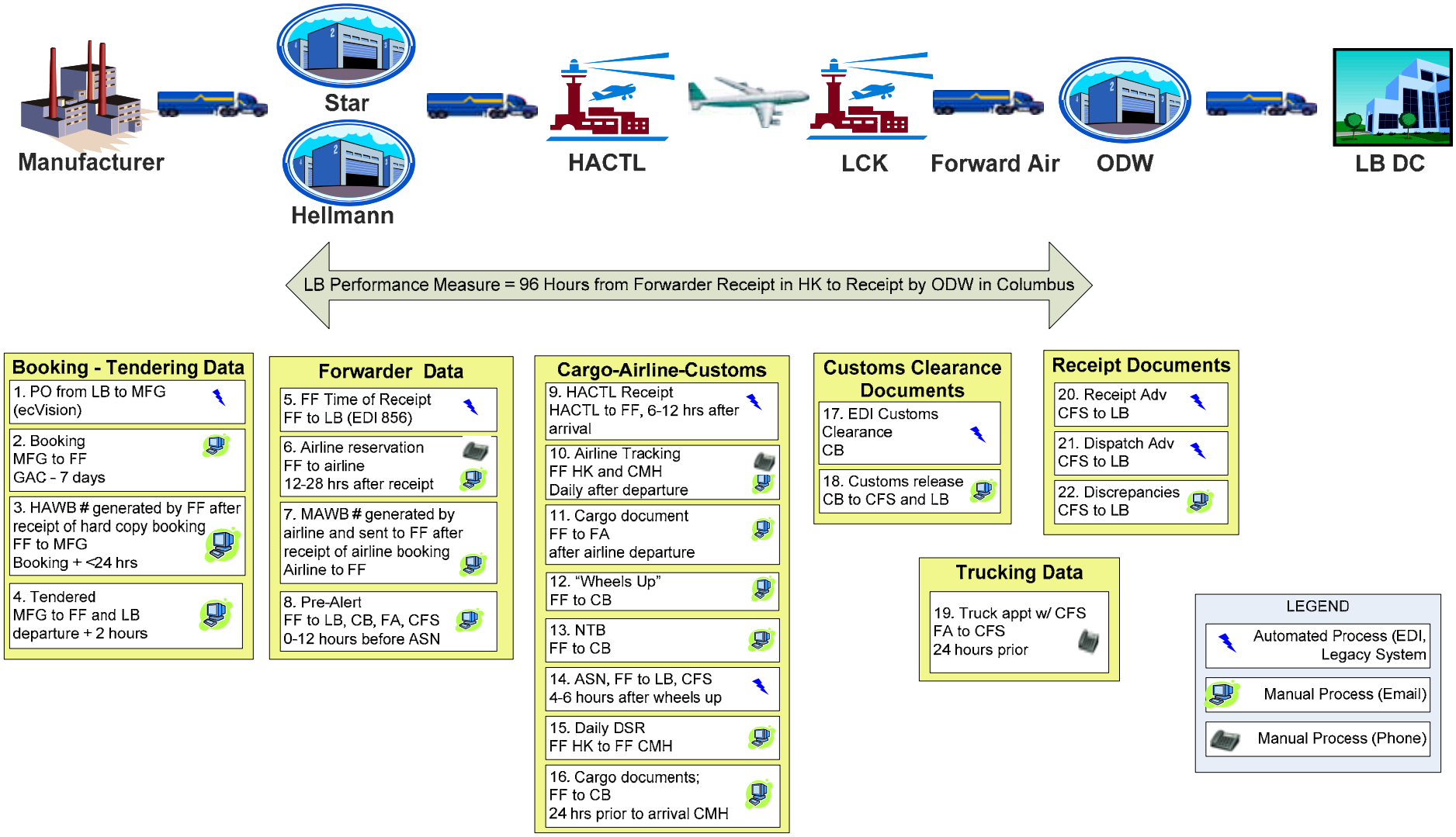

Figure 2. Supply Chain Data Flows Before CEFM.

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To complete a booking, the manufacturers fill out a hard copy or Excel form containing the following with eight pieces of information: Mast Purchase Order (MPO) number; style number; shipment quantity; total carton count; ship mark information; total gross weight; and total cubic meters (CBM). This form is sent to the freight forwarder specified on the PO via email or fax. Once the freight forwarders receive the booking, they enter the details into their existing systems and automatically generate a House Air Waybill (HAWB) number. The freight forwarders typically contact the manufacturer within 24 hours of receiving the booking to provide the manufacturer with the HAWB number.

- **Supply Chain Event #2: Loading consignments on a truck and reporting "freight tendered" when the loading is completed.**

> **Manufacturer loads consignment:**
>
> The Manufacturer arranges for export (Hong Kong) Customs. Once the consignment and associated documentation are loaded onto the truck for shipment to Hong Kong, the Manufacturer "tenders" the freight, indicating that the truck is proceeding to the freight forwarder's facility in Hong Kong.

The manufacturer uses the HAWB number and additional shipment details (such as ship quantity and piece count) to fill out the official packing list. The manufacturer also completes the hard copy export Hong Kong Customs documents. These hard copy forms are provided to the manufacturer's driver, who is trucking the shipment to the freight forwarders' consolidation facility in Hong Kong. The manufacturers also send an email message to notify LB that the freight has left the factory.

- **Supply Chain Event #3: Processing consignments for shipping by the airline.**

> **Consignment is processed for air shipment:**
>
> When the freight forwarder physically receives the goods from the manufacturer, the forwarder provides a "Cargo Received" status update to LB. The export Customs status is automatically updated as either "Cleared," or if the documents are complete, as "Documents Received."

Once the consignment arrives at the freight forwarder's consolidation facility, the forwarder records the time that the shipment arrived in its internal IT systems. The forwarder provides the time to LB via an email or an EDI message. Sometimes, the manufacturer provides hard copy shipment documents as an electronic "Portable Document Format" (PDF) attachment to an email, in which case the documents would arrive before the shipment. In this case, the forwarder would record both the time of the cargo and documents receipt.

- **Supply Chain Event #4: The Freight Forwarder books a shipment with an airline and assigns appropriate numbers to the consolidated shipment.**

> **Consignment is booked with the airline:**
>
> The freight forwarder books the shipment with an airline and receives a confirmation from the airline. The freight forwarder receives the Master Air Waybill number (MAWB) and unit load device number (ULD) from the airline. There may be multiple consignments and HAWBs on an airline's MAWB, depending on how the shipment is consolidated.

The booking information sent to the forwarder contains a "Goods at Consolidator" date, which indicates the expected arrival into the forwarder's Hong Kong facility. Typically, this date is specified by LB within the PO sent to the manufacturer. Once the forwarders receive the booking with this date, they contact the airline by phone or email to complete the air booking. Typically, the shipments that were part of the CEFM test were moved by charter aircraft, although a near-term "iN Distribution Center" (NDC) date may result in using an express carrier such as UPS. The airline bookings are usually completed between 12-48 hours after the goods are received in Hong Kong. Currently, there are two charter flights per week moving these brands from Hong Kong directly to Columbus.

Similar to the process by which the forwarders generate a HAWB number, once the booking is received by the airline, the airline generates a MAWB number. This number is provided to the forwarders for entry into their existing IT systems and is included on the shipment and Customs documents.

- **Supply Chain Event #5: The Freight Forwarder arranges for the shipments to be transported by local drayage to the air cargo terminal.**

> **Forwarder schedules local dray to Hong Kong Air Terminal (HACTL):**
>
> To meet the required time for aircraft loading, the freight forwarder has the shipments transported by a local drayage company to HACTL, which then records the receiving information and official weight in its own system.
>
> **NOTE:** HACTL events were not a part of the Deployment Test.

The forwarders are responsible for arranging the truck transportation between their consolidation facility and the air terminal, which are located about 1 hour apart. Once the shipment is received at HACTL, the air terminal company confirms the shipment receipt and the shipment weight back to the forwarder via telephone, fax, or email.

- **Supply Chain Event #6: The Air Terminal Company (HACTL) loads the shipments on the appropriate aircraft.**

> **Aircraft is loaded:**
>
> Based on information from the airline concerning the outbound charter flight, HACTL loads the shipments on the outbound aircraft. After HACTL completes the loading, it confirms the loading in its own system. The freight forwarder accesses HACTL's system via the Web and generates a "confirmed on board" notice to the broker.

There is no data entry on the part of the freight forwarder for this event.

- **Supply Chain Event #7: The Freight Forwarder provides airline departure data and the third-party airline data company captures and provides airline data within U.S. airspace, including arrival information.**

> **Departure data transmitted and airline tracking begins:**
>
> When the cargo airline departs Hong Kong, HACTL captures departure time information that is provided to the freight forwarder. The freight forwarder makes "Wheels Up" status available to the broker and LB. The forwarder next sends an Advanced Ship Notice (ASN), which includes the "Wheels Up" information, to other authorized partners within 4 hours of the wheels up event.
>
> If the aircraft makes any stops after departing Hong Kong, FlyteComm will record the airport code of any location where the aircraft touches down.

Once the forwarder releases the freight to the airline, data transmissions between Hong Kong and Columbus are initiated, which are summarized as follows:

- Shortly before the aircraft departs, the forwarder prepares a "pre-alert email," which contains about 25 pieces of information related to the consignment. The pre-alert is an Excel spreadsheet attached to an email and sent to the inbound trucking company, the CFS, LB, the Customs broker, and the forwarder's Columbus office.
- Next, the forwarder sends a separate email to the inbound trucking company containing the scanned MAWB and cargo manifest documents as attachments. This notifies the trucking company as to when the cargo will arrive in Columbus and what equipment is needed for cargo handling (i.e., oversized pallets).
- The trucking company manually enters information from the MAWB into its legacy system for billing purposes.
- The forwarder prepares and sends a "Wheels Up" email to notify the Customs broker that the aircraft has departed. This notification notifies the Customs broker to begin preparing the Customs documentation.
- Approximately 4-8 hours after the "Wheels Up" email, the forwarder sends a second email, the "Notice to broker" (NTB) to the Customs broker. The Customs broker must receive this form (usually via email) to submit the Customs clearance application to U.S.

Customs and Border Protection (CBP). If the aircraft departs on a weekend, however, the NTB is not sent until Monday morning, which is about 24 hours after the aircraft departs. Since the Customs broker in the United States works on Sundays and the forwarders do not, this can sometimes delay the Customs documentation preparation and create a backlog of applications on Mondays.

- The forwarder also sends the shipment documents to the Customs broker about 24 hours before the aircraft arrives in Columbus. Typically, these documents are provided as PDF attachments that must be printed out so that the broker can manually input the pertinent information into the EDI system used to prepare the Customs application.
- Within 4 hours of the aircraft's departure, the forwarder prepares an EDI 856 E4 message, which is an Advance Shipment Notice (ASN). The ASN is sent to LB and the CFS in Columbus. For the CFS staff, the ASN provides detailed information on the shipment, which assists them in populating their legacy system with these facts.
- Once the aircraft departs, the forwarder's Columbus office prepares a daily status report (DSR) which is sent to LB two or three times daily depending on the time of year (more often during holiday/seasonal events). The DSR is similar to the pre-alert spreadsheet and contains about 25 data elements by PO, HAWB, and MAWB numbers. The forwarders in Columbus use several internal reports and the pre-alert email from their Hong Kong office to prepare the DSR. Additional information for the flight number, status, and routing details are obtained through daily research on the airline's home page; airline tracking services, such as Red Berry; and phone calls to the airline. These 25 data elements are entered manually into an Excel spreadsheet that is provided to LB as an email attachment. It takes the Columbus forwarder between 4-6 hours to prepare the DSRs and their associated multiple updates each day.

✦ **Supply Chain Event #8: The Broker updates the Import Customs clearance status, notifying Customs and Border Protection.**

Customs clearance status:

The freight forwarder in Hong Kong scans the Customs documents and sends them by email to the Customs broker (Barthco). When the Customs broker receives notification of "Wheels Up" in Hong Kong, the broker files for Customs clearance with CBP. The broker's own system connects with CBP using the Automated Broker Interface (ABI).

Customs clearance occurs after the aircraft arrives in Columbus, and CBP in Columbus will send an electronic clearance notification to the broker. Depending on when the clearance occurs, the freight may be at the in-bound trucking company (Forward Air) or the CFS.

As stated in Event 5, the Customs broker relies on the Hong Kong forwarder to provide these emails (some with attachments). The Customs broker also receives the pre-alert email, and although the broker cannot begin Customs clearances processes, the broker is aware of the freight in the queue. The three pieces of information the Customs broker needs from the forwarder to prepare and submit the Customs clearance application are the "Wheels Up" email, the NTB form, and the cargo documents. Once the EDI Customs application is submitted, CBP has 5 days to release the freight. After the

Customs broker receives the release from CBP, the broker provides copies of all Customs-related documentation as email attachments to the CFS and LB.

- **Supply Chain Event #9: The Ground Handling Agent/Trucking Agent transfers consignments from the aircraft to the CFS in Columbus.**

> **Ground handling agent transfer:**
>
> After the aircraft arrives at its destination in Columbus, the ground handling agent transfers the consignments to the trucking agent, who moves the shipments to the CFS in Columbus. The Trucking Agent (Forward Air) creates an Airfreight Waybill number and generates an EDI 214 status message.

As stated in Event 7, once the inbound trucking company receives the attachments via email from the forwarder in Hong Kong (the MAWB and cargo manifest), the MAWB number is manually entered into the trucking company's billing system. The email receipt also provides the forwarder with the expected arrival time in Columbus. Depending on when the cargo arrives at the airport in Columbus, the inbound trucking company will either pick up the load and return to it to the company's complex to hold the freight overnight, or proceed directly to the CFS. For either method, the trucking company must call the CFS to make an appointment to drop off the freight. For morning appointments, the inbound trucking company representatives can call the CFS anytime up to 5 p.m. Eastern Standard Time (EST) the day before. For same-day appointments, the representatives must call the CFS by 10 a.m. EST. The CFS will not receive cargo without an appointment.

- **Supply Chain Event #10: The CFS, ODW, receives and processes the consignments for delivery to The Limited Brand's distribution center.**

> **CFS receipt and breakdown:**
>
> The CFS receives shipments from the trucking agent and records receipt in its own system. A Receipt Advice message is sent to LB. The CFS then breaks down shipments and prepares individual consignments for delivery. The CFS identifies discrepancies during this "unstuffing" and sorting operation and updates its own system.
>
> The CFS receives consignment-related documents, including cargo manifest, HAWB, Customs documents, and a packing list. The CFS updates ODW's system with receipt of each of these documents.
>
> The CFS creates truck shipments for delivery to consignee at the Limited Brands distribution center. Consignments are assigned a Truck Manifest number. A "Dispatch Advice" message is sent to the buyer from the ODW system as an EDI 861 message.

The CFS receives specific data through the forwarder —the pre-alert as an Excel spreadsheet, and the EDI ASN, which are critical for the CFS's operation. Once the CFS's existing system receives the data, it allows cartons to be scanned when first received in the warehouse, and then later enables the carton to be identified and located within the warehouse when ready for delivery to the DC.

Although the CFS receives the ASN automatically, there may be errors in the message receipt, or there are errors or missing fields within the EDI message, which can cause numerous problems. For example, if the inbound trucking company makes the appointment for delivery and there is no related information found when the CFS searches by the MAWB number, when the truck shows up, the CFS staff have to manually enter all shipment information from the Excel pre-alert. If data is missing, when the inbound trucking company makes the delivery and the carton is scanned, the warehouse floor staff must stop work to check with their supervisor to resolve the missing or incorrect data. When there is missing data within the EDI, the CFS staff must pull the hard copy shipping documents (such as the HAWB or packing list) to verify the correct information, and then enter it into its legacy system.

After the CFS receives the load from the inbound trucking company scans the load on the warehouse floor, the CFS closes out the shipment in its legacy system. This close-out process triggers a Receipt Advice message to be sent via EDI to LB. During the unstuffing and break-down processes, if the CFS finds a discrepancy between the carton's contents and the items on the packing list, or if any pieces are damaged, the CFS sends three emails to LB detailing with the discrepancy issues: discrepancies created; discrepancies resolved; and a copy of the cargo manifest.

The freight remains in the CFS, a bonded warehouse, until the CFS and LB receive a copy of the Customs clearance as an email attachment from the Customs broker. Once the Customs clearance email is received, the CFS arranges for shipment delivery to the LB's DC. Since the CFS has its own trucking company, once delivery is arranged, a CFS staff enters a "shipped" time into its legacy system, which generates another EDI message, the Dispatch Advice, which is then sent to notify LB that the freight has left the CFS.

The CFS does not forecast delivery times to the LB's DC. On a daily or near daily basis, CFS management staff queries its legacy system with a defined past 30-day date range to include approximately 14 data fields related to the shipment. These data fields include the expected and received quantity; received date and time; and MAWB, HAWB, and PO numbers.

- **Supply Chain Event #11: The Inbound Trucking Company delivers the consignments to The Limited Brand's Distribution Center in Columbus.**

Delivery to DC:

The in-bound trucking company, in this case ODW itself, delivers consignments to the LB's DC. For the supply chains involved in the Deployment Test, although there are two LB companies with two separate warehouses, the consignments were entered via the same gate.

The LB's gate guard representatives validated the shipment, signed the truck manifest, and directed the truck to the appropriate building for delivery. In some cases, the truck was staged in LB's yard.

Due to the geographic proximity between the CFS and the LB DC, it takes approximately 30 minutes to travel between the two locations. The truck driver carries a hard copy of the shipping manifest to present to the LB DC gate guard representative, who stamps the paperwork and returns it to the truck driver. After delivering the consignments, the truck driver brings the stamped paperwork back to the CFS. There is no additional communication required to complete the delivery.

2.3. CEFM TEST DATA FLOWS

The CEFM test data flows design is built upon the LB's 11 supply chain events discussed in section 2.2. As defined, CEFM uses Web services to transfer this information from partner to partner. Web services and the CEFM architecture are described in detail in section 3, but a brief overview is provided here to provide the reader with an understanding of a few key concepts that are referred to in this section. A "Web service" is a computer application that follows a basic profile to transfer data between one or more partners, and is formatted as a simple object access protocol (SOAP) and transported via hypertext transfer protocol (HTTP), or "the Web."

The foundation for Web services is a service-oriented architecture (SOA), which serves as the environment in which Web services are run. In the CEFM test, the Freight Information Highway (FIH) was the SOA used since it relies on standard processes, schemas, and definitions that are unique to the freight transportation world. SOAs, including the FIH, utilize extensible markup language (XML) to describe both document-oriented and procedure-oriented messages such as the EDI messages that are a part of CEFM.

Figure 3 displays a diagram showing how the supply chain events are executed within CEFM. Following this figure, how CEFM gathers and shares data among the supply chain partners is explained in detail within the context of the 11 LB supply chain events.

As a note of clarification, within the CEFM system, the term "consignment" can be used interchangeably with the term "shipment," but is defined as a **single unit of goods** being moved. Therefore, for the purpose of explaining how the 11 supply chain events are executed within CEFM, the term "shipment" is used in the text to designate **a single unit of goods** being moved.

Event 1: LB Sends PO to Manufacturer for Booking

Within the CEFM test, LB sends the PO to the manufacturer using EDI or ecVision, an LB legacy off-the-shelf apparel sourcing system, which makes POs available to the manufacturer via the Web portal. In addition to this existing transaction, a Web service also sends a PO in XML format to the manufacturer's shadow database in CEFM. Once the manufacturer's staff reviews the PO, fulfills the order, and is ready to book the shipment's transportation, the manufacturer logs on to the CEFM system via the Web, selects the PO number from a drop-down menu, or clicks and selects the PO from a list of all POs available for booking. After the appropriate PO number is selected, the manufacturer's staff enters the quantity to be shipped (designated in pieces), and presses the "Submit" button. When the booking is submitted, CEFM assigns a unique consignment reference (UCR) to the shipment. The Web services make the booking available to the freight forwarder named on the original PO, and notify LB via a status message "Booking, complete."

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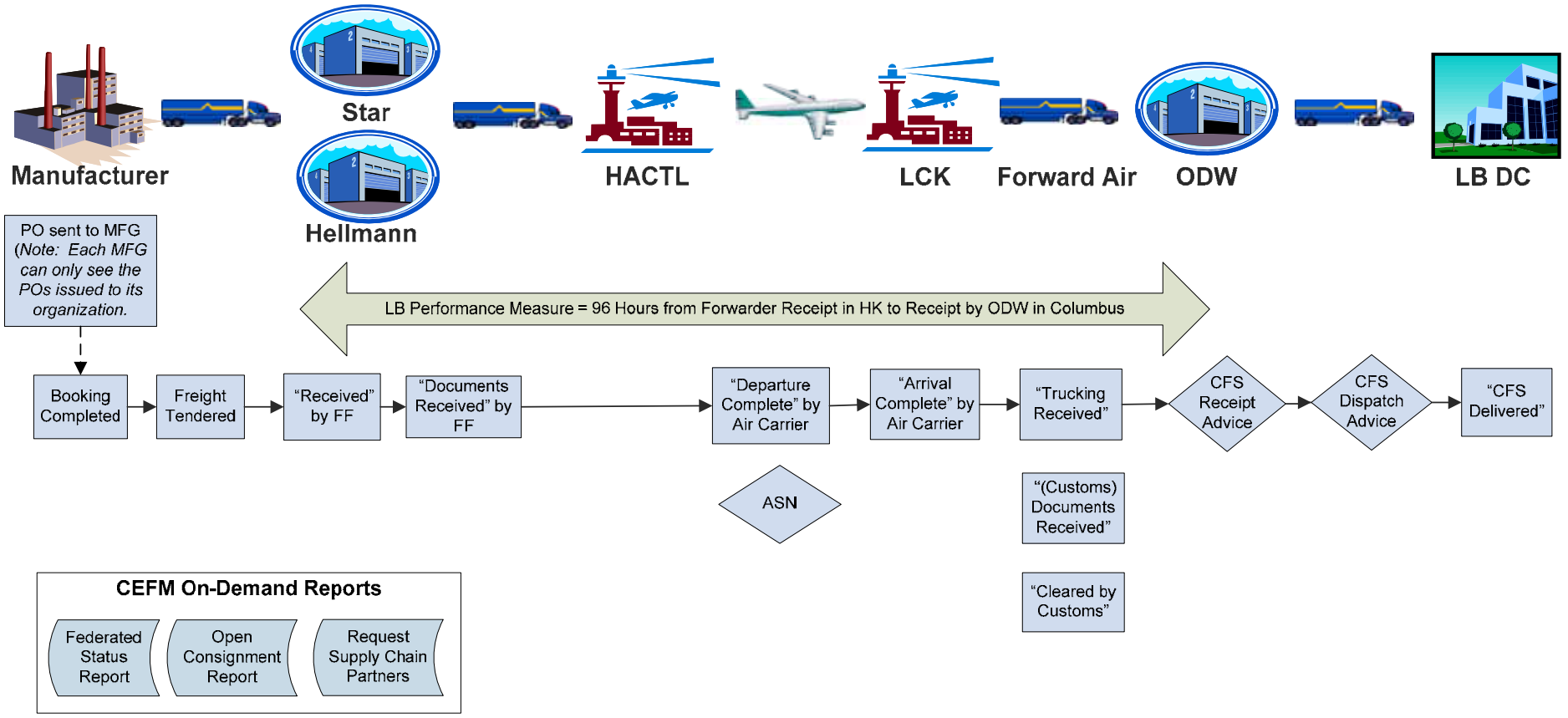

Figure 3. CEFM Supply Chain Data Flows.

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Figure 4 presents a sample view from the manufacturer's booking screen to create a consignment to track a shipment in CEFM.

Create Consignment

PO Number: VSS59847391

Product	Style	Color Code	Color	Size	Quantity Ordered	Quantity Previously Shipped	Quantity Consigned
BBV INFINITY EDGE LL PLUNGE	1546350	401	MAGENTA	36B	400	0	400
BBV INFINITY EDGE LL PLUNGE	1546350	401	MAGENTA	34C	800	0	800

Submit

Figure 4. Manufacturer's Booking Screen.

Event 2: Manufacturer Loads Consignment

Once the consignment and its paperwork are loaded on the truck bound for Hong Kong, the manufacturer's staff logs on to the CEFM system to tender the shipment by performing the following functions: select the appropriate PO number from a drop-down list; select "Update Consignment;" enter the carton count and gross and volumetric weights; and then press the "Submit" button.

The tendering date and time are automatically entered by CEFM when the manufacturer's staff submits the information. CEFM publishes a new status, "Freight tendered," which is available to authorized partners via Web services. Figure 5 shows a sample from the manufacturer's "Freight tendered" status screen in CEFM.

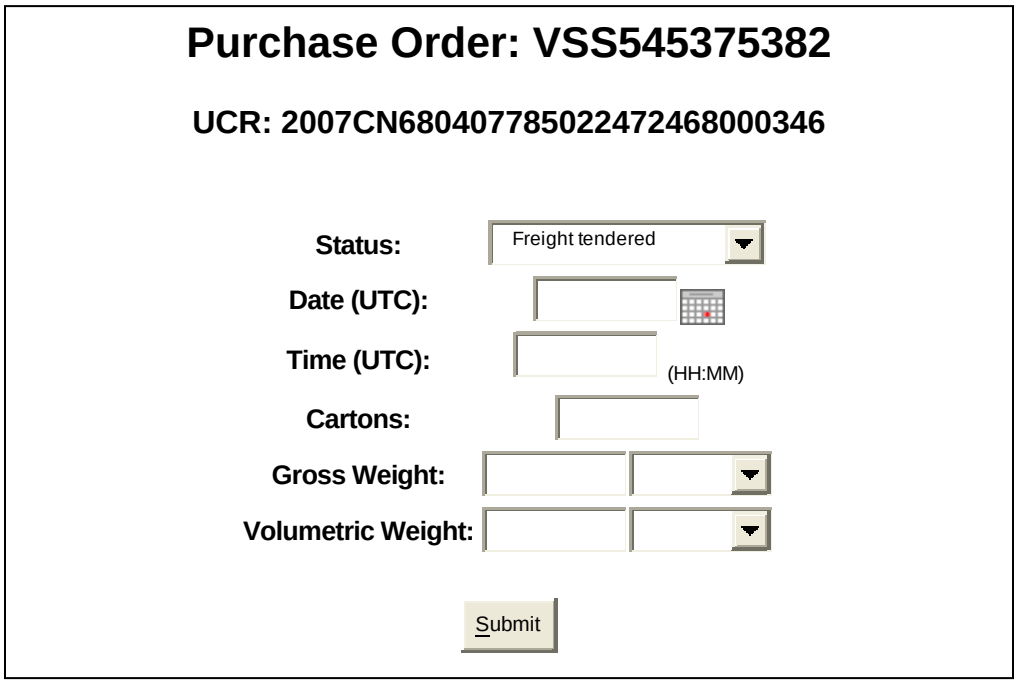


Figure 5. Manufacturer's "Freight Tendered" Status Screen.

Figure 6 shows a sample of a transportation status message for this event in the XML style sheet view.

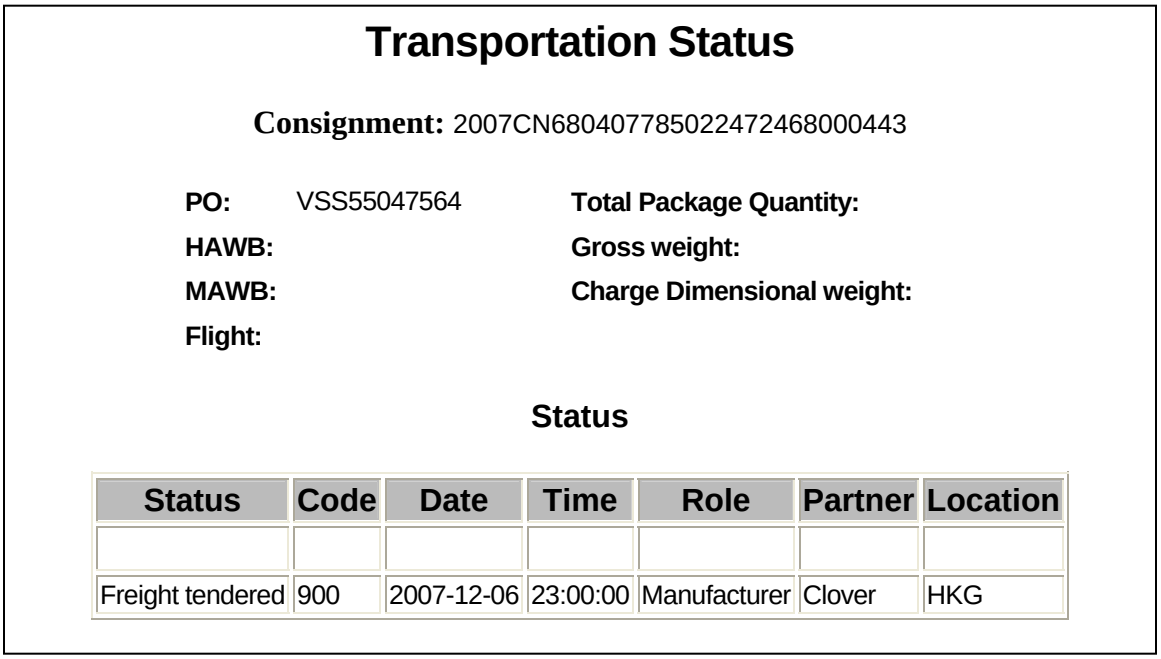


Figure 6. Freight Tendered Transportation Status Message.

Event 3: Consignment is Processed for Air Shipment

For all CEFM partners, information pertinent to CEFM shipments entered into the freight forwarders' existing IT systems is automatically pushed to CEFM via each partner's shadow database. When the forwarders receive the freight in Hong Kong, they enter the time of receipt for both the cargo and its associated export documents into their systems. These events, along with their associated times of occurrence, are automatically included in CEFM as a status update and made available through the Web services—no manual input is required from the forward to update these status messages within CEFM.

Three transportation status messages looking similar to the one presented under Event 2 in Figure 6 can be generated from the forwarder's cargo receipt information and associated documents in Hong Kong. Two messages, "Received" and "Documents Received," indicate that the cargo receipt information and associated documents are received without issue. However, if an issue occurs with the documentation, for example, the cargo receipt information and associated documents are held for further research, and CEFM publishes a third status message, "Documents, incorrect."

It is important to note that once the freight forwarders enter the cargo information into their existing systems, a HAWB is generated and added to the consignment information within CEFM.

Event 4: Consignment is Booked with an Airline

Freight forwarders book the shipment with an airline by phone or email. Once the booking is completed with the airline, the MAWB number is generated by the airline's system and provided back to the forwarder via phone or email for entry into the forwarder's existing system. Once the number registers within the existing system, it is also added to the consignment record within CEFM without any required manual data entry. No status message is pushed using CEFM to notify the partners that the shipment has been booked with an airline.

Event 5: Forwarder Schedules Local Dray to HACTL

While the freight forwarder arranges truck transportation from its Hong Kong consolidation facility to the HACTL, there is no information about this movement within CEFM. In addition to the forwarder's arrangements for this move, HACTL records the truck receipt and its cargo information, along with the consignment's official weight into its existing system. While originally envisioned in the CEFM design that these events would be included, HACTL's overall reluctance to participate in the test resulted in omitting these status messages from the final CEFM system design.

Event 6: Aircraft is Loaded

As with Event 5, since HACTL is not a participant in the CEFM deployment test, there are no status messages within the system to reflect HACTL's involvement with freight movement.

Event 7: Departure Data Submitted and Airline Tracking Begins

HACTL provides departure data to the forwarder when the flight departs Hong Kong. In the pre-CEFM operations, the forwarder would notify its Columbus partners of "Wheels Up" in Hong Kong.

Using CEFM, the information is automatically available through the forwarder's shadow database, and partners are notified by a "Departure, completed" status message via Web services.

Within 4 hours following aircraft departure from Hong Kong, the forwarders create and send an EDI 856 message (ASN) to the broker, the CFS, and LB. CEFM also makes this message available to the partners. Unlike the previous events, which were status messages only, the ASN is considered a "robust" message within CEFM. The ASN message contains PO details describing the goods and the quantity consigned. This additional information appears within the ASN message's XML style sheet. When the partners view their messages by PO number, the ASN appears as a hyperlink to enable access to shipment details. These details may include departure times, consignment quantities, weights, and so forth. The event of the forwarder sending the ASN message also appears as a status message within CEFM. Figure 7 shows a copy of the ASN XML style sheet.

Advance Shipment Notice

Consignment: 2007CN6804077850224724680000401

Gross Weight:	670.00 LBT		
HAWB:	STI8025012	**Chargeable Weight:**	670.00 LBT
Departing MAWB:	36940307956	**Charge Dimensional Weight:**	622.00 LBT
Arriving MAWB:	36940307956	**Packages:**	37 CTN90
Customs Office:	4103	**Package Range Start:**	1
Arrival Port:	CMH	**Package Range End:**	37
Destination:	CMH	**Buyer Package Description:**	CTN
Delivery Date:	2007-11-16	**Pre-Packed:**	N
Delivery Time:	01:00:00.000	**Package Configuration:**	Y

Parties

Party	Name	ID	Division	Department
Consignor	CLOVER GROUP INTERNATIONAL LTD.			
Importer	xxxxx	MFE		
Final Delivery				
Buyer			MII	98

Goods Items

Sequence	Quantity	UOM	Style Code	Style	Size Code	Size	Color	Vendor Color	PO	CPO
1	463	EA	4102	ST	IZ	4102	TRIUMPH WHITE	BO	VSS59840100	91746
2	543	EA	4102	ST	IZ	4102	TRIUMPH WHITE	BO	VSS59840100	91746
3	663	EA	4102	ST	IZ	4102	TRIUMPH WHITE	BO	VSS59840100	91746
4	364	EA	4102	ST	IZ	4102	TRIUMPH WHITE	BO	VSS59840100	91746
5	322	EA	4102	ST	IZ	4102	TRIUMPH WHITE	BO	VSS59840100	91746

Shipment Stages

Stage	Mode	Date	Time	Carrier	Flight	Port
Departing flight	A	2007-11-15	01:00:00.000	Empty: TODO	5Y2857	HKG
Arriving flight	A			Empty: TODO	5Y2857	

Transport Events

ID	Date	Time	Code	Description
1	2007-11-12	13:30:00.000	74	Cargo Receipt
1	2007-11-15	01:00:00.000	24	WheelsUp
2	2007-11-12	13:30:00.000	901	Document Availability Date

Figure 7. CEFM Advanced Shipment Notice (XML Style Sheet).

When any aircraft enters U.S. airspace, a subscription service known as FlyteComm begins to track the flights, including the charter aircraft that transported CEFM shipments from Hong Kong to Columbus. CEFM receives updates on the airlines used by the CEFM deployment test forwarders (Atlas, Evergreen, and Kalitta) from FlyteComm, which populates the airlines' shadow databases so that the system may update status messages on the final stop and any intermediate stops that may occur (Alaska, for example). One intermediate stop would result in two status messages being available in CEFM through Web services: "Arrival Complete" and "Departure Complete." These status messages include the location code of the intermediate stop (ANC) for Anchorage, Alaska, for

example). FlyteComm also captures the final arrival or "Wheels Down" in Columbus, published as "Arrival Complete" into code for Rickenbacker Airport (LCK) in Columbus, Ohio.

Event 8: Customs Clearance Status

Upon receiving the export documents for the cargo in Hong Kong, the forwarders scan and email these documents to the LB's Customs broker—Barthco—in Columbus. As with the other partners, Barthco uses an existing IT system to track certain events required to obtain clearance by CBP. These events appear as status messages in CEFM, and are available to all partners using Web services. The status messages in CEFM are:

- "Documents Received," which indicates the scanned documents were received by email.
- "Customs clearance in progress," which indicates that Barthco has noted the time of "Wheels up" in Hong Kong and has filed for clearance.
- "Missing document," which indicates that the Customs documents were not received by Barthco in Columbus.
- "Customs clearance, refused," which indicates that the consignment has been held for examination upon landing in Columbus.
- "Cleared by customs," which indicates that the freight has cleared.

It should be noted that these status messages may appear while the freight is being repositioned within Columbus, i.e., picked up by the inbound trucking company; in temporary storage at the inbound trucking warehouse; or at the CFS. While Customs clearance is being obtained, the freight continues to be processed until it reaches the CFS.

Event 9: Ground Handling Agent Transfer

Once the aircraft lands in Columbus, the ground handling agent unloads the cargo and transfers it to Forward Air, which then transports the cargo from the airport to the CFS in Columbus. Forward Air receives MAWBs scanned from the forwarders, and then uses the information from the MAWBs to enter information into its existing system for financial tracking purposes. Once this information is entered, Forward Air generates an EDI 214 message in its existing system, where it is consumed, or integrated, into the CEFM shadow database. The CEFM system is updated with a status message of "Inbound Trucking Received" that is now available to all supply chain partners via Web services.

Event 10: CFS Receipt and Break-Down

The CFS in Columbus (ODW) receives the shipment from Forward Air. ODW requires that every truck have an appointment. Once the shipment arrives at the warehouse, the ODW staff scans the physical documents, which triggers ODW's existing system to identify that the shipment has been received. Unlike the other supply chain partners, ODW fully integrated CEFM with its existing system (see section 3.2 for a detailed discussion of this integration). Once the data is entered into ODW's existing system, it is automatically available within CEFM. When the shipment documents are scanned, CEFM is automatically updated with a CFS status message "Received." If the shipment quantity is over or short, or the cargo is damaged, ODW staff enters a discrepancy into its existing

system. Likewise, CEFM then publishes a "Discrepancy" status update to other partners via Web services.

Once the warehouse receives the cargo, the CFS generates a "Receipt Advice" message, which is sent to LB via EDI. In CEFM, the Receipt Advice is sent by ODW as a "robust" message. As with the forwarder ASN, the event of ODW sending the Receipt Advice appears in CEFM as a status message with a date and time. Figure 8 displays a copy of the robust XML receipt advice.

Receipt Advice

Consignment: 2007CN68045153102247246800052

PO:	EXP09688406	**Gross Weight:**	1359.050	LBT
HAWB:	HKT563139	**Trailer:**	74706	
MAWB:	49401759833	**Warehouse:**	LCK	
O MAWB:	49401759833	**Appointment:**	56540	
CPO:	96531	**Received Quantity:**	50	CT
Export Country:	HK	**Total Package Quantity:**	50	CT
Air Carrier:	FRWD	**Total Received Package Quantity:**	50	CT
Ship Whole:	false	**On Hold:**	false	

Note:
EDI - 0000050 Expected, 0000050 Received, 0000000 Short

Parties

Party	ID
Consignee	BAR
FreightForwarder	HIF
Customs	BAR
Division	EXP
Department	

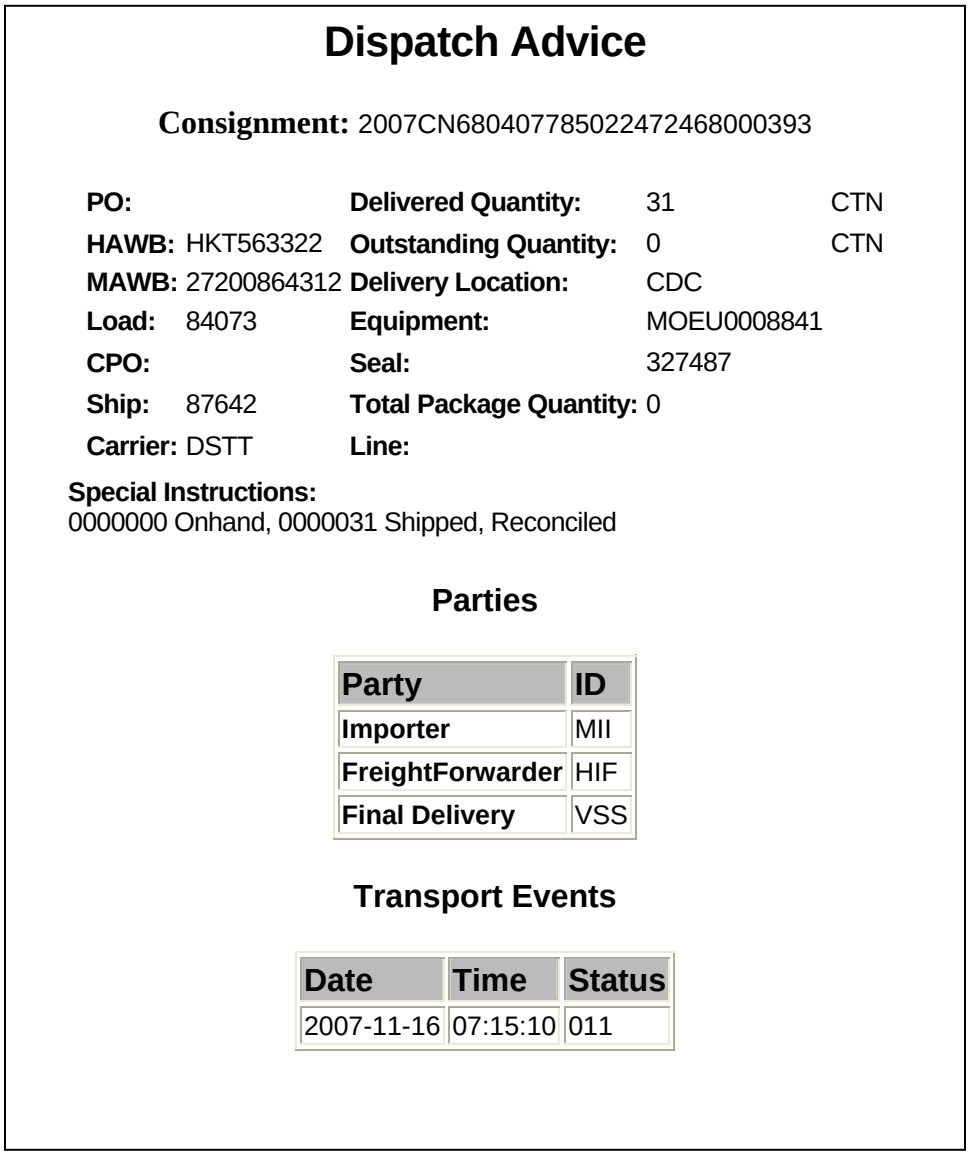
Transport Events

Date	Time	Code
1940-01-01	00:00:00	001
2007-11-07	22:00:00	002
2007-11-08	00:45:00	003
2007-11-08	00:45:00	372

Figure 8. CFS Receipt Advice XML Style Sheet.

The CFS receives shipment-related documents, including the cargo manifest, HAWB, Customs documents, and packing list, from various supply chain partners. Once ODW receives these documents and updates its existing system, this generates the CEFM status "Documents received," which is available to all partners using Web services.

After the shipment is received and broken down for delivery to the LB, ODW generates a second robust message, the "Dispatch Advice," or EDI 861, which is sent to LB. Again, within CEFM, the robust text of this message is available as a hyperlink to the XML style sheet with the full content. This robust message is accompanied by a status message indicating the date and time when ODW sent the Dispatch Advice message. Figure 9 shows a copy of the XML dispatch.



Dispatch Advice

Consignment: 2007CN68040778502247246800039 3

PO:		**Delivered Quantity:**	31	CTN
HAWB:	HKT563322	**Outstanding Quantity:**	0	CTN
MAWB:	27200864312	**Delivery Location:**	CDC	
Load:	84073	**Equipment:**	MOEU0008841	
CPO:		**Seal:**	327487	
Ship:	87642	**Total Package Quantity:**	0	
Carrier:	DSTT	**Line:**		

Special Instructions:
0000000 Onhand, 0000031 Shipped, Reconciled

Parties

Party	ID
Importer	MII
FreightForwarder	HIF
Final Delivery	VSS

Transport Events

Date	Time	Status
2007-11-16	07:15:10	011

Figure 9. Dispatch Advice XML Style Sheet.

Event 11: Delivery to DC

For this particular supply chain, ODW acts as its own inbound trucking company and delivers the shipments to the LB DC. Although there is hard copy verification of the driver's paperwork upon arrival at the LB gate, neither LB nor ODW records a delivery time in either of their existing systems. Therefore, CEFM does not rely on an official delivery time. Rather, through ODW's integrated system and per LB guidance, CEFM automatically creates the final shipment status message, "Delivery, completed" by adding 30 minutes to the "Dispatch, complete" status time.

Summary

It should be noted that all status and robust messages are available for viewing from the partners' CEFM portals by selecting "View Message" from the main menu. Once the partners select this action, they can view numerous transportation status messages, ASNs, and Receipt and Dispatch Advices. To view the message or status, the partners click on the number available to view a complete list by sender, or by individual PO, HAWB, or MAWB number (if assigned). The partners can elect to view either the XML language or style sheet version to view the message content. Table 8 presents a complete list of the CEFM status and robust messages.

Table 8. CEFM Messages

Partner	Definition	Message Type	Supply Chain Event
Manufacturer	*Booking, completed*	Status	Event 1
Manufacturer	*Freight, tendered*	Status	Event 2
Freight Forwarder	*Received*	Status	Event 3
Freight Forwarder	*Documents received*	Status	Event 3
Freight Forwarder	*Documents, incorrect*	Status	Event 3
Freight Forwarder	*Departure, completed*	Status	Event 7
Freight Forwarder	*ASN*	Robust	Event 7
Air Carrier	*(Intermediate) Arrival completed*	Status (airport code)	Event 7
Air Carrier	*(Intermediate) Departure completed*	Status (airport code)	Event 7
Air Carrier	*(Final) Arrival completed*	Status (airport code)	Event 7
Customs Broker	*Documents received*	Status	Event 8
Customs Broker	*Missing document*	Status	Event 8
Customs Broker	*Customs clearance, in progress*	Status	Event 8
Customs Broker	*Customs clearance, refused*	Status	Event 8
Customs Broker	*Cleared, by customs*	Status	Event 8
Inbound Truck	*Received*	Status	Event 9
CFS	*Documents received*	Status	Event 10
CFS	*Received*	Status	Event 10
CFS	*Receipt Advice*	Robust	Event 10

Partner	Definition	Message Type	Supply Chain Event
CFS	*Dispatch, completed*	Status	Event 10
CFS	*Dispatch Advice*	Robust	Event 10
CFS	*Delivery, completed*	Status	Event 10

In addition to the CEFM status and robust messages described within the 11 supply chain events, CEFM also provides users with access to three on-demand reports: "Consignment Status," "Open Consignment Status Report," and the "Request Supply Chain Partners" report. Since these reports are available any time the user would like to view them, the reports are shown on the bottom of Figure 2 in a separate box.

Consignment Status Report

For each consignment, CEFM retains all status and robust messages that occur as the consignment moves from Hong Kong to the DC in Columbus. After a logging in to CEFM, the users may select the "Consignment Status" report, which is considered to be the "federated" status for an individual consignment. Users can search for a consignment by the individual PO, HAWB, or MAWB numbers.

The "federated" report is created by querying each partner's shadow database (or in ODW's case, its actual shipment database) for status messages they have sent, combining them, and sharing them with the requesting user. This is a unique means of providing shipment visibility, which is "asking" each partner's shadow database individually for what information the partner knows about a shipment and sharing it with the requesting user, as opposed to storing the statuses in a centralized database. Therefore, this report provides all status information from multiple partners available on a particular shipment at a particular point in time. Figure 10 presents a sample federated "Consignment Status" report.

Consignment Status

Purchase Order: VSS54537687

HAWB: STI8023948

MAWB: 36940306663

Consignment: 2007CN6804077850224724680000347

Supply Chain Partner	Status	Location	Date/Time
Clover	Booking, completed	HKG	2007-11-12 06:29
Clover	Freight tendered	HKG	2007-11-16 08:00
Star	Documents received	HKG	2007-11-16 11:10
Star	Received	HKG	2007-11-16 16:10
Star	Departure, completed	HKG	2007-11-18 01:00
Barthco	Documents received	CMH	2007-11-18 04:00
Atlas	Departure, completed	KIX	2007-11-18 23:30
Barthco	Cleared, by customs	CMH	2007-11-19 04:00
Atlas	Arrival, completed	ANC	2007-11-19 06:33
Atlas	Departure, completed	ANC	2007-11-19 09:24
Atlas	Arrival, completed	LCK	2007-11-19 15:04
ForwardAir	Received	LCK	2007-11-19 23:00
ODW	Received	LCK	2007-11-20 06:50
ODW	Despatch, completed	LCK	2007-11-22 18:43
ODW	Delivery, completed	LCK	2007-11-22 19:13

Figure 10. Sample Federated "Consignment Status" Report.

Open Consignment Status Report

The second on-demand report, the "Open Consignment Status Report" (OCR), was originally prepared in a similar manner to the Federated Status Report by polling each partner for status. This method of gathering and displaying each partner's status caused excessive timing delay issues, where CEFM could take more than 5 minutes to return the information. Several weeks into the test, the OCR was redesigned to pull the most current status information directly from LB's shadow database rather than running separate, federated queries of all the other partners.

The OCR returns all information for all open consignments, i.e., those that have not been delivered to LB in Columbus. Each UCR number is presented as a hyperlink, and when selected, CEFM displays the federated status for that consignment. The OCR report provides a complete picture of all freight

that is en route from China to Columbus. A sample OCR is presented in Figure 11 and Figure 12 (due to the number of horizontal field values, the report is presented in two screen captures).

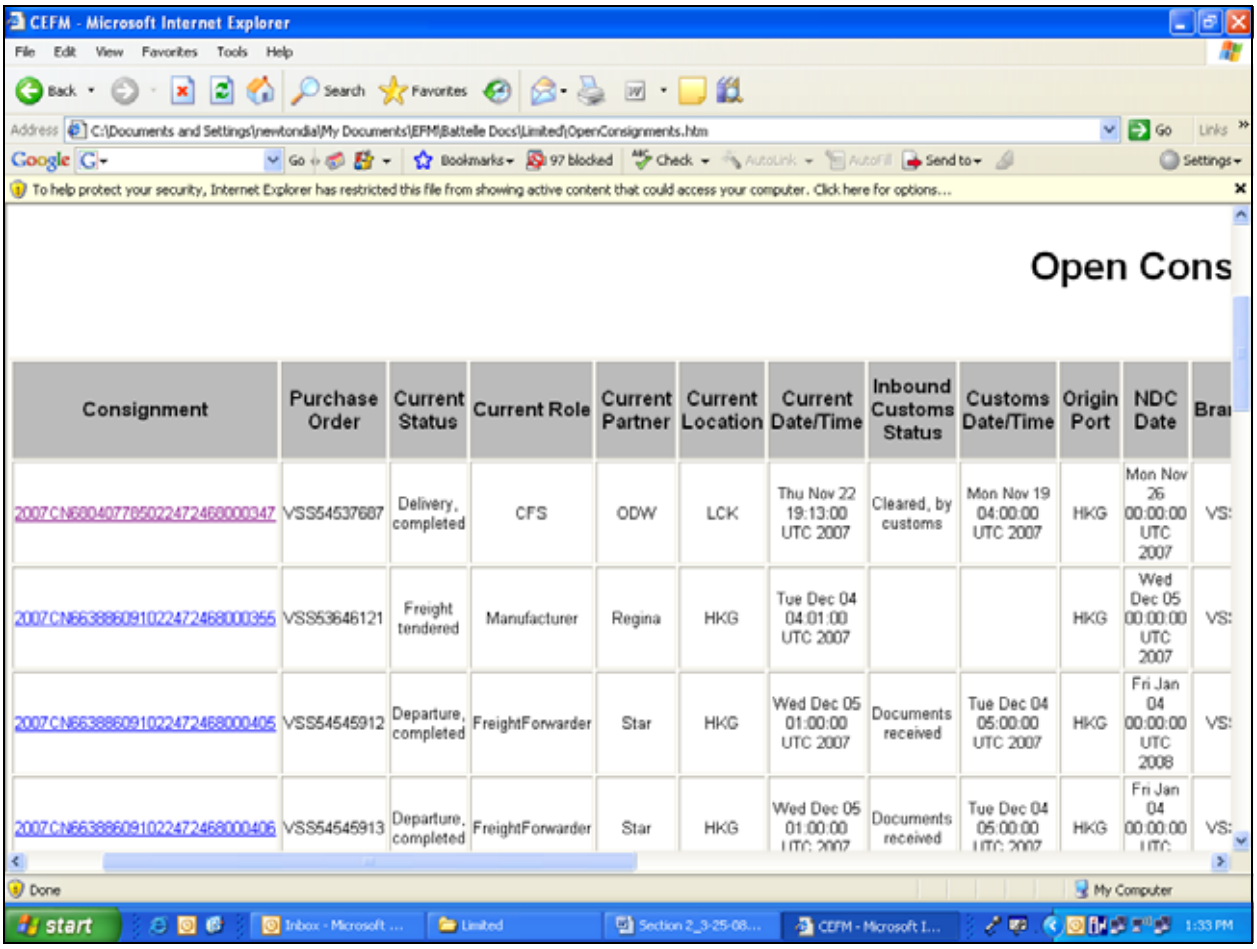
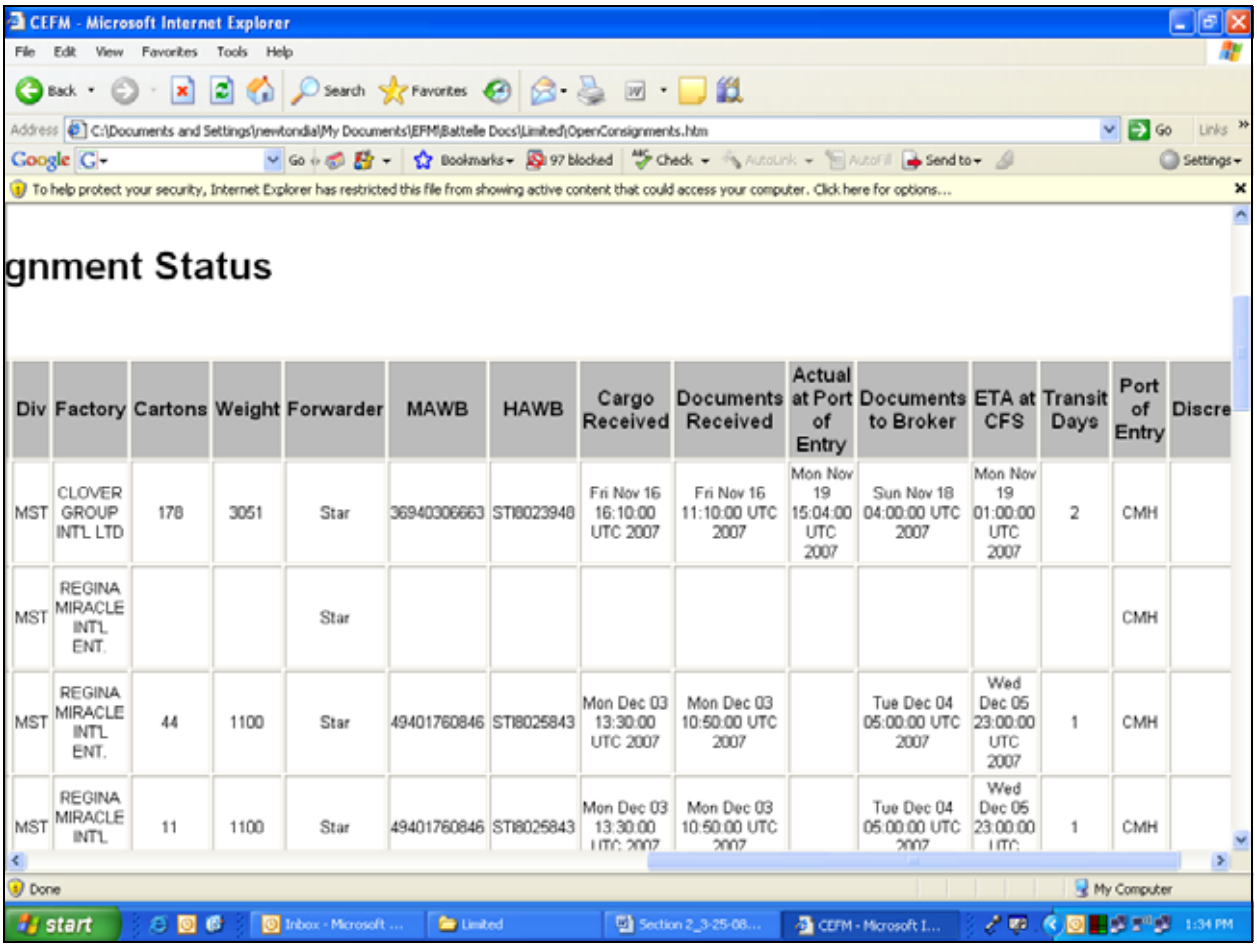


Figure 11. Sample "Open Consignment Status" Report – Part 1.



Div	Factory	Cartons	Weight	Forwarder	MAWB	HAWB	Cargo Received	Documents Received	Actual at Port of Entry	Documents to Broker	ETA at CFS	Transit Days	Port of Entry	Discre
MST	CLOVER GROUP INTL LTD	178	3051	Star	36940306663	STI8023948	Fri Nov 16 16:10:00 UTC 2007	Fri Nov 16 11:10:00 UTC 2007	Mon Nov 19 15:04:00 UTC 2007	Sun Nov 18 04:00:00 UTC 2007	Mon Nov 19 01:00:00 UTC 2007	2	CMH	
MST	REGINA MIRACLE INTL ENT.			Star									CMH	
MST	REGINA MIRACLE INTL ENT.	44	1100	Star	49401760846	STI8025843	Mon Dec 03 13:30:00 UTC 2007	Mon Dec 03 10:50:00 UTC 2007		Tue Dec 04 05:00:00 UTC 2007	Wed Dec 05 23:00:00 UTC 2007	1	CMH	
MST	REGINA MIRACLE INTL	11	1100	Star	49401760846	STI8025843	Mon Dec 03 13:30:00 UTC 2007	Mon Dec 03 10:50:00 UTC 2007		Tue Dec 04 05:00:00 UTC 2007	Wed Dec 05 23:00:00 UTC	1	CMH	

Figure 12. Sample "Open Consignment Status" Report – Part 2.

Request Supply Chain Partners Report

The third on-demand report available to all users through the CEFM "Status" menu is the "Request Supply Chain Partners" report. A simple query, once the user enters the individual PO, HAWB, or MAWB number, CEFM returns the name and functional role of each partner involved in the transport of goods. Figure 13 presents a sample "Request Supply Chain Partners" report.

Figure 13. Sample "Request Supply Chain Partners" Report.

2.4. COMPARISON OF CEFM AND NON-CEFM DATA FLOWS

This section provides a comparison of the two data flows (non-CEFM and with CEFM) and highlights the improvements in supply chain visibility that are attributable to CEFM. Figure 14 on the following page combines the processes presented in Figure 2 and Figure 3, respectively, to show how and when the CEFM data flows occur as compared to the pre-CEFM data flows. This combined diagram also shows the timing of the pre-CEFM and CEFM events with the LB's 96-hour transit time standard, and the timings between respective events, as calculated using archived CEFM data.

Based on calculations of the mean transit time of 82.3 hours using CEFM deployment test event data, and verified through the Evaluation Team's interviews with the supply chain partners, it is evident that the majority of the LB shipments originating in Hong Kong meet the 96-hour time standard. In fact, many shipments were found to arrive sooner than the 96 hours, especially priority shipments.

The period of the CEFM deployment test fell during the LB's peak shipment period that precedes the holiday season. During the peak period, there is an increase in "hot" or priority shipments, which also helps verify the CEFM transit time calculation as being less than the required 96 hours. The final LB supply chain diagram displayed in Figure 14 contains background shading to illustrate the time of each supply chain partner's possession of the freight; these times represent each partner's mean time of possession, as calculated using archived test data from CEFM. The specific timings and their measurements are discussed later in this section.

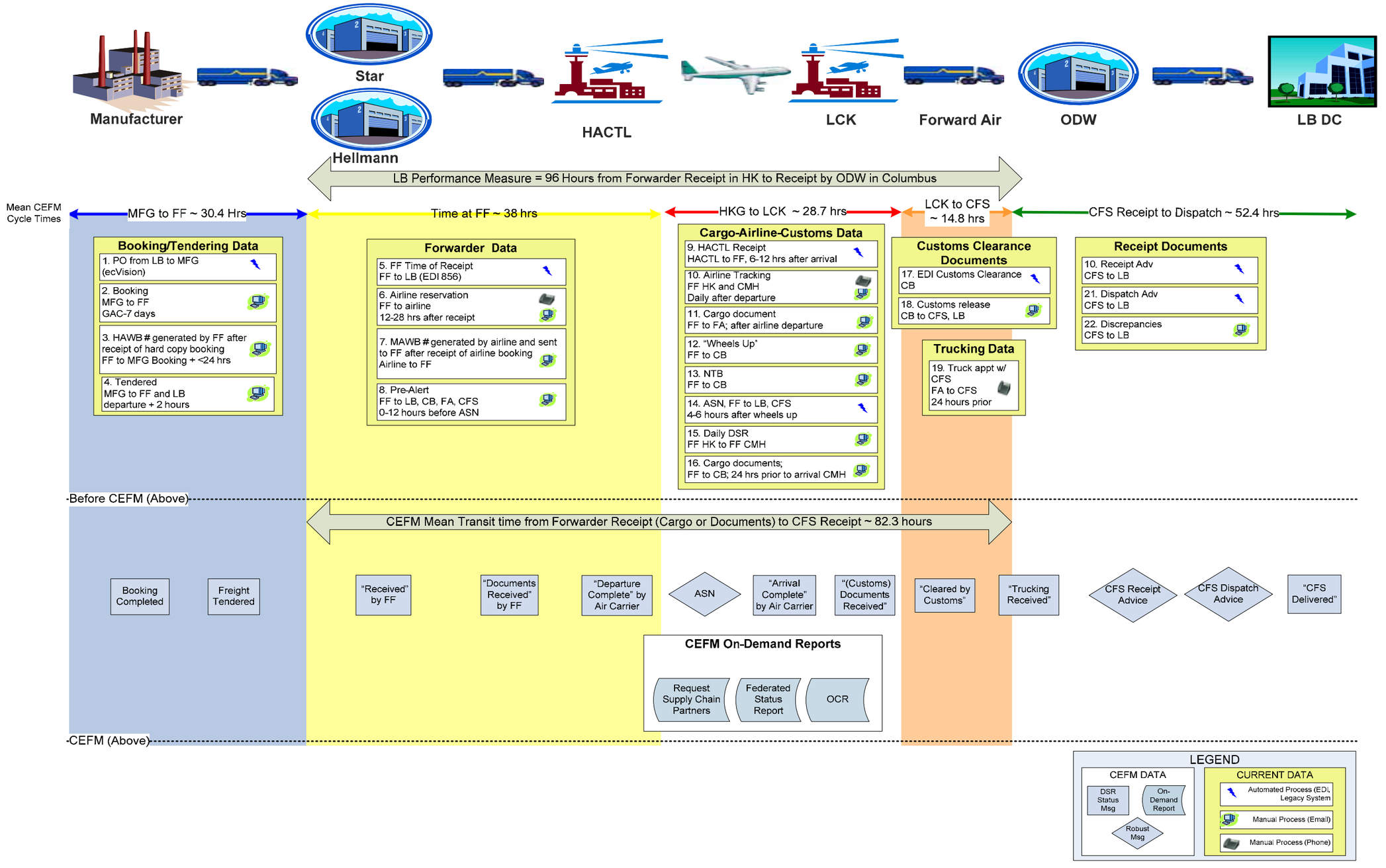


Figure 14. Pre-CEFM and CEFM Comparative Data Flows.

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The main difference between CEFM and non-CEFM data flows is that the CEFM data flows are initiated by a single point of data entry. Under the manual method of booking a shipment, the manufacturers must fill out a hard copy form with eight pieces of information, including: MPO number; style number; shipment quantity; total carton count; ship mark information; total gross weight; and total cubic meters (CBM). The completed form is then sent to the forwarder via email or fax. CEFM only requires the manufacturer to log in, select the PO, and enter the piece count; the process is streamlined and requires no paper transfer. Once the manufacturer updates the consignment after the truck departs its factory (i.e., "tenders" the freight), this is the last point within the CEFM data flow where data is manually entered.

With the exception of its many manufacturers in China, most of LB's current partners use EDI and submit various transaction sets to LB, including: the forwarder's time of receipt; the ASN; the Customs release; and the Receipt and Dispatch Advice information. With CEFM, these EDI messages are replaced with XML-based messages that contain essentially the same information, but are sent to other partners via the Internet using Web services.

In addition, the on-demand reports in CEFM, particularly the federated status and OCR reports, provide much of the information provided by the manually created and sent reports in the non-CEFM model. In particular, the OCR report has similar data elements to both the Hong Kong forwarder's pre-alert Excel spreadsheet and the Columbus forwarder's DSR spreadsheet. In the case of the pre-alert, the OCR contains 65 percent of the data elements within the pre-alert. For the DSR, the OCR contains 75 percent of the data elements.

Table 9 contains a list of all data elements contained in each of these three documents: the OCR, the pre-alert, and the DSR. It is important to note that there is a second header row in this table denoted by the shadow and double line border; below this second header row are the unique data elements found in each of the three reports. In reviewing this table, it is evident that much of the data within the Pre-Alert and DSR is also contained in the CEFM OCR.

Table 9. Data Fields in OCR, Pre-Alert, and DSR

OCR	Pre-Alert	DSR
Division Name	MAST Office/Division Code	Division
Brand Name		
Carton Count	Carton Count	Cartons/Pieces
		Quantity (in pieces)
Factory	Shipper/Factory	Factory
Cargo Received Date and Time	Cargo Received Date	Cargo Received Date/Time
	Cargo Received Time	
Documents Received Date and Time	Documents Received Date	Documents Received Date/Time
	Documents Received Time	
Documents to Broker (date and time)		Documents to Broker Date/Time
Forwarder Name	Forwarder	Forwarder

OCR	Pre-Alert	DSR
HAWB number	HAWB Number	HAWB Number
MAWB number	MAWB Number	MAWB Number
Weight	Gross Weight	Gross Weight
	Volume Weight	Volume Weight
	Chargeable Weight	Chargeable Weight
NDC Date (due date in the Columbus distribution center)	Expected Ready Date	
Origin Port	Port of Discharge	FOB Port
	Country of Origin	
Port of Entry	Port of Entry	Termination Port
		Delivery Terminal
PO Number	PO/MPO Number	PO Number
Actual Date and Time at Port of Entry		ETA at CFS or Port of Entry
Estimated Time of Arrival at CFS		ATA at CFS or Port of Entry
Discrepancies		Discrepancies
Current Date and Time	Report Date	
Unique OCR Fields	**Unique Pre-Alert Fields**	**Unique DSR Fields**
Current Location	Booking Notice Date	Removed?
Current partner	Cubic Feet	Routing Details
Current role	Planned Flight Number and Date	Split?
Customs Date and Time	Style	GOH[10]
Customs Status	Comments	Comments
Number of Transit Days	Air by Express?	Pre-Class?
Unique Consignment Reference		
Current [shipment] Status		

An on-demand OCR report can be run and then exported to Excel. Using this report instead of current email-based processes could significantly reduce the need to manually key information into the pre-alert and DSR by using the cut-and-paste functions within Excel to move the information from the OCR to the pre-alert or DSR (this process is discussed in more detail in section 4).

[10] GOH is defined as "Goods on hand."

With respect to the DSR, CEFM may contain much of the visibility information that the forwarders must gather to complete this form. One key function that the Columbus forwarders must complete is researching the airline status. In the Evaluation Team's interviews with the Columbus forwarders, the respondents estimated that they spent approximately 1 hour per day on airline-tracking Websites such as Red Berry, or in calling the airlines directly.

CEFM is unique in that it includes airline-tracking information, especially the information on the location and timing of interim stops between Hong Kong and Columbus. In addition, occasionally time-sensitive Columbus-bound freight is booked on a charter flight to John F. Kennedy (JFK) International Airport in New York if the departure date is sooner than the Columbus charter. Before CEFM, the Columbus partners (especially LB, the inbound trucking company, and the CFS) were unaware that the freight was arriving in JFK rather than Columbus, and when this occurred, the airline would arrange for trucking to Columbus. See section 4.3.2 for more information on the tracking of this type of shipment.

Another unique aspect of the CEFM data flows is that certain pieces of information are now visible where they were not before as per the pre-CEFM model. In particular, the interim aircraft stops and inbound trucking receipt were pieces of information that were nearly invisible to most partners. Also, under the pre-CEFM data exchanges, the data was frequently flowing from one partner to another, or sometimes from one partner to two or three partners, but there were no instances where every partner had access or visibility to each piece of information.

Using CEFM, each supply chain event and the robust messages that support the event are available to all authorized supply chain partners. As the supply chain "owner," during the deployment test, LB had the ability to denote which partners were "authorized," and then CEFM would distribute the information to only those partners.

It also is important to understand that except for the booking and tendering events, all CEFM events are automated. With the pre-CEFM events, many of the information exchanges are manual (as indicated by the computer or telephone icon next to the exchange), and require not only manual data entry but also re-keying of information previously entered. Particularly significant is the simplicity of the CEFM process as compared to the pre-CEFM exchanges. Where the pre-CEFM information exchange relied on 22 separate information exchanges (as shown on Figure 14), CEFM achieves the same level of visibility with only 2 points of manual entry and 13 status messages, plus 3 on-demand visibility reports.

Earlier in this section, the LB's key 96-hour transit time performance measure for direct flights from Hong Kong to Columbus was discussed. This measure is what each of the LB's Hong Kong freight forwarders work toward (see section 4.3 for more details). CEFM tracks the key events used to calculate this metric; in addition, the on-demand OCR contains a data field listing the transit days of each consignment. Again, this 96-hour "clock" begins when the forwarder receives either the cargo itself or its documents in Hong Kong (whichever occurs later), and ends when the consignment is received at the CFS in Columbus (the time of the CFS robust "receipt advice").

Although the partners could not view the data contained in their partners' shadow databases, the CEFM Evaluation Team was provided access to all partners' shadow databases. This allowed the

Evaluation Team to calculate the time between each of the events along the supply chain for all consignments. The mean times between the key events are presented in Table 10. The calculation of these mean timings is discussed in more detail in section 4.3.

Table 10. CEFM Mean Timings

Event	Calculation	Mean Time (Hours)
Time at Manufacturer	Forwarder Receipt – Booking	30.4
Time at Hong Kong Forwarder	Airline Departure – Forwarder Receipt	38.0
Flight Time	Arrival Columbus – Airline Departure	28.7
Time at Inbound Truck	CFS Receipt – Arrival Columbus	14.8
Time at CFS	CFS Dispatch – CFS Receipt	52.4
Transit Time	CFS Receipt – Forwarder Receipt	82.3

The diagram in Figure 14 will be presented again in section 4 to visually explain the benefits of using CEFM information on the LB supply chain. The following section 3 defines the CEFM architecture and Web services, and how they worked together to achieve the data exchanges during the CEFM deployment test.

3. CEFM DEPLOYMENT TEST OVERVIEW

3.1. INTRODUCTION

This section presents a specific discussion on the CEFM system design, architecture, deployment test, and evaluation. While section 2 described the baseline information flows associated with the pre-CEFM supply chain and how they were impacted during the 6-month CEFM deployment test, this section discusses the technical aspects of the CEFM deployment test. This discussion includes the specifics behind the CEFM system's technical architecture and operation, to the coordination of the multiple partners and test phases that led up to the official "turn on" of the CEFM deployment test in May 2007. This section also will begin to define the Evaluation Team's activities, including its role in the test design and execution, and subsequent activities since the test concluded in December 2007.

3.2. CEFM DEPLOYMENT TEST DESCRIPTION

3.2.1. Overview and Review of Participants

The process of designing, building, and planning the CEFM deployment test was a multi-year effort involving extensive public-private partnership among the USDOT, the Deployment Team, the Evaluation Team, and the supply chain partners. The deployment test design revolves around the key test participant, The Limited Brands—the "owner" of the supply chain. The CEFM deployment test involved one of the LB's international in-bound air freight supply chains: a Hong Kong–Columbus supply chain that originates with manufacturers in the Guangdong province in southern China, and concludes with delivery to an LB distribution center in Columbus. Products were trucked into Hong Kong, transported via air cargo into the United States to Rickenbacker Airport in Columbus, Ohio, and then trucked to LB's distribution centers in Columbus, Ohio.

Although LB is a large company with multiple global supply chains, the CEFM deployment test focused on a small segment of the LB's Hong Kong-based supply chain. The goal of the deployment test was to provide visibility for approximately 1,000 purchase orders (POs) over the 6-month test period.

The CEFM deployment test involved two of the LB's business unit supply chains, or brands: the Express brand and the Victoria's Secret brand. The CEFM deployment test included four manufacturers in China who produce these brands: Regina and Clover, who primarily produce items for the Victoria's Secret brand; and Kingmax and Esquel, who primarily produce items for the Express brand.

LB works primarily with two freight forwarders to handle shipments for the two brands: Hellmann Worldwide Logistics (HWL) and StarTrans (Star). Both forwarders had their respective Columbus and Hong Kong offices participating in the deployment test. In Columbus, the LB partners involved in the CEFM deployment test included:

- **Barthco**, who works as LB's Customs broker.

- **Forward Air**, who is the inbound trucking agent responsible for picking up the cargo at Rickenbacker and transporting it to the container freight station.
- **ODW Logistics**, who works as the container freight station (CFS) for all of LB's Columbus freight.
- **Secondary supply chain partners**, who were indirectly involved in the test, including the air cargo charter airlines of Evergreen, Atlas, and Kalitta. These airlines were considered as secondary partners because they did not have direct connectivity to the CEFM architecture. Although each air carrier had a shadow database, the source of the data for their shadow databases was FlyteComm, a third-party provider of airline status information.

3.2.2. Deployment Test Set-Up

Leading up to the official system "turn on," there were numerous activities involving both the Deployment Team and the supply chain partners. From May 7-9 2007, the Deployment and Evaluation Teams gathered to test the CEFM system functions using a sample data set of POs, robust messages (ASNs, Receipt and Dispatch Advices), and partner data (from the air carriers, forwarders, Customs broker, and inbound trucking agent). These tests were conducted to assess whether in a "laboratory" environment located at the Battelle facility the CEFM system met the functional, software, business, and evaluation requirements as outlined by the Deployment Team.

The purpose of the testing was to ensure that the critical CEFM components were operating correctly prior to system turn on. The CEFM deployment test results were evaluated during the week of May 10, 2007, and any necessary modifications to the CEFM system or its architecture were made.

The Hong Kong and Columbus partners were trained by the Deployment Team during the weeks of May 14, 2007 in Hong Kong, and May 22, 2007 in Columbus, respectively. The training focused on the use of each partner's user interface. The training began with a general overview of the CEFM system and then instructed each partner's staffs in using their respective user interfaces regarding log-on activities; main menu option selections; executing the on-demand reports; and reviewing robust message contents. The Evaluation Team was present at the Columbus user training sessions, which enabled members to undergo training and afforded them the opportunity to ask baseline questions about the various partners' pre-CEFM operations.

Immediately following the Columbus partner training, the CEFM system became operational on May 29, 2007.

3.2.3. CEFM

CEFM is actually a collection of individual systems as opposed to a singular system accessed by multiple partners. This collection of systems represents each supply chain partner's presence and participation in the visibility of individual consignments or POs. CEFM relies on several data sources and methods of communications to gather, analyze, and present the data to each of the test participants. CEFM consists of the following components:

- A process to extract data from the partners' internal existing systems.

- A shadow database to store the data extracts from the partners' systems.
- Web services, which either:
  - Respond to requests for information from other partners' CEFM presence, or
  - Make requests to other partners' Web services (for example, a push for status information).
- A Web application to allow manual updates to the partners' shadow database.

To deploy these components and the hardware, software, and services associated with each, the Deployment Team relied on components from the previously tested FIH, along with components that were created specifically for the CEFM deployment test. The FIH, the CEFM architecture, and the system models used by the supply chain partners are discussed in detail in the following sections.

FIH

The FIH is essentially an existing, non-proprietary standards-based architecture that defines a service-oriented architecture (SOA) to support business process coordination and real-time data exchange; its processes, schemas, and definitions are specific to freight transportation.[11] The FIH is a network allowing connected trading partners to communicate directly with each other; it is an example of an SOA. SOAs, including the FIH, utilize extensible markup language (XML) to describe both document-oriented and procedure-oriented messages. For CEFM, the FIH permitted the translation of the EDI 214 message sent by Forward Air to XML. For the other EDI messages sent by the supply chain partners participating in CEFM, the raw data from these messages was received loaded into each partners' shadow database for use in the CEFM messages. The benefit of using XML is that it can be transferred via the Internet without the need for a Value Added Network that EDI usually requires.

In addition to the use of XML, the FIH utilizes Web services to transfer shipment visibility information from partner to partner. A "Web service" is a computer application that follows a basic profile that transfers data between one or more partners, is formatted, packaged in a simple object access protocol (SOAP), and transported via hypertext transfer protocol (HTTP) on the Internet. Web services are typically deployed in an SOA such as the FIH. For the FIH, this network defines the requirements for the implementation of Web services in a transportation environment.[12]

The FIH provides a centralized location in which the Web services registry resides. The FIH provides a standard method for users such as the supply chain partners to list and discover the Web services. The use of Universal Description, Discover, and Integration (UDDI) registry technology is typical in the information technology community. This registry provides information on the format of data to be sent to a Web service and the information that will be retrieved once the request is received. The FIH provides a Website that provides its users access to all the information in the UDDI registry, which acts as a "yellow pages" containing the location and format for data exchange among network participants.[13]

[11] USDOT, FHWA, *Columbus Electronic Freight Management Detailed Test Plans* (Washington, DC: October 4, 2007), page 3.
[12] Draft Section 5.0 CEFM Detailed Design Document, Battelle, November 21, 2006. [it would be better if we used the DDD 3.0 throughout.]
[13] Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 80.

The final key element of any SOA, including the FIH, is security. Security within the FIH occurs via digital certificates. A digital certificate is a component of a cryptographic, or secure computer system. Just as digital signatures provide the same security properties as a handwritten signature on to authenticate that the data contained in the certificate is actually produced by the partner issuing the certificate, digital certificates use cryptographic keys to encrypt the data so that only the other partner can de-crypt and receive the data.

The CEFM test relied on two digital certificates, one for secure socket layer (SSL) encryption, and one for XML signatures. The SSL encryption ensures that data within the message is encrypted, while the XML signature ensures the message is digitally "signed" by the party who is sending it. Together, these certificates identify the data's source (real or shadow database) and the partner sending it (company, role, and country of origin). These signatures are captured in the SOAP "envelope" of the XML message. For the CEFM deployment test, the CEFM Deployment Team acted as the [digital] Certificate Authority who issued the digital certificates to each partner as opposed to a third-party issuer. Below is an excerpt from an XML message that includes the SOAP envelope in the message header, along with the digital certificate. These items are highlighted in yellow.

```
<soapenv:Envelope
xmlns:ns1="http://schemas.xmlsoap.org/ws/2004/08/addressing"
xmlns:ns2="http://www.w3.org/2000/09/xmldsig#" xmlns:ns3="urn:/fih/c-
efm/purchase-order/1.0/LimitedPurchaseOrder" xmlns:ns4="urn:/fih/c-
efm/purchase-order/1.0" xmlns:ns5="urn:/fih/1.0"
xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
- <soapenv:Header>
- <ns5:request-header>
  <ns1:To>O=mfg_c.cefm-dot.com, OU=manufacturer</ns1:To>
- <ns1:From>
  <ns1:Address>O=buyer.cefm-dot.com, OU=buyer</ns1:Address>
  </ns1:From>
  <ns1:MessageID>83A75C33:011132549D37:5E4A:014D4313</ns1:MessageID>
- <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
- <ds:SignedInfo>
  <ds:CanonicalizationMethod Algorithm="http://www.w3.org/TR/2001/REC-xml-
c14n-20010315" />
  <ds:SignatureMethod Algorithm="http://www.w3.org/2000/09/xmldsig#dsa-
sha1" />
- <ds:Reference URI="">
- <ds:Transforms>
- <ds:Transform Algorithm="http://www.w3.org/2002/06/xmldsig-filter2">
  <dsig-xpath:XPath xmlns:dsig-xpath="http://www.w3.org/2002/06/xmldsig-
filter2" xmlns:fih="urn:/fih/1.0"
xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
Filter="intersect">/soap:Envelope/soap:Header/fih:request-header |
/soap:Envelope/soap:Body</dsig-xpath:XPath>
  <dsig-xpath:XPath xmlns:dsig-xpath="http://www.w3.org/2002/06/xmldsig-
filter2" xmlns:fih="urn:/fih/1.0"
xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
```

Filter="subtract">/soap:Envelope/soap:Header/fih:request-header/ds:Signature</dsig-xpath:XPath>
</ds:Transform>
</ds:Transforms>
<ds:DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1" />
<ds:DigestValue>2jmj7l5rSw0yVb/vlWAYkK/YBwk=</ds:DigestValue>
</ds:Reference>
</ds:SignedInfo>

<ds:SignatureValue>g9u2nwFI2WbBkW+iP5e51ildmmoNyZf5ZX+AxXIgmBYGbrWbpj7hYQ==</ds:SignatureValue>
- <ds:KeyInfo>
- <ds:X509Data>

<ds:X509Certificate>MIIB7DCCAawCAwCY+jAJBgcqhkjOOAQDMFAxCzAJBgNVBAYTAlVTMRswGQYDVQQKExJVU0RPVCAtLSBGSUgvQy1FRk0xJDAiBgNVBAsTG0MtRUZNIENlcnRpZmljYXRlIEF1dGhvcml0eTAeFw0wNzAxMTAyMTIxNDlaFw0xNzAxMTEyMTIxNDlaMDUxDjAMBgNVBAsTBWJ1eWVyMSMwIQYDVQQKExpodHRwczovL2J1eWVyLmNlZm0tZG90LmNvbTCB8DCBqAYHKoZIzjgEATCBnAJBAP7MhiABTkdjDGkOsnSvUTQtIRsv3BBk1l8IBfSitnmhGD9ilxr16VgVxHtOE7oDdKlWipwlSH1lwPLOI47qaXMCFQCaXRSP+8T/8Hzx6nhdS/cJ7PshKwJAWxNMNIBnL6XLxFuvs3ylNKhXefUZHToT51PQjae2/YAcfzfsp0Vgi3nJ4tB82fKnLAiqXZxAdlsongX+zMS8BQNDAAJAIaGE7SVq3UaTlnSGqlo0y8ws0yM0i3N0F+XlVWUWvJaOfQ6wk+HjHosWUDx8rDod3e7cJi8dt2xil/aYYyf6BzAJBgcqhkjOOAQDAy8AMCwCFAN3IVsH4Yj52xh2N5vXX5yNV9NpAhQ4ZlzE9BCPawbHXwrD+9jbdd8JHA==</ds:X509Certificate>

For the CEFM deployment test, the FIH provided the following capabilities:

- A Web services registry in which each partner published the Web services description language (WSDL) descriptions of each Web service that the partner made available to other authorized partners.
- A Universal Description, Discovery, and Integration (UDDI) capability that allowed the partners to search for services published by other partners.
- Messaging using XML.
- Use of Simple Object Access Protocol (SOAP) "envelope" to package and exchange the XML messages.[14]
- Security:
  - Installed a secure socket layers (SSL) interface between parties.
  - Provided XML document signatures as a SOAP extension to ensure authenticity of the documents.

[14]Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 56.

Using the FIH in the deployment test was critical since it enabled an evaluation of the FIH as a means of integrating multiple partners, and networks while exchanging and sharing data; maintaining security of the information exchanges; and maintaining the integrity of each partner's individual operations systems. The following section describes how these key elements of the FIH were applied to the CEFM system design.

The CEFM Architecture

Web Services

Within the CEFM deployment test, the FIH concepts provided the base layer of architecture upon which the system was built as shown in Figure 15.[15] The CEFM architecture began by using the key FIH network elements: Web services and SOA technologies (including XML messages and SOAP message envelopes). The FIH enabled the LB supply chain partners to exchange information with each other by locating Web services via a central UDDI registry and using the Web services in the FIH (as the SOA) to enable the partners to:

- Describe the Web services (using WSDL).
- Publish the Web service (makes the WSDL description available to a broad group of partners through a functionality called the "discovery agent"). For CEFM, the discover agent was essentially the FIH Web services registry, which allowed the FIH to be used as the single location for multiple partner offerings.
- Discover the Web service (enabled the "yellow pages" capability provided by the UDDI).
- Exchange messages—as the Web services previously been described, published, and discovered, the requesting partners can now implement the services necessary for their systems to interact with that of the partner who is providing the services.

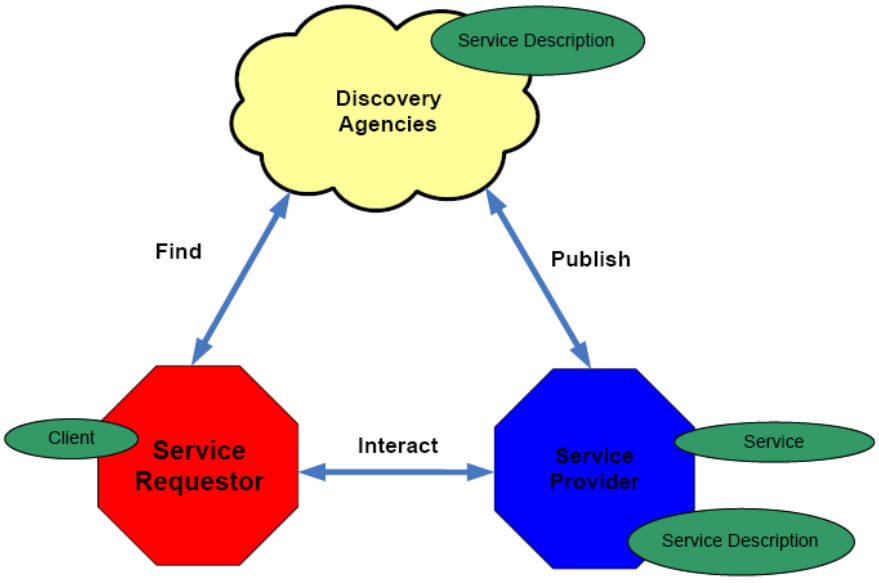

Figure 15. Web Services in an SOA.

[15] Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 72.

The FIH manages the 21 request and response Web services in CEFM, and contains the listing of which partners receive which messages. These Web services are identified as public or private Web services that can only be invoked or requested from within the partner's CEFM interface. The Web services are considered private and are not published in the FIH Web services registry since there is no need for another partner to "Discover" those services. Public Web services are just the opposite—they can be requested from outside the partner's CEFM interface, and their description is published in the FIH directory so that other partners may access them. Table 11 lists the Web services that were a part of the CEFM deployment test.[16] Please note that the Web services correspond to many of the supply chain events discussed earlier in section 2. These public and private Web services are reusable and can save implementation costs in future CEFM-like systems.

The message components of the SOA within the CEFM architecture were XML-based, as specified in the FIH architecture. Within CEFM, these XML messages have been harmonized with the Universal Business Language (UBL). Currently being ratified by the OASIS standards organization, the use of UBL was included as part of the CEFM deployment test to create a wider EFM package for adoption. Using UBL in XML-based documents and messages has been shown to lower integration costs and provide an easier learning curve for XML business schemas. UBL is available for use without cost. The UBL specification was a particularly good fit within the CEFM deployment test and FIH architecture because it helps to enable trading relationships among multiple adopters.[17]

Table 11. CEFM Web Services

Web Service	Type	Description	Buyer	Manufacturer	Freight Forwarder	Air Carrier	Customs Broker	Inbound Truck	CFS
Generate UCR	Private	Generates a unique UCR number for a new consignment.		x					
Request Booking	Private	Requests booking of a new consignment at a freight forwarder.		x					
Book Consignment	Public	Books a new consignment.			x				
Request Supply Chain Partners	Private	Requests a list of supply chain partners for a consignment.	x	x	x	x	x	x	
Get Supply Chain Partners	Public	Provides a list of supply chain partners for a consignment.	x						
Request Transportation Status	Private	Requests status of a consignment at a single partner.	x	x	x	x	x	x	
Request Federated Status	Private	Requests a status of a consignment at the Buyer for federated status across all partners.	x	x	x	x	x	x	

[16] Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 117.
[17] Krill, Paul "OASIS approves XMLBusiness Document Specifications," *Infoworld*, May 3, 2004. Source: <http://www.infoworld.com/article/04/05/03/HNubl_1.html >, last accessed March 26, 2008.

Web Service	Type	Description	Buyer	Manufacturer	Freight Forwarder	Air Carrier	Customs Broker	Inbound Truck	CFS
Reply Federated Status	Public	Provides federated status of the consignment across all partners.	x	x	x	x	x	x	
Get Transportation Status	Public	Provides an open consignment status report.	x	x	x	x	x	x	x
Request Open Consignments	Private	Requests an OCR status report.	x	x	x	x	x	x	
Get Open Consignment Status Report	Public	Provides an OCR status report.	x						
Publish Purchase Order	Private	Sends PO message to a manufacturer.	x						
Receive Purchase Order	Public	Receives a PO message.		x					
Publish Advanced Shipment Notice	Private	Sends an ASN message to subscribed partners.			x				
Receive Advanced Shipment Notice	Public	Receives ASN message.	x				x		x
Publish Transportation Status	Private	Sends a status message to subscribed partners.		x	x	x	x	x	x
Receive Transportation Status	Public	Receives status message.	x	x	x	x	x	x	
Publish Receipt Advice	Private	Sends a Receipt Advice message to subscribed partners.							x
Receive Receipt Advice	Public	Receives a Receipt Advice message.	x						
Publish Dispatch Advice	Private	Sends a Dispatch Advice message to subscribed partners.							x
Receive Dispatch Advice	Public	Receives a Dispatch Advice message.	x						

Unique Consignment Reference

Another unique aspect of the CEFM architecture was the concept of a Unique Consignment Reference (UCR) number. Although LB as the supply chain owner did not need or plan to use the UCR (LB manages shipments at the PO level), project proponents believed that CEFM needed a unique shipment identifier that could follow a shipment from end-to-end across any number of shipper, carrier, and consignee organizations. The UCR was adapted from the World Customs Organization (WCO) guideline. The WCO definition of consignment is: The total number of items specified in the commercial contract between the supplier and the customer and transported in a single or in multiple shipments. Other aspects of the WCO guideline that are important in the CEFM use of the UCR include:

- The UCR must be created as early as possible in the supply chain.

- The UCR should be applied at the consignment level.
- The UCR must be able to uniquely identify data related to individual international trade transactions at both the national and international level for a sufficient period of time in accordance with national data retention rules.

For the LB supply chain in the deployment test, a consignment was usually defined as a PO, although sometimes there were multiple shipments against the same PO, in which case separate consignments were created. Per the WCO guideline, the UCR remained the same in CEFM for a consignment, whether the consignment was consolidated with others or split. However, CEFM was not designed to provide a sub-identifier for split consignments.

The UCR in CEFM is a unique 30-digit alphanumeric code that was automatically assigned by CEFM to each consignment when the consignment was booked by the manufacturer in the system. The UCR format uses the industry-standard DUNS number, and the ISO Country Code as shown in the diagram in Figure 16. Note, this figure displays the UCR's original 33-digit format. ODW's existing system could only accommodate 30 digits, so the unique number assigned by the manufacturer was shortened by 3 digits. This did not impact the test, since there were fewer than 1,000 completed consignments.

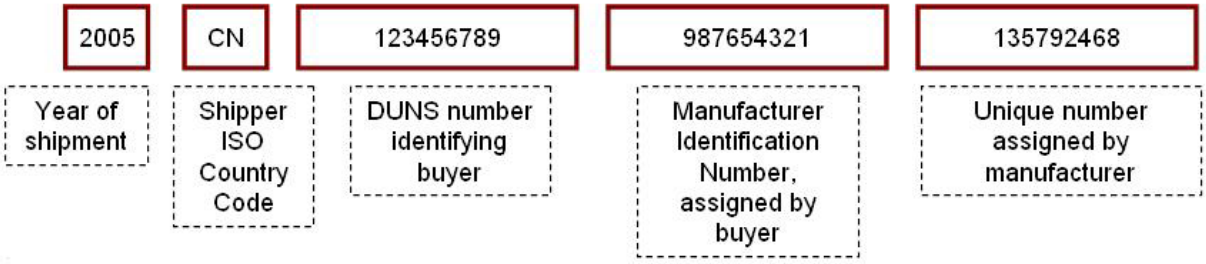

Figure 16. Unique Consignment Reference Data Element Structure.

There had been substantial interest expressed in the international data standards groups for including the UCR concept number in the CEFM test. Project proponents believed the CEFM's use of the UCR would serve as a proof of concept for data standards development within the ISO Supply Chain Data Dictionary (CD 24533) work group under TC204, and provide useful feedback to WCO and TC204.

Enterprise Service Bus

Another aspect of the CEFM architecture is the use of the Enterprise Service Bus (ESB). ESB applications are used to aggregate application servers. Application servers are used within the CEFM deployment test to host Web services, as they provide the environment in which Web services reside. While application servers are part of FIH, and thus, CEFM, they are not technically a "specification." Within CEFM, the ESB is part of the management layer of the SOA model used that brings together multiple application servers. Given that CEFM brings together multiple partners, the ESB is used to route service requests to the appropriate partner who is providing the information because it provides a single location from which to request information. The key benefit of an ESB is the centralization of various functions, such as performance monitoring, activity logs, and authentication.

The use of UBL, the UCR, and an ESB in the CEFM deployment test were vital in demonstrating how a network like the FIH and a subsystem like CEFM could be used across varying types of supply

chains and businesses. Using these standard languages, references, and servers were a critical aspect of the test in that their use may facilitate the adoption of a similar system by other supply chain owners with minimal modification to the architecture.

Shadow Database

Up to this point in discussing the CEFM architecture, the explanation has focused on how information is exchanged. The information source is another unique aspect of the system architecture. The information exchanged among the CEFM partners through FIH elements and CEFM architecture comes from each partner's legacy system. CEFM relies extensively on what is known as a "shadow database."

A shadow database is a separate data storage file that contained each partner's exclusive data within the CEFM deployment test, thereby protecting the partner's production data from the deployment test. The shadow database was largely populated automatically through either CEFM Web services message content, or from the partner's existing Information Technology (IT) system. Although manual entry input was allowed via the user Web interface for the manufacturer, or by the CEFM Deployment Team, this method only was used when automatic population was not feasible. Since the data population was automatic in most cases, CEFM provided near real-time data to the supply chain partners. The timing and information associated with each of the supply chain events was discussed in detail in section 2. Generally, the shadow database was populated by extracting certain data elements from a partner's existing system, which was more prevalent in the early stages of a consignment, while CEFM-based message content provided more information later in the consignment cycle.

Data from the partners' existing systems was provided in the multiple formats including comma-separated value (CSV) file. To maintain isolation from the partner's existing system, only data that pertained to the CEFM test was included in the file. For each partner, once this file was generated, it was copied to a file transfer protocol (FTP) location on each partner's Internet server. The CEFM database server hosted all shadow databases. The data for each partner's shadow database was either "pushed" from or "pulled' to the database from the partners' FTP location at regular intervals; thereby refreshing the shadow databases with new data files as they became available.

For data that was provided by CEFM messages, the process was nearly the opposite: first, a Web service requested a piece of information from one partner's shadow database; next, an XML message provided this information to the requesting partner or partners. Once the receiving partner's system had validated, extracted, and possibly combined this information with data from other partners, their shadow database was populated. These activities occurred automatically, and did not require any manual entry by the partner. For both automatic means of updating the shadow database, the CEFM server transferred the data to or from the shadow database. Depending on the partner, data and timing of the event as compared to the movement of the consignment, the data transfer to and from the shadow databases may also trigger a CEFM supply chain event such as the transmission of a robust message. CEFM relied largely on these automatic means of data exchange to populate the partners' shadow databases. The manufacturers who participated in the CEFM deployment test manually entered the information required for booking and tendering a consignment through their Web user interface.

In addition to allowing the manufacturer to record the number of cartons to be included in a consignment, the choice to include this in the design was a function of the unpredictability within the particular LB supply chain that was used. The demand along this supply chain is inconsistent and the trade quotas can change frequently. To avoid the effort and cost associated with generating the appropriate links between the manufacturers' IT systems, had the manufacturers changed mid-test, the developers created a generic shadow database for each manufacturer. These shadow databases were populated by the manufacturer through manual entry. Although it was not necessary to change manufacturers, this approach would have allowed for an easy transition had it been necessary.

While the air carriers did not have direct connectivity with CEFM, they each had a shadow database. The data source for the air carriers' shadow databases was not the individual airlines' existing systems; rather, the air carriers' CEFM shadow database would securely connect to FlyteComm, a third-party provider of airline tracking data for aircraft traveling in U.S. air space. FlyteComm would then provide the latest status information to the shadow database for use in the CEFM system. From this point, the airline shadow database would provide airline event data via Web services as explained above. In the true sense of CEFM partners, FlyteComm was the source of the airline tracking information available and viewed in the on-demand reports and status messages, since FlyteComm was the entity publishing the airline data in a CSV format to a secure FTP location for the shadow database to pick up.

The Evaluation Team had access to various data elements within each partner's shadow database, which were designed in MySQL format. The Deployment Team used MySQL queries to create three the following three types of logs for the Evaluation Team, which were then provided to the Evaluation Team weekly in Excel format:

- **Service Execution Log:** This log summarized all interactions (i.e., Web service requests and responses) between partners. This log helped the Evaluation Team assess all of the Web services that were requested and provided and the timing between the request and the provision of the information.
- **Message Log:** This log created a record of each robust XML message transferred by CEFM, including the POs, ASNs, status messages, and receipt and dispatch advices. This log was not as useful as the Service Execution Log, since the Service Execution Log provided visibility over these messages while also providing the response time and success or failure classification of the exchanges.
- **Consignment Events Log:** A MySQL query was created to generate a Consignment Events log. This log provided a complete picture of all activities taking place for each consignment in the CEFM test. Although this log first seemed to be the most useful, shortly after the test began, the Deployment Team began generating a "Pivot Table" of all consignments in Excel. This pivot table showed all end-to-end consignment data, including completed consignments. Essentially, this pivot table was a cumulative version of the Consignment Events log; thus, the Evaluation Team began to use this pivot table instead of combining weekly Consignment Events log. Specific evaluation activities pertaining to these logs are discussed in section 3.3.

The physical CEFM architecture is a complex assortment of components from the FIH. To summarize, the CEFM architecture was responsible for:

- Constructing XML schemas based on UBL standards.
- Implementing the UCR specification per WCO.
- Implementing an Enterprise Service Bus (ESB) to aggregate the application servers that hosted Web services.
- Facilitating the storage and analysis of the data stored in the partners' shadow databases.[18]

Figure 17 presents the physical architecture.[19]

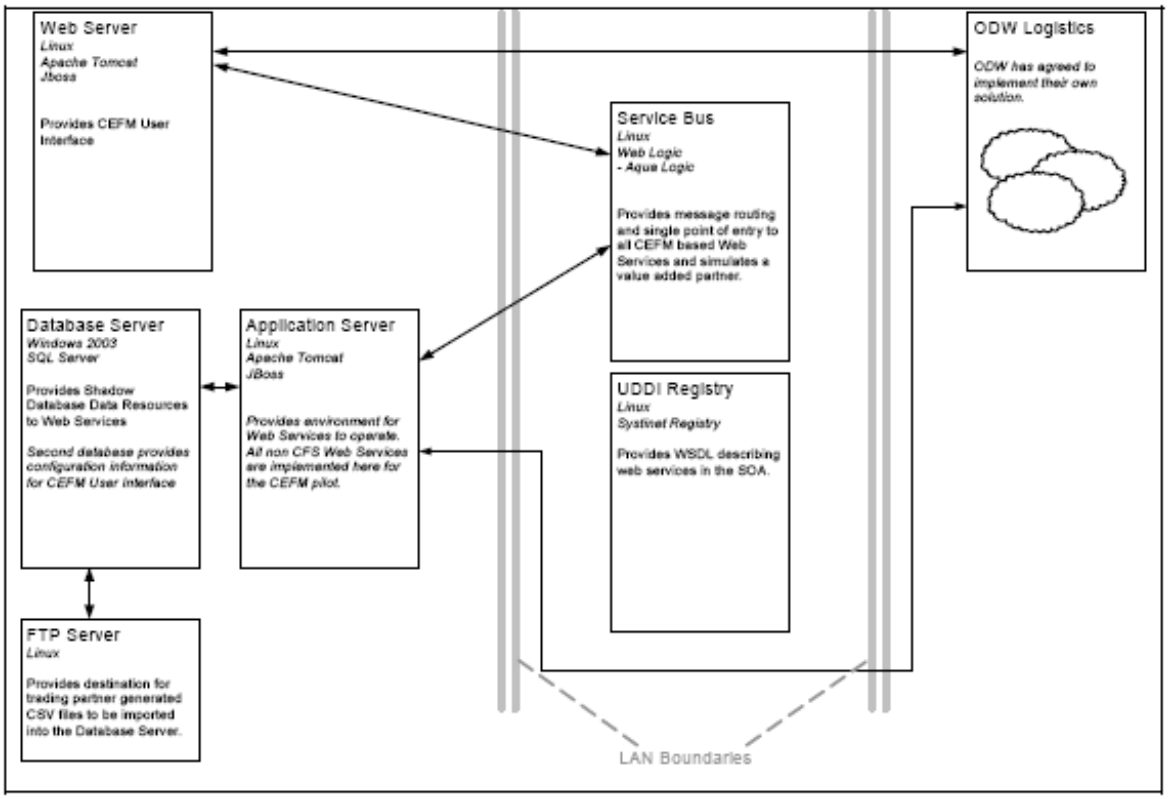

Figure 17. CEFM Physical Architecture.

CEFM User Interface Models

In discussing the use of the partners' shadow databases, various means of updating and transferring data between them were presented. The use of the shadow database varied among the different partners; in actuality, the CEFM system architecture can also be deployed in various ways. The key architecture behind the operation of CEFM, the FIH and Web services may be integrated with a partner's existing system; may be accessible through a Web portal without any integration; or may be partially integrated by interfacing existing systems through a shadow database. Each of these approaches is discussed in the following sections.

[18]Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 57.
[19]Ibid, page 89.

Fully Integrated Model

ODW was the only supply chain partner to be considered fully integrated with CEFM. Rather than utilizing the Web services as they exist and reside within the FIH, ODW implemented the necessary Web services and event data within its own existing IT system. Therefore, there is no need to have a shadow database; when ODW received a Web service request, the Web service could request or provide the information directly to ODW's own database, rather than polling a shadow database. For example, the EDI messages normally received by ODW were ignored for CEFM test shipments since the Web services they had implemented consumed the XML ASN from the forwarder and then populated ODW's database with this information.

The integrated model of CEFM deployed by ODW is considered to be the typical and most effective implementation of Web services today. The data within ODW's IT system was automatically populated and updated through CEFM's Web service; likewise, the capabilities of ODW's system (generating receipt notification and Receipt and Dispatch Advice messages) extended to the CEFM test. Thus, there was no need for ODW to have a Web-based user interface, although ODW staff was given access to LB's user interface they could view the messages and see the update screens as all the other partners were seeing them. ODW's use of the integrated model is discussed in more detail in section 4.2. Figure 18 shows the fully integrated CEFM model.[20]

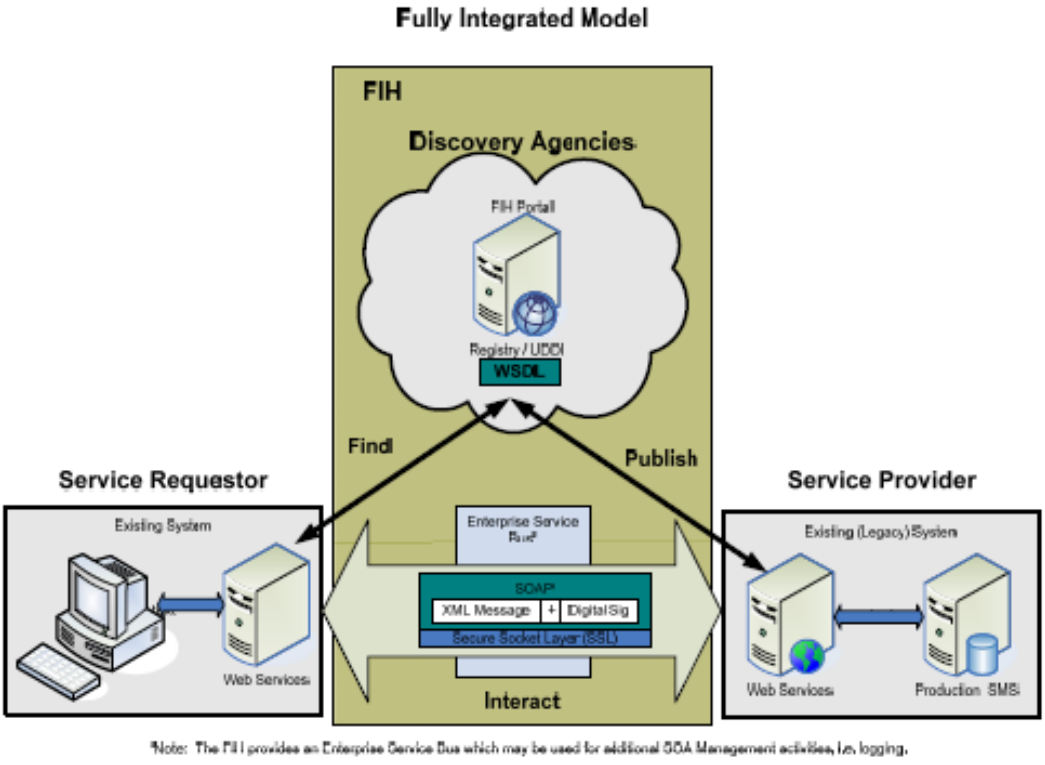

Figure 18. Integrated CEFM Model.

Hybrid Model

As described in the previous section, within the CEFM deployment test, most users had a shadow databases through which data extracted from their existing systems was provided to populate shipment

[20]Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 77.

status messages. In this hybrid approach, the data received from other partners was not integrated into the legacy system and the partner's existing system remained intact and isolated from the CEFM deployment test. The Web services and SOA were implemented on separate systems from the existing systems, with the shadow database acting as the link between the Web services, which transmitted the data and the existing system, which was the data source. The FIH components (XML messaging, security, Web services registry) were used in the transmissions of the messages. In this way, the FIH acted as a value-added network, since it was used to route consignment information and provide security over these transmissions.

This hybrid approach was developed to alleviate the supply chain partners' concerns over protecting existing systems. In actuality, this approach is not considered to be ideal for a long-term, mature deployment of Web services and an SOA. When a partner has not fully integrated Web services into its existing system, the partner does not have access to the CEFM data associated with the test consignments. The pros and cons of using shadow databases and the hybrid model in CEFM are discussed in more detail in section 4.2.

To provide these partners with visibility over the CEFM deployment test consignment events and data, the Deployment Team created a Web-based, password-protected user interface. This user interface is discussed in detail at the conclusion of this section. LB, HWL, Star, Barthco, and Forward Air all followed the hybrid approach to implementing CEFM and provided data to CEFM, but did not actually use CEFM data in their existing systems. Figure 19 shows the hybrid implementation[21] used in the CEFM test.

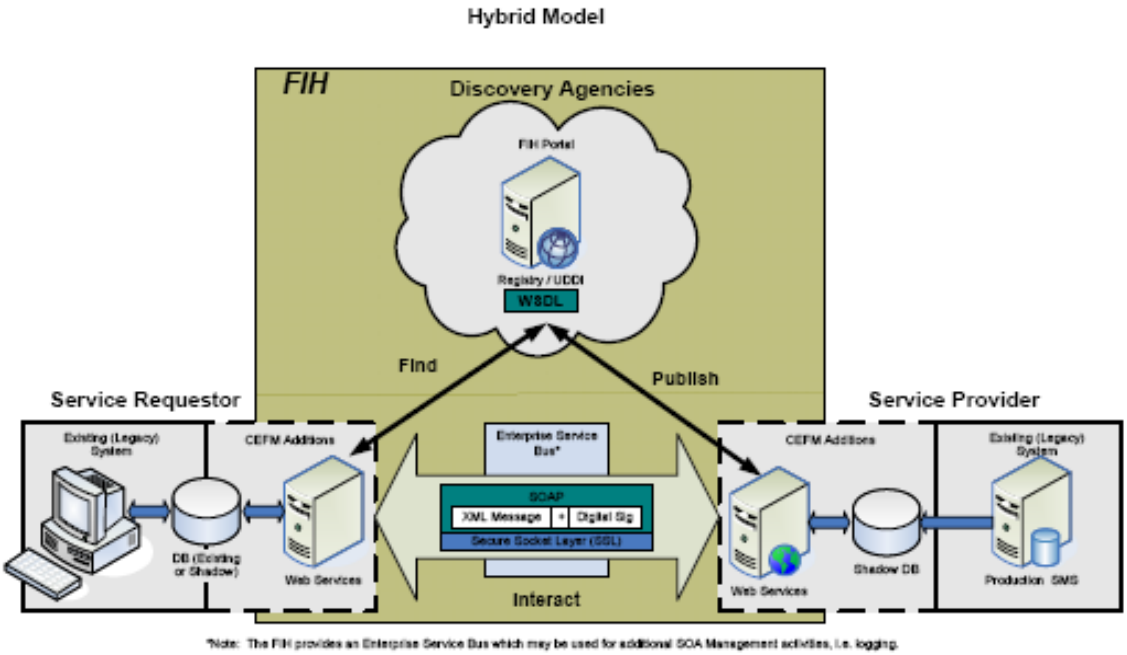

Figure 19. CEFM Hybrid Model.

CEFM Web Portal

[21] Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 79.

The four manufacturers used the CEFM Web portal to send and obtain status information. Unlike the hybrid model, where the shadow database acted as the interface between the FIH Web services and the partner's existing system, these functions (user interface, database, and Web services) all exist within the FIH. The manufacturer accessed the user interface only through the Internet. In this model, the FIH acted as a third-party host for the manufacturer's functions and data. The Web portal provides shipment visibility to users who have no other shipment management or visibility system. Figure 20 shows the portal models,[22] which visually illustrates the differences wherein the CEFM functions reside.

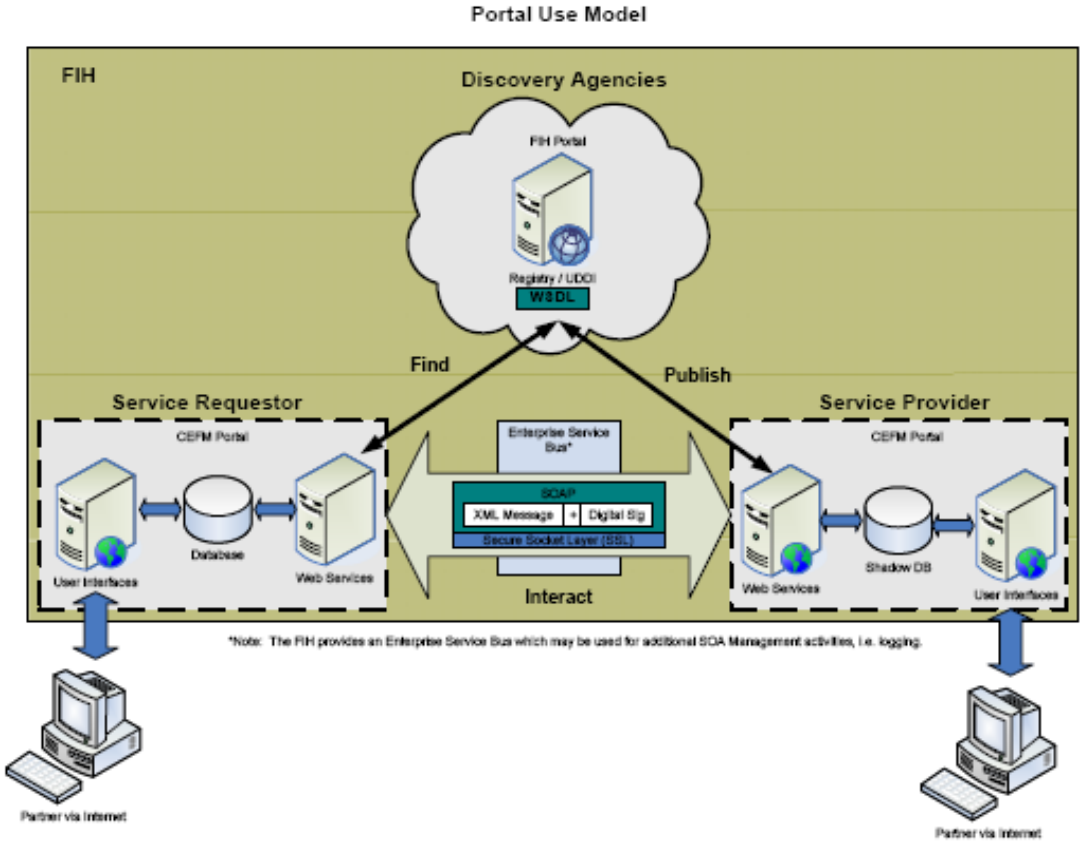

Figure 20. CEFM Portal Model.

Figure 21 shows the complete FIH network architecture,[23] including how each partner utilized the network (integrated, hybrid, or portal) and the CEFM test.

[22] Ibid., p. 78.
[23] Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 81.

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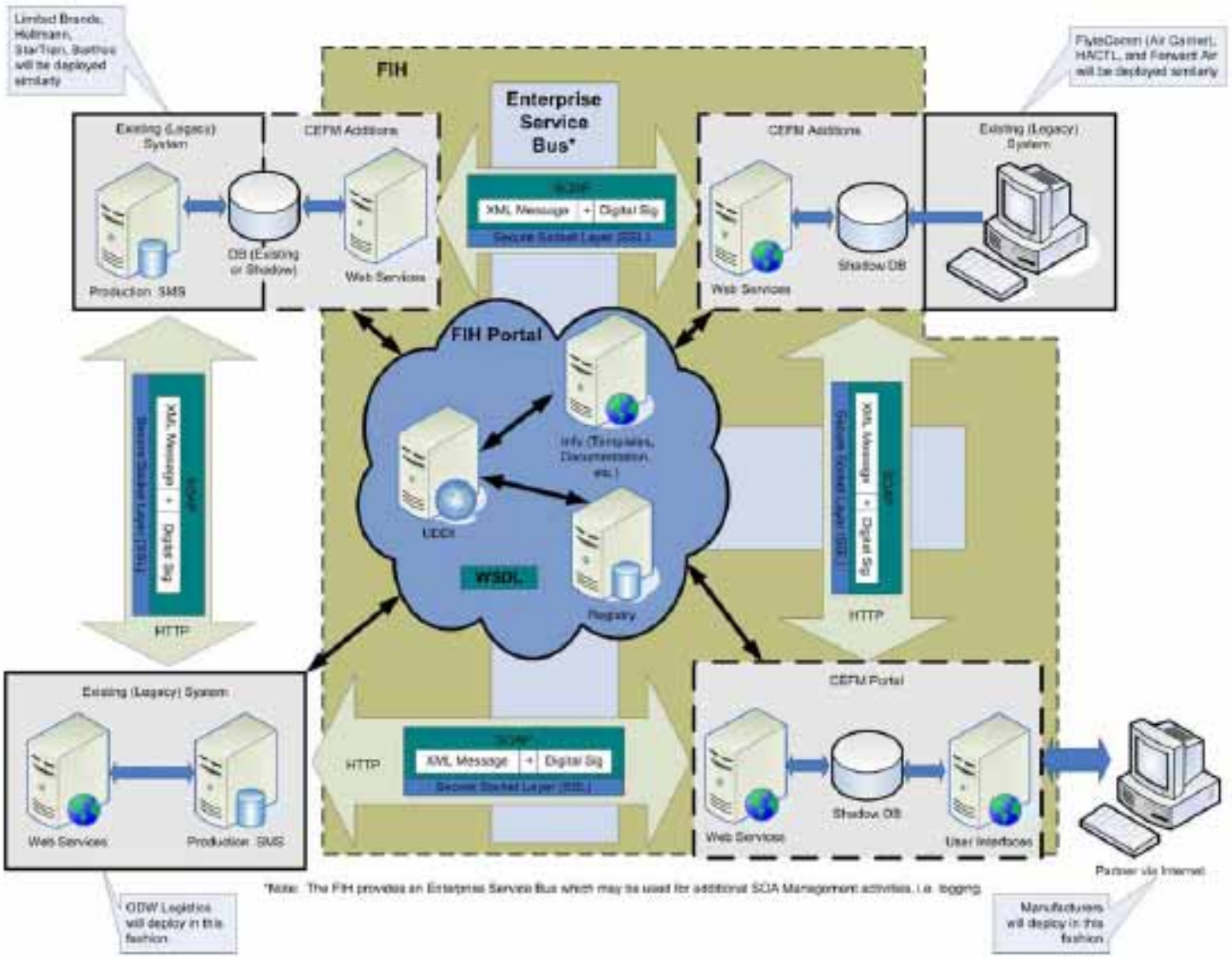

Figure 21. FIH-CEFM Architecture.

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CEFM Website

For the partners adopting the CEFM hybrid or portal models, a mechanism was needed for them to input data and view the status message, robust messages, and on-demand reports generated by the CEFM system. The CEFM Website provided this access, which was hosted on a separate CEFM server dedicated to this purpose. The user interface enabled the partners to view the robust messages, status messages, and on-demand reports discussed in section 2. As noted above, ODW also used this interface to view CEFM messages even though the data was integrated into ODW's system. In addition, the Evaluation Team was provided with a user name and password along with the URL to each partner's user interface so that the Evaluation Team could access the same data as the partners for evaluation purposes.

Although each partner's user interface varied slightly on the partner's role in the supply chain, the main menu upon system log in was essentially as seen in Figure 22. From this screen, the partner could view one of the on-demand reports under "Status Reporting" or view the robust message content under the "Messages" category. Samples status and robust messages are presented in section 2.

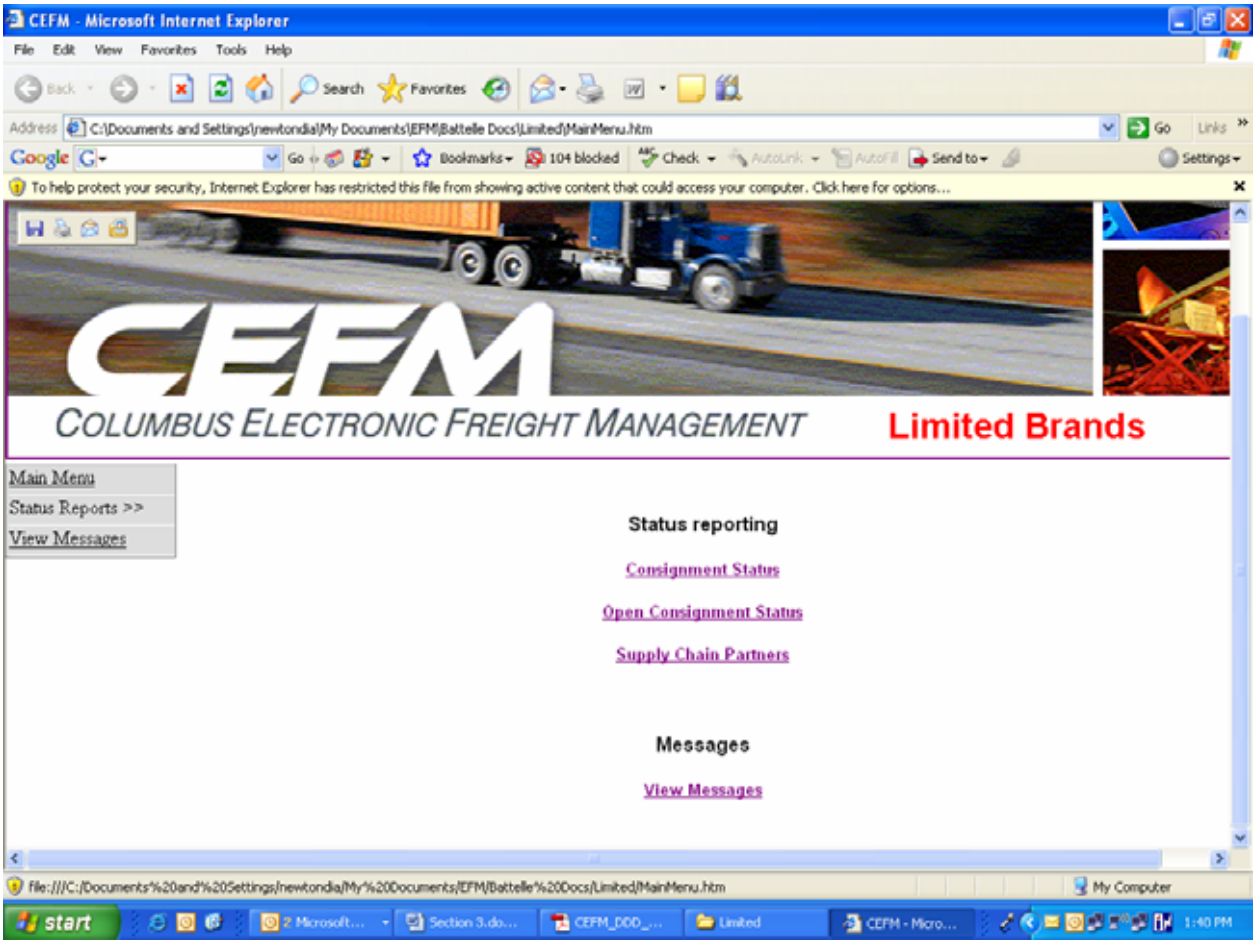

Figure 22. CEFM User Interface Main Menu (LB).

When selecting an on-demand report under "Status Reporting," a partner was prompted to enter a full or partial UCR, HAWB or MAWB number, though entering this number was not mandatory. If a

number was not entered, once the user pressed the "Submit" button, a full list of open consignments by PO and UCR number was displayed, from which a selection could be made as shown in Figure 23.

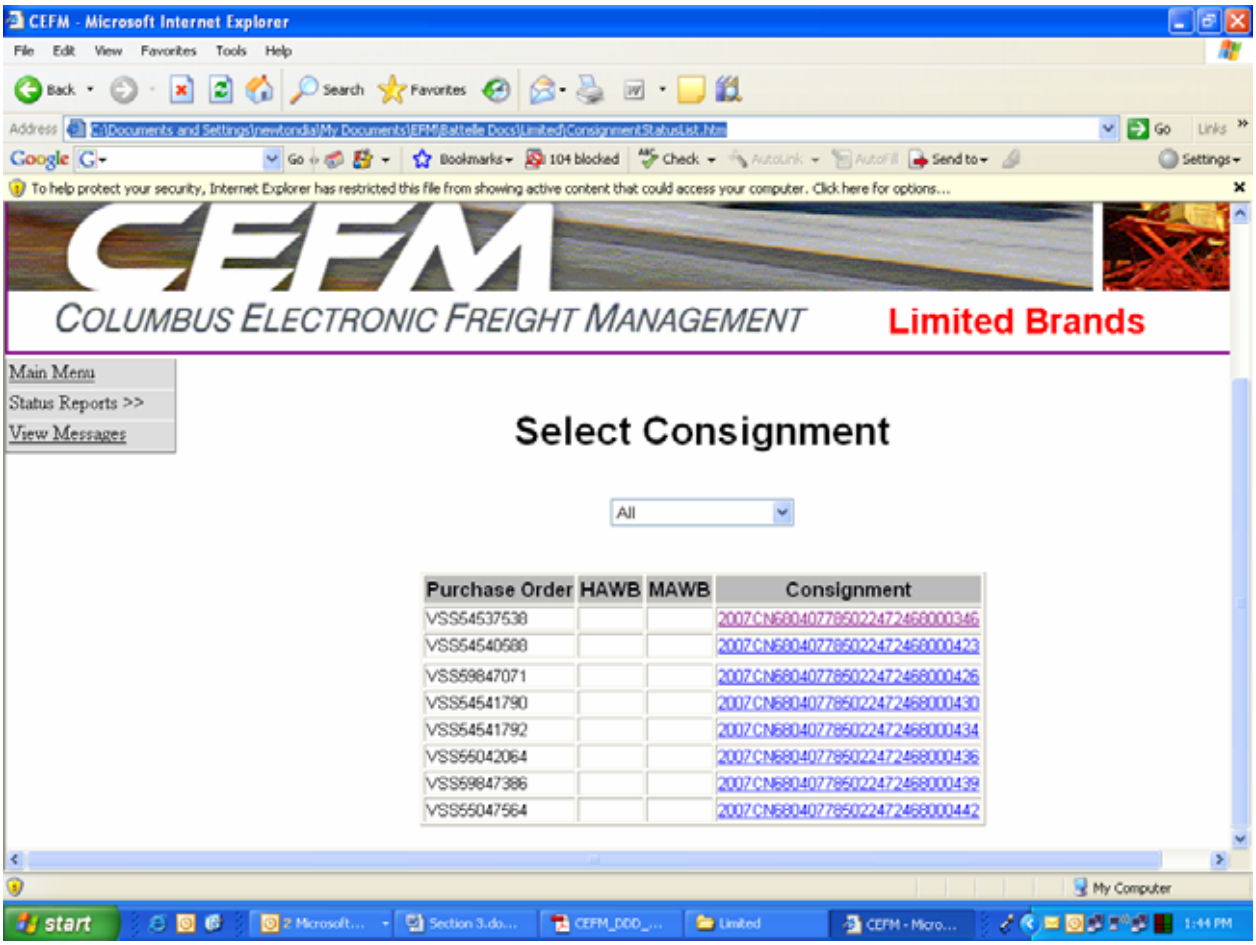

Figure 23. Selecting a Consignment for an On-Demand Report.

The on-demand report contents are generated from a variety of data contained within the CEFM architecture: data from the shadow databases; content from robust or status messages; and even content from other robust messages (for example, the OCR may draw from the Federated Status report). The OCR was the most extensive of the on-demand reports. Table 12 shows the various data sources for the data contained in the OCR.[24]

[24]Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 135.

Table 12. Data Source for the OCR

OCSR	
Column	**Source**
Consignment	UCR from consignment table
Origin Port	Constant = "HKG"
Forwarder	Consignment table via booking
MAWB	Consignment table via ASN
HAWB	Consignment table via ASN
Purchase Order	Consignment table via booking
NDC Date	PO table
Brand	PO table
Division	PO table
Factory	PO table
Cartons/Pieces	Consignment table via ASN
Weight	Consignment table via ASN
Cargo Received	Federated status
Documents Received	Federated status
ETA at Port of Entry	Consignment table via ASN
Actual at Port of Entry	Federated status
Documents to Broker	Federated status
ETA at CFS	Consignment table via ASN
Trans Days	Calculation
Port of Entry	Constant – "CMH"

When selecting the menu option "View Messages," CEFM returned a list of all messages received by that partner, as shown in Figure 24. When the user clicked on the hyperlinked number of messages, CEFM displayed a list of all messages by PO and consignment number. Next, the user selected either "XML" or "style sheet" in the desired consignment row to view the message content. A sample message content in style sheet format is shown in section 2.

Figure 24. Sample "View Messages" Screen.

For most partners, the main menu, status report, and view messages screen were consistent for all partners. As mentioned earlier in this section, the manufacturers implemented a portal model of CEFM, which required the manually inputting the booking and tendering information. Therefore, the manufacturer's main menu screen also presented the option to create a consignment (i.e., book the consignment) or update a consignment status (i.e., tender the freight). The manufacturer's main menu screen is shown in Figure 25. Note that these options to manually add information are presented under the heading "Modify Information in a Partner's CEFM Database." The manufacturers are the only partner to have this option in their user interface.

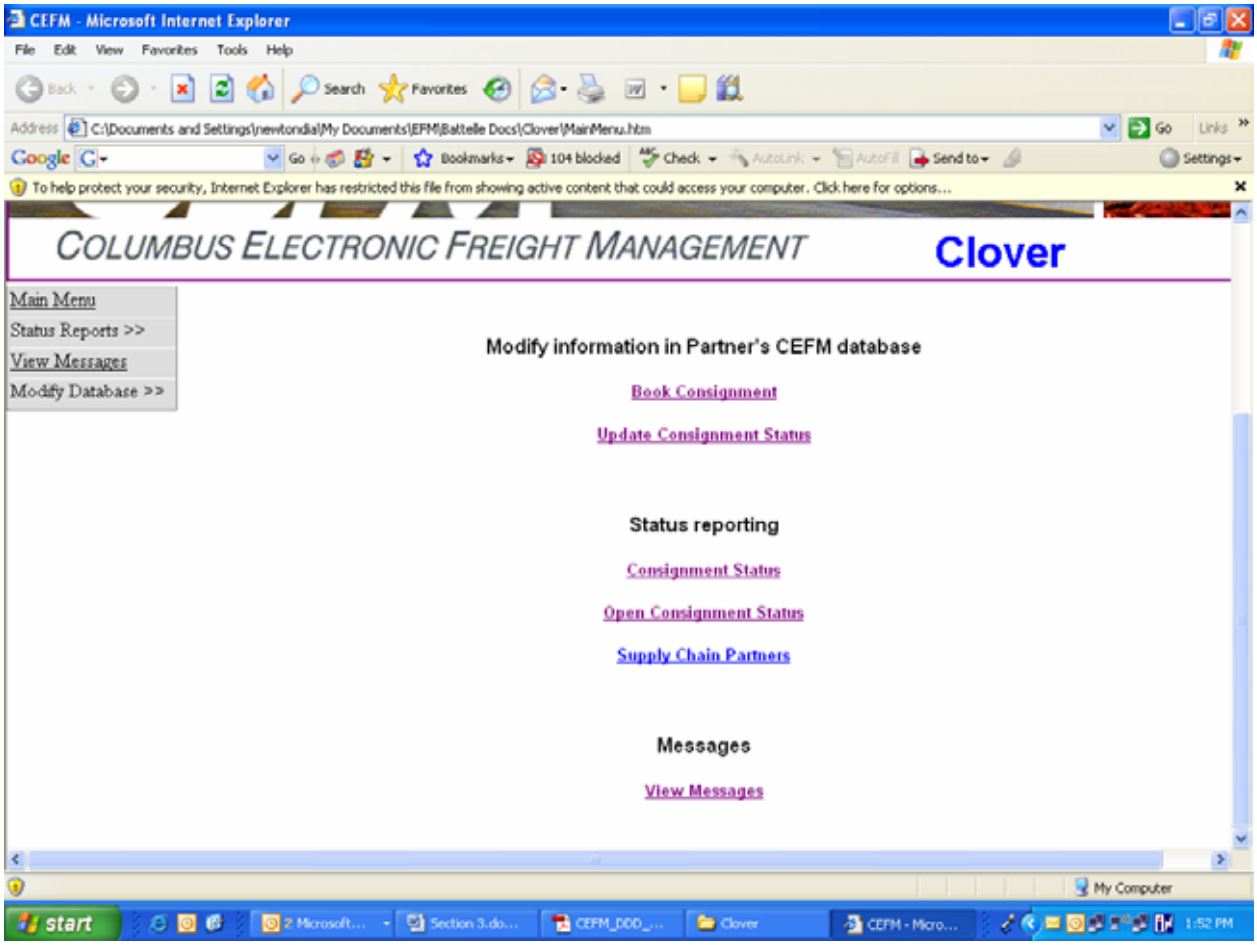

Figure 25. Manufacturer's Main Menu Screen.

Regardless of the type of CEFM model used by each partner, overall, the CEFM model provided the following functions to the supply chain partners:

- The hybrid and portal model required each partner to maintain a user name and password login to identify specific organization and supply chain role.
- Provided data storage capability to:
  - Isolate the partner's production system from the CEFM deployment test via a relational database (i.e., the shadow database).
  - Enable this relational database system to provide an individual shadow database for each partner and:
    - Was accessible through the Internet via standard and customized interface.
    - Utilized a schema specific to the partner data.
    - Stored inbound and outbound CEFM messages.
- Provided a secure location for partner data feeds by:
  - Implementing a secure file transfer protocol server (FTP).
  - Using a standard security feature of the FTP server.
- Implemented a user interface for each partner via the Internet that:
  - Permitted automatic assignment of the UCR to a partners' shipment record after booking.

- Provided the ability to conduct a status inquiry for a particular consignment (by PO number, UCR number, or HAWB/MAWB number).
- Provide the ability to locate and view CEFM-related messages (status and robust messages).

Table 13 summarizes the CEFM components used by each partner. [25]This table is useful in showing which CEFM elements came from the partner's shadow database; which were extracted or loaded from an existing system; and which were obtained by the partner through the Web-based user interface. Within this table, the column for the container freight station is highlighted because ODW integrated the CEFM components rather than maintaining a CEFM "presence" through a shadow database and user interface.

Table 13. Supply Chain Partner Presence in CEFM

Component	Buyer	Manufacturer	Freight Forwarder	Air Terminal	Air Carrier	Broker	Container Freight Station	Trucking Agent
Database Tables								
Purchase order	X	X						
Consignment	X	X	X	X	X	X		X
Consignment/shipment relationship			X				X	
Messages	X	X	X	X	X	X		X
Service log	X	X	X	X	X	X		X
Extract and Load Processes								
Purchase order	X							
Advance shipment notice			X					
Shipment status		X	X	X	X	X		X
Web Interfaces (GUIs)								
Create consignment		X						
Update consignment		X	X	X	X	X		X
Consignment/shipment relationship			X					
Open consignment status report	X		X			X	X	
Consignment status	X	X	X	X	X	X	X	X
Supply chain partners	X	X	X	X	X	X	X	X
View messages	X	X	X	X	X	X		X

System Test

The system test consisted of evaluating whether or not the partners' existing systems were providing data for the CEFM; that the CEFM was correctly receiving and copying the partner data into a

[25]Battelle and Transentric, *CEFM Detailed Design Document v. 3.0,* September 28, 2007, p. 91.

separate shadow database (except for ODW); and that the FIH was operating as required by using Web services to make the partner information available to other interested parties. The testing process took 2 days to complete, and consisted of the Deployment Team "moving" fictitious test shipments through the supply chain. Some of the movements included triggering test shipment events in the existing systems (such as creating and sending a robust message) and transferring the information between the partners' shadow databases as it would move during the flow of goods from China to Columbus. Special test databases and data were created and used for the system test. For those supply chain processes involving ODW (receipt, dispatch, and delivery to LB), ODW participated remotely from its site with a member of the Deployment Team present to trigger the events in ODW's existing system. In addition to the Deployment Team, individuals from the Evaluation Team and Adoption Strategy project were present, as well as representatives from USDOT.

The testing was conducted in various ways to test the functional, software, and business requirements. The Deployment Team logged onto CEFM through the user interface on one computer as each partner, such as the CEFM Website. There were multiple windows open in Internet Explorer, one for each partner, except for ODW, who does not use a shadow database. As a shipment's information was transferred between partners, the Deployment Team could verify that data entry, processing, and retrieval was functioning properly.

The user interface also helped to test the system's security and access control. For example, Star and HWL should only have been able to view consignments for which they were the forwarder. By logging on to each forwarder's user interface, the Deployment Team could verify that both Star and HWL were receiving the proper consignments. The user interface also allowed testing of evaluation and logging requirements by checking for specific event data and user input.

To test the data and database integrity, a second computer was logged on to each partners' shadow database to ensure the data was populating the shadow databases correctly; that there was no data corruption; and that the database was accessible and functioning properly. A third computer was used to trigger the supply chain events within the existing systems to populate the supply chain issuing POs and ASNs just as the partners' existing systems would do during an actual shipment. ODW's IT provider, CodeWorks, participated remotely and triggered sample ODW robust messages for the test (Receipt and Dispatch Advices).

This test set-up supported the test of 89 test cases. Each test case consisted of a:

- Location: was one of the partner types (buyer, manufacturer, forwarder, air carrier, customs broker, trucking agent, or container freight station).
- Service:
  - User interface (the partners' Websites).
  - Web services.
  - [Data] extraction and load, i.e., the extraction and load of partner data from proprietary formats to the shadow databases.
  - Event notification service, i.e., the triggers for the robust and status messages within CEFM.
  - File transfer service, i.e., the receipt of data from the supply chain partners
- Text description of the event (for example, load a set of POs from a sample data set).

- Test objective.
- Test steps.
- Verification method (inspection, analysis, or test).
- Resources (i.e., the workstations used to access the user interface or shadow database).
- Entrance and exit criteria (what, if any, information is required to be entered, and what verifies the requirement was satisfied).
- Expected data outputs, such as a user interface screen capture.
- Test case results – pass or fail.

Those test cases that failed upon first the test were subsequently retested on the second day.

The test cases were laid out in a specific order to correspond to the execution of the supply chain events, from the first event (loading a set of POs from a sample data set) through the final event (the CFS updating the discrepancy information) with the on-demand CEFM functions (federated status, OCR, and Request Supply Chain Partners) being tested at the end. After testing the supply chain events execution within CEFM, additional tests were conducted to test the CEFM architecture functionality for FIH components (Web services, UDDI, security such as the XML signatures, and the SOAP package) and CEFM components (use of UBL standards, specification of the UCR, implementation of ESB, access through user interface, shadow database criteria, and the creation of the Evaluation Team logs).

A few critical items emerged from system testing. First, it was noted that the Open Consignment Report would populate as designed, but the time to populate this information was excessive, between 2 and 5 minutes, with the times becoming longer as more consignments were completed. The extent of this issue was not known until the live system test began. Once the live system test was underway, it was evident to the Deployment Team that the time needed to return the OCR report information would grow longer as more consignments were initiated. Therefore, with USDOT concurrence, the Deployment Team changed the process by which the OCR was created shortly after the live system test began, which resulted in the OCR being returned in under 1 minute.

The second critical item emerged when the Deployment Team began testing ODW functions. While the ODW system was sending and receiving data as expected, it was cutting off the last 3 digits of the 33-digit UCR number. Since the last character in the UCR was the first unique number to change with each consignment, followed the second to last, third to last, and so forth, when these characters were excluded from ODW's system, there was no way to view the UCR. The only way to avoid this problem without redesigning ODW's existing system was to shorten the UCR from 33 characters to 30 characters; this did not adversely impact the test, since fewer than 1,000 POs were included in the test, and there were extra characters included in the original UCR structure. In addition, it was determined that most industry applications, including the widely used Department of Defense Transportation Control Number, use fewer characters. Data standards experts in industry were consulted before all agreed to the 30-character UCR number.

Following are the test case results conducted during the 2-day test in Columbus:

- 84 tested/completed (78 percent of total test cases).

- 79 of 84 passed (94 percent).
- The enterprise service bus (ESB) in the FIH went down the second morning for several hours, halting the test until the system was rebooted.
- FIH tests were not completed; these were completed by the Deployment Team during the following week and were successfully tested.
- Testing ODW's functionality was partially completed, since its system could not yet push or request functions because it was not operational within the ODW system at the time.

Live CEFM Deployment Test

The CEFM Deployment live test kicked off immediately following user training on May 29, 2007. The original live test was planned to continue until November 13, 2007 (but actually ended December 4, 2007) with a goal of providing visibility over 1,000 consignments from booking through delivery to the LB distribution center in Columbus. The starting point for a consignment in CEFM was that LB issued a PO meeting test criteria, which included the following:

- The PO was originated for either the Express or Victoria's Secret brands.
- The PO was sourced to one of the four manufacturers participating in the test (Regina, Clover, Esquel, or Kingmax).
- The transportation of the completed PO would be handled by either HWL or Star.
- The PO was scheduled for air freight delivery out of Hong Kong into Rickenbacker Airport in Columbus.
- The consignment was scheduled for breakdown at ODW in Columbus, who also provided delivery to the brand's Columbus distribution center.

A stored procedure within the LB legacy purchasing system recognized issued POs meeting these criteria. Once identified, the PO information was copied onto the LB's shadow database for consumption by CEFM. This triggered a Transportation Status message of "Purchase Order Issued" that was pushed to the manufacturer via Web services. Since the PO from LB specifies the brand, the manufacturer, and the forwarder, CEFM automatically makes the status available to the manufacturer and forwarder noted on the PO. From this point on, the system made assumptions that were developed from LB interviews to make the various status messages available to the correct partner:

- All consignments for the Express and Victoria's Secret brands out of Hong Kong were handled by either HWL or Star.
- HWL consignments from Hong Kong are exclusively transported on Evergreen Airlines.
- Star consignments out of Hong Kong are exclusively transported on Atlas Airlines.
- Barthco acts as the Customs broker for all Columbus-bound consignments.
- Forward Air transports the all CEFM consignments from Rickenbacker to the CFS.
- ODW acts as the CFS for all Columbus-bound consignments.

For example, when a Victoria's Secret PO was issued to Clover and Star identified as the forwarder, CEFM would then populate the remaining partners' shadow databases with the consignment

information: Atlas, Barthco, Forward Air, and ODW. Conversely, for an Express Brand consignment with HWL specified as the forwarder, CEFM would populate the databases of Evergreen, Barthco, Forward Air, and ODW. In actual test operations, some of these assumptions did not occur and this created problems in CEFM (see section 4.2).

The remaining data transfers in CEFM occurred as the consignment moved through the supply chain. This process and associated screen shots were detailed in section 2.3.

The goal of the live CEFM deployment test was to track approximately 1,000 LB POs that met the defined criteria through delivery to Columbus. The number of POs issued as part of the CEFM test far exceeded this goal; however, in many cases, the time difference between the PO's issue date and the date that LB specified the manufacturer must have the goods to the forwarder's consolidation facility in Hong Kong was more than a few days, and sometimes as long as a few weeks. The weekly and cumulative number of POs issued changed frequently during the test due to LB's periodic cancellation of certain POs for varying reasons. Once cancelled, the PO was sometimes re-issued under different PO number. Figure 26 shows the cumulative number of POs issued as part of the CEFM live test.[26]

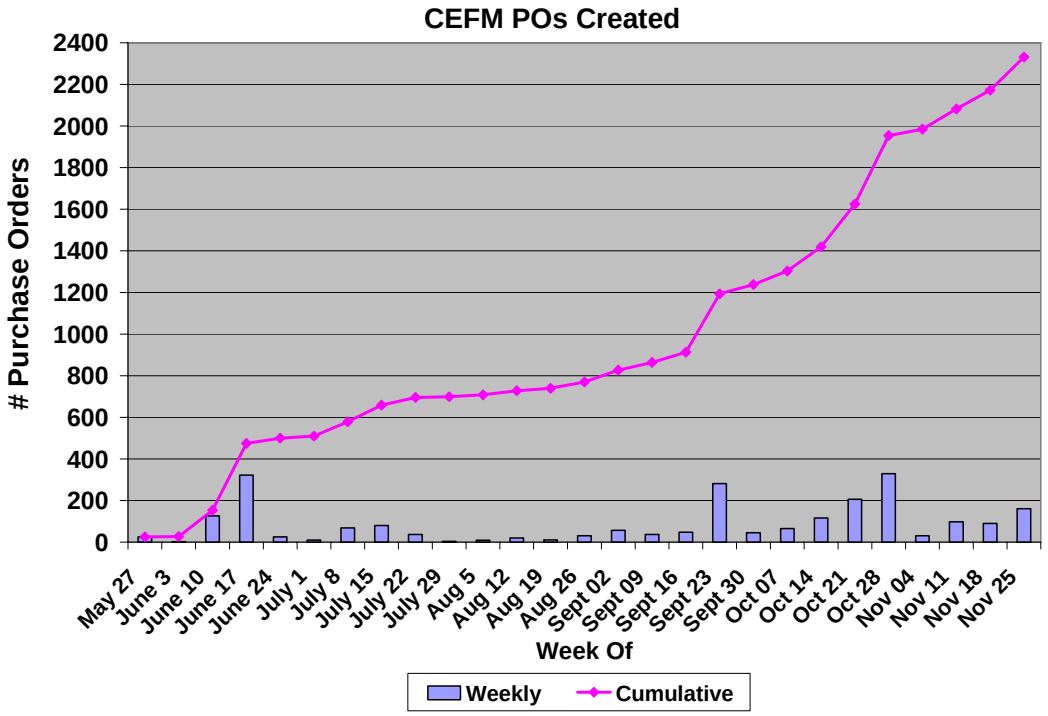

Figure 26. POs Created in CEFM.

When the test concluded on December 4, 2007, 871 completed consignments had been logged. Figure 27 presents the cumulative number of completed consignments along with the monthly total of completed consignments.[27]

[26]Battelle, "CEFM Weekly Status Report," from week of November 20 through December 3, 2007, page 2.
[27]"Completed Consignments Report," prepared by Battelle, January 4, 2008.

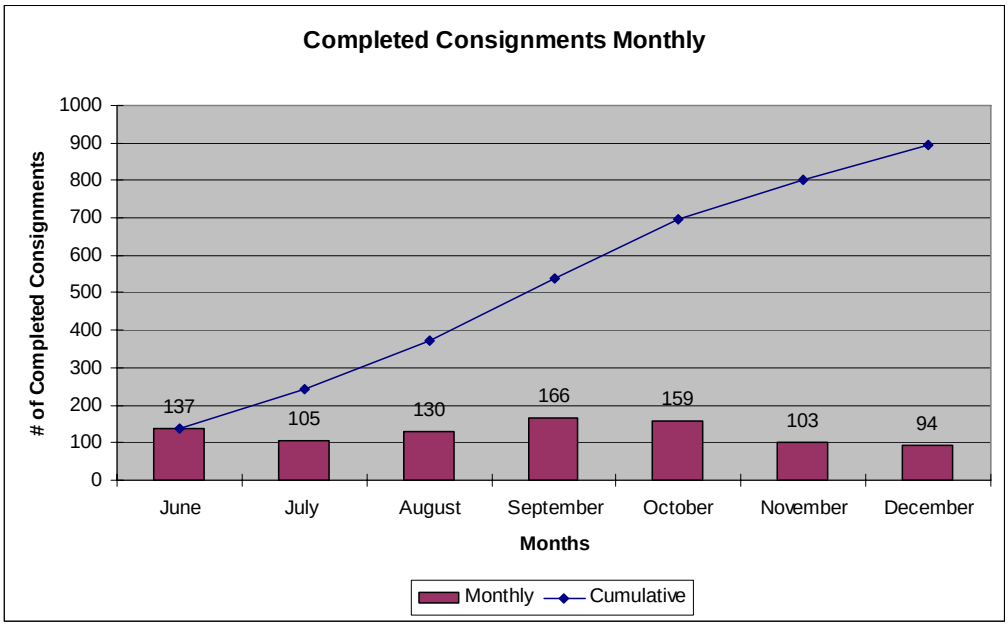

Figure 27. Consignments Completed in CEFM.

When the completed consignments were reviewed by manufacturer and forwarder, the majority of consignments were produced by two of the four manufacturers: Regina and Clover. Likewise, Star handled the larger percentage of completed consignments as compared to Hellmann (544 consignments versus 293, respectively).

In conducting interviews with LB, this percentage completed is consistent with historic shipment patterns. The bulk of the POs issued during the test period were for the Victoria's Secret brand: 802 versus only 67 for Express. The Victoria's Secret POs were 14.94 percent of the total Victoria's Secret from Hong Kong, while the Express test POs were only 2.78 percent of the total from Hong Kong. The Victoria's Secret brand is predominantly produced by Regina and Clover.

In terms of the forwarders, while HWL is a larger, global forwarder, Star typically handles a larger percentage of LB's freight into Columbus. Figure 28 and Figure 29 show the breakout of completed consignments by manufacturer[28] and forwarder, respectively.

[28] "Completed Consignments Report," prepared by Battelle, January 4, 2008.

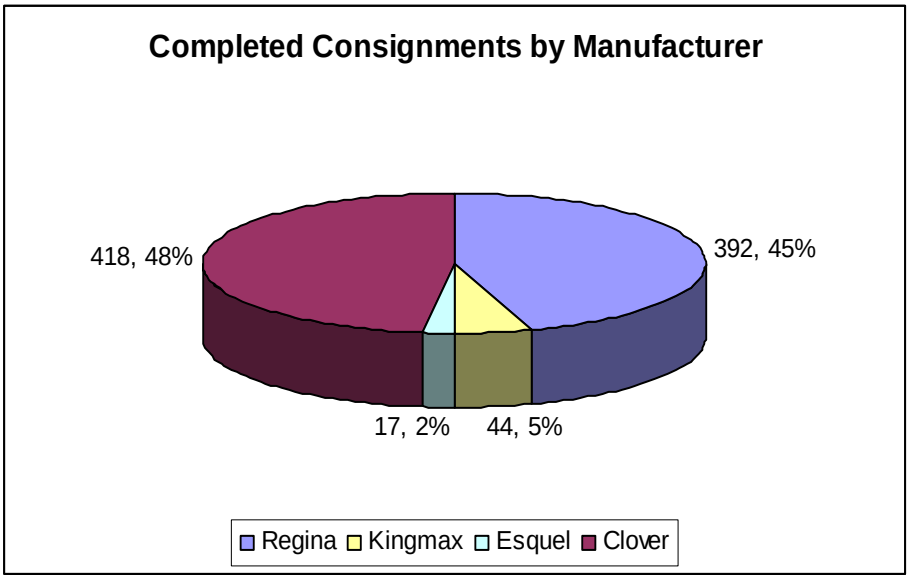

Figure 28. Completed Consignments by Manufacturer.

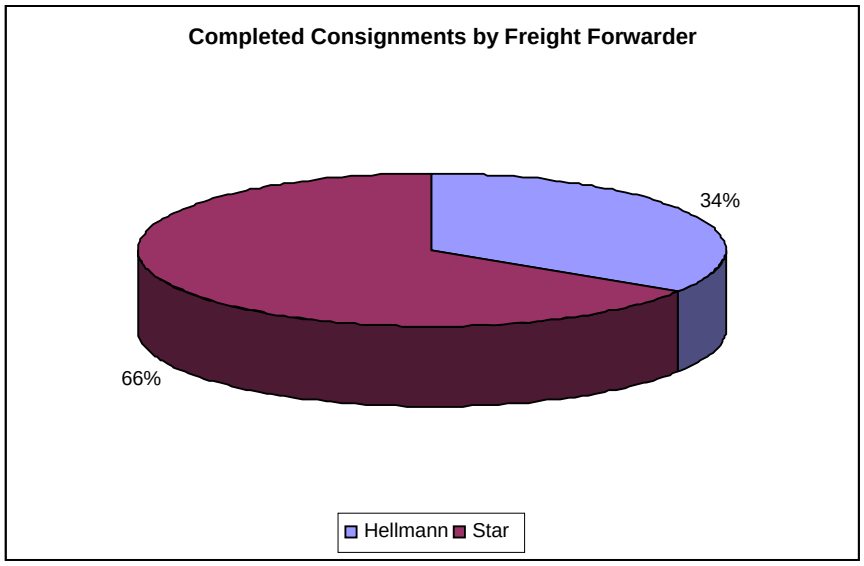

Figure 29. Completed Consignments by Forwarder.

LB and its partners estimated that CEFM consignments constituted about 10 percent of the total shipments from Hong Kong to Columbus. LB provided data to the Evaluation Team that showed there were 12,383 shipments from Hong Kong during the test period, which is 7.03 percent. Star's CEFM test shipments were 14.08 percent of Star's total from Hong Kong, while Hellmann's were 7.49 percent.

Test Limitations and Errors

System Errors

Once the test began, the deployment and Evaluation Teams began to review the archived data within the partners' shadow databases (mainly through the pivot table) and log on to the partners' user interface (mainly LB's, since it provided the widest view of the supply chain events). The first group of system issues was noticed as soon as the first consignments arrived in Columbus. For nearly the first month of the test, there were few, if any, ODW data entries. In reviewing the baseline data flows, it appeared that the ASN always was sent before the pre-alert, and with partner agreement, the Deployment Team designed CEFM around that assumption. In actuality, the pre-alert would occasionally arrive before the ASN. This order of events was preventing the ODW data from receiving the UCR, thus generating the CFS receipt status, and the corresponding robust messages (the Receipt and Dispatch Advices).

Within the CEFM architecture structure, one supply chain event triggered the next; however, within the pre-CEFM supply chain, there were additional data flows such as the pre-alert, which was sent by the Hong Kong forwarders to ODW, the Columbus forwarders, and LB.

For non-CEFM shipments, when ODW received the pre-alert prior to the ASN, ODW staff manually entered the shipment information into its existing system, and then proceeded to process the data according to pre-CEFM supply chain procedures.

In CEFM, ODW's receipt of the XML ASN would trigger its Symphony system to consume the message and add the UCR number to its database, thereby identifying the consignment as part of the CEFM test and then generating receipt and dispatch advice messages. When the pre-alert arrived before the CEFM ASN, ODW had no method to detect that the shipment was part of the CEFM test, and if the ASN had not been received, its staff would process the consignment according to pre-CEFM supply chain procedures. Therefore, when the pre-alert message arrived before the CEFM ASN, ODW's system would discard the message and then no Advice messages would be generated.

The only way to correct this problem was for ODW to receive the CEFM ASN before the appointment was made for the consignment to be processed at ODW. To correct this issue, the Deployment Team tracked the ASNs by receiving and reviewing the pre-alert and DSR worksheets from the forwarders. The Deployment Team next identified the CEFM shipments and notified ODW's CEFM point of contact via email that the CEFM ASN was to be expected. This procedure was done every few days, which helped to correct the problem for the test period. In an operational environment, however, the triggers within CEFM would need to be adjusted to ensure that the pre-alert/ASN error would not occur.

In addition to this issue, there were some operational issues within ODW that affected the system turn on, as ODW was not fully operational, but sending robust messages and status messages on a regular basis until mid-June. These issues were corrected by CodeWorks, ODW's contracted IT support.

PO Issues

The second major group of issues was related to the POs. One example of a PO issue occurred when LB modified or cancelled POs. LB sometimes modified the due dates for the consignment to be

received by the forwarder's consolidation point in Hong Kong (known as Goods at Consolidator date, or GAC date) and the date for the consignment to be received "In Distribution Center" (NDC date) in Columbus. When LB issued these changes, sometimes the consignment had already been booked in CEFM, and CEFM would not be able to pick up these changes and edit the GAC or NDC dates in the system. There were other issues related to POs that were cancelled, such as when LB drops a PO from its system once the GAC date has expired. However, once the PO was issued by LB and booked by the manufacturer, the PO existed within CEFM and was not deleted. The Deployment Team had to change the "rules" within the CEFM design specifications to denote when LB must stop providing information about a specific PO by extending the time to the GAC date plus 48 hours.

Another PO-related issue occurred when the LB changed the freight forwarder name specified on the PO. When this occurred after the GAC date and the manufacturer had already booked the consignment, there would be no record of the consignment in CEFM after the manufacturer tendered the freight. This happened because CEFM was populating CEFM with forwarder, airline, and the Columbus partner data from the original PO information in CEFM. This issue was corrected by running a query within the LB's and manufacturers' shadow database, which checked the forwarder on each partner's version of the PO; if the query revealed two different forwarders on the partner's PO, the query instructed CEFM to identify the forwarder from the LB shadow database rather than the manufacturer's database. This query was run daily.

Manufacturer Issues

The third group of issues related to the manufacturers' use of CEFM. The manufacturers were the only partner to manually enter its data. Sometimes the manufacturers would book and tender the freight anywhere from 1 to 7 days in advance of the GAC date. When LB would subsequently change the GAC date after the booking had been made, there was no method to remove the consignment from CEFM and update the PO.

Occasionally, the manufacturer would neglect to tender the freight after booking, either because the manufacturer had received word that the PO was cancelled, or the manufacturer's staff simply forgot. To avoid this issue, the manufacturers sometimes entered a date and time for tendering in the future, and some selected a standard time on the day after booking. In this case, this method of entering the tendering date/time caused inaccuracies in the CEFM data. For example, if the GAC date had changed, but the manufacturer had already entered a standard tendering time, the CEFM data would reflect that the cargo had been received by the forwarder in Hong Kong prior the cargo being tendered by the manufacturer. Figure 30 shows an example of a transportation status where this anomaly occurred.

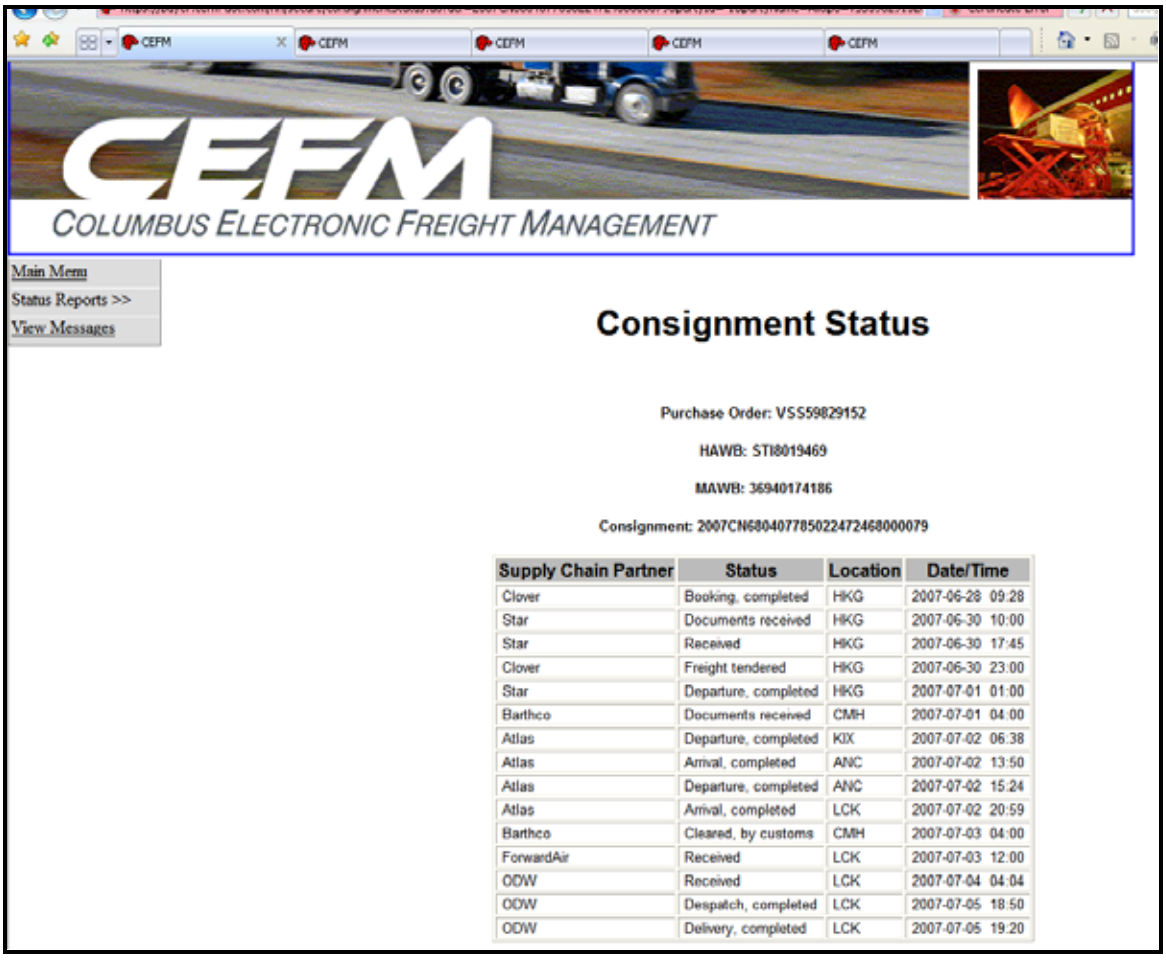

Figure 30. Manufacturer Tendering Error.

All issues related to the manufacturers' manual data entry were resolved through continuing communication with the manufacturers on the proper system. This communication provided "instructions" on making the booking and tendering only 48 hours prior to the GAC date (to correspond to the "rule" previously described above), and offered guidance entering the actual time of freight tendering as opposed to an estimated or future date and time.

Freight Forwarder Issues

The fourth group of issues related to the freight forwarders in the CEFM test. The first issue that occurred was that some consignments were missing all air carrier status data. The visibility over these consignments would resume within CEFM once the cargo arrived in Columbus. When the Deployment Team investigated these instances with the freight forwarder, they discovered that the forwarders used other airlines besides Atlas and Evergreen for consignments meeting the CEFM criteria (this error and its consequences are discussed in more detail in section 4.2).

Frequently, when manufacturers' staff reviewed the OCR and message logs, the consignments were missing the robust ASN message. After interviewing both forwarders, the Deployment Team worked with FlyteComm to add Kalitta (the most common other airline used) to CEFM by creating a Kalitta presence with shadow database. As it did with Atlas and Evergreen, FlyteComm actually provided the data to CEFM. Likewise, once the forwarders were made aware of Kalitta being added as an air

carrier within the CEFM system, they would send the ASN as normal. These modifications largely resolved this issue, although there were still some instances of the forwarders using United Parcel Service (UPS) or Federal Express (FedEx) for extremely time sensitive consignments, however this was a very small number of consignments.

Additional missing ASNs were attributed to the issue of modifying or dropping POs by LB – this would trigger a missing ASN because the manufacturer would not tender the freight (if the PO was modified or cancelled). Missing ASNs also occurred if the freight forwarder was changed from what was listed on the POs, which would cause the tendering data to be submitted by CEFM to the forwarder on the original PO, rather than to the forwarder on the updated PO who actually moved the freight.

Similarly, Star would also sometimes deviate from the LB supply chain assumptions by using an Atlas charter flight into New York's JFK International Airport. CEFM was tracking this activity. While the Deployment Team expected all final arrival information to be tracked to Columbus, there were shipments with a final arrival code of JFK. For these consignments, the shipment would "disappear" (i.e., have no data after JFK arrival) from CEFM until it was received by ODW in Columbus. Upon further investigation with the forwarders, the Deployment Team discovered that JFK was a legitimate destination, and the CEFM design was modified to correctly capture all events associated with Atlas flights into JFK, with the exception of Forward Air, since this entity was not the trucking company used to transport the shipment from JFK to Columbus. Additionally, a small number of consignments were booked with a non-CEFM forwarder, Speedmark. For these consignments, there was no further information associated with the consignments after they were tendered by the manufacturer. No adjustments were made within CEFM to account for these instances; however, Speedmark did account for a small number of consignments.

The preceding cited issues affected a large percentage of the 871 completed consignments (more than 43 percent were missing ASN data). For some issues, such as missing ODW information or missing ASNs, the Deployment Team was able to modify the archived shadow databases (and the pivot table) using information from the pre-CEFM tracking information (pre-alerts or DSR), or from information contained within a partner's existing system specifically, ODW. These actions provided a more complete view of each completed consignment for both the Evaluation and Deployment Teams.

Table 14 and several of the subsequent tables and figures are drawn from an analysis of data anomalies performed by the Deployment Team and included in Appendix B. Table 14 summarizes the range of issues presented herein, including the various causes of major problems like missing ASN data. It should be noted that more than one issue could affect an individual consignment.

Table 14. Summary of CEFM Errors

Error		Number of Instances
Missing ASN Data	Kalitta	153
	Mfg operational issue	129
	FF Changed	61
	UPS	35
	Total	378
Unknown		187
Early System Issues (ODW not operational)		92
GAC and NDC Date Changed		81
Early Booking and or Tendering		49
Speedmark		34
JFK International Airport		31

For items listed as "Unknown" within Table 14, Table 15 identifies the reasons associated with these errors. CEFM, as any IT system, encountered occasional system outages. Likewise, many of the supply chain partners' existing systems encountered similar unplanned outages. By design, CEFM relies on the partners' existing system to send the appropriate data to the shadow database, or in the case of ODW, resides directly within the partner's system. When the partners' existing system experienced an outage, CEFM could not exchange data during this time. The majority of "Unknown" system errors were caused by these outages, although a small number of consignments (47) experienced an error that could not be traced back to a specific reason.

Table 15. Summary of "Unknown" Errors

Error	Number of Instances
Missing ODW data	26
Missing Forward Air data	56
Missing Air carrier and Customs data	19
ODW System downtime	15
Missing Forward Air and ODW data	24
Total	140

Figure 31 shows the relationship between the specific errors to the total percent of errors. Known as "Pareto analysis," this method identifies how many errors of each type make up the total percentage of errors.

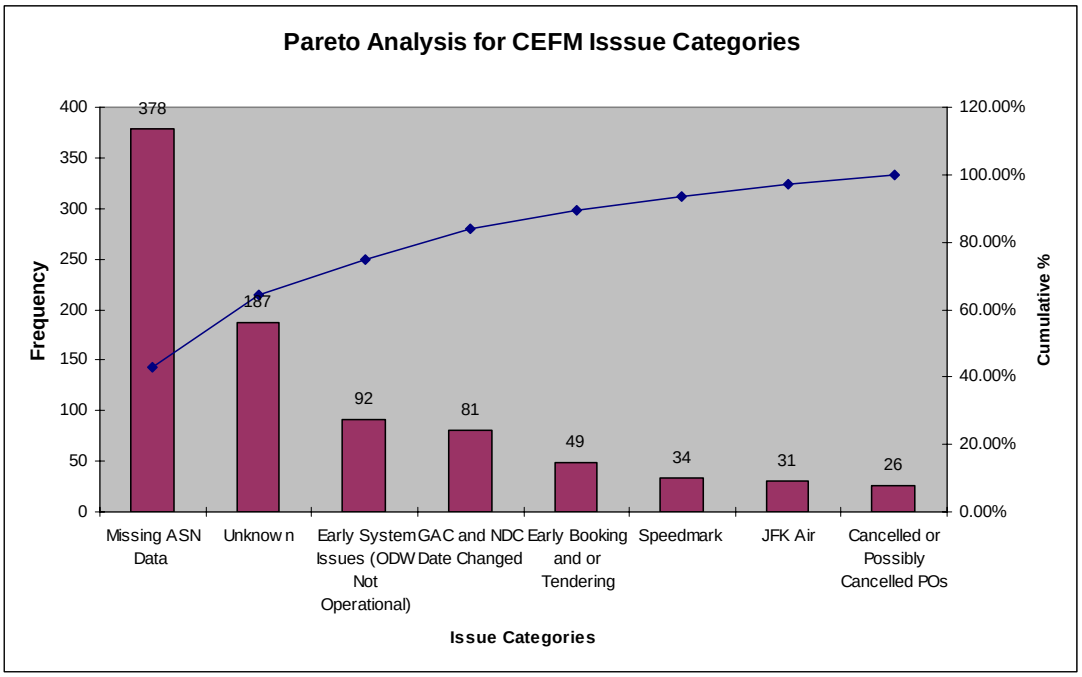

Figure 31. Pareto Analysis of CEFM Errors and Anomalies.

The impact of these errors on the partners and on the archived data within MySQL is discussed in section 4.4 in the Study Results.

3.3. EVALUATION TEAM ACTIVITIES

Four sets of evaluation hypotheses were defined for the CEFM deployment test and approved by USDOT in September 2005. The four categories of hypotheses, along with an accompanying objective and learning outcomes, were included in the CEFM Evaluation Plan and Detailed Test Plans, and are presented in Figure 16. The Evaluation Team defined a series of measures of effectiveness (MOEs) for each hypothesis, which became the basis for evaluation. Data sources were defined in general terms to indicate where baseline and CEFM system information supported the testing of the MOEs. The data sources included automated data outputs from the partners' existing logistics management systems; partner interviews; CEFM system data; and observations of the CEFM user interface.

Wherever possible, actual before and after (with or without) operational data was collected and analyzed to determine CEFM's effectiveness. The analysis was supplemented as required to extrapolate from the data and to perform qualitative analyses of improvements. Section 4 describes the various methods of quantitative and qualitative analysis, and the outcomes of these analyses.

Table 16. CEFM Evaluation Objectives and Learning Outcomes

Title/Section	Objective	Learning Outcome
System Usefulness	Assess CEFM system usefulness in terms of participants' perceptions regarding the system's ability to improve their daily operations and whether CEFM represents an improvement in their IT environment (improved information quality and flow).	• Will the technologies tested in CEFM be used by the private sector participants? • Can the advantages of using the technologies be seen by the participants?
Cargo Visibility	Assess the ability of CEFM to improve cargo visibility in terms of more actionable (complete, accurate, and timely) cargo location and status information for public and private sector participants.	• Does CEFM improve the visibility of the supply chain being tested? • Is improved visibility data useful to both private sector and public participants?
Supply Chain and Logistics Performance	Assess CEFM's ability to improve supply chain and logistics performance by reducing supply chain costs, shipping delays, cargo clearance times, or to improve overall levels of partner coordination and ultimate customer satisfaction.	• Do the CEFM technologies improve the performance of the supply chain and of the operations conducted by the various participants? • Are there measurable public benefits from the performance improvement?
Deployment and Scalability (from CEFM to EFM)	Assess deployment scalability (CEFM to EFM) through participant willingness to integrate the EFM concept into their overall IT environments and establishment of a business case demonstrating the public and private sector value propositions.	• Will the participants and other industry organizations adopt the CEFM technologies? • Will there be a positive benefit to cost ratio and related public and private benefits?

The CEFM design and development activities began in August 2006. The "before" data was collected prior to start of the test and CEFM system data was continuously collected during the test period. The post-test evaluation period began in earnest in December 2007, and concluded in March 2008.
The remainder of this section describes the evaluation activities in detail as they were executed during each test phase (pre-test, test, and post-test).

3.3.1. Pre-Test Activities

The Evaluation Team's involvement in the CEFM deployment test began in mid-2005. During this time, the system Deployment Team was working on the CEFM system design. The Evaluation Team participated in these design reviews, which were held in Columbus, and began to develop the evaluation hypotheses. Since the supply chain partners and USDOT also participated in the design reviews, these meetings provided the Evaluation Team with the opportunity to meet the supply chain partners and document each partner's baseline supply chain data flows as recorded in section 2. In addition, being involved in the early design reviews allowed the Evaluation Team to review and comment on the CEFM Concept of Operations and Detailed Design Document draft documents. These documents provided the design specifications that were critical for the Evaluation Team to obtain a detailed understanding of the technical relationship between the FIH and CEFM architectures. The system design process lasted until April 2007.

During the time that the system design was being completed, the Evaluation Team conducted interviews with key supply chain partners in Columbus on December 13-14, 2005; January 8, 2006; January 11, 2006; and December 13-15, 2006. These interviews helped the Evaluation Team to document the baseline data flows (both format and content); develop process flow documentation; identify key data users and providers; and discuss the partners' current IT infrastructure. These results were documented in the Final Evaluation Plan, which contained the finalized hypotheses for the CEFM Evaluation, and was approved by USDOT and published in January 2007.

As discussed previously, the CEFM system testing was held in Columbus at Battelle from May 7 through May 9, 2007. The tests and discussions included review and explanation of the event and message logs that were available to the Evaluation Team throughout the deployment test. The Evaluation Team's presence at the system testing enabled discussion about the information that was provided and the form in which the data was provided.

Test participants discussed the anticipated improvements from CEFM, including the likelihood using the CEFM information by the various partners. There was concern that CEFM does not provide users with enough logistics-related information and tools to be able to aid in logistics decision-making. One recommendation accepted by USDOT is that status information in CEFM be retained and then used with an ad hoc report generation program. Similarly, the USDOT representatives were concerned about the lack of logistics management tools in CEFM; such tools could assist partners in resource planning, asset management, reducing a shipments time in the supply chain, and so forth. There was concern that without such tools, CEFM would not be able to support logistics planning and would, therefore, be less likely to be adopted by industry. This issue was one that was re-visited throughout the deployment test, and is discussed in detail in section 4, along with other deployment test lessons learned.

Following the CEFM system test, the Deployment Team conducted training at each supply chain partner's location, both in Hong Kong and in Columbus. Each partner had its own training session, which lasted between 2 and 4 hours. The Evaluation Team was able to participate as observers at the training conducted by the Deployment Team from May 22 through May 24, 2007 at five of the local Columbus partners: Forward Air, Barthco, Hellmann, Star, and The Limited Brands. The training session began with a brief overview of the CEFM project and system, and then moved to a live demonstration of the partner's user interface. Participants were trained in how to view consignment status; request a Federated consignment status; request an Open Consignment Report; and view the partner's message logs.

Throughout the training session, the participants discussed the anticipated benefits/improvements from CEFM, and detailed their current or "before" processes as they related to the information contained within CEFM. This was extremely helpful to the Evaluation Team in documenting the baseline processes and data sources. The Deployment Team was flexible in the training schedule and allowed open discussion between the supply chain partners and the Evaluation Team. The concern that was identified during the system test—that CEFM does not provide the user with enough logistics-related information and tools to be able to aid in logistics decision-making—was lessened as a result of the partners' observations in these areas. One recommendation that came up multiple times was the potential to archive, especially to allow that completed shipments be made available in CEFM for more than the 48 hours currently planned. The Deployment Team reviewed with all partners some

changes that had been made to CEFM that differed from the training materials. For example, the freight forwarders were originally the partner who provided the "Booking Completed" status to CEFM; under the final version of CEFM, this status message was entered manually by the manufacturers in China.

Involving the Evaluation Team in the CEFM test design, planning, testing, and training phases deviates from a typical Intelligent Transportation System (ITS) evaluation. The Evaluation Team was rewarded for this involvement during the live test and post-test activities because of its ongoing working relationship with the Deployment Team and supply chain partners. During the live deployment test, the Evaluation Team worked closely with the Deployment Team to document the data gaps and anomalies that occurred. Likewise, when the Evaluation Team began to analyze the CEFM data as compared to the baseline data provided by the supply chain partners, the lines of communication were open and active with most partners. In a standard evaluation, it can sometimes be difficult to get timely and fulfilling responses back from test participants. For the CEFM test, the partners were key sources of baseline data and provided helpful anecdotes about the use and benefits associated with the CEFM system.

3.3.2. Test Activities

During the 6-month test period, the Evaluation Team focused on monitoring the CEFM-generated content through the user interfaces; reviewing the data contained in the database logs (especially the Service Execution Log and the pivot table); and periodically corresponding with the supply chain partners about the level of use and the partners' perceived system benefits.

Efforts conducted during the first 3 months of the live test (June through August) were focused on analyzing the data being collected by CEFM. During this time, the Evaluation Team logged on to the CEFM through the user interface nearly every day. While logged on, the Evaluation Team examined contents from the three on-demand reports, since these reports contained the most complete picture of the data contained in CEFM. By doing so, the Evaluation Team was able to identify the data gaps and anomalies that were discussed in section 3.3.1.

The Evaluation Team also was provided access to ODW's existing system user interface, an application known as "Scoreboard." By reviewing Scoreboard, the Evaluation Team was able to assist the Deployment Team in populating archived pivot tables with the ODW shipment information to create a single record containing all the consignments completed in the CEFM test. This information was annotated as being entered post-consignment from an existing system or pre-CEFM piece of data (for information coming from the pre-alert and DSR spreadsheets provided by the freight forwarders). The Evaluation Team also monitored all planned CEFM system outages and received updates from the Deployment Team regarding the reasons for outages and outage durations.

At the deployment test's mid-point, the Evaluation Team conducted another round of interviews with the supply chain partners in Hong Kong and Columbus to understand how each partner had used the system; how often the partners had logged on; the partners' perceived system benefits; and to ask clarifying questions about the partners' baseline data exchange processes. The interview guides used for the various partners are contained in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report*, Appendix A, provided under separate cover.

For the Columbus partners, members of the Deployment Team accompanied the Evaluation Team to the interviews. The interview guides provided an overview of discussion topics, and these interviews revealed surprising details about the partners' usage. The interview details are discussed in depth in the following section. The coordination between the deployment and Evaluation Teams also proved beneficial during these interviews. At the mid-point in the test, sufficient design changes had warranted a "refresher" training session for some of the partners. For some partners, like the Columbus forwarders and the Customs broker, the refresher training session allowed them to become more familiar with some of the CEFM functionalities that they had not noticed previously.

The mid-test partner interviews also provided the Evaluation Team with the opportunity to discuss the potential benefits of CEFM with each partner. Some partners, such as Barthco and ODW, had already noted CEFM-related benefits, and were enthusiastic to discuss them. The Evaluation Team used this information to begin determining qualitative and quantitative benefits, and which hypotheses they supported. Conversely, these interviews also helped the Evaluation Team identify gaps where more information or data analysis was needed to support a particular hypothesis's evaluation.

For the remaining 3 months of the test, the Evaluation Team focused on gathering information by closely analyzing the evaluation logs created by the Deployment Team, and in developing follow-up interview guides for the partners who had identified perceived benefits (see *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report*, Appendix A, provided under separate cover).

Following the deployment test's conclusion, the Evaluation Team distributed these interview guides to be completed by phone or email. Again, the close working relationship between the Evaluation Team and supply chain partners was greatly beneficial in evaluating the benefits perceived by the partners. Of particular note, ODW, as the only integrated partner, was extremely responsive to questions, and was a key provider of quantifiable benefits for the evaluation.

3.3.3. Post-Test Activities

The data analysis required for the CEFM evaluation began near the end of the live system test and continued through March of 2008. The Evaluation Team first reviewed the logs created by the Deployment Team, who had calculated many operational statistics for the CEFM system throughout the test. The Evaluation Team focused on several items when reviewing these logs:

- Service Execution Log:
  - Timings of the OCR Report by month:
    - Number of successful reports.
    - Average time to return the report.
    - Average number of consignments included in each report.
    - Number of "time-outs" (the service timed out and no OCR was returned).
  - Timings of the Federated Status Report by month:
    - Average time to return the report.
    - Number of requests.
    - Number of "time-outs" (the service timed out and no Federated Status was returned).
- Pivot table:

  - Number and type of data gaps (missing data).
  - Number and type of data anomalies (incorrect data).
  - Resolution of issues (filling in data from pre-alert, DSR or ODW legacy system).
  - Calculation of average transit time segments.

The CEFM baseline proved especially helpful to the Evaluation Team. This data provided a point of comparison from which to measure CEFM benefits. Baseline data sources were provided by multiple partners and included:

- Manufacturer:
  - Sample paper bookings.
  - Answers to detailed interview questions about current operations
- Forwarder:
  - DSRs for test period.
  - Pre-Alerts for test period.
  - Sample internal shipment tracking reports.
  - Sample LB performance reports.
  - Staffing levels for baseline reporting (time to create DSR, research airline status, etc.).
- Inbound Trucking Company:
  - Sample communication from the Hong Kong forwarder.
- LB:
  - Sample EDI accuracy report.
  - Shipment totals from Hong Kong during test period.
  - Spreadsheet of CEFM test shipments from LB existing system
  - Sample "hot shipment" report.
- ODW:
  - Shipment volumes in the Columbus warehouse.
  - ASN accuracy: CEFM versus EDI.
  - Staffing levels for baseline reporting (time to correct missing or incorrect EDI, number of instances, and so forth).
  - Email answers to many detailed questions about current operations

These data points provided the necessary data to bound the CEFM analysis in terms of number of consignments each partner handled, labor rates, staffing levels, and perceived quantified benefits from CEFM. This data was crucial in creating the benefits documented in section 4 of this Evaluation Final Report.

The post-test activities focused on further definition of the follow-on evaluation activities that will be documented in the CEFM Deployment and Scalability Evaluation Report to be completed in September 2008. These activities have included applying the benefits quantified by the CEFM test to a larger study of the Return on Investment (ROI) offered by these types of visibility systems. In addition, the Evaluation Team has begun to gather past studies and reports to assess the wide-reaching impacts to the freight industry and public sector stakeholders.

3.4. INTERVIEW RESULTS

The benefit of early participation by the Evaluation Team in parallel with the CEFM system design and testing phases was that the Evaluation Team members had frequent opportunities to interact with both the Deployment Team and the supply chain partners. While there were numerous informal conversations conducted over the phone and via email, the Evaluation Team still planned and conducted official interviews with the supply chain partners, both in Hong Kong and Columbus. The following two subsections describe these interviews and their high-level results. In the *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report* document provided under separate cover, Appendix A contains copies of the interview guides and responses received during these interviews.

3.4.1. Columbus Partners

As mentioned previously in this section, the unique structure of this evaluation provided the Evaluation Team with open access to the test participants. The Evaluation Team began working with the Deployment Team early in the system design phase and tracked lessons learned. Likewise, the periodic design and project team meetings also involved the supply chain partners, which gave the Evaluation Team regular opportunities to interact with the partners and document their "As-Is" or "before" processes. These early meetings opened the lines of communication between the Deployment and Evaluation Teams and the supply chain partners. In-depth interviews began during the system testing phase in May 2007, with the most important interviews being conducted in late September 2007.

Interviews with four of the six Columbus-based partners were conducted the week of September 24, 2007. The partners interviewed included: ODW, Star, Forward Air, and Barthco. The meeting notes from these four meetings are contained in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix A, provided under separate cover. Although Hellmann had originally scheduled an interview during this week, it was cancelled due to an unexpected scheduling conflict. A brief phone interview was conducted with the key Hellmann staff member in November 2007 with Deployment Team and USDOT participation. Likewise, although the Evaluation Team scheduled an interview with LB during this week, it also was cancelled due to unexpected scheduling conflicts. The Evaluation Team had conducted interviews with LB staff earlier in the deployment test, in July 2007, and also interviewed the key LB staff point of contact during February, March, and May 2008.

The input provided by these partners is summarized below.

The Limited Brands

The July 2007 interview with LB verified for the Deployment Team certain business processes that were impacting CEFM operations. For example, the original CEFM design assumed that POs did not change once they were issued by LB to the manufacturer. The Deployment and Evaluation Teams, however, noticed missing and incorrect data once the CEFM deployment test began in May.
LB verified that POs do sometimes change after they are issued, specifically, the GAC and NDC dates, the quantity to be issued, and perhaps even the forwarder who handles the consignment. During

this interview, LB verified with the Deployment Team various types of operational issues that were impacting CEFM. This interview was largely run by the Deployment Team with the Evaluation Team observing. At this meeting, however, the Evaluation Team did discuss with LB the possibility of running regular comparative reports between the CEFM-provided OCR and the weekly DSR roll-ups that LB performs under its existing operation. This idea was suggested to help the Evaluation Team could obtain a "snapshot" of how LB could use CEFM data and populate missing shipment data within CEFM, and to help LB identify unique CEFM data elements that LB had not received in previous reports. Ultimately, time constraints and the demands of the peak season prevented LB from spending much time on comparing CEFM-generated data with existing LB shipment data. LB did provide to the Evaluation Team some existing LB shipment data after the test was completed, from which the Evaluation Team did some comparisons that are discussed in subsequent sections.

Once the Evaluation Team began to analyze CEFM during the post-test period, several email discussions and two additional phone interviews were conducted with LB. These discussions helped the Evaluation Team to verify the scope of LB's operations and quantify baseline information. Following are some of the items discussed:

- The number of service providers, shipments, and POs.
- The use of EDI and DSR data and the accuracy rates of these reporting tools.
- Internal reporting capabilities, data sources, analysis methods, and the frequency of these reports.
- LB performance metrics including data accuracy and quality.
- The scope of the CEFM test in terms of how many of LB's total shipments were included.
- LB's perceptions of the CEFM system and the accuracy of the information contained within CEFM.

September 2007 Interviews

These interviews were conducted at the mid-point of the deployment test and served two purposes: the first was to get the partners' comments and perceptions about CEFM and discuss how they had been using the system; and the second was to discuss the partners' baseline operations and how they conducted business before CEFM. Members of both the Evaluation and Deployment Teams attended these interviews, conducted at each partner's facility in Columbus, with the results summarized as follows:

- **ODW:** ODW provided the most comprehensive information at this point in the deployment test, perhaps because it was the only partner who had integrated CEFM with its existing system. At this point in the test, ODW had already begun to recognize the following improvements resulting from CEFM: faster receipt of the ASN message; improved data availability in the warehouse for CEFM test shipments; and improved accuracy within CEFM data. ODW and its IT contractor, CodeWorks, also provided helpful lessons learned in the deployment of the integrated CEFM model, which included:
  - ODW's EDI data impacted the data within CEFM. EDI message strings typically track at the MAWB level, which may contain many consignments. CEFM, however, tracks at the

individual consignment level. Therefore, if there was an error in one EDI message string, or one EDI transmission was read incorrectly by ODW's existing system, the data for many CEFM consignments may be affected. It was initially difficult for ODW to correct missing or incorrect data within CEFM, and the lesson learned was that ODW would have preferred using raw shipment data from its existing system in the design of the CEFM integrated model as opposed to EDI message strings.

- ODW felt strongly that one of the big benefits to CEFM was that the use of the FIH and its use of XML messages and WSDLs did not require a server. This may be beneficial to small or medium size companies who do not want to assume high implementation costs.
- The other big potential benefit of a CEFM-type system that ODW identified is the potential labor savings that would result from having automated data available to all partners, and which should reduce the amount of manual data created and shared along the supply chain in the form of email and email attachments.

- **Star:** At the time of this interview, Star had not used the CEFM system very much. The Evaluation and Deployment Teams took the time to show Star some potentially useful aspects of CEFM, particularly the ASN's style sheet message format. Star was able to provide useful information about its baseline operations, including the existing reports it creates for LB, as well as reports it receives from LB. Star also discussed the messages that are exchanged between its Hong Kong and Columbus offices, and the frequency and timing of these messages. Star also provided information on the daily level of effort spent on these reports and messages, and shared sample copies of these reports and messages with the Evaluation Team.
- **Forward Air:** As with Star, Forward Air had not spent much time using CEFM at this point. After the Deployment Team shared with Forward Air some potentially useful aspects of CEFM, the bulk of the interview focused on gathering additional detail on its baseline operations. This information detailed the data exchanges between Forward Air and the other supply chain partners, as well as any internal performance measures. The Deployment Team also highlighted some consignments where CEFM had not picked up Forward Air data and provided the UCR numbers to the Forward Air point of contact to research the cause of the missing data.
- **Barthco:** After ODW, Barthco had been using the CEFM system the most frequently. Barthco staff had been regularly logging on to CEFM and running the OCR report to identify which consignments were bound for Columbus. Because the OCR provided much of the information Barthco required for filling out the Customs paperwork, Barthco's staff could begin working on this documentation without waiting for the "Wheels Up" and NTB emails from the Hong Kong forwarders. After receiving these messages, the paperwork only needed to be submitted. This helped Barthco to better balance its workload, especially early in the work week, because although the Hong Kong forwarders do not work on Sundays, Barthco does have staff working that day.

  Barthco, like the other interviewees, also provided baseline information about its pre-CEFM supply chain operations. Specifically, Barthco staff members provided details on the timing of the messages provided to them by the Hong Kong forwarders, and what information the Barthco staff then could pass on to its Columbus partners. As with the other Columbus

partners, the Barthco staff also provided high-level information about its internal and external performance measures.

Follow-Up Questionnaires

Once the deployment test concluded, the Evaluation Team followed up with Barthco and ODW through email questionnaires. As the partners who had used CEFM the most often and had identified benefits from doing so, these questionnaires helped the Evaluation Team quantify the benefits identified by these two partners.

For Barthco, these questions focused on the potential time savings from completing Customs paperwork without waiting for email notification from the Hong Kong forwarders.

For ODW, the questions focused on the improved accuracy and data availability provided by CEFM as compared to EDI. ODW also provided helpful information on the scope of CEFM test consignments as compared to the total number of consignments processed by its Columbus warehouse. These follow-up questionnaires are included within *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix A, and provided under separate attachment, and are identified as "Barthco" or "ODW."

3.4.2. Hong Kong Partners

Shortly after the September interviews conducted in Columbus, two members of the Evaluation Team traveled to Hong Kong to conduct interviews with LB staff, the four manufacturers, and the two forwarders. These interviews were conducted over 2 days, October 14-15, 2007. Due to the short time available for these interviews, the partners were provided with interview guides in advance, which asked them about their use of CEFM and baseline questions about their pre-CEFM operations. These interview guides were then reviewed with the Evaluation Team members, and the remaining time was spent on a few high-level questions developed by the Evaluation Team, summarized as follows:

1. From your point of view, how has the CEFM Deployment Test gone, and what have you learned about your current operations?
2. How have you used CEFM, and do you think your use would be different if you could use it for all your shipments? Please explain.
3. What would you change within CEFM to make it more useful for your operations (consider formats, content, response time, program used, etc.)?
4. Do you see potential in using CEFM data for business planning, and if so, how would you use the information?
5. Do you think your operation would be improved if CEFM data were integrated into your existing information system and analysis tools? Please explain.

Overall, the Hong Kong partners had slightly less enthusiasm for CEFM than did the Columbus partners. The Hong Kong partners used CEFM very sporadically, except for the initial booking of a consignment by each manufacturer. There were 871 consignments completed during the deployment test, with most partners logging on to CEFM mostly out of curiosity.

For the second question, all of the Hong Kong interviewees felt that CEFM may have more utility for them had it included all of their shipments, and if it had been integrated with their existing systems. The concept of integrating CEFM into the partners' existing systems was also brought up in the responses to the fourth and fifth questions. In terms of how CEFM could be changed, both the manufacturers and forwarders felt that the accuracy of the data presented could be improved; interestingly, this contradicted with the Columbus partners' perceptions about CEFM actually improving the accuracy of the supply chain data. LB staff in Hong Kong felt that CEFM did not provide it with any new or different capabilities; therefore, while CEFM was an interesting test, the capabilities it offers are currently provided to LB through its existing systems and within the data it receives from its partners.

The completed questionnaires – one for the group of manufacturers and one for the forwarders – are contained in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix A, under separate cover. These answers mainly provided information on the format and frequency of the partners' current data exchanges, the frequency and scope of their CEFM use, and their perceptions about CEFM data quality and accuracy.

3.5. BUSINESS REQUIREMENTS

The CEFM Detailed Design Document contained a table with a series of business requirements that CEFM must meet. In other project documents, these requirements were discussed with relationship to EFM value proposition statements.[29] The business requirements are relatively high level and cut across each of the four study areas that have been defined for the CEFM evaluation. This section presents the overall evaluation of each business requirement as shown in Table 17. The table includes the description from the Detailed Design Document of how the requirement was to be addressed in CEFM, and the Evaluation Team's comments about whether or not the requirement was achieved is included in the right-hand column. As a convenience for the reader and as the prelude to the detailed discussion of the evaluation in section 4, each evaluation comment has a section reference and associated MOE for more detailed explanation.

Table 17. CEFM Business Requirements and Evaluation

Business Requirements	How Business Requirements are Addressed in CEFM Design	Evaluation Findings as of March 31, 2008
Provide shipment status information.	The CEFM will demonstrate the ability to link shipments together along the end-to-end supply chain and provide status of these shipments to all interested and authorized parties on near-real-time basis.	This was accomplished with the Federated Status Report and Open Consignment Report. These reports are available at any time in CEFM. Event status is updated by extracting data from existing partner systems as soon as those systems are updated. Some authorized parties did not have the information before (see section 4.3.1, MOE 2).
Provide for information security and integrity.	The CEFM will share shipment-related information among partners in a safe and secure environment. Shipment information	This was accomplished and each partner had a separate, password-protected log on. The partners shared supply chain event

[29]Columbus Electronic Freight Management (CEFM) Program: Design Foundation: Value Propositions, Business Requirements, Functional Specifications and Use Cases, Version 1.3, dated June 12, 2006.

Business Requirements	How Business Requirements are Addressed in CEFM Design	Evaluation Findings as of March 31, 2008
	will be available to authorized users only and authorized users must have the confidence in the system that the information provided is accurate and current.	information via a shadow database while protecting their individual existing systems. Most users thought the information was more accurate, and often available sooner with CEFM (see section 3.2.3 above and section 4.2.3).
Provide open-source applications based on standards.	The CEFM will be constructed using open-source, non-proprietary business applications and processes to the extent possible. Implementation will facilitate ease of entry by participants, and will support the overall FIH objective of reducing barriers to entry for new participants in the supply chain.	This was accomplished. CEFM used a variety of Web products and 21 reusable Web services. While no new participant was brought into the system during the test, users thought implementation would be easier and as little as one tenth the cost compared with current EDI-based systems (see section 4.2.2).
Integrate with the supply chain partners' existing systems.	The CEFM will integrate with the partners' existing logistics management and business process systems. The EFM is not designed to be (or require) a replacement of existing systems. The level of integration will vary among supply chain partners.	This was accomplished very successfully with ODW, the container freight station. Shadow databases were used to interface successfully with all other partners. Partners with shadow databases did not automate the consumption of CEFM data into existing systems. Partners continued to use their existing systems and supplemented that use with Web-based access to the CEFM status reports and XML style sheet documents (see section 4.2.1, MOEs 2 and 3).
Improve the efficiency of the existing supply chains.	The CEFM will improve the efficiency of existing supply chains by: 1) removing unnecessary duplication of data entry throughout the supply chain; 2) providing data sooner to partners to allow them to make better resource management and shipment-related decisions; 3) providing more efficient and robust processes to manage shipment exceptions; and 4) reducing the dwell time of freight that is sitting "idle" waiting on paperwork or information exchanges to occur.	1) This was accomplished. Only the manufacturer enters booking data one time; all other data is automatically extracted without user intervention. 2) This was accomplished. Most users thought they did receive data sooner, and if CEFM was applied to all shipments, resources could be saved. In particular, users in Columbus (especially the broker and container freight station) had visibility of shipments in Hong Kong as much as 2 days before they do currently. 3) This was not specifically addressed during the test, as a decision was made to not change any partner business processes. In interviews, however, users thought the information presented to the user in CEFM could be used as a basis for eliminating some processes, such as manual preparation of the daily status report, and for investigating exceptions (e.g. delayed shipments). 4) This was not specifically accomplished in the test because CEFM only applied to about 10 percent of shipments, and because partners did not actually manage the supply

Business Requirements	How Business Requirements are Addressed in CEFM Design	Evaluation Findings as of March 31, 2008
		chain using CEFM. Partners supplemented existing operations and systems with the CEFM data. The broker and CFS did observe the potential for reductions in the Customs clearance process. Numerous quantitative benefits were calculated in the evaluation to show the potential for reduction in labor and improvements in all these areas (see section 4.4).
Provide a single window for user to access all relevant shipment-related information.	The CEFM will provide "one-stop-shopping" for supply chain partners to access all data related to CEFM shipments, including shipment status, content, and routing information.	This was accomplished and all supply chain partners used the CEFM Web-based screens to view information that was previously not available. In particular, airline data was available that was not available currently, including data on arrivals at JFK. Partners had no knowledge of routings via JFK previously. Content information in CEFM is included in the Open Consignment Report and ASN message (see sections 4.2.1 and 4.2.2).
Provide for sharing intermodal shipment-related information.	The CEFM will implement more efficient and timely sharing of shipment-related information between the partners in the deployment test through the implementation of Web services and an SOA. The CEFM will implement the truck-air-truck portion of the overall FIH intermodal framework.	The Web services and SOA implemented in CEFM did allow much more timely sharing of information that previously required multiple sources and manual effort. The supply chain tested with truck-air-truck and CEFM represented improvements to the FIH architecture that will be available to subsequent FIH implementations. Industry experts knowledgeable in SOA and Web services were impressed with the CEFM implementation of SOA (see sections 4.2.2 and 4.3.1, MOE 2).
Provide a reliable method of uniquely identifying each transaction for all authorized partners at all times.	The CEFM will provide a process and mechanism for reliably and uniquely identifying each transaction for all authorized supply chain partners. The Unique Consignment Reference (UCR) will be consistent with the World Customs Organization's (WCO) guidelines for UCR.	This was accomplished. The UCR meets most WCO guidelines and a transportation status message that meets UBL standards was implemented in CEFM and submitted to the UBL community for further implementation. Preliminary comments by industry experts in UBL were very favorable toward the CEFM design use of UBL (see section 3.2.3 and section 4.2.1).

4. CEFM EVALUATION STUDY AREA RESULTS

4.1. INTRODUCTION

Sections 2 and 3 provided the reader with a detailed description of the data flows involved with CEFM and the LB supply chain and of the CEFM system and the deployment test conducted during that latter half of 2007. Table 18 displays the four evaluation study areas previously shown, along with their associated hypotheses, as included in the evaluation study results detailed within this section. This section describes the results of the evaluation of the first three study areas for the CEFM deployment test. It should be noted that the fourth study area will involve a wider analysis of supply chain improvements in the industry, and is not evaluated in this report. The fourth study area will be evaluated in the subsequent *CEFM Scalability and Deployment Evaluation Report* that will be completed in September 2008.

Table 18. CEFM Evaluation Objectives and Hypotheses

Title/Section	Objectives	Hypotheses
System Usefulness (Section 4.2)	1. Assess CEFM system usefulness in terms of participants' perceptions regarding the system's ability to improve their daily operations and whether CEFM represents an improvement in their IT environment (improved information quality and flow).	1. CEFM technologies will be accepted by system users as valuable new tools to support their daily operations. 2. The CEFM participant experience in using FIH information exchange technologies will illustrate the advantages of integrating existing and disparate freight Information Technology (IT) systems into a common XML-based environment. 3. System security features and protection of proprietary information in the CEFM test will demonstrate the ability of EFM technologies to protect sensitive data and restrict access to existing systems.
Cargo Visibility (Section 4.3)	1. Assess the ability of CEFM to improve cargo visibility in terms of more actionable (complete, accurate, and timely) cargo location and status information for public and private sector participants.	1. Implementation of the CEFM on LB supply chains will yield improved supply chain visibility. 2. State and/or Federal Government agencies will find greater value in the improved cargo visibility information demonstrated by the CEFM such that the data can be utilized to support Government interests such as transportation planning, safety, and security.

Title/Section	Objectives	Hypotheses
Supply Chain and Logistics Performance (Section 4.4)	1. Assess CEFM's ability to improve supply chain and logistics performance by reducing supply chain costs, shipping delays, cargo clearance times, or to improve overall levels of partner coordination and ultimate customer satisfaction.	1. Implementation of the CEFM on LB supply chains will indicate the potential for improved supply chain logistics performance. 2. Implementation of the CEFM supply chains will indicate the potential for increased productivity for logistics services. 3. For performance benefits successfully realized or indicated in the two private sector hypotheses, derived public sector transportation system, congestion mitigation, and environmental benefits can be measured or forecasted.
Deployment and Scalability (from CEFM to EFM) (Section 4.5)	1. Assess deployment scalability (CEFM to EFM) through participant willingness to integrate the EFM concept into their overall IT environments and establishment of a business case demonstrating the public and private sector value propositions.	1. The information exchange technologies tested in CEFM will be considered for operational use. 2. A benefit-cost case can be developed from the CEFM test data and evaluation assessments that can illustrate EFM system scalability and deployment benefits at a national level. 3. Those working in the transfer of freight information will deem the CEFM freight information standards appropriate. 4. Benefits to industry productivity highlighted by the CEFM test can lead to improvements in U.S. economic competitiveness under a national-scale EFM deployment.

Section 2 introduced a supply chain timeline diagram to explain the flow of both the freight and data along the LB supply chain included in the CEFM deployment test. That timeline diagram is repeated here with annotations of the benefits found during the evaluation. Each major benefit area is shown with a **$** and is discussed later in section 4. The primary message of the timeline diagram in Figure 32 is that CEFM data is very often available earlier in the supply chain than current data, and which translates into visibility, time, and cost savings benefits to the various supply chain partners.

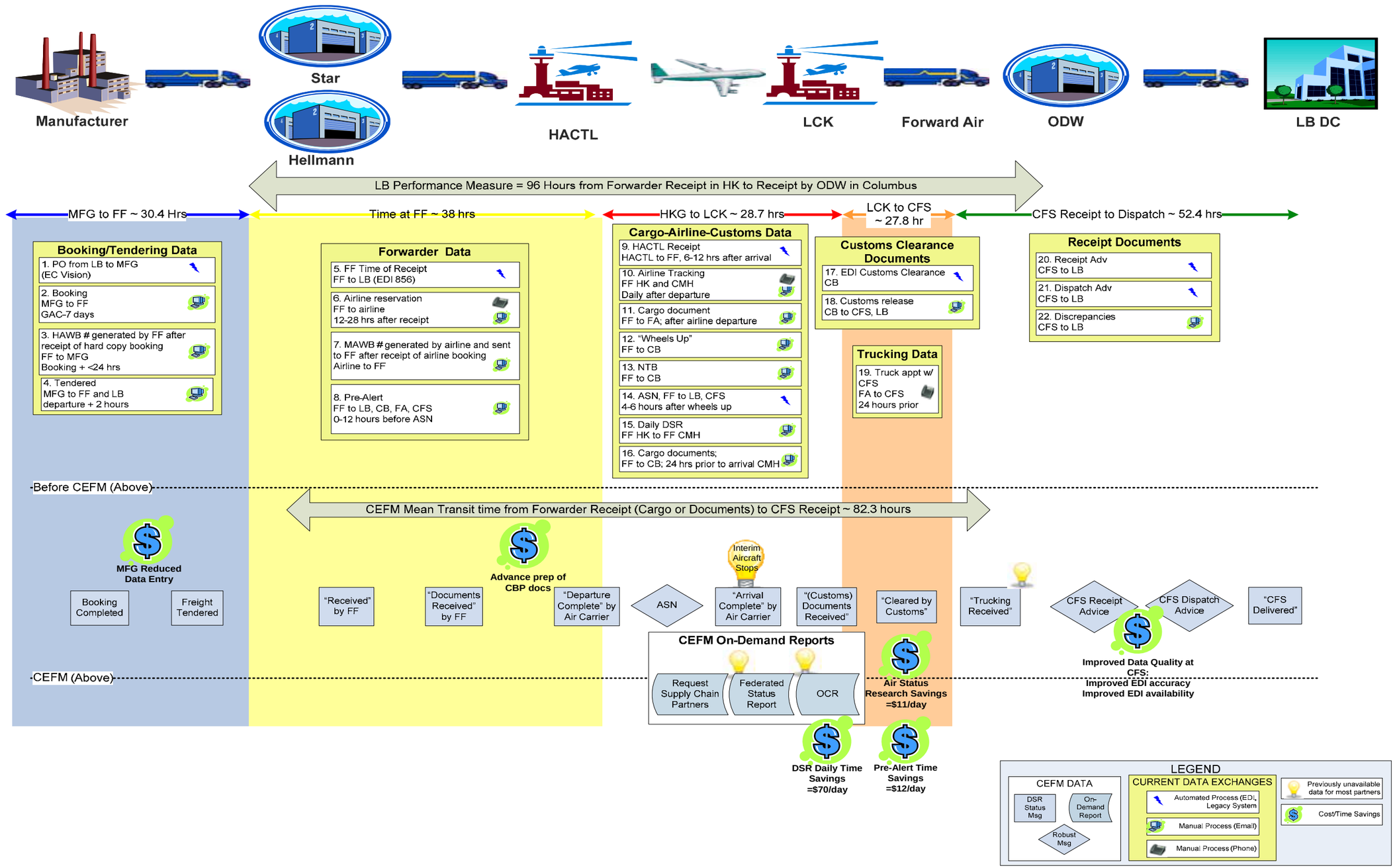

Figure 32. CEFM Timeline Diagram with Benefits.

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The benefits noted in the timeline diagram are:

- **Manufacturer Reduced Data Entry:** Refer to the quantitative benefits in section 4.4.2, MOE 5.
- **Advance Preparation of Customs and Border Protection Documents:** Refer to the qualitative benefits in section 4.3.1, MOE 4, and section 4.4.1, MOE 5.
- **Air Status Research Savings:** Refer to the qualitative benefits in section 4.3.1, MOE 3, and quantitative benefits in section 4.4.2, MOE 5.
- **Daily Status Report Daily Savings:** Refer to the qualitative benefits in section 4.3.1, MOE 2, and quantitative benefits in section 4.4.2, MOE 5.
- **Pre-Alert Time Savings:** Refer to the quantitative benefits in section 4.4.2, MOE 5.
- **Improved Data Quality at CFS:** Refer to the qualitative benefits in section 4.3.1, MOE 4B, and quantitative benefits in section 4.4.2, MOE 2:
  - Improved EDI Accuracy.
  - Improved EDI Availability.

The remainder of this section is organized by study area. Section 4.2 builds on the previous section 3 content, and evaluates the extent to which CEFM meets its design specifications. Section 4.3 discusses benefits related to improved visibility of the supply chain. Section 4.4 discusses performance and productivity improvements to the supply chain, with wider supply chain measures discussed in section 4.4.1, and partner-oriented improvements (primarily labor savings) in section 4.4.2.

4.2. SYSTEM USEFULNESS

The purpose of this System Usefulness section is to discuss the extent to which CEFM achieved its technical objectives and was found to be a useful addition for supply chain users. This set of hypotheses deals with technical details including system specifications; business requirements; use cases; assessment of CEFM user screens; and evaluation of CEFM data. This section also reviews the FIH application within CEFM. Each hypothesis and its associated measures of effectiveness (MOEs) are discussed with an indication of whether or not the hypotheses were met, including participant perceptions, and results of test data evaluation. The subsections that follow discuss the evaluation and findings in more detail.

Table 19 presents the three hypotheses that were evaluated as part of the System Usefulness study area. “Stop light” icons are used to indicate whether the evaluation has a positive (green) or negative (red) rating.

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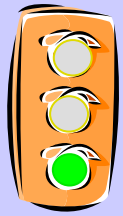
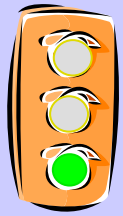
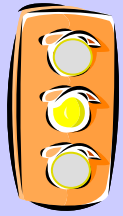
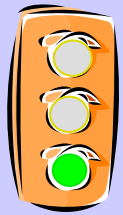
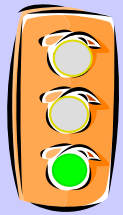
Table 19. Results of Private Sector System Usefulness CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. CEFM technologies will be accepted by system users as valuable new tools to support their daily operations.	1. Meets system specifications in Detailed Design Document and use cases.	• System screens and user interfaces including the CEFM Website. • Observations of test shipment data during test. • Participant interviews in person, via telephone, or follow up via email. • Current DSRs. • Consignment status information for test shipments.	• Analyzed CEFM screens and test data including observation of test data moving between and among partners. • Compared test data and screens with specifications and use case definitions. • Conducted interviews with all partners. Obtained follow-up information by telephone and email.	 Green	• The Evaluation Team reviewed the specifications during and after the test and found that the specifications were met (see section 4.2.1, MOE 1). • Users, as well as the Evaluation Team, found the screens straightforward and useful, perhaps with less flexibility or ability to customize than they wanted (see section 4.2.1). • The ability to export the OCR to Excel was a very important feature and widely used (see section 4.2.1).
	2. Usefulness of CEFM data and reports in daily operations as compared with current operations.		• All users were interviewed either in person (both Hong Kong and Columbus) or via email (LB and follow up with all users). • Samples of user reports and documents were obtained and compared with CEFM data.	 Green	• Content of screens and reports was as designed. Users were impressed with the quality and content of the reports (see section 4.2.1, MOE 2). • Users seemed to want and expect transportation management system (TMS) capabilities from CEFM. By design, CEFM is a data exchange system, and not a TMS, and therefore, has limited reporting capability, and is not as flexible in its analysis capabilities as one would find in a typical TMS (see section 4.2.1, MOE 2).

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
	3. Modified business process to conduct daily operations.	• Observations of test shipment data during test. • Participant interviews in person, via telephone, or follow up via email.	• A decision was made early in the project to not have any business processes change as a result of CEFM. • Conducted interviews with all partners, and Obtained follow-up information by telephone and email.	 Yellow	• Integrating ODW data into CEFM ODW system showed the promise of modifying business processes. By agreement prior to the test, no partner business processes were changed during or as a result of the test because CEFM represented only about 10 percent of the total shipments, and partners had to continue to perform their work. Partners discussed the potential use of CEFM-type data if it applied to all shipments. The Evaluation Team would expect process changes in full adoption of CEFM (see section 4.2.1, MOE 3).
2. The CEFM participant experience in using FIH information exchange technologies will illustrate the advantages of integrating existing and disparate freight Information Technology (IT) systems into a common XML-based environment.	1. Improved system user ease, timeliness, and accuracy of obtaining/ sharing information. 2. Reduction in time required to retrieve data using FIH compared with like data exchanges with current systems. 3. Reduced effort in establishing data exchanges with a new supply chain partner. 4. Ability of each partner to send or receive and correctly interpret messages from other partners.	• Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • On-site observation/ process timings. • On-site visits to measure the "before: (or without) condition: – At LB's DC in Columbus. – At ODW and other partners in Columbus. • Current DSRs.	• Performed qualitative analysis of before and after (or with or without) daily operations based on participant interviews/ surveys and stakeholder observations. • ODW provided very useful anecdotes about EDI use. The Evaluation Team was not able to meet with LB. No operating statistics were obtained, nor any historical performance reports. LB did provide a file of data from its DSRs for the CEFM shipments.	 Green	• The SOA, FIH, and Web services performed well. The Web services did manage the data exchanges as was planned (see section 4.2.2). Where there were data errors or gaps, they tended to occur due to design issues or integration problems with existing systems, and not because of FIH (see sections 3.2.3 and 4.2.2). • The technical partners, including representatives from ODW, perceived improvements resulting from using the FIH for data exchange. For most users, the FIH was transparent, and the users did not really interact directly with the FIH. • ODW, the one partner who integrated, thought there would be

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
		• CEFM standardized and unstructured messages including consignment status report data.	• ODW's experiences are likely to be the basis for primarily qualitative benefits compared with EDI. The Evaluation Team will try to determine if there is other industry experience of XML implementation versus EDI. • Some EDI statistics were reviewed; the Evaluation Team generally relied on the users' perceptions about their existing EDI.		reduced implementation barriers. This was never proven during the test because additional partners were not added. Industry representatives familiar with EDI and Web services concurred that implementation would be easier. • The information sharing as a result of Web services worked extremely well. The Evaluation Team is not aware of any data errors that resulted from using the Web services.
3. System security features and protection of proprietary information in the CEFM test will demonstrate the ability of EFM technologies to protect sensitive data and restrict access to existing systems.	1. Legacy systems and data are protected from unauthorized partner access. 2. Ability to restrict data to particular users. 3. Improved security against unauthorized accesses to the system.	• CEFM partners' files and authorizations to data. • Digital certificates within CEFM related to data exchanges. • Data exchanged on test shipments during the deployment test.	• Observing unsuccessful efforts to gain unauthorized access to data during the test. • Examining partner privileges and ability to restrict access to data for each type of CEFM user. • Identifying discrepancies or differences and assess significance.	 Green	• Through test observation and their own use of CEFM, the Evaluation Team determined that the existing systems were protected from access by other partners. Password-protected user authorizations were observed and understood by all partner participants. • Users thought the password for accessing CEFM was too hard to use and remember, perhaps a testament to CEFM's system security features. • The Evaluation Team reviewed XML message formats of some test data and found that the digital certificates functioned as designed.

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4.2.1. CEFM Technologies Evaluation

Hypothesis 1. CEFM technologies will be accepted by system users as valuable new tools to support their daily operations.

This portion of the evaluation began with the Deployment Team's system test in May 2007 and continued throughout the test period. The Evaluation Team had access to all shadow databases and accessed the system throughout the test to observe consignments; review the various reports and system outputs, and capture open consignment report and screen captures for later analysis in the evaluation. The Evaluation Team interviewed all Columbus partners except the LB during late September 2007, and all Hong Kong partners during mid-October 2007 (see *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix A, under separate cover). The Evaluation Team also corresponded via numerous email exchanges and telephone conferences with LB and the other partners in the months following the initial interviews.

The Evaluation Team followed the work steps included in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Review each supply chain event and inputs/screens.
- Review consignment status, open consignment status, and content.
- Review CEFM event logs periodically.
- Assess end-to-end status data business requirement.
- Assess consignment data and identify anomalies.
- Conduct user observation and interviews (after 1 month).
- Assess legacy system integration business requirement.
- Assess single-user window business requirement.
- Document user experience with monthly follow up.
- Perform statistical analysis of supply chain test data.
- Integrate interview results with data analysis.
- Incorporate analysis results into draft CEFM Evaluation Report.

Periodically throughout the test, approximately every 2 to 3 weeks, the Evaluation Team sent screen prints of anomalies or questions regarding CEFM test shipments to the Deployment Team. Some of these items were used by the Deployment Team to investigate system issues. The reports created by the Evaluation Team using those screen prints are contained in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix C, under separate cover).

Several CEFM Business Requirements (see section 3.5) were assessed during this evaluation. These Business Requirements were related to user interfaces and the CEFM-generated output reports. Throughout the test, the Deployment Team collected and made CEFM-based Excel transaction files available to the Evaluation Team, which included CEFM outages and timing statistics regarding various CEFM transactions (see *Attachment I: Appendices to the Columbus Electronic Freight*

Management Evaluation Final Report, Appendix D, provided under separate cover). These files enabled the Evaluation Team to observe and measure how long it would take to prepare and transmit various reports.

MOE 1: Meets System Specifications in Detailed Design Document and Use Cases

The Evaluation Team accessed the system throughout the test via the LB's user interface to view test data and to use the various screens and reports. This allowed the Evaluation Team to monitor shipment progress; identify data anomalies; and assess the various CEFM screens and functions. In addition, the Evaluation Team was provided with both the LB's system and a manufacturer's system in a shadow database environment populated with data to provide screen captures for use in preparing this report.

The Evaluation Team reviewed the CEFM specifications[30] during and after the test and found that the specifications were met. Table 20 was developed by the Evaluation Team by summarizing each specification and explaining in more detail the manner in which the specification was achieved. Taken together, the evaluation comments included in the table provide a useful review of how CEFM worked and how the architecture and data standards were implemented. As part of the analysis, the Evaluation Team concluded that the CEFM screen and report contents operated as designed.

Open Consignment Report

An important function of CEFM was creating the Open Consignment Report as described in specification 6 under the buyer system in Table 20. The OCR uses Web services to automatically interrogate each partner in the supply chain for any information about shipments that are booked, but not yet delivered to LB. This feature functioned correctly to obtain status information from the appropriate shadow database.

However, early in the test when only a few test consignments had been entered into CEFM, the OCR creation times took as much as 7 minutes or more, as well as experiencing numerous instances of timeouts. By consensus, the Development and Evaluation Teams, and the USDOT managers concluded that users would not use a report that took so long to create.

Therefore, the OCR function was redesigned so that the Web service would access only the LB shadow database, which contained all supply chain data to enable access to the most recent information from each partner, rather than polling all partners for information individually. This redesigned process reduced the processing time for the OCR to an acceptable 1.5 minutes per OCR that remained more or less constant even as the shipment volume increased during the test.

[30]USDOT, FHWA, *Columbus Electronic Freight Management (CEFM) Detailed Design Document Version 3.0* (Washington, DC: September 27, 2007).

Table 20. CEFM System Specification Evaluation Results Table

System Specifications	Evaluation	
	Achieved?	Comments
CEFM High Level System Specifications		
1. Adopt existing and create new data standards – XML schemas using UBL standards.	✓	XML schemas were used for all data elements in CEFM. XML documents and style sheets were created for ASN, Receipt Advice, and Dispatch Advice messages. UBL 2.0 standards were used. The Transportation Status message was developed using UBL core component libraries and submitted for incorporation in UBL 2.0.
2. Uniquely identify a consignment – implement Unique Consignment Reference (UCR) adapted from World Customs Organization (WCO).	✓	UCR was successfully implemented. Though originally designed for 33 characters, was reduced to 30 characters to accommodate ODW. CEFM's UCR meets most WCO guidelines, but does not accommodate split shipments, nor does it address the registering authority for issuing numbers.
3. Include digital signatures on XML messages.	✓	This was successfully implemented. CEFM used the SOAP standards and XML message envelopes for the data transmissions and robust messages it used.
Evaluation-Related Specifications		
1. Implement logging feature for each transaction in CEFM – store in database for use by Evaluation Team.	✓	Service Execution Logs and Consignment Event Logs were created weekly throughout the test and saved on the Deployment Team's Website for download by the Evaluation Team.
2. Provide access to CEFM Website of transactions and information exchanges for Evaluation Team's use.	✓	The Evaluation Team had log on access to all partners' systems, and generally used the LB's system because it contained all CEFM data, but also used other partners' versions to assess the screens included.
Partner Website Specifications		
1. Provide user account and account management.	✓	Each partner and its principal users had log on and password authorization for the CEFM Website.
2. Implement data storage capability on Website for each partner.	✓	Each partner had a shadow database accessible via a separate CEFM Website. The manufacturers' databases were on the Website server, while other partner databases were on servers at the Deployment Team's location.

System Specifications	Evaluation	
	Achieved?	Comments
3. Provide secure location for FTP data feeds from existing systems.	✓	Each partner had a shadow database that received data feeds from existing systems. Additionally, the shadow databases were connected via the Internet and used Web services to push and pull data to and from the shadow databases. These processes worked well and the Evaluation Team is not aware of any errors that occurred in the data feed process or with the Web services.
4. Provide user interfaces for each partner, including data accesses, inquiries, and messages.	✓	Each partner, as well as the Evaluation Team, accessed the user interface throughout the deployment test to view POs, Federated Status Reports, and to create Open Consignment Reports. The partners and Evaluation Team also were able to view ASNs and other robust XML messages with style sheets.
Buyer (Limited Brands) Specifications		
1. Provide PO data from existing system.	✓	The LB ran a query against its existing system to extract a portion of the POs for the four manufacturers. This data was loaded into the LB's shadow database, after which the CEFM Web services automatically pushed a PO XML message to the manufacturers' CEFM shadow databases, which enabled the manufacturers to create consignments and book shipments.
2. Maintain partner list for each consignment.	✓	The LB's shadow database retained partner information for each consignment. This information could be queried by users and provided a listing of all partners involved in a consignment's movement within the supply chain.
3. Maintain lists of planned and actual dates for each consignment.	✓	The Open Consignment Report contains columns for Estimated Arrival Time at Port of Entry and Actual Time of Arrival. While this meets the specification, it is not possible in CEFM to perform separate queries on planned and actual dates, nor does the system contain logic to compare dates or highlight consignments with actual dates after planned dates.
4. Provide ability to query all partners for status.	✓	CEFM allows all users with proper authorization to perform queries from any single partner or from all partners. Web services query the appropriate partner and return the status response from the partner. The responses are restricted by the need to know for partners other than LB, who has full access.
5. Provide status if queried.	✓	CEFM runs Web services that send the appropriate status information in response to queries from other partners.

System Specifications	Evaluation	
	Achieved?	Comments
6. Provide "Open Consignment Status."	✓	CEFM allows a user to create an Open Consignment Status report that lists all consignments that have been booked but not yet delivered to LB. In addition to showing the table on the screen, CEFM allows the user to Export the Open Consignment Report as an Excel spreadsheet. Initially prepared by polling each partner via Web services, the OCR took as much as 7 minutes to create; this particular feature was redesigned to create the OCR from the most recent data in the buyer database and the report was available in about 1.5 minutes. The OCR is the heart of CEFM.
7. Provide various supply chain messages (consignment information, ASN, Receipt and Dispatch Advice, and transportation status).	✓	The buyer version of CEFM has access to each of the supply chain messages noted in the specification. The robust messages (ASN, Receipt Advice, and Dispatch Advice) can be viewed on the screen as XML style sheets that CEFM users found useful.
8. Provide method for evaluating planned versus actual ship dates.	✓/ -	As noted in item 3 above, the OCR contains planned and actual dates, but there is no assessment capability within CEFM for planned versus actual dates and no apparent visual identification of differences. The Deployment Team explained that during requirements definition, LB determined that visual identification was not necessary, and it was satisfactory for CEFM to contain both dates and allow the user to compare planned and actual dates in the user interface. Therefore, this specification was largely satisfied.
Manufacturer Specifications		
1. Consume PO data from buyer (LB).	✓	A Web service at the manufacturer's presence in CEFM received the pushed PO from LB's CEFM presence and consumed it into the manufacturer's CEFM shadow database.
2. Create consignment and assign UCR automatically.	✓	Manufacturers could create one or more consignments from a PO by selecting a quantity for each line item. After creating the consignment, CEFM automatically assigned a UCR number that is based on the date, the manufacturer's DUNS number, and a sequential number. The consignment data identifies the forwarder for the manufacturer. There were some errors in the CEFM data when the forwarder was changed after the consignment had already been booked with the originally planned forwarder.

System Specifications	Evaluation	
	Achieved?	Comments
3. Update status to "Booking" and to "Tendering."	✓	With a single key stroke, the manufacturer booked the consignment with the forwarder. CEFM automatically assigned the booking date and provided the booking data to other partners. When the manufacturer was ready to move the freight, the user accessed the Update Consignment screen, selected the appropriate consignment, and entered the tendering date to the forwarder, and that status was automatically provided to partners.
4. Push status updates to all parties.	✓	This automatic CEFM function occurred after the user completed booking and tendering. No user effort was required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
5. Provide status if queried.	✓	This function occurred automatically. No user effort was required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
Forwarder Specifications		
1. Provide shipment-related data from existing system.	✓	Overall, this CEFM function worked correctly and is an automated function that does not require any user effort.
2. Consume status messages from partners.	✓	This was done on shadow databases, but the messages were not consumed by the partners' existing systems. The consumption to the shadow database worked well.
3. Automatically update consignment records in shadow database.	✓	The automatic updating worked correctly. The status messages were available for users on the CEFM Website.
4. Update status to "Received" and "Documents Received."	✓	These updates were automatic in CEFM, without any data entry or operator intervention, and were based on extractions from the forwarder's existing system.
5. Push status updates to all parties.	✓	This automatic function occurred after the status was automatically updated. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
6. Provide status if queried.	✓	This function occurred automatically. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.

System Specifications	Evaluation	
	Achieved?	Comments
7. Push ASN to all parties.	✓	This function occurred automatically without any user intervention and involved extracting ASN data from the existing system. The ASN was pushed in XML format and was usually available prior to the EDI ASN being available to partners.
Air Carrier (FlyteComm) Specifications		
1. Provide shipment-related data from existing system.	✓	The intent was for an airline to provide information. For the test, FlyteComm was used as a substitute for each of the three airlines. Airline data was provided automatically and it generally worked as designed. However, there were some errors when CEFM was provided data for flights with the same flight number but on different dates that clearly had nothing to do with the consignment. According to the Deployment Team, this was primarily due to the forwarder (Star) using a rerouted charter flight to an airport different than LCK, which prevented the original software logic from terminating the flight in Columbus. The Deployment Team said this CEFM feature was corrected after it was discovered.
2. Consume status messages from partners.	✓	There was a shadow database for each air carrier, so this function worked, but as implemented in CEFM, it had no relevance because there was no "partner" to use any of the information. FlyteComm provided all the airline data to CEFM but did not itself receive or consume any CEFM data.
3. Update status to "Intermediate Stop Arrival", "Intermediate Stop Departure" and "Arrival-destination."	✓	This generally worked as designed. However, there were some errors in the data when flight data were provided that clearly had nothing to do with the consignment (see item #1 above).
4. Push status updates to all parties.	✓	This automatic function occurs after the status was automatically updated. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
5. Provide status if queried.	✓	This function occurred automatically. No user effort is required. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
Trucking Agent (Forward Air) Specifications		
1. Provide shipment-related data from existing system.	✓	The data for receipt by the trucking agent was provided automatically, and it generally worked as designed. However, there were a number of consignments for which no trucking data was provided, and there was no explanation provided.

System Specifications	Evaluation	
	Achieved?	Comments
2. Consume status messages from partners.	✓	There was a shadow database for the trucking agent, so this function worked, but as implemented in CEFM, the trucking agent really did not use the information or the Website; rather, the trucking agent was a provider of information as in item #1 above.
3. Update status to "Received."	✓	This generally worked as designed. However, there were consignments for which no received status was provided and there was no particular indication of why the status was not updated.
4. Push status updates to all parties.	✓	This automatic function occurs after the status is automatically updated. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
5. Provide status if queried.	✓	This function occurred automatically. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
Customs Broker (Barthco) Specifications		
1. Provide shipment-related data from existing system.	✓	This function worked correctly, and is an automated function that does not require any user effort.
2. Consume ASN from forwarder.	✓	This was done with shadow databases, but the messages were not consumed by the partners' existing systems. The consumption to the shadow database worked well. Users were able to view the ASNs on the Website as XML style sheets.
3. Update status to "Documents Received."	✓	These updates were automatic in CEFM, without any data entry or operator intervention, and were based on extractions from the broker's existing system after the broker made the "Documents Received" entry.
4. Push status updates to all parties.	✓	This automatic function occurs after the status was automatically updated. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.
5. Provide status if queried.	✓	This function occurred automatically. No user effort is required. This CEFM feature worked for all partners; no errors were observed during the test, or could be detected by reviewing the CEFM data.

System Specifications	Evaluation	
	Achieved?	Comments
Container Freight Station (ODW) Specifications		
1. Provide shipment-related data from existing system.	✓	This function worked correctly and is an automated function that does not require any user effort. ODW integrated CEFM and provided the shipment-related data to other CEFM partners via Web services in conjunction with creating ODW's conventional EDI messages. There were some early system problems at ODW that resulted in some data not being provided to CEFM, but those problems were solved during June 2007, and worked correctly for the rest of the test.
2. Consume ASN from forwarder.	✓	This function worked correctly. ODW found the ASN received via CEFM to be more timely and more accurate than the EDI ASN.
3. Update transportation ID/consignment reference relationship.	✓	The ODW Symphony system, into which the CEFM Web services were integrated, treats the UCR as a number and associates it with MAWB / HAWB / PO / MPO numbers in the system.
4. Update status to "Received," "Documents Received," "Dispatched," and "Delivery."	✓	These updates were automatic in CEFM and in this case were integrated into ODW's system. No data entry or operator intervention into CEFM was required for any update. However, the Delivery update was calculated in CEFM as 30 minutes after the dispatch and not retained in ODW's existing system.
5. Push status updates to all parties.	✓	This automatic function occurs after the status is automatically updated. No user effort is required. This CEFM feature was integrated into ODW's system and worked correctly.
6. Provide status if queried.	✓	This function occurred automatically. No user effort is required. This CEFM feature was integrated into ODW's system and worked correctly.
7. Push "Receipt Advice" message to all parties.	✓	This function occurred automatically without any user intervention and involved extracting data from the existing ODW system. The "Receipt Advice" meets UBL 2.0 standards, and was pushed in XML format and available to authorized partners.
8. Push "Dispatch Advice" message to all parties.	✓	This function occurred automatically without any user intervention and involved extracting data from the existing ODW system. The "Dispatch Advice" meets UBL 2.0 standards, and was pushed in XML format and available to authorized partners.

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Table 21 shows some of the data from the service execution log for the OCR. The table shows the June timing problems and the average time to prepare OCRs during the remainder of the test.

Table 21. Time Comparisons in Creating OCRs during CEFM Deployment Test

Month (2007)	Time to Create (hour:min:sec)	Number of OCRs	# Shipments per OCR
June	0:02:05	311	49.05466
Jul-Dec	0:00:21	557	124.2352
July	0:00:15	169	107.716
Aug	0:00:13	109	100.5596
Sept	0:00:26	94	186.4255
Oct	0:00:30	98	137.398
Nov-Dec	0:00:27	87	103.9655

Note that the numbers in the Table 21 are for successfully created OCRs. In June, there were 54 instances where the OCR timed out and was not being successfully created. The June average for successful OCR creation was just over 2 minutes, while the average for the rest of the test was 21 seconds, with only a total 15 timeouts in the remaining 5 months of the test.

It also can be seen that the time involved in creating the OCR was not affected by the number of shipments included in the report. Initially, there was some concern that the time of creation would increase with the number of shipments, but the design change was able to negate that concern.

Airline Data

One important CEFM objective was to capture airline data in the supply chain. The system design called for each airline to be a partner and have its own shadow database, Web services, and Web access to CEFM data.

For the deployment test, airline data was provided automatically by FlyteComm for each of the airlines. Originally, there were two airlines, Atlas and Evergreen, but Kalitta also carried a number of CEFM consignments, and for those consignments during June, no airline data was reported. The Deployment Team then added Kalitta to the system and established appropriate shadow database and services.

While this worked as designed, the Evaluation Team observed that it would be more flexible to use a third-party airline data provider for any and all airlines that might carry shipments on the supply chain. For example, there were some consignments that went via UPS, but no airline data could be recorded because UPS was not a system participant.

For the system to be truly effective and usable by the supply chain partners, it needs to be flexible enough to accept and provide data about any partner that may be involved in the supply chain. There should be consideration given in future implementations to the tradeoffs involved in meeting the complex partner requirements in the supply chain.

There were at least two instances during the test (two MAWBs with three consignments in late October, and four consignments in early November, respectively) when CEFM was provided data for flights with the same flight number but on different dates that clearly had nothing to do with the consignment. These included arrival at both Columbus and JFK, with the JFK arrival 6 days earlier than the Columbus report. All the other data came through CEFM correctly, including trucking arrival and the several CFS data elements, and they reconcile with the JFK arrival.

Data obtained from LB that was based on current LB system data for the same two MAWBs showed the first shipment arriving 1 day after the JFK arrival, which is logical, and the second with a different arrival date, though somewhat related to the Columbus arrival of the JFK shipment, but a day earlier. According to the Deployment Team, these two situations were primarily due to the forwarder (Star) using a rerouted charter flight to an airport different from LCK (in this case JFK), which prevented the original software logic from terminating the flight in Columbus. The Deployment Team also said that after the event occurred, the logic was corrected.

An important lesson learned from this error is that future iterations of CEFM software should have a means of identifying and correcting or deleting errors and illogical data. There is no mechanism in CEFM to flag these errors or to correct them. Future versions of CEFM/FIH need to have logic that detects double flight arrivals or completely illogical dates and flags such errors for users to investigate and correct as needed.

On the benefits side, it should be noted here that current systems on the supply chain including LB's have no record of consignments going to JFK and being trucked to Columbus. This is a lack of visibility in the current system that has been improved upon with CEFM, and is discussed in more detail in section 4.4.

Additional Error Examples

For two shipments containing four consignments each, CEFM showed the manufacturer's booking to be October 8, but the Forwarder Receipt date to be September 24. This same forwarder date of September 24 was found in LB's database. The documents and departure dates were within days after September 24, both in the CEFM and the LB database.

LB's database shows the arrival at the LCK airport to be September 29. CEFM, however, had airline intermediate departures and arrivals on October 26 with an arrival at LCK on October 27. CEFM data ended with the LCK airport arrival. ODW's Symphony system showed a Customs clearance date of October 3, while LB's database showed Customs clearance to be September 28.

These errors have not been explained and the Evaluation Team is unable to conclusively say what happened. It appears that CEFM is somehow overwriting manufacturer and airline data for a PO that was reactivated or completed at a later date. This seems plausible, since there is no new forwarder data and no new ASN on the shipment; this would explain why CEFM did not capture any ODW data for the shipment.

There are two important points to consider about such errors. Shipment errors like this need to be dropped from any overall supply chain analysis. More importantly, the Evaluation Team observed that CEFM is not capable of identifying this type of problem. There is no logic in CEFM to flag these

consignments as a problem for possible investigation by a user. The Evaluation Team also believes that these errors are related in part to the JFK-LCK error previously cited above, because it appears that CEFM is simply grabbing airline data from FlyteComm without any logic or determination that the data collected was not really for the appropriate consignment. It may be that the correction that the Deployment Team implemented in the first instance would have corrected this problem as well. The problem with respect to a user is that without any way to identify or correct such errors, a user could lose confidence in the data and not use a system.

While the examples cited above are extreme, data gaps and errors in the CEFM data occurred throughout the test period. The Deployment Team tracked anomalies and completed a report in which they categorized data anomalies (see section 3 above and *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix B, under separate cover).

In addition to these anomaly reports, the Evaluation Team periodically identified anomalies or questions about test shipments via real-time observation of CEFM screens and informed the Deployment Team about these issues. Some of these situations led to minor system changes, while others had operational explanations. The Evaluation Team's reports are summarized in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix C, provided under separate cover. While some of the actual reports are included in the appendix, some others are simply referenced, but are available.

The data maintained in the CEFM system tended to be very accurate, as it was drawn directly from partners' systems. The Evaluation Team observed that data problems tended to occur because the business rules or design decisions used to design the system were somewhat different from what actually occurred in supply chain operations. While data gaps can inhibit system accuracy, the overall CEFM evaluation during the deployment test was positive, and the use of Web services and XML-based data exchanges for this kind of supply chain operation shows great promise.

Use Cases

The Deployment Team defined "use case" as a technique for capturing a system's functional requirements, and that CEFM had the following five use case types: status, message, routing, implementation, and evaluation. Table 22 shows the CEFM Use Cases as taken from the CEFM Detailed Design Document, with accompanying evaluation comments as appropriate about the actual CEFM implementation. Some of the use cases numbered in the CEFM documentation were deleted; hence, those deleted use cases are not shown included in the table below.

Table 22. CEFM Use Cases Evaluation

Use Case #	Use Case Title	Evaluation Comment
1	Send Purchase Order.	Performs as described.
2	Define Supply Chain Partners.	Performs as described.
3	Create Consignment and Update with Booked with Forwarder Status.	Performs as described.
4	Update Consignment with Freight Tendered Status.	Performs as described.
5	Create Shipment and Update with Dock Receipt Status.	Performs as described.

Use Case #	Use Case Title	Evaluation Comment
6	Create Consolidated Shipment and Update with Booked with Airline Status.	Not implemented due to partner availability. Airline booking information in use case 5.
7	Update ULD with Received by Air Terminal Status.	Not implemented due to partner availability.
9	Send Advance Shipment Notice.	Performs as described
10	Update Shipment with Departure, Origin Status.	CEFM actually used the forwarder departure to represent this data. Normally airline data would be actual "Wheels Up."
11	Update Consignment with Customs Status.	Performs as described
12	Update Shipment with Intermediate Stop Arrival, Departure Status.	Performs as described. The data came from FlyteComm for all three airlines in CEFM
13	Update Shipment with Arrival, Destination Status.	Performs as described. The data came from FlyteComm for all three airlines in CEFM.
14	Update Shipment with Received by Trucking Agent Status.	Performs as described.
15	Update Shipment with Received by CFS Status.	Performs as described.
16	Update CFS Shipment with Dispatched by CFS Status.	Performs as described.
18	Update Consignment Supply Chain Partners.	Performs as described.
19	Send Receipt Advice.	Performs as described.
20	Send Dispatch Advice.	Performs as described.
21	Request Status.	Performs as described.
22	Assist with Decision Making.	Uses 21 status to provide supporting information.
23	Exception Evaluation Receive Status of Consignment.	Status data only.
24	Support Contract Management.	Status data only.
25	Update Consignment with Documents Received by CFS Status.	Performs as described.
26	Update Consignment with Forwarder Document Status.	Performs as described.
30	Update Consignment with Delivered to Ultimate Consignee Status.	The intent of this use case is to close out a consignment with a proof of delivery. In CEFM, delivery was calculated as 30 minutes after dispatch.
31	Record Estimated Dates.	Performs as described. CEFM does have ETA, but as noted the planned or estimated dates are not to be used for robust supply chain planning.
32	Send Status Updates.	Performs as described.
33	Receive Advance Shipment Notice.	Performs as described.

Use Case #	Use Case Title	Evaluation Comment
34	User Authentication.	Performs as described.
35	User Authorization.	Performs as described.
36	Data Authentication.	Performs as described.
38	Receive Purchase Order.	Performs as described.
39	Receive Dispatch Advice.	Performs as described.
40	Receive Receipt Advice.	Performs as described.
41	Book Consignment.	Performs as described.
44	Receive Consignment.	Performs as described.
45	Receive Status Update.	Performs as described.
46	Respond Status Request.	Performs as described.
47	Request Federated Status.	Performs as described.
48	Respond Federated Status Request.	Performs as described.
49	Request Consolidated Status Report.	Performs as described.
50	Update Consignment with Documents Received by Broker Status.	Performs as described.

Generally speaking, CEFM performed as described in the use cases. For the most part, the use cases are basic descriptions of how CEFM met its requirements. An important application of the use cases is in future implementations where these use cases could be adapted and reused to more quickly achieve the operational capability. It should be noted that use case 23 was limited in CEFM to just updating status information, and does not allow the user to establish criteria for identifying exceptions.

In addition, use case 24 says that it might be used to monitor performance against delivery standards, and as the description states "any storage or calculations would be outside of the CEFM installation." This is an example of the discussion in the next MOE concerning Transportation Management Systems (TMS).

Use case 30 is appropriate for most supply chains as a report of ultimate delivery. In CEFM, however, the consignee was a short drive from the CFS and LB does not have a separate delivery confirmation report. Therefore, in CEFM, delivery was calculated to be 30 minutes after dispatch from the CFS.

MOE 2: Usefulness of CEFM Data and Reports in Daily Operations as Compared with Current Operations

This MOE deals with the users' perceptions about CEFM. The Evaluation Team interviewed users at several points before, during, and after the test. In some cases, the Evaluation Team also observed users operating the system.

User Perceptions and Suggested Additions

Users found the CEFM screens straightforward and useful, perhaps with less flexibility or ability to customize than they wanted (see the TMS comments below). Since CEFM is primarily a data

exchange system, and was specifically designed **not** to be a transportation management system, the screens in the user interface were straightforward and provided a simple view of the status data being received. Some users were interested in additional report writing capability or the ability to address "what if" questions, or prepare different views of the data that were not possible. There was some discussion at the time the test began about including an off -the-shelf report writing program, but that was not done. Some examples of user comments (italicized) about suggested additions to CEFM from the interviews are provided as follows:

- *About once per week, LB may call Star to see if a shipment has been moved from the factory—this could be a useful piece of information to get from CEFM.*
- *ODW said it occasionally has consignments that are split both in receipt by ODW and in subsequent delivery (with multiple receipt advice messages) to LB. CEFM has no provision for record-keeping below the UCR level, but does record each receipt and delivery with the date and time.*
- *A manufacturer said that if the CEFM system could create a booking / HAWB# report to the truck driver for delivery to warehouse, it would be more convenient for the manufacturer to arrange shipment.*
- *Another manufacturer thought that if the PO information screen could be sorted by color or size, it would be easier to check.*
- *The ability to export the Open Consignment Report (OCR) to Excel was a very important feature and widely used. Once the OCR report was adjusted so that it took about 1.5 minutes to complete, users were impressed with the quality and content of the reports. Particularly since no partner was integrated except ODW, the exported OCR was the only way a partner had to use CEFM data in other applications without re-keying. By design, the format of the Excel OCR was nearly identical to the DSR, so it could be used by the LB and the other partners in the same way the DSR is used (this is discussed in more detail in section 4.4).*

Observations About Test Shipments

As discussed earlier, the CEFM test shipments represented about 10 percent of shipment volumes from Hong Kong to Columbus. Running a live test on live shipments as part of current operations has both advantages and disadvantages. The shipments are diverse and realistic which helps to identify where business rules in the software need to be tweaked before future use. The live test allowed comparisons with current data and shipping practices; this is extremely helpful and positive, and these are discussed in more detail in subsequent sections. A disadvantage of a live test is that users have on-going jobs to move cargo that involve the other 90 percent of the shipments. Therefore, the Evaluation Team observed that in general, the partners and LB did not use CEFM during the test. All of the users said, however, that if CEFM applied to all shipments, they would use the system more and thought that using the system would be beneficial. This is discussed in detail in the Visibility (section 4.3) and Logistics Performance (section 4.4) sections below.

Transportation Management System Capabilities.

Users seemed to want transportation management system (TMS) capabilities from CEFM, but by design, CEFM is a data exchange system and not a TMS, and therefore, has limited reporting capability. Since it is not a TMS, CEFM is not as flexible in its analysis capabilities as one would find in a typical TMS. Except where CEFM was integrated into an existing system, this mismatch in

expectation limits perceived usefulness, but this is another reason why it is so important for CEFM-type capabilities to be integrated with existing systems. For future implementations, it is important for users to understand that CEFM is a supplement to existing systems, not a separate or replacement transportation management system.

Integration of CEFM Capabilities

ODW perceived far more benefit from integrating CEFM with its existing system, than partners who did not integrate. This was because CEFM provided more accurate and more timely data to ODW's existing system than was available without CEFM. A partner that integrates automatically consumes data into its existing system; a partner that does not integrate either has to use the CEFM system for decision making, report writing, and so forth, or else must re-key or otherwise input data (for example by cutting and pasting from Excel exported OCRs) into its existing system.

Using the system for decision making is self limiting because of the previous comments about CEFM's not being a TMS, and therefore, cannot write reports beyond the two or three mentioned. Re-keying defeats the purpose of CEFM and re-introduces data entry time and error potential that a system such as CEFM is supposed to eliminate. The contrast between the ODW operation and those of other CEFM partners was striking, not in a negative sense about what partners did or did not do, but in a positive sense about how well the integrated system at ODW worked.

ODW saw significant improvements in timeliness and accuracy of data from CEFM as compared with EDI, but the partners in Hong Kong did not. In part, this seemed to be related to ODW's being integrated with CEFM, and also with a general lack of understanding of CEFM functionality by the Hong Kong partners (the TMS expectation).

In addition, there were some situations in which the forwarder was changed by LB after consumption of a PO by CEFM, and such a change was at variance with some CEFM business rules. The Hong Kong forwarders showed the Evaluation Team some CEFM test shipments in which the system indicated the use of a forwarder different from what was actually used. Had CEFM been integrated at the forwarder, adjustments to PO data and to which forwarder was being specified by LB would have been relatively easy. Without integration during the test, this situation sometimes led to data errors and the perceptions noted by the Hong Kong forwarders.

In part because of the partner views with respect to TMS capabilities, several of the partners thought that CEFM would be useful to firms that are more manual with less automated capability.

- *A number of partners thought that CEFM might be useful for small- to medium-sized businesses, which lacked much TMS capability.*
- *LB management thinks the new CEFM capabilities will be particularly useful with smaller suppliers who have less sophisticated IT systems.*
- *ODW said the true benefit may be for small- to medium-sized entities who do not want to assume the cost associated with implementing EDI because once the bugs in CEFM are worked out, it should be less costly to conduct the electronic data exchange via CEFM versus EDI.*

MOE 3: Modified Business Process to Conduct Daily Operations

As the only partner integrating CEFM data into its system, ODW's participation showed potential promise of modifying business processes. By joint agreement prior to the test, no partner business processes were changed during or as a result of the test. This was because CEFM represented only about 10 percent of the total shipments, and partners needed to continue performing their work. Partners discussed the potential use of the CEFM-type data if it applied to all shipments. The Evaluation Team would expect process changes in full adoption of CEFM. As noted in the previous MOE, the Evaluation Team believes that when integrated, the CEFM data becomes a part of existing business processes, and is not as subject to operational changes or differences in business rules.

The use of shadow databases at most CEFM partners in the deployment test was a convenient way to protect partner data and to more quickly and painlessly implement CEFM. This use worked well in CEFM, but the fact that none of the partners consumed any data from the shadow database made the data less useful to them, and helped assure that no business processes would be changed. The Evaluation team understands the reasons why the shadow databases were used, and agree that they made the deployment test easier to conduct.

In addition, some of the partners had expressed security concerns about "sharing" data extracts. These concerns were causing some of the partners to hesitate to commit to the test; introducing the concept and use of the shadow database alleviated these concerns and allowed all partners to participate.

Nevertheless, the security concerns seemed to be part of a pattern within CEFM that inhibited partners from actually using the system, the data, and considering any changes in business processes. The Evaluation Team suggests that future implementations strive harder to integrate partners.

Air AMS, an automated system for submitting clearance documents to Customs and Border Protection (CBP) and receiving electronic clearance, was agreed upon by ODW, Barthco, and LB prior to the test. Although not a mandated standard in Columbus as it is in New York and Chicago, Air AMS was implemented at Barthco on October 16. Air AMS holds promise of changing business processes at Barthco and ODW as a result of the electronic release (see section 4.4 for more information on Air AMS).

Lessons Learned from CEFM Test

Following are the lessons learned from the CEFM Test:

- Integrating CEFM system capabilities into an existing system is critical to obtain the benefits of reduced data entry and increased data quality.
- Future versions of CEFM/FIH need logic that detects double flight arrivals or completely illogical dates and flags such errors for users to investigate and correct as needed.
- For future implementations, it is important for users to understand that CEFM is a supplement to existing systems, not a separate or replacement transportation management system.
- For the system to be truly effective and usable by the supply chain partners, it needs to be flexible enough to accept and provide data about any partner that may be involved in the

supply chain. In future implementations, consideration should be given to the tradeoffs involved in meeting the complex partner requirements in the supply chain.

4.2.2. Freight Information Highway

Hypothesis 2. The CEFM participant experience in using FIH information exchange technologies will illustrate the advantages of integrating existing and disparate freight Information Technology (IT) systems into a common XML-based environment.

This portion of the evaluation actually began during CEFM development and continued during the Deployment Team's system test in May 2007, and throughout the remaining test period. The Evaluation Team had access to documentation about FIH and its use in CEFM and worked with the Deployment Team to understand how FIH was used. Although the wording of the hypothesis indicates that the participants would be involved, in fact, the FIH is the underlying architecture, is transparent, and is not something that participants and system users really see. The Evaluation Team followed the work steps included in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Observe CEFM operations that manage FIH.
- Measure event processing time with legacy system.
- Interview users about perceptions of FIH.
- Measure event processing time with CEFM.
- Assess open source applications and reduced implementation barriers.
- Analyze timeliness of CEFM transactions.
- Collect EDI data received by users.
- Assess ease of FIH interface implementation and expansion.
- Assess improved information sharing from CEFM Web services.
- Incorporate analysis results into draft CEFM Evaluation Report.
- Incorporate comments and final results into final CEFM Evaluation Report.

MOE 1: Improved System User Ease, Timeliness, and Accuracy of Obtaining/Sharing Information

Section 3.2 describes the FIH architecture and how it was implemented in CEFM. The SOA, FIH, and Web services performed well. The Web services did manage the data exchanges as was planned. The information sharing as a result of Web services worked extremely well. The Evaluation Team is not aware of any data errors that resulted from using the Web services. Where there were data errors or gaps, they tended to occur because of design issues or integration problems with existing systems, and not because of FIH.

MOE 1 in section 4.2.1 includes a table and discussion of the timing measurements for creating the OCR. In Table 23, similar timing information is presented for the Federated Status Report, which is created by Web services polling each partner for status information about a particular shipment.

Table 23. Service Execution Log for Federated Status Report Timing

Month (2007)	# Federated Status Reports	Timing (minute:second)	# Time-Out Errors
June	9,947	00:08	91
Jul-Dec	730	00:21	7
July	235	00:21	3
Aug	184	00:18	1
Sept	106	00:24	0
Oct	107	00:23	2
Nov-Dec	98	00:22	1

As with the OCR described in the previous section, there were startup problems with the Federated Status Report in the early weeks of the test. There were many more timeouts during those early weeks and many more instances of partner, Deployment Team, and Evaluation Team members accessing the status reports. Note that the "steady state" during the remainder of the test had an average time to provide the Federated Status Report of 21 seconds. As described later in section 4.4, the Federated Status Report is something that had not been available to users before, and is generally not available today in any logistics system. In particular, the real-time polling of partners external to a company is rare, even in the SOA sphere.

MOE 2: Reduction in Time Required to Retrieve Data Using FIH Compared with Like Data Exchanges with Current Systems

As the only CEFM partner to integrate the data into its own system, ODW was very positive about the length of time regarding the CEFM data in XML as compared with the batch EDI data that ODW currently receives.

- *ODW said it has been seeing a lot of CEFM ASNs ahead of the EDI or at the same time, and has used those when available.*
- *ODW Columbus prefers communicating through CEFM because it requires less effort (for example, to pull out the ODW shipments from other shipments in the LB EDI data set), and the data is more timely and more accurate. In addition, CEFM runs on demand and does not require batches.*

For other partners, there is really no time comparison possible because the partners' systems are not consuming data. Data timeliness in CEFM is discussed in more detail in section 4.4.

It should also be noted here that during the test, the Deployment Team continually monitored the flow of shipment data through CEFM. Because of problems early in the test with the number of ASNs being received by ODW, the Deployment Team tried to identify CEFM shipments before they arrived and notified ODW by phone or email to alert the ODW staff to run the appropriate queries. This became less necessary as the test progressed. ODW explained to the Evaluation Team that in

hindsight, it would have designed the interface differently if there had been a better understanding about the timing mismatches between CEFM and EDI.

The Deployment Team performed the type of monitoring function that a third-party operator of an FIH network could perform. It is anticipated that once the issues are identified and resolved in an integrated implementation, such oversight and advanced warning of pending shipments would not be required.

MOE 3: Reduced Effort in Establishing Data Exchanges with a New Supply Chain Partner

The one partner who integrated, ODW, thought that there would be reduced implementation barriers, but this was never proven during the test because additional partners were not added. Industry representatives familiar with EDI and Web services concurred that implementation would be easier.

- *One of the executives for CodeWorks, the software contractor for ODW, said the system setup cost is a tenth of the cost of traditional EDI systems and is easy to setup and connect.*

The Evaluation Team had discussions with developers about what is involved in implementation. A recent analysis by members of the wider EFM project team estimated the cost of implementation to be $125,000, including labor and hardware/software for a medium-sized company to implement an FIH node that integrates with existing systems. This is less expensive than typical EDI implementations.

MOE 4 : Ability of Each Partner to Send or Receive and Correctly Interpret Messages from Other Partners

The CEFM Concept of Operations (ConOps) and other program documents defined seven objectives of the deployment test of FIH capabilities in CEFM, which are described as follows:

- *Provide comprehensive visibility of shipment information to appropriate LB supply chain partners.* This was achieved (see section 4.3).
- *Provide the ability and platform for LB supply chain partners to communicate electronically.* This was achieved through implementing the FIH platform and the receipt of OCRs and Federated Status Reports by users.
- *Improve the ability for consignees within the supply chain to schedule/plan for receipt of shipments.* ODW, who integrated CEFM, thought it could better plan its operations. ODW's logistics staff used the exported OCR to forecast anticipated shipments.
- *Provide carriers with real-time lading and cargo management information.* This was not specifically addressed in CEFM since the "presence" of the three airlines was provided via a third-party airline data firm. However, separate shadow databases were implemented in CEFM for each airline, and were the airlines to use that information, it could provide them with real-time data about booked cargo in Hong Kong.
- *Provide a means for manifest data to be electronically delivered to its intended receivers securely and on a near real-time basis.* This was achieved by transmission of the ASN to LB, ODW, and other partners. Some of these partners did not receive the ASN before (see sections 4.3 and 4.4).

- *Increase the ability of LB supply chain partners to collaborate with each other to improve service.* This was achieved (see sections 4.3 and 4.4 below).
- *Enable the deployment of universal and distributed applications among LB supply chain partners.* This was achieved. Each partner had a shadow database, integrated the system, or used the CEFM Web portal. All of the data used UBL international data standards.

The technical partners, including representatives from ODW, perceived improvements based on results from using the FIH for data exchange. For most users, the FIH was transparent, and the users did not really interact directly with the FIH (see section 3.2 for more detailed discussion of FIH).

Lessons Learned from CEFM Test

Based on CEFM development and the deployment test activities, the Deployment Team created an unofficial lessons learned document.[31] The Evaluation Team reviewed the document and discussed the lessons learned with the Deployment Team. Following are some of the key Deployment Team lessons learned that are related to the core data standards and reference codes included in CEFM.

UBL Standards

The Deployment Team explained that it did not actually use the draft UBL 2.0 schemas "as-is," but instead, a tailored version of "FIH-UBL" was developed for this project. The Deployment Team said this was done to accommodate the current EDI messages that LB was using.

- *The Deployment Team said that rather than saying "we are 'UBL compliant,' it is more correct to say we are 'UBL consistent."*
- *Anyone implementing FIH will need to make some changes. The Deployment Team said that UBL intended that subsets of the standards be used as appropriate.*

Very Broad Standards

To cover many different business data elements, the UBL standards are very broad and require considerable tailoring and guidance in using UBL schemas. The Deployment Team said that the guidance it received was not as clear as it might have been, and that the UBL standards are relatively new and immature. UBL was successfully used in CEFM and the test provided several additions to the UBL standards or its associated codes.

- *The Deployment Team said that FIH schemas were unwieldy but that profiles needed to be developed to tailor UBL to different business applications. Data element mapping is an important requirement.*
- *The Deployment Team said that in retrospect, it would have done schema design in CEFM differently by tightening the portions of the standards that were used in CEFM, making the schemas smaller and more carefully using the subsets noted above.*
- *The Deployment Team also noted that it is applying this lesson learned in Kansas City in the EFM project with Kansas City SmartPort.*

[31] *Lessons Learned in CEFM ,i*nformal unpublished document by Battelle, (Columbus, OH: November 6, 2007).

UBL-Related Status Codes

CEFM used status, location, and similar codes for events, places, and characteristics that are related to UBL. The Deployment Team noted that CEFM used UN 24 status codes, which is a list of about 300 codes. Although it used UN 24 codes for most of the data elements in CEFM, the Deployment Team had to create several codes for CEFM, one for tendering the freight from the manufacturer to the forwarder, and the others involving Customs (e.g., "Customs clearance, in progress").

- *The Deployment Team noted that the code list is more focused on ocean transportation.*
- *The Deployment Team said that an overhaul to the code list should be considered: "There is no need for 300 different codes."*
- *The Deployment Team suggested eliminating the numerical code and replacing it with short status descriptions, for example use "Received" rather than "113" to avoid the need for all parties to maintain a database of code translations.*
- *The Evaluation Team was told that while using the location codes related to UBL, the Deployment Team discovered that the code was missing a state/province field or element. The Deployment Team reported this to the UBL committee, and the codes have been corrected.*
- *The Deployment Team recommends the use of city name and state/province abbreviation instead of a 3- or 4-character port code.*

Unique Consignment Reference

The Deployment Team identified several issues with the use of consignment in the CEFM deployment test. The Deployment Team said the consignment should be at a small enough level that it will not normally be split and transported in multiple shipments. This was borne out in the CEFM deployment test, where there were only 11 of 871 consignments that were split onto 2 or more HAWBs.

- *The Deployment Team is not sure that all partners will or even could adopt the idea of a consignment. For example, an air carrier is moving containers, and the carrier does not necessarily need to know the consignment(s) inside of a container, depending on the type of carrier, and their level of sophistication.*

The Evaluation Team found in their discussions with the partners that ODW manages at the MAWB level, and the forwarders generally manage at the HAWB level. LB and its manufacturers manage POs, which may or may not have a one-to-one correspondence between the PO and consignment. The Evaluation Team also found that partners did not object to having an additional number to include in their data.

- *The Deployment Team noted that as the provider of airline data for CEFM, FlyteComm provides data only at the flight number level.*
- *The Deployment Team noted if third parties are the source of airline data in future FIH adoptions, some other partner will need to translate flight information at the flight number level to consignments inside the airplane.*

UCR Length

CEFM used the UCR design recommendation prepared for CEFM, which was based on the World Customs Organization's (WCO) Unique Consignment Reference (UCR) number. As noted in section 3, the UCR in CEFM was shortened from the originally proposed 33 to 30 characters to accommodate ODW's integration of the data into its existing system. The proposed 33-character implementation is not a specific WCO recommendation, but was part of the early EFM analysis work provided to the Deployment Team.

- *The Deployment Team noted that there are likely to be other companies that will have limitations for reference number length.*
- *The Deployment Team noted that the EDI specifications allow for 30 characters for reference numbers. However, a common comment by those using the screens is that the UCR number, at 30 characters, was too long, and uses up too much space on the screen.*
- *The Deployment Team recommends implementation of the UCR specification in a manner that provides for a manageable length, perhaps fewer than 20 characters. The Deployment Team believes that the goal of global uniqueness is still achievable even at the reduced length.*

Creation of the UCR number in Adoption

The Deployment Team explained that in CEFM each manufacturer creates UCR numbers at the time consignment is created in CEFM. The Deployment Team noted that there have been discussions in EFM adoption meetings of some third party serving as the creator of UCR numbers.

- *The Deployment Team said it can envision manufacturers willing to use a UCR number, but not being able to implement clients to invoke a "Generate UCR" service from a third party. Also, if a third party UCR generator has an outage it would impact global shipping.*
- *As a result, the Deployment Team recommends that each manufacturer continue to create the UCR number for its consignments in accordance with a globally standardized process.*

Experience with Open-Source Software

The Deployment Team provided the following experience and lessons learned concerning their use of various open source software components in CEFM. While the Deployment Team strongly advocated the continued use of open source, it made the following comments:

- *While the open-source approach is still the preferred approach to implementing Web services in CEFM, it is not without concerns and needed precautions. In particular, because many of the toolkits/add-ins used are from different sources, compatibility and interoperability of different versions are a concern. For example:*
  - *JAX versus AXIS: Variance in how these tools used the WSDLs and associated schemas led to multiple WSDL iterations.*
  - *ANT Deployment Tool maturation or testing: Deployment is not 100 percent reliable and consistent.*
  - *Difference between reference standard (WSDL) and tool implementation of the standard: Tools interpretation of standard for WSDL was not consistent with manually generated reference implementation.*

- *XML Element constraints and automated tools: Error occurred when unconstrained elements cause overflow issues in automatic code generation tools.*
- *XML Schema Namespace issues: Absolute versus relative paths caused problems with various toolkits.*
- *Apache Message Size limitations: Application of security patch reduced size of allowable message to a point where it impacted CEFM messaging.*

4.2.3. System Security

Hypothesis 3. System security features and protection of proprietary information in the CEFM test will demonstrate the ability of EFM technologies to protect sensitive data and restrict access to existing systems.

This portion of the evaluation actually began during CEFM development and continued during the Deployment Team's system test in May 2007, and throughout the remaining test period. The access security was included among the test cases at the system test. In addition, The Evaluation Team had access to CEFM throughout the test. The Evaluation Team followed the work steps included in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Review system access procedures.
- Observe legacy system operation during data transfer.
- Assess business requirement of information security.
- Examine digital certificates in CEFM.
- Interview partner IT concerning CEFM security.
- Incorporate interview and analysis results into draft CEFM Evaluation Report.
- Incorporate comments and final results into final CEFM Evaluation Report.

MOE 1: Legacy Systems and Data are Protected from Unauthorized Partner Access

Through observation of the test and their own use of CEFM, the Evaluation Team was able to determine that the existing systems were protected from access by other partners. Passwords and users authorizations were observed and understood by all users.

- *Users thought the password for accessing CEFM was too hard to use and remember, perhaps a testament to the system security features of CEFM.*

MOE 2: Ability to Restrict Data to Particular Users

The Evaluation Team reviewed some of the test data's XML message formats and found that the digital certificates functioned as designed (see section 3.2 for examples and further discussion).

MOE 3: Improved Security Against Unauthorized Accesses to the System

Based on data collected by the Deployment Team during the test, there did not seem to be any instances of unauthorized access to CEFM. A number of partners and their users complained about the complexity of the password used for CEFM access, which may be a testament to the level of access security provided.

- **Self-Certification:** Self-certification for digital certificates is still acceptable for pilot test purposes, but with the release of Internet Explorer v.7, the use of these certificates caused additional steps to be necessary to access partner Website.
- **Apache Security:** Using the default installation Apache did not correctly reject invalid or unauthorized certificates. It wasn't until a suite of test cases was developed that this problem was discovered.

4.3. CARGO VISIBILITY

The purpose of this section is to discuss the hypotheses associated with the Cargo Visibility study area being evaluated for CEFM. Each hypothesis and its associated MOEs are discussed with an indication of whether or not the hypotheses were met, including participant perceptions and results of test data evaluation. The subsections that follow discuss the evaluation and findings in more detail.

4.3.1. Improved Supply Chain Visibility

This portion of the analysis evaluated the accuracy, timeliness, and usefulness of information collected via CEFM and compares the CEFM data against current visibility data on the LB supply chain. The MOEs in this hypothesis deal with the timeliness and quality of CEFM data. The Evaluation Team followed the work steps first defined in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Obtain information about current visibility measurement.
- Interview users about cargo visibility improvement.
- Assess unique shipment transaction identifier.
- Examine use of CEFM tools to improve visibility.
- Assess improvement in accuracy of supply chain data.
- Assess ability of users to trace shipments.
- Incorporate interview and analysis results into draft CEFM Evaluation Report.
- Incorporate comments and final results into final CEFM Evaluation Report.

This portion of the evaluation involved interviewing the partners to determine how they currently trace shipments and to what extent they have visibility of shipments in the supply chain. The Evaluation Team had access to the system throughout the test to observe consignments and become familiar with the kind of information presented to users in the various reports and outputs from the system. During the test, the Evaluation Team created open consignment reports both to examine unusual shipments and for later analysis in the evaluation. The Evaluation Team interviewed partners

in Columbus and Hong Kong during the test period, and had numerous follow-up phone and email exchanges after the test ended (see *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix, A, which contains interview reports for each partner, under separate cover). Table 24 presents the two hypotheses that were or will be evaluated (private and public sector, respectively) as part of the Cargo Visibility study area. Each MOE for the hypothesis is discussed below. Items in italics under each MOE represent observations or comments from users during the interviews and follow up.

MOE 1: Improved Tracking Information and Ability to Trace Shipments

Partners agreed that CEFM information provides better visibility. They agreed that if CEFM applied to all shipments there would be measurable benefits. Users have the ability to trace shipments with less effort required because of automated capture of air and other status data. LB has an existing shipment tracing system. ODW has the receiving-related information about shipments available to customers and partners in its Scoreboard system. Forwarders do not have complete tracing systems per se. Each partner agreed that CEFM provided information that could be used, if necessary, for tracing shipments. The extent of improvement in the information is discussed as follows. Quantification is primarily in the administrative savings in the Productivity study area immediately following Table 24.

- *Star Columbus does not currently have access to EDI but the Hong Kong office does. The Columbus office uses its parent company's (Schenker) system to track non-Hong Kong shipments. The CEFM data could provide data that could be used for shipment tracking, if it applied to all Star shipments.*
- *Currently, the only advance information ODW receives is the pre-alert or the appointments from Forward Air. ODW did not indicate the need for shipment tracing, but the CEFM data would be available to them for tracing if needed.*

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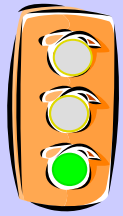
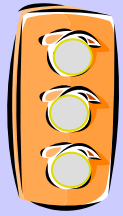
Table 24. Results of Private and Public Sector Cargo Visibility CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. Implementation of the CEFM on LB supply chains will yield improved supply chain visibility. (Defined as accuracy, timeliness, and usefulness of information not currently being provided.)	1. Improved tracking information and ability to trace shipments. 2. Improved cargo status information. 3. Improved air mode information. 4. Increased timeliness and quality of visibility information.	• Baseline types of information. • DSRs. • Shipment information from ODW. • Test data from CEFM • Pre-alerts from forwarders. • CEFM-generated consignment status reports.	• Comparative analysis of baseline versus CEFM types of information. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements.	 Green	• Partners agreed that CEFM information provides better visibility. They agreed that if CEFM were integrated with existing systems and applied to all shipments, there would be measurable benefits (see all MOEs). • CEFM provided significantly improved status information along the entire supply chain, including the ASN and air mode data. The Federated Status Report of all supply chain events in CEFM was not previously available to any partner (see MOEs 2 and 3). • CEFM improved data timeliness at forwarders and at other partners including earlier access to overseas supply chain events and status reports. Earlier access to data allows Barthco to process customs clearance documents earlier (see MOE 4A). • CEFM improved data quality because it eliminated data entry after the manufacturer's booking. This reduced data entry errors, improved accuracy of XML data compared with EDI, and made it easier for all partners to respond to errors or discrepancies (see MOE 4B).

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
2. State and/or Federal Government agencies will find greater value in the improved cargo visibility information demonstrated by the CEFM such that the data can be utilized by applications such as governmental transportation planning, safety, and security.	1. Improved information transfer to government agencies. 2. Enhanced safety and security information.	• Public sector interviews in person or by telephone. • Public sector surveys via email or standard mail.	• Qualitative analysis of agency perceptions regarding the adequacy/applicability of CEFM information to meeting the agencies' transportation planning, safety, and security needs.	 Gray	• The public sector and industry-wide benefits and impacts will be covered in the second evaluation report. • The analysis will examine visibility improvements in industry and additional analysis of cost of quality and efforts to quantify the improvement in data quality in CEFM. • The CEFM Deployment and Scalability Evaluation Report will include lessons learned in cargo visibility efforts throughout the industry and government from the industry-wide supply chain research.

MOE 1: Improved Cargo Status Information

One of the most important capabilities that CEFM demonstrated was providing improved status information to all partners, which is used to provide enhanced supply chain visibility. Cargo visibility is an important goal throughout industry as evidenced by a very relevant September 2007 study by the Aberdeen Research Group.[32] Figure 33 is extracted from that report and shows an industry-wide view of supply chain visibility that parallels what was included in the CEFM requirements and demonstrated in the deployment test.

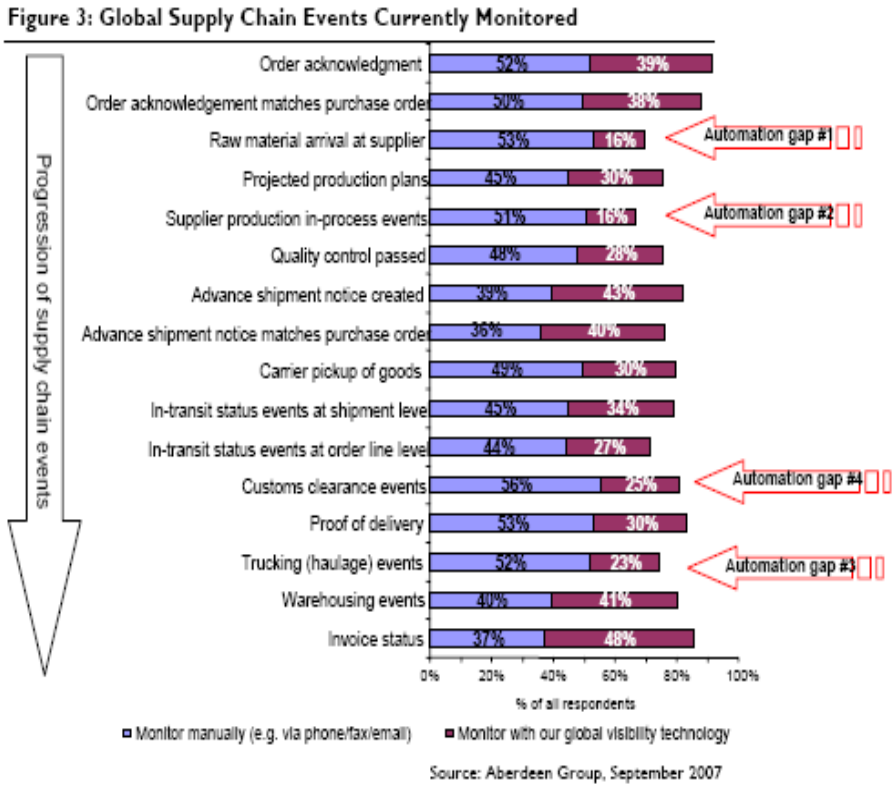


Figure 33. Aberdeen Survey for Supply Chain Events.

Note that CEFM addresses automation gaps #3 and #4 in the above figure. CEFM provides visibility over these events, largely unavailable in other visibility systems. CEFM provides most of the supply chain events in Figure 33, and provides them largely without the need for manual data entry.

The CEFM partners found the status information provided by CEFM to be useful and agreed that if CEFM applied to all shipments there would be measurable benefits.

- *The supply chain partners described how they could use more accurate status information, but they could provide no quantitative data about potential improvements.*
- *The Advanced Shipment Notice (ASN) and the Open Consignment Report (OCR) in CEFM were reviewed by Hellmann Hong Kong, which referred to the reports as "Very convenient; cannot see this in other system."*

[32] *"A View from Above:Global Supply Chain Visibility in a World Gone Flat," Aberdeen Research Group September 2007.*

- *Hellmann Hong Kong examines the ASN to review MAWB, HAWB, weights, cargo/ documents received times.*
- *Star Hong Kong checks on MPO status and booking information, and also views the ASN.*
- *Hellmann Hong Kong noted that it can see entire summary of pre-shipment information.*
- *Star Hong Kong said "CEFM system is quite helpful for us," and "If we can find the "GAC date, expected quantity, shipper's contact information, and NDC Date in the open consignment [that] will be great."*
- *CEFM improved data availability at forwarders and at other partners. The ASN was not previously available to one forwarder. Star said "If we could use the CEFM information for all of our origins, it would certainly cut out a lot of time we spend retrieving emails and shipment information from various origins, and putting our files together each morning."*
- *Forward Air doesn't send any automated data to ODW or LB at present. CEFM provides arrival information at Forward Air that could provide advance notification to ODW that it will be receiving appointment requests.*
- *ODW said the "Departure Complete" element would be useful and "will give us a better glimpse into the near future and what freight should be arriving within maybe a 2-3 day window."*
- *LB management indicated that visibility at the earliest opportunity, such as CEFM would provide, has advantages for planning and scheduling. Being able to determine what is in the carton is of value to the logistics operation and distribution center personnel.*
- *LB indicated that carrier data would be helpful and useful. While the air freight data it currently receives meets industry standards, LB continually stresses the importance of more accurate data with its service providers. LB continues to raise its internal expectations for this type of data.*

The Federated Status Report of all supply chain events in CEFM was not previously available to any partner and provided data more quickly and with less effort than current data. The Federated Status Report is automatically created, without the need of any data entry, and consists of data requested from and automatically provided by each partner shown. This report and capability are very rare in industry in that they pull together data from multiple separate companies, in this case, six firms. Some of the firms have some of the data available on Websites, but no one has all of this data available, particularly with virtually no effort required to create it. Users were very positive toward the content of this report and of the near real time nature of the data.

Another important aspect of this status data is that it includes air mode data that was previously available only by telephone or from multiple airline data Websites. By its nature, CEFM was limited in the air data it had, but the air interfaces and the capture of the air data in the Federated Status Report is still a very important benefit of CEFM.

As discussed in sections 2 and 3, CEFM was designed to produce an Open Consignment Report that would mimic the current Daily Status Report that forwarders prepare for The Limited. Within the

scope of the CEFM test, the DSR could not be completely replaced because LB relies on archived DSR data to complete regular macro-level analysis for all shipments coming out of Hong Kong and other origins, and this type of analysis drives internal LB reports. The OCR is available on demand, and is available to all authorized partners. A key aspect of the OCR is that it requires no effort on the part of any party to respond to the status request or to prepare the report.

- *Star said that the completion of the DSR is where CEFM could provide the most assistance, if all of Star's shipments were in the system.*
- *At Star, the DSR is a simple spreadsheet that gives the basic MAWB and customer information. It is not specific on a HAWB level, but it does provide the origin with the status from Star's end for each MAWB and any exceptions. The OCR contains both MAWB and HAWB data. The OCR spreadsheet, when exported to the local computer, can be used to group consignments by HAWB or MAWB.*
- *Forward Air typically tracks by MAWB, and thought the OCR spreadsheet from CEFM might be helpful for receiving MAWB information even further in advance than when the forwarder currently sends it.*
- *ODW thought the structure of the OCR report is good, and could be good for expanding CEFM since it is not too specific to LB supply chain. "This is a significant improvement over current version and the availability of current status reports."*
- *ODW used the OCR to review current shipments and expected shipments. ODW exports the OCR and sorts it in Excel based on the date to see what is coming in.*
- *LB rolls DSR data from all partners into a report database accessible to LB users. If LB had the OCR for all forwarders, the Excel spreadsheets could be easily combined or used separately by forwarder without additional processing.*

As noted in section 3.5, one of the CEFM Business Requirements that was achieved was to provide status information as shown in Table 17.

MOE 3: Improved Air Mode Information

As noted in MOE 2 above, automated air information is new to the LB supply chain. Because of operational constraints in the deployment test, only three airlines provided information. Nevertheless, the concept of capturing airline data and of establishing trading partner relationships with either airlines or a third-party airline data firm (such as FlyteComm that was used in the deployment test) was proven. The airline data, as shown in the Federated Status Report in Figure 10 and Figure 33 above, included interim stops, visibility data not previously available.

Another aspect of airline data that was new in CEFM was information about JFK arrivals. As discussed in section 3, no partners had visibility of JFK arrivals or JFK-Rickenbacker truck shipments in the past.

- *ODW said it does not know about JFK shipments until it receives a phone call for an appointment.*
- *Prior to the deployment test, LB noted that it gets its information from freight forwarders, and not from the airlines directly. While the air data that LB currently receives meets*

industry standards, LB remains interested in the better visibility that may be possible from looking in more detail at airline data.

- *LB indicated after the test that direct air information would be beneficial, and believes it would be "a little more real time than the DSR." LB also noted that it will be receiving an airline status update message as part of its SAP project and expects it to be more real time than available on the DSR.*

Knowing that a shipment went to JFK might provide ODW with advanced notice of the expected arrival in Columbus and allow all partners to have visibility they did not have before. Knowing that consignments were in New York coming to Columbus by truck might allow LB to make decisions to divert consignments to sites east of Columbus.

The following discussion regarding the Supply Chain Productivity study area identifies potential labor savings from obtaining the airline data automatically. The benefit of having airline data in the Federated Status Report is part of the substantially improved visibility that partners have with CEFM data. Unfortunately, no partner has been able to provide any information to help quantify the benefits of this improved visibility, but comments from CEFM users (as noted above) clearly indicated this to be an important qualitative benefit.

It should be noted here that there were limitations in the CEFM air mode information collected during the test. This was discussed in more detail in sections 3.2 and 4.2 above under the Deployment Test Description and the System Usefulness study area, respectively. As the following lessons learned indicate, these limitations could be mitigated in any future implementation so that the full value of air mode data could be realized.

MOE 4: Increased Timeliness and Quality of Visibility Information

The visibility information provided by CEFM does not require any manual data entry after two entries by the manufacturer. This improves the quality of the data compared with current supply chain exchanges. Since the data is sent over the Internet as soon as data elements are available in partners' existing systems, it is more timely than current data. This subsection highlights improvements related to timeliness and quality.

- **A. Timeliness Improvements and Benefits:** In interviews and discussions, ODW and Barthco provided to the Evaluation Team important insights into the impact of having information earlier. The items discussed below are derived and synthesized from analysis of CEFM data and discussing current operations and the use of CEFM data with the supply chain partners.
  - Earlier Access to PO Data: Currently, downstream partners do not have access to PO data until data is reported in cargo documents or ASNs. With automated inputs of PO data in CEFM and the ability of authorized partners to access data in the system, PO data is available more than 4days earlier for Columbus partners, and more than 2 days earlier for Hong Kong partners. Having such information earlier allows partners to have an indication of what is coming and to better plan for the workload for the next week or more.

- *Both Star and Hellmann in Hong Kong reviewed the PO file to compare with bookings received from manufacturers and verify their relevance.*
- *Kingmax said that compared with current booking procedure, using CEFM seems easier.*

– Earlier Access to Manufacturer Booking and Tendering: Knowledge of POs by forwarders and other partners listed above is currently somewhat general in nature. Booking and tendering information from the manufacturer is more current and more specific to the consignments that will actually move. This information provides data at least 1 day earlier for the Hong Kong forwarders. This could allow the forwarder to plan for receipt, and begin to arrange for space on aircraft. The Columbus partners would have this manufacturer information more than 3 days earlier than they do currently. This gives each partner the opportunity to forecast its workload and to function more efficiently.

- *Both forwarders in Hong Kong currently receive shipment information from manufacturers via phone, fax, and email. This requires labor at the forwarder to enter the data into its existing systems. In addition, the manufacturer must enter all information about the shipment (PO#, quantity, style, weight). With CEFM, less data is entered to book and tender the freight.*
- *Manufacturers currently prepare an email for the forwarders within 30 minutes to 2 hours after the truck departs. With CEFM, the data is at least 1 day earlier than currently.*

– On Demand Status Data versus Current Pre-Alert and DSR: The LB supply chain is characterized by the use of forwarder-prepared pre-alert emails and daily status reports, as well as regular analysis of the EDI transmissions received by LB. While LB utilizes both EDI transmissions and manually prepared documents, Barthco and ODW rely extensively on the information contained in the pre-alert spreadsheets.

- *With the status information available in CEFM and the ability of any user to create an on demand report, comparable reports about shipments can be available 4-6 hours earlier at the office of the Columbus freight forwarder, and even earlier than at present for other Columbus partners.*

LB can have better forecasts of shipment arrival at DC to better prioritize work. Such automated data could be useful for planning and scheduling at LB.

- *At LB where DSRs are received and used, receipt and roll up is a completely automated process. A Visual Basic (VB) program gathers the DSR Excel files from a dedicated email box; at scheduled times during the day, the VB program rolls them up together; summarizes the information into one Excel file; and sends the file out to an internal distribution list. This VB program also populates a shipment details database, which feeds the creation of macro-level transit reports.*

– Eliminate Email to Forwarders About US Arrival: Currently, ODW emails the arrival time at the CFS to the forwarders in Hong Kong. With CEFM, ODW would be able to eliminate the email, and more importantly, the arrival data would be available as soon as it was posted to ODW's system (see the Productivity section 4.4). Having information earlier about US arrival could allow LB to make improved decisions about outbound truckload versus LTL shipments from the DC, where the CEFM freight will be delivered.

- Advanced Notice of Movement from Manufacturer to Forwarder: With CEFM, LB would have access to status information about freight tendering by the manufacturer and receipt by the forwarder. This is earlier than the email and EDI transactions currently prepared by the manufacturer and forwarder and sent to LB. The advanced data might allow LB to identify when shipments are delayed to better schedule DC workload and identify exception shipments.
- ASN Available Sooner than Current EDI: The Evaluation Team analyzed the CEFM data and selected ODW shipment data to determine that the ASN data in CEFM was available at least 6 hours up to 1 day earlier than the current ASN. This means that ODW can process shipment data sooner.
  - *Hellmann said that while it normally sends the ASN by EDI within 4 hours after "Wheels Up," it is not sent until the next day if flight is at night. CEFM data is available as soon as produced by the existing system.*

  The earlier shipment data means there is reduced occurrence of missing data on the warehouse floor of the CFS. Currently, the ASN and other data are presented to warehouse workers on hand-held computers, which they use in the picking and packing process.
  - *ODW explained that if it doesn't have the MAWB and other shipment-identifying information received electronically, then it has to do a manual data entry of MAWB, and so forth, and then proceed with shipment processing in the warehouse. CEFM has meant an improvement in data availability in the warehouse from 80-85 percent for non-CEFM freight to 90-95 percent with CEFM shipments.*
  - *The ODW warehouse manager plans for staffing the warehouse about 1 day in advance. It would be helpful if the warehouse manager knew what was coming and when. LB provides ODW with annual forecasts, but the warehouse manager said that knowledge of the "Wheels Up" information for a shipment would be useful in planning staffing resources.*

  Missing data requires warehouse workers to leave their stations/forklifts and seek additional or corrected information from the warehouse office (see MOE 2 in the Productivity section 4.4.2 for a quantification of this benefit).

- Earlier Information than DSR at Barthco: Currently, LB sends the DSR to Barthco to identify shipments that will be coming to Columbus. The OCR available within CEFM to Barthco would be available at least 4-6 hours sooner than the DSR, which provides Barthco with additional time to plan for and arrange customs clearance documentation.
  - *Barthco said it uses the OCR to see if a flight has left and then begin working on the documentation they have to prepare. Barthco does not always receive the Wheels Up email from the forwarder, so CEFM has helped them process shipments earlier.*
  - *Barthco used CEFM when they received a "Documents Received" email with the attachments and looked up the appropriate shipments using a MAWB or HAWB number.*

- *Barthco found some HAWBs in CEFM that were not in the email from the forwarder and used that information to contact the forwarder to see when the documents would be available.*

Earlier information about shipments may end up allowing earlier delivery of the freight if clearance is able to occur in advance of the freight being ready for delivery from ODW.

- **B. Data Quality Improvements and Benefits:** During interviews and discussions with ODW and Barthco, the Evaluation Team gained important insights into the impact of having higher quality data than is available today. The LB and its partners described numerous measures and reports that LB uses to measure data quality and performance of the supply chain. One of the Evaluation Team's findings in the deployment test is that LB has spent considerable effort in measuring the quality of different facets of the supply chain and measures, or requires its partners to measure, the quality of supply chain data. The following items discussed are derived from discussions with the various supply chain partners and their current and potential use of CEFM data.

  None of the partners could provide any quantified information for improvements in data quality. However, there is a body of literature related to data quality and to the cost of quality, which is a measure of the cost of **not** having high quality data or products. According to a 2002 study by the Data Warehousing Institute, the annual cost of data quality problems in US industry is $600 billion.[33] The Evaluation Team applied some cost of quality principles to the supply chain represented by CEFM.

  – Reduction in Data Entry Errors: Data entry errors are a major source of data quality problems and as systems become more sophisticated, the more important quality becomes. Industry studies have established a 0.1 to 2.3 percent error rate for manual data entry.[34] In the LB supply chain included in the deployment test, there were at least three related aspects of data entry that could represent important areas of improvement in data quality:

    - *No data entry after manufacturer: CEFM requires no data entry by any user except for the booking quantities and tendering event confirmation by the manufacturers.*
    - *No re-keying: The two key status reports that are prepared by CEFM do not require users to re-key any information; current email-based reports require a considerable amount of re-keying. Not only does this increase the probability of errors, but it requires additional labor.*
    - *Reduces date entry errors: When considering the costs of data entry errors, improvements in data quality such as CEFM could provide may have indirect cost savings as well, including: senior management time save; improved operations personnel motivation; improved team work among company departments; mind-set change; and producing quality saves money.[35] In addition, eliminating manual data entry also reduces administrative costs involved in correcting errors, and reducing overall setups, idle time, and costs of expediting.[36] Use of CEFM data would eliminate entry errors for partners, but only if the system is integrated as in*

[33] "Data Quality and the Bottom Line: Achieving Business Success through a Commitment to High Quality Data." The Datawarehousing Institute 2002.
[34] The "Measuring Outcomes of Clinical Connectivity (MOCC) Trial: Investigating Data Entry Errors in the Electronic Primary Care Research Network (EPCRN), doi: 10.3122/jabfm.2007.02.060069.
[35] "Six Sigma Case Study: Converting Paper to Electronic Documents," by Nijah Goyal, source: < www.isixsigma.com>, last accessed April 29, 2008.
[36] ROI Characteristics 2002. Source: <www.barcodepartners.llc.com>.

ODW; it would reduce entry errors (or re-keying) if non-integrated users could capture CEFM's Excel spreadsheets, and copy from the CEFM data to other systems or reports.

- *Reduced errors from small partners without EDI: There is very little delay and very little effort required for ODW to do the EDI reports to LB, except for those small freight forwarders that don't have EDI. These require a lot of manual data entry, which increases the chances of errors. If the small partners also have CEFM, such data entry error opportunities are reduced.*
- *Maintains quality required by Government: CBP's documentation about Air AMS says "In order to continue processing through AMS, participants must maintain a high level of quality as well as a low error ratio. Participants who do not maintain these standards may be placed in a probationary status or removed from AMS." CEFM used in conjunction with Air AMS could help maintain the quality needed.*

– XML Data More Accurate than EDI: ODW told the Evaluation Team that the ASN data received from CEFM was more accurate than the EDI version of the ASN it currently receives. ODW said it is common currently to have to make manual corrections in shipment data based on EDI, but that is not required with CEFM. There is also less technical effort with CEFM data than to process EDI and fill data gaps in ASNs received currently at the CFS.

- *ODW said that it was not able to quantify the number of errors in EDI and that there is a great deal of variation in the amount of time it takes to correct the EDI errors.* This is discussed in more detail in MOE 5 in the Productivity hypothesis in 4.4 below.

– Easier for Forwarder to Respond to Discrepancies from LB: Currently, LB emails a discrepancy report to each forward, which the forwarders need to research and provide a response back to LB with the status and proposed resolution of the discrepancy. While LB felt that the data quality within CEFM was equivalent to the DSR and EDI data that it receives, other partners such as ODW felt CEFM data was more accurate than EDI. Thus, the higher quality data available from CEFM could make it easier for the forwarders to obtain up-to-date and accurate information about its shipments to LB, especially if CEFM included all of the shipments ODW handles for LB.

– Fewer Trips to Verify Data: Improved data accuracy at the container freight station means a reduced number of trips to the office to verify data (see the bullet in the discussion above about timeliness of data and see MOE 2 in section 4.4.2 for quantification).

- *ODW said that CEFM has meant an improvement in data availability in the warehouse from 80-85 percent for non-CEFM freight to 90-95 percent with CEFM shipments, but that it could not determine either the number of occurrences that require trips or the amount of time lost in verifying the data.* This is discussed in more detail in MOE 5 in the Productivity hypothesis in section 4.4.

– Data Quality Within the Supply Chain: The LB issues a monthly performance report (Scorecard) to each forwarder and reports on line performance; EDI validity and discrepancies; EDI timeliness; customer service quality; DSR quality; and PO update percentage in the LB's Booking Information Management (BIM) system. In addition, the

monthly Scorecard report contains a Forwarder Feedback and Acton Plan, which the forwarders are required to provide to LB in response to the Scorecard information (see *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report, Appendix E*, for a sample of the monthly report form, provided under separate cover).

The LB generates a weekly transit report that it uses in house to calculate transit time and rolls up the information into the monthly Scorecard report. This report is described in more detail in MOEs 2 and 3 in the Productivity section in 4.4. That report has a 5-10 percent error rate, showing an important opportunity for improvement in data quality.

- *LB thought that CEFM might be able to facilitate integrating and sharing of supply chain information. LB thought this might provide business opportunities for smaller service providers of information. For example, LB currently strives for improved visibility into the airline activity that could be provided by companies that specialize in airline data gathering.*
- *LB management thinks the new capabilities will be particularly useful with smaller suppliers who are less sophisticated, and for shippers that do not have a high level of sophistication within their internal systems.*

Lessons Learned from CEFM Test

Following are the lessons learned from the CEFM test:

- *Partners who integrate are better able to benefit for the quality of the data because they do not have to re-key.*
- *The OCR should be expanded to include all data elements needed by the users for the various status reports*
- *The airline data capability should be examined carefully to improve its flexibility to address multiple airlines moving freight on the supply chain.*

4.3.2. Public Sector Benefits

The Evaluation Team intends to follow the work steps first defined in the CEFM Detailed Test Plans dated October 4, 2007. The evaluation results will be reported in the CEFM Deployment and Scalability Evaluation Report to be completed in September 2008. These work steps for the public sector benefits are:

- Formulate lessons learned and presentation on improvements.
- Interview Government personnel involved in transportation/security.
- Assess improvement in information transfer to Government.
- Analyze enhancement in safety/security information to Government.
- Incorporate interview analysis and results into draft CEFM Deployment and Scalability Evaluation Report.
- Incorporate comments and results into final CEFM Deployment and Scalability Evaluation Report.

The second report, the CEFM Deployment and Scalability Evaluation Report, will examine how the improved information from CEFM might benefit the Government, or help promote Government initiatives and interests such as congestion, safety, and security. This portion of the effort will be largely qualitative and anecdotal, but will place visibility improvement in the context of overall national freight objectives and policies. The Evaluation Team will review other research studies and freight improvement projects and interview appropriate officials.
Following are the two MOEs in this hypothesis that will be addressed in the CEFM Deployment and Scalability Evaluation Report:

1. Improved information transfer to Government agencies.
2. Enhanced safety and security information.

Another important feature of the CEFM Deployment and Scalability Evaluation Report will be visibility improvements in industry, and additional analysis of cost of quality and efforts to quantify the improvement in data quality in CEFM. The CEFM Deployment and Scalability Evaluation Report also will include lessons learned in cargo visibility efforts throughout the industry and Government from the industry-wide supply chain research.

4.4. SUPPLY CHAIN AND LOGISTICS PERFORMANCE

The purpose of this section is to discuss the extent to which there is a potential for improving supply chain performance through the application of data obtained from improved CEFM-type data and the use of that data to improve supply chain performance. This set of hypotheses deals with the broader performance objectives related to supply chain improvement. Each hypothesis and its associated MOEs are discussed with an indication of whether or not the hypotheses were met, including participant perceptions and results of test data evaluation. The subsections that follow discuss the evaluation and findings in more detail.

4.4.1. Potential for Improved Logistics Performance

The first hypothesis focuses on the LB and its role as the supply chain owner. The Evaluation Team reviewed the potential for supply chain improvements from automated and improved supply chain data from CEFM. The emphasis in this evaluation was on the potential use of improved supply chain data, whereas the hypotheses in the previous section on Visibility focused on the adequacy of the data itself. The MOEs in this hypothesis are more classic measures of supply chain improvement, based largely on actions that can be taken by a supply chain partner in response to the improved information that is available from CEFM. The Evaluation Team followed the work steps included in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Conduct interviews related to improved supply chain management.
- Assess reduction in dwell or idle time waiting for information.
- Analyze use of supply chain management tools by partners.
- Assess improvement in transit time and schedule adherence.
- Assess reductions in time to release freight.
- Assess use of CEFM data to reduce shipment errors.
- Incorporate interview results and analysis into draft CEFM Evaluation Report.

- Incorporate comments and results into final CEFM Evaluation Report.
- Incorporate industry-related results into draft CEFM Deployment and Scalability Evaluation Report.
- Incorporate comments and results into final CEFM Deployment and Scalability Evaluation Report.

This portion of the evaluation involved comparative analysis between current operations and operations that would be conducted using the kind of information available from CEFM. The evaluation involved assessment of interviews, surveys, and anecdotal information from participants and analysis of consignment data collected during the deployment test. The effort included interviewing the partners to determine how they used supply chain management tools and how they could use CEFM data to improve the supply chain. The Evaluation Team had access to the system throughout the test to observe consignments and become familiar with the kind of information presented to users in the various reports and system outputs. During the test, the Evaluation Team created OCRs both to examine unusual shipments and for later analysis in the evaluation. The Evaluation Team interviewed both Columbus and Hong Kong partners during the test period, and had numerous follow up phone and email exchanges after the test ended (see *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report* , Appendix A, under separate cover).

Table 25 presents the three hypotheses that were or will be evaluated as part of the Logistics Performance study area. Each MOE for each hypothesis is discussed in the subsections below. Items in italics under each MOE represent observations or comments from users during the interviews and follow up. It should be noted that because of unexpected changes in its business operations, the LB did not use CEFM or otherwise evaluate the use of CEFM data during the deployment test. As a result, the MOEs discussed below deal with the potential for improvement from the use of such data.

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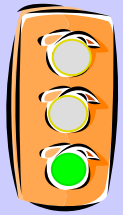
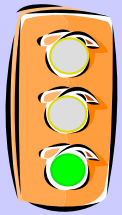
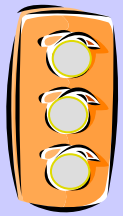
Table 25. Results of Private and Public Sector Supply Chain and Logistics Performance CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. Implementation of the CEFM on LB supply chains will indicate the potential for improved supply chain logistics performance. (Defined as benchmarking the performance of the overall supply chain. The Limited Brands and its customers are the beneficiaries.)	1. Reduction in lost cargo via more accurate information. 2. Increased schedule adherence. 3. Reduced end-to-end transit times. 4. Reduced dwell time at nodes. 5. Improved timeliness of freight release process.	• Participant records. • CEFM system outputs. • Current DSR data as well as consignment status reports generated by CEFM. • Measurements of time to prepare DSR before and after CEFM. • Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • End-user customer interviews. • Design/Deployment Teams' and participants' estimates of costs to map across data sources and implement interfaces with CEFM system.	• Compared available baseline supply chain data from each supply chain participant with CEFM data. This included the DSR and the time it takes to create the DSR before and after CEFM. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements. • Factor in interviews/ surveys results and anecdotal information from participants. • Estimate qualitative and quantitative (as data permits) improvement.	 Green	• LB has a number of performance reports that it issues to its partners, including a 96-hour transit time standard. The users believed that if CEFM applied to all shipments there would be performance improvements (see MOEs 2 and 3). • CEFM measured both dwell time at nodes and overall transit time; none of the partners thought that the schedules or transit time of CEFM test shipments were affected, primarily because test shipments were a relatively small percentage of the total, and no partner made an effort to separately manage those shipments (see MOEs 3 and 4). • Data from CEFM could relieve a backlog in the processing of customs clearances by Barthco, which could improve the timely release of shipments from ODW to LB (see MOE 5). • Air AMS was implemented October 16, but isn't being used operationally by the partners. ODW and Barthco

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
					expect significant improvement in the timeliness of the release process from Air AMS (see MOE 5).
2. Implementation of the CEFM supply chains will indicate the potential for increased productivity for logistics services. (Defined as improved business efficiency and information from the freight forwarders and third-party logistics providers. The supply chain participants are the beneficiaries.)	1. Reduced erroneous billings. 2. Reduced labor applied to solving shipment errors or problems, such as misroutings. 3. Reduced delays in transferring custody from one intermodal partner to another through improved information exchange. 4. Increased schedule adherence/avoidance of penalties/detention fees. 5. Reduced data entry and staff time from automatically generated status reports. 6. Improved accuracy of information transfer from brokerage houses to CBP.	• Participant records. • On-site observations and timings. • CEFM system outputs. • Participant interviews in person or via telephone. • Participant surveys via email or standard mail. • Design/Deployment Teams' and participants' costs to map across data sources and implement interfaces with CEFM system.	• Compare before and after data (or with or without) regarding information from each supply chain participant. • On-site time and motion studies. • Analysis of responses to surveys and assessment of test observations versus CEFM business requirements. • Model and/or forecast improvements where test data is limited, including technology descriptions, and operations and implementation costs. • Factor in interviews/ surveys results and anecdotal information from participants.	 Green	• CEFM eliminated manual data entry errors for supply chain events. No data entry was required by any partner after manufacturer tendering of the freight. CEFM also eliminated re-keying along the supply chain if system is integrated with legacy transportation management applications (see all MOEs). • There are quantified labor savings attributed to the improved data available from CEFM and the reduced data entry (see MOEs 2 and 5). These include reductions in time to: – Enter shipment data at the manufacturer. – Prepare Daily Status Report and other status reports at all partners. – Resolve data errors at the CFS. – Monitor hot shipments at LB. • LB maintains visibility on hot shipments and LB and

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
					the partners would be able to manage such shipments better with CEFM data (see MOE 2).
3. For performance benefits successfully realized or indicated in the two private sector hypotheses, derived public sector transportation system and environ-mental benefits can be measured or forecasted	1. Reduced traffic congestion through reductions in erroneous moves and reductions in dwell times at nodes. 2. Reduced air pollution associated with congestion reduction (see above). 3. Enhanced safety and security.	• Results from the assessment of the two private sector hypotheses. • Environmental Protection Agency Air Quality tables. • Public sector stakeholder interviews in person or via telephone.	• Application of environmental cost factors to the data. • Other public sector benefits estimation techniques. • Model and/or forecast benefits where test data may be limited.	 Gray	• Most of the analysis will be conducted during the spring and summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report • The analysis will include logistics performance and productivity improvements in industry and additional analysis of cost of supply chain improvements in industry, particularly those related to better information for decision making.

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MOE 1: Reduction in Lost Cargo Via More Accurate Information

The deployment test itself did not result in any exception shipments and the Evaluation Team was not able to obtain useful information about lost shipments. LB continually measures the performance of its partners and maintains reports of schedule and transit time adherence (discussed in more detail in the following MOEs). The Evaluation Team found that lost cargo is not a key problem on the LB supply chains tested. However, LB said that 10-15 percent of the shipments are considered "hot shipments" that require better visibility and more detailed tracking than normal shipments.

At least one of the partners, ODW, maintains spreadsheets of hot shipments that allow it to more closely manage those shipments for LB. Figure 34 shows an extract from one of the Victoria Secret's hot shipment reports from June 2007. The spreadsheet includes a comment column with information about the hot shipment.

	A	B	C	D	E	G	H	I	J	K
	SHIP #	LINE #	MAWB	HAWB	PO	DIV	SCAC	EVENT CODE	EVENT DESCRIPTION	FWDR
8	82510	9	49401607115	HKT559647	85642	EXP	FRWD	1028	HOT PER CUSTOMER	HIF
9	82573	1	61843848453	MNL948125	86398	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
0	82573	2	61843848453	MNL948126	86399	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
1	82573	3	61843848453	MNL948574	87927	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
2	82579	1	5782969176	16697	88062	EXP	TOWE	1028	HOT PER CUSTOMER	EXPO
3	82579	3	5782969176	16698	88074	EXP	TOWE	1028	HOT PER CUSTOMER	EXPO
4	82585	4	27200813304	HKT559715	87593	EXP	FRWD	1028	HOT PER CUSTOMER	HIF
5	82696	1	14526103895	20861	87797	EXP		1028	HOT PER CUSTOMER	SOV
6	82696	2	14526103895	20828	87242	EXP		1028	HOT PER CUSTOMER	SOV
7	82697	1	12533301612	DEL67043	87069	EXP	TBA	1028	HOT PER CUSTOMER	EXPO
8	82699	2	1675632174	MNL948651	87466	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
9	82699	3	1675632174	MNL948652	87206	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
0	82699	4	1675632174	MNL948650	87934	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
1	82710	1	95781198515	548940	86380	EXP	TBA	1028	HOT PER CUSTOMER	SOV
2	82738	1	49401752004	HKT559571	87210	EXP	FRWD	1028	HOT PER CUSTOMER	HIF
3	82738	3	49401752004	HKT559761	84539	EXP	FRWD	1028	HOT PER CUSTOMER	HIF
4	82738	4	49401752004	HKT559778	84641	EXP	FRWD	1028	HOT PER CUSTOMER	HIF
5	82748	1	1675632196	MNL948655	88578	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
6	82748	1	1675632196	MNL948655	88578	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
7	82748	2	1675632196	948656	89275	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
8	82748	3	1675632196	948654	86400	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
9	82748	4	1675632196	948832	86401	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
0	82748	5	1675632196	948653	87298	EXP	CTRL	1028	HOT PER CUSTOMER	PAN
1	82755	1	29760726175	SMT296058	87629	EXP	CTRL	1028	HOT PER CUSTOMER	SMT
2	82755	2	29760726175	SMT296059	87630	EXP	CTRL	1028	HOT PER CUSTOMER	SMT
3	82756	1	95781198530	548995	86387	EXP	TBA	1028	HOT PER CUSTOMER	SOV
4										
5	Record	for	EXP	217						

Figure 34. Extract from ODW Hot Shipment Report June 2007.

LB pays special attention to hot shipments as well, and explained that if the DSR doesn't have the information about a particular hot shipment or if the DSR information isn't as detailed as it would like, LB calls the forwarder for that information. LB indicated that 10-15 percent of shipments are hot, but that this is somewhat seasonal, with more hot shipments during peak season.

The use of improved information in reducing lost cargo in other supply chains and studies will be investigated in more detail in attempting to quantify this benefit in the CEFM Deployment and Scalability Evaluation Report.

MOE 2: Increased Schedule Adherence

The LB supply chain chosen for the deployment test was highly predictive. It involved orders by LB from four manufacturers in South China through the airport in Hong Kong to LCK-Rickenbacker Airport in Columbus, and subsequent delivery to LB's distribution centers by ODW and its truckers. For an apparel company like LB, adhering to delivery schedule is important. POs to the manufacturers include two important schedule dates. One is the Goods at Consolidator (GAC) date, which is the date by which the cargo needs to be at the forwarder's office in Hong Kong. The second important schedule date is the required delivery date at the LB distribution center of the iN Distribution Center (NDC) date. LB currently uses NDC date as a measure of supply chain reliability and provides a periodic report to its partners to show them how well the supply chain is performing. Figure 35 is a weekly report from LB that shows the number of and percentage of shipments that did not arrive as expected, and subsequently missed the NDC date.

Brand	A/O	Total FOB Anticipated		Total FOB Misses (LLS & MAST)		
	On time %	Shipments	Units	Shipments	Units	Percentage of Units
EXP	97.8%/NA	223	1,056,740	50	220,914	20.9%
LTD	95.5%/NA	125	322,524	1	202	0.1%
VSD	93.4%/NA	0	0	0	0	-
VSS	99.0%/NA	586	1,938,542	14	7,728	0.4%
LNY	100%/NA	176	659,448	4	22,668	3.4%
Total	**96.5%/NA**	**1,110**	**3,977,254**	**69**	**251,512**	**6.3%**

Figure 35. LB Weekly On-Time Report for the Week of February 2-8, 2008.

Following are several statements from LB during the several interviews conducted by the Evaluation Team:

- *LB said that typically shipments that are late for consolidation at the Hong Kong forwarder (the GAC Date) will have a late delivery at LB in Columbus.*
- *LB explained that the variation in the on time percentages among brands in Figure 35 does not mean one brand is "worse" than another. These percentages usually relate to that brand's sourcing strategy, for example, emphasis on cost or emphasis on transit time reduction.*
- *LB said that it doesn't look at the data from an individual PO perspective (except for hot shipments), but by the number in a group that have been cleared. LB explained that Customs clearance is key for LB to determine how many orders are on hand at the CFS, and how many of those are cleared and ready for delivery the next day.*

LB said its primary database that is used for shipment tracking combines DSR data with EDI transmissions from the forwarders. There is a 10-15 percent mismatch between the two, which is identified to the forwarder for resolution. Once the data has been automatically verified and combined with EDI, a transit report is created that LB uses to measure on time performance. For the purpose of this evaluation, LB created a transit report of all CEFM test shipments for the Evaluation Team. The report consisted of an Excel file that included a column with an "O" indicator if the shipment is on time and an "L+1" indicator for shipments that are 1 day late, and so forth. The data showed that 6.54

percent of the CEFM test shipments were late. LB's data quality is likely to improve when partners provide automated data without the need for re-keying and with less manual entry than the DSR requires. CEFM is capable of providing such automated data, and would help improve LB's data. In discussion with LB, however, the Evaluation Team found that schedule adherence was unlikely to be affected by such information at LB.

CEFM can measure adherence to NDC date, and also computes transit days using the same definition that LB uses of the later of cargo or documents received by the forwarder in Hong Kong to the receipt at the CFS. These items are contained in the Open Consignment Report, which can be exported and saved by users. Figure 36 shows an extraction from an OCR that shows these data elements.

Open Consignment Status

Customs Date/Time	Origin Port	NDC Date	Brand	Div	Factory	Cartons	Weight	Forwarder	MAWB	HAWB	Cargo Received	Documents Received	Actual at Port of Entry	Documents to Broker	ETA at CFS	Transit Days
Mon Nov 19 04:00:00 UTC 2007	HKG	Mon Nov 26 00:00:00 UTC 2007	VSS	MST	CLOVER GROUP INTL LTD	178	3051	Star	36940306663	STI8023948	Fri Nov 16 16:10:00 UTC 2007	Fri Nov 16 11:10:00 UTC 2007	Mon Nov 19 15:04:00 UTC 2007	Sun Nov 18 04:00:00 UTC 2007	Mon Nov 19 01:00:00 UTC 2007	2
	HKG	Wed Nov 28 00:00:00 UTC 2007	VSS	MST	CLOVER GROUP INTL LTD	3	2194	Hellmann	49401760533	HKT563666	Mon Nov 19 20:27:00 UTC 2007	Mon Nov 19 20:27:00 UTC 2007			Wed Nov 21 16:00:00 UTC 2007	1
Mon Oct 22 04:00:00 UTC 2007	HKG	Sat Oct 27 00:00:00 UTC 2007	VSS	MST	CLOVER GROUP INTL LTD	180	2793	Star	36940308004	STI8023999	Wed Oct 17 11:44:00 UTC 2007	Wed Oct 17 10:14:00 UTC 2007	Fri Oct 26 11:34:00 UTC 2007	Fri Oct 19 04:00:00 UTC 2007	Fri Oct 19 15:00:00 UTC 2007	8

Figure 36. CEFM Open Consignment Report Showing NDS Date and Transit Days.

Figure 37 shows the Excel version of the OCR exported from CEFM.

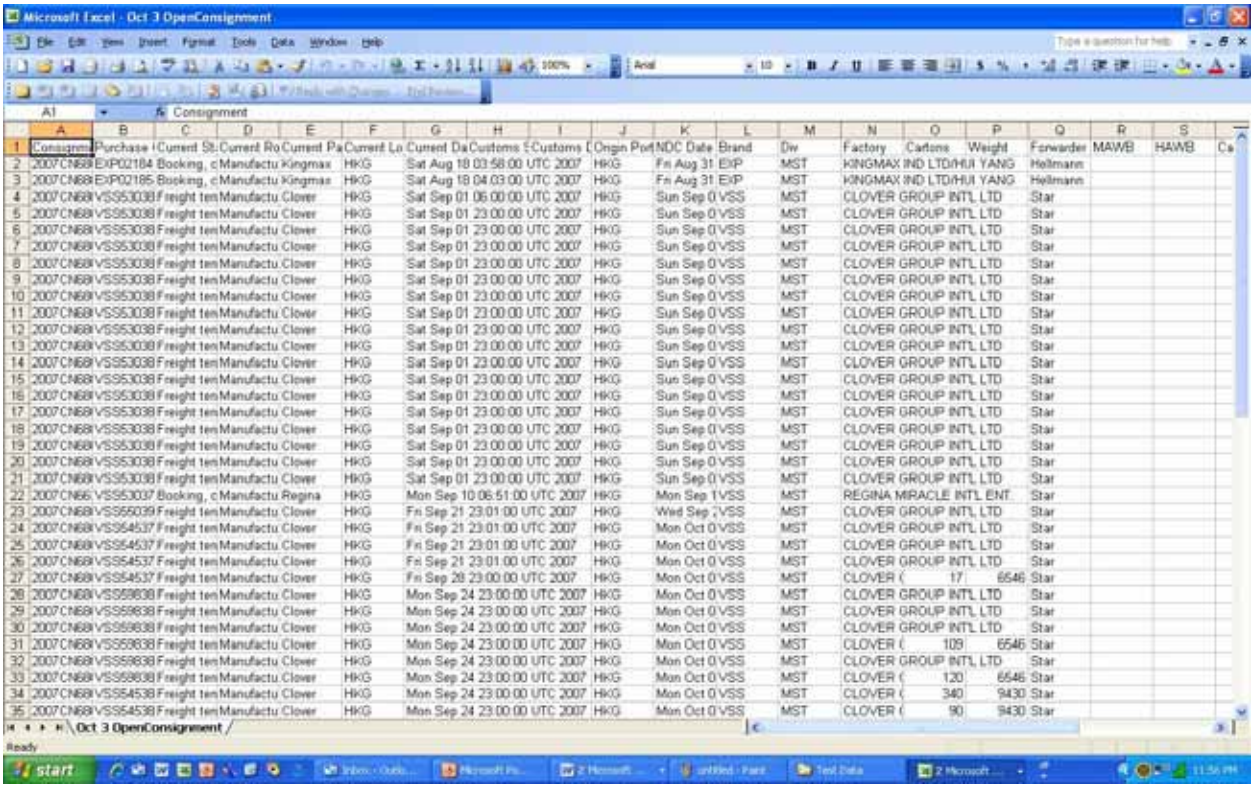


Figure 37. CEFM Open Consignment Report Exported to Excel.

In its interviews and follow-up discussions, the Evaluation Team s found that none of the partners thought that the schedules of CEFM test shipments were affected, primarily because test shipments were a relatively small percentage of the total and no partner made an effort to separately manage those shipments.

There have been numerous studies in industry attempting to quantify improvements in schedule adherence that will be investigated and included in the CEFM Deployment and Scalability Evaluation Report. If necessary, modeling will be employed in the analysis.

MOE 3: Reduced End-to-End Transit Times

One of the most important measures that LB uses on the supply chain is meeting a transit time standard. LB measures transit time performance and uses it in future order planning. Transit time performance helps LB in determining how long it would take to receive a product. These measurements tell LB how the service providers are doing. Although an LB logistics analyst has automated the performance analysis, LB believes that more real-time and accurate data can reduce its current error rate and its ability to measure transit time.

For the air supply chain from Hong Kong to Columbus used in the deployment, the LB transit time standard is 96 hours as measured from the later of receipt of either the cargo or documents at the

forwarder in Hong Kong to receipt of the cargo at the CFS in Columbus. Partners explained that payment is reduced for shipments that do not meet the standard.

LB uses the DSR and EDI ASNs to compute transit time. As mentioned above in the Visibility study area, forwarders submit DSRs to LB in Excel format via email twice a day. An automated process receives the DSR and creates a database that compares the DSR data to EDI data for verification. It also fills in any missing data from the EDI information to give full view of shipment.

LB's Rockport system runs calculations for transit time for each shipment for each forwarder for each lane. The data is rolled up into a weekly "transit run" on Monday morning, and this is subsequently rolled up into the monthly Scorecards for the forwarders.

LB automatically creates the weekly transit run in an Excel spreadsheet. For the Evaluation Team, LB extracted from the transit report all test shipments from CEFM, from which a portion of that transit report is shown in Figure 38. For each PO, column T shows the calculated transit time in days.

	A	B	C	Q	R	S	T	U	V	W	X
1	PONumbe	city name	place_co	Cust Clr D	Flight I	Carr	Ttime	ATtime	Tm	Toffs	Tcomm
2	EXP02079742	HONG KONG	HKG	06/04/07 08:54	823	K4	2.27083333	1.27083333	12	1	5
3	EXP02079743	HONG KONG	HKG	06/18/07 09:38	825	K4	2.29166667	1.29166667	12	1	5
4	EXP02079744	HONG KONG	HKG	06/26/07 09:45	023	5X	3.07222222	2.07222222	12	1	5
5	EXP02080163	HONG KONG	HKG	06/18/07 09:38	825	K4	2.29166667	1.29166667	12	1	5
6	EXP02080164	HONG KONG	HKG	06/04/07 08:54	823	K4	2.27083333	1.27083333	12	1	5
7	EXP02080165	HONG KONG	HKG	06/26/07 09:45	023	5X	3.07222222	2.07222222	12	1	5
8	EXP02080166	HONG KONG	HKG	06/25/07 09:22	023	5X	2.94097222	1.94097222	12	1	5
9	EXP02080170	HONG KONG	HKG	06/04/07 09:06	823	K4	3.05138889	2.05138889	12	1	5
10	EXP02080171	HONG KONG	HKG	06/25/07 09:22	023	5X	3.09722222	2.09722222	12	1	5
11	EXP02080756										
12	EXP02080757	HONG KONG	HKG	06/25/07 09:22	023	5X	2.94097222	1.94097222	12	1	5
13	EXP02080863	HONG KONG	HKG	06/11/07 09:44	823	K4	3.40277778	2.40277778	12	1	5
14	EXP02081128	HONG KONG	HKG	07/02/07 10:30	823	K4	2.19236111	1.19236111	12	1	5
15	EXP02081129	HONG KONG	HKG	07/09/07 09:41	823	K4	2.09722222	1.09722222	12	1	5
16	EXP02081504										
17	EXP02081505	HONG KONG	HKG	06/25/07 09:22	023	5X	2.94097222	1.94097222	12	1	5
18	EXP02082656	HONG KONG	HKG	08/27/07 09:50	823	K4	4.16666667	3.16666667	12	1	5
19	EXP02083249	HONG KONG	HKG	08/27/07 09:50	823	K4	4.16666667	3.16666667	12	1	5
20	EXP02083278	HONG KONG	HKG	08/27/07 09:50	823	K4	4.16666667	3.16666667	12	1	5
21	EXP02085060	HONG KONG	HKG	09/24/07 08:31	2859	5Y	2.08194444	1.08194444	12	1	5
22	EXP02085069	HONG KONG	HKG	08/27/07 09:50	823	K4	4.16666667	3.16666667	12	1	5

Figure 38. Extract from LB Transit Report for CEFM Test Shipments.

Because shipments sometimes arrive or travel on holidays and weekends, LB adjusts its transit time calculations to reflect those days, so as not to penalize forwarders for these external situations. Each PO shown in Figure 38 had an adjustment of 1 day as shown in column U. For all of the POs in the deployment test, the LB adjusted transit data indicated that 137 POs were in excess of the 96 hours standard, or 15.5 percent. The percentage of unadjusted transit times that did not meet the standard was 37.6 percent.

LB does not use the transit database for a simple query about a PO, but LB's analysts do use the data for larger macro-level analyses. LB researches the database and finds it useful to investigate transit

times or volume from origin, and so forth. This weekly transit report rolls up to the monthly Scorecard report that is provided to the forwarders to show the forwarders their on-time performance.

CEFM can be used to calculate transit time. In comparing the "Documents Received" date with "Cargo Received" date at the Hong Kong forwarder, the Evaluation Team found that nearly 19 percent of the test shipments used the "Documents Received" date as the starting point for transit time calculation because that date was later than the cargo was received. From the CEFM test shipment data, the Evaluation Team calculated the transit time and compared it with the LB's 96-hour standard. Without attempting to account for the difference between cargo and document receipt, the transit time statistics were as shown in Table 26.

Table 26. Transit Time Calculations CEFM Test Data

Transit Time Statistics	Item Description
Number of Test Records	863
Average Transit Time	77.96 hours
Median (middle value)	82.317 hours
Most Common Value	60.43 hours
Standard Deviation	62.82 hours

It should be noted that there were some "outliers" in the test data that can be explained by changes to the PO data that did not get recorded in the CEFM test data or errors in the data. For example, the maximum was 557 hours, or more than 23 days, and there were some negative records meaning that the arrival dates were shown before departure dates, which, is not logical.

What is relevant about the data is that it shows that most test shipments were within the 96-hour time standard. To do a more rigorous and accurate transit time analysis would require researching the outliers and correcting or removing illogical records and making adjustments for the later of cargo or document receipt at the Hong Kong forwarder. The important point to recognize here is that CEFM can measure transit time and that CEFM did not affect transit time during the test. With improved information on all shipments and the ability to apply that information, there are opportunities for improvement in transit time.

The Deployment Team performed a monthly transit time analysis of the CEFM test data with numerous charts and statistics, which is included in *Attachment I: Appendices to the Columbus Electronic Freight Management Evaluation Final Report,* Appendix B, provided under separate cover. Figure 39 shows one of monthly transit time breakdown charts.

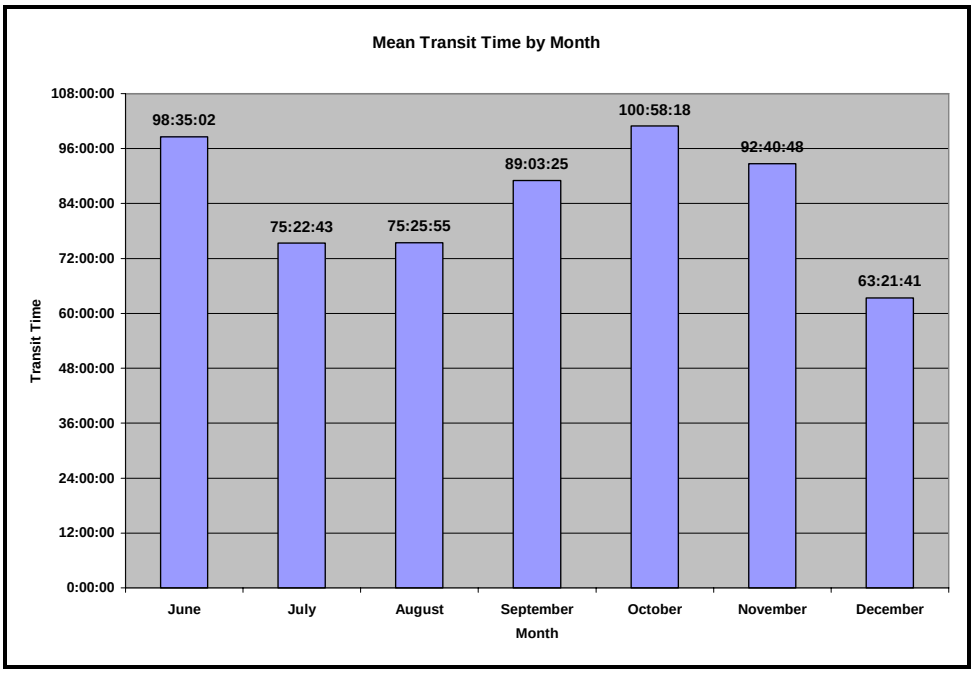


Figure 39. CEFM Monthly Mean Transit Time Statistics.

As with the data in Figure 39, it should be noted that no effort was made to remove data errors and obvious illogical records from the Deployment Team's analysis. The data in Figure 39 is representative of activity during the 6-month test, but additional analysis is needed to clean up the data before more accurate transit time averages could be presented.

It is important to note that no partner managed CEFM shipments separately; thus, there is no indication that CEFM had any effect on transit time during the deployment test. While this is regrettable, the Evaluation Team noted that the range of test shipments exceeding the transit time standard, 15.5 percent for LB data versus 19.0 percent from the CEFM data, indicates there are opportunities for improving transit time in the future if improved information is used in management of the supply chain.

There have been numerous studies in industry attempting to quantify improvements in transit time that will be investigated and included in the CEFM Deployment and Scalability Evaluation Report. If necessary, modeling will be employed in the analysis.

MOE 4: Reduced Dwell Time at Node

The Evaluation team used the test data to measure the dwell time at each of the principal partners within CEFM. The timeline diagram that was first introduced in section 2 shows those measurements. The two key points in the supply chain where time could be lost are 1) the arrival at the forwarder's in Hong Kong, where the freight is then consolidated and loaded into Unit Load Devices for subsequent loading on aircraft, and 2) in awaiting Customs clearance in Columbus. Table 27 shows selected mean, median, and mode data for dwell time at various points in the LB supply chain. Showing all three measures provides more useful information to viewers, since there are some illogical values in the CEFM data that would distort data results.

Table 27. Dwell Time Statistics from CEFM Test Data

Time Segment	Mean Hours	Median Hours	Mode in Hours
Time at HKG Forwarder	42.28	38	6.76
Flight time to CMH	68.34	28.68	12.4
Time of Arrival to Trucking Agent	6.88	2.33	12.4
Time at Trucking Agent	22.38	14.77	1.25

For ODW and its operation of the CFS, dwell time at its location is important and is carefully measured by ODW. The CFS creates an On-Time Report, in this case looking at the comparison between Customs clearance and the time when the freight is otherwise ready to be moved to LB. In addition, ODW has an agreed-upon standard with LB by which freight that has been received and cleared by 10 a.m. will be delivered to LB by 5 p.m. that day, and if cleared during the day will be delivered by 10 a.m. the next day.

As shown in Figure 40, ODW creates monthly On-Time Reports that include the percentage of shipments that clear Customs before they arrive at the CFS.

	A	B	D	F	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
	entity	div	mawb	po	shpd qty	arr'l date	arr'l time	clear date	clear time	shpd date	shpd time	comments	disc	time to clearnace	on time	0-2	2-4	4+	ndc date
82	vss	VSS	7451391001	56732	40	12/28/06	18:40:00	12/28/06	16:52:00	12/29/06	21:35:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/02/07
83	vss	VSS	7451391001	53400	27	12/28/06	18:40:00	12/28/06	17:20:00	12/29/06	21:35:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/02/07
84	vss	VSS	7451391001	53400	4	12/28/06	18:40:00	12/28/06	17:20:00	12/29/06	21:35:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/24/07
85	vss	VSS	7451391001	53400	15	12/28/06	18:40:00	12/28/06	17:20:00	12/29/06	21:35:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/24/07
86	vss	VSS	7451391001	53387	46	12/28/06	18:40:00	12/28/06	16:53:00	12/29/06	21:35:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/15/07
87	vss	VSS	7451391001	53383	01	12/28/06	18:40:00	12/28/06	16:53:00	12/30/06	7:00:10	heavy in 12/28 = 16,131 ctns & 56 loads out		Prior Clearanc	1				01/03/07
88	vss	VSS	16082314142	55541	9	12/29/06	13:00:00	12/28/06	16:52:00	12/30/06	11:40:10	Arr'd Friday, Shpd Sunday		Prior Clearanc	1				12/18/06
89	vss	VSS	16082314142	53576	3	12/29/06	13:00:00	12/28/06	17:20:00	12/30/06	11:40:10	Arr'd Friday, Shpd Sunday		Prior Clearanc	1				12/18/06
90	vss	VSS	16082314142	57608	3	12/29/06	13:00:00	12/28/06	17:20:00	12/30/06	11:40:10	Arr'd Friday, Shpd Sunday		Prior Clearanc	1				12/18/06
91	vss	VSS	16082314142	990000	82	12/29/06	13:00:00	12/29/06	13:04:00	12/30/06	11:40:10	rel'd Friday, shpd Sunday		0:04:00	1				02/01/07
92														30:45:54	1018	0	10	1	
93														48:40:54	3556	21	10	2	
94																			
95																			
96																			
97																			
98							Number of Shipments Clearing before Arrival							1959					
99							Average Clearance Time							48:40:54					
100							Total Shipments							3589					
101							Number of discrepancy Shipments							193					
102							Percentage of discrepancy Shipments							5.38%					
103																			
104																			
105							Total # of Prior Clearances							1959					
106							Percentage of Prior Cleared Shipments							54.58%					

Figure 40. Extract from ODW On-Time Report December 2006.

An important dwell time measure shown in the ODW data summarizes the number of shipments clearing before arrival, in this case 54.58 percent. Notice in the report that ODW tracks the number of hours the shipment is late (columns S, T, and U) as well as column R for a 1 or 0 for On Time. ODW uses these reports to keep time at the CFS to a minimum, and allows delivery to LB to be at the expected time. Those shipments that do not clear Customs have to wait at the CFS to be delivered.

As a point of comparison with ODW's calculation of cleared shipments, the Evaluation Team determined from the CEFM test data that approximately 41.1 percent of test shipments had cleared

Customs before arrival at the CFS. During the test, the clearance time varied from several days before arrival to several days after arrival at the CFS, with the mean being 17.56 hours after arrival and median being 3.28 hours after.

- *ODW said that if it is able to reduce the dwell time in the warehouse while shipments are held waiting for clearance, it would even be able to reduce warehouse space. This is because more goods could be "crossed docked" without having to be "put away" waiting for further instructions and clearance.*

The next MOE discusses Customs release in more detail, and the opportunities to reduce the delay both from earlier processing on Sunday and from Air AMS electronic release.

While the deployment test did not show any improvement per se in dwell time, partners agreed that if they had complete visibility and up to date and accurate information, it would help in managing the supply chain, and ultimately reducing dwell time. CEFM could be used to measure that time as has been shown. The deployment test data showed that there are important opportunities to improve the time at some of these hand-off points.

Studies prior to the CEFM deployment test indicated that dwell time waiting for information was a major target of opportunity. This will be studied in more detail along with other studies in industry attempting to quantify reductions in dwell time, and included in the CEFM Deployment and Scalability Evaluation Report. If necessary, modeling will be employed in the analysis.

MOE 5: Improved Timeliness of Freight Release Process

As noted in the previous MOE, nearly half of the shipments that arrive at the CFS have not received Customs clearance. Since the freight must be held at ODW until Customs clearance has been received, this is an important opportunity for improvement. A more timely process at the broker can reduce the time; a more timely release by CBP can reduce the time. This section discussed the current release process and explains the potential improvements.

About 24 hours before the shipment arrives in Columbus, Barthco receives a shipment's documents via email for direct shipments from Hong Kong. Upon receiving the email, Barthco opens the attached documents and prints them out. Barthco staff can then key the applicable information into its system, which will send an EDI feed to CBP at the proper time. Barthco receives a second email from the forwarder approximately 4 to 8 hours after "Wheels Up" with the notice to broker (NTB) attached. The NTB is a form created by LB but used by the forwarder. There can be errors in the information on this form, so Barthco compares and verifies the NTB content with the information in the additional documents received from the forwarder. Barthco explained that it cannot transmit the filing to CBP prior to receiving the NTB.

Air AMS, a software program that operates in an electronic network with CBP, is intended to improve the timing and accuracy of Barthco's submission to CBP, and provide an electronic release from CBP to Barthco and ODW. Air AMS was initiated at Barthco and ODW as a result of the CEFM deployment test activities. In addition to and separate from potential improvements from Air AMS, CEFM provides data that can improve Barthco's operation and potentially shorten the release process.

Barthco's shipment volumes and weekly workload help illustrate the operations and indicate the opportunity for improvement. Typically, Barthco processes 600 shipments per week. Figure 41 shows the approximately daily distribution, with the current workload in burgundy and a post-CEFM projected workload in light blue.

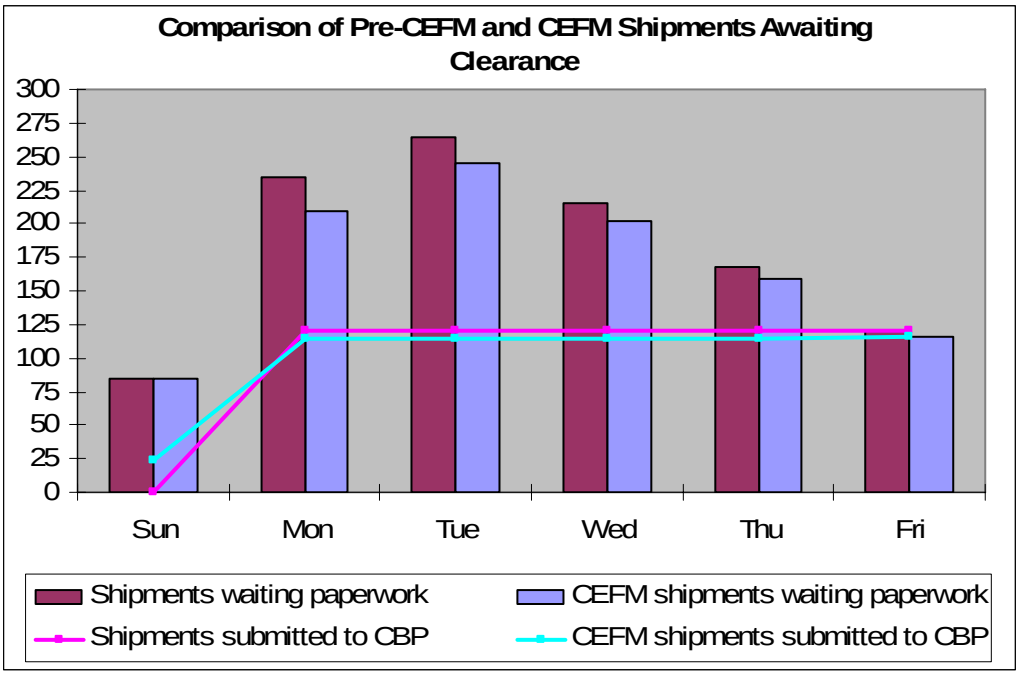


Figure 41. Comparison of Pre-CEFM and CEFM Shipments Awaiting Clearance.

The weekends are particularly a problem, and Barthco believes that CEFM could improve its ability to process those shipments. Barthco has two to three staff members who rotate shifts to work on Sundays. An issue for Barthco is that forwarders typically do not work Sundays, so if the flight arrives on Saturday or Sunday, notice of "Wheels Up" will not be received in current practices until Monday between 10 a.m. and 4 p.m. This creates a shipment backlog that could range between 220-400 that require processing on Monday. This backlog is clearly shown in Figure 41, which also shows that the backlog ripples through the week. The result of not being able to process shipments on Sunday, and the combined backlog on Monday can be an inefficient use of staff, thereby increasing the potential in delay for submitting release documentation to CBP.

After interviews with Barthco, the Evaluation Team made some assumptions about the relationship between Sunday processing and document submission to CBP. Based on information provided by Barthco, the Evaluation Team estimated that 24 shipments could be processed on Sunday that are not currently processed today. The Evaluation Team further assumed that half of these shipments, or 12, could be released by CBP 1 day earlier. This is shown by the line graph in Figure 41 and indicates that the additional shipments would be released by shipment processing on Sunday.

One question the Evaluation Team wrestled with is, "What is the economic benefit to ODW or LB from having 12 additional shipments released?" With approximately 67 shipments arriving each day at ODW, the 12 additional shipments represent about 18 percent, which is about half the percentage of shipments that currently arrive *after* the shipment has arrived at the CFS. This would obviously

improve ODW's on-time performance, but the Evaluation Team was not able to determine whether there would be a financial impact for that on-time performance. Nevertheless, Barthco, ODW, and LB all benefit from earlier processing of shipments and the potential for earlier release from CBP. Some of the partners comments are as follows:

- *With CEFM's status information that includes automated airline departure and arrival, CEFM allows the broker to obtain electronic verification of "Wheels Up" on Sunday.*
- *Although Barthco still has to wait to receive the NTB to submit the documentation, CEFM could allow Barthco staff to prepare documentation on Sundays, thereby reducing its backlog of Monday shipments, which would potentially help Barthco better allocate its labor force throughout the week (as shown in* Figure 41*).*
- *CEFM also helps Barthco to preemptively view all the HAWBs under each MAWB; then, if Barthco staff see that it has not received documentation or emails for some HAWBs, the staff can contact the forwarders or LB to track it down rather than waiting for LB or the forwarder to contact Barthco about these shipments. This was demonstrated to the Evaluation Team by Barthco during the test.*
- *Barthco says that CEFM would allow it to handle the Customs documentation one time (e.g. Sunday processing) instead of twice (Sunday start and Monday completion after arrival of "Wheels Up" and NTB) as is required by current processes.*

Labor savings at Barthco related to the use of the CEFM information are discussed in MOE 5 in section 4.4.2. Being able to complete the release sooner could improve the timeliness of the release.

- *Barthco said "It [CEFM data] means that we can process the current paperwork and the Customs clearance can be processed earlier."*
- *CEFM could keep the preparation time within the 1 hour range through this reduction of paperwork handling.*

After Barthco receives the Customs release either in hard copy or electronic form, Barthco provides an email to ODW and LB containing an attached copy of the Customs release. This is one of the important reasons that Air AMS was implemented during the test. A pilot test for Air AMS was implemented on October 16, which Barthco and ODW participated in, but neither ODW nor Barthco had changed its operating procedures for clearance by the end of the test.

Since LB receives the electronic release as well as ODW, LB needs to be fully committed with the Air AMS process. Currently, Air AMS has not been made standard within the Port of Columbus; until Air AMS is established as a rule by the Port Director, there is no guarantee that all local partners are providing data in this fashion. Therefore, there will be missing data, which some of the CEFM partners experienced during the pilot test. LB's Customs Service has endorsed the use of Air AMS with the Port Director in Columbus, but the concept has yet to be made mandatory as it is in other areas such as Chicago and New York.

During March 2008 interviews with ODW, the Evaluation Team learned that ODW was experiencing errors in the electronic process that required research and requested suspension of Air AMS with CBP. Nevertheless, both Barthco and ODW expect significant improvement in the timeliness of the release

process from Air AMS once the implementation bugs are worked out and all local partners are participating.

As an example of how Air AMS is expected to help, if notice of "Wheels Up" has been received and Air AMS is being used, Customs will accept electronic submission on a Sunday, and shipments can be released on the basis of electronic shipping information, which may reduce delay at ODW. The electronic Customs clearance would save ODW time and resources. For most MAST shipments that arrive and are released by CBP on a particular day, the shipments must be delivered to LB by 5 p.m. or by 10 a.m. the next day if the shipments are received during the day.

- *Barthco said that it expects to save 15-30 minutes of the 1-3 hours it takes to prepare a Customs filing, which may yield a potential savings of 8-25 percent.*
- *Barthco explained that because ODW will release the freight via Air AMS transmission, Barthco would not have to scan the paper releases, and some data fields would not require manual input.*
- *Barthco also explained there may be fewer errors because, according to Barthco, any confusion of what is listed on the paper will not be a factor. Barthco stated that there are times when Barthco scans a release, but ODW does not show a record of receipt, therefore, delaying the freight. Barthco stated that "More mistakes can happen with manual process."*
- *ODW agreed that it will be a good thing when it is able to integrate the electronic clearance information into its system so it can eliminate the process of manually entering that data. Today that information is taken off the clearance form received from Barthco. A clearance number is entered along with the number of cartons, which are then matched with PO or MAST PO numbers and the HAWB number.*

Barthco told the Evaluation Team that a lot of its effort is focused on exceptions that did not clear, perhaps due to the documents being incorrect or that the forwarder information was incomplete. Unfortunately, Barthco could not identify either the number of exceptions or the time required to research an exception. It is also worth noting that no Customs exceptions occurred with any CEFM shipments during the deployment test. This meant there were no reports regarding CEFM data events "Missing Document" or "Customs Clearance, Refused" in the CEFM deployment test.

Although both Barthco and ODW identified important potential improvements in the release process as documented above, the Evaluation Team was not able to quantify the dollar value associated with the reduction in the timeliness of the release. Once Air AMS is in full operation and electronic releases are being sent to ODW with far fewer errors, it is quite possible that before and after release times can be measured. It is also possible that ODW will be able to identify and quantify impacts within the CFS from timelier release. The CEFM Deployment and Scalability Evaluation Report will examine the release process more broadly and specifically any progress made in Air AMS implementations in other supply chains as well as at Barthco, LB, and ODW in Columbus.

Lessons Learned from CEFM Test

Following is the lesson learned from the CEFM test:

- As much as supply chain professional and Government officials want to reduce transit time, improve shipment reliability, and reduce dwell time, live tests cannot be expected to address these measures. Tests that are part of existing operations as occurred with CEFM are generally only a subset of the shipments and the users and managers must first move the freight and second provide support to the test. While these measures are appropriate goals for the supply chain and something that could be used if the participating companies implemented the system in operation, they should not be used in the test itself.

4.4.2. Potential for Increased Productivity

The second hypothesis is similar to the first, but focuses on the information obtained from freight forwarders and third-party logistics providers. In the first hypothesis, the beneficiaries are primarily LB and its customers; in the second hypothesis, the beneficiaries are the various supply chain partners, including the air carriers and trucking companies. The Evaluation Team followed the work steps included in the CEFM Detailed Test Plans dated October 4, 2007, which are summarized as follows:

- Conduct interviews related to improved supply chain management.
- Analyze use of supply chain management tools by partners.
- Assess efficiency improvements in data acquisition and use.
- Assess reductions in errors and erroneous billings.
- Assess improvements in supply chain management.
- Assess reductions in time to create status reports.
- Assess reductions in delays and better schedule adherence.
- Assess improvements in Customs clearance process.
- Incorporate interview results and analysis into draft CEFM Evaluation Report.
- Incorporate comments and results into final CEFM Evaluation Report.

This portion of the evaluation involved comparative analysis between current operations and operations that were or would be conducted using the kind of information available from CEFM. The evaluation involved assessment of interviews, surveys, and anecdotal information from participants and analysis of consignment data collected during the test. The effort included interviewing the partners to determine how time could be saved or administrative resources reduced through the use of improved information from CEFM. This evaluation included analysis of test results for reduced labor costs and data entry time compared with "before" data or processes. It also included comparative assessment of costs to obtain pre-CEFM data from the partners with CEFM end-to-end consignment data and on demand consignment reports.

MOE 1: Reduced Shipment Errors

The MOE included in the original Evaluation Plan and Detailed Test Plans was for reduced erroneous billings. No partner indicated any knowledge of the extent of errors in billing, and none thought that CEFM would help reduce such errors. The Evaluation Team determined that billings are beyond the scope of the CEFM system. Although no partner had statistics on shipment errors, the Evaluation Team found several different areas in which shipment errors could potentially be reduced as a result of CEFM information. These errors and the potential benefits will be investigated further and included in the CEFM Deployment and Scalability Evaluation Report.

MOE 2: Reduced Labor Applied to Solving Shipment Errors or Problems, such as Misroutings

Whereas the previous MOE discussed the impact of shipment errors on the supply chain, this MOE deals with labor that must be applied by the various partners to solve errors. Two types of errors are quantified and one other is discussed.

- Labor Savings From Fewer Warehouse Data Errors: Improved data accuracy at container freight station means a reduced number of trips to the office to verify data. This saves warehouse and administrative staff time as needed to respond to problems caused by inadequate or missing data on the warehouse floor. ODW explained that sometimes data is not available to warehouse workers on their hand-held computers.
  - *ODW estimates that approximately 10 percent of the inbound shipments have neither hard copy pre-alert (HAWBs) nor EDI information to pull in, and must contact the forwarder and request it to be sent.*

  If data is missing, the ODW warehouse staff may have to perform the following activities to retrieve the information: stop their forklifts; check with their supervisor downstairs; walk up stairs and check with logistics staff; use the restroom or get coffee; check back in the with logistics staff to acquire the correct information; walk back downstairs; report to the supervisor; rescan the paperwork; then return to their forklifts and resume their original activities. The Evaluation Team estimated this sequence of warehouse events to take between 13 and 18 minutes as shown in Table 28.

Table 28. Time to Process Errors at ODW-CFS

Warehouse Work Steps	Number of Minutes
Travel Time from Warehouse Storage:	1
Discuss Problem with Supervisor:	5
Check/Solve Problem with Logistics Staff:	5
Research Problem:	3
Return to Warehouse Vehicle:	4
Time Range =	13 to 18 minutes

The higher number in the range assumes that the problem required both the supervisor and the logistics staff help in solving the data problem; the lower number assumed the supervisor solved the problem. ODW said that it receives about 67 shipments (HAWBs or MAWBs) per day. If the occurrences are with 10 percent of the shipments as noted above, this could be as many as 6 occurrences per day.

The value of reducing these occurrences because of better data available from CEFM is shown in Table 29, which shows occurrences of 1, 3, 6, and 10 shipments.

Table 29. Daily Labor Savings Because of Less Missing Data

Description	Number of Occurrences				Minutes Needed to Resolve Problems
	1	3	6	10	
Minutes/Error	13-18 min	13-18 min			
Wage/Minute	0.393	0.393			
Cost of Error	$5.11	$15.33	30.65	51.09	13
	$7.07	$21.22	42.44	70.74	18
Discount	65%	65%	65%	65%	
Savings	$3.32	$9.96	$19.93	33.21	13
	$4.60	$13.79	$27.59	45.98	18
Average	$3.96	$11.88	$23.76	$39.59	Average: 15.5

For the preceding calculation, it was assumed that some of the missing data would not be able to be solved by CEFM, so the potential benefit was discounted to 65 percent. Based on ODW's shipment volume, approximately one data problem per day is equivalent to a shipment accuracy rate of 98.5 percent; three per day, 95.5 percent; and six per day, 91.1 percent. LB reported an accuracy rate in the DSR and EDI data it received of 90-95 percent, so the Evaluation team included six errors per day in Table 29. Based on ODW's estimates described just before the table, the Evaluation Team used six errors in the potential savings calculation.

- Reduced Effort in Corrected Errors in EDI: ODW identified the steps required to correct EDI information. ODW said it could involve researching a small number of issues and take 5 minutes, or it could be a large number of issues (greater than 30) and take 45 minutes. ODW, however, said that it could not quantify the number of errors or the typical duration. Table 30 is the Evaluation Team's estimation of the typical time that may be needed for correcting errors.

Table 30. Steps for Resolving EDI Errors

EDI Error Resolution Steps	Minutes
Pull the Hard Copy HAWB:	1
Pull the Hard Copy Packing List:	1
Verify the Missing or Incorrect Information:	2

EDI Error Resolution Steps	Minutes
Manually Correct Information:	1
Enter Information in ODW Symphony:	1
Total Estimated Minutes:	6

ODW informed the Evaluation Team that its EDI accuracy rate is about 65 percent, which offers substantial room for improvement. LB said that its error rate for EDI is 90-95 percent, and that it refers those errors back to the partners for resolution. ODW is not in a position to refer errors back to other partners, so it needs to address the errors identified in the data.

Based on the data and observations made by the Evaluation Team, this analysis includes five errors per day (in terms of the number of shipments processed at ODW), which is 92.6 percent accuracy, in the range of the reported LB EDI error rate. Table 31 shows the EDI savings based on the estimated 6 minutes it takes to correct an error.

Table 31. EDI Error Correction Savings

Time to Correct Error / Savings Values	6 Minutes
Estimated Time Savings by using CEFM Data:	4 min
Labor Rate per Minute:	$0.80
Value of Savings for 1 Error Correction:	$3.20
Value of Savings for Correcting 5 Errors:	$16.00

- Reduction in Labor Related to Obtaining Information about Hot Shipments: As noted earlier, if the DSR doesn't have the appropriate information about a "hot" shipment, LB would call the forwarder for additional information about the specific shipment. The total volume of hot shipments, according to LB, is about 10-15 percent.
  - *LB said that for a hot shipment, "We would want to know it is on a truck moving to CFS rather than it has arrived in Columbus. In this case, we would have to call."*
  - *For a hot shipment, LB wants to know the details, what time it will arrive, when will it be on a truck headed to the DC, and so forth.*
  - *Forward Air said the forwarders will contact them by email or phone if they need to have a hot shipment picked up and delivered to CFS on the same day.*

When interviewing LB, the Evaluation Team explained that the assumption of 10 percent of shipments being considered as "hot" was used as a baseline. The LB stated that the percentage of "hot" shipments can escalate beyond 10 percent, depending on peak season or business needs. Although LB has many internal tools available to research this type of shipments, many shippers may not have either the internal tools or the close working relationships with their service providers; therefore, the Evaluation Team computed a time savings for a shipper researching the details of hot shipments.

ODW told the Evaluation Team that it received about 67 shipments per day destined for LB, a large shipper. Therefore, the Evaluation Team used 67as an estimated number of daily shipments handled by a large importer. Table 32 shows the computation for a large shipper's time savings.

Table 32. Labor Savings for Researching "Hot" Shipments at a Large Shipper

LB Costs of Additional Processing for 6.7 "Hot" Shipments per Day	Unit	Notes
Telephone Call to Forwarder:	10 minutes	
Manual Review of Rolled Up Status Reports to Verify CFS Receipt:	5 minutes	
Log onto Custom Broker's System to Monitor Customs Clearance:	15 minutes	Assume 5 minutes each time, logging on three times total per day for the hot shipments.
Log onto CFS's System to Monitor Warehouse Events:	10 minutes	Assume 5 minutes each time, logging on twice per day for hot shipments.
Potential Daily Time Saving:	40 minutes	
Time to Pull Up and Review OCR for "Hot" Shipment Data:	3	Includes logging onto CEFM and running Open Consignment Report.
Discounted Time Savings for Mismatch between Manual Processes and OCR:	27.75	(= 40-3 min x 75%)
Labor Rate per Minute:	$0.39	Assumed admin labor rate per minute.
Daily Value of using OCR to Reduce Manual Research for "Hot" Shipments:	$10.91	Daily savings.

Depending on how quickly hot shipments are delivered to LB, the labor required could be even longer. It also should be considered that there may be additional work required or additional hot shipments that may impact labor requirements, for example as noted here:

- *About once per week, LB may call Star to see if a shipment has been moved from the factory, and this could be a useful piece of information to get from CEFM.*
- *LB noted that the assumption of 10 percent of shipments being "hot" is a baseline, and this number can vary and even escalate, depending on business needs and the demands of the peak shipping seasons.*

It also is worth noting that time savings well in excess of these noted for a large shipper could occur with smaller shippers that do not have the kinds of existing shipment management systems that a large shipper such as LB uses. LB indicated that such small shippers would be more likely to access partner Websites, even for routine shipments, and on many occasions, would make phone calls to partners trying to establish the visibility over shipments. LB indicated that the small shippers would be ideal candidates for automated data from CEFM.

MOE 3: Reduced Delays in Transferring Custody from One Intermodal Partner to Another Through Improved Information Exchange.

Custody transfers occur at the following points within the CEFM supply chain:

- Manufacturer to Local Trucking Company (reported as Tendering).
- Local Trucking Company to Forwarder in Hong Kong (reported as "Received" by Forwarder).
- Forwarder to Airport Handling Agent in Hong Kong (not included in CEFM).
- Handling Agent to Airline (not included in CEFM).
- Airline to Ground Handling Agent in Columbus.
- Ground Handling Agent to Trucking Agent (reported as "Receipt at Trucking Agent").
- Trucking Agent to Container Freight Station (reported as "Receipt at CFS").
- Container Freight Station to LB Distribution Center (reported as "CFS Dispatch").

CEFM has information about most, but not all of these transfer points as noted in the list. See MOE 4 in the Performance section for discussion of the CEFM receipt dates related to these transfers. Several partners discussed delayed shipments and believe the improved data from CEFM can help identify delayed shipments and plan for them. Having accurate, real-time information may allow each partner to better manage these transfers. As has been noted elsewhere, the partners did not separately manage the CEFM test shipments, so there was no identifiable change in dwell time at points of change in custody. Nevertheless, there are clear opportunities for improvement if CEFM information were available for all shipments.

MOE 4: Increased Schedule Adherence/Avoidance of Penalties/Detention Fees

ODW and Star provided performance reports that include schedule adherence. The users believed that if CEFM applied to all shipments there would be performance improvements. Several partners discussed delayed shipments and believe the improved data from CEFM can help identify delayed shipments and plan for them. The test itself did not result in any exception shipments, and the Evaluation Team was not able to obtain useful information about lost shipments. Some partners indicated that reduced shipment costs to LB may be possible because of LB's use of improved data for decision making:

- *ODW said that LB is a very unique buyer, and that "if you can make it work with them you can make it work with any buyer." ODW said that LB's international freight is more diverse in terms of origins. For other international supply chains, ODW has a better idea of what is coming from where, and has a lot of advance information on the shipments.*
- *Some partners said that LB requires a high level of customization and it is difficult to communicate with them electronically. LB has many standard reports, forms, and performance measures that its partners are required to use.*

A previous MOE has discussed in more detail the Scorecard transit time reports that are provided monthly by LB to the forwarders. Of significance to this MOE are facts related to the penalties that accrue if the transit time standards are not met:

- *LB requires that 95 percent of shipments meet the 96-hour criteria.*
- *LB actively manages the performance standards for its service providers. Previous performance, such as adherence to the transit time standard, is an important input used by LB to develop long-lasting relationships with its provider, and that good performance has led to success for LB and its partners.*

MOE 5: Reduced Data Entry and Staff Time from Automatically Generated Status Reports

The Evaluation Team identified potential data entry and staff savings at a number of points in the supply chain. CEFM eliminates manual data entry errors by any partner for all supply chain events after manufacturer booking. CEFM also eliminates re-keying along the supply chain if the system is integrated with existing transportation management applications. Manufacturers have less data entry in CEFM to book shipments that currently. Forwarders could use the OCR to prepare pre-alerts in Hong Kong and DSRs in Columbus. ODW could save staff time at the CFS in correcting current data and in reducing the errors in data used on the warehouse floor. These savings are quantified as follows:

- Manufacturers' Reduced Data Entry Savings: Manufacturers would have reduced data entry and staff time because fewer data elements need to be entered to book a consignment using CEFM. In current practice at the manufacturers, there are eight required data fields that must be entered, but there are only two required in CEFM. The value of this reduced data entry is shown in Table 33.

Table 33. Manufacturers' Reduced Data Entry Savings

4 CEFM Manufacturers Deployment Test Shipments	CEFM POs	4 Manufacturers for 100% of Shipments	All POs
Clover = 407 CEFM POs, Regina = 397 Kingmax = 48, Esquel = 19	4.83 POs/day	29.8 Victoria's Secret POs/day 13.4 Express Brand POs/day = 43.2 POs/day all shipments	43.2 POs
Paper booking 7 minutes x 4.83 POs	33.8 min	Paper booking 7 minutes x 43.2 POs	302.4 min
Time to book in CEFM 2 minutes x 4.83	9.7 min	Time to book in CEFM 2 min x 43.2 POs	86.4 min
Time Savings using CEFM	24.1 min	Time Savings for all shipments	216 min
South China labor rate per minute	$.025-.037	South China rates per minutes	$.025-.037
Value of daily time savings for booking with CEFM per mfg	$.60-.89 avg .$.75	Daily time savings for booking all shipments	$5.40-7.99 avg $6.70

Of the four manufacturers in CEFM, Regina and Clover had 92.3 percent of the POs moved during the deployment test, and Esquel and Kingmax had 7.7 percent. The CEFM POs amounted to 4.83 per day (871 POs completed during the 180-day deployment test).

The time to complete the manual booking currently includes filling out forms (eight data fields), plus time to email or fax the form to the forwarder. The Evaluation Team assumed 5 minutes to complete the form and 2 minutes to email or fax. For CEFM, the Evaluation team assumed 2 minutes for the CEFM booking, which includes logging on, selecting a PO, and completing two data fields.

Table 33 shows that the savings were the difference between the current booking time of 7 minutes and the CEFM time of 2 minutes for each of the 4.83 POs per day, for a total daily time savings of 24.1 minutes for the four manufacturers.

South China labor rates were estimated by LB's representatives in Hong Kong to be $1.50-$2.20 USD per hour, for a labor savings of $.60 to .89 per day.

The right table column shows the potential savings if the automated data from CEFM were applied to all shipments from Hong Kong for these four manufacturers. Data from LB during the test period showed an average of 29.8 Victoria's Secret POs (based on 14.94 percent of total shipments) and 13.4 Express POs (based on 2.7 percent of total shipments) per day. Together, this was 43.2 POs per day, which was applied to the time savings to yield a total labor savings of $5.40 to $7.99.

- Pre-Alert Data Entry Savings: Staff time could be reduced in preparing the pre-alert emails (at the Hong Kong forwarders) if CEFM OCRs are used for all shipments. Many of the data elements in the pre-alert are the same as in the OCR. The forwarders prepare an Excel spreadsheet that conforms to an LB format for the pre-alert. The spreadsheet is sent as part of an email to the Columbus forwarders, LB, and Barthco. The Evaluation Team determined that 17 of the 26 pre-alert data elements could be provided automatically by the OCR. It takes a forwarder about 2 hours to prepare pre-alerts each day, as opposed to the OCR, which can be created in about 3 minutes. If the partners could rely on checking CEFM instead of using the pre-alert emails, there would be a definite reduction in data entry for the Hong Kong forwarder. The value of the potential data entry time savings is shown in Table 34.

Table 34. Pre-Alert Data Entry Savings

Activity	Description
Time to Prepare Pre-Alert:	120 min
Time to Prepare OCR:	3 min
Discount for Mismatch Pre-Alert OCR:	65%
Discounted Time Savings by using OCR:	76.05 min
Labor Rate per Minute:	$0.162
Value of Daily Time Savings for OCR per Forwarder:	$12.33

Because 17 of the 26 pre-alert data elements are contained in the OCR, the potential savings were discounted to represent only those data elements (17/26=.65). This

resulted in a daily savings per forwarder of more than 1 hour and 15 minutes. The Evaluation Team determined the Hong Kong labor rates to be $1556.27 USD/month, or (.73 per hour, assuming 20 work days per month, per 8-hour days). The average monthly wage was obtained from www.yearbook.gov.hk/2006/en/06_02.htm. The estimated pre-alert labor savings for each forwarder was $12.33.

- Reduction in Airline Status Research: CEFM's status data includes departure, arrival, and interim stop information for flights from Hong Kong to Columbus (or as discussed in the Visibility section 4.3 airline flights to JFK). As with other CEFM status information, the airline data requires no manual data entry. Currently, forwarders must contact airlines directly via telephone or Website or contact a third party such as Red Berry or FlyteComm to obtain the information. Based on discussions with the forwarders, the Evaluation Team determined that each forwarder spends as much as one hour per day researching airline data. The value of the potential data entry time savings is shown in Table 35.

Table 35. Reduction in Airline Status Research

Activity	Description
Time to Research Airline Information:	60 min/day
Time to Prepare OCR per Day:	3 min
Discount for Mismatch Telephone information for OCR:	50%
Discounted Time Savings by using OCR:	28.5 min
Labor Rate per Minute:	$0.393
Value of Daily Time Savings for OCR per Forwarder:	$11.20

Note that in the savings calculation, the value was discounted to account either for airlines not available from CEFM or for other issues about airline schedules. The labor rate used was the administrative labor at ODW adjusted for fringe benefits (it was assumed that logistics administrative labor in the Columbus area was basically the same).

- Daily Status Report Preparation Savings: Staff time could be reduced in preparing the DSR (at the Columbus forwarders) if CEFM OCRs were used for all shipments. The Evaluation Team's interviews with the forwarders determined that each forwarder spends between 4 and 6 hours per day preparing the DSR. CEFM was designed to produce the Open Consignment Report that could replace the DSR. The various partners agreed this could happen if CEFM applied to all shipments. The forwarders in Columbus prepare an Excel spreadsheet that conforms to an LB format for the DSR. The spreadsheet is sent as part of an email to LB and Barthco at 10 a.m. each weekday morning and usually an update is sent mid-afternoon. The Evaluation Team determined that there are 21 of the 28 data elements of the DSR that could be provided automatically by the OCR. In contrast to the 4 to 6 hours needed to prepare the DSR, the OCR can be created in about 3 minutes. The value of the potential data entry time savings for the DSR is shown in Table 36.

Table 36. Daily Status Report Preparation Savings

Activity	Description
Time to Prepare DSR per day:	240 min
Time to Prepare OCR per day:	3 min
Discount for Mismatch DSR-OCR:	75%
Discounted Time Savings by Using OCR:	177.75 min
Labor Rate per Minute:	$0.393
Value of Daily Time Savings for OCR per Forwarder:	$69.86

Note that in the savings calculation, the value was discounted because only 75 percent of the data elements in the DSR are in the CEFM OCR (21/28 = .75). The labor rate used was the administrative labor at ODW adjusted for fringe benefits.

- Eliminate Email to Forwarders Regarding US Arrival: Currently, ODW emails the arrival time at the CFS to the forwarders in Hong Kong. With CEFM, ODW would be able to eliminate the email and more importantly, the arrival data would be available as soon as it is posted to ODW's system.

MOE 6: Improved Accuracy of Information Transfer from Brokerage Houses to CBP

The LB and ODW each receives a copy of the Customs release via email from Barthco; there is no advance information about clearance status. ODW then manually enters the release date, time, and entry number into Scoreboard. LB's performance measure compares Customs release time with time of receipt at ODW. Barthco's information in CEFM is not useful to ODW because it still needs a hard copy of the release from Customs. The electronic release that will be possible with Air AMS will significantly improve both Barthco's and ODW's release information (see section 4.4.1, MOE 5, for a more detailed discussion of the release process and the potential improvements from CEFM and Air AMS). The CEFM Deployment and Scalability Evaluation Report will examine the accuracy improvements in the release information in more detail, both in the Columbus implementation at Barthco and ODW and at other industry implementations of Air AMS.

4.4.3. Savings per Shipment

The quantitative benefits of CEFM data identified in this study area accrued primarily to LB's partners in the supply chain, and for the most part, not to LB itself. There may be a derivative benefit to the shipper regarding savings for other partners. For example, a more efficient forwarder may be able to reduce its rates to the shipper. It is also possible that improved data quality at the partners could translate into fewer errors or exception shipments, with a resulting improvement in on-time performance at the shipper, or a reduction in labor to use automated reports from the partners or to research errors or data problems. It is also possible that existing systems (such as the Access database used at LB for managing the DSRs) could be turned off if CEFM/FIH were implemented.

It should be emphasized that shipper benefits of improved data quality from CEFM-type data can only accrue if the data is integrated into the operations and existing systems at the company. Some of the

partners, as well as LB, told the Evaluation Team that CEFM would be good for small- to medium-sized shippers who have less supply chain sophistication. Large firms that already have sophisticated visibility technologies in place might show some benefit from improved data quality, but as a portion of revenues, those savings might be fairly small. A small company with largely manual processes could enjoy a significant improvement in data accuracy, but its magnitude of benefit would be less because its business volume is so much less than the larger firms. A company that has primarily manual processes could achieve a substantial improvement over an 8 percent error rate for manual data entry that has been found in earlier USDOT Field Operational Tests (FOTs). The various sizes and types of shippers and their potential benefits from improvements in data quality and the use of automated information will be further investigated and documented in the CEFM Deployment and Scalability Evaluation Report from the Evaluation Team.

In reviewing the shipments involved in the deployment test, it was found that 871 consignments were completed. This was equivalent to 4.83 consignments per day for each of the 180 days of the deployment test. To compute the percentage that CEFM shipments represented, the Evaluation Team compared CEFM data and total shipment data for the same period as the test and performed the following calculation:

> 4.83 consignments per day multiplied by the percentage of CEFM shipments divided by the percentage of total shipments from Hong Kong to Columbus.

Table 37 shows the calculations for the two brands (two manufacturers each) and for the two forwarders. The CFS and the shipper used the manufacturers' average consignments/day.

Table 37. Consignment per Day Calculation

Partner	% CEFM Test Shipments	CEFM % of Total HKG Shipment	Number of Daily Consignments
Victoria's Secret manufacturers	92.3	14.94	29.8
Express Brand manufacturers	7.7	2.78	13.4
Forwarder (Star)	65.0	14.1	22.3
Forwarder (Hellmann)	35.0	7.5	22.6

The number of daily consignments above was divided into the daily savings. The savings derived from this analysis and described in the preceding two sections are summarized and then applied to the number of expected shipments for the supply chain. Table 38 shows the quantitative savings that have been calculated for the CEFM supply chain. For simplicity, the numbers were rounded to the nearest dollar and midpoints were taken where ranges were included in previous calculations. The daily savings identified for the particular partners involved were $259.

Table 38 also shows the breakout of per-shipment savings each partner could be expected to achieve along with the rolled up total per shipment daily labor savings.

Table 38. Estimated Daily Savings per Shipment

Partner	Partner Labor Function	Calculation for Daily Cost Savings	Daily Labor Savings	Per Shipment Labor Savings
Manufacturer	Data entry activities to book consignment.	$6.70 x 4 manufacturers (216 minutes saved).	$27	**= $0.61**
Forwarder	Data entry for pre-alert.	$12.32 x 2 forwarders (76 minutes saved).	$25	**= $4.16**
	Time for researching airline status.	$11.20 x 2 forwarders (28.5 minutes saved).	$22	
	Time to prepare DSR.	$70 x 2 forwarders (178 minutes saved).	$140	
CFS	Warehouse staff time to research data errors.	60 minutes saved.	$24	**=$0.92**
	Management staff time to correct missing or incorrect EDI data.	20 minutes saved.	$16	
Shipper	Staff time to research and process priority shipments.	28 minutes saved.	$11	**= $0.25**
		TOTAL:	**$259**	**$5.94**

Lessons Learned from CEFM Test

Following are the lessons learned from the CEFM test:

- Labor savings are the easiest to quantify when looking at the benefits of improved information. Care needs to be taken in selecting MOEs to be sure that they are achievable and relate to what is happening in the supply chain and in the test. Fewer is better. Even though labor savings were the most quantifiable, the partners had a difficult time providing estimates of errors and time to conduct various work tasks.

4.4.4. Public Sector Benefits from Private Sector Logistics Improvement

The Evaluation Team intends to follow the work steps first defined in the CEFM Detailed Test Plans dated October 4, 2007. This analysis will be included in the CEFM Deployment and Scalability Evaluation Report. The work steps for the public sector benefits are summarized as follows:

- Formulate lessons learned and presentation on improvements.
- Interview Government personnel involved in transportation/security.
- Assess potential improvement in traffic congestion and air pollution.
- Assess potential improvement in safety/security to the public.
- Incorporate results into draft CEFM Deployment and Scalability Evaluation Report.
- Incorporate comments and results into final CEFM Deployment and Scalability Evaluation Report.

The second report, the CEFM Deployment and Scalability Evaluation Report, will include information about how the improved information from CEFM might benefit the Government, or help promote Government initiatives and interests such as congestion, safety, and security. This portion of the effort will be largely qualitative and anecdotal, but will place productivity improvement of the freight industry in the context of overall national freight objectives and policies. The Evaluation Team will review other research studies and freight improvement projects and interview appropriate officials.

There are four MOEs in this hypothesis that will be addressed in the CEFM Deployment and Scalability Evaluation Report:

1. Reduced traffic congestion through reductions in erroneous moves and reductions in dwell times at nodes.
2. Reduced air pollution associated with congestion reduction (see above).
3. Enhanced safety and security.
4. Second report will include lessons learned from the supply chain research.

Another important feature included in the CEFM Deployment and Scalability Evaluation Report will be logistics performance and productivity improvements in industry, and additional analysis of cost of supply chain improvements in industry, particularly those related to better information for decision making. The CEFM Deployment and Scalability Evaluation Report also will include lessons learned in supply chain productivity improvement efforts throughout the industry and Government from the industry-wide supply chain research.

4.5. ANALYSIS PLAN FOR DEPLOYMENT AND SCALABILITY REPORT

The CEFM deployment test was narrowly focused on a single supply chain. However, the EFM project and the DOT interests in improving supply chain performance and visibility both address potential Government impacts and wider industry impacts. For this reason, a fourth study area was defined early in the project to address deployment of EFM technologies beyond the deployment test. This section discusses the plans for further deployment and scalability, and describes some of the adoption activities that have already occurred.

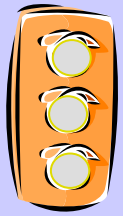
Building on the quantitative and qualitative benefits, as well as the lessons learned during the evaluation CEFM Evaluation Final Report, the Evaluation Team will provide additional analysis of the potential benefits from expansion and further deployment of CEFM technologies among the

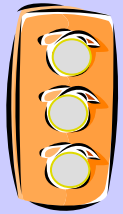
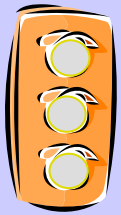
CEFM supply chain partners and the wider manufacturing and distribution industries in the CEFM Deployment and Scalability Evaluation Report. Table 39 presents the three hypotheses that will be evaluated as part of the Deployment and Scalability study area. Except for limited discussions at industry workshops during 2006 and 2007, the evaluation and results for this study area will be completed and included in the CEFM Deployment and Scalability Evaluation Report to be produced in September 2008.

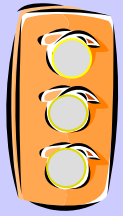
This future Deployment and Scalability evaluation will be particularly important to the USDOT since it will attempt to quantify the national benefits of automated data exchange utilized in the CEFM test. The Evaluation Team will follow the work steps below on completing and documenting wider industry improvements in supply chain technologies, summarized as follows:

- Formulate lessons learned and presentation for industry leaders.
- Conduct trade press and current literature search, especially SOA.
- Synthesize anecdotes and trends from current literature.
- Analyze supply chain trends in other industries.
- Calculate return on investment of technology improvements, employing cost/benefit models as appropriate.
- Review additional efforts to implement EFM; for example, KC SmartPort.
- Participate in industry supply chain improvement meetings.
- Participate in EFM Adoption Strategy discussions with industry.
- Incorporate results into draft CEFM Deployment and Scalability Evaluation Report.
- Incorporate comments and results into CEFM Final Deployment and Scalability Evaluation Report.

Table 39. Results of Private and Public Sector Deployment and Scalability (CEFM to EFM) CEFM Deployment Test Evaluation

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
1. The information exchange technologies tested in CEFM will be considered for operational use.	1. Successful integration by one or more supply chain partners of CEFM technology with legacy system. 2. Deployment of the EFM components and technologies beyond the Deployment Test into a production environment by any participants or other industry supply chains. 3. Integration of EFM technologies into the companies' evolving IT systems. Positive efforts by partners and others to expand the use of EFM technologies.	• On-site observation and participant interviews from test participants and other organizations who implement EFM. • EFM adoption strategies and advocacy presentations by partners. • Observations and results from Kansas City EFM Adoption Effort. • Industry surveys and literature searches of supply chain enhancement trends in industry. • Definition of EFM components and implementation issues.	• Analysis of industry survey results and of supply chain trends in other industries. • Observation of and participation in industry meetings where EFM adoption is discussed. • Analysis of Kansas City EFM Adoption Effort results, interviews, and identified benefits. • Use of Cost-Benefits Analysis. • Analysis of industry studies to estimate or calculate industry-wide benefits of supply chain visibility improvements. • Review of other industry studies or implementations of Web services and SOA. • Review of lessons learned from the supply chain research	 Gray	• EFM and CEFM technologies have been discussed with industry at IFTWG meetings. USDOT also has conducted small group discussions with potential adopters. There is a favorable view toward the use of EFM technologies. An adoption strategy has been published and materials for potential adopters have been prepared and included on an EFM-FIH publicly available Website. • Most of the analysis will be conducted during the spring and summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report.

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
2. A benefit-cost case can be developed from the CEFM test data and evaluation assessments that can illustrate EFM system scalability and deployment benefits at a national level.	1. Private sector net benefits of CEFM over costs and other benefit-cost measures. Public sector net benefits of CEFM over costs and other benefit-cost measures. 2. Continued growth in supply chain industry of the use of EFM technologies including SOA, FIH, and Web services-based data exchanges. Continued progress toward objectives of EFM adoption strategy to deploy EFM technologies throughout industry.	• Data and results from the earlier CEFM hypotheses assessments and from other industry implementation of EFM. • Industry/supply chain demographics and trends. • Industry supply chain analyses and plans for implementing technologies. • Interviews with industry supply chain leaders. • Interviews and results from Kansas City EFM Adoption Effort.	• Use of cost-benefit models including DOT's FTAT. • Analysis of trends in supply chain technology in industry including adoption of SOA. • Review industry studies to estimate or calculate industry-wide benefits of supply chain visibility improvements. • Analysis and observation of Kansas City EFM Adoption Effort.	 Gray	• Kansas City SmartPort is planning to implement EFM capabilities and have been involved in EFM team conference calls since the fall of 2007. Anticipated cost benefit estimates were completed for the likely Kansas City operational scenario. • The analysis will be conducted spring/ summer |of 2008 and included in the CEFM Deployment and Scalability Evaluation Report
3. Those working in the transfer of freight information will deem the CEFM freight information standards appropriate.	1. Use of UBL standards within CEFM. 2. Ability to submit non-standard CEFM messages (such as Open Consignment Report) for UBL certification. 3. Increased use of XML messages compared with EDI.	• CEFM data structures and message formats. • UBL and other data standards. • Industry trends in implementation and approval of data standards.	• Review and comparison of current automated message flow among partners versus schemas and standards in CEFM. • Examine lessons learned from the CEFM and industry use of UBL data standards.	 Gray	• CEFM successfully used UBL standards and created a transportation status message for submittal to UBL certification See the discussion in section 4.2, System Usefulness. • The analysis will be conducted spring/summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report

Hypothesis	MOE	Data Sources	Analysis Methods	Results	
				Rating	Findings
4. Benefits to industry productivity highlighted by the CEFM test can lead to improvements in U.S. economic competitiveness under a national-scale EFM deployment.	1. Reduced resources required by industry as measured in many of the efficiency benefits measured in this independent evaluation.	• Evaluation of efficiency-related results and benefit-cost assessment results.	• Macro-economic assessment methodologies to estimate national factors such as employment, added productivity, net profit. • Use of cost-benefit models including DOT's FTAT.	 Gray	• The analysis will be conducted spring/summer of 2008 and included in the CEFM Deployment and Scalability Evaluation Report.

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4.5.1. Wider Industry Supply Chain Analysis

The wider EFM adoption evaluation involves reviewing industries beyond retail apparel and shipments by other modes of transportation to determine the applicability of CEFM technologies beyond the deployment test. The analysis involves identifying areas where CEFM could apply and where similar improvements in other industries could be useful in expansion of CEFM in the apparel industry.

An important part of this evaluation involves identifying barriers to implementation and examples of quantitative and qualitative benefits of supply chain improvements that have been derived by supply chain users and consultants who have analyzed other industries. The Evaluation Team will draw from recent supply chain reports to identify technology implementation trends that may indicate how CEFM can best be expanded in industry. With respect to scalability and implementation, the Evaluation Team will enumerate benefits of supply chain improvements and then derive quantified benefits as they may be available. Quantified benefits may be derived from case studies presented at conferences or documented in industry trade press and research reports. There also may be some quantifiable benefits information from the assessment of the Kansas City EFM Adoption Effort.

The deployment test was limited in terms of the number of test shipments (between 7 and 14 percent of the LB supply chain's total, on average) and in terms of integration of Web services technologies into partners' systems. Therefore, this wider evaluation will include results of cost-benefit modeling. The Evaluation Team will use CEFM test data and industry data to provide inputs to cost-benefit models that can determine net present value, rate of return, and other measures of quantified benefits.

The Evaluation Team will first examine the FHWA-developed supply chain model Freight Technology Assessment Tool (FTAT) for its applicability to the CEFM supply chain. Other models known to the Evaluation Team may be used as well. The Evaluation Team will run the models to provide a benefit-cost case for CEFM expansion.

As other parts of the evaluation will have assessed the use of the UCR within CEFM, the Evaluation Team will build upon the lessons learned from CEFM to further analyze CEFM's use of the Unique Consignment Reference number (UCR) and its relationship to World Customs Organization (WCO) guidelines. The evaluation in these hypotheses will examine future use of or constraints about the UCR.

The evaluation of this Deployment and Scalability study area relates to be ability of the tests' results to be spread to other supply chains and other industries and presenting a benefit-cost analysis that will help demonstrate the value of expansion. The likely next adopter of EFM technologies is a supply chain within Kansas City. It is anticipated that the results of the Kansas City EFM Adoption Effort will provide important input to this hypothesis and the expansion of EFM technologies to other industries.

The Evaluation Team will work with industry and Government leaders to identify the macro-economic benefits of CEFM improvements. The emphasis will be on gaining perceptions as to the public sector impact of industry-wide expansion of CEFM. Using Delphi techniques with industry and

Government leaders, the Evaluation Team will document the likely economic impacts of the type of supply chain improvements being tested in CEFM.

4.5.2. Preliminary Observations of CEFM by partners and industry.

During a demonstration of the CEFM system at the November 2007 Intermodal Freight Technology Working Group (IFTWG), project participants discussed potential adoption of EFM technologies with industry representatives participating in the workshop. Discussion topics, questions, and answers from that workshop are noted below. The Evaluation Team will build upon the IFTWG discussion in performing the adoption and deployment analysis and will document the results in the CEFM Deployment and Scalability Evaluation Report.

- *Workshop participants and the CEFM Development Team thought that CEFM-type Web portals would not be used if all the partners were integrated. However, it is worth noting that ODW used the Website during the deployment test to see what shipments were coming to them because ODW's existing system does not have that capability. The Web portal could be a supplement to the existing systems, depending on the functional capability of those systems.*
- *For the most part, implementing CEFM in the future would involve mapping partner data elements to UBL. Some workshop participants pointed out that in existing systems, partners might call things different names (such as NDC date), and that would need to be mapped. A partner would have to determine the appropriate communications mechanism to send and receive Web services, and what information the partner would use so that the appropriate Web services could be chosen.*
- *One workshop participant advocated pushing exceptions or changes in status by a partner (rather than having all data simply available within a status report). This is something that the Hong Kong partners mentioned to the Evaluation Team in interviews during the deployment test.*
- *There was discussion about what a small carrier needs to do to access the Web service:*
  - *An Internet connection to a Web portal would be needed if the partner had limited IT resources. In that case, the portal would house the Web services. Normally, the Web services would be integrated.*
  - *The EFM Adoption package is intended to include a "connect and configure" approach that would be part of the registry that would contain available Web services to allow users to pull them down. Instructions on how to communicate with partners would be included in the registry.*
  - *An initial one-time mapping effort would be required for each partner, and presumably, the IT organization for a partner would host the Web services for that partner.*
- *Throughout the industry, each partner has a different method of using standards, and even using apparently standard documents. For example, the ASN is different from partner to partner; even the 214 Status Report is different. Some of the workshop participants were concerned about whether or not CEFM was trying to replace EDI; the EFM Deployment and Evaluation Teams carefully explained that EFM opens more doors to enter into automation and provides a standard that can be used, but it does not necessarily replace EDI.*

4.5.3. Kansas City Adoption Effort

The EFM Adoption Effort in Kansas City is being conducted in conjunction with KC SmartPort and will provide additional information and insights that can be included in the CEFM Deployment and Scalability Evaluation Report. This is particularly appropriate because the Kansas City EFM Adoption Effort will be adapting the lessons learned and technologies from CEFM and the FIH. Including the Kansas City results in the CEFM Deployment and Scalability Evaluation Report will provide additional inputs and data for cost-benefit analyses. At the IFTWG meeting noted above, representatives from KC SmartPort said that the organization was interested in hosting a registry and implementing Web services.

Since an important objective of the Deployment and Scalability study area is to examine whether or not CEFM can be implemented more widely in industry, the Evaluation Team will work closely with the Kansas City developers and implementers to obtain Kansas City results that can be included in the CEFM Deployment and Scalability Evaluation Report. This will leverage both projects and provide a compendium of EFM technologies, lessons learned, and benefits (realized or anticipated) in a single document.

Another part of the EFM initiative is development of an architecture framework for the FIH that will facilitate the adoption of the FIH into all freight transportation modes and in any supply chain throughout the United States.[37] The Kansas City Adoption Effort will be a part of KC SmartPort's Trade Data Exchange (TDE). Four potential supply chain partners are being identified for a domestic or North American ground (most likely truck) supply chain.

For the Kansas City Adoption Effort, Battelle is managing the project and, along with Transentric, will adapt the CEFM technologies to Kansas City. Once the supply chain members have been agreed upon, Electronic Data Systems (EDS) will develop the requirements and business rules and operate the system for KC SmartPort.

Once the design is approved by FHWA and KC SmartPort, Battelle's Deployment Team will build the system, and involve the following major activities:

- Update the FIH registry used on the CEFM deployment test to identify the supply chain participants in KC SmartPort and the information it shares with other partners.
- Update the security implementation for messages and user-based access.
- Build the Web-based data entry screens included in the design.
- Revise the CEFM system design to a portal server model.
- Revise the CEFM Web services and messages shared to address the data model and business rules for the KC SmartPort deployment.

Data entry and system use for the Kansas City EFM Adoption Effort for each partner is planned to be via a Web portal interface, and not integrated with any existing logistics or transportation management system. The supply chain owner and all of its partners will log into the Web site to manually input

[37] Two documents related to the Kansas City EFM Adoption project were used: "Standing Up an Economic Development Node in Kansas City – FIH Implementation with Kansas City SmartPort" draft, September 11, 2007; and a PowerPoint briefing of the same title and date.

their information related to freight booking, tendering, and shipping, as well as to inquire about the status of shipments. To facilitate these activities, the Deployment Team will design KC SmartPort-specific data entry screens with integrated logic to implement the business rules defined in the project. This product will cater to small business partners with little automatic or sophisticated data exchanges, and add to the available EFM technology base.

The Evaluation Team will work closely with KC SmartPort personnel and the several consultants and IT companies involved in the Kansas City EFM Adoption Effort. Documents and experiences will be exchanged, lessons learned will be provided, and implementation scenarios will be discussed. Based on its experience in CEFM, the Evaluation Team will provide comments and feedback to Kansas City EFM Adoption Effort participants on Kansas City documentation and design issues. The Evaluation Team's efforts will facilitate knowledge transfer so that when the CEFM Deployment Evaluation Report is published after the Kansas City demonstration has been completed, that report can reflect the Kansas City results in the impact of EFM technologies on the industry.

5. SUMMARY OF OBSERVATIONS, FINDINGS, AND LESSONS LEARNED

This section summaries the benefits and lessons learned that were compiled from the detail provided in section 4.

5.1. QUANTITATIVE BENEFITS SUMMARY

The quantitative benefits of CEFM data identified in this study area accrued primarily to the other partners in the supply chain rather than to the shipper, LB. There may be a derivative benefit to the shipper of savings for other partners; for example, a more efficient forwarder may be able to reduce its rates to the shipper. It is also possible that improved data quality at the partners could translate into fewer errors or exception shipments, with a resulting improvement in on-time performance at the shipper or a reduction in labor to use automated reports from the partners or to research errors or data problems. It is also possible that existing systems (such as the Access database used at LB for managing the DSRs) could be turned off if CEFM/FIH were implemented.

It should be emphasized that shipper benefits of improved data quality from CEFM-type data can only accrue if the data is integrated into the operations and existing systems at the company. Some of the partners, as well as LB, told the Evaluation Team that CEFM would be beneficial for small- to medium-sized shippers who have less supply chain sophistication.

The savings found by the Evaluation Team in this analysis were summarized and then applied to the number of expected shipments for the supply chain.

In reviewing the shipments involved in the deployment test, it was found that 871 were completed consignments. This is equivalent to completing 4.83 consignments per day for each of the 180 days of the deployment test. To compute the percentage that CEFM shipments represented, the Evaluation Team compared CEFM data and total shipment data for the same period as the test as described in section 4.4.3.

The number of daily consignments (4.83) was divided into the daily savings. Table 40 shows the breakout of the per shipment savings each partner could be expected to achieve when using CEFM, along with the rolled up total per shipment daily labor savings.

Table 40. Estimated Daily Savings per Shipment

Partner	Partner Labor Function	Calculation for Daily Cost Savings	Daily Labor Savings	Per Shipment Labor Savings
Manufacturer	Data entry activities to book consignment.	$6.70 x 4 manufacturers (216 minutes saved).	$27	**= $0.61**
Forwarder	Data entry for pre-alert.	$12.32 x 2 forwarders (76 minutes saved).	$25	**= $4.16**
	Time for researching airline status.	$11.20 x 2 forwarders (28.5 minutes saved).	$22	
	Time to prepare DSR.	$70 x 2 forwarders (178 minutes saved).	$140	
CFS	Warehouse staff time to research data errors.	60 minutes saved.	$24	**=$0.92**
	Management staff time to correct missing or incorrect EDI data.	20 minutes saved.	$16	
Shipper	Staff time to research and process priority shipments.	28 minutes saved.	$11	**= $0.25**
		TOTAL:	**$259**	**$5.94**

The daily savings identified for the particular partners were derived as follows:

- **Manufacturer data entry savings** of 5 minutes per PO from only having to enter two data elements instead of eight to book a shipment. Hourly rates cited are for Chinese labor.
- **Hong Kong forwarder data entry savings for automating portions of the pre-alert** (76 minutes per day). Hourly rates cited are for Hong Kong labor.
- **Columbus forwarder labor savings for reducing research to obtain airline data** (28 minutes per day). Hourly rates cited are for Columbus labor.
- **Columbus forwarder labor savings for eliminating manual work on the daily status report (DSR)** (178 minutes per day). Hourly rates cited are for Columbus labor.
- **Columbus container freight station (CFS) warehouse labor savings** of $4 per error for less time spent researching missing data. Hourly rates cited are for Columbus labor.
- **Columbus CFS logistics staff labor savings** of $3 per error for correcting EDI data. Hourly rates cited are for Columbus labor.
- **Columbus shipper savings for reduced effort in monitoring hot shipments** (27 minutes a day). Hourly rates cited are for Columbus labor.

5.2. QUALITATIVE BENEFITS SUMMARY

In addition to the quantitative benefits, there were important qualitative benefits to LB and its partners, which are summarized as follows:

- **Improved timeliness of freight release process:**
  - CEFM could allow the broker to prepare documentation on Sundays, thereby reducing its backlog of Monday shipments, which would potentially help the broker to better spread out its labor force throughout the week.
  - CEFM data means that the broker can process the current paperwork and the Customs clearance can be processed earlier.
- **Improved cargo status information:**
  - CEFM improved data availability for freight forwarders and for other partners. The ASN was not previously available to one forwarder.
  - CEFM provided near real-time automated status reports containing all supply chain events that either were not available before, or required significant manual effort to prepare.
- **Improved timeliness of supply chain data:**
  - CEFM provides downstream partners earlier access to PO manufacturer booking and tendering data.
  - Users can access status data on demand that is currently available only from manually prepared daily pre-alerts and status reports.
  - The CEFM ASN is available at least 6 hours up to 1 day earlier than current EDI versions of the ASN.
  - Shipment status information is available to the broker at least 4-6 hours earlier.
- **Improved data quality, especially for less automated supply chains:**
  - There would be a reduction in data entry errors when using CEFM because of less data entry and no need to re-key data on the supply chain.
  - Improved quality data from CEFM would make it easier for forwarders to respond to discrepancies from the shipper.
  - XML data is more accurate than EDI, requiring less error correction.
  - While CEFM data accuracy was consistent with the EDI and DSR accuracy rates tracked by LB, for supply chains that rely heavily on manual data entry and re-keying information, data accuracy could potentially have greatly improved data accuracy rates.

5.3. ADDITIONAL KEY EVALUATION FINDINGS

The additional key evaluation findings are summarized as follows:

- The Federated Status Report is a new report not previously available to users before CEFM, and is generally not available today in any logistics system. In particular, the real-time polling of partners external to a company is rare, even in the SOA sphere.
- The Open Consignment Report and improved airline data were well received by users from the various partners.
- All of the LB's partners said that if CEFM was applied to all shipments, they would use the system more, and indicated that using the system would be beneficial.

- ODW, the one partner who integrated, perceived far more benefit from CEFM than did the partners who did not integrate. This was because CEFM provided ODW with more accurate and more timely data to its existing system than was available without CEFM.
- ODW, the one partner who integrated, expected that there would be reduced implementation barriers at lower cost; however, this was not proven during the test since additional partners were not added.
- A recent analysis by members of the broader EFM project team estimated the cost of EFM implementation to be $125,000 for a medium-sized company. This estimated cost includes labor; hardware and software; and an FIH node that includes integration with the company's existing systems.

CEFM did meet the Business Requirements and System Specifications for the system included in the Detailed Design Document and Design Foundation documents (see detailed tables included in sections 3.6 and 4.2). The CEFM Concept of Operations and other program documents defined the seven objectives of the deployment test of FIH capabilities in CEFM, with the outcome summarized as follows:

1. **Provide comprehensive visibility of shipment information to appropriate LB supply chain partners.** This was achieved (see the qualitative benefits listed above and section 4.3).
2. **Provide the ability and platform for LB supply chain partners to communicate electronically.** This was achieved through the implementation of the FIH platform and the receipt of OCRs and Federated Status Reports by users (see the discussion about the CEFM architecture and data flows in sections 2, 3, and 4.2).
3. **Improve the ability for consignees within the supply chain to schedule/plan for receipt of shipments.** ODW, the only partner that integrated CEFM with its existing system, thought CEFM could help staff to better plan ODW's operations. ODW's logistics staff used the exported OCR to forecast anticipated shipments (see section 4.3).
4. **Provide carriers with real-time lading and cargo management information.** These items were not specifically addressed in CEFM since the "presence" of the three airlines was provided via a third-party airline data firm. However, separate shadow databases were implemented in CEFM for each airline, and were the airlines to use that information, it could provide them with real-time data about booked cargo in Hong Kong (see section 3 and sections 4.2 and 4.3).
5. **Provide a means for manifest data to be electronically delivered to its intended receivers securely and on a near real-time basis.** These items were achieved by transmission of the ASN to LB, ODW, and other partners, some of whom did not receive the ASN before (see sections 4.3 and 4.4).
6. **Increase the ability of LB supply chain partners to collaborate with each other to improve service.** This was achieved (see sections 4.3 and 4.4).
7. **Enable the deployment of universal and distributed applications among LB supply chain partners.** This was achieved. Each partner had a shadow database, integrated the system, or used the CEFM Web portal. All data used UBL international data standards.

5.4. LESSONS LEARNED SUMMARY FOR ADOPTION STRATEGY

Following are the lessons learned that were derived from the three study areas evaluated that can be valuable for the Adoption Strategy effort:

- For future implementations, it is important for users to understand that CEFM is a supplement to existing systems, not a separate or replacement transportation management system.
- As much as supply chain professional and Government officials want to reduce transit time, improve shipment reliability, and reduce dwell time, live tests cannot be expected to address these measures. Tests that are part of existing operations as occurred with CEFM are generally only a subset of the shipments and the users and managers must first move the freight and second provide support to the test. While these measures are appropriate goals for the supply chain and something that could be used if the participating companies implemented the system in operation, they should not be used in the test itself.
- Integrating CEFM system capabilities into an existing system is critical to obtain the benefits of reduced data entry and increased data quality.
- Partners who integrate are better able to benefit from data quality because they do not have to re-key the data.
- Future versions of CEFM/FIH need to have logic that detects double flight arrivals or completely illogical dates and flags such errors for users to investigate and correct as needed.
- For the system to be truly effective and usable by the supply chain partners, it needs to be flexible enough to accept and provide data about any partner that may be involved in the supply chain. Consideration should be given in future implementations to the tradeoffs involved in meeting the complex partner requirements in the supply chain.
- The OCR should be expanded to include all data elements needed by the users for the various status reports.
- The airline data capability should be examined carefully to improve its flexibility to address multiple airlines moving freight on the supply chain.
- Labor savings are the easiest to quantify when looking at the benefits of improved information. Care needs to be taken in selecting measures of effectiveness—fewer is better—to ensure that they are achievable and relate to what is happening in the supply chain and in the test.
- Even though labor savings were the most quantifiable, the partners had a difficult time providing estimates of errors and time to conduct various work tasks.

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