Improving Cargo Security and Efficiency Through the Development and Testing of an Electronic Supply Chain Manifest

Prepared by the American Transportation Research Institute (formerly the ATA Foundation)

For the Federal Aviation Administration and the Federal Highway Administration

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Phase II:
Developing and Testing an
ELECTRONIC SUPPLY CHAIN MANIFEST

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FOREWORD

This report summarizes the research design, implementation, testing and evaluation activities associated with the Electronic Supply Chain Manifest (ESCM) operational research test. The report represents a compilation of six technical memoranda and an interim report produced over the 18-month course of the project.

The Electronic Supply Chain Manifest project was one of two national intermodal operational research projects sponsored by the U.S. DOT. Funding and technical assistance was provided by the Federal Aviation Administration, Federal Highway Administration, U.S. DOT Office of Intermodalism and the State of Illinois.

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Numerous trucking and aviation industry participants and experts contributed to the operational test and final report.

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Abstract

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The global economy is undergoing a significant transformation. Despite cyclical upturns and downturns, the international marketplace has experienced tremendous growth over the last decade. Increasing competition is putting pressure on businesses to increase productivity, improve customer service, reduce costs and ensure the safe and secure movement of goods along the supply and distribution chains. This increased pressure on supply chain partners has resulted in an unparalleled investment in technology solutions by business and government.

A primary strategy for managing supply chain efficiency and security is better utilization of the freight shipping options. With increasing cargo values and expedited delivery pressures, ground-air intermodalism has now become the fastest growing sector of the freight industry. For related reasons, including the preponderance of air cargo that’s transported in passenger planes, the impact of the September 11 attacks, in the short-term, has hurt air cargo operations more than the other modes. Nevertheless, a recent DRI-WEFA study estimates that air cargo’s growth rate will exceed 7% annually.


Security Issues
Terrorism and political upheavals around the world also threaten supply chain efficiencies. It is well documented that the vast majority of terrorist attacks utilize some aspect of the transportation system. The costs associated with loss of human life, as well as lost, damaged, delayed or stolen cargo is often incalculable.

For this reason, the federal government as well as most pilots’ unions continue to identify air cargo security as a primary area of vulnerability.

A crucial aspect of air cargo security relates to controlling access to cargo and information flows along the supply chain; from the manufacturer, to the ground and air cargo carriers, on to the cargo recipient. Fortunately, technological advancements in applications now allow businesses to dramatically improve the electronic flow of information to all points in the supply and distribution chains, thus providing new opportunities to identify, control and manage cargo security. Technology systems such as smart cards, biometrics, encryption software, and web-based EDI transfers can be interfaced with existing logistics systems to improve the efficiency and security of freight movement, both domestically and internationally. Aside from the direct benefits of a multi-tiered technology system, the FAA attributed a high level of deterrence to the system.

Efficiency Opportunities
Many IT-based supply chain research initiatives were underway prior to September 11th with the primary goal of increasing cargo transportation efficiencies and system productivity. Initially, this was a response to a major shortage of workers during the booming economy of the late 1990’s. After the technology crash of April 2000, the motivation was to reduce labor and overhead costs through technology investment.

Government Interest
Recognizing the vital function government can play in developing and testing innovative technology systems for air cargo movement, public sector stakeholders – including the US Department of Transportation’s Office of Intermodalism, Federal Aviation Administration, Federal Highway Administration, State of Illinois and the Chicago Department of Aviation – partnered with the American Transportation Research Institute Project Team (formerly the ATA Foundation) to develop and operationally test an Electronic Multimodal Supply Chain Manifest system.

Project Design and Objectives
The operational test – informally known as the “Phase 2 Electronic Supply Chain Manifest” (ESCM) project – designed, installed and evaluated an internet-based manifest system protected with fingerprint biometrics, smart card readers and data encryption software. The
operational test was supported and tested by participants in the manufacturing, trucking, and airline industries – in both the Chicago-O’Hare International Airport and New York City-JFK International Airport service areas.

The government sponsors were strong advocates of the multi-objective approach offered by the system: the ESCM system was designed to improve cargo security by protecting and tracking shipper and cargo information using encrypted Internet software with biometric smart card technologies to improve intermodal communications between distribution chain partners. Furthermore, it linked enrolled personnel with the cargo transactions. Beyond security, the ESCM system was proposed to increase productivity by expediting cargo processing, reducing manifest lead times, and reducing the probability of human error during data entry.

A Phase III expansion of the project is extending the ESCM testing program by adding Los Angeles International Airport and Toronto’s Pearson International Airport to the overall system. By expanding the system to Canada, the Research Project Team is attempting to interface the ESCM manifest with Customs information as part of the US Customs AMS program.
Project Background

Economic Pressures

New macro-economic realities, changing freight delivery patterns and increased security initiatives have compelled the transportation industry to re-examine the methods in which business is currently being conducted. The United States’ and worldwide economies have recently experienced a period of rapid growth where business is being conducted at the speed of a mouse click. While air cargo is the fastest growing sector of the freight industry, it is also the most volatile.

While the other modes experience pressure to deliver goods in proper condition, in a reasonable time, and at the lowest cost, air cargo is somewhat of an exception: it typically consists of higher-cost service in order to deliver high-value items requiring expedited and highly secure delivery. Nevertheless, pressured by market demand and just-in-time management, all freight delivery methods are giving way to more complex multimodal formats.
Further complicating the freight delivery and processing system is the multitude of manually processed documents accompanying a shipment such as air waybills, dangerous goods declarations and security declarations. When traditional paper documents are used, one will see an increase in processing times and an increased chance for human error. Errors in such a scenario may include missing or incorrect manifest data, missing shipment security documents, or lost or incorrect delivery information. Ultimately, efficient air cargo transport demands a seamless information flow devoid of the piles of paperwork now created with each air cargo transaction.

The advent of the Internet offers the prospect of greatly simplified information processing and forwarding between modal participants, setting the stage for paperless communications. The Phase II Electronic Supply Chain Manifest system allows for a quick and seamless dissemination of data throughout the system via the internet.

**Security Pressures**
Cargo security and safety are critically important in the movement of freight as multimodal transport becomes more prevalent. Traditional single mode freight transport allows far fewer chances of tampering or theft than do multimodal configurations. Multimodal freight is handled by many more individuals and has more transitions as goods are moved between modes. More contact by various hands results in more chances for something to go awry. The events of September 11, 2001 reiterate the necessity to tighten security measures in relation not only to passenger entry but cargo entry onto commercial flights as well.

**Proposed Solution**
The Phase II Electronic Supply Chain Manifest Project (ESCM) was designed to test improvements over the existing manual system — in both the efficiency and security of truck-to-air cargo operations. This project also addresses the interests and concerns of the public sector.

The Phase II Project developed a secure electronic manifest that permits manufacturers to send cargo information real-time along the distribution channel in advance of pick-ups and deliveries to motor carriers, consolidators, freight forwarders and airlines. The Phase II electronic manifest offers a secured identity process through biometric imprints (fingerprint recognition) in addition to the reduction in information errors due to electronic processing at all points. These improvements to the data transfer process as well as the incorporated security steps add value to the truck-to-air cargo transport operation.

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1 O’Hare Air Cargo Security Access System, Final Report; June, 2000
1.1 Phase I - O’Hare Air Cargo Security Access System

The Phase I air cargo security access field test designed, developed, installed and evaluated the potential superiority of a biometric/smart card system in the verification of truck driver identities and cargo content at air cargo facilities. The Phase I testing involved nearly 500 truck drivers from 87 companies delivering air freight to Chicago’s O’Hare International Airport.

The Phase I process encompassed the following:
1) driver and attendant enrollment of data and fingerprints into centralized database and individual smart cards;
2) installation of computer systems with biometric/smart card software and components;
3) biometric log-on/log-off by air cargo attendant;
4) driver confirmation at time of pick-up/drop-off;
5) acceptance by airline of electronic, smart card-based data on cargo and company.

This operational test demonstrated that a cargo security system utilizing biometric/smart card technology was more efficient than manual processes in verifying driver, company and freight information. It also demonstrated the potential cost savings and security enhancements of a secure and automated system to both public and private stakeholders.

In identifying these initial system findings – both failures and successes – the Phase I Access System paved the way for the Phase II ESCM test.

1.2 Phase II - ESCM Project Objectives and Concept

Project Goals and Objectives
The Phase II ESCM system built upon the success of the Phase I operational test by integrating internet transactions to the efficiency and security gains realized by the biometric smart card system. This combined system was then installed and tested along a series of three-node supply chains.

The overall goal of the ESCM test was to develop, deploy and evaluate a secure electronic manifest system, supported by leading edge security technologies.

The research hypothesis was: can a viable technology-based alternative to traditional supply chain processes be developed to improve efficiency, safety, and security for the movement of air cargo?
**System Concept**

The Phase II project allowed only authorized users to enter and monitor cargo movement or access important shipment information at specific points in time, thus allowing staff to more effectively manage the screening and movement of cargo along the logistics chain. This information enabled an authorized user at any point in the supply chain to poll the system for information that was applicable to their precise business requirements. In the case of an airline, it supplied advance notice of incoming freight, providing them with reduced consolidation time in planning specific flight loads. In the unfortunate case of an air transport incident, the immediate ability to catalog and audit electronic manifests could provide essential cargo content records to public sector agencies as an aid in incident reconstruction.

Additionally, the system was designed to ostensibly enhance the traditional FAA-mandated security methods utilized in the transfer of cargo shipments from one leg of the logistics chain through the use of automated identification and authorization technologies.

**Step-by-Step Process**

A manufacturing attendant, who biometrically logs onto the system and fills out the manifest on the Phase II system software, initiates the Phase II system. The attendant then transmits this electronic manifest to the central server. The designated motor carrier and airline are notified via e-mail that a manifest – hence a shipment – is available on the server.

The motor carrier dispatches a driver to the manufacturing facility. Upon arrival, the driver’s identity is verified using the biometric smart card validation process. The driver picks up the cargo and the airline is automatically notified via e-mail of the pending delivery details. The driver arrives either at a cargo consolidation center (at which point the cargo and bills of lading are consolidated into a “master manifest” for delivery to the airline) or proceeds directly to the air cargo facility where the driver’s identity is again verified and the forwarded manifest is checked against the physical cargo. All distribution participants are notified electronically upon successful receipt of the cargo by the airline.

**Research Partnership**

The Phase II operational test was a public-private partnership led by the American Transportation Research Institute (formerly the ATA Foundation) and supported by:

- Federal Aviation Administration;
- US DOT Office of Intermodalism;
- Federal Highway Administration;
- State of Illinois;
- Chicago Department of Aviation;
- New York Department of Transportation;
- New York-New Jersey Port Authority.
The Phase II ESCM was tested with manufacturers/shippers, motor carriers, and airlines representing distribution chains in the Chicago O’Hare and New York City JFK airport areas.

**Project Timeline**

Phase II began in the summer of 2000 with site visits at manufacturers, motor carriers, and air cargo carriers to document their current business processes with particular emphasis on the use of both internal/external manual and electronic information transfers and processes for freight movement within the distribution chain. These site visits determined the business environment in which an electronic manifest test system would need to operate. Resulting from these site visits, a composite manifest was developed (including some variations of the International Air Transport Association standard air waybill) and incorporated into the Phase II system to closely reflect the observed business requirements.

The Phase II Electronic Manifest System was designed and installed in Chicago during the winter of 2000. Shortly after a successful system beta test, operational testing began on a limited basis with select participants in the Chicago area. Full operational testing began in the fall of 2001 at both Chicago-O’Hare International Airport and the New York-JFK International Airport. For the purposes of this report, data and information collection continued through April 2002. Phase 3 activities continued through December, 2002.

### 1.3 Purpose and Organization of Report

This report is organized to describe intermodal operational environments; policy issues relating to the test; enabling technologies; ESCM’s functional and technical design; project outputs and findings; and final project analysis. The report attempts to follow a logical continuum of information and processes, allowing readers to gain familiarity with subject material and then applying that knowledge base to the specifics of the Phase II Electronic Supply Chain Manifest system operational test.

**Section 2** provides an overview of the operational processes for each of the three modal units (manufacturers, motor carriers and airlines) and emerging trends for each mode.

**Section 3** provides a description of regulatory oversight of air and airport technology/security policy initiatives.

**Section 4** discusses various Phase II ESCM technologies that are being applied to enhance efficiency and security in business and government.
Section 5 presents the functional and system architecture of the Phase II ESCM system along with process flow descriptions for each participant mode (manufacturers, motor carriers and airlines).

Section 6 describes the recruitment processes for test users, including participant solicitation, enrollment, training, and technical support.

Section 7 provides the Phase II evaluation plan including development of measures of effectiveness and data collection methodologies and activities.

Section 8 presents the quantitative and qualitative evaluation findings including user perceptions, user acceptance, recommended system enhancements, and time efficiency and labor savings.

Section 9 analyzes potential economic and institutional issues that could potentially affect wide-scale ESCM system deployment.

Section 10 presents project conclusions and recommendations.
Private Sector Operational Environments

At the highest level of analysis, business models are constantly changing and industry consolidation is resulting in new partnerships for spreading investment risk and promoting pooling of scarce capital resources to achieve common strategic business goals. A single business will likely have multiple partnerships to consolidate areas of common infrastructure and applications in order to increase efficiency and customer service delivery. Partnerships are becoming common particularly in the area of communications. By sharing resources and information, the industry is able to quickly deploy cutting-edge technology solutions.

In turn, the private sector is seeking technology solutions for increasing air cargo efficiency while simultaneously enhancing cargo security. Efficiency is sought to eliminate paperwork and duplication of effort, speed response times at each modal step, and to provide instant access to cargo information for all authorized users at any point in the supply chain.
Security is desired to limit liability and protect the public by allowing only authorized personnel to access cargo and documentation. These private sector efforts are generally conducted in a controlled environment, but when combined with their trading partners, meaningful efficiency and security gains can be gained.

Independent of the ESCM testing, businesses all utilize a myriad of processes that provide a framework against which to understand the increased efficiency and security of the Phase II system (in comparison with traditional manifesting methods). The Phase II ESCM system is composed of three distinct yet connected components:

- Manufacturers;
- Motor Carriers; and
- Air Cargo Carriers.

These three supply chain “nodes” comprise the supply chain along which cargo and information are transferred between modal trading partners. Consignees often represent a fourth component in supply chains but in this instance, airlines often act as consignees since regulations require that they accept both physical and security control over cargo.

This section provides operational overviews of typical business processes for each modal business unit covered in the ESCM. Figure 1 graphically depicts these processes. The focus is on the cargo information flows, which also mirror the physical movement of the cargo.

### 2.1 Manufacturers

Manufacturers are the initial link in the intermodal supply chain for freight movement. The types of products they create are quite varied in respect to size, weight, shape, and handling requirements. This complexity in physical cargo attributes is matched with an equal complexity in the types of information that a manufacturer’s system must be able to capture and disseminate both internally and externally. Procedures are designed to simplify both information and product flow throughout the system, with the ability to track a customer’s product being particularly crucial.
**Figure 1. Distribution Chain Event Sequence**

### Manufacturers
1. Order Entry
2. Order Flow (Sales Receipt-Production Instructions-Product Made-Bar Coded Tracking)
3. Staging in Shipping Department (priority orders vs. normal orders)
4. Entry of Shipment Information into Computer System
5. Package Preparation for Shipping
6. Carriers Contacted about Shipment

### Motor Carriers
1. Motor Carrier Receives Shipment Pick-Up Request
2. Driver Dispatched to Manufacturer
3. Driver Identity Verified and Pick-Up is Accomplished
4. Driver Returns to Terminal or Goes Directly to Air Cargo Carrier
5. At Terminal, Freight is Configured for Outbound Shipment
6. Freight is Loaded for Outbound Delivery and is Dispatched to Air Cargo Carrier
7. Motor Carrier Contacts Air Cargo Carrier about Shipment Delivery

### Air Cargo Carriers
1. Receive Notification of Pending Delivery from Motor Carrier
2. Driver Check-In and Identity Verification
3. Unloading of Freight at Air Cargo Terminal
4. Computer Cargo Booking
5. Scheduling/Pre-Notification
6. Flight Lockout (Final Manifest Delivered)
Business Objective
Manufacturers must be continuously responsive to their customers’ needs in a time-efficient and cost-minimizing manner while maintaining a reasonable profit margin. Flexibility is now of paramount importance in responding to orders from small and large clients alike while keeping operational costs under control.

Manufacturer Processes
Order Entry: Manufacturers receive orders from their customers in a variety of ways. Sales orders may be sent in from company sales representatives in the field or may be generated by similar individuals contacting customers from a central location. Customers may initiate the sales process by contacting the company or their representative based on their need for a product. In either case, incoming orders record necessary customer information such as destination and billing address, product requirements, and preferred shipping method. Often times an order number is used to track an order throughout the manufacturing process.

Production Planning/Inventory Control: These functions are based on customer demand measured in current orders or based on a combination of current orders and historical trends in customer demand patterns for specific manufactured items. Production planning normally estimates order volume as a baseline for their production with capacity flexibility to deal with order volume fluctuation. Now described as JIT, manufacturers can minimize inventory levels by maintaining constant communication between manufacturer, transportation providers and customers, thus tracking demand and providing timely dispatching/routing of shipments.

Order Flow: A sales order receipt, or some other internal company form describing the customer order specifications, accompanies the physical orders. This form may have a bar code printed on it to allow the order to be tracked internally via computer at any point during production, and allows for instant information on order location.

Staging in Shipping Department: Completed sales orders may be sent to a staging area to await available shipping personnel, or the sales orders are directly forwarded into shipping. The staging area allows for a more controlled order flow into the shipment processing area. As the orders are entering the shipping department, if bar code systems are used, the sales orders will be scanned into the shipping department from their previous location.

Entry of Shipping Information: The sales order will be checked for accuracy against the physical product going out to the customer. The shipping department employee will confirm that the product to be shipped matches the customer's request on the sales order, and that important customer information concerning shipping requirements are met. When all information is checked and documented, a shipping slip will be produced for the sales order. This is a crucial point where only authorized system users have access to entering shipment information and forwarding the information to downstream business partners.
**Package Preparation:** Manufacturers ship out a vast array of order sizes and weights. The main criterion used in preparing an order is to protect the product while in transit. Precautions are taken to prevent product damage by using impact-absorbing materials and by minimizing product movement within the package. Shipping labels and instructions are prominently affixed on the shipping container to be easily visible. Customer invoices and internal manifests are often separated from final shipping documents to maintain customer confidentiality. Again, it is important that only authorized personnel be allowed the prepare freight for shipment to prevent a safety breach by altering a product or insertion of a dangerous item into a shipment. This is particularly important since final packaging such as shrink-wrapping occurs at this point in the processing.

**Shipping Information Forwarded to Carriers:** Appropriate carriers are chosen based on the transportation needs of the customer. These determinations are based on the physical requirements along with location and expediency with which the order must be delivered. Account carriers are contacted to arrange pick-up times and are provided with a description of cargo. The bills of lading or manifests, along with other customer documents, are placed with the carrier’s driver upon arrival or may be forwarded to the carrier electronically.

**Industry Trends**

There are several trends that are drastically altering the traditional methods by which manufacturers are producing their goods and communicating with their customers. Among these fundamental changes are:

- Increasing utilization of outsourcing due to competitive pricing pressures brought about by the increasing globalization of trade. Some firms find it advantageous to “farm out” some or all their production to firms dedicated solely to component manufacturing. The firm that chooses outsourcing will concentrate on product design, marketing, finance or other core business functions that are the primary strengths of their company;

- Increasing communications with customers via Internet. Customers are being urged by manufacturers to place orders, update order status, lodge customer service inquiries and even make electronic payments over the Internet. Companies see dramatic cost savings from utilizing internet-based functions. This requires that a firm’s customer base be internet/computer-capable and willing to make continuous technology upgrades.

- Increasing utilization of expedited or “rush” orders to fulfill customer demands for faster turnaround time on orders. This JIT-mentality forces a firm to deploy personnel and resources in various ways depending on the urgency of an order. This “rushing” of orders also causes the manufacturer to choose faster forms of freight delivery than in the past, such as air cargo delivery.
2.2 Motor Carriers

The motor carrier is the middleman of the intermodal distribution chain. The products that are transported via motor carrier range vastly in size, configuration and value. Motor carriers that focus on air cargo transport primarily move higher value freight of a time-sensitive nature. This forces the carrier to be as responsive as an airline in both pick-up and delivery of contracted freight while maintaining tight security control of the shipment and shipment information.

Business Objective

The goals of the motor carrier are to maximize utilization of driver and vehicle resources, minimize operating costs, and satisfy customer delivery requirements while providing outstanding customer service.

Motor Carrier Processes

Manufacturer Pick Up Requests: Manufacturers will contact a carrier to request a driver pick-up at a specified time and place. This contact is usually via fax or phone, but contacting carriers via the Internet is becoming much more common. The manufacturer will relay the freight weight requirements and/or number of skids to be picked up. Certain manufacturers may have a daily or scheduled pick up with a particular carrier. In these instances, contact between the manufacturer and the trucking company occurs only in “exception-based” or special-order instances. By combining these automatic pick-ups with other customer requests, driver pick-up routes are created. Drivers are assigned pick-ups that provide geographic continuity with other outbound delivery routes. At pick-up, it is extremely important to verify driver identity to ensure they are an authorized agent for the motor carrier. This is currently done by checking their Commercial Drivers License (CDL) or company-sponsored identification.

Inbound Pick-Up Procedures: There are several documents utilized at the pick-up location. A bill of lading may be provided by either the trucking company or by the customer. A delivery receipt or similar trucking company form enables relevant data and information concerning the shipment to be captured at the moment of pick-up. This document not only describes the cargo weight and number of pieces, but also contains driver and trailer information along with destination information and handling charges.

The driver arrives at the pick-up location and fills out the appropriate paperwork, checking for any discrepancies that could complicate matters later. This potentially includes all primary shipment information as well as proper markings for hazardous materials or dangerous goods. As each pick-up is completed, the driver usually notes the cargo location within their trailer to speed up the unloading of freight back at the terminal. As described earlier, the driver will begin his pick-ups at a point furthest from the terminal working his/her way back.
Frequent communication between the driver and the terminal dispatcher allows efficient route adjustments if necessary. This is often done via wireless communications or onboard computers. When the driver has completed his final pick-up, a call is placed to the terminal for assignment of a docking slot number for that truck/driver. This arrangement allows terminal personnel to prepare assignments for the unloading process in advance. The driver’s route is then closed for any additional pick-ups.

**Terminal Procedure and Outbound Procedure:** As the drivers arrive from their inbound pick-ups, the dock personnel collect the bills of lading and the signed delivery receipts or similar forms for internal processing. Dock personnel confirm that all trucks are located in the correct docking slot to assure freight movement accuracy. The bill of lading is sometimes affixed with a bar code label used to enter customer freight information for retrieval and viewing at a later time.

At this point, freight is typically processed in one of two ways. Some freight is quickly “cross-docked” and moved to another trailer to commence outbound delivery. Other freight will be stationed awaiting the “building” of another trailer by compiling outbound delivery freight and assigning it by delivery location and time requirements. Only authorized personnel must handle freight in the terminal facility. Outbound delivery route schedules are built much as inbound pick-up schedules. Customer deliveries are (usually) matched geographically to create an outbound route for the driver to follow.

The outbound freight paperwork is processed during the loading of a trailer. It contains relevant delivery location information including cargo weight and handling instructions. The outbound paperwork that travels with the driver may be bar coded to allow for efficient transfer of information. The paperwork will note the delivery location and expected time of arrival. Hazardous materials locations inside the trailer are often diagrammed to note their location in respect to other cargo. The percentage of allotted trailer space is noted. All the driver’s outbound deliveries comprise the final delivery schedule. Finally, the outbound sheet, often referred to as a “master manifest” is date-stamped and the driver leaves to deliver the load.

**Information Capture:** Drivers’ receipts and bills of lading are scanned into a server database or copied on a routine basis to allow for easy and timely retrieval. A company may have multiple terminals across regions or throughout the nation. It is commonplace for this information to be consolidated at a centralized location. Freight bills can then be printed together and sent out to customers. By using technology, transferable information can be captured at the different terminals, and forwarded to company headquarters.
Industry Trends
There are several significant trends emerging in the motor carrier industry that are altering the structure of the industry and how its business is conducted.

- Tremendous cost pressure is being placed on the motor carrier industry. Insurance costs are rising, fuel prices are unstable and competitive pricing pressures are taking a toll. The result is rapid consolidation within the motor carrier industry. Many smaller fleets are either being acquired by larger carriers or are exiting the business;
- Increased utilization of technology to improve fleet operations and customer service capabilities. Vehicle tracking using GPS/wireless systems is enabling carriers and customers to have real-time tracking of vehicles and package locations. Customer invoices are being sent electronically, and the carrier is receiving electronic payments in return. As the costs for these technologies decrease, more carriers are offering a variety of wireless communications and computer-aided routing and dispatching systems;
- Increased pressure from governmental agencies, customers and the public for tighter security on freight, particularly air cargo in the wake of the events of September 11, 2001. These various groups want to restrict access to freight by authorized personnel only to minimize the potential for cargo tampering.

2.3 Air Cargo Carriers
Air cargo carriers may be airlines, cargo consolidators or freight forwarders. They may receive air cargo from the motor carrier on behalf of the shipper and acquire space on a cargo or commercial flight without ever taking physical possession of the cargo. Security is maintained by constantly checking the identity of individuals handling the air cargo and verifying information pertaining to it.

Business Objective
The objective of the air cargo carrier is to expeditiously and cost-effectively transport higher-value or time-sensitive freight from the motor carrier to the receipt point (most likely another motor carrier) in a secure environment. This is done by encouraging operational efficiency including full utilization of personnel and equipment and maximizing flight capacity. Security is achieved by limiting access to work areas and cargo, and vigilance in monitoring personnel and freight.

Air Cargo Carrier Processes
**Truck Driver Check-In and Verification:** A driver will arrive at the front counter of the air cargo handler. This front counter area is generally separated from the rest of the air cargo facility to restrict unauthorized access. The driver will, at a minimum, present his CDL to the attendant at the counter along with the master bill of lading from the shipper and/or
cargo agent and an endorsed security letter. The CDL is the only nationally acceptable form of truck driver identification and must always be presented. No exceptions to this requirement are made. A closed pouch containing shipper’s house manifests or bills of lading and customer invoices will remain sealed from personnel. The pouch is to be opened only by the consignee upon final cargo delivery.

Air cargo handlers make a copy of all relevant documents to establish a file for each incoming truck delivery. A photocopy of the driver’s CDL is taken and kept on file with the rest of the transaction materials. Other materials copied will also include a signed security endorsement, shipper’s export declaration, master airway bill, and a manifest description. All these materials are kept together and time-stamped at the time of entry to keep track of cargo transaction orders and allow for sequential item handling.

Check-in time for the driver may depend on the number of drivers awaiting service and the number of separate airway bills that an individual driver may be submitting to the attendant. If the driver represents an unknown shipper, additional forms are required at the time of check-in. Once all these processes are completed, the necessary paperwork is copied, and the original paperwork is sent to the warehouse to wait for unloading.

**Unloading Procedure:** The driver will usually pull up to a dock door to wait for unloading of cargo. The driver will sign in and give the time at a log-in station. The driver may need to wait for unloading depending on personnel and facility utilization levels. When warehouse personnel are available to attend to a truck, an attendant will again check the manifest materials to verify the accuracy of a shipment. Parcels of cargo are counted and matched up to manifest information. Dock employees can then proceed to unload the truck.

Only authorized air cargo carrier personnel (most air cargo carriers conduct criminal background checks on employees) are allowed to transport the cargo from the truck to the appropriate staging area within the facility. If the air cargo handler serves multiple airlines, the cargo will be placed in an appropriate staging area for that airline.

At the staging area, the cargo will either be assembled onto a pallet or into a container, unless the shipper has pre-built a cargo shipment. Shipper-built pallets or containers can be moved immediately to their designated staging area.

**Cargo Booking:** Cargo booking procedures will differ depending on whether an air cargo handler is working with cargo for a single airline or as an air freight forwarder representing multiple airlines. The air freight forwarder is used to consolidate freight for many airlines who do not require or desire the capacity of an entire terminal devoted solely for their airline cargo shipping. Air freight forwarders provide flexibility for airlines that experience great fluctuation in their air cargo shipment volumes.
An attendant will begin a transaction by checking for the appropriate security endorsement in the paperwork. The transaction is then initiated by entering the airway bill number into the computer. This airway bill number is used to track and access each particular cargo shipment throughout the airline’s shipping process.

**Scheduling/Pre-notification:** This is the brief process of booking a flight for an individual airline cargo handler. As cargo shipments are unloaded and placed in a designated holding area, personnel begin to consolidate freight shipments together and assign them to either freight or commercial flights as patterns emerge. This is done continually until a flight’s available space is taken up; even then high-priority cargo may still find its way onto a flight.

The booking process for an air freight forwarder involves slightly different procedures. A pre-manifest is completed and initial flight loading information is sent to the airline. An attendant will pre-notify the airline as to cargo contents, freight, weight and dimensions of a shipment to help the airline and request allotment space on an available flight. The attendant must be authorized to forward this information to the carrier. A preliminary flight confirmation number and departure time are relayed back to the freight forwarder from the transporting airline. A rebooking may occur if any cargo information changes after the pre-manifest has been submitted. The final manifest is submitted before the flight’s lockout time. This is the specific time before flight departure when cargo space is “locked in.” This allows the airline to prepare for cargo shipment and provides an approximation of total cargo weight for a particular flight, but also gives the air cargo handlers a cut-off time that enables them to have sufficient time to process and prepare the cargo shipment. Acceptance of any additional cargo after the lockout time is at the discretion of the airline.

Documents are then sent to the airline along with its corresponding cargo. International cargo is routed to customs. The captain of a flight must ultimately decide what cargo will be stored on his flight, and has the discretionary ability to eliminate any cargo from his flight. A single cargo item that is rejected by the captain may lead to an entire pallet or container being kept off of a flight. Finally, an attendant at the air cargo handler will release flight cargo from the computer system once the flight has taken off and before the projected touchdown time for a flight. No more changes are allowed in the computer system after this point.

**Dangerous Goods:** Dangerous goods are to be identified as such by the original shipper of any cargo. If the shipper is unknown, special procedures are followed by personnel to ensure cargo safety is at no time compromised. The unknown shippers are required to fill out special documentation about themselves and their cargo shipment to prevent any breaches in cargo security. Any improperly completed forms will likely lead to rejection of dangerous goods cargo.
Unknown shippers’ cargo and any other suspicious items will be examined by either an x-ray machine or be subjected to a chemical analysis that can pinpoint specific chemicals that could pose a security risk. Visual inspections of cargo can also indicate potential safety threats.

A holding area exists for the separation of dangerous goods from other cargo. Dangerous goods are sometimes held for up to 24 hours from their arrival time as a “cooling off period” so that additional information about the cargo can be gathered. Air cargo handlers have processing checklists specifically for dangerous goods to help pinpoint potential problems. Typical errors include: incorrect packaging of cargo, failure to display cargo warning labels, incorrect form submission and incorrect identification of the specific type of dangerous good or hazardous material.

**Industry Trends:** There are a number of important trends occurring in the air cargo carrier industry that are impacting the structure of the air cargo carriers and how their business is conducted.

- **Consolidation** due to a general economic slowing was an important trend before September 11, 2001. The events of that date exaggerated the economic downturn further reducing air freight demand. Additionally, large increases in insurance premiums following “9/11,” placed further financial stress on the industry. Though the airfreight industry in North America is beginning to show signs of recovery, economic uncertainties continue to hamper significant improvement in air freight performance;

- **New regulations** are adding to the complexity and cost of each transaction. An FAA provision prohibits airlines from accepting cargo from companies without a steady track record of doing business with the airlines. Shippers and motor carriers are supposed to be more thoroughly screened. Air cargo companies that handle freight are now required to keep more precise records of transactions;

- **Increasing use of internet-based cargo tracking** by customers to monitor cargo and transactions along the supply chain.

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Unlike passenger baggage, air cargo is not accompanied by the owner. During air cargo transportation, numerous parties are involved in the handling process including the shipper, motor carrier, freight forwarder, and air carrier. The more parties handling a shipment, the greater the vulnerability is of a security breach. Combined with the fact that nearly 60% of air cargo is moved via commercial passenger airlines, it is understandable that air cargo restrictions and regulations are stringent.

The September 11, 2001 terrorist attacks involving United States commercial aircraft elucidated the need for increased air transportation security measures. Federal task forces were created and recommendations were quickly made to address security gaps in the aviation system. This led to new regulations being adopted, as well as the creation of the Transportation Security Administration to oversee and coordinate all transportation security initiatives at the federal level.
The security focus was initially on passenger screening and luggage checks, but government officials readily acknowledge that cargo security is an area that deserves equal focus when contemplating increased security measures. This heightened state of concern surrounding air cargo security within the government and aviation industry has prompted the TSA to reexamine their air cargo and passenger security policies and commit substantial resources to explore technology as a solution to eliminating security loopholes.

The TSA, Federal Aviation Administration, and other governmental entities monitor air cargo transport and enforce regulations to guard airline passengers and the general public from potential safety threats to the best of their ability. These agencies are looking into not only preventing security threats at the airports themselves, but are considering applications that will identify trouble further upstream in the supply chains.

There are myriad security initiatives affecting air cargo that are being undertaken by federal agencies as a result of last September's tragic events. While the list of agencies involved in developing security systems and reformulating air cargo security policy is extensive, the following represent some of the more prominent stakeholders.

### 3.1 Transportation Security Administration

The recently enacted Aviation and Transportation Security Act (ATSA) states that by November 19, 2002 the responsibility for inspecting persons and property carried by aircraft operators and foreign air carriers will be transferred to the TSA and Under Secretary of Transportation for Security. The ATSA legislation requires that air cargo on passenger planes must be screened if it does not originate from a known shipper. The Federal Aviation Administration has previously toughened the existing “known shipper” protocol, spelling out some of the qualifications shippers must meet to be certified by forwarders and airlines as known shippers. These qualifications include the requirement that shippers must have sent 24 shipments over the previous two years through the freight forwarder or air cargo carrier and assurances from the forwarder/carrier that the shipper’s security status is not suspect.

“A system must be in operation to screen, inspect or otherwise ensure the security of all cargo that is to be transported in all-cargo aircraft in air transportation and intra-state air transportation as soon as practicable after the Act.” There are no specific measures in place at this print date to fulfill this portion of the ATSA law, but the United States Department of Transportation and the FAA are working to clarify the rule for carriers to comply with this stipulation.

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3 The Aviation and Transportation Security Act, 2001
3.2 Federal Aviation Administration

Long before 9/11, the FAA had dedicated substantial resources to ensuring aviation security. The policy office of the FAA/TSA that has air cargo security oversight is the Office of Civil Aviation Security.

The mission of the Office of Civil Aviation Security has been to ensure and promote a secure and safe civil aviation system. Three of the four most important mission statements of the Office of Civil Aviation Security are:

- Preventing fatalities related to the transport of dangerous goods and cargo;
- Ensuring the security of the increasing numbers of passengers and goods moving through the aviation system;
- Deploying critical technologies to all U.S. airports.\(^4\)

Through the William J. Hughes Technical Center, the FAA/TSA has been keenly involved in developing and testing new technologies to examine cargo and restrict access to airport/cargo areas to only authorized personnel. Some of these technology options include:

- Biometrics: A multi-agency working group led by the FAA/TSA is accelerating its study of the integration of biometrics into airport security systems. Areas that appear to present the greatest opportunities for these new technologies include access control, protection of the public in and around airports, passenger identification and flight crew identification;
- Explosive Detection Systems (EDS): The FAA has been deploying explosives detection systems that meet the agency’s high certification standards of high detection and low false-alarm rates;
- Threat Image Projection (TIP): TIP is a software system developed by the FAA that can be used to test and measure screener proficiency. Installed on conventional X-ray machines, TIP electronically inserts fictitious images of threatening items into images of real passenger bags going through the checkpoint X-ray machines. The monitors show the images as if they were within bags being screened. TIP’s purpose is to provide training, keep screeners alert, and measure screener performance.

3.3 US DOT Office of Intermodalism

The Office of Intermodalism was created in 1992 within the Office of the Secretary of Transportation with the responsibility for coordinating Department of Transportation projects, programs and policies involving more than one mode of transportation. The Office of Intermodalism undertakes research and sponsors operational test initiatives with other federal agencies, private industry, state and local agencies to facilitate the development of working partnerships that encourage safe and efficient intermodal freight operations.

\(^4\) Civil Aviation Security Strategic Plan 2001-2004, Federal Aviation Administration
The Office of Intermodalism does not enact or enforce any regulations in regard to transportation, but works in an oversight capacity to encourage inter-governmental cooperation and involvement with the private sector to solve intermodal problems. There is an increasing effort to promote information technology options to improve intermodal freight operations. The Office of Intermodalism has two primary objectives in the application of high-technology solutions to intermodal freight:

- Enhance the safety, reliability, and responsiveness of the intermodal freight system;
- Contribute to the national goals of economic growth and national security.¹

### 3.4 Airports

Individual airports have traditionally had broad discretion in interpreting and implementing security programs required under federal regulations and guidelines. Security measures were developed on an individual basis at each airport in response to assessments based on the relative risk at each airport.

In the wake of recent events, there will be much closer involvement of federal agencies in both passenger and cargo security at American airports. Among other things, the new role will include expanded authority, requirements and actual federal employees on airport premises.

Information technology will play a prominent role in security monitoring and prevention of future security breaches at domestic and foreign airports. Frequent air travelers may be electronically profiled and screened for faster flight check-in. Rosters of suspected terrorists would be loaded in computers that may use facial recognition or biometric technology to prevent their entry onto aircraft. Employees will be required to pass even more stringent background checks to gain access to areas where cargo is processed on and off airport grounds. Information collected will be provided to relevant federal and possibly international authorities to provide full security information worldwide.

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¹ ITS/Intermodal Freight Program, US DOT Office of Intermodalism, 1998
Emerging Transportation Technology Applications

The transportation industry is rapidly embracing technology in many varied forms to fundamentally alter the way that business takes place. Technology is allowing the transportation industry to redefine itself, providing the customer with more cost-effective and expedited delivery processes than ever before. Customers now expect multiple access points to cargo transport information in a real-time environment. Industry has responded by offering customers various flexible communication sources to accommodate these customer requirements. These communication sources may include call centers, wireless communication, web sites, or e-mail information transactions.

Increasing demands on the freight industry will be met by an information infrastructure to support the physical distribution infrastructure. The application of advanced technological solutions allows for better data-gathering, management, and dispersion to concerned parties in less time than ever before.
Biometric Uses

With increasing frequency, industry and government entities are incorporating biometric identification components into a variety of systems to improve the security and efficiency in their operations. Some of the more common applications include:

Industrial Applications
In a number of facilities, hand geometry readers have replaced time clocks/cards for employee attendance and pay applications. The Coca Cola Company has adopted this application. Hand geometry readers have also been used as employee access control to restricted/secured areas of facilities. Custom Cartage uses this application to verify drivers and grant only authorized access to docks. On a limited scale, fingerprint readers, facial recognition, and voice recognition systems are used to ensure secure access to corporate computer networks and databases.

Universities/Research Facilities
Fingerprint scanning is used for access control to computer and laboratory facilities. Organizations using these applications include the State University of New Jersey’s Micro Electronics Research Laboratory and the Townson University (MD) Data Center. Hand geometry readers are used to validate persons for access to cafeteria facilities.

Prison Facilities
Facial recognition and iris scanning is used to confirm positive identities for prison releases (Cook County, IL), as well as validate visitors’ identities, and monitor/control prisoner movement.

Welfare Systems
Seven states have begun to use iris scanners to validate identification of welfare recipients in an effort to reduce multiple-identity fraud.

Drivers Licensing Agencies
Fingerprint scans are being incorporated into requirements to obtain a drivers license in Georgia and California.

Technology Systems
A number of technology providers and computer manufacturers have developed off-the-shelf biometrically secured computer systems. Compaq for instance, now manufactures computer keyboards with a fingerprint reader for access control.
Integration and cooperation between new technologies promotes information synergy, enabling faster and more flexible cargo shipping practices.

The Phase II ESCM System was developed and tested in this environment. The Phase II ESCM system fulfills the need to rapidly gather and move information between supply chain partners. At the same time, the system will only permit data accessibility by authorized individuals.

This section examines the technologies considered for and incorporated into the Phase II ESCM system. These technologies include the Internet, Electronic Data Interchange (EDI), Extensible Markup Language, Smart Cards and Biometrics. Each technology contributes to the Phase II ESCM system. A brief examination of each will provide a knowledge base to more effectively understand the technology involved in making the Phase II ESCM system functional.

4.1 Internet Activities and Trends

The Internet provides the ability to link companies together and allows customers instant access to more readily obtain needed transportation information. The Internet provides a viable inexpensive method to transmit and receive manifest information quickly and securely. The Phase II ESCM System utilizes the Internet as the choice for data transmission based on universal user access, inexpensive connectivity, integrated security and flexible scalability.

Internet usage has skyrocketed because of decreasing prices, more sophisticated hardware, software, and user interfaces, and a better understanding of the benefits of business conducted over the web. Initially, the Internet was used primarily as means to distribute general company information, rather than specialized transactions.

Several obstacles need be overcome before the full potential of Internet communication between supply chain partners can be realized. One obstacle is the perceived security deficiencies that were evident in early Internet transmission systems. Modern Internet transmission systems are based on protocol such as Secure Socket Layers (SSL) and encryption to ensure information is only available to authorized users. Another former obstacle was the cost in leasing dedicated transmission lines to create a private network for partners to transact electronic business securely. The Internet has allowed the creation of Virtual Private Networks (VPN) to securely move data and information at a fraction of the cost of traditional private networks.

The Phase II ESCM combines the ease of electronic manifest data transmission offered by the Internet with system security features such as SSL, 192-bit encryption and VPN-like technology to create a protected transactional environment.
4.2 Electronic Data Interchange

Electronic Data Interchange (EDI) works by providing a collection of standard message formats and element dictionaries for businesses to exchange data from one database to another. EDI improves the speed and accuracy of data transfer by eliminating repetitive re-entry of information. EDI systems are designed to encourage efficient information exchange without needless human intervention. EDI is used to connect key business partners in a proprietary network to transfer valuable and often sensitive data.

The proprietary nature of traditional EDI has caused businesses difficulty in expanding EDI as a solution for their data transmission needs. Each EDI vendor sets up a proprietary network (for a set of companies) that will not easily facilitate data flow with either competing EDI systems or even with some other databases. A single company using EDI with several trading partners might have a different EDI system package for each partner. This lack of compatibility can cause a company to have difficulty in maintaining and updating their own internal database. Fortunately, several large-scale industrial organizations have created a critical mass of EDI networks (EdiFact for example).

Despite business advantages, EDI is only used by approximately 20 percent of U.S. businesses. Larger companies tend to expend revenues on the expensive hardware and software needed to participate in an EDI network. High costs prevent many smaller firms from implementing EDI solutions.

A critical issue in regard to EDI data transmission is information security. Many EDI processes involve the transfer of sensitive business information. EDI systems must be secure on both sender and recipient ends to ensure system integrity. Each company within an EDI network must communicate to their business partners to maintain adequate security levels.

Traditional EDI systems are not prevalent in air cargo distribution chains where the shippers are the most likely proponents of such systems. Motor carriers tend to be much smaller in scale and more resistant to committing the vast resources needed to implement an effective EDI deployment. For a variety of financial and procedural reasons, typical air cargo carriers do not rely on EDI transactions although they’re constantly in search of cost-effective solutions for moving information.

A hybrid consideration exists for integrating and blending EDI and XML data sets. It is important to note that the Phase II ESCM did not employ traditional EDI technology due to high cost, implementation issues, and the availability of superior open standard, Internet-based data transmissions solutions.
Banking
Texas-based Bank United, the Bank of America and Wells Fargo are using fingerprint and iris scanners to improve the security of online banking and replace PINs and bank cards at ATMs. Mastercard and Visa are testing the feasibility of using fingerprint scanners at point-of-sale to verify cardholder identity. Many e-commerce enterprises are adopting a combination of biometrics and smart cards to better authenticate customers and ensure the integrity of purchasing transactions.

Law Enforcement
For many years now, law enforcement departments have utilized fingerprinting for background/history checks against the FBI AFIS database. Facial recognition applications in event settings such as the Olympic Games have been used to identify individuals for outstanding warrants or criminal intent. A small number of agencies have developed and tested wireless roadside fingerprint checks using wireless communications linked to central databases. Redlands, CA and West Valley, UT are two examples.

Immigration
The US Immigration and Naturalization Service’s Passenger Accelerated Service System uses hand geometry in nine international airports to identify and process pre-enrolled, low-risk frequent travelers through an automated immigration system.

Transportation Security
Fingerprint and other biometrics have been proposed and tested to facilitate transportation workers’ background checks and authorized access to facilities. Facial recognition is being used at a limited number of airports to scan passengers’ facial features and compare them to images of “watch-listed” criminals and terrorists. Fingerprint readers are used in airports such as Chicago’s O’Hare for access control to high security areas and to create an access audit trail.

Special Events/Theme Park Access
During the 1996 Olympics in Atlanta, GA, hand geometry readers were used to provide high-volume access control to the facilities. Over 65,000 athletes, coaches, and officials used the system. Walt Disney World in Orlando, FL has started taking hand geometry scans of people who purchase yearly passes. These visitors now must utilize a scanner when entering the park to prevent the transfer of annual passes to other people.
4.3 XML/EDI

Business had been conducting electronic commerce even before the Internet popularized the concept in recent years. Prior to the widespread Internet revolution, electronic commerce was transacted between companies’ mainframes with the assistance of direct dial-up capabilities or with third-party assistance via Value Added Networks. The Internet, with growing importance in business matters, is serving increasingly as a conduit for business data transmission.

The largest problem in conducting electronic business over the Internet is that there are no common standards for how data is formatted from one company to another. The Internet marketplace is full of various solutions to help connect companies to transact Internet business together. The lack of standardization has been a huge hurdle to overcome. The hybrid concept is to have an application tool to allow for both the presenting of information on the Internet and the translation of the data sets into another company’s database.

Extensible Markup Language (XML) allows database communication capabilities to be leveraged by the Internet. XML is a standardized data format that provides computers with the ability to capture and transmit data that is capable of being understood by any other computer. XML maintains the content and structure of information and keeps the business context within specified tags allowing automated data transfer between company databases with no human interaction (see Appendix A for ESCM XML Data Sets).

XML can be integrated with EDI by providing specific electronic forms that users can fill out to generate their EDI data transmissions. XML-generated EDI messages can be transmitted via the Internet or through traditional Value Added Networks. XML allows EDI data to be displayed according to predefined rules agreed upon by an industry, without the cost of requiring customized display packages developed for an EDI system.

Traditional EDI required participants to contract with an EDI provider to set up software on each participant’s computer. Each time another participant wanted to join a particular EDI network, that participant would have to pay the EDI provider for software to coordinate standard EDI messages between all network participants. This often became an expensive proposition. XML via the Internet eliminates the need for proprietary software and hardware to send data transmissions.

XML-based capability is built into the Phase II ESCM System allowing users to have electronic manifest information directly deposited into their database from other distribution chain partners and information generated from the central ESCM server. ESCM information in XML
format can easily be utilized by each company’s computer system without any data reformatting. However, because very few ESCM motor carrier participants had resource planning applications that could manage and manipulate XML-based cargo data, participants did not typically integrate the data with other systems.

### 4.4 Smart Cards

Smart cards are a specific type of chip card embedded with an active computer chip that captures and transacts data between the card-holder and a card-reading mechanism (they are technically different from memory cards). The smart card data is transacted by means of a card reader that is a conduit for a larger computer system, although many smart cards conduct independent and internal transactions.

#### Primary Mobile Technologies for Storing & Transferring Data

<table>
<thead>
<tr>
<th>Type</th>
<th>Storage Capacity</th>
<th>Volume in Use</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Stripe Cards</td>
<td>161 to 1,000 bytes</td>
<td>Over 10 billion</td>
<td>Relatively low capacity; greater vulnerability to tampering; subject to wear/non-readability; low cost</td>
</tr>
<tr>
<td>Bar Codes</td>
<td>1,000 to 1,850 bytes</td>
<td></td>
<td>Relatively low capacity; greater vulnerability to tampering; subject to wear/non-readability; low cost</td>
</tr>
<tr>
<td>Memory Cards</td>
<td>128 to 1,000 bytes *</td>
<td></td>
<td>Non-dynamic, passive storage</td>
</tr>
<tr>
<td>Smart Cards</td>
<td>2-64 kilobytes *</td>
<td></td>
<td>Secure, but more costly than memory cards</td>
</tr>
<tr>
<td>Optical Cards</td>
<td>2.8 megabytes</td>
<td></td>
<td>Secure; high storage capacity, relatively high cost</td>
</tr>
</tbody>
</table>

* Combined: memory and smart cards shipped worldwide in 2001 were approximately 2.2 billion

Smart cards help improve the convenience and security of many types of transactions. These cards allow for the development of tamper resistant storage of user account identity. In a larger sense, smart cards are an important component of any network system’s security structure when confidential data is being exchanged. Smart cards not only serve to store data...
and information, but are increasingly being used for individuals to gain access to secure networks where user identification is critical. Lastly, smart cards provide low-cost data mobility in comparison to wireless systems.

Smart cards are utilized in the Phase II ESCM to store cargo and personnel information and capture biometric data for system users including attendants and commercial drivers. Smart cards are a convenient and effective method to restrict system usage to only authorized individuals.

There are two basic types of smart cards: contact and contactless versions. A contact smart card requires the card to be inserted into a reader for transferring information or data. A contactless smart card only needs to be in close proximity with a reader in order to function.

The two types of chips that are used in smart cards are memory chips and microprocessor chips. Memory chip cards are the lowest cost per bit of user memory. They work like small floppy disks holding between 103 bits to 16K bits of data. Microprocessor chip cards allow for the addition, subtraction and manipulation of data much as a personal computer does. Data storage capacity is between 300 bytes to 64K bytes of data. This technology allows for card updates without replacing the card itself. 8k microprocessor chip cards are used in the Phase II ESCM.

Card-based security systems utilize the smart card as an interactive computing device. This makes such a system useful in conjunction with microprocessor chip cards. The Phase II ESCM utilizes card-based security to allow interactive communication between the smart card and the ESCM system. Businesses are using smart cards to monitor and control access to their company Intranets and Virtual Private Networks across the Internet. Users of these systems are identified via their smart card and are granted access to specified areas and information within these systems. The smart cards create a log of system users and the information that they received.

There are many and growing applications of smart card technology within the transportation sector, including toll collections, transit systems and facility access.
4.5 Biometrics

“Biometrics” historically refers to a science concerning the statistical analysis of biological characteristics. Biometrics in practice usually refers to technologies that analyze human characteristics for security purposes.

Biometric technologies are dealing with recognizing various physical parts of the human body or the personal traits of individual subjects. Biometric technology has the ability to identify or verify a human characteristic quickly and automatically. The most common physical biometric characteristics to measure are the eye (iris and retina), face, finger image, hand and voice. Behavioral biometric characteristics include typing rhythm (keystroke dynamics) and signature. For additional background information on biometric applications in transportation, see the full report on the Phase 1: O’Hare Air Cargo Security Access System.  

All biometric systems function in a similar manner. In the first step, the system captures a sample of the biometric characteristic that is termed the enrollment phase. During the enrollment phase, biometric systems may require a number of samples from an individual in order to build that individual’s biometric characteristic profile. Unique features are then extracted and typically converted by the system into a mathematical algorithm. This sample is then stored as the biometric template for the enrollee. The template may reside in the biometric system itself, or in any other form of memory storage, such as a computer database, smart card or bar code.

Biometric systems may require a way of tying the template to the individual being tested. A personal identification number (PIN) may be entered to access the template, or a smart card storing the template may be inserted into a card reader. A new biometric imprint for the individual is taken and compared to the original template. If the original template and the new sample match, the user is granted entry by the system.

Fingerprints have gained support as a biometric technology that will be widely utilized in the future; this is particularly true in the transportation industries: an FHWA-sponsored report in 1997 identified fingerprints as the most appropriate biometric for the trucking industry. As importantly, a fingerprint identification device can require very little space on a desktop or outside a facility.

Security against fraudulent access to computer systems and networks is a new but growing application for fingerprint biometric technology. In use, individuals must place their finger on a server computer.
scanner unit that verifies their identity against an employer database to gain entry to the company’s computer system.

Phase I demonstrated the viability of biometrics for positively verifying system users and driver identities in an operational test setting. Phase I system testing was found to have reasonably acceptable error rates in regard to “false rejection” – when a system fails to recognize an authorized user, and “false acceptance” – when an imposter/Unauthorized user is granted access to a system.

Phase II is fully utilizing biometric technology in conjunction with smart cards to verify user identity, thus limiting access to authorized system users. Users gain ESCM system access by having their fingerprint verified against the database algorithm and/or smart card template.

7 Phase I Final Report O’Hare Air Cargo Security Access System-ATA Foundation, June 2000
The Electronic Supply Chain Manifest System was designed to promote the efficient and secure transmission of manifest information between business partners. A combination of technologies has been integrated to simplify air cargo notification and information transfer while significantly limiting authorization access to move physical cargo and corresponding sensitive freight information.

This section explains the process functionality and system architecture utilized within the Phase II ESCM system. An in-depth explanation of functional ESCM processes at each modal point is provided to illustrate step-by-step system user procedures. Following the ESCM process sequence, the technological architecture and component technologies that facilitate optimum system utilization are covered.

Phase II ESCM system design considerations focused on satisfying public and private sector demands for
both security and efficiency applications in the system design framework. The system architecture proposed provided the convenience of Internet access, security of biometrics, smart cards and data encryption with centralized, scalable server capacity.

5.1 Design Considerations and Applications

The Phase II project team designed the system to address an assortment of public- and private-sector interests and issues. The first consideration was to design a system with proven security technologies to support FAA security programs, and ensure the protection of sensitive shipper information and cargo data from outside tampering. The second consideration was to create an efficient, user-friendly program to improve productivity and promote a high level of user comfort and system utilization. These design considerations were met through the following features:

Security Considerations — The system was designed, to the greatest degree possible, to automate a series of security procedures — particularly those associated with the FAA’s “Known Shipper Protocol” — in order to reduce human error and cargo data manipulation, and improve cargo tracking and auditing.

System security is achieved using:

- **Biometric fingerprint readers to restrict unauthorized system access and validate driver identification.** Biometric log-ins were required at all access points to create, modify, send, receive, or view data and information within the enclosed test system;

- **Smart Cards that integrate data encryption and biometrics to enhance security of the ESCM system.** Encrypted smart cards containing shipper, cargo and driver data were utilized throughout the ESCM supply chain to transfer and validate essential supply chain information;

- **Triple DES 192-bit encryption to protect data.** This 192-bit Triple DES encryption technology created a relatively low-cost but highly secure, encrypted data pipeline (an alternative to a Virtual Private Network) across the Internet. The Triple DES is the current federal government Data Encryption Standard and is one of the most trusted encryption algorithms in use today;

- **System computers configured to prevent tampering of data once it has been entered into the computer.** The users had limited access to information stored on the computer and no physical access to floppy or CD drives. The computer manifest screens were also set up to log the user off automatically if they were inactive for 20 minutes. To prevent unauthorized use, the system users were instructed to log off the system when it was not in use.
**Efficiency Considerations** – This particular objective was based on the hypothesis that cargo processing can occur faster and more efficiently when real-time information is transferred and processed in advance of the physical goods transfer.

System efficiency was achieved through:

- **Internet traffic routing to a central server for reliability and peak-load handling capability.** The central server, under Phase II ESCM team control, ensured the system could meet peak demand levels. The central server received and sent all message notifications for cargo manifest status as well as forwarding the electronic manifests themselves in response to valid inquiries;

- **User familiarity with data fields.** The system incorporated the vital aspects and look of traditional manifests, bills of lading and air waybills;

- **Ease of use.** The system used a robust software suite in a Windows-based environment, which provided drop down menus and automatic recalls of vital customer information to minimize attendant entry repetition and error;

- **Data import capabilities.** The software had the capability for information import with other software to allow for data sharing between the Phase II System and participants’ back-room systems;

- **Ubiquitous communication options.** The system was designed to allow the transfer of real-time ESCM data and activity to multiple (valid) audiences using both wire and wireless hardware.

### 5.2 Overview: ESCM Processes

The Phase II ESCM consisted of a series of efficient, secure electronic transactions that replace traditional paper-based transactions. The ESCM system was accessed at each step with security composed of biometric/smart card system authorization and transmitted via encrypted, SSL Internet transactions.

The following is an overview of the ESCM processes. A depiction of major steps in the ESCM system is also documented in Figure 2. The complete review of ESCM events for each mode is contained in subsections 5.2.1 through 5.2.3.

The Electronic Supply Chain Manifest system process was initiated with the manufacturer biometrically logging onto the system and preparing the electronic manifest. The “manifest,” also described as a bill of lading or air waybill, resides on a software template. Upon completion of the appropriate data fields (the system notifies the user if essential fields are incomplete or incorrectly filled out), the manufacturer initiates the transmission of data and information to the central server and logs out. All identified supply chain partners are notified via e-mail of the submission.
The manifests are stored and routed through a central database where the actual electronic manifests are viewed. A biometric log-on ensured that only authorized personnel are granted access to the electronic manifest at any point in the supply chain. Downstream participants receiving advanced notification were better able to deploy personnel and resources, and to ascertain what, if any, inspection of the cargo was warranted based on the cargo information contained in the electronic manifest. It is important to note that supply chain participants could only receive and view data that was essential to their role in the supply chain transaction. Furthermore, no supply chain participants could amend, add or delete shipping information other than the shipper/manufacturer.

Upon arrival at the manufacturing facility, pick-up and delivery personnel utilized their biometric-encrypted smart card to verify themselves (and their cargo) at the pick-up point (and drop-off point). The smart card contained an electronic version of the specified manifest, an electronic copy file of the personnel’s fingerprint to verify identity, and a copy of the driver’s CDL.

### 5.2.1 Manufacturer ESCM Processes

The initial step in the electronic manifest process began when an attendant accessed the manifest software and placed an enrolled fingerprint on the reader. Based on the individual configurations of manufacturer computers, some attendants were also required to enter an identification code prior to fingerprint authorization. The biometric logon provided the access to both the server and manifest template software. The computers were set up to allow attendants to only use the computer for the authorized purpose of conducting test business. There was no access to the hard drive or other computer components to either monitor or tamper with test operations. After this biometric code was verified against the template on the card and/or database, the computer screen displayed a log page of manifests that had previously been entered into the test system. Each manifest possessed a unique identification number that was utilized to track it throughout the system.

Clicking on a manifest activated software and/or contents. This took the attendant to the actual electronic manifest template to either be completed or amended. Pulling up a completed manifest identified the other participating supply chain partners used in that transaction; in the case of a new manifest, the attendant could use pull-down menus to identify the new motor carrier and airline partners that would be selected.

The electronic manifest was composed of template fields. There were certain required fields that had to be filled in by the attendant or an error message would occur when trying to submit the manifest. Other fields were optional within the electronic manifest template since they may pertain to only certain transaction types or circumstances.
Manufacturer creates a manifest using the ESCM system, which generates an e-mail letting the authorized individuals know that a shipment is ready.

Trucking Company gets notice of the shipment and is able to view the manifest through the ESCM system.

Truck Driver arrives and verifies himself biometrically and with his smart card and takes possession of shipment, which generates an e-mail letting those authorized know that the shipment is in transit.

Driver can bring shipment back to his warehouse for consolidation and then a new manifest is created.

The shipment is transferred to the air cargo facility and an e-mail is generated letting the authorized individuals know the status of the manifest.

Trucking Company in JFK gets notice of the shipment and is able to view manifest through the ESCM system.

Air Cargo Facility gets notice of the shipment and is able to view the manifest through the ESCM system.

Air Cargo Facility gets notice of the shipment and is able to view the manifest through the ESCM system.

Air Cargo Facility in JFK gets notice of shipment and is able to view manifest through the ESCM system.

Air Cargo facility in JFK gets notice of shipment and is able to view manifest through the ESCM system.

Truck Driver takes shipment to air cargo facility.

Driver must verify himself to the air cargo attendant by producing his smart card and biometrically logging on to the system.

Trucking Company in JFK gets notice of shipment and is able to view manifest through the ESCM system.

Air Cargo Facility in JFK gets notice of shipment and is able to view manifest through the ESCM system.

Shipment is flown to JFK International Airport.

Truck Driver arrvies at air cargo facility and verifies himself biometrically with his smart card and takes possession of shipment, which generates an e-mail letting those authorized know the shipment is in transit.

Truck Driver conveys shipment to next step in transportation chain.

→ Pertains exclusively to shipments that are forwarded to JFK.
The manifest screen permitted an attendant to complete the form, and then return and modify it if necessary; all modifications were automatically sent down the supply chain. These functions were called “create” and “search” in the context of this system. The manifest was “locked out” at the point when the driver took actual delivery of the freight.

Many standard fields were enabled with drop down menus to speed up manifest preparation time. Data such as number of freight pieces or gross weight were logged to a supplementary screen not in view on the manifest screen.

Also, on the manifest listing screen, there were appropriate codes alongside each manifest number designating its position within the system. “C” designated the manifest was created at the manufacturer or shipper site. “A” designated an active or authorized manifest still within the manufacturer’s control. “P” designated a shipment that was picked up by the trucking company and was in transit. “D” designated a shipment that was delivered to the airline/air freight forwarder. “M” designated a modification to the original manifest.

Prior to release, the order could be modified multiple times, but all modifications were captured and tracked by the system. Order status at this point was indicated by various colors. White signified that an order has been delivered. Red signifies when the order had been released and was awaiting action from the motor carrier. Black meant that the motor carrier had picked up a shipment. Blue meant that a shipment had been picked up by the carrier and was en route to the airline.

All manifests could be printed, providing hard copies of the electronic transaction to fulfill current company manifest protocol. When the manifest was accepted by the system, the system recorded who created the manifest, when it was created, and for whom the manifest was created. The manifest is then relayed to the central server and forwarded to the motor carrier and airline after they received electronic notification of the manifest’s existence.

5.2.2 Motor Carrier ESCM Processes

At the motor carrier, the attendant logged on to the system using biometrics and a smart card. Upon verification with the server, an e-mail notification directed the trucking company to the manufacturer-generated manifest (located on the server). The truck attendant then reviewed the manifest and its contents on the Internet. The attendant could not alter the manifest in any way and only the authorized supply chain participants had the ability to view the manifest.

When the truck driver arrived at the manufacturing plant to pick up the cargo, the driver logged in using his/her smart card and was validated via fingerprint. Once verified, the shipment was transferred over to the truck driver. If the individual was not authorized to pick
up this shipment an error message was displayed. After the shipment was released to the driver, there were two options:

1) the driver transported the shipment to the truck facility for consolidation; or,
2) the driver took the shipment directly to the air cargo facility.

If the shipment was consolidated at the truck facility, the attendant followed the same procedures as a manufacturer – the attendant logged on to the system, filled out a master manifest, and assigned it to a certain air carrier.

Upon arrival at the air cargo facility, the server, using the biometric/smart card process, verified the identity of the truck driver. Upon verification, the shipment was transferred to the air cargo attendant. At this point, an e-mail was generated letting all the original participants in the distribution chain know that the shipment had reached its air cargo terminal. In some instances, the ESCM test was used to track and verify cargo between Chicago and New York.

5.2.3 Air Cargo Carrier ESCM Processes

After an airline attendant successfully logged on to the system via their workstation computer, the ESCM software opened and alerted the attendant to any new shipments that were created and assigned to their facility. As was the case for motor carriers, the airline attendant could view the manifest but could not alter it in any way.

When the truck driver arrived at the air cargo facility, the attendant logged on to the system again and opened the corresponding manifest. At this point the system prompted the driver to log on using his/her smart card and fingerprint. Upon verification, the shipment was then transferred over to the air cargo facility. If the driver was not an authorized user of the system, an error message was displayed and the driver and cargo were subject to additional screening procedures. Once the driver was verified and the cargo was accepted by the air cargo facility, an e-mail was generated notifying the rest of the supply chain of the transfer.

For those shipments tracked across O’Hare and JFK (required a continuous supply chain), similar notification e-mails were generated as the cargo was transferred to facilities/transporters downstream. The transfer of freight from final air cargo facilities to final (truck-based) destinations used the same procedures of verification and notification as originating shippers to originating air cargo facilities to destination air cargo facilities.

In these instances, the system established transfer/status notifications of freight movement between participating air cargo facilities at O’Hare and JFK airport service areas. Given the scope of the operational test, tracking freight across airport systems was limited by the extent of the supply chain networks.
5.3 ESCM System Architecture

The system was designed to allow only authorized users to enter and monitor cargo movement, and access critical shipment information. Depending on their status as manufacturer, trucking/consolidator or airline, authorized users within the system could contact the system and either input or modify cargo data and shipping information (manufacturers/shippers), or access the read-only information that is applicable to their precise requirements. Figure 3 presents a high level overview of the Phase II ESCM system architecture.

Specific ESCM system components used to facilitate operability, authorized access, electronic transactions, data capture and information storage included:

- **Biometric** authorization capabilities were accessed through both hardware for fingerprint imaging and software for comparative analysis of fingerprint submissions against repository image database. The biometric hardware used was Secugen’s EYE D Hamster HFDP02. The biometric software was a combination of Secugen’s Desktop Biometrics 2000 and software specially developed for the ESCM system.

- **Smart Cards** were utilized to confirm identity, transfer and validate data, and/or gain authorized access to the ESCM database. The smart card reader unit used in the operational test was the Litronic 210 Netsignia. The Smart Cards were 8K byte EEPROM with a cryptographic coprocessor. The smart cards are ISO 7816-based with an ISO 7816 T=0 transmission protocol.

- **Computers** were provided to all participant organizations for the duration of the operational test and were solely dedicated to Phase II ESCM transactions. The hard drives of the test computers were only accessible to test administrators, not to participant employees. Computers used for the ESCM test were Compaq DeskPro Model EN equipped with 600 mhz Pentium III processors, Windows NT 4.0, 10gb hard drive and 64 RAM memory.

- **ESCM Software** was developed to fully incorporate necessary elements contained in traditional air cargo manifests while adding user-friendly features such as capturing customer information and being able to quickly locate manifests by reference number. Coding for the ESCM was developed primarily in Visual Basic.

- The server/database was built on a Proliant ML570 platform using a Proliant 7/700 1MG processor, and a Smart Array 431 controller. The system’s primary memory used 512MB. Microsoft SQL Server was utilized for database management.
Figure 3.
ESCM System Architecture

Manufacturer → Trucking Company → Air Cargo Carrier →
Connected to Internet through T1, Cable, DSL, ISDN, Dial-up →
Connected to ESCM website through biometric reader and smart reader →
Server

development and testing of an electronic supply chain manifest
Recruitment Overview

The Phase II mission was to test the ESCM System with multiple, complete supply chains in the regions surrounding Chicago O’Hare Airport and New York JFK Airport. The Final Phase II ESCM Participant tally includes 8 manufacturers, 20 motor carriers and 5 airlines encompassing both New York and Chicago metropolitan areas. The manufacturers, motor carriers and airlines comprised actual commercial supply chains to reflect real world business conditions. A listing of the operational test participants is presented in Appendix B.

The following section examines the assembly of the multiple distribution chains involved in the Phase II ESCM operational test at O’Hare and JFK International Airports. It also details the recruitment goals, participant enrollment, user system training and issues arising from system operation in regard to both system installation and technical concerns.
6.1 Recruitment Goals

The Phase II Project Team focused recruitment efforts on finding participants that would comprise complete, currently existing supply chains, thus leveraging established business relationships among participants. This was necessary to maximize test effectiveness in relationship to current/pretest transaction patterns and to minimize any inconvenience to test participants. The supply chains each consisted of three members, a manufacturer, a motor carrier, and an airline or air cargo forwarder.

To meet or exceed recruitment goals, the Phase II Project Team conducted an intensive recruitment campaign. Companies were identified as prospects for participation based on several criteria: previous participation in the Phase I study, companies that expressed interest as a result of Phase I, companies conducting business with Phase I partners, or through domain knowledge of companies active in air freight-related transport. Also, throughout the project, research team members went to a number of industry-specific functions in both Chicago and New York and promoted the Phase II project. Furthermore, state and national associations for air cargo companies, trucking companies, and manufacturing companies assisted in recruitment.

Prior to receiving a phone call, potential participants were mailed printed materials highlighting the possible efficiency and security gains that the ESCM could provide not only to their organization, but to their trading partners as well. Following this initial contact, each interested candidate was sent a video that described Phase II project, a PowerPoint presentation outlining key project concepts, and supplementary documentation to fully inform candidates on the operational test requirements and expectations.

Demonstrations of the Phase II ESCM System were given at potential participants’ locations to demo the system and allow “test runs” as a final effort to sign up organizations in the operational test.


6.2.1 ESCM Enrollment

Once candidates agreed to participate (non-binding letters of participation were sought), personnel were formally enrolled into the Phase II ESCM operational test. Participants were informed of the procedures and obligations including the strict process for conducting
manifest transactions, collecting test data and submitting to interviews and questionnaires in the gathering of qualitative system/user information.

Participating companies were provided with the required hardware and software for the operational test. This included computers and ESCM system software, biometric readers, smart cards and corresponding smart card readers.

Employees at the participating test organizations had biometric images of their fingerprints taken via a biometric reader and entered into the ESCM system database for system authorization/computer access. This same fingerprint recognition was also enrolled into a smart card for user access to the ESCM system. A smart card was issued for each employee enrollee in the ESCM operational test.

### 6.2.2 ESCM Participant Training

Research team members installed complete ESCM systems on site and immediately engaged company personnel in training. Demonstrations of the ESCM system were the primary tool used to train users on the system; subsequent one-on-one training provided specific guidance individualized according to user needs. For example, an attendant at a manufacturing plant would have training focused on manufacturing screen attributes while still understanding system-wide ESCM capability. Training manuals were provided to each system user for follow-up instruction on system procedures/features. The training manuals for manufacturers, motor carrier and airlines are presented in Appendix C. On-call technical assistance was also available for participant organizations.

After initial training sessions, follow-up calls and additional training were provided when necessary to maximize understanding and minimize problems. This ostensibly led to their consistent utilization of the system during the operational test period.

With initial qualitative user data collection completed and after several months of regular operational use, the research team implemented an incentive program to encourage participants to increase their use of the Phase II system. The goal was an increase in the critical mass of data hits to the central server. This would allow a more in-depth quantitative examination and analysis by the project team. Companies that had the highest utilization received a prize. One incentive prize was awarded in Chicago and one in New York.

### 6.2.3 System Installation and Technical Issues

There were a variety of issues that came up during the recruitment process that caused potential candidates to decline enrollment in the Phase II project. Issues varied by the type of participant in the project (manufacturer, motor carrier and air cargo carrier), but some overlap did occur in several specific issues. One of these issues was the amount of time
companies felt would be required to train staff on the Phase II ESCM System and perform the required tasks in accordance with enrollment in the program. Companies felt the time constraints on staff would be too burdensome. Some manufacturers and motor carriers declined to participate citing a perceived lack of air cargo freight being processed by their company.

Several specific responses noted by companies that declined to participate included:

- Company did not want to train staff or had reasons that they didn’t want staff having access to the Internet;
- Company felt they didn’t have enough air cargo business to provide sufficient data;
- Company did not want to spend time training staff for a “temporary” system;
- Company felt that they would not benefit from such a system and that they already had a tracking system in place;
- Company did not have enough resources (employees) to participate adequately;
- Manufacturer thought the system was designed to help the airlines;
- Company thought the process of training employees to use the system would be too time-intensive.

The most daunting technical issue that the research team faced was connecting participants to the Internet. Many companies did not have additional analog phone lines, and in other instances the research team needed participants to order Internet access before system installation could occur. Also, a number of companies would not permit the project to use their network system for the required dial-up connections needed to send and receive manifest information.

Some specific technical issues faced during the project are summarized below:

- In the midst of the project, a company changed their network and was unable to utilize their network to access the Internet. Therefore, the project team had to reconfigure the participant computer to work with a dial-up connection and order analog phone line;
- The project team had to have an analog phone line installed at a company in order to utilize the system and had to have a switch box installed, so the user could use their normal computer and ESCM system at the same location, which required additional technical support;
- A network administrator only authorized certain individuals to utilize the Internet, so only when those authorized personnel were around would the system be in use, plus the company had no analog phone lines to tie into the system;
- It was discovered that several companies, after agreeing to participate, did not have internet access. To preserve the full supply chain, the research team facilitated the installation of internet service.
Evaluation Plan

The goals of the ESCM operational test evaluation were two-fold:

1) assess the impact of the system on the overall cargo shipping operations of the participants; and

2) analyze the efficiency and security gains that would be realized over the traditional processing methods.

The evaluation of the system was conducted by two teams:

1) An internal or self-evaluation conducted by the ATRI/ATA Foundation team.

2) An independent evaluation conducted by Science Applications International Corporation (SAIC) assisted by Cambridge Systematics, Inc. (CSI).

Though the emphasis of the two evaluation teams differed slightly in overall scope, the methodologies and evaluation metrics used in the two efforts were developed cooperatively between the ATRI/ATA
Foundation team and the independent evaluators. Additionally, the ATRI/ATA Foundation Project team and the independent evaluators agreed to share data and insights, but with caution not to bias the results of the two separate efforts. This was done to limit operational disruptions for participants, facilitate data gathering, and to ensure consensus among all parties regarding the parameters for assessment of the operational test.

The sections that follow describe the agreed upon Measures of Effectiveness (MOEs) and the data collection methodologies/activities used in the ATRI/ATA Foundation self-evaluation.

7.1 Measures of Effectiveness

The evaluation focused on two key sets of MOEs:

- Operational efficiencies along the intermodal supply chain (quantitative);
- Institutional/participant issues and perceptions of the system and conduct of the operational test (qualitative).

Operational MOEs

The first set of MOEs represented potential improvements (ESCM versus current processes) in manifest processing and transactional activities as measured by time-on-task. These MOEs were:

- Reduced manifest preparation time;
- Reduced paperwork handling time;
- Reduced time in communicating with up- and down-stream intermodal partners;
- Reduced load transference times between intermodal partners;
- Reduced overall freight cycle times.

These MOEs were assessed in the quantitative analysis.

Qualitative MOEs

The second set of MOEs focused on the perceptions of the operational test participants regarding:

- Ease of system use;
- System performance and reliability;
- Workflow using the ESCM system compared to current systems and procedures;
- Adequacy of training and technical support;
- Ability of the system to enhance air cargo security;
- Overall experiences and reactions as participants;
- Enhancements to the ESCM system they would recommend.

These MOEs were assessed through a range of qualitative analytical tools.
7.2 Data Collection and Analysis Methodology

To meet the broad goals of the evaluation and assess the many MOEs, the team used a combination of data collection and analysis methods. These are detailed in the following sections.

7.2.1 Data Collection

The primary data collection activities included:

- On-location timings and transactional analysis at participant locations;
- Surveys of participants;
- Interviews with participants;
- ESCM automated data capture.

On-Site Timings and Analysis

The site visits allowed the research team and the independent evaluators to observe the participants’ operations and procedures, obtain preliminary information on participant expectations and experience in the test to date, and to conduct time-on-task observations. The site visits were conducted by two groups comprised of ATRI/ATAF project team members and the independent evaluators from SAIC and CSI.

The first set of participant site visits was conducted in September 2001 in both the Chicago O’Hare International Airport and the JFK International Airport service areas. The project team conducted one additional site visit with the independent evaluators in the JFK International Airport service area in January 2002. The project team also conducted additional observations any time they visited a participant’s location for equipment installation, training, or to provide technical support.

During these visits, the teams timed numerous activities (either manual processes or those conducted using participant legacy systems) in which the ESCM system would either mimic or obviate the activity. These timings provided baseline data that was later compared to ESCM system reports and supplemented by visual observations of ESCM use to quantify any significant differences in time-on-task. The specific activities timed were:

 Manufacturers:

- completing shipping manifests;
- contacting motor carriers and arranging shipments;
- motor carrier pick-up of the load, involving the manufacturer searching out load documentation, verification of the load, and driver sign-off/acceptance of the load;
- Paperwork error detection and correction.
Motor Carriers:
- pick-up order acceptance over phone and data input;
- load acceptance at manufacturer location;
- creation of master manifests;
- reproduction of manifests;
- paperwork error detection and correction;
- contacting airlines to arrange shipping;
- delivery of loads to airlines.

Airlines:
- Order taking;
- Acceptance of load from motor carrier, involving verification of driver identification, photocopying the CDL, and verification of load documentation;
- Creation of airplane load documentation/master air bill;
- Copying and filing load documentation for FAA Audits;
- Paperwork error detection and correction.

Surveys and Interviews

Surveys were used to gather basic company/operational information from companies in the beginning of the operational test. This information was used to differentiate the participant responses to the exit interview questions based on any significant participant demographics. These pre-test surveys are presented in Appendix D.

The original test plan included administering a brief survey via fax to all system users on a monthly basis. The survey would be used to obtain periodic feedback on the users’ perceptions of the ESCM system and to identify and correct problems the users were having with the system in a timely manner. The survey responses were also to be used to establish whether users’ perceptions of the system changed over time. Two important factors led to discontinuing this particular survey effort:
- The project team was in frequent contact with the ESCM users, enabling them to address any issues the users might have had;
- The terrorist attacks of September 11, 2001 resulted in massive layoffs of workers associated with air cargo transport, including many of the operational test participants. As disruptions in the industry lessened over time, new users were trained in both companies previously enrolled as well as several new companies. Given the time period of operational testing, it was decided that user perceptions of the system would be evaluated on an ad hoc basis and through the exit interview process.
The exit interviews began at the end of April 2002. The interview questions were developed jointly by the project team and the independent evaluators. The interview guide is presented in Appendix E.

The ESCM users were contacted in advance of the interviews and sent a copy of the interview guide to provide them time to consider their responses. This was done to ensure the robustness of the responses and streamline the interview process. In total, 11 ESCM users were interviewed. They represented users in all three legs of the intermodal supply/distribution chain.

In addition to interviewing the ESCM users, the system vendors on the research team were interviewed to gather their unique insights into the recruitment, training, and participant retention issues; and, the technical factors that either enhanced or detracted from the operational test.

**ESCM Automated Data Capture**

A key feature of the ESCM system was that it not only stored and routed manifests and other data, it also tracked and date-stamped all transactions and activities by location and personnel.

Examples of manifest transactions and other related activities that were recorded by the ESCM system include:

**Creation of a manifest/waybill**  
(prepared by manufacturers, motor carriers, and airlines)  
- Opening a new manifest;  
- Releasing the manifest.

**Modification of an existing manifest**  
- Opening an existing manifest;  
- Modifying and releasing the manifest.

**Transfer of a shipment from manufacturer to motor carrier**  
- Notification of shipment release by manufacturer;  
- Notification of shipment acceptance by motor carrier.

**Delivery of shipment by a motor carrier to an airline**  
- Notification of load acceptance by airline;  
- Notification of load delivery by motor carrier.
System-generated error messages

- Notification of errors associated with release/acceptance of load to/from non-enrolled companies.
- These time/date-stamped transactions allowed for the computation of elapsed times for the various participant-initiated ESCM activities that were compared to the timings of manual processes collected during the site visits.

7.2.2 Methodology for Data Analysis

The analyses conducted for the evaluation of the ESCM operational test involve both quantitative statistical analysis and qualitative descriptive analysis. The analytical findings are described in section 8.

Quantitative Analysis

The focus of the quantitative analysis was to establish if, and at what levels, efficiencies can be attained using the ESCM system versus current processes. This was accomplished by developing and comparing baseline time-on-task estimates for activities/processes conducted by the participants using both the traditional processing systems and ESCM-based processes. The average (mean) time-on-task was calculated for identifying differences between the manual and the ESCM processes. As discussed previously, the data sources for the quantitative analysis included the visual timings collected by the project/independent evaluator teams and elapsed time calculations from the time-stamped activities captured by the ESCM server.

The side-by-side comparison of time-on-task (processing) allowed the project team to estimate time savings for either individual transactions, or overall savings for a supply chain sector (i.e., manufacturer, motor carrier, or airline). The estimated time-on-task savings were given values in the analysis using national wage estimates for specific occupational categories associated with the intermodal supply/distribution processes. For example, time savings in the preparation of manifests were valued using hourly wage estimates for transportation clerks, or time savings in the acceptance of a shipment by a motor carrier or in the delivery to an airline were valued using estimated hourly wage rates for truck drivers.

By valuing the time savings, attributing costs to the minimum hardware and software requirements to use the ESCM, and using assumptions for shipment levels and overall participant rates for ESCM, benefit/cost ratios and break-even use levels were calculated.

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Qualitative Analysis

The qualitative analysis was based on substantial input from ESCM users and their management, comments from individuals/companies who declined to participate in or dropped out of the operational test, and the detailed perceptions of the ESCM users gathered through the exit interviews. The qualitative analysis focused on assessing the second set of MOEs, described in section 7.1.

This feedback was reviewed for commonality of response types and tabulated accordingly. The responses were also examined by user type and other demographic factors such as firm size to determine if the factors influenced the type of responses provided to the team.
As described in section 7, the focus of the quantitative analysis is on potential time and cost savings that could be realized by companies using the ESCM system rather than their current processes. The qualitative analysis examined the perceptions of the ESCM users regarding ease of system use, system reliability, potential operational and security benefits, and their overall experience in the operational test. This section presents the results of the two analyses.

8.1 Quantitative Analysis

The average time-on-task for the various ESCM and traditional cargo shipping processes conducted by manufacturers, trucking companies, and airlines were cataloged and compared. Time-on-task metrics were assigned a cost value using standard labor rates obtained from US Bureau of Labor Statistics for transportation clerks, truck drivers and other relevant labor categories.9

It should be noted that the ESCM could obviate the need to conduct several of the current processes. These include contacting and notifying supply chain partners – both upstream and downstream, photocopying documents, and identifying and correcting errors. The analysis assumes that the ESCM will automatically notify and transfer/store all shipment paperwork electronically to authorized parties. The ESCM will also not accept invalid information. For these processes, a zero time-on-task is assumed for the ESCM.

In a scenario in which most, if not all, supply chain partners are using the ESCM, a zero time-on-task for the creation of new manifests during load consolidation could also reasonably be assumed. This analysis is conservative in that it does not make this assumption. Rather, the project team used literal time-on-task comparisons for transactions, e.g., the creation of load documentation, using the ESCM versus current procedures to compute potential administrative efficiencies inherent in the ESCM system.

8.1.1 ESCM Time and Potential Cost Savings

The time-on-task comparisons and estimated procedural cost savings are presented in tables 1 through 3 and illustrated in figures 4 through 6.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Manual Time</th>
<th>ESCM Time</th>
<th>Time Savings</th>
<th>Estimated $ Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filling Out Manifests</td>
<td>2:35</td>
<td>1:07</td>
<td>1:28</td>
<td>$0.36</td>
</tr>
<tr>
<td></td>
<td>n=8</td>
<td>n=81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contacting Motor Carriers</td>
<td>0:51</td>
<td>0:00</td>
<td>0:51</td>
<td>$0.21</td>
</tr>
<tr>
<td>(from carrier order acceptance)</td>
<td>n=26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Search Out Documentation</td>
<td>4:12</td>
<td>0:18</td>
<td>3:54</td>
<td>$0.95</td>
</tr>
<tr>
<td>Load Verification, Driver Sign-Off</td>
<td>n=13</td>
<td>n=16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paperwork Error Correction</td>
<td>0:12</td>
<td>0:00</td>
<td>0:12</td>
<td>$0.00</td>
</tr>
<tr>
<td></td>
<td>n=1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The occurrence of manifest errors is unpredictable and can originate from several sources – illegible handwritten information, data entry errors, misassignment of information to manifests, etc. Anecdotal information from participants indicates that errors are frequent, but due to their unpredictability, are excluded from calculation of per-manifest cost savings.
**Table 2**

ESCM Versus Manual Process Times and Estimated Cost Savings Per Shipment For Trucking Companies

<table>
<thead>
<tr>
<th>Activity</th>
<th>Manual Time</th>
<th>ESCM Time</th>
<th>Time Savings</th>
<th>Estimated $ Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Acceptance over Phone and Data Input</td>
<td>0:51 n=26</td>
<td>0:00</td>
<td>0:51</td>
<td>$0.21</td>
</tr>
<tr>
<td>Load Acceptance at Manufacturer</td>
<td>4:12 n=13</td>
<td>0:18</td>
<td>3:54</td>
<td>$1.03</td>
</tr>
<tr>
<td>Input to Create Master Manifest</td>
<td>2:08 n=113</td>
<td>0:43</td>
<td>1:25</td>
<td>$0.35</td>
</tr>
<tr>
<td>Reproduction of Manifests</td>
<td>1:03 n=15</td>
<td>0:00</td>
<td>1:03</td>
<td>$0.26</td>
</tr>
<tr>
<td>Paperwork Error Correction</td>
<td>1:03 n=3</td>
<td>0:00</td>
<td>1:03</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contact Airline and Arrange Shipping</td>
<td>4:09 n=38</td>
<td>0:00</td>
<td>4:09</td>
<td>$1.01</td>
</tr>
<tr>
<td>Delivery to Airlines</td>
<td>3:03 n=41</td>
<td>0:11</td>
<td>2:52</td>
<td>$0.75</td>
</tr>
</tbody>
</table>

**Table 3**

ESCM Versus Manual Process Times and Estimated Cost Savings Per Shipment For Airlines

<table>
<thead>
<tr>
<th>Activity</th>
<th>Manual Time</th>
<th>ESCM Time</th>
<th>Time Savings</th>
<th>Estimated $ Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Taking/Contact Motor Carriers</td>
<td>4:09 n=38</td>
<td>0:00</td>
<td>4:09</td>
<td>$1.01</td>
</tr>
<tr>
<td>Load Acceptance</td>
<td>3:03 n=41</td>
<td>0:11</td>
<td>2:52</td>
<td>$0.70</td>
</tr>
<tr>
<td>Clerical Time for Creating Airplane Load Documentation</td>
<td>3:00 n=32</td>
<td>0:00</td>
<td>3:00</td>
<td>$0.73</td>
</tr>
<tr>
<td>Paperwork Error Correction</td>
<td>0:41 n=3</td>
<td>0:00</td>
<td>0:41</td>
<td>$0.00</td>
</tr>
<tr>
<td>Copy &amp; File for FAA Audits</td>
<td>1:10 n=25</td>
<td>0:00</td>
<td>1:10</td>
<td>$0.28</td>
</tr>
</tbody>
</table>

11, 12 See Table 1 footnote regarding error calculations

development and testing of an electronic supply chain manifest
Figure 4
Estimated Cost Savings Per Shipment for Manufacturers
ESCM versus Manual Processes

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>Filling Out Manifests</th>
<th>Contacting Motor Carriers</th>
<th>Search Out Documentation, Load Verification, Driver Sign-Off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0.36</td>
<td>$0.21</td>
<td>$0.95</td>
</tr>
</tbody>
</table>

Figure 5
Estimated Cost Savings Per Shipment for Trucking Companies
ESCM versus Manual Processes

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>Order Acceptance over Phone and Data Input</th>
<th>Load Acceptance at Manufacturer</th>
<th>Input to Create Master Manifest</th>
<th>Reproduction of Manifests</th>
<th>Contact Airline and Arrange Shipping</th>
<th>Delivery to Airlines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0.21</td>
<td>$1.03</td>
<td>$0.35</td>
<td>$0.26</td>
<td>$1.01</td>
<td>$0.75</td>
</tr>
</tbody>
</table>

quantitative and qualitative results
The time-on-task comparisons demonstrate significant performance improvements using the ESCM within the MOEs of:
- Reduced manifest preparation time;
- Reduced paperwork handling time;
- Reduced time in communicating with up- and down-stream intermodal partners;
- Reduced load transference times between intermodal partners;
- Reduced overall freight cycle times.

Based on the previously described assumptions, strong inferences can be made regarding the potential cost savings per shipment for companies using the ESCM. The savings per shipment can total:

- Manufacturers: $1.52
- Trucking Companies: $3.61
- Airlines: $2.72

The total potential savings for (outbound only) shipments could reach $7.85 per shipment using the ESCM. It has been observed that the procedures involved in the inbound handling of shipments closely emulate those for outbound shipments. With this in mind then, potential cost savings for point-of-origin to ultimate destination shipments could reach $15.70 per shipment. Again, this level of time/cost savings could only be realized – even potentially exceeded – if a “critical mass,” i.e., significant participation in ESCM by supply chain partners, is attained.
8.2 Qualitative Analysis

Section 8.1 demonstrated the potential effects of ESCM on intermodal operations. This section examines the hands-on experiences and perceptions of the ESCM by the operational test participants. In total, eleven participating “high-user” participants were interviewed in depth. Personnel attrition due to normal business turn-over or that resulting from the impacts on the air cargo industry of the September 11, 2001 terrorist attacks made debriefing of several additional high-user participants infeasible.

Both the project team and evaluation team have concluded that commonality of responses from interviewed participants is so consistent that the relative number of full final interviews is significant in elucidating the perceptions, issues and concerns of the full participant user community. Additionally, less formal feedback from users who dropped out prior to the end of the operational test confirm many of the perceptions obtained during the full interviews. The composition of the group of interviewees is described in Table 4.

Table 4
Composition of ESCM Users Interviewed

<table>
<thead>
<tr>
<th>Company Type</th>
<th>Number of Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>3</td>
</tr>
<tr>
<td>Trucking Company</td>
<td>5</td>
</tr>
<tr>
<td>Air Cargo Carrier</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>11</strong></td>
</tr>
</tbody>
</table>

8.2.1 ESCM System Use and Performance

Non-ESCM Processing
The ESCM was often used in parallel with current participant manifesting activities (i.e., manual day-to-day shipping paperwork was still completed prior to using the ESCM system). The current, pre-ESCM processing of manifests within the participating companies can be broken into three approaches:
2) Use of legacy computer systems with limited or no connectivity to supply chain partners. These systems usually require manual input of paper-based shipping data, and labor-intensive communications (phone, fax) between partners.

3) Use of legacy computer systems with connectivity to supply chain partners. This approach is generally automated to populate data cells and provide some cargo data exchange between supply chain partners.

In categories 2 and 3, cargo pick-ups and deliveries were conducted manually with exchange of paperwork and sign-off, and photocopying of the driver's license. Notification of pick-ups and deliveries, if conducted, was usually performed via phone between back-office operations or, in a few cases, via mobile communications between drivers and their dispatch offices.

**Level and Type of ESCM Use within Operational Test**

Following installation, the ESCM system was used at varying levels for all of the processes described in section 7.2.1. Additionally, two participating motor carriers and two airlines used the ESCM to track shipments to provide information on when pick-ups and deliveries were made and to plan for incoming loads.

In use, ESCM represented a relatively small portion of participants’ total manifest-related processing activities. This was due to several interrelated factors:

- Any one participant had relatively few intermodal partners enrolled in the operational test. Regardless of how many total air cargo manifests a company may process (varying from relatively few to several thousand per month), the number of manifests involving cargo movement among other participating companies was often a small proportion of the total;
- Using the ESCM was considered a duplication of effort by some of the test participants; the participants would complete an activity using current methods, then would have to complete the same activity using the ESCM. Within the framework of the operational test, the ESCM was a stand-alone system not integrated with any other legacy systems. Often these legacy systems contained a large degree of customer information embedded within the system to automatically populate data entry fields. The ESCM sometimes required the direct input of customer information to create a manifest (especially if a shipment were to be handled or destined for a non-participating company). In these cases, the level of effort to use the ESCM system exceeded that of using the legacy systems;
- Staffing levels constrained the ability of companies to use the ESCM system. Within the intermodal supply chain, competition is intense and operating margins are generally thin. This is especially true for trucking companies and airlines. In the best of economic times, staffing is maintained at minimal levels. Given the general
downturn in the economy, aggravated by the events of September 11, 2001, many companies had further reduced staff. This had a two-fold effect on the participants’ use of the ESCM system: 1) many persons who were trained in the system’s use were lost due to layoffs and 2) remaining, or newly hired, participants had substantially greater workloads and found that the amount of extra time they had available to use the ESCM system was limited.

**8.2.2 Participant Perceptions of ESCM System**

**Ease of Use**

Ninety-one percent of users interviewed found the ESCM system intuitive and easy to use. Back office users particularly noted that the screen layout and pre-populated data input fields facilitated manifest creation/processing. Truck drivers had no problems using the ESCM load transference processes.

The only difficulties that users experienced in incorporating the ESCM system into their daily routines were noted in section 8.2.1.

**Overall System Performance and Reliability**

The users were asked if they were aware of any times the ESCM system did not function. Eighty-two percent of those interviewed indicated that they were unaware of any system problems, errors, or malfunctions. Two participants that cited problems indicated the need for a faster connect speed to the ESCM server, and less system down-time (due to the participant’s change-over to a new telecommunications provider). These user perceptions are validated in the independent evaluator’s analysis of ESCM technical effectiveness. In this analysis, the ESCM technologies “were found to be operating correctly and in a timely manner.”

**Operational Process Improvements**

The participants were asked if they believed that the ESCM system accurately duplicated and/or improved upon their current system or processes. Again, 81.8% of users interviewed said the ESCM provided improvements to their current methods and could potentially save time and effort. Cited improvements include:

- Pre-population of data fields with required information reduced data input time;
- Pre-notification of shipments coming into air cargo facilities;
- Ability to track shipment status as a client satisfaction tool;
- Elimination of paperwork and points-of-data entry;
- Reduced phone/fax time;
- Expedited pick-ups/deliveries and reducing paperwork for drivers;
- One-stop location for all shipment information.
Those participants who said the ESCM did not adequately duplicate or improve upon their current processes cited duplication of effort and additional work to their current processes. These responses were from companies who had legacy computer systems that were tied to other company data processing functions such as inventory control. In two cases, the companies already had the means for electronic data exchange with their supply chain partners.

Additionally, 91% of system users said that the ESCM has the potential to allow for better/easier scheduling of shipments under a wide-scale deployment scenario (i.e., a broad-base of system users). The participants cited two common reasons: 1) timely notification of shipments to be picked up/delivered, and 2) advanced notification of inbound cargo provides for more efficient dispatching of trucks and drivers (considered a transportation efficiency benefit by transportation planners) and improved cross dock planning/management. Lastly, seven participants indicated that customer service could be dramatically enhanced by sharing ESCM's cargo tracking information with their customers.

**Security Perceptions**

The participants were asked if they felt that the ESCM system provided a high-level of security in protecting information, and if they believed that the ESCM system could enhance air cargo security. Nine of the 11 participants felt that the ESCM information was secure and that the system could improve cargo security. These respondents all indicated that the ESCM system provided better access control to shipping and cargo information vis a vis the biometric identification, smart cards, and secured log-in and processing procedures, as well as generating a detailed tracking trail of cargo and authorized users.

Of the two remaining respondents, one was unsure of any potential security improvements and the other felt that current processes were adequate.

### 8.2.3 General Participant Perceptions of Operational Test

#### General Expectations Over Time

The participants’ expectations of the ESCM system at the beginning of the operational test varied among the respondents. The initial expectations included:

- No particular expectations (36%);
- Ease of systems use (27%);
- Faster than current processes (27%);
- A more secure system (27%);
- Wanting to see what shipment information the system could provide (9%);
- Understanding system capabilities for possible integration with company enterprise system (9%);
- Leery about system capabilities as described during orientation (9%).

\(^{13}\) Percentages are non-additive due to multiple responses by participants
The participants were also asked at the end of the operational test whether the ESCM system met their expectations. One hundred percent of the participants that indicated they had defined expectations of the ESCM system had their expectations met or exceeded. Specifically, they provided the following responses:

- The ESCM “far exceeded his expectations” in terms of timeliness and detail of shipment information;
- Would like to integrate ESCM with current tracking system and internet-based customer service functions for load tracking and driver management;
- The system met the functional descriptions provided during recruitment and training;
- The system was easy to use and all shipment information was available “at the push of a button.”
- The system exceeded expectations in ease of use and being faster than current processes;
- The system performed as promised;
- Yes, it [ESCM] met expectations.

**ESCM Training and Technical Support**

All of the interviewed participants said that the training/orientation provided in the use of the ESCM system was adequate to very thorough. Overall, the users felt the one-on-one hands-on training sessions, the user guides, plus the system’s ease-of-use made the training process successful.

Though there were a few technical difficulties recorded during the operational test, the perceived level of technical support from the project team was high. Often, technical support involved answering general questions about the use of the ESCM system and in these cases the questions were answered quickly and to the users’ satisfaction. In the single case of connectivity problems, the research team was able to arrange appropriate dial-up capabilities in a timely manner.

**8.2.4 Participant Recommendations**

The interviewed participants were asked – based on their experience during the operational test – if they had any specific recommendations for how the ESCM system could be improved. Four participants had “no specific recommendations.” The research team attributes the underlying reasons for these “default” answers to one of two factors:

- These companies experienced severe staffing limitations, resulting in their inability to fully “exercise” the ESCM system, and form opinions and ideas about the system;
- Several companies perceived the ESCM system as duplicative because of the lack of integration with legacy systems and few intermodal partners on the system, and therefore did not have positive, forward-thinking recommendations.
The responses from the other respondents were straight-forward and consistent with their responses about the overall use, and perceived strengths and weaknesses of the system. These recommendations can readily be categorized in the following way:

1) Need to develop a “critical mass” of ESCM system users to reduce or eliminate the need for duplicative efforts. (54%).

2) Need for integration of ESCM with current legacy systems (18%).

3) Need for faster connections (rather than current dial-up) to ESCM server (18%).

The research team designed the ESCM system as a stand-alone test to reduce the liability and costs associated with integrating with other resource management applications.
Institutional Issues

The quantitative analysis and the qualitative feedback from system users show that the Phase II ESCM system holds promise for delivering benefits both in terms of efficiency and security when compared to traditional manual or legacy system manifest processing methods. These benefits are largely theoretical within the context of a limited operational test. Based on participant comments, it is seen that only through a larger-scale deployment of the ESCM system would users begin to accrue the potential range of benefits that the system could offer.

To expand ESCM usage and accrue many of the benefits, a number of institutional issues, for both the public and private sectors, must be addressed. These include:

- National security issues and applications;
- Data privacy and accessibility;
- System interoperability;
- Benefits versus costs.
9.1 National Security

Following the terrorist attacks on the World Trade Center and the Pentagon on September 11, 2001, addressing the vulnerabilities of air passenger and air cargo security became leading objectives of newly created agencies such as the Transportation Security Administration and the Department of Homeland Security. Measures taken to assure the safety of air cargo (the majority of which is transported in the cargo holds of passenger jets) are being directed at freight inspection, documentation, and secure access to air cargo.

The intermodal supply chain is becoming more closely knit as a result of the need to transact business with known shippers and carriers of air freight. For those who are new entrants to the business or ship infrequently, security substantial documentation and background checks are required. Within certain parameters, the ESCM system could provide a platform in which air cargo security can be enhanced without burdening the intermodal supply chain participants – based on ESCM security protocols associated with its secure identification and controlled-access architecture, plus its capability for maintaining known or frequent air cargo shipper and carrier information. It also ostensibly provides the capability to meet any additional documentation requirements of governmental security entities through protected access to cargo information.

The challenge will be to deploy the ESCM system on a broad enough basis to provide comprehensive cargo tracking and access control to a large proportion of air cargo transport.

9.2 Data Privacy and Access

The ability of the ESCM system to capture and maintain air cargo shipment information can create a unique data set that could be used (under strict rules dictating who can access what information and in what forms) to:

- enhance cargo monitoring by agencies charged with air cargo security;
- improve public policy development and infrastructure investment decisions;
- and,
- provide the private sector with information to enable better business decisions.

To realize these potential externalities of the ESCM system, the data privacy issues of the end users in the private sector must be recognized and addressed. Private sector entities are extremely concerned about keeping proprietary information out of reach from unauthorized parties. There are two distinct areas of data privacy to point out in regard to private sector entities. The first is data privacy in relation to other private sector commercial firms (competitive data), and the second is data privacy in relation to governmental access (data protection and regulatory/revenue) to ESCM generated files.
Competitive Data Issues

To prevent competitors from accessing business-critical information, only designated/authorized individuals must be able to access confidential organizational data. Data is kept secure in the ESCM System from unauthorized commercial parties via biometric system access, ESCM software password log-on and 192-bit Triple DES encryption/SSL web-based security. Only authorized users may view sensitive manifest information during and after transmission on the ESCM System. However, the ESCM system is designed to allow System Administrators to view all transactions.

An opportunity exists for individual firms or value-added resellers of information to access specifically parsed (aggregated, stripped of sensitive identifying information, and possibly time-lagged) ESCM data to establish operational benchmarks to enhance business decision-making.

Public Sector Access Issues

Private sector entities are also concerned about providing copious amounts of operational and financial data to governmental agencies for two primary reasons:

1) there is too little precedent and case law relating to public sector protection of confidential data. Quite the opposite, legislation exists, e.g., Freedom of Information Act, that make it more difficult for government to protect private sector data.

2) Historically, an important role of government is developing regulatory program and revenue-collection programs. Some elements in the private sector feel that operational and financial data could be used to enhance and intensify taxation and regulation. It could also be garnered in civil litigation cases.

It is clear that certain data elements contained in the ESCM system might be of interest to local, state or federal agencies charged with compliance and collection, or to legal entities associated with tort law. Assurances regarding non-disclosure agreements, and limitations on use and exchange by government agencies need to be developed to assuage private sector concerns of “big brother” watching over them.

The potential upside of government interaction with ESCM data, albeit strictly controlled, can enable the following capabilities:

- government agencies to monitor air cargo shipments from a security standpoint and detect potential threats in an exception-based environment;
- government agencies to collect in near real-time freight data to improve the timeliness and effectiveness of transportation policy decisions;
- private sector companies to conduct business with government regulatory agencies in a paperless environment.
9.3 System Interoperability

The ESCM system demonstrated a range of benefits, mostly through the automation of the manifest processing activities. As previously discussed, these benefits have been examined in the context of a “closed system” in which only participants in the operational test have the capability to exchange information. Within the operational environment of the test participants, the ESCM system was a stand-alone system (i.e., was not integrated with the participants’ other business systems such as inventory control, costing, routing and dispatching, space utilization software, etc.).

To realize the full potential of the ESCM system, integration with other platforms and systems within and outside of participating companies is needed. The ESCM is based on an open architecture readily enabling import/export of data to other applications. This is significant in terms of compatibility with the National ITS Architecture and currently used and/or available business software applications.

Within private sector organizations, the development of interface software between the ESCM system and current business applications could eliminate manual or duplicate data entry processes. For example, it would be extremely beneficial to automatically populate current billing, freight tracking, dispatching, manpower optimization, and customer service applications with real-time information. Many of the aforementioned applications within the air cargo transportation community are proprietary legacy systems that will require the development of data translators to integrate the information to/from the ESCM system.

The specificity and stability of the data accepted or provided by the ESCM system and the format of the data indicate that development costs for integrating the ESCM system with current in-house systems would be a one-time marginal cost, readily offset by potential productivity gains. For freight operations that are using vendor-provided optimization software suites, open data import capabilities are the norm. In these cases, often a simple macro program needs to be developed within the software suite to accept the data.

In the future, the ability to interact with government regulatory entities, especially the U.S. Customs Service, could expand the viability of the ESCM system as a productivity tool. Several main points must be addressed for a successful information/data electronic communication between an enhanced ESCM system and the US Customs system. These are:

- An enhanced ESCM system design effort should consult with both US Customs and third party experts with experience in developing AMS/ACE\textsuperscript{15}-compliant solutions.

\textsuperscript{15} The Automated Manifest System (AMS) is a U.S. Customs-operated multi-modular cargo inventory control and release notification system for sea, air, and rail carriers. AMS speeds the flow of cargo and entry processing and provides participants with electronic authorization to move cargo prior to arrival.
to determine the best software/hardware blueprint for meeting the multiple needs of ESCM system users and US Customs;
- An enhanced ESCM system design should also consider compatibility with future federal governmental trade information systems such as the Automated Commercial Environment/International Trade Data System.¹⁶
- Future ESCM system users must be presented with an intuitive interface in which to enter, amend, send and receive information between the ESCM system and the US Customs system. Only minimal user training should be required in order to operate the system effectively.

9.4 Benefits versus Costs

Installation and use of the ESCM system by supply chain trading partners will be a business decision based on expected return on investment. The potential efficiency cost savings for using ESCM must be sufficient to recoup any initial and recurring costs incurred by a company and within a reasonable timeframe.

Tangible Benefits
The benefits of the ESCM System can be expressed in both tangible and intangible terms. Tangible benefits are relatively numerous and quantifiable. Using the ESCM System could save at least several minutes in manifest processing time. Additional tangible benefits include: efficient deployment of labor and material resources at transportation facilities, advance notice of arrival and shipment details, electronic and immediate shipment tracing, and elimination of paperwork as the ESCM records will be kept electronically.

Intangible Benefits
Intangible benefits are not as easily quantifiable, but are of at least equal importance with the tangible ESCM benefits. The ESCM System allows only authorized personnel to enter and view sensitive shipping manifest information via biometric/smart card accessibility. The ESCM documents an electronic record of every shipment’s transport movement details including complete entries of everyone who handled a shipment within the distribution chain. The tangible and intangible benefits will be directly affected by the level of ESCM use.

¹⁶ The Automated Commercial Environment (ACE) is being developed by the U.S. Customs Service to enhance its current data processing capabilities. The system is scheduled to be operational in 2003. ACE is being designed to integrate with a larger-scale federal government project, the International Trade Data System (ITDS) to electronically collect, store and disseminate all international trade data. ITDS, scheduled for deployment in the 2005-2007 timeframe, will provide a single public interface to submit and receive trade related data stored to/from many public agencies. ITDS will then forward information to the relevant federal agency or authorized system user.
Private sector companies will carefully weigh the costs of ESCM use against the potential benefits. These cost factors can include:

- The purchase and installation of computers and peripheral equipment;
- Integration of the ESCM with company legacy systems;
- Staff time for training;
- Any recurring system upgrades.

Vital to lowering ESCM unit costs and maximizing a company’s return on investment will be eliminating duplicative manifest processing by establishing a critical mass of system users and amending government requirements associated with the existing “known shipper” protocols. Organizational resources are burdened when a company is forced to use automated manifesting systems for some partners and manual manifesting systems for others. Critical mass for the ESCM System is needed to enable all of an organization’s partners to conduct transactions on a single automated air cargo system.

The type of business model used to deliver ESCM service will likely have a large impact on potential participation levels. The challenge will be to deliver ESCM services at low enough unit costs for companies to minimize business risk and begin to quickly accrue benefits. One possible business model would have the public sector supporting software development costs with ongoing system provision/support provided by a private sector service company – possibly as a third-party contractor. Individual companies willing to use the ESCM system would be responsible for perhaps purchasing all or part of some ESCM System hardware sub-components. Maintenance and general computer hardware upkeep would be the responsibility of the private sector participants, but the ESCM System does not require any unusual hardware beyond the biometric/smart card subcomponents. These components do not require any modifications to existing computer systems in order to operate effectively.
Conclusions and Recommendations

Overview

The ESCM operational test generated a substantial amount of data and other forms of information for the research and evaluation teams to tabulate and analyze. Almost all of the ESCM quantitative and qualitative data supports the hypothesis that an electronic manifest designed to support both efficiency and security is viable within many business operating conditions, given that certain conditions are met. These include creating a critical mass of system users, providing quick ROIs, and providing adequate data protection.

It is also clear that the ESCM project was a first-of-its-kind in terms of integrating biometrics, smart cards and secured internet transactions for the air cargo industry. Consequently, the project received considerable attention from private- and public-sector entities involved in all varieties of security and
business productivity. System tours and demonstrations were provided to 21 different
government entities, 7 academic institutions and 67 known private sector interests. This does
not include the numerous large-audience presentations made before prestigious groups
such as:

- Transportation Research Board;
- ITS America;
- Airports Council International;
- American Trucking Association’s Executive Committee;
- Intermodal Freight Technology Working Group;
- Institute of Transportation Engineers;
- Los Alamos National Laboratory;
- ITS World Congress;
- Council on Competitiveness;
- MN Guidestar.

The benefits associated with “showcasing” the project are real, but difficult to quantify. One
important outcome clearly was providing the business and technology vendor communities
with a federally sponsored (i.e., low-risk) proof-of-concept study. Towards this end, the
ESCM project identified appropriate end-users, market research findings, barriers to entry,
ROIs and financial analyses, an accurate functional architecture and a manageable technical
architecture. It become more evident over the course that the U.S. DOT’s role as a
transportation technology facilitator is well founded, particularly when the outcomes –
system efficiency and security – provide strong public benefits. Participants were particularly
impressed with the open architecture and research objectivity that comes from public-
sponsored technology testing.

Primary Findings and Recommendations

Given the sheer volume of quantitative and qualitative information derived from the project, it
is not surprising that many unexpected benefits and analyses arose. However, the essential
conclusions are as follows:

**FINDING:** The ESCM system demonstrated significant efficiency benefits over non-
interfaced legacy systems through reduction in paperwork, error correction,
reduced data input, and transaction times (contacting supply chain partners
and transference of loads).
FINDING: Conservative estimates of time savings in the processing of manifests are:
- $1.52 per manifest for manufacturers/shippers;
- $3.61 per manifest for trucking;
- $2.72 per manifest for airlines.

FINDING: ESCM system strengths cited by participants included:
- Ease of use;
- System reliability;
- Reduced paperwork;
- Ability to track loads and potentially improve scheduling and planning;
- Ability to review who had cargo and system access;
- ESCM limited access to system and cargo to only authorized participants.

FINDING: Weaknesses of ESCM cited by participants included:
- Limited number of supply chain partners using the system, limiting participants’ ability to maximize system benefits;
- Lack of ESCM integration with participants’ corporate legacy systems, thus resulting in duplication of effort.

FINDING: Overall perceptions of the system fell within the parameters of the project’s qualitative objectives. Perceptions included:
- ESCM performed as proposed during recruitment and training processes;
- Training and technical support processes were considered adequate to very thorough by participants;
- A range of expected and unexpected ESCM benefits, in terms of efficiency and security, were identified by participants;
- System enhancements and participation by a significant number of supply chain partners would be needed to realize ESCM’s full benefits.

FINDING: General constraints on operational test:
- Participant staff turnover or otherwise encumbered due to general economic downturn and, more directly, economic shocks resulting from the 9/11 terrorist attacks.
Recommendations

To ensure that the ESCM project’s data, deliverables, and findings provide benefit and utility to the business operating environment as well as future research efforts, the project team has identified a series of “next steps” for consideration:

RECOMMENDATION: Expand the ESCM system to increase the universe of participating companies and airports. Incorporate an international airport to increase understanding of the role and impact of international shipments on the ESCM system and processes.

Recognizing the opportunities associated with expanding the ESCM test environment, the FAA/TSA and U.S. DOT Office of Intermodalism approved a project expansion to include the airport districts of Los Angeles, CA and Toronto, Ontario, Canada. The expanded system is now fully operational in those two cities, data is being collected and analyzed, and discussions have occurred between the research team and US Customs staff regarding the operational and policy issues associated with integrating ESCM with the US Customs AMS system.

RECOMMENDATION: Develop and/or improve data and transaction standards for electronic manifesting.

It became apparent to the project team that, within the marketplace and government, there was relatively little interest in standardizing electronic manifests (pre-9/11). The primary reason for this appears to be:

Given the tight, contractual partnerships that exist in supply chains, there has been very little interest by government or industry in standardizing data and transactions. In other words, proprietary systems have been relatively effective to date and, prior to the 9/11 attacks, government did not necessarily see a “public good” being derived from formalizing standards. It is clear that this cloistered perspective no longer exists in either the public or private sectors.

RECOMMENDATION: Integrate ESCM systems with other resource planning systems (legacy, etc.). The private sector continues to expend huge resources on technology platforms for managing finances, inventory, pricing/costing, routing and dispatching, and a myriad of other operational functions.

For an ESCM system to succeed, it must integrate and interact with these other systems for real-cost savings and efficiency gains to occur. As indicated in the qualitative research section, participants believed that a stand-alone system was ultimately (post-research) too inefficient to justify the investment.
RECOMMENDATION: Identify and implement changes to data privacy laws.

Given the compelling need for the government and private sector to work together to improve the transportation system and enhance national security, it is essential that information-sharing occurs. However, the existing legal, jurisdictional and political environments make this unlikely. New policies, agreements and legislation are needed to allow government to protect data, information and operational entities from access by unauthorized or unnecessary entities. Given adequate protection in these areas, it appears that industry would be more willing to work with government partners on information-sharing.

RECOMMENDATION: Promote and encourage public-private ESCM systems and data pipelines.

The public sector has a real need for interacting and partnering with private industry, primarily for transportation and security planning. To ensure that the technology systems and platforms are installed and used, government should consider developing financial and non-financial incentives and programs. These could range from tax-incentives to free software and training. Obviously such programs would have to be developed in concert with technology vendors to diminish the appearance of government interdiction in competitive arenas.
Appendix A
XML Electronic Manifest Data Sets

<?xml version="1.0" encoding="UTF-8"?>
<!--Phase II ESCM DTD -->
<!ELEMENT SHIPPER INFO>
<!ATTLIST SHIPPER INFO
Air_Waybill_# CDATA #REQUIRED
Original_Bill_of_Lading_# CDATA #REQUIRED
Original_Waybill_# CDATA #REQUIRED
Issuing_Person CDATA #REQUIRED
Shipper’s_Phone_Number CDATA #REQUIRED
Shipper’s_Name_and_Address CDATA #REQUIRED
Shipper’s_account # CDATA #REQUIRED>

<!ELEMENT CONSIGNEE INFO>
<!ATTLIST CONSIGNEE INFO
Consignee’s_Name_and_Address CDATA #REQUIRED
Consignee’s_Account_Number CDATA #REQUIRED>

<!ELEMENT ISSUING CARRIER INFO>
<!ATTLIST ISSUING CARRIER INFO
Issuing_Carrier’s_Name_and_City CDATA #REQUIRED
Agent’s_IATA_Code CDATA #REQUIRED
Account_Number CDATA #REQUIRED>

<!ELEMENT CARGOINFO>
<!ATTLIST CARGO INFO
Airport_of_Departure CDATA #REQUIRED
Requested_Routing CDATA #REQUIRED
By_First_Carrier_to_by CDATA #REQUIRED
Currency CDATA #REQUIRED
Charge_Code CDATA #REQUIRED
WT/VAL_PPD/COLL CDATA #REQUIRED
Other_PPD/COLL CDATA #REQUIRED
Airport_of_Destination CDATA #REQUIRED
Flight/Date CDATA #REQUIRED
Declared_Value_for_Carriage CDATA #REQUIRED
Declared_Value_for_Customs CDATA #REQUIRED
Amount_of_Insurance CDATA #REQUIRED
Handling_Instructions CDATA #IMPLIED
Weight_Charge_PPD/COLL CDATA #REQUIRED
Valuation_Charge_PPD/COLL CDATA #REQUIRED
Tax_PPD/COLLECT CDATA #REQUIRED
Other_Charges CDATA #IMPLIED
Total_Other_Charges_Due_Agent_PPD/COLL CDATA #REQUIRED
Total_Charges_Due_Carrier_PPD/COLL CDATA #REQUIRED
Total_Prepaid CDATA #REQUIRED
Total_Collect CDATA #REQUIRED
Currency_Conversion_Rates CDATA #REQUIRED
Currency_Conversion_Charges_in_Debt_Currency CDATA #REQUIRED
Charges_at_Destination CDATA #REQUIRED
Total_Collect_Charges CDATA #REQUIRED>

<!ELEMENT TRANSACTION EXECUTION>
<!ATTLIST TRANSACTION EXECUTION
Signature_of_Shipper/Agent CDATA #REQUIRED
Execution_Date CDATA #REQUIRED
Execution_Place CDATA #REQUIRED
Signature_of_IssuingCarrier/Agent CDATA #REQUIRED>
Appendix B
Phase II Participant List

Manufacturers
- Hayward Industrial
- Jaguar Components
- Culligan
- Metal Impact
- Cherry Vale
- Fischer Scientific
- Citation Paper
- Transilwrap

Motor Carriers
- Custom Companies
- Focus Logistics
- Mat's Trucking
- Thrift Trucking
- R&M
- Towne Air Freight (ORD & JFK)
- CargoTech
- New England Motor Freight
- Central Jersey Air Transport
- Mobile Trucking
- Pace
- Bax Global
- Dedicated Express (ORD & JFK)
- CCX
- AIP
- AIP Unified
- Alliance Roadfeeder Service (ORD & JFK)
- GOD
- J&T Services

Airlines
- United (ORD & JFK)
- American (ORD & JFK)
- Alliance Air Cargo (ORD & JFK)
- Nippon (ORD & JFK)
- JAL (JFK)
Appendix C
ESCM Training Manual Summaries

Manufacturer

1. Turn on the computer.
2. You must biometrically login with your fingerprint in order to get on the machine.
3. Double click in the Internet Explorer and then you must insert your smart card in order to logon onto the ESCM website.
4. You are now into the system and are ready to begin transactions.
5. You can click on Search key in order to see the status of an existing manifest or double click on a certain Waybill # to see the status. Once the Waybill has opened up, click on the Transfer tab and you can see the status of every transaction that occurred to that Waybill. Refer to the codes on the last page as a reference.
   – or –
6. Click on the Create key in order to create a new manifest.
7. Fill out all necessary fields in the manifest. Refer to the IATA form attached to fill in all necessary codes if unsure.
8. Press the Accept key, in order to view the document, and if you want to enter the exact information of the shipment click on the Items Tab of the manifest and enter the data.
9. When everything is complete, click on the Accept key and verify everything again.
10. Once the entire manifest is complete, click on the Release key in order to send an electronic notification to the trucking company and airline if known.
11. When truck driver arrives, you must logon again if you have logged out using your fingerprint and your smart card. Double click on the correct Air Waybill # that corresponds to that truck driver.
12. Then click on the Transfer button in order to transfer shipment over to the truck driver.
13. The truck driver will then be prompted to present his smart card and biometrically login with his fingerprint.
14. A message will then appear accepting the transfer or declining the transfer depending on the truck driver's verification in the system.
15. An electronic notification is then passed on to that trucking company and the airline letting them know that the shipment is in transit and the status of that Air Waybill # will change.
16. You can then logout if desired.
17. Once the shipment has reached its final destination, air cargo facility or trucking company for consolidation, the status of the Air Waybill # will change.
**ESCM Manufacturer Codes**

**Blue/A**
The manufacturer has created a manifest but has not yet released the notification that the shipment is ready to be picked up to the trucking company and airline (if known).

**Red/R**
The manufacturer has released an electronic notification to the trucking company and airline (if known) letting them know that a new Waybill has been created and is ready to be picked up.

**Black/P**
The truck driver has arrived at the manufacturer and picked up the shipment and is now in transit.

**Grey/D**
The shipment has been delivered to the final destination in the supply chain (airlines or trucking company for consolidation).

**Transfer Section of Manifest**

- **C** – Created
- **M** – Modified- changes were made to the shipment
- **R** – Released notification of a new Waybill
- **AM** – Authorized Manufacturer made transfer
- **P** – Picked up by truck driver
- **AR** – Authorized Receiver received the shipment
- **D** – Delivered to the authorized receiver

**Motor Carrier**

1. Turn on the computer.
2. You must biometrically login with your fingerprint in order to get on the machine.
3. Double click on the Internet Explorer and then insert your smart card in order to logon to the ESCM website.
4. You are now ready to begin using the system.
5. You can click on Search key in order to see the status of an existing manifest or double click on a Waybill and when it opens click on the Transfer tab to see the status of each transaction that occurred to it. Refer to the codes on the last page as a reference.
6. When the truck driver arrives at the manufacturing facility and/or air cargo facility, he will have to present his smart card as well as biometrically login in order to transfer the shipment over to him or transfer it over to the air cargo facility.
7. If you consolidate your shipments follow the procedures for the manufacturer’s next.
8. If not, once the shipment reaches the air cargo facility it was assigned to, the driver will have to present his smart card and biometrically logon again in order to transfer the shipment over to the air cargo facility.

9. Once the shipment has reached its final destination, you will receive an electronic notification that the shipment has been transferred and the status of the corresponding Waybill # will change.

**Codes for Motor Carrier**

**Red/R**
A shipment has been created by a manufacturer and is ready to be picked up.

**Blue/P**
A shipment has been picked up by a truck driver from your company and is in transit.

**Grey/D**
The shipment has been delivered to the next destination (airlines or back to your facility for consolidation).

**Transfer Section of Manifest**

- C — Created
- M — Modified by the creator of the shipment
- R — Released to truck driver
- AM— Authorized Manufacturer made transfer
- P — Picked up by truck driver
- AR — Authorized Receiver received the shipment
- D — Delivered to the authorized receive

**Airline**

1. Turn on the computer.
2. You must biometrically login with your fingerprint in order to get on the machine.
3. Double Click on the Internet Explorer icon to open up the Internet, then you will be prompted to insert your smart card.
4. You are now ready to begin using the system.
5. Click on Search key in order to see the status of an existing manifest or click on a certain Waybill # and when the document opens up click on the Transfer tab to see the status of each transaction that occurred to the Waybill. Click on the Items tab in order to see what the shipment entails. Refer to the codes on the last page as a reference.

- or -

6. When the truck driver arrives, click on the Waybill # that corresponds to that company in order to transfer the shipment over to you.
7. Click on the Transfer button in order to transfer the shipment over to you, at this point you will have to biometrically verify yourself as well as insert your smart card.
8. The truck driver will then have to present his smart card and biometrically login to the system.
9. Upon verification in the system, a pop up screen will appear approving the transfer.
10. Click on the Close button in order to end this transaction.
11. An electronic notification will then be sent to the trucking company and manufacturer if applicable letting them know that the shipment was delivered.
12. You can then logout if desired.

**Codes for Air Cargo Screen**

**Blue/R**
A shipment has been created by a manufacturer and is ready to be picked up by the trucking company assigned to that Waybill.

**Red/P**
The shipment has been picked up by the trucking company and is in transit.

**Grey/D**
The shipment has been delivered to the air cargo facility that it was assigned to.

**Transfer Section of Manifest**

- **C** – Created
- **M** – Modified by the creator of the shipment
- **R** – Released to truck driver
- **AM** – Authorized Manufacturer made transfer
- **P** – Picked up by truck driver
- **AR** – Authorized Receiver received the shipment
- **D** – Delivered to the authorized receiver
Appendix D
Pre-Test Surveys

Manufacturer/Shipper

1. Description of your operation:
   a) What do you manufacture?
   b) Location of your key suppliers? Location of your main customers?
   c) What transport companies do you use to move your product to the customer?
   d) How many air cargo shipments do you ship per day/week/month? How do you define a shipment? What is your average shipment value?
   e) What % of your shipments is truckload vs. less-than-truckload quantities?

2. What percent of your outbound shipments use air transportation and why?

3. Do you currently have an automated bill of lading generation process? Yes or No. Please describe your system and/or process.

4. What type of computer system do you use for shipping (operating system, software, hardware, etc.)?

5. How do you communicate with your customers and your carriers? (e.g., how is the order placed?, what is the shipment status?, when was the product shipped? where is it now? what is the estimated time of arrival?)

6. What % of customer orders request shipment status/location information?
7. Briefly describe the shipment pick-up process.
   a) What are the primary activities undertaken to prepare the shipment?
   b) How long is the shipment ready before it is picked up?
   c) Is the pick-up a regularly scheduled stop?
   d) How long does it take to load the truck?

8. What security protocols do you have in place to ensure shipment security from pick-up to delivery at the air cargo operation?

9. Do you have any plans for investing in new technologies to facilitate your operation? Yes or No. If yes, what will you invest in? [NOTE: “New” is defined as a product that changes the way you do business; it does NOT include standard upgrades in software and/or hardware]

10. What general benefits do you believe might arise from this pilot test for project participants? and specifically, what do you feel will the benefits for your company?
Phase II Electronic Manifest
Participant Questionnaire

Motor Carrier | Response:

1. Description of your operation:
   a. What types of freight do you transport?
   b. Do you have fixed routes?
   c. How many pick-ups do you make per day?
   d. Where are your air cargo customers (manufacturers) participating in this test geographically located? What is the radius (in terms of miles) of your customer base?
   e. What airlines or air freight forwarders do you transport cargo to?

2. Do you currently have an automated process to handle bills of lading? Yes or No. Please describe your system or process.

3. What type of computer system do you use for fleet operations (operating system, software, hardware, etc.)?

4. Briefly describe the shipment pick-up (at manufacturer's site) and drop-off (air freight forwarder's site) processes. How long do they take? What do they involve?

5. How do you communicate with your customers (manufacturers and freight forwarders)? (e.g., what is the shipment status, when was the product shipped? where is it now? what is the estimated time of arrival?)

6. What % of customer shipments request freight status/location information?
7. Do you communicate with your drivers en-route? If yes, how? (telephone, fax, e-mail, radio, OBC, etc.)?

8. Do you have any plans for investing in new technologies to facilitate your operation? Yes or No. If yes, what will you invest in? [NOTE: “New” is defined as a product that changes the way you do business; it does NOT include standard upgrades in software and/or hardware]

9. What general benefits do you believe might arise from this pilot test for project participants? and specifically, what do you feel will the benefits for your company?
## Phase II Electronic Manifest
### Participant Questionnaire

### Airline/ Air Freight Forwarders

<table>
<thead>
<tr>
<th>RESPONSES:</th>
</tr>
</thead>
</table>

1. **Description of your operation:**
   - a. What % of the time do you use cargo vs. passenger planes for your freight shipments? If you use both, are there different processes between the two operations? Yes or No. If yes, please describe:
   - b. Locations of your major (participating) shippers and cargo recipients?
   - c. How many different trucking companies provide service to your Chicago facilities? who are they?
   - d. How many air cargo shipments do you ship per day/week/month? How do you define a shipment?

2. Do you currently have an automated air bill generation process? Yes or No. Please describe your system and/or process.

3. What type of computer system do you use for shipping (operating system, software, hardware, etc.)?

4. Describe the general shipment drop-off process at your facility. How long does it take? What does it involve?

5. How do you communicate with your customers (as defined above)? (e.g., what is the shipment status, when was the product shipped? Where is it now? What is the estimated time of arrival?)

6. What % of customer orders request shipment status/location information?

7. Briefly describe your security protocols & systems. Do you have any security protocols in place in addition to FAA requirements? Yes or No. If yes, please describe.
8. Do you have any plans for investing in new technologies to facilitate your operation? Yes or No. If yes, what will you invest in? [NOTE: “New” is defined as a product that changes the way you do business; it does NOT include standard upgrades in software and/or hardware]

9. What general benefits do you believe might arise from this pilot test for project participants? and specifically, what do you feel will the benefits for your company?
Appendix E
Interview Guide

Electronic Supply Chain Manifest:
Participant Perceptions – Interview Guide

Purpose of interview: to collect user perceptions about the ESCM, their experiences during participation in the operational test, and any comments or recommendations they may have regarding improvements in the system or test process.

Interviewee:
Date:

1. Describe overall deployment at your company. Were manifests handled simultaneously in both existing and test systems? If not, explain typical daily operation.

2. How many air cargo manifests/shipments does your company process (wk/mo/yr)?

3. How many manifests have you entered into the system? (Total? Last month? Last week? Try to determine if interest in the system waned after the training “wore off” or if over time it became second nature or more accepted) What are the primary reasons more weren’t entered (lack of time or staff, lack of satisfaction, system errors, etc.)?

4. Has your operations staff (or you) found the system easy to incorporate into the staff’s (your) daily routine? If not, what was their biggest complaint?

5. How much additional work (how is this measured? Man-hours?) Have they (you) had to undertake to participate in this test? (differentiate between extra time spent in training and extra time spent operationally).

6. Please describe the major differences between this system and your existing process (different steps, time to process, transfer of shipments, etc.).

7. Did the system adequately duplicate or improve your existing system or process? If yes, how? If not, why/how not?

8. Can you identify any specific examples that illustrate the success and/or failure of the system?
11. Were there any times you were aware of that the system did not function (server crashes, PC problems, Internet access issues, etc.)? If so, what was the problem? Generally how long did it take to have the problem resolved?

12. Did you track shipments by viewing manifests in the system? If yes, how often? If no, why not?

13. Do you feel the system has allowed for better or easier scheduling of shipments? Why? If it hasn’t made scheduling easier, what elements of the system can be changed to do so? If you had a new employee responsible for scheduling, would this system be easier to learn and master than your current system? Why or why not? (Note that this question will require the participant to hypothesize an answer given that they are operating dual systems. So the question should focus on comparing the two systems and hypothesizing about what would happen if we went to full deployment).

14. Do you feel the system has allowed (or could allow, if expanded) for better service to your customers? If yes, how? If no, why not?

15. Do you feel the system has been secure in protecting information? If yes, why? If no, why not? Is the system more or less secure than your current system? Why or why not?

16. Do you feel the system can save time/effort? If yes, why? If no, why not?

17. Do you feel the system can improve cargo security? If yes, how? If no, why not?

18. What were your expectations for the system at the beginning of your participation in the operational test?

19. Based on your participation in this operational test, has the system met your expectations? If yes, how? If no, why not?

20. Was the training adequate? Why or why not? Describe training received.

21. Was the technical support adequate? If not, why? Describe any instances where support was requested or provided.

22. Do you have any specific recommendations for how the system can be improved? If yes, what recommendations? If no, why not?