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Volume II

Architecture Survey Analysis by Organization

Final Report

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Report on the Deptartment of Defense Corporate Information Management Initiative

1. Program Description

Overview

The Department of Defense program for Corporate Information Management (CIM) provides the overall framework for management of Information Technology. CIM is under the authority of the Director of Defense Information who has responsibility for management of all DoD Information Systems. The Office of the Director of Defense Information (ODDI) maintains a staff that establishes overall policy and maintains oversight of the CIM-related programs. The implementing organization for CIM is the Defense Information Systems Agency Center for Information Management (DISA/CIM). (It has recently been announced that DISA/CIM will be merged with the Joint Interoperability and Engineering Organization (JIEO).) It remains to be determined how the functions now performed by DISA/CIM will be affected by the re-organization.

Relation to FAA Environment

The CIM initiative consists of a number of programs, many of which are administered through the DISA/CIM and the JIEO. These programs are described below:

- **Office of Technical Integration** - has responsibility for architecture definition and consulting support for integration planning.
- **Data Administration Program Management Office (PMO)** - has responsibility for data standardization and procedures, repositories and related training and consulting support.
- **Information Engineering Services PMO** - has responsibility for implementing Business Process Improvement (BPI) programs.
- **Software Systems Engineering Directorate** - has responsibility for implementing software process improvement and software re-engineering programs.
- **I-CASE support** - initiative for acquisition of a DoD standard computer-aided engineering environment (managed under Software Systems Engineering Directorate)
- **Software Reuse PMO** - has responsibility for promoting software reuse practices and technologies.
- **Infrastructure Engineering Directorate** - has responsibility for managing technology infrastructure implementation, including computing and communications.
- **Joint Interoperability Engineering Organization (JIEO)**- has responsibility for engineering support, especially development and testing of standards. (According to recent reports, the JIEO will acquire oversight for many of the current responsibilities of DISA/CIM.)

- **Information Technology Reuse Service (ITRUS)** - has responsibility for promoting acquisition and use of commercial technology within DoD.

Many of the objectives of CIM and the DoD programs that support these objectives have a close relationship with the FAA Corporate Information Environment (CIE). Figure 1 illustrates a high-level mapping between DISA/CIM programs and the CIE Framework Initiatives.

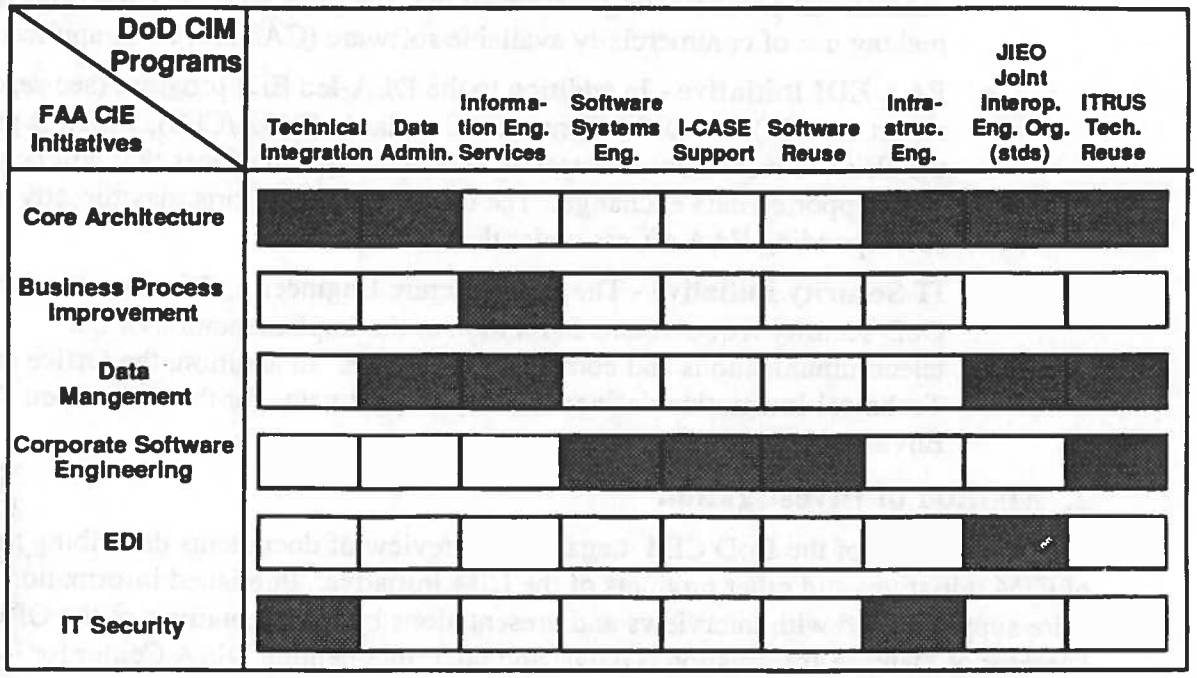

Figure 1. - Relationships between CIM Programs and CIE Initiatives

Because of the close relationship of CIM programs to the FAA initiatives, the discussion of CIM is more extensive than the reports on other programs in the Survey. Examples of these relationships include the following (see Figure 1):

- **FAA Core Architecture Initiative** - The CIM Office of Technical Integration has developed and applied architectural frameworks for the definition of Open Systems Environment (OSE) characteristics. The CIM Data Administration Program establishes standards and policies for data that overlap with the FAA Core Architecture responsibilities for standards implementation.
- **FAA Business Process Improvement Initiative** - The CIM Information Engineering Services PMO has developed and applied a standard methodology for BPI in DoD organizations. This responsibility is similar to the focus of the FAA BPI Initiative.
- **FAA Data Management Initiative** - The CIM Data Administration PMO has responsibility for the development standard data definitions and the implementation of a data repository similar to the objectives of the FAA Data Management Initiative. The Information Engineering Services PMO will also produce process and data models that are relevant to the creation of a data repository.

- **FAA Corporate Software Engineering Initiative** - CIM programs that are directly relevant to the FAA Corporate Software Engineering Initiative include the Software Systems Engineering Directorate, the Software Reuse PMO and the I-CASE program. The programs address areas related to FAA requirements for the implementation of standard software development methodologies, CASE tools, and Reuse. In addition, the DoD ITRUS program, which evaluates commercial products for government use, overlaps with the FAA objective of making use of commercially available software (CAS) for FAA applications.
- **FAA EDI Initiative** - In addition to the DLA-led EDI program (see separate report on EDI), the DISA Center for Standards (DISA/CFS), which is part of the JIEO, is responsible for testing standards and interfaces that will be used for EDI supported data exchange. The results of such efforts may directly impact corresponding FAA efforts under the EDI Initiative.
- **IT Security Initiative** - The Infrastructure Engineering Directorate addresses DoD security requirements in relation to the implementation of the telecommunications and computing platforms. In addition, the Office of Technical Integration defines security requirements for the DoD Open Systems Environment.

2. Method of Investigation

The examination of the DoD CIM began with a review of documents describing the status of CIM initiatives and other products of the CIM Initiative. Published information sources were supplemented with interviews and presentations by representatives of the Office of the Director of Defense Information (ODDI) and the implementing DISA Center for Information Management.

3. Relationship to CIE Initiatives

CIM Program Logic

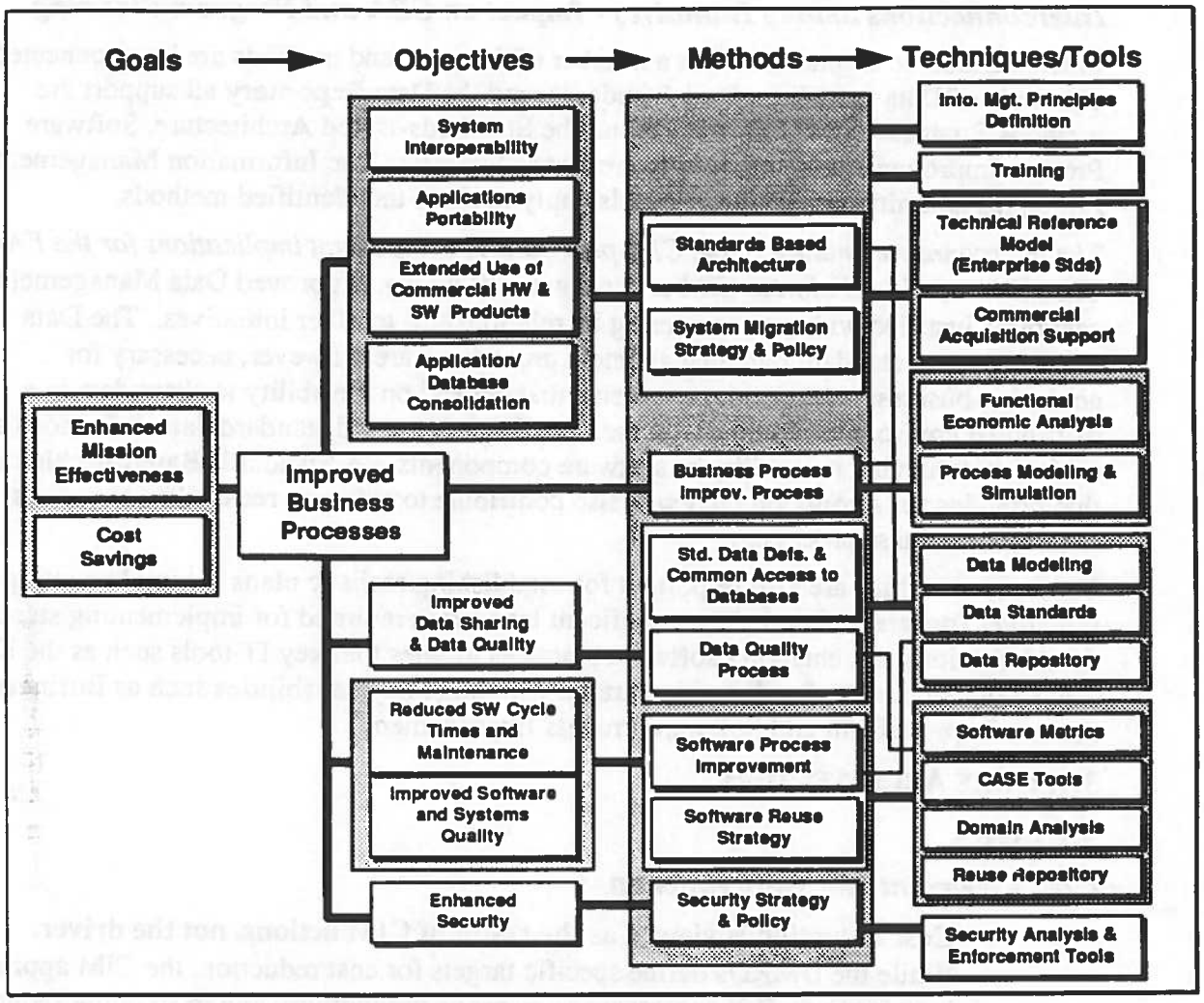

Figure 2. - CIM Tools and Techniques in relation to Objectives and Goals

Figure 3 illustrates key features of the CIM approach by showing the relationship between the CIM objectives and tools and the tools and techniques that will be applied to attain those goals. For example, in order to achieve objectives of reduced software development and maintenance cycle times and improve software quality, the CIM initiative applies methods of Software Process Improvement and Software Reuse. These, in turn, require the use of CASE Tools, Software Metrics, Domain Analysis, and a Reuse Repository. The tools are supplied by the CIM programs in Software Systems Engineering, I-CASE and Software Reuse. In a similar fashion, the Information Engineering Directorate provides the tools required for Business Process Improvement.

A fundamental feature of the CIM approach is the focus on improving business processes as a means to achieve cost reductions and enhanced mission capabilities. IT programs are ultimately justified on the basis of effects on business processes. All of the objectives that are related to IT, such as interoperability, data sharing, and reduced cycle times are support

improvements in business functions. IT programs can then be structured to achieve the key objectives the improved business processes require.

Interconnections among Initiatives - Impact on CBA and Program Planning

In should also be emphasized that a number of the tools and methods are interconnected. The tools of Data modeling, Data Standards, and the Data Repository all support the methods Business Process Improvement, the Standards-Based Architecture, Software Process Improvement, and the Software Reuse Strategy. The Information Management Principles Definition and Training tools apply to all of the identified methods.

The interconnected nature of the CIM programs has important implications for the FAA CIE initiatives in relation to CBA and program planning. Improved Data Management cannot be justified without considering its relationships to other initiatives. The Data Repository and standard data management procedures are, however, necessary for achieving business process improvements that depend on the ability to share data in a distributed environment. Similarly, the Data Repository and standard data definitions are critical to achieving reusability of software components. A Standards Based Architecture that provides for a common GUI will also contribute to software reusability as well as improved business processes.

These relationships are also important for establishing realistic plans for implementing the initiatives (program plans). The significant lead times required for implementing standard data definitions and changing software practices implies that key IT tools such as the Data Repository should be developed in parallel with other key capabilities such as Business Process Improvement and Software Process Improvement.

3.1. CORE ARCHITECTURE

3.1.1 CBA

CIM Viewpoint on Cost-Reduction

- **Cost reduction is viewed as the result of CIM actions, not the driver.** While the DMRDs define specific targets for cost reduction, the CIM approach is to focus on BPI as a means to improve productivity and in so doing reduce budget requirements. The key is to meet timing targets for implementing structural changes in the way that information is accessed and used to support the DoD mission.

EDI and GUI Opportunities

- The major short-term opportunities for cost savings and productivity improvements are changing business processes to take advantage of EDI and the implementation of a common graphical user interface (GUI). DISA/CIM estimates that 30% productivity improvements can be gained from the replacement of traditional command based user interfaces with a common, i.e. uniform GUI. Role of a Standards-based Technical Reference Model (TRM)

Benefits of Implementing an standards-based Open Systems Environment (OSE)

The DoD Standards-Based Architecture process for defining the OSE results in a Technical Reference Model. This model contains specifications for standards and interfaces that

enable industry to build applications for DoD-wide use. Products based on DoD and industry standards can spread the cost of development and maintenance over a much larger base than proprietary products. The reduced cost of open systems products is a powerful motivation for FAA adoption of DoD and industry standards.

3.1.2. Lessons Learned

Unified Management of Information Systems

> ***Key Lesson Learned: The example established by the CIM initiative is to coordinate all information management under a single responsible organization.***

With the appointment of a Director of Defense Information, the DoD put the management of all information systems--administrative systems and weapons-related (mission critical) systems unser one authority (see Figure 3). The CIM Initiative represents a unified strategy for all DoD information and supporting technologies. Finally, the DoD established DISA and the Center for Information Management to support the implementation of the strategy. If the FAA is to follow the DoD example, the FAA Chief Information Officer would have overall responsibility for all FAA information systems. The CIO becomes the advocate for a management strategy for NAS and non-NAS systems and for the establishment of organization and technical support for implementing the strategy. The definition of the CIE initiatives is a first step in establishing the required strategic framework.

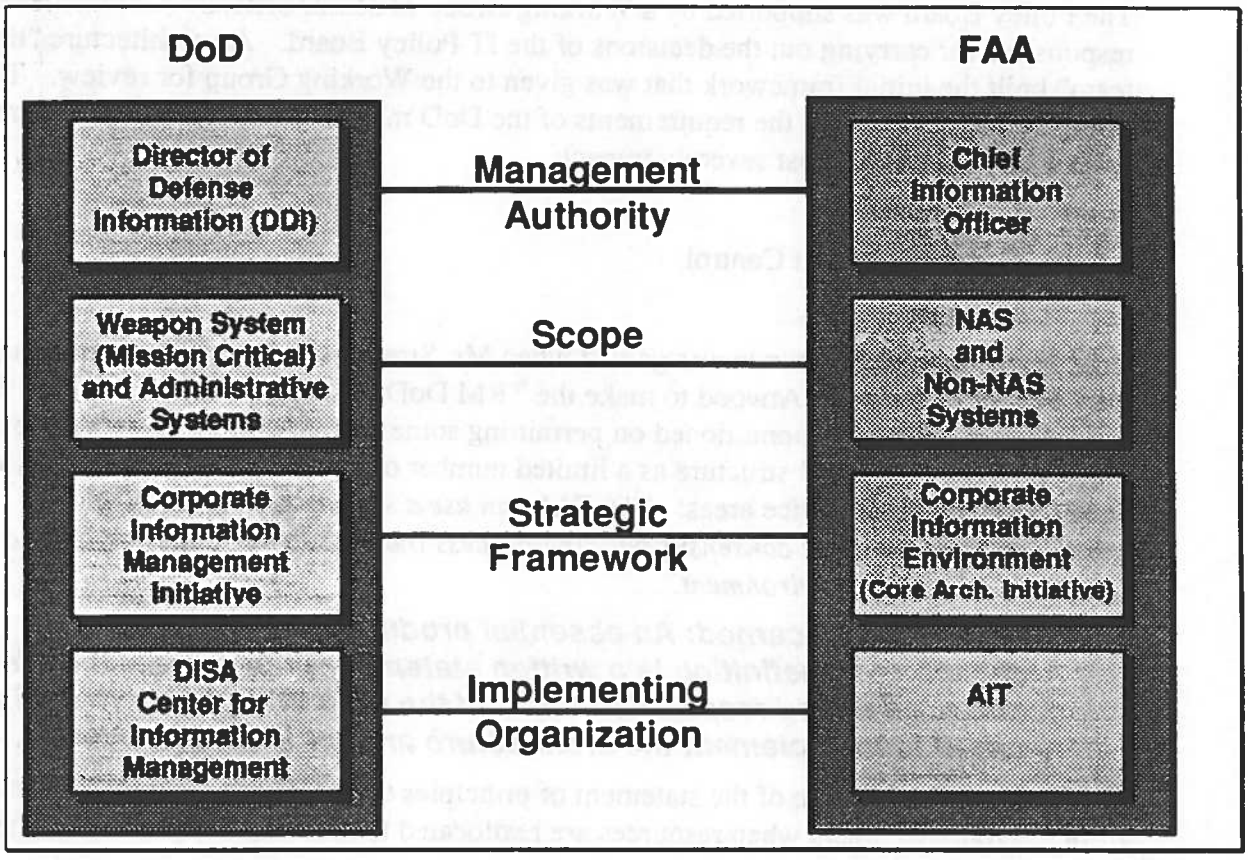

Figure 3. - Correspondence between DoD and FAA IT Management Structures

Consensus Building Process

Key Lessons Learned:

- ***Use the Technical Reference Model (TRM) as a means to build consensus among the functional managers on architectural requirements.***
- ***Involve the functional decision makers early in the process.***
- ***Top-management commitment is required for gaining consensus on enterprise-wide requirements.***

The existence of many stovepiped systems that obstruct interoperability has been widely recognized within the DoD. The DDI, Mr. Paul Strassman, understood the need to change a DoD culture that gave too much weight to autonomy over interoperability. A starting assumption for CIM was that a single architecture was better than many. The definition of a DoD-wide architecture could be used as a vehicle for building consensus around an improved view of the relationships between information systems and the organizations and business processes supported.

In order to break down the local spans of control that would obstruct the evolution toward an interoperable open-systems environment, OSD established an Information Technology Policy Board consisting of decision makers from the services (Three-Star level). These functional managers were made responsible for arriving at a consensus on the architecture. The Policy Board was supported by a Working Group of senior officials (Colonel level), responsible for carrying out the decisions of the IT Policy Board. An architecture "tiger team" built the initial framework that was given to the Working Group for review. The resulting TRM addressed the requirements of the DoD mission and focused on the three areas that CIM would most severely impact:

- Intelligence
- Command and Control
- Logistics.

A large degree of concurrence was gained when Mr. Strassman obtained authorization from Deputy Sec. of Defense Atwood to make the TRM DoD-wide policy in a thirty-day time frame. Agreement was conditioned on permitting some variation in the interpretation of the DoD reference model structure as a limited number of specific reference models were defined for different service areas. *The FAA can use a similar process to involve functional managers in a consensus building process that results in the definition of a TRM for an Open Systems Environment. .*

Key Lesson Learned: An essential product of the process of Architecture Definition is a written statement of principles that define goals, roles and responsibilities and the criteria that govern decisions required to implement the architecture and other IRM objectives.

For the DoD, the purpose of the statement of principles is counter the inevitable resistance from program managers when resources are reallocated to meet CIM objectives. The FAA

may this technique of value in the process of aligning FAA functional organizations with CIE objectives and implementation plans.

The principles for the CIM Initiative include the following:

- Information will be managed through centralized control and decentralized execution.
- Simplification by elimination and integration is to be preferred to automation whether developing new or enhancing existing information systems.
- Proposed and existing business methods will be subject routinely to cost-benefit analysis which includes benchmarking against the best public and private sector achievement.
- New business methods shall be proven or validated before implementation.
- Information systems performing the same function must be common unless specific analysis determines they should be unique.
- Functional management shall be held accountable for all benefits and all directly controllable costs of developing and operating their information systems.
- Information systems shall be developed and enhanced according to a Department-wide methodology and accomplished in a compressed time-frame in order to minimize the cost of development and achieve early realization of benefits.
- Information systems shall be developed and enhanced in the context of process models that document business methods.
- The computing and communications infrastructure shall be transparent to the information systems that rely upon it.
- Common definitions and standards shall exist DoD-wide.
- Data must be entered only once.
- The presentation between the user and system shall be friendly and consistent.

Overall Structure of Corporate Architecture

The DoD architectural concept is similar to the proposed structure for the FAA Corporate Architecture. It addresses "systems" architecture requirements in relation to:

- Data Architecture - addresses the requirements for standard data and shared databases
- Application Software Architecture - addresses requirements for mission-specific applications
- Technical Architecture - addresses requirements for generic supporting applications, computing platforms, and communications networks.

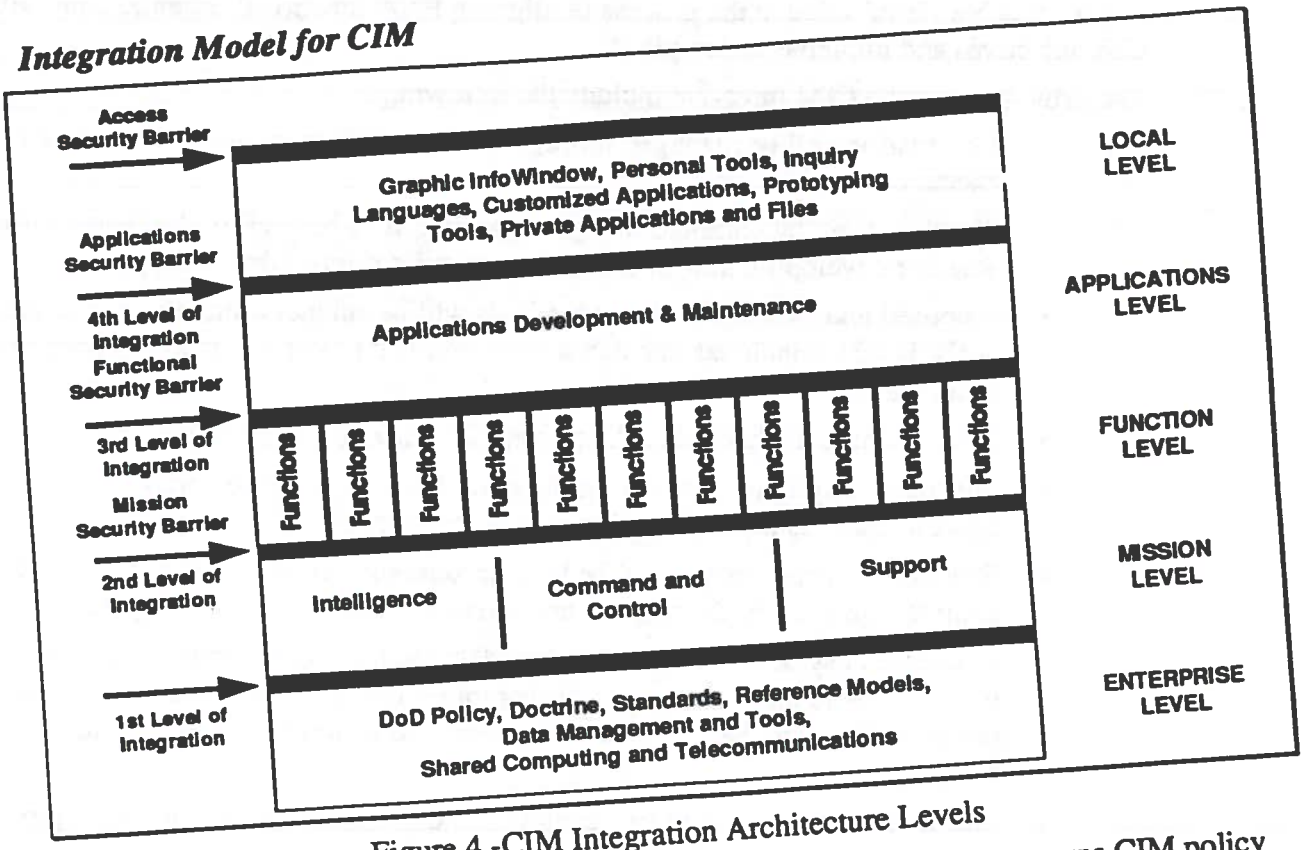

Figure 4 -CIM Integration Architecture Levels

The above diagram (Figure 4) illustrates the model of integration that governs CIM policy development. The five levels are described as follows:

Enterprise Level - provides the framework for policy, methodology, standards and technology within which all functional organizations must fit. It will provide the tools for analysis and decision making and the communications and computing backbone for DoD information technology.

Mission Level - addresses the requirements of the DoD mission in relation to required capabilities, readiness and security for war plans and execution. All decisions at the Enterprise level are evaluated in relation to mission requirements.

Function Level - defines the business processes that satisfy mission requirements. **Ideally, such processes should be defined without regard to organizational boundaries.**

Applications Level - contains the manual and automated processes that support the business processes. Integration at the application layer involves the identification of shared data resources that are required for carrying out the business processes.

Local Level - provides the tools that enable the use to access applications and data, including customization of processes to meet user requirements.

The major focus for the Office of the Secretary of Defense (OSD) is the Enterprise Level. The OSD Enterprise Level requirements are embodied in the CIM initiative. The Enterprise Level policies define constraints on the operation of the lower levels, including integration criteria and security requirements. The goal is to establish a managerial framework that permits the highest level of local authority within the boundaries of conforming to the Mission and Enterprise Level requirements. A key part of the managerial framework is the TRM that establishes the interface between applications and the enterprise-wide technologies.

Development of Implementable Technical Architecture

> ***Key Lesson Learned: The process used to define the architecture should address the needs of non-technical functional managers to establish and implement individual IT plans that meet the requirements of the enterprise-wide IT architecture.***

The CIM process for defining architectural requirements follows the Standards Based Architecture (SBA) methodology promoted by the DMR Group, Inc. This approach was used by the Marine Corps, the DoD service organization that will continue as a testbed for the technical architecture methodology. It has also been applied to the OSD Office Automation (OA) Architecture.

The Technical Architecture development begins from the initial definition of the TRM. The DMR methodology defines a process by which non-technical functional managers can arrive at a plan to implement the OSE in a way that meets the mission requirements.[1] The process of defining the architecture will produce a TRM that defines the requirements for applications to operate in a specified Open Systems Environment. In so doing, the Technical Reference Model will meet the fundamental requirements for applications interoperability, portability, and scalability.

The process begins with a statement of principles that defines how the organization will use Information Technology in the long-term. The major guideline is that the *"principles belong to the functional user, not the technologist."* An example of an architectural principle defined for the OSD (OA) Architecture is the following:

> *We will implement technology components based on the DoD Technical Reference Model where those components satisfy the following criteria: Functional Requirement, Cost Benefit, Technical Feasibility and Schedule.*

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[1]For a detailed discussion of the Standards-Based Architecture methodology, see DMR Group, Inc., *Standards-Based Architecture Planning Handbook*, Draft Version 1.0, U.S. Department of Defense, 6 March 1992.

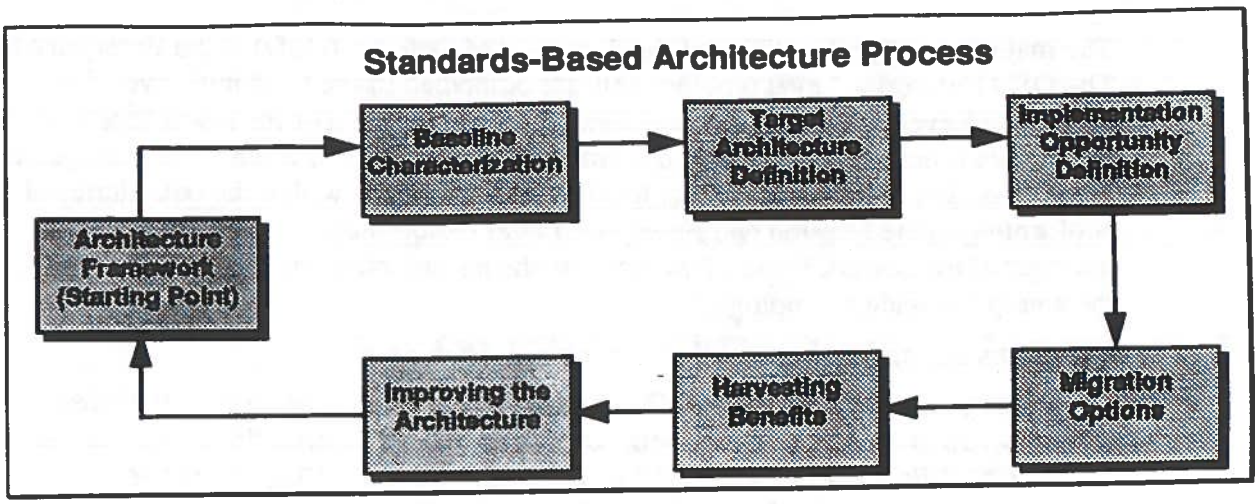

Figure 5 -CIM Standards-Based Architecture Process

Lessons Learned on Process

Guidelines for each of these steps in the Standards-Based Architecture (SBA) Process are described below:

- Architecture Framework - Defines vision.
  - The Architecture Committee authorized to approve the vision should consist of key stakeholders,
  - Users are more important than technical experts.
- Baseline Characterization - Provides high-level inventory of application, platforms and standards
  - Be satisfied with a high-level definition of the baseline.
  - **Avoid massive inventory effort because the baseline changes more rapidly than a detailed assessment would warrant.** Note: This guideline conflicts with the current ACT-600 baseline inventory effort.
- Target Architecture Definition - Profiles new technology environment and highlights key opportunities to improve on baseline
  - Show how to implement the Technical Reference Model
  - Assume co-existence of legacy and target systems.
- Implementation Opportunity Definition - Identifies opportunities derived from Target Architecture
  - Focus on "fast-path" approach
  - Prioritize projects with Functional Economic Analysis (FEA)
- Migration Options - Selects from among opportunities.
  - Screen out high-risk and high-cost projects
- Harvesting Benefits - Develops detailed implementation plans.
  - Focus on short term projects (to be completed within sponsor's tenure)

- Improving the Architecture - Define continuous process for upgrading architecture (TQM for architecture)

Product Testing

Key Lesson Learned: The FAA will need a means for evaluating and testing open systems products for conformance to standards and other performance requirements.

Testing functions for the CIM Initiative are performed by the DoD Joint Interoperability Test Center (at White Sands, New Mexico). Fee-for-service revenues from the testing process support the operation of the Center. The requirements for testing products for conformance to standards is a cost that is often overlooked in planning for open systems implementations.

Migration Strategy to Government Open Systems Interconnection Profile (GOSIP)

While the GOSIP standard for communications interfaces is assumed to be the target standard for the DoD Open Systems Environment, TCP/IP is likely to become an intermediate standard for OSE that supports an open Unix environment while OSI capabilities are implemented. TCP/IP may be incorporated within GOSIP as an explicit transition strategy.

3.1.3. Technology Transfer/Procurement Vehicles

POSIX 1000.3 Standard / Application Profiling Process

The POSIX Standard (Portable Operating System Interface for Computer Environments) for a Unix OSE has been adopted as an American National Standard (ANSI). It provides the basis for the CIM Technical Reference Model. A key component of the National Institute for Standards and Technology (NIST) POSIX 1003.0 standard approach (see FIPS PUB 151-1) is to define Application Program Profiles (APP) that permit vendors to build applications consistent with the physical architecture requirements.

DoD CIM Architecture Framework

The DDI is publishing products of their architecture effort that are likely to be useful to the FAA. The Technical Architecture Framework for Information Management (TAFIM) consists of five volumes:

- **Implementation Concept** - Describes the overall approach to the definition and implementation of requirements for an OSE
- **Architecture Guidance and Design Concepts** - Provides guidance for development of the DoD technical architecture
- **Reference Model and Standards Profile** - Defines the information services including communications that the architecture will provide and the requirements for interfacing applications and legacy systems with the architecture
- **Support Plan** - provides guidance on the use of commercial products (via the ITRUS program) and reusable software components (via the Software Reuse program)

- **Implementation Manual** - helps developers apply the architecture and how to tailor the architecture to meet requirements of the functional communities

The CIM TRM can be a foundation for a TRM for the FAA. It conforms to the framework defined by NIST that for a federal Open Systems Environment.

Resources Supporting the DISA/CIM Architectural Approach

The documents produced by DMR that define the CIM architecture process have been licensed for DoD use. Negotiations are underway to make the methodology available for government-wide use. The documents are available through DTIC.

Title	DTIC Accession Number
• Stage One - Open Systems Status Report	B163950L
• Stage Two - The Experience with Open Systems	B163976L
• Stage Three - The Marketplace	B163909L
• **Stage Four - Standards-Based Architectures**	**B163891L**

The "Stage Four" document was used in DISA/CIM architecture (SBA) planning and is highly recommended by CIM.

Graphical User Interface

An improved user interface to automated systems has been recognized as a key source of increased productivity. CIM has defined an initial set of requirements for a common GUI in the DISA/CIM *Human Interface Style Guide*, Version 2.0. Sept. 30, 1992. It addresses operational requirements for "windows"; object-oriented metaphors and requirements for interactions with systems users, help support, and the role of function keys. Some organizations within DoD, such as the Navy have developed more specific requirements that mandate, for example, where particular classes of information should be placed on the user's screen.

Consulting Services

The DISA/CIM Office of Technical Integration, Mr. Michael Mestrovich, director, is working with civilian agencies, such as the Department of Veterans Affairs (VA), to assist with development of technical architectures. The office has special expertise in the areas of integrated support for personnel, finance, logistics, medical and acquisition systems.

- **Defense Technical Integrated Services acquisition (DTIS)** - The DTIS procurement, estimated at $830 Million over seven years, will provide for technical integration consulting services. It is possible that services can be provided to other federal agencies on a fee-for-service basis. A formal RFP is expected to be released in summer, 1993.

Support for Acquisition of Commercial Products (DoD ITRUS Program)

The DoD ITRUS Program provides a model for the Core Architecture Initiative support for Functional Technology Services. It supports the assessment of COTS for the DoD infrastructure and coordinates COTS acquisitions with the requirements of the DoD Software Reuse Program.

Use of DIS/CIM SETA SOW for Contract Requirements

The DoD has issued a Statement of Work for a Systems Engineering and Technical Assistance Support (SETA) contract for the DISA/CIM Center for Information Management. The SOW contains requirements, test problems, and contract language that may be useful for a corresponding FAA support needs. Such language would be relevant to other initiatives as well, including BPI, Data Management, and Corporate Software Engineering.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA

Key Lesson Learned: The major impact of CIM will be on productivity improvements that result from changes in the conduct of DoD business, not from savings on IT expenditures.

The DMRDs define mandated targets for savings. Of the $71B that the DMRDs target for productivity improvements, the CIM Initiative estimates that $36B can be facilitated by IT. Of this only $6.9B will be saved due to direct savings in IT.

Supply-related Savings

The largest area of potential savings identified by CIM is for reduced supply costs. $17.3B out of a total of a total of $36B can be saved as a result of streamlined processes that eliminate transactions and reduce transaction costs due to use of EDI. The consequence will be consolidation of depots improved delivery of supplies.

Personnel and Resources Allocations for DISA/CIM

The following chart (Figure 6) shows the distribution of personnel within the DISA Center for Information Management.

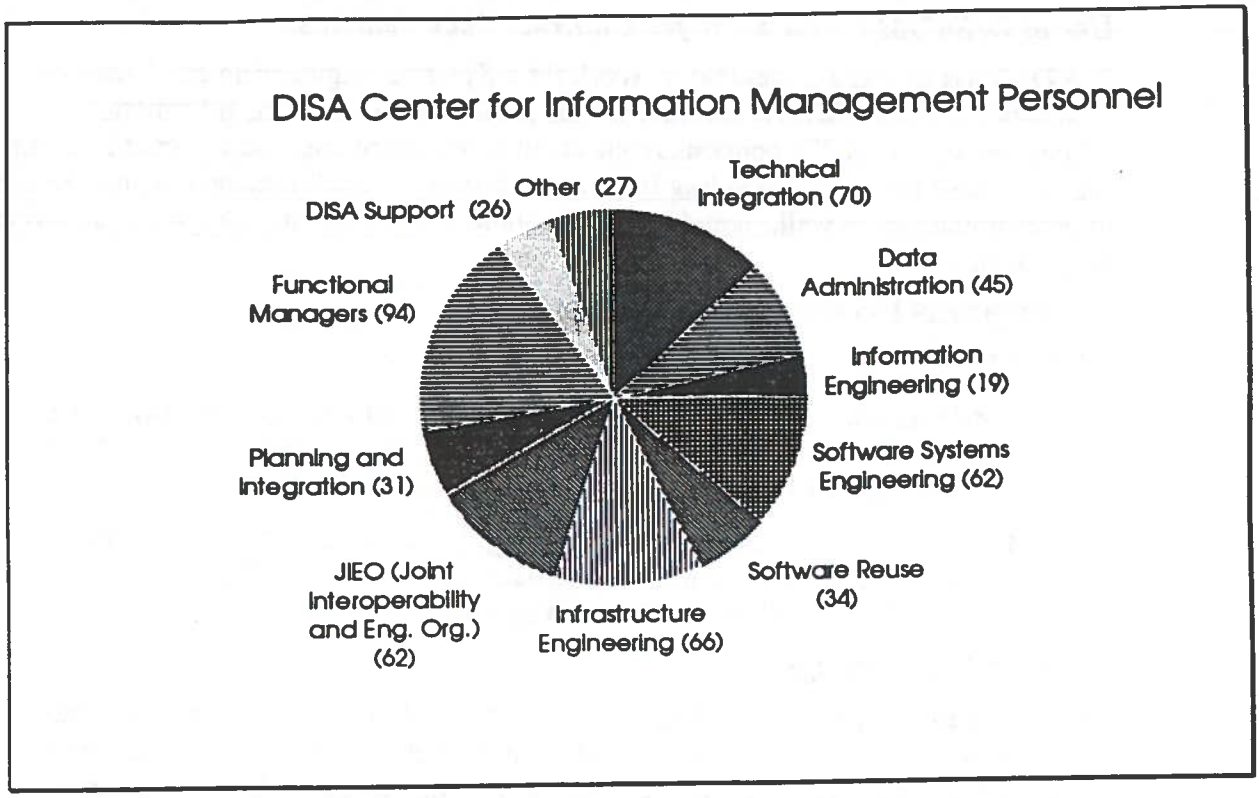

Figure 6. - DISA Center for Information Management - Personnel Distribution

Cost of BPI Analysis

DISA/CIM estimates that the cost of internal analysis is $4-5K per week versus $17 per week for outside consulting support. Completion of an FEA can require 3-6 months per functional area.

Other Examples of BPI Benefits

The Medical Logistics Group has already achieved enough savings to pay for the CIM Initiative. The implementation of just-in-time delivery for drugs has reduced the required surcharge from 19% to 4%.

3.2.2. Lessons Learned

Vision for IT and BPI

Key Lesson Learned: Market the vision defined by the CIE principles to the functional managers as early in the program as possible.

One of the requirements of the Core Architecture initiative is to generate a commonly accepted vision for IT within the FAA. To establish the vision as an active process, a primary role of the ODDI and the deputy director for BPI is to market the vision for BPI to the functional managers within DoD. Involving the functional managers in BPI is the purpose of the various workshops on the FEA process being carried out by the CIM Initiative. **The FAA should initiate this type of marketing and education process, as soon as possible.**

In the view of the CIM BPI managers, a successful plan for carrying out BPI must be based on two premises:

1) The functional community has to lead

2) Top down support is required from beginning.

Carrying out the CIM goals will require a huge cultural change within DoD. CIM needed to encourage, and sometimes, force the functional managers to abandon individual prerogatives and cooperate in the process. Consistent application of BPI would address the problem of legacy systems and data by building a consensus around migration paths towards technology support for value-adding business processes.

Key Requirements for Implementing BPI

- **Commitment - Obtain top-down, visible commitment to implement BPI.** BPI was premised on commitment to the process by the highest administrative authorities in the DoD, including the Secretary of Defense, the Dep. Secretary of Defense for Information Systems, the Director of Defense Information, and the Comptroller. The commitment was supported by means of key reports and Defense Management Review Decisions. These included:
  - Command and Control Functional Analysis and Consolidation Review Panel Report (FACRP)
  - The Executive Level Group (ELG) Report
  - DMRDs defining roles for CIM, DISA and mandated cost reductions
- **Principles and Policies - Establish principles that embody key directions for BPI and IT policy.** The ELG, and later, the Information Technology Policy Board established objectives and principles to guide the CIM Initiative. BPI is at the center of the information management strategy. These principles were amplified in policies contained in the 8000 series directives.
- **Methodology - Use an existing methodology that is simple enough to be applied by functional managers.** A key requirement for implementing BPI is to develop a BPI methodology and adopt it as a standard approach. DoD CIM has developed a methodology, based on standard industry approaches, that both meets CIM process improvement requirements and also is simple enough for execution by typical functional managers. The methodology for FEA includes activity based costing (ABC) and TQM principles. In order to contain costs, CIM uses techniques and tools, such as IDEF modeling, that are available from industry and government sources.

  The CIM Initiative created guidebooks to simplify the BPI process and to define a common set of modeling techniques. One consequence of the standard methodology is that CIM Initiative can train DoD functional managers to carry out BPI analytical processes (FEA) and thus reduce the dependence on consultants. DISA/CIM estimates that the cost of internal analysis is about one-fourth the cost of outside consulting support.

  It is important to adopt a methodology as quickly as possible that can be made standard throughout the organization. This makes it possible to standardize training

across functional units and to be able to evaluate and compare the results of different FEAs. The utility of the initial FEAs carried out by the CIM Initiative has been compromised by the variances in the methods by which they were carried out.

Key Lesson Learned: Definition of information systems requirements should not take place before process changes are defined and carried out.

The approach followed by DoD CIM for BPI assumes that information systems requirements will be defined following analysis of the business processes they support.

The steps followed by CIM for BPI are:

1. Establish Process and Data Baselines
2. Establish Information System Baseline
3. Perform Activity Modeling
4. Perform Data Modeling
5. Select Improvement Alternatives
6. Prepare FEA
7. Prepare Data Management Plan
8. Prepare Technical Management Plan
9. Execute Approved Process Changes
10. Define Requirements for Information Systems

- **Techniques - Make BPI techniques accessible to the entire organization.**

Standard techniques adopted by the BPI program include:

- TQM
- Benchmarking
- IDEF0 and IDEF 1X
- Activity Based Costing (ABC)
- Economic Analysis (defined in Functional Economic Analysis Guidebook)
- Stochastic and deterministic process simulation
- Color Petri Net Analysis
- Best business practice identification

- **Technologies - Automated tools to support BPI techniques should be adopted as standard for the organization and integrated into the BPI process.**

CIM is exploring a number of technologies that can support BPI analysis (see Technology Transfer section below.) Automated tools can be used to standardized the process and resulting data which can then be entered into a repository for process, data, and performance modeling.

- **Metrics and Rewards**

Key Lesson Learned: Defining and monitoring metrics is required to implement the BPI process and business process changes.

CIM is defining metrics that can track the progress of the BPI program in effecting desired changes in the conduct of DoD business. The metrics focus on:

- Time required for business process execution and time reductions
- Quality standards
- Cost savings

Key Lesson Learned: Success in BPI depends on a satisfactory incentive system for functional managers. CIM has not defined a set of rewards for functional managers that will motivate radical changes in business processes.

The BPI program recognizes the importance establishing incentives for BPI. Those identified include implementing changes that will able the organization to

- Remain competitive
- Optimize scarce resources
- consolidate wisely
- Improve quality
- Empower the workforce
- Leverage technology to improve business
- Create conditions for individual creativity.

It is not clear that such goals, worthy as they are, will be sufficient to motivate functional managers who may be required to substantially reduce personnel and other resources in the course of implementing business process changes.

- **Training - Establish training programs early to standardize the analysis process and develop in-house resources.**

It should be noted that the emphasis is on training experts in modeling and analysis required for BPI planning . There has been less attention to the requirements for implementation business process changes in relation to functional and organizational requirements.

Contrast between SBA Methodology and CIM BPI Methodology

Key Lesson Learned: The FAA needs to evaluate SBA versus BPI approaches used by CIM to define IT requirements.

Without advertising the fact, the CIM Initiative has employed two distinct methodologies for defining IT requirements that satisfy the business requirements of the organization. One approach, Standards Based Architecture (SBA), developed by DMR, Inc. has been applied by the Architecture effort of the ODDI Information Technology Directorate and the DISA/CIM Technical Integration Directorate (see above under Core Architecture). The other approach, based on FEA is the basis for Functional Process Improvement, that has been applied by the ODDI BPI Directorate, and the DISA/CIM Information Engineering Directorate. The second approach (BPI) requires a higher degree of expertise in economic modeling to arrive at required changes in the business processes. The IT requirements are a secondary product of the modeling effort. The first approach emphasizes the role of the non-technical managers in arriving at the process and information requirements of the organization.

The approach used to carry out BPI will an important factor in gaining the support of FAA functional managers for CIE objectives. It will, therefore be important for the FAA to evaluate alternative methodologies with respect to risks and effectiveness in meeting its own organizational and technical requirements.

Implementation Risk

Key Lesson Learned: CIM has not addressed obstacles to implementing BPI recommendations for process change.

The cost reductions anticipated from BPI are typically derived from elimination of formerly required activities and associated reductions of personnel. Potential resistance from existing organizations presents a significant risk to realizing CIM benefits. The CIM Initiative has not explicitly addressed requirements for organizational change. Addressing human resource requirements and "change management" was noted by the GAO (in interviews) as one of the key requirements for IRM success.

3.2.3. Technology Transfer/Procurement Vehicles

Enterprise Model

The DoD CIM Enterprise Model (EM) is viewed as a foundation for business process improvement (BPI) as well as establishing a framework for enterprise-wide data management. For BPI the EM defines the core processes that are required to meet the mission of the enterprise. For Data Management, the model is required for the definition of enterprise-wide data-naming conventions including class names and prime words.

Repository for Process Modeling

The CIM Initiative is building an IDEF repository to support reuse of process definitions. The IDEF models will support a 3-schema approach. *GM is also sponsoring the development of a model for a repository under a 3-schema concept.* A key requirement for the government is to define data needs and structures and build a repository for the models. The program has explored the use of Index Technology's Excelerator and Oracle for the repository DBMS. The repository data will be available on CD-ROM.

Use of IDEF Modeling to Link Software Objects to BPI

One of the goals of the DoD BPI program is to incorporate identification of objects that are critical to the business into the BPI modeling process. Future versions of IDEF modeling will address some of these requirements. The CIM Initiative intends to prototype the use of extended IDEF tools to model objects in relation to business processes.

IDEF Standards

NIST is publishing a standard for IDEF modeling as a FIPS PUB. The CIM Initiative is planning to establish standards for process and data modeling (founded on IDEF) and a repository of process and data models. One of the obvious applications is to create standard processes and standard data structures for commonly performed processes. This resource will support the consolidation of multiple information systems that perform similar functions (e.g. payroll, human resource management). *The FAA should examine the use of such a repository for its own process modeling.*

Information on Techniques and Technologies to Support BPI

The CIM Initiative is publishing guidebooks that discuss techniques and technologies that can be used to support an FAA implementation of a BPI process. Subjects areas to be addressed include:

- Business Process Improvement Methodology
- Functional Economic Analysis (FEA)
- Integration
- Repository
- Functional Process Simulation (published 1 January 1993)
- Groupware.

Documents on BPI include:

- *Corporate Information Management: Process Improvement Methodology for DoD Functional Managers,* D. Appleton Company, Inc., 1992.
- DoD Corporate Information Management, *Functional Economic Analysis Guidebook,* version 1.0, 15 January 1993.
- DoD OASD, C^3I, DoD 8020.1-M (Draft) *Functional Process Improvement,* August 1992.
- DoD Director of Defense Information, *CIM Business Process Improvement Workshop: ABC Foundation, Final Report, Defense Investigative Service,* 26 May to 3 July 1992.

BPI Tools

DISA/CIM is supporting the acquisition and/or development of a number of automated tools to support BPI analysis. The tools will provide inputs to the FEAs and assess the anticipated and realized effects of process change. They include support for:

- Group decision-making (e.g. groupware)
- IDEF process and data modeling
- Activity-based costing
- Process simulation
- Performance analysis
- Prototyping

Navy Groupware Implementation

In Feb. 1993, the Navy inaugurated the first DoD center to support BPI. The Groupware Center for Functional Process Improvement, at the Washington Navy Yard, combines technologies for group decision making and automated support for process modeling and simulation. The electronic meeting software (EMS) used is Group Systems V from Ventana Corp. (Tucson, AZ). The use of the EMS is supported by a Center facilitator, who

edits inputs to the system to avoid duplication of ideas. The results of the group sessions are entered into an IDEF modeling tool. The IDEF tools available include:

- Design/IDEF - Meta Software (Cambridge, Ma.)
- IDEFine - Wizdom Systems, Inc. (Napierville, Il.)
- IDEF Solutions - Structured Solutions (Vienna, Va.)

Contact: Rear Adm. Robert Moore, Cmdr. Naval Information Systems Management Command

3.3. DATA MANAGEMENT

3.3.1 CBA

DISA/CIM is developing a business case (FEA) for Data Administration. The results, however, will not be available until October 1993. Among the benefits that will be examined in the FEA are:

- reduced numbers of data elements
- improved data (in relation to business process requirements)
- easier maintenance.

Note: The Gartner Group has performed a study of 18 companies that demonstrates a 90% potential reduction in the number of data elements using data administration procedures. The study also found a 33% reduction in DBA efforts, a 33% reduction in DASD requirements and a 20% reduction in systems maintenance.

3.3.2 Lessons Learned

Data Management Policy and Organization

Key Lesson Learned: Achieving consistent data definitions and shared data requires an oversight organization with the authority to define and implement data management policies and procedures on an enterprise-wide basis.

The creation of a DoD data management infrastructure was initiated with the publication of the DoD Data Administration Policy (DoD Directive 8320.1, first issued 26 Sept. 1991). The Army had been appointed Executive Agent for DoD data management. The Executive Agent responsibilities were transferred to the DISA DISA/CIM).

The DoD organizational infrastructure created to carry out the policy includes a DoD Data Administrator and Functional Data Administrators who will oversee processes of data standardization within the DoD functional area. The Component Data Administrators will perform these functions within the Services and Defense Agencies. The Data Administration functions are managed by the Data Administration Council and supported by the Center for Data Administration Operations. The DoD Data Administrator is the Director of DISA/CIM, Denis Brown.

DoD actions in data management are guided by the Data Administration Strategic Plan (DISA/CIM 14 July 1992). This strategy is an evolution of the initial Data Administration Implementation Plan developed by the Army-led task force on data administration.

Scope of CIM Data Management Policy

Data management policy applies to all DoD data except for data elements and data content unique to cryptologic activities. This includes embedded, command and control and administrative systems. *The corresponding scope in the FAA would therefore apply to "real-time" NAS as well as administrative systems.*

Identified data management functions include:

- data planning
- analysis
- standards
- modeling
- configuration management
- storage
- retrieval
- protection
- validation
- documentation (for DM policies, procedures, and operations)

Data Management Principles

Key Lesson Learned: Need commonly agreed to principles for Data Management which are consistent with the governing Information Management principles.

The principles for DoD data management are derived from the general statement of CIM principles produced by the CIM Executive Level Group. The clear statement of principles is required to reduce the risk that individual functional managers may resist processes that define common data and eventual consolidation of databases.

The principles that have been defined by the CIM program can apply the global data management in any large organization with defined missions. They can form a set of core requirements for FAA data management.

Characteristics of the future vision for DoD Data Management include the following:

- Clearly defined responsibilities and accountabilities
- Major policies for control of the definition, standardization, organization and structure of data
- Issuance of data-definitions as Government Furnished Material (GFM)
- Creation and maintenance of data models and for all functional subject areas
- Standard data elements derived from data models
- Independence of data definitions standards and structures from supporting information technologies and specific applications
- Life cycle management of data to improve business processes
- Centralized control and decentralized execution of data management functions
- Easy access to data by functional managers regardless of physical location
- Strategic planning for data based on DoD mission requirements
- Collection of data only once, as a by-product of normal business operations
- Storage of data in shared, non-redundant databases

- Pursuit of agreements for EDI with other agencies, suppliers, and contractors
- Centralized control of database backup and archival functions in accord with records management policies
- Storage and distribution of image data in compressed format

An important lesson is that the process of defining the common principles is as important as the principles themselves.

Data Management Strategy

Key Lesson Learned: To meet the objective of accurate, sharable information, the Data Management strategy must meet all of the following interdependent strategic requirements for data management.

- Global repository for common names, definitions, and rules
- Standards for data models, data elements, and data architecture
- Common procedures, and tools to support procedures
- Data quality process and metrics
- Education and training
- Effective organizational infrastructure involving senior managers and functional managers.

The strategy will implement the principles for data management defined above. The FAA would, of course, define its own set of principles. DoD experience and documentation on Data Administration can provide a starting point for the process.

Examples of interdependencies among the strategic requirements are identified below in Table 1.

Table 1.- Interdependencies among Data Management Strategic Requirements

	Repository	Standards	Procedures	Data Quality	Training	Organization
Repository		Repository records and maintains configuration of standards.	Repository verifies application of procedures and related business rules to data.	Repository maintains Data Quality through application of business rules.		Repository supports Data Mgt. organizations across functional areas.
Standards	Standards govern models and naming conventions in the Repository		Standards simplify Procedures by reducing variation in data names and data types.	Standards support Data Quality processes by maintaining consistent rules for data in the Enterprise.	Standards reduce training requirements by maintaining consistent rules for data across functions.	
Procedures	Procedures govern metadata in the Repository.	Procedures define process of establishing and applying data standards.		Procedures define 'best practices' for improved Data Quality.	Standardized procedures minimize training requirements.	
Data Quality	Data quality processes maintain metadata in Repository.	Data Quality processes enable consistent application of standards.				
Training	Supports procedures needed to maintain metadata.	Training provides knowledge required for application of data Standards.	Training provides skills and knowledge required to implement procedures.			
Organization	DM organization establishes and oversees application of procedures to Repository.	Organizational infrastructure supports applications of standards across functional units.	Organization authorizes procedures and monitors implementation.	Organization establishes processes for improving and maintaining Data Quality.	Organization implements uniform training to support DM requirements.	

Global Repository

Key Lesson Learned: The repository naming conventions should depend on a simple set of data classes and prime words derived from the Enterprise Model.

Data Modeling and Class Definitions

The DDRS (Defense Data Repository System) is the main mechanism for maintaining information on standard data elements and associated definitions and rules. The identification of standard data elements is being performed in parallel with the development of naming conventions for data elements. The standard for data classification is based on class words that pertain to the entire DoD and prime words that address the requirements of the business processes.

The development of the Enterprise Model is viewed as a key part of linking the data to the processes. In advance of the publication of the DoD Enterprise Model, the data administration initiative has been employing candidate prime words. One of the products of the Enterprise Model will be the standardization of prime word classifications. The current DoD class word set contains 17 items.

Repository Extensions - Integrated Repository

The initial concept for the data repositories in the DoD includes the DDRS (Defense Data Repository System) and the DSRS (Defense Software Repository System). It is now becoming more widely recognized that there are substantial areas of overlap between use of these two repositories. For example, what is reusable in a software component often includes data structures and data definitions which may also form the content of the DDRS. The process of system design (in the future I-CASE environment) will require access to both existing data definitions maintained in the DDRS and specifications of reusable objects in the DDRS.

Potential categories of content for the Integrated Repository include:

- Data definitions and rules
- Enterprise model
- Process models
- Other FEA products
- Data models for business areas
- Data models for applications
- System requirements
- Design specifications
- Domain analysis products - reusable object characteristics

The Data Administration program has not yet defined an architecture for the repository. The process of defining the repository requirements started with a 'blue-sky' concept for the repository created a joint effort by experts in the various potential repository domains. Following agreement on this meta-model, the scope of the repository will be narrowed to meet a schedule for incremental implementation.

Common Standards and Procedures for Data Models, Data Elements, and Data Architecture

Key Lessons Learned: Build on industry standards; implement standards and uniform procedures via enterprise-level policy.

Supported by the Joint Interoperability and Engineering Organization (JIEO), the CIM program is evaluating standards for data content and data management processes. In addition to industry standards for data interchange, the CIM program is overseeing the establishment of standard data elements derived from the DoD Enterprise Model and functional data models (see below under Technology Transfer). The objective is to make data **a shared resource** across functional organizations.

Data Quality Process and Metrics

Key elements of the Data Quality Improvement Program are to

- involve the functional community in the process of developing and verifying data models
- involve the technical staff (DISA/CIM) in the process of checking conformance to procedures and other technical requirements.

The global data dictionary (DDRS) is an essential tool to maintaining data quality. The DDRS will play a central role in the Data Quality Improvement Program by applying standards to data definitions in physically distributed systems. *The FAA will need to use a repository to assist in the FAA Data Quality Improvement Program.*

The Data Quality Improvement Program also intends to address two important problems:

- maintenance of integrity between the logical models and physical implementations
- controlling synchronization of interdependent data in distributed databases.

Organizational Infrastructure

Key Lesson Learned: Establish organizational support for data management at the enterprise level to serve the requirements of functional managers.

DISA/CIM provides technical and consulting support for functional managers to support data management objectives. *AIT needs to provide services to functional managers in the area of data management that they cannot provide themselves.* Potential services to be provided by a central organization include:

- Tools such as the Data Repository and CASE products to support data management
- Support for pilot projects
- Access to shared data and system resources

Education Training, and Consulting

Key Lesson Learned: To gain the active participation of the functional managers, demonstrate benefits that data administration will deliver in the short-term.

The Data Administration program is developing a business case for data administration that will provide a FEA for the application of data standards and procedures to data within the functional areas. The program is also providing a consulting service that shows how the data administration policies can reduce costs and improve business processes. The consulting program addresses particular problems in data management that the functional managers view as having a high-priority. The program also has developed a plan for training and education in the application of standard procedures to the development of data models, data element names and definitions, and the implementation of data quality improvement processes.

Another technique that is being used by DISA/CIM is to offer seed money for visible projects aimed at involving the "power-players."

3.3.3. Technology Transfer/Procurement Vehicles

Information Repository

The DDRS is currently using a DoD developed automated data dictionary system to support the repository. It has been operational since August 1992. The DoD product is available free-of-charge to other government agencies. Recognizing that it will be more cost effective to use a commercial product than to enhance the existing DoD repository database, the DoD plan is to move to a commercial system within about a year. Commercial products that are being evaluated include the Rochade dictionary system from R&O, Inc., Infospan, and Wisdom, an Oracle based CASE tool and dictionary. (The FAA is also investigating the R&O product.)

Information Warehouse

The DoD has identified a goal and tentative project that would establish a "DoD Enterprise Database." If the project is approved, DISA will create a multi-agency task force to define a vision for the Enterprise Database, develop a concept of operations, perform a functional economic analysis, and define a process to migrate data. It is not likely that this effort will be of benefit to the FAA in the short-term.

Data Administration Policies and Procedures

The DoD Data Administration program has created a number of policies and procedures that can provide a basis for corresponding policy development in the FAA. These include:

- DoD8320.1 - DoD Data Administration - 26 Sept. 1991
  This document defines general policies and responsibilities for data administration . The policies authorized development of a DoD-wide data dictionary system and the procedures manual.
- DoD8320.1-M - DoD Data Administration Procedures Manual - 21 Sept. 1992 (draft); completion scheduled for 31 Aug. 1993. The manual provides an overview of:
  - Data Administration program goals and objectives
  - Roles and responsibilities
  - Concept of operations
  - Procedures for program administration, technical infrastructure,
  - Procedures for metadata management and control:
    - Technical resource objects
    - Data models
    - Process models
    - Data configurations
    - Data quality
    - Data security
  - Procedures for data handling
    - Data capture
    - Data storage
    - Data transformation
    - Data distribution
    - Data retirement
- DoD8320.1-M-1- DoD Data Element Standardization Procedures - completed Jan. 1993
- DoD8320.1-M-2 - DoD Data Security Procedures - Interim Draft Nov. 1993
- DoD8320.1-M-3 - DoD Data Quality Assurance Procedures - coordination copy Nov. 1993
- DoD8320.1-M-4 - DoD Database Administration Procedures - completion anticipated Dec. 1993.

Data Standards

The FAA can benefit from the standards development activities in which the DoD is participating. These include:

- CASE Data Interchange Format (CDIF)
- Information Resources Dictionary System (IRDS) 1 & 2
- EDI (ANSI STD X.12.)
- Semantics Unification Data Model
- CALS (Computer-aided Acquisition and Logistic Support) standards, e.g. SGML, ODA/ODIF, CGM)
- Portable Common Tool Environment (PCTE)
- CASE Interchange Standard (CIS)
- IEEE Computer Society Task Group on Professional Computing Tools (P1175)
- Model Harmonization Efforts (X3H4)

Data Quality

DISA/CIM has produced a draft concept paper on Data Quality. They have also initiated a pilot project with the Marine Corps to test a metrics tool. It is not yet a production system available for outside use.

Education, Training and Consulting

The FAA can build upon plans, course materials, and consulting techniques that the CIM program has developed for Data Administration.

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. CBA

Software Reuse Benefits

The DoD spends approximately $24B/year on software for weapons, command and control, and administrative systems.

The benefits of software reuse will be realized through change in the software development process. Incorporation of reusable components will impact requirements analysis, development, and maintenance. Life cycle benefits include:

- reduced risk
- improved quality and reliability
- reduced cycle times for development and maintenance
- an improved capability to adapt to changing technologies and change user requirements.

Software Reuse Costs

According to DoD information supplied to the GAO[2] development of reusable components costs 10 to 55 percent more than system specific development. A component must be reused 3 times to save on the up-front investment.

It should be noted that GTE finds that little added resource is required to produce a reusable component if the software development process is initially designed to achieve that result.

Software Process Assessment (SPA)

The cost for hiring a contractor to perform an SPA on a DoD site (Central Design Agency) is $50-55K per case.

3.4.2. Lessons Learned

DoD Organizational Infrastructure to Improve Software Development and Maintenance

Policy oversight for software engineering, under Mr. Fred Hathorn, is carried out within the Information Technology Directorate. The three areas of focus are:

- Software Process Improvement
- Software Reuse
- I-CASE.

The Software Engineering Directorate under Mr. Jerry Russomano DISA/CIM supports implementation of software process change. The following areas are addressed:

- Software Engineering Environments - responsible for I-CASE Implementation and evaluation of methods and tools
- Software Process Improvement - responsible for Software Process Assessments, process implementation, guidelines, and baseline surveys
- Metrics - responsible for core measures, a metrics architecture, metrics tools and metrics pilot projects
- Re-engineering - responsible for software re-engineering strategy, process definition , and supporting tools.

The Directorate is also investigating the potential of Object-Oriented (O-O) technology and requirements for applying O-O analysis and development technologies within the DoD.

Software Process Improvement

Key Lesson Learned: A standard assessment methodology must be applied to establish a baseline for software process improvement.

One of the main functions of the DISA/CIM Software Process Improvement branch is to develop a capability to perform formal Software Process Assessments. This is in accord

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[2]See Government Accounting Office Report, "Software Reuse: Major Issues Need to be Resolved Before Benefits Can be Achieved," March 1993.

with DoD policy to require that "All DoD Central Design Agencies will perform self-assessments of their software development processes to establish a baseline of software practice." The product of the assessment is a baseline that leads to the formulation of an action plan for software process improvement. The goal is to perform 50 SPAs/year. As of March 1993, DISA/CIM has completed six SPAs.

I-CASE Environment

The implementation of an Integrated Computer Aided Software Environment (I-CASE) is viewed a key component of the DoD strategy to enhance productivity for software development and maintenance and improve the quality and reusability of the software products.

The I-CASE environment is intended to manage data for both application development and testing. It will create a test database for facilitating access to test data.

> ***Key Lesson Learned: Use of CASE must be mandated for the entire enterprise.***

DoD Implementation Policy -- I-CASE will be required for "each military department and defense agency for all in-house, government development automated information systems. (DoD I-CASE Policy Letter, 27 Feb. 1992)

> ***Key Lesson Learned: Address the training requirements for I-CASE implementations.***

CIM recognizes the importance of introducing training in process change to support the implementation of CASE tools. For the 19 pilots that will implement tools derived from the I-CASE procurement, an I-CASE Readiness Program will be implemented to prepare the sites. CIM will carry out an assessment to identify site requirements for training and to identify other obstacles that may inhibit the movement toward a CASE environment.

Metrics

> ***Key Lesson Learned: Build on pilot projects and gain consensus on metric definition and implementation. Establish a management structure to implement metrics and integrate the metrics into all levels of project management and decision-making.***

The DoD Metrics Program is beginning with the existing SEI Core Metrics and evaluating their utility in pilot projects. CIM is also working the GTE in relation development of a metrics hierarchy to address requirements of multiple managerial levels in software development. A consensus on metrics will be developed with the support of the DoD Information Management Software Metrics Council.

Re-engineering

Legacy systems in the DoD contain more than 1.4 billion lines of source code. The capability to re-engineer these systems is critical to the CIM effort to consolidate existing databases and applications. The re-engineering process must preserve existing functionality where required and migrate systems to the future Open Systems Environment.

Key Lesson Learned: Technical support must be provided to functional organizations to support re-engineering.

Types of tasks for which DISA/CIM will provide consulting support include:

- Evaluation of trade-offs between development and re-engineering
- Preparation of re-engineering plans
- Tailoring re-engineering model to project requirements
- Evaluation of software re-engineering tools
- Use of reverse engineering tools to model existing system
- Validation and testing of re-engineered database designs.

Reuse

Reuse Program Organization

The DoD reuse programs are coordinated by the a newly established DoD Software Reuse Executive Steering Committee. That committee is headed by Joanne Piper Arnette who also directs the DoD Reuse Program Management Office within DISA/CIM. The Software Reuse Program Management Office is the implementing organization for software reuse. Areas of focus include:

- Reuse Engineering
- Asset Management
- The Defense Software Repository System (DSRS)
- Reuse Management Issues
- Reuse Training

Closely related to the DISA/CIM reuse program are a number of on-going DoD programs that address reuse. The ARPA-funded STARS (Software Technology for Adaptable and Reliable Systems) program addresses software environments for embedded systems. DoD programs designed to develop capabilities for software reuse include ASSET and CARDS for embedded software and RAPID for administrative systems. The STARS program has supported the development of a search engine for CARDS and ASSET that permits users to access the two libraries via a remote index.

- ASSET (Adaptable CALS Catalog for Embedded Systems Software) - ASSET is support by IBM and SAIC. The library contains reusable source code, designs, architectures, documentation, interfaces, and development tools.
- CARDS (Central Archive for Reusable Defense Software) - The Air Force reuse program contains reusable architectures, requirements, subsystems, interfaces, and commercial software products.
- RAPID (Reusable Ada Packages for Information Systems Development) - The RAPID program includes a library of components to support the development of administrative systems and a means for locating modules for reuse in defined applications domains.

The RAPID program, originally developed by the Army, has been brought within the CIM Program to support accelerated development of software reuse.

Specific requirements for the DoD Reuse have been developed which can inform similar FAA efforts. These include:

- Requirements for legal access, ownership and accounting
- Need to identify domains
- Providing access to reusable components across domains (interconnected reuse libraries)
- Asset Management - The Reuse Initiative formally evaluates and certifies components for reuse

Reuse Strategy

The following guidelines for the basis for DoD reuse strategy.[3] They may be regarded as lessons-learned for a corresponding FAA reuse program.

- **Establish domains.** - Domain Analysis is central to enabling reusable software objects to be accessed and applied to on-going software development. The Domain Analysis process creates the knowledge base that supports software reuse. The process identifies the scope of reuse applications and the potential relationships between reusable objects and the "problem environments" that employ them.
- **Define reuse products.** - Products that support reuse include:
  - Domain models - describes the classes of problems that can be addressed by software solutions
  - Software architectures - map domain model requirements to reusable components
  - Component specifications - specifies requirements for design of reusable components
  - Domain taxonomy - the classification framework for reusable components
  - Candidate recommendation for reusable objects.
- **Establish criteria for deciding ownership.**
- **Integrate Reuse into the development and maintenance process.**
- **Define model for business decisions.**
- **Define metrics to evaluate reuse success.**
- **Define evaluation criteria for certifying reuse components.**
- **Identify technology base investment strategy.**
- **Carry out training at all levels of management.**

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[3]See. Joanne Piper, "DoD Software Reuse Vision and Strategy," *Crosstalk*, Oct. 1992, pp.2-8.

Further discussion of Domain analysis may be found in Domain Analysis Guidelines (Draft), SofTech, Inc. (Contract No. 62K-RF029C).

Areas that Require Additional Development

- Process of Domain Selection - The Reuse Initiative has not developed a good procedure for targeting specific domains for development.
- Mechanism for locating reusable components - While the DARPA ASSET program has developed support for reusable component location, the DoD has not adopted a particular approach to meet this need. The reuse program recognizes that **it is necessary to involve the user in the development of an appropriate schema for component identification. The taxonomy must be "user-friendly."**
- Bridging administrative and non-administrative systems

Object-Oriented Technology (OOT)

There is a growing body of opinion within DISA that OOT has matured sufficiently to be considered for use in specific applications. The ODDI tasked DISA/CIM to develop recommendations for potential implementation of OOT. CIM now considers OOT and reuse to be mutually supportive efforts. Advantages include:

- Easier maintenance
- Enhanced traceability and reliability for reusable components.
- Improved modeling of original problem
- Better representation of complex information structures.

CIM also recognizes that extended use of OOT will require better tools and Object-Oriented databases, and a significant investment in education of technical staff, management, and users.

Integration of CASE, Reuse and Data Repositories

Key Lesson Learned: Effective implementation of software process improvement will require integration of processes and supporting technologies for CASE, Reuse and Data Management.

DISA/CIM plans to develop a strategy and Concept of Operations for integrating Reuse, CASE, and Data Administration. It is recognized that the I-CASE tools must be interfaced to the data repositories, i.e. the DDRS (Defense Data Repository System) and the DSRS (Defense Software Repository System). The I-CASE tools must support the full-suite of process and system engineering tools, including process simulation, functional decomposition, and data-oriented information engineering approaches.

3.4.3. Technology Transfer/Procurement Vehicles

Software Engineering Environments

I-CASE Procurement

The procurement for the Integrated Computer-Aided Software Engineering Environment (I-CASE) a major vehicle for the DoD to implement a standard software development and

production environment for all DoD developed information systems. The award is expected to be made in September 1993 with 19 pilot implementations to begin several months after the date of contract award.

The procurement is structured so that the vendor will need to meet minimum requirements for a Software Engineering Environment (SEE) in the first year and define a migration path to meet a broader set of requirements. For example, the I-CASE procurement will allow for a proprietary environment at the time of contract award. Within three years of the award, however, the contractor will be required to migrate to an open systems environment. The migration strategy provides a path toward integration of the requirements tool and the development tool (upper and lower CASE). Initial implementations are not likely to support such integration.

Standards

The I-CASE program requires that industry standards are employed where they exist. PCTE (Portable Common Tools Environment), for example, will be used as the interface to the repository for software product data.

The new standard for software, MIL-STD-SDD (Software Development and Documentation), will combine development and documentation standards to address both business and weapons systems requirements. The result will supercede MIL-STD 2167A and DOD-STD 7935A.

Software Process Improvement

Software Process Assessment Methodology

The Software Engineering Institute Capability Maturity Model (CMM) is being used as basis for the assessment methodology that DISA/CIM is applying to DoD software development sites. This approach should be evaluated for establishing a software process baseline for FAA organizations.

Metrics

The DoD has placed a high priority on the development of a metrics program to support software process improvement and software reuse. The FAA may be able to benefit from the experience of the DoD in adapting existing metrics programs developed by the SEI, GTE and other organizations.

Software Re-engineering

CIM is supporting the acquisition and development of automated tools to support software re-engineering. The FAA program should evaluate these tools in relation to FAA re-engineering requirements.

Object-Oriented Methods and Technology

CIM is evaluating OOT for potential DoD applications. It is uncertain at this time how broadly the DoD will implement OOT for requirements analysis and/or software development.

Reuse

Defense Software Repository System (DDRS)

The DDRS is founded upon the products of the RAPID (Reusable Ada Packages for Information Systems Development). There are 2575 objects in the repository (as of March 1993). According to the ODDI, this program offers the best prospects for implementation within the DoD.

CARDS (Central Archive for Reusable Defense Software) Program

CARDS - Use of RLF (Reusability Library Framework, a knowledge representation framework to support use of domain specific reuse libraries. This is publicly available software.

The CARDS Program has also produced a set of handbooks that address potential obstacles to reuse. These include:

- Direction Level Handbook (for top level-managers)
- Acquisition Level Handbook (for program managers)
- Engineer's Handbook
- Component Developer's and Tool Builder's Handbook.

Other areas that the FAA should look for transfer opportunities include:

- the classification schema developed for categorization of reusable components
- legal and accounting procedures for authorizing and tracking reuse

3.5. EDI

3.5.1. CBA

Supply Cost Reduction

EDI offers one of the most significant opportunities to reduce operational costs through improved business process design. A large part of the $17.3 B in Supply Cost Reductions mandated by the DMRDs are derived from the elimination of transaction costs and depot functions through the use of EDI in the conduct of supply operations.

Other large potential cost reductions include elimination of manual production and processing of forms. $1.2B savings due to automating 16 commonly used forms

For more detail, see the separate report on EDI.

3.5.2. Lessons Learned

EDI is discussed in detail in separate EDI reports. Some key lessons learned from the DoD experience include the following requirements for successful implementation:

- fundamentally changing business processes and organizations that depend on manual transactions.
- establishing DoD-wide standards for EDI that conform to industry implementations

- implementing standards for the content of EDI messages that are integrated with the standard data definitions, structures, models, contained in the DoD repository (DDRS).

The overall implication is that **realizing potential EDI benefits requires the support of the other CIE initiatives** to establish standards (Core Architecture), change business processes (BPI), integrate EDI content with other data (Data Management), modify applications to build in standard EDI components (Corporate Software Engineering); establishing security for EDI messages (IT Security).

3.5.3 Technology Transfer

EDI Gateway

The DoD is developing a single gateway to provide a interface to multiple Value Added Networks that support EDI. A joint DoD/Air Force pilot project, Government Acquisition through Electronic Commerce (GATEC) demonstrated feasibility of the standard gateway for EDI transactions in October 1992. The development of the standard gateway will depend on a uniform DoD VAN agreement and the use of X.12 standards for transaction sets, X.400 telecommunications messaging standards, and the X.500 standard for directory access.

EDI Standards

The DoD is evaluating the desirability of moving to the United Nations EDIFACT standard, which would support international exchanges of data.

3.6. SECURITY

3.6.1 CBA

3.6.2. Lessons Learned

In general, CIM has pay relatively little attention to security requirements. The repositories that are being developed currently store non-secure data. Problems of data aggregation (changed security levels due to access to combinations of data sources) make it difficult to implement security requirements for data with multiple classifications levels.

> ***Key Lesson Learned: Distinct plans for security must be developed for each of the levels of integration.***

The CIM initiative addresses security requirements in relation to four interfaces in the integration model (see Figure 3):

- Personal to Local
- Local to Applications
- Application to Function
- Function to Mission.

Security and Repositories

The repositories for data administration (DDRS) the repositories for software reuse (DSRS) have so far only included unclassified data.

3.6.3 Technology Transfer

The DoD is examining products that support secure access to servers in a TCP/IP environment.

- DoD 8320.1-M-2 - DoD Data Security Procedures

4. Summary - Key Conclusions from Survey

The follow tables provide a summary of key conclusions referenced to the CIE Initiatives.

Table 2. - CIM Relationships to CIE Initiatives (Part 1)*

	Cost Benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles
Core Architecture	• 30% productivity improvement due to use of uniform GUI • Cost/benefit assessments must take into account the interconnected nature of IT initiatives. • A principle benefit of a Standards-Based Architecture (SBA) is the ability to use commercial open-systems products.	• Coordinate management of all information under a single responsible organization. • Use the Technical Reference Model (TRM) as a means to build consensus on OSE requirements. • Establish a visible commitment from top management. • Formulate a statement of principles to govern future IT decisions. • Process of architecture definition must involve and benefit non-technical managers who will implement enterprise-wide requirements. • The FAA will need a means for testing conformance to standards. • Avoid massive inventory effort because the baseline changes more rapidly than a detailed assessment would warrant.	• DoD use of POSIX 1000.3 standard/Application Profiling process. • CIM TRM and standards profile • ***CIM Architecture Docs. - "Technical Architecture Framework for Information. Mgt."*** • ***DMR Standards Based Arch. (SBA) Methodology*** • ***DISA/CIM "Human Interface Style Guide"*** • DoD Defense Technical Integration Services acquisition (DTIS) (consulting services for technical integration) • Transfer of techniques from DoD ITRUS Program to support acquisition of commercial products • ***Use of DIS/CIM SETA SOW for contract requirements***
Business Process Improvement	• Major CIM savings are to be gained through BPI-related productivity increases, not though direct savings on IT. Impact of CIM will be on productivity improvements due to BPI ($35B)not savings on IT. ($6.9B)	• Market the BPI vision and process to functional managers as early. as possible. • Use an existing methodology and automated tools that can be applied by functional managers. • Establish metrics and rewards for BPI process implementation. • Address organizational requirements for implementing BPI recommendations. (Not yet addressed by CIM.)	• DoD Repository for process modeling • IDEF standards • IDEF repository for process models • ***BPI methodology*** • ***CIM tools for BPI process*** ◆ Group decision-making ◆ IDEF modeling ◆ ABC ◆ Process simulation ◆ Performance analysis ◆ Prototyping • ***Use of DIS/CIM SETA SOW for contract requirements***
Data Management	• DoD business case for Data Admin. (to be completed in Oct. 1993)	• Data mgt. requirements: enterprise-wide DM policies, global repository; standards for models and elements; common procedures; data quality process; training; organizational infrastructure. • Use a simple set of class names as basis for data element naming conventions. • Build on industry standards.; establish stds. and procedures for shared data via enterprise-level policy. • Develop integrated repository for data, software, and process models • Demonstrate short-term benefits of repository and data mgt. procedures to gain support of functional mgrs.	• ***Defense Data Repository System (DDRS)*** - available free-of-charge to other federal agencies ◆ Repository mgt. SW ◆ Data models and definitions • DoD Enterprise Database: tentative project that may support the FAA Information. Warehouse capability • ***Data Admin. policies and procedures*** • ***DoD data standards: FAA use of DoD standards evaluations and implementations*** • GM model for 3-schema repository • ***Use of DIS/CIM SETA SOW for contract requirements*** • Draft concept paper on Data Quality

*CIM documentation, software, and other resources that the FAA may be able to leverage are highlighted.

Table 3. - CIM Relationships to CIE Initiatives (Part 2)

	Cost Benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles

Corporate Software Engineering	• No FEAs available for software
	• Software benefit categories for CIM
	  ◆ reduced risk
	  ◆ improved quality and reliability
	  ◆ reduced cycle times for development and maintenance
	  ◆ adaptability to changing technologies and user requirements
		• Apply standard assessment methodology to establish process baseline.
		• Use of CASE must be defined as an enterprise-wide policy.
		• Address CASE training requirements.
		• Establish consensus on metrics; apply to all levels of management
		• Provide technical support for re-engineering
		• Institute domain analysis to support reuse
		• Define model for reuse business decisions
		• Integrate reuse into SW development and maintenance processes
		• Develop reusable component locator
		• Integrate CASE, reuse, and data management
			• ***I-CASE procurement: evaluate I-CASE technologies and pilots for application to FAA***
			• MIL-STD-SDD - evaluate for application to FAA SW life cycle process standard.
			• DoD Software Process Assessment (SPA) methodology
			• ***Metrics - FAA can build on DoD SW metrics for process and reuse***
			• DoD re-engineering tools
			• Defense Software Repository System (DSRS)
			  ◆ Repository mgt. SW
			  ◆ DoD SW components
			• DoD legal and accounting procedures for reuse
			• ***Use of DISICIM SETA SOW for contract requirements***

Electronic Data Interchange	• $17.3B in supply cost reductions result from BPI and use of EDI • $1.2B savings in DoD due to automating 16 commonly used forms	• Need to use EDI to change business processes that depend on manual transactions • Realizing savings will require change in job functions and organizations. • The FAA should adopt enterprise-wide stds that conform to industry implementations. • Integrate content of EDI messages with data management (data definitions, models in the data repository.	• ***DoD gateway to multiple Value Added Networks for EDI: Government Acquisition through Electronic Commerce (GATEC)*** • The FAA should evaluate the EDIFACT standard for EDI. • ***EDI guidelines and procedures***
IT Security		• CIM repositories currently contain only non-secure data. • DoD has recognized, but has not formulated a detailed strategy for security in the open systems environment.	• DoD is evaluating products that support security in a Unix OSE using TCP/IP. • ***DoD will publish guidance on security procedures (DoD 8320.1-M-2).***

*CIM documentation, software, and other resources that the FAA may be able to leverage are highlighted.

CONCLUDING REMARKS

The similarities between the objectives of the DoD CIM Initiative and those of the FAA CIE Initiative make CIM the most important outside effort from which FAA can derive benefit. The DoD and FAA also share some of the same organizational characteristics that will affect the implementation of enterprise-wide efforts in information management. In particular, both organizations have a history and culture based on operational independence of the existing functional organizations. In both DoD and FAA, the process of building consensus on IT policy will strongly affect the outcome of implementing business process and IT changes in the functional organizations.

The FAA can make use of CIM experience and technologies in the areas of open-systems architecture, business process improvement, data administration and software tools and software reuse. These have been detailed in the previous sections. Several points deserve emphasis.

- A consensus on how the enterprise is to achieve productivity improvements through IT is achieved via two vehicles--a statement of governing principles and the Technical Reference Model that defines enterprise-wide open system requirements.
- The major benefits from improved use of information will be achieved via changes in the core business processes.
- The Data Repository is a key integrating mechanism required for implementing all of the initiatives.
- EDI offers a major short-term opportunity for productivity improvement. Realizing theses benefits will require support from all other initiatives. EDI, therefore, provides a justification for not only the EDI Initiative, but also the initiatives on which the implementation of EDI will depend.

The history of the CIM Initiative also offers important lessons on obstacles that may confront the FAA CIE Initiative in the future. In spite of great care exercised to involve the DoD operational units, CIM has not succeeded in gaining unqualified support from the implementing organizations. One result has been the resignation of the DDI (Mr. Paul Strassman), and the decline in influence of the DISA Center for Information Management. While the DoD has given the process a Business Process Improvement a prominent role, the impact of process changes on the DoD functional organizations remains to be determined.

Key similarities between CIM approach and FAA approach

- establishment of organization for enterprise=-wide oversight of data
- adoption of open systems environment
- emphasis on BPI

To be mentioned under CBA

- big hits in terms of process improvement are EDI (elimination of Depots)and GUIs
  - productivity increase of 30% due to graphical interface
- reduced cost of OSE components

Key conclusions from Survey

Issues

- lack of change management strategy (CIM does not address organizational change - it leaves that to the functional units.

This has become particularly evident in the battle between the DISA (uniformed orgs. and the DISA CIM (civilian led org) The uniforms won. (Analogous to the divisions between FAA regional and field offices and HQ)

- need definition of principles

Interdependence among initiatives • architecture is means for gaining concurrence (technical correctness is not the main criterion of success; degree of concurrence is more important)

The major benefit from the CIM initiative will be from BPI effects. BPI benefits are likely to be 10 times as great as cost savings due to more efficient implementation of IT.

- In BPI, need to evaluate the contrasting approaches of the standard DoD FEA and the approach proposed by John Keane.
- Need to emphasize the relationships among the initiatives from the standpoint of lessons learned
  - The repository is a central integrating mechanism for data required for all the initiatives
  - The content of EDI messages needs to be managed via the repository
  - Models that are used for BPI FEAs need to be kept in the repository
  - Craig Johnson - memo on links between EDI, security, BPI and CASE -- One argument that can be made is that the large benefits from EDI cannot be realized with equivalent attention to BPI, the repository and security
  - The big hits from a benefits standpoint are
    - EDI (elimination of transactions and supply infrastructure

Reduced software time to market (development costs)

Reduced software maintenance

Enhanced productivity through uniform GUIs

Enhanced productivity thorough BPIP

to do

Human Interface Spec.

Failure to address org change

finish Enterprise Model desc.

add detail to TAFIM parts -

While it is difficult to cost-justify data mgt. on its own, data management is a ncessary condition for many of the objectives of the corporate informtion environment to be realized. The repository is required to maintain consistency among data employed in distributed repositories.

Some of the FEAs were performed using different methodologies

There are savings within the functions and there are savings outside fo the functional boundaries -- Issue : Are the outside savings realizable.

History of CIM -- Responsibility for Information Technology had been jointly held by the Under Secretary of Defense and the Comptroller. Two years ago the responsibility for all non-embedded information systems was put under Paul Strassman, the Director of Defense Information (DDI). The Office of the DDI has responsibility for CIM funding as well as policy. In addition to the DDI, the reorganization established six deputy directors: one for policy, one for business process improvement, one for information technology, and three functional information managers (Personnel, Finance and Health; C^3I, and Materiel and Logistics).

March 15, GCN --

Navy and p. 43 BPI

p. 37 CALs --

lessons learned: under CALS -- The FAA has many programs that are addressing CALS stds on their own -- need a single program for FAA CALS

lessons learned under CIM -- they put every \thing under one house -- analogous to NAS non-NAS programs in FAA

Add relationship of ITRUS to Functional Services provided by core architecture

Discards

> ***Key Lesson Learned: A Standards-Based Architecture (SBA) will enable the use of COTS products. It must be specific enough to permit building of applications that meet functional requirements and general enough to gain consensus.***

Section 2

Electronic Data Interchange (EDI)

Table of Contents

Report on the Electronic Data Interchange Initiative

1. Program Description

Electronic Data Interchange (EDI) is the exchange of routine business transactions in a computer-processable standard format. If recent history is any guide, EDI will also dramatically change the way most companies conduct business.

EDI is a tool by which an organization exchanges information via standardized machine-processable formats with other organizations or "trading partners." **The Accredited Standards Committee for EDI of the American National Standards Institute (ANSI) defines EDI as:**

- the transmission, in a standard syntax, of unambiguous information of business or strategic significance between computers of independent organizations;
- the users of EDI do not have to change their internal databases;
- EDI is the common "language" used to get information from one computer system to another; and
- the users must translate this information to or from his own computer systems, but this translation software has to be prepared only once.

The last three decades have seen impressive developments in EDI. The pre-EDI "old days" were characterized by a single application within a single industry. "Industry standards" the emerged which allowed participants within an industry to exchange a relatively small variety of messages with each other. EDI in the 1980s was limited to single applications, one or two transaction sets, and a predictably narrow trading partner population. By 1990 almost 15,000 companies around the world (including some 10,000 in north America alone) had adopted some kind of EDI application.

FIPS Pub 161, effective in September 1991, demonstrates the federal government's interest in the value of EDI. Federal agencies that choose to implement EDI systems must adopt recognized X12 (national) and EDIFACT (international-EDI for Administration, Commerce, and Trade) standards that meet their requirements. The X12 Committee has approved for use over 100 transaction sets.

The great number of goods and services for which the federal government contracts each year makes any decision to change the way it does business worthy of the business community's close scrutiny. The advantages of EDI suggest that it is the wave of the future in how government conducts its business. in the commercial sector, EDI is revolutionizing business process innovations such as just-in-time inventory, direct-vendor delivery, and invoice payment that are dramatically reducing investment and operating costs. The reasons for doing so are compelling: **the typical costs for processing a multipart document from "cradle to grave" can range from $10 to $40 or more; conducting business electronically can reduce those costs by 33% to 50%.**

The Department of Defense (DoD) seeks similar savings by creating a totally electronic business relationship with industry called Electronic Commerce (EC). EC, initiated at the Defense Logistics Agency (DLA) in 1990, is the integration of EDI, electronic mail,

electronic bulletin boards, electronic funds transfer, and similar techniques into a comprehensive, electronic-based system - encompassing all DoD business functions, including procurement, contract administration, payment, supply management, transportation, and maintenance.

DoD, in its "Business Case for Electronic Commerce." identified $1.2B in savings by automating 16 most used forms over a ten year period. The Defense Management Review Decision (DMRD) 941 identified that $4M spent in FY 1992 saved $60M in FY 1993. This estimate was considered by many to be extremely "conservative".

The thrust of DoD's EC program is not just to automate manual processes but to put in place the necessary systems, capabilities, and procedures that will enable DoD Components to fundamentally alter and improve the way they carry out their day-to-day business operations.

Appendix A lists eight detail tasks that an organization typically needs to satisfy as it replaces paper documents with electronic transactions (EDI). Appendix B lists many of the Value Added Networks (VANs) that provide those services needed to facilitate EDI procurement between the federal government and the vendor community.

2. Method of Investigation

The primary source of information has been documents produced in support of DoD's accelerated use of EDI to achieve programming cost reductions outlined in DMRD 941. Additional material has been obtained from; related EDI books, magazines, and periodicals; discussions with the DoD Office of The Director of Defense Information, Executive Agent for EDI/EC, EDI project leaders in the Veterans Administration and Department of Commerce; and with private sector companies.

3. Relationship to CIE Initiatives

In recent years, many private-sector companies have reaped substantial benefits from automating their internal operations, such as accounting, order entry, purchasing, scheduling, and material processing. Those same companies **are now focusing on automating their external operations using EDI and, in doing so, are reporting significant economic rewards - between $2 and $10 or more in direct cost savings for every document that they transmit electronically to their trading partners.**

In spite of the magnitude of direct cost savings achieved through EDI, many proponents note that **the real benefits of EDI come from using it as a tool to simplify and improve business procedures (i.e., Business Process Improvement - BPI).** Automating manual processes alone will yield some benefits, **but changes in business processes are required to maximize return on technology investments.** As a consequence, **they are reporting $3 to $5 in indirect cost savings for every $1 in direct cost savings from various business improvements made possible by EDI,** such as reduced inventories, improved competitive pricing strategies, enhanced auditing procedures, and streamlined operations.

Additionally, several data exchange techniques are frequently mislabeled as EDI and often become an issue and a challenge to an organization implementing EDI (i.e., integrating EDI applications with all FAA business systems), they are described below:

- Facsimile (FAX) transmission of a paper document. It requires someone to interpret the written data and rekey it into an applications system. Both of these functions, in addition to taking time, introduce errors into the processing of data.
- Electronic mail (E-mail) eliminates the paper associated with FAX, but the information moved is unstructured and requires someone to interpret the information and then rekey specific data elements into an applications system for processing.
- Dedicated computer terminals to link two or more activities also is not EDI because the data is not being transmitted in a standard format.
- The electronic exchange of information with a single trading partner using non-standard data formats is a proprietary form of EDI.

3.1. CORE ARCHITECTURE

3.1.1. Lessons Learned

The EDI enabling technology is automated information systems (AIS) independent, therefore, EDI can be implemented in support of all legacy systems. The keys to a typical EDI application include:

- The availability of universally accepted data formats, frequently referred to as EDI standards or *transaction sets*, to exchange business information
- The accessibility of trading partners (i.e., vendors, carriers, and banks) to commercial value-added networks (VANs) that receive store, and transmit EDI transmissions
- The capability of all *trading partners* to automatically send, receive, and process purchase-order, shipment, and payment information.

The wide availability of EDI transaction sets stems primarily from the efforts of two standard groups: the Electronic Data Interchange Association (EDIA) and ANSI. In 1979, ANSI formed the Accredited Standards Committee (ASC X12) to develop uniform standards for electronic interchange of business transactions. Those standards are now widely used by U.S. and International industries.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA

This section presents a methodology for assessing economics effects of replacing the paper documents identified in Section 3.2.2 with electronic transmissions

Conducting Economic Analyses

The benefits that result from implementing EDI are divided into two categories (direct and indirect).

Direct Benefits

The processing and distribution of paper forms within the FAA share some common processing operations. Since EDI would eliminate and/or streamline most of these operations, the associated savings would be direct benefits. These include:

- Distribution (making copies of documents and distributing them among users);
- mailing sorting, reconciling and auditing;
- data entry, which occurs several times if the same information is entered into more than one computer system;
- error resolution (checking for and correcting mistakes);
- storage and retrieval; and, for some documents;
- placement of procurement orders by telephone.

Table 1 lists these processing operations along with three estimates of projected savings (on a per document basis) that could result if the manual processing was replaced with EDI. Table 2 lists 16 commonly used DoD documents, while Table 3 shows the savings.

Indirect Benefits

Many private sector companies have found that EDI can result in significant savings in addition to those resulting from replacing manual processes with electronic transmissions. Reductions cited include reduced inventories, improvements in customer service, and streamlined operations as additional, yet indirect, benefits of EDI.

TABLE 1

Direct Cost Savings Through EDI

Operation	Activity	Comment	Savings per Document		
			Low Complexity ($)	Medium Complexity ($)	High Complexity ($)
Document distribution	Separate documents, make copies, route to mail room, prepare address labels, and stuff envelopes	Costs increase with complexity of operation	0.02	0.04	0.06
Mailing	Place material in envelopes and apply stamps	Costs increase with number of documents requiring single envelopes	0.11	0.16	0.26
Document receipt	Receive, open, sort, date, stamp, and route	Costs increase with complexity of sorting	0.01	0.02	0.03
Document processing	Match, reconcile, audit, and general document processing	Costs increase with complexity of document and volume of data	0.15	0.26	0.41
Document preparation and control	Examine and prepare document for data entry	Costs increase with complexity of document	0.13	0.21	0.47
Data entry	Enter data in system	Costs increase with volume of data	0.06	0.17	0.68
Error resolution	Research and correct errors, and prepare correspondence	Costs increase with volume of data	0.05	0.07	0.09
Document storage and retrieval	Log, separate, sort, microfilm, box, file, and retrieve documents	Costs increase with filing and microfilming requirements	0.10	0.16	0.28
Telephone procurement	Purchase materials or services	Costs increase with percent of telephone solicitations	1.78	3.50	5.33

Note: savings figures are based upon engineered work standards developed by the Defense Finance and Accounting Service - Indianapolis Center; A Business Case for Electronic Commerce, LMI, September 1990.

TABLE 2

Frequently Used Documents

Document Type	Form	EDI transaction equivalent
Materiel Inspection and Receiving Report	DD 250	ANSI 856, Shipping Report ANSI 861, Receiving Advice
Purchase order	DD 1155	ANSI 850, Purchase Order
Request for Quotations (written)	SF 18	ANSI 840, Request for Quotation
Request for Quotations (Telephone)	SF 18	ANSI 840, Request for Quotation
Amendment of Solicitation/Contract Modification (Local)	SF 30	ANSI 840, Request for Quotation ANSI 860, Purchase Order Change
Amendment of Solicitation/Contract Modification (Non-local)	SF 30	ANSI 840, Request for Quotation ANSI 860, Request Order Change
Solicitation Mailing List	SF 129	ANSI 838, Trading Partner Profile
Contractor's Request for Progress Payments	SF 1443	ANSI 810, Invoice
Freight GBL, CBL, and Public Voucher	SF 1103, SF 1113	ANSI 858, Shipment Information ANSI 859, Freight Invoice
Government Travel Request and Public Voucher	SF 1169, SF 1113	ANSI 859, Freight Invoice
Personal Property GBL, Statement of Accessorial Services Performed, and Public Voucher	SF 1203, SF 1113	ANSI 858, Shipment Information ANSI 859, Freight Invoice
Monthly Report of Repairables	SAV 926	
Transportation Discrepancy Report	SF 361	ANSI 842, Nonconformance Report
Report of Discrepancy (Supply)	SF 364	ANSI 842, Nonconformance Report
Product Quality Deficiency Report	SF 368	ANSI 842, Nonconformance Report

Notes: ANSI=American National Standards Institute; DD=Department of Defense; SF=Standard Form; ASC=Accredited Standards Committee of ANSI. ANSI transactions are approved and implemented; ASC X12 transactions are in development; SAV=Standard Aviation; GBL=Government Bill of Lading; CBL=Commercial Bill of Lading

TABLE 3

Direct Cost Savings For Frequently Used Documents

(Dollars)

Activity	Document								
	DD 250	DD 1155	SF 18 (written)	SF 18 (tele)	SF 30 (local)	SF 30 (non-local)	SF 129	SF 1443	SF 1103/ SF 1113
Document distribution	—	0.04	—	—	0.04	0.06	—	0.04	0.06
Mailing	—	0.26	—	—	0.26	0.26	—	0.11	0.16
Document receipt	0.16	0.07	0.02	—	0.07	0.14	0.02	0.02	0.08
Document processing	1.82	0.82	0.26	—	0.82	1.53	0.26	0.41	1.04
Document preparation and control	2.25	0.76	0.47	—	0.76	1.41	0.47	0.34	0.89
Data entry	1.19	0.57	0.17	—	0.57	0.92	0.17	0.17	0.97
Error resolution	0.49	0.32	0.07	—	0.32	0.29	0.07	0.12	0.26
Document storage and retrieval	0.16	0.68	—	—	0.68	0.38	—	0.16	0.16
Telephone procurement	—	—	—	3.50	—	—	—	—	—
Total	6.07	3.52	0.99	3.50	3.52	4.99	0.99	1.37	3.62

Activity	Document					
	SF 1169/ SF 1113	SF 1203/ SF 1113	SAV 926	SF 361	SF 364	SF 368
Document distribution	0.06	0.06	0.04	0.06	0.06	0.04
Mailing	0.11	0.16	0.16	0.52	0.42	0.52
Document receipt	0.03	0.09	0.01	0.03	0.08	0.04
Document processing	0.78	1.45	0.26	0.67	0.82	0.41
Document preparation and control	0.52	1.36	0.60	0.39	0.68	0.34
Data entry	0.18	1.14	0.68	0.06	0.34	0.17
Error resolution	0.15	0.31	0.09	0.05	0.14	0.07
Document storage and retrieval	0.16	0.32	0.16	0.16	0.16	0.16
Telephone procurement	—	—	—	—	—	—
Total	1.99	4.89	2.00	1.36	2.22	1.75

Life-Cycle Cost Savings

The sum of the direct and indirect savings total is equal to the value of the annual savings from EDI if *100 percent* of the documents are transmitted electronically. Of course, 100 percent implementation for any document is highly unlikely because some trading partners may not conduct enough business with the government to warrant an investment in EDI.

Many organizations find that 80 percent of their business transactions are conducted with 20 percent of their trading partners. Called the 80/20 rule, it focuses an activity's attention on its high volume trading partners because they will yield the greatest return on investment.

After obtaining its "critical mass" level, the organization determines the number of years it will take to reach that level, Figure 1. **An organization should allow at least 5 to 6 years to achieve its target implementation goal. Most private-sector companies plan for an implementation rate of less than 15 percent during the first 2 years of an EDI project, primarily because of the time required to procure hardware and software, develop EDI conventions, and make the necessary enhancements to internal applications systems and operating procedures.**

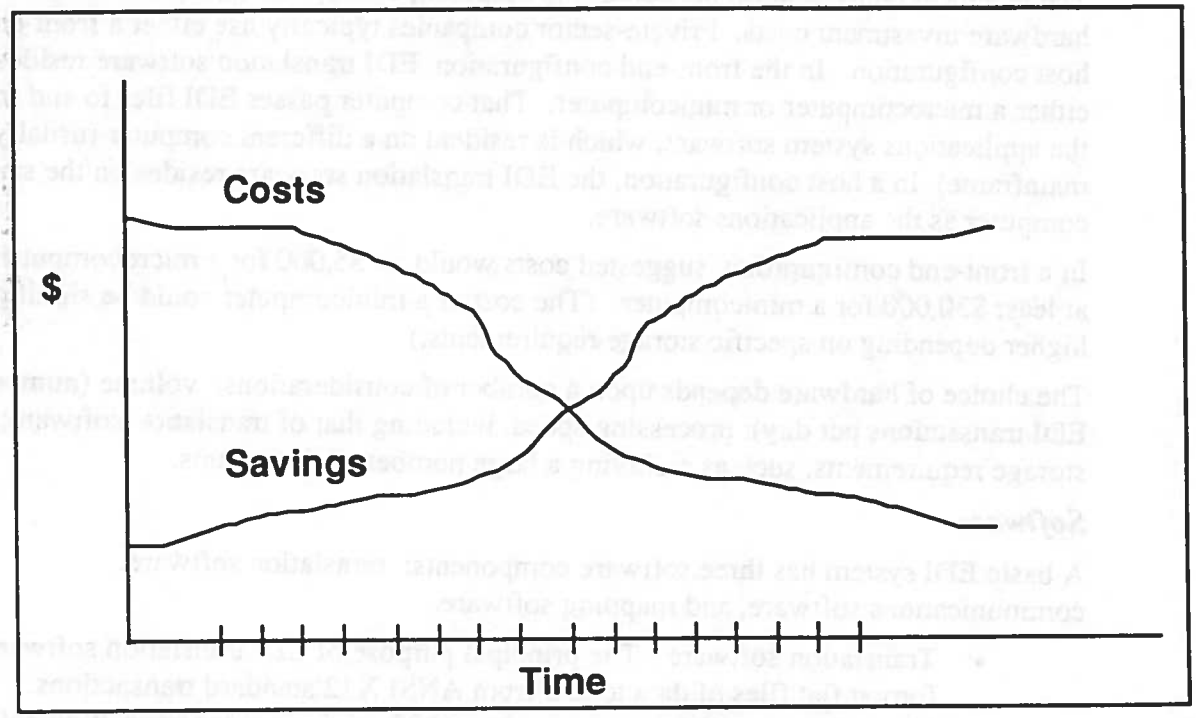

Figure 1. - EDI Economies of Scale

Defining Investment Costs

Once the organization estimates the life-cycle savings for each document, it then formulates an operating concept that outlines how it will replace the flow of paper with electronically transmitted information.

Estimating Investment Costs

Although both private and public sectors have only limited experience in estimating the level of investment necessary to achieve a given level of cost savings, DoD's EDI program for transportation provides some insight. This program estimates a cost savings-to-investment ratio of 14 to 1 ($140 million in life-cycle savings for $10 million in investment costs).

The investment costs of any EDI initiative fall into one of six categories:

- Hardware
- Software
- Telecommunications
- Systems Integration
- Program management
- Implementation support.

Hardware

The technical configuration portion of the operating concept determines most of the hardware investment costs. Private-sector companies typically use either a front-end or a host configuration. In the front-end configuration, EDI translation software resides on either a microcomputer or minicomputer. That computer passes EDI files to and from the applications system software, which is resident on a different computer (usually a mainframe) In a host configuration, the EDI translation software resides on the same computer as the applications software.

In a front-end configuration, suggested costs would be $5,000 for a microcomputer and at least $30,000 for a minicomputer. (The cost of a minicomputer could be significantly higher depending on specific storage requirements.)

The choice of hardware depends upon a number of considerations: volume (number of EDI transactions per day); processing speed, including that of translation software; and storage requirements, such as archiving a large number of documents.

Software

A basic EDI system has three software components: translation software, communications software, and mapping software.

- Translation software - The principal purpose of EDI translation software is to format flat files of data to and from ANSI X12 standard transactions. Currently, over 60 microcomputer and 30 minicomputer translation software packages appropriate for government use are commercially available. Choosing, the most appropriate translation software package, however, can be a complicated process given the many features included in those packages.
- The cost of translation software is primarily a function of the hardware that supports the application. For a microcomputer-based application, translation software costs between $1,000 and $5,000, while for a mainframe it may cost

$15,000 or more. The cost for translation software for minicomputers is more variable, between $10,000 and $20,000 depending on the hardware.

- Communications software - In order to exchange EDI data with commercial activities, a basic EDI system must be capable of passing information to and receiving information from an EDI value added network (VAN).
- Mapping software - To generate an X12 transaction set, a special program called an interface program extracts information from an activity's application system and formats it into an American Standard Code for information exchange (ASCII) flat file that is accepted by the EDI translation software.

Telecommunications

This category includes set-up costs, such as the installation of dedicated telephone lines.

Systems Integration

Two types of systems integration activities are generally required: interface programming and enhancements to applications systems.

- Interface programming formats data from EDI translation software into flat-file records for processing by the applications systems. Without such a program , the activity's systems could not accept EDI data.
- Even if an activity's applications systems can accept EDI, some systems may need to be modified to process EDI data and take advantage of the full benefits made possible by EDI.

Program Management

Includes promoting and coordinating EDI initiatives among program participants; revising operating procedures and developing new procedures to govern EDI transactions; and establishing and nurturing trading partner relationships and agreements.

Implementation Support

Implementation support for an EDI project encompasses a wide variety of tasks, including the following:

- Planning and coordination - finalizing and carrying out an organizations implementation plan
- Standards development - working with ANSI committees to modify EDI standards to meet an activity's data requirements (if required)
- Implementation guidelines - mapping specific data elements from an activity's application system to EDI transaction sets
- Training - educating activity personnel in EDI concepts
- Trading partner expansion - working to increase an activity's trading partner base to achieve its target implementation goal.

Estimating Operating Costs

An activity's document processing costs should decrease dramatically following implementation of EDI. However, two categories of operating expenses likely to experience increases are telecommunications and software maintenance.

Telecommunication Costs

A VAN provides a number of services that simplify EDI communications. Those services include document handling and distribution (electronic mailboxing), protocol and speed conversion, network connections, data back-up, and customer support. Without a VAN, an activity would need to negotiate individually with the vendors to establish these capabilities. The Industry average of $0.10 kilocharacters (1,000 characters) is used to calculate annual transmission costs

Software Maintenance Costs

These costs are driven primarily by the need to update EDI translation software with new standards. Software updates usually occur on an annual basis at a cost of 10 to 20 percent of the software purchase price.

3.2.2 Lessons Learned

Every prospective EDI project needs to be supported by a business plan. That plan consists of the following three parts:

- An **opportunity assessment process** that identifies the paper documents dominating an organization's workload; evaluates the organization's and all trading partners' computers' capabilities for sending, receiving, and processing EDI transactions; presents an understanding of the business effects of replacing specific paper documents with electronic transmissions; and, based on these results, formulates a list of promising EDI applications.
- An **economic analysis**, building upon an operating concept for each EDI application, that includes the calculation of direct and indirect cost savings, investment costs, and rates of return for each EDI application under consideration. These calculations yield a list of potential EDI applications in order of priority.
- An **implementation plan** that identifies, sequences, and schedules all of the events necessary to implement the organization's most promising EDI applications.

Identifying EDI Opportunities

Although procurement, contract administration, and payments appears to offer the most significant EDI opportunity for FAA, little is known about what types of contracting actions are conducive to EDI and the capability of its contractors to exchange procurement information electronically. Opportunities exist in contracting activities with the following characteristics:

- High document volume - Processing a large volume of procurement and contract administration documents.

- Suitable documents - Most of the documents processed are suitable for EDI translation; e.g., all the information that needs to be conveyed in the document can be mapped to EDI transaction sets.
- Trading Partners - Exchanging procurement documents with a few major trading partners.
- Automation - All trading partners must be capable of generating and receiving procurement information electronically.

Contracting Information Flows

Typical information flows associated with issuance of a purchase or delivery order and the receipt and payment of goods and services:

- Purchase request - The requiring activity states its requirement by submitting a purchase request that specifies a description of the item, estimated value, need date, priority, delivery point, and known sources, if any.
- Solicitation/quotation - The purchasing office solicits quotations from industry and receives quotations in response.
- Order - The purchasing office executes the purchase order (if the item was solicited) or delivery order (if the item is available on an indefinite quantity [IDQC] or delivery contract) and provides the contractor/vendor with a copy (i.e., Office Automation Technical Services - OATS).
- Obligation - The purchasing office forwards a copy of the order to the accounting office for recording of the obligated amount against the appropriate account. The purchase/delivery order is filed for reference at voucher examination
- Status - The purchasing office forwards a copy of the order to the requiring activity to document completion of the procurement action and to give notice when the item is scheduled for delivery or performance.
- Due-in - The purchasing office forwards a copy of the purchase/delivery order to the receiving office to notify it when the item is scheduled for delivery.
- Invoice - Upon completion of delivery or performance of the required item, the contractor/vendor either uses the invoice portion on the purchase/delivery order form upon delivery of the item or submits a commercial invoice directly to the accounting office.
- Receipt - The receiving office forwards a delivery ticket or completed receiving/acceptance section of the purchase/delivery order to the accounting office.
- Payment - Following approval of the voucher, the disbursement section of the accounting office pays the contractor by either issuing a check.

EDI Opportunities Methodology

The description of the five-step methodology that is used to identify an organization's most promising opportunities and the conditions that must exist for the implementation of EDI to be both practicable and beneficial is described below.

Step One: Select Key Documents

Much of the savings from EDI occur because electronic processing of documents is less costly than manual processing. As a consequence, the number of times that an activity sends or receives a particular document **(i.e., its transaction volume) is the primary criterion in selecting documents for potential transmission by EDI.** However, volume is not the only consideration. Other criteria require that the document be used extensively throughout the FAA, be handled by several departments within the organization, and be supported by an existing EDI transaction set.

Step Two: Assess the Capabilities of Internal Systems

Following the identification of the best candidates for EDI, the activity assesses its system capability to electronically send, receive, and process business documents. Without this capability, EDI is little more than a telecommunications method - which could lead to higher rather than lower processing costs. For each document or category of documents, a variety of information must be obtained: the automated system currently supporting processing of the document; the hardware, software, and operating system configuration of the current systems; and any planned enhancements to that system (with EDI initiatives singled-out for additional detail.)

Step Three: Assess the Capabilities of Trading Partners

Each organization needs to estimate the investment required by its external trading partners to implement EDI, following the same methodology described here:

For each candidate document, specific information must be listed: the external activity with which the document is exchanged; the capability of those systems to send, receive, and process EDI transactions; and the number of documents exchanged each year. The organization also **lists the number of trading partners required to reach a 70 to 80 percent implementation level (in terms of the number of transactions) for the documents. (Many private-sector firms use this range as the "critical mass" level for achieving the economies of scale associated with EDI.)**

Step Four: Review Business Practices and Workflows

In determining whether a document is a good candidate for EDI automation, each organization needs to consider its specific business practices. For example, before making a payment on an invoice, many activities require a record of acceptance showing that delivery has occurred and that the material received is not defective. If invoices are received electronically and, say, acceptance notices are received manually, the number of late payments could actually increase rather than decrease using EDI. Many private-sector companies have found that they cannot make effective use of EDI without changing their internal business practices and workflows (i.e., Business Process Improvement).

Step Five: Summarize EDI Opportunities

Based on the information collected in the four steps described above, the organization summarizes its findings about EDI opportunities. For each document, the

organization lists the corresponding EDI transaction set, the volume rating, the EDI capability of the internal automation systems, the ratings for external trading partners, and the business practices rating. Using this information, the organization then assigns an overall opportunity rating to each document.

Special Issues:

Trading Partner Agreements

The trading partner agreement is the key document that sets forth the rights and obligations of the trading partners, until it's negotiated, you can't turn over the implementation.

- A trading partner agreement is a written instrument of understanding negotiated between EDI trading partners. Its primary purpose is to decrease the cost of telecommunications by eliminating the need to transmit lengthy repetitive administrative material with each EDI message.
- In the private sector, trading partner agreements accomplish two purposes: state the contractual relationships and references (terms of conducting business) between trading partners, and specify the EDI technical protocols (such as transaction sets and mailbox addresses) that will be used in conducting business through EDI.
- Government-prepared trading partner agreements are not contractual documents. Instead, they focus on clarifying various technical and telecommunications issues associated with exchanging business information electronically. The typical Government trading partner agreement includes the following terms:
    - The applicable EDI implementation guidelines
    - The telecommunications mailbox addresses and routings for each trading partner
    - The schedules for transmitting messages and which trading partner pays for telecommunications costs
    - The procedures for resolving transaction and system errors
    - The back-up procedures in the event of system failure
    - The electronic record keeping responsibilities of each trading partner
    - The password generation and security methods that each trading partner will use.

Electronic Signatures

Contracts are typically considered valid only when signed by an individual. More recently, the General Accounting Office (GAO) has recognized facsimile signatures and machine-made signatures to be legally binding. A recent Comptroller General decision authorized the use of electronic signatures in the transportation industry provided they are properly authenticated.

Security

As with paper documents, care must be taken to ensure that EDI messages are authentic, properly authorized, and traceable; the messages also need to be protected from loss, modification, or unauthorized disclosure both during transmission and storage. **Major EDI software vendor packages include access security measures (passwords, electronic signatures, and so on) for disguising EDI data for secure electronic data transfer between organizations; Encryption - ensures data confidentiality; and Authentication - ensures data integrity.**

Use of EDI will have a profound effect on auditing activities, as shown in Table 5. With these issues in mind, the information systems can be designed to account for the changes brought on by EDI.

TABLE 5

Auditor concerns	Effect of EDI	Changes
Payment validation		
• Reconciliation of invoice, purchase order, and receiving documents to assure correct payment amount.	• All of these documents are now computerized. Lack of paper changes the validation process.	• Automate the validation process - in fact, this time savings is a key benefit of EDI.
Audit trail of activity		
• Tracking data flow within the organization. • Recording authorizations	• Computerized data changes information security procedures. • Lack of paper includes paper backup files. • EDI data flow can be documented internally, between organization and EDI VAN, and between organization and trading partner.	• Replace signatures with codes and IDs; electronic signatures are also an option. • Date/time stamp all activity and attempts to access the information system. • Maintain a specific audit trail database. • Require identification of terminal/PC to track point of access.
Order/payment control		
• Insuring only authorized sources can place orders and initiate payments.	• No authorization "sign-off."	• Create safeguards parallel to those of paper systems. • Require password access to the system. • Incorporate "reasonable checks" into the system ("Is it reasonable that 500 PCs were ordered for home delivery to John Smith?") • Emphasize user training to reduce system errors.
Correspondence of accounting records with actual transaction		
• Insuring that internal organization data reflects actual inventory and dollar figures.	• All files are computerized; no paper backup to verify records.	• Spot check actual transactions versus system files. • Verify assets with different (that is, non-EDI) data.

Value Added Networks (VANs)

Businesses can exchange data either by connecting to each other directly or by hooking into a VAN. A VAN is a communications network that typically exchanges EDI messages among trading partners and provides other services that include holding messages in "electronic mailboxes," interfacing with other VANs, and supporting many telecommunications modes and transfer protocols.

VANs provide many services. Since cost is always a big factor, it is advisable to closely scrutinize what the startup and continuing costs of VAN service really are, Appendix B provides a list of selected VAN's.

VAN services are offered by the General Services Administration (GSA) and DoD is developing a means of interchanging data internally, with private industry, and with other Federal Agencies - with minimum impact on its installed systems.

The DoD EDI architecture is based on the principles of open systems. The common approach requirement is being satisfied through the use of distribution points that provide connectivity between the DoD EDI Gateway and EDI VANs that have entered into a license agreement to communicate DoD (government agency) EDI data to and from their subscribers.

Examples of Economic Benefits:

- Pacific Telesis (PacTel) eliminated 51% of its paper-based systems, and lowered its cost per transaction from $78.00 to 48 cents.
- The Long Island Medial Center reduced its inventory of medical supplies by 25% over a two year period, while at the same time the number of orders (per year) increased from 22,000 to 35,000.
- The Department of Veterans Affairs saved $2.1 million annually and cut $70,000 in overtime.
- The DLA General Supply Center (DGSC) in Richmond identified $24.5 million in savings with their Paperless Order Processing System (POPS) due to paperwork elimination, inventory reduction, and reduced costs.
- The Defense Personnel Support Center (DPSC) in Philadelphia, has more than 300 trading partners and spends $56 million a month on EDI purchases (food, clothing, and medical supplies). The EDI system is called the Supply Automated Materiel Management System (SAMMS) Procurement by Electronic Data Exchange, or SPEDE, system SPEDE is "total hands off - no human intervention."
- The Directorate of Medical Materiel, part of DPSC, saved $24 million in the last two years by using EDI to order medical supplies The Navy expects to save $70 million in eight years by using EDI in areas ranging from procurement administration to transportation services. The time between when an order is placed and when it is shipped has dropped from 60 days to two.
- Texas Instruments states that before EDI implementation in their procurement organization, it cost an average of $49.00 to process a purchase order. After EDI implementation, together with extensive business process re-engineering, the average cost was lowered to $4.70.
- Internal Revenue Service spends an average of $82.00 to manually process a Tax Return, while it costs an average of $8.75 to process a return electronically.

- EDI is not new to the U.S. Customs Service, began implementation in 1983, and a joint Department of Treasury-Office of Management and Budget (OMB) study shows Customs productivity increases of over 10 percent per year since 1984. The number of imports has increased 100 percent, while the customs work force has increased only seven percent.
- The Workgroup for EDI (WEDI) convened by Department of Health and Human Services Secretary Sullivan in November 1991 identified between $4B-10B could be saved per year in the administrative costs for the nation's health care system through the use of EDI. This is in relation to the $120B of administrative costs for the $900B U.S. health care system.
- The Health Care Financing Administration estimates it cost between three and 10 cents to send a check electronically. This compares to the 29 cent cost of mailing a check and the $47 cost to the agency to replace each check lost in the manual system.
- The Electronic Data Interchange Association (EDIA) estimates that EDI cuts the cost of sending a bill of lading from $13 to $1.50. It is estimated that 70 percent of the computer-originated information exchanged between businesses is subsequently reentered into another computer.
- EDI has been found to significantly reduce administration costs. It is estimated that 25% of the cost of executing a business transaction is data entry and rekeying. Additional time and costs are also incurred correcting errors made in the original entries and managing related inventory management problems.
- The major auto manufacturers such as General Motors and Ford have created a payment system entirely dependent on electronic transactions. The use of EDI for replacement or invoices, checks, and other financial settlement instruments has become a model for corporate trade payments in a number of industries.
- Wal-Mart's replenishment system was touted in a recent Harvard Business Review article, not merely as a model for the retail industry but as a model for what all organizations must do to compete in the coming decade. For example, they are sharing point-of-sale (POS) data with 3,000 vendors while there competitors talk about doing EDI with 2,000.
- Sears investment to convert over 5000 suppliers to EDI totaled over $5 million, but the company has quickly experienced a payback in several areas. The benefits to vendors have included a reduction in clerical errors, a reduction in inventory and manufacturing times, a shortening of the order cycle, and improved document processing. The result of all these efficiencies is that goods move more quickly and easily to Sears stores, resulting in greater productivity and profitability for both the company and its suppliers.
- Toys 'R' Us has reaped tremendous benefits since it implemented a network to its suppliers in the late 1980s. One immediate result of its work was a streamlined accounts payable process. Toys 'R' Us can now do an immediate

electronic line-by-line item match for each of the 500,000 invoices it processes annually.

- Pratt & Whitney in a preliminary evaluation estimated they could save between $20 an $30 per purchase order through the use of EDI. After three years of hard work 83 percent of the 635 targeted suppliers are EDI capable, this targeted group represents 92 percent of the purchasing volume.

Viewing these examples and other, the general range of economic savings varies from 10% to 10 times improvement. As mentioned before, however, most organizations do not implement EDI exclusively to save money. While they recognize that EDI is an excellent method to contain escalating costs for the future, and even reduce costs in the near term, **EDI is most often implemented primarily to perform their business and mission more effectively.**

EDI also transforms the ways organizations work together. For example, when large auto manufacturers demand that their suppliers communicate with them using EDI, one of the objectives is to make suppliers more productive, profitable, and therefore stable.

3.2.3. Technology Transfer

GATEC

A DoD pilot project called the Government Acquisition Through Electronic Commerce (GATEC), will allow vendors to conduct business electronically using one of the VANs participating in the project. GATEC was developed as a standard system (participation is open to Federal Agency's). It is an end to end connection tool, capable of communication with any/all standard procurement systems providing data to it **Via these VANs, vendors will have access to Request for Quotation (RFQ) issued (under $25,000) by any participating federal agency**. RFQs will be issued as "public RFQs" accessible to any interested vendor. Similarly, public award summaries will be accessible via the VANs to inform interested vendors of awards made in response to RFQs.

Pilot project buyers may send an electronic RFQ to a specific vendor; as a public RFQ; or as both. Also, as is now the case, buyers may occasionally issue a purchase order of delivery order without competition.

The project is conducted using ANSI X12 standards and the acquisition network in which requests for quotation, bids, and awards flow back and forth through a prototype gateway was developed by (and is maintained by) the Lawrence Livermore National Laboratory (LLNL). LLNL is also responsible for testing each VAN for compliance with standards and conventions being used. Six firms have been qualified to participate in the project; Bell Atlantic, Datamix, AT&T EasyLink, EDI Able, Harbinger EDI, and Simplix.

ANSI 841 Specifications/Technical Information

This transaction set can be used to transmit specifications or technical information between organizations (i.e., CALS documents). The detail area can include graphic, text, parametric, tabular, image, spectral, or audio data. A transmission includes information to assist the receiver in interpreting and utilizing the information included in the transaction.

The detail area of the Specification/Technical Information transaction set provides a structure which allows for the exchange of a variety of specification information. For example, if the transaction contains information describing a complete assembly, it would be necessary to include the assembly model, the models for each of the individual parts, and the associated specifications. This transaction set can also be linked to other transaction sets.

This transaction set could possibly support the transmission of Procurement Spares Packages (Bid Sets) from the FAA Logistics Center.

4. Summary: Key Conclusions from Survey

A successful EDI system does not depend on technology; it relies on a strong business relationship with the trading partner. It has to be truly a partnership agreement because it involves a commitment to a long-term investment, to refine the system over time. An organization should not initiate EDI Projects by sending transactions back and forth; it should go back and think about the whole process, end-to-end. The implementation of **EDI will require a fundamental change to business processes (i.e. BPI).**

The following table provides a summary of key conclusions referenced to the CIE initiatives.

Summary Table of EDI to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicles
Core Architecture	• DoD documented direct savings of $3.52 per purchase order • PacTel lowered its cost per transaction from $78.00 to 48 cents • TI lowered cost to process a purchase order from $49.00 to $4.70	• Enabling technology should be independent of specific automated information systems. • Begin pilots with EDI experienced trading partners. • Plan for resistance and develop contingencies. • Training is an investment. • Use of EDI usually requires a change in an organization's business paradigm.	• Procurement, contract administration, and payments appears to offer the most significant opportunity* • ANSI X12 transaction sets*
Business Process Improvement	• Typical costs for processing a document can range from $10 to $40; conducting business electronically can reduce those costs by a third to a half • Realizing indirect cost savings of $3 to $5 for every $1 in direct cost savings • DoD estimates a cost savings-to investment ratio of 14 to 1	• EDI requires solid management of expectations, resources & funding • Can be used for *all* business functions • Every prospective EDI project must be supported by a business plan • Five-step methodology to identify promising opportunities	• Technology issues represent about 20% of the total business solution
Data Management	• Estimated that 25% of the cost of executing a business transaction is related to rekeying	• EDI can reduce manual re-entry of data. • EDI establishes standards for data interfaces.	• ANSI standards provide universally accepted data formats, transaction sets, to exchange business information* • Major VANs are interconnected*
Corporate Software Engineering		• EDI can promote application integration.	
Electronic Data Interchange	• Benefits reaped with volume	• It is not a technological program	• GATEC pilot project for acquisitions under $25,000* • ANSI 841 transaction set supports CALS type documents*
IT Security		• Payment validation - automating the process is a key benefit • Replace signatures with codes and IDs • Record all activity and attempts to access the information system • Maintain a specific audit trail database • Incorporate reasonable checks into the system	• Encryption ensures data confidentiality* • Authentication ensures data integrity*

* Technology Transfer Applicable to FAA

APPENDIX A
Steps to Implementation

There are eight detailed tasks that an organization typically needs to satisfy as it replaces paper documents with electronic transactions. Depending on the nature of an organization's project, some of the tasks discussed below may not be required. Also, they may be accomplished in a different order than listed here.

1. Establish project team

   The team should include representatives from all functional areas within the organization that may be affected by EDI.

2. Develop business plan

   The plan lays out in broad terms the expected accomplishments, benefits, and associated technical requirements to achieve them.

3. Identify functional requirements

   Organization identifies the operational, business, legal, security, data, and technical issues that effect establishment of an electronic operating environment.

   3.1 Complete operating concepts

   Develop a formal document that describes in detail, the data flows, trading partners, work methods, and procedures that the organization will employ in an electronic environment.

   3.2 Detail data requirements

   Identify all data elements required to accomplish the data flows. Data will be used to develop or modify EDI standards, conventions for their use, and programs to interface the application system database with the EDI translation software package.

   3.3 Determine applications systems modifications

   Identify needed enhancements to application systems and formulate a plan for implementing them.

   3.4 Identify and resolve business, legal, and security issues

   Investigate and resolve all business issues and examine the legal and security requirements of EDI and its audit capabilities to ensure the integrity of the functions is maintained.

4. Specify operating requirements

   Organization must address its hardware, software, facility, and manpower requirements.

   4.1 Review and complete hardware specifications

   Reexamine the technical architecture and system throughput requirements to determine the hardware required to support EDI applications.

   4.2 Identify EDI translation software requirements

Selection is based upon a number of considerations, including final operating concepts, functional requirements, hardware capabilities, as well as options offered by the vendor.

4.3 Establish telecommunications strategy

This strategy builds upon an organization's telecommunications requirements as measured by the number of transactions sent to and received from its trading partners.

4.4 Identify facility and personnel requirements

Examination includes facilities, including telephone lines, electrical outlets, and office space, to ensure that they are adequate.

5. Review EDI standards and conventions

Review current standards and propose any needed modifications.

5.1 Map data requirements to ANSI standards

Match data requirements from each document (or opportunity area) to a specific location in the applicable EDI transaction set.

5.2 Develop new or modify existing standards

Organization works with the ASC X12 subcommittees to either develop new EDI standards or modify existing ones.

5.3 Prepare data conventions

Publish data conventions that detail the rules that the organization plans to follow when transmitting information.

6. Integrate and test system

Involves all the efforts required to field an EDI capability.

6.1 Procure and install hardware and software

6.2 Modify applications system

Organization enhances its application systems to both accept EDI information and make maximum use of that information.

6.3 Develop interface programs

Work with an EDI translation software vendor to define formats for passing data between its applications systems and the EDI translation software.

6.4 Arrange for telecommunications

Implement telecommunications strategy.

6.5 Update operating procedures

Formulate detailed operating procedures for day-to-day EDI operations.

6.6 Train operators

Formulate a comprehensive EDI training program and oversee its implementation.

6.7 Test, evaluate, and modify system

Test the EDI system using sample data, evaluate the results, and make appropriate modifications.

7. Establish trading partner relationships

Formulate a strategy for soliciting and working with trading partners.

7.1 Develop trading partner implementation strategy

Strategy should address the pace of implementation, establishment of milestones, and methods of operation.

7.2 Prepare and distribute trading partner information

Package would include such information as implementation procedures, operating concepts, EDI passwords, and codes, points of contact, and EDI trading partner agreements.

8. Implement production system

Organization should focus on increasing the number of trading partners by a fixed number each month. As the trading partner base expands, the organization should explore additional EDI applications and incorporate other trading partners that were not initially targeted.

APPENDIX B
Selected VAN Services

VANs that provide those services needed to facilitate EDI procurement between the federal government and the vendor community.

APPENDIX B

Analytical Software

Mark Haley

214-340-2564

Bell Atlantic

Network Services

703-914-3919

Datamatix

Richard Bearinger

215-397-0900

General Electric Information Services (GEIS)

Jacelyn Swanson

301-340-4485

Infomaze

Sam Nicolosi

513-254-2673

Sales Opportunity Services, Inc.

Sales Department

814-949-3339

United Communications Group

Joseph Klem

301-816-8950, ext. 234

AT&T EasyLink

Telephone Sales

800-242-6005

Data Management

James Davis

407-725-8081

EDI Able

Howard Bennett

800-622-6118

Harbinger EDI

John Goetzman

800-367-4272

Martin-Marietta

Butch Mills

703-802-5161

Simplix

George Chisa

313-740-8150

Section 3

Joint Computer-aided Acquisition and Logistics Support (JCALS)

Table of Contents

Report on
Joint Computer-aided
Acquisition and Logistic Support (JCALS)

1. Program Description

The Computer-aided Acquisition and Logistic Support (CALS) Program of the DoD is the major DoD initiative to support the development of standards, architecture, and infrastructure by which electronic technical information for weapon systems can be exchanged, shared, and integrated. CALS is a major DoD-wide effort to move to a "paperless" environment. Other related initiatives include Concurrent Engineering, Electronic Data Interchange (EDI), and Corporate Information Management (CIM). While focused on DoD requirements, the program has promoted the development of standards for logistics data, technical documentation, engineering data, product data and other types of information that will have applicability to industry as well as the FAA. A key requirement of CALS has been the capability to exchange information with industry contractors. *In many cases, the same contractors support both the DoD and FAA.*

The overall CALS program is coordinated by the Defense CALS Executive, MGEN. E.R. (Russ) Baldwin of the OSD (Production and Logistics). The major implementing organization for CALS is the Joint Logistics Systems Center (JLSC) in Dayton, Ohio. The DISA/Joint Interoperability Engineering Organization (JIEO) is also concerned with CALS implementation especially in regard to standards testing and implementation of EDI.

One of the major objectives of CALS has been to foster parallel development of CALS approaches and technologies within the DoD and in industry. DoD representatives for CALS have actively participated in the Industry Steering Group (ISG) and in the activities of standards bodies. However, the combination of declines in defense expenditures and a general recession have threatened the financial health of many aerospace contractors, diminishing industry support for CALS development. With the decline of aerospace efforts, the DoD role in CALS has become more critical, and JCALS is the major vehicle for DoD CALS implementation.

THE JCALS PROGRAM

As part of the DoD effort to achieve the CALS objectives, the DoD supported several initiatives within the services. The JCALS program began as an Army initiative, ACALS, to provide an integrated capability for managing all types of technical information required for logistics operations. This strategy differed from the more gradual approaches of the other services which pursued programs for managing particular classes of logistics data such as technical manuals in the Air Force Technical Order Management System (AFTOMS) or engineering data in the Navy Engineering Data Management and Information Control System (EDMICS).

The Army followed at four-phase acquisition strategy that encouraged competing contractors to develop alternative approaches to the ACALS. By August 1989, the field had been narrowed to four contractors--TRW, BDM, Xerox, and CSC. The final two entrants demonstrated parts of the design concepts in late 1991. At about the same time the Pentagon decided to elevate the ACALS program into a joint program, JCALS, which

would provide CALS capabilities for all the service components. With the creation of the joint program the number of implementation sites increased from 50 for the Army program to a current total of 248. The DoD sites will serve requirements of the Army, Navy, Air Force, Marines, and Defense Logistics Agency.

The primary responsibility for JCALS development and integration was awarded to Computer Sciences Corporation (CSC) in December 1991. If all options are exercised, the contract will be worth approximately $744 million. Because of the decline on industry efforts in CALS, JCALS has become the major vehicle for CALS implementation.

The major initial application of JCALS is to technical manuals. The change in focus from Logistics Support Analysis Requirements (LSAR) data to technical documentation was in response to two factors. First, agreement among the services on the common requirements for LSA data was difficult to obtain. Second, The Air Force had developed a detailed set of requirements for technical documentation, the AFTOMS. While the program had been initially approved for implementation as a joint service program (JUSTIS), funding was discontinued as the DoD redirected and consolidated CALS programs. To fulfill that requirement, the Air Force requested that JCALS implement document management as the first application to demonstrate CALS capabilities.

ECALS

CSC has established a program, designated ECALS (Enterprise CALS) to provide capabilities similar to JCALS to commercial organizations and other federal agencies. One significant difference between ECALS and JCALS is that ECALS is written in "C" and JCALS is written in Ada, conforming to the DoD language requirement.

Relation to FAA Environment

The value of the CALS program has already been recognized by the FAA. ANS-400/AOS-300 has produced a CALS Development Strategy for the FAA, which recommends that the FAA makes use of CALS standards and technologies to support the standardization and exchange of electronic technical information. The JCALS program addresses a number of key requirements for FAA information management including capabilities for document management and the implementation of CALS standards for the exchange of technical information. JCALS capabilities should be evaluated for application to the technical information requirements of FAA user organizations, specifically, AOS-200/300, AML-400, AMA-400/500, ACN-600, and ARTCC/GNAS field sites.

In addition, JCALS has implemented a number of tools, such as the JCALS Global Data Management System, a system for accessing distributed data, that the FAA may want to build upon to meet its own information management requirements.

Key JCALS Personnel

- DoD CALS Executive: Defense CALS Executive, MGEN E.R. (Russ) Baldwin
- DoD JCALS Program Manager: Dr. J. Tomlinson, 908-532-0400
- Computer Sciences Corporation CSC JCALS Program Manager: Mr. J. Plotnick 609-983-4400

2. Method of Investigation

The Volpe Center has been a major contributor to the DoD CALS effort since the inception of the program (see the Report on CALS). The Volpe Center has supported the DoD Services (and the FAA) on a wide variety of CALS tasks such as:

- Air Force - development of automation plans, functional requirements, and CBAs for technical manuals, LSA/LSAR product definition data. In addition, the Volpe Center developed and demonstrated a prototype of the original requirements for an automated technical manual system (AFTOMS). (The original AFTOMS requirements are now being implemented under JCALS.)
- Navy - definition of CALS functional requirements, acquisition guidelines for CALS standards, CBAs, and an assessment of flexible manufacturing technology.
- OSD - development of CALS strategic plans and architecture for Congress.
- *FAA - definition of the concept, functional requirements, system architecture, program plan and CBA for Automated Documentation Development and Maintenance (ADDM). ADDM is a proposed NAS Program Initiative to develop and implement the capability to create, manage, and distribute electronic NAS technical documentation and FAA directives.*

This perspective provided the background for the analyses of the DoD CALS Program and JCALS.

The primary source for the JCALS study were program descriptions supplied by Computer Sciences Corporation (CSC) and an interview with one of the original designers of the JCALS concept, Dr. Robert F. MacLean, Manager, Technical Operations for CALS Business Systems in the Integrated Systems Division at Moorestown, NJ.

3. Relationship of JCALS to CIE Initiatives

3.1. CORE ARCHITECTURE

3.1.1 CBA

One of the major benefits of the JCALS design is the ability to make use of commercial products in an open systems environment. This permits reduced costs *for federal agencies like the FAA* and private industry due to the larger customer base of commercial products and more rapid updating of technology that supports evolving system functionality.

3.1.2. Lessons Learned

Key Lesson Learned: JCALS has demonstrated the feasibility of developing transportable applications in a Unix based OSE.

One of the requirements of JCALS is to provide functionality that can be easily transported to future technology platforms that may be adopted by the DoD. For example, the Global Data Management System (GDMS) is designed to be independent of the Unix hardware platform. While the software is currently based on Sybase, it is designed to be transportable to other DBMS environments.

The OSE has made it possible for JCALS to employ commercially available software packages, such as Information Dimensions Basisplus and the ArborText SGML Editor, to

support the functionality required for JCALS data management and data distribution. The exceptions are the Global Data Management System and the Workflow Manager.

3.1.3. Technology Transfer/Procurement Vehicles

Technical Architecture of JCALS

JCALS provides a number of capabilities that should be evaluated when similar capabilities, e.g. ADDM, CAEG, are implemented in the FAA environment. These include:

- **Open Systems Environment** - JCALS supports a distributed database environment based on UNIX/POSIX standards.
- **Client/Server Architecture** - The processing architecture for JCALS is based on a client/server model (see Figure 1.). The Workstation Server runs user applications and controls the local Ethernet network. The Network Processor links the JCALS Site with other JCALS sites and the other sources of DoD data. These may include DoD systems that manage legacy data which JCALS users need to access. The Data Management Subsystem is the key integrating capability for the JCALS site. It manages databases that support local user tasks and requirements. Data Management for the site also makes use of the GDMS to maintain links between site JCALS databases at the site and other sources of data.
- **Communications** - For each of the local sites, JCALS will provide a FDDI standard 100 Mbit/sec. backbone. The Network Processor connects the LAN to other sites by means of FTS 2000 DDN telecommunications support. The communications protocol for data communications is TCP/IP. GOSIP capabilities will be introduced as OSI capabilities become available. JCALS employs DEC Network Management Control software for network administration.
- **Data Management** - The key integrating mechanism is the GDMS, which performs *directory* functions. *The GDMS capabilities are similar to the requirements for the FAA Repository including active retrieval of data in a distributed database environment.* (The GDMS is discussed in more detailed in the Section 3.3.3 below on Data Management.)
- **User Interface** - The primary platform selected for JCALS is a DEC workstation that provides an X-Windows/Motif interface. JCALS also provides for PC and MacIntosh access to JCALS databases, provided the PCs can operate in the X-Windows environment.

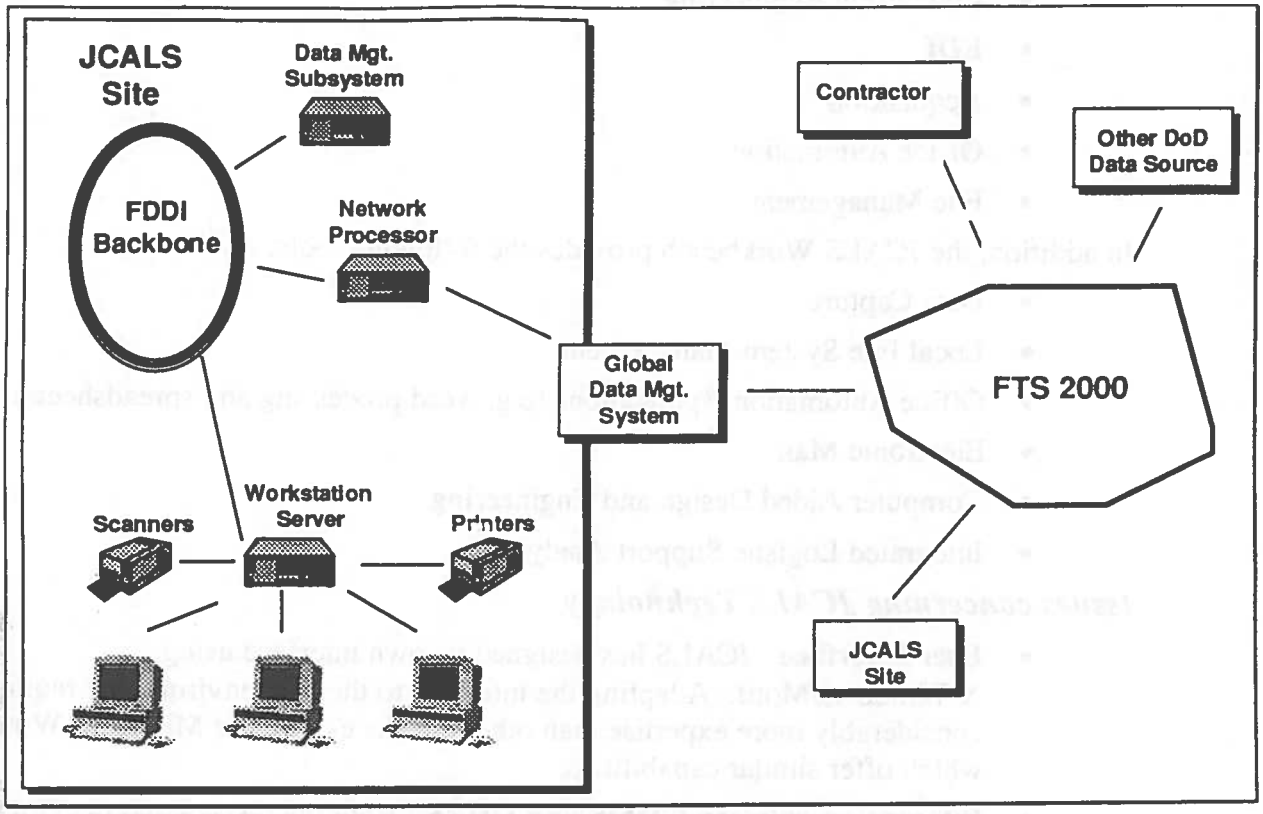

Figure 1. JCALS System Components

The JCALS Workbench - Core Functions and Applications

One of the major features of JCALS is a suite of applications that support DoD requirements for managing and using technical information.

The **core functions** of JCALS are the following:

- Global Data M[illegible]agement System - directory for distri[illegible]d data access
- Reference [illegible]rary - management and retrieval of stored technical information
- Data Communications Network Management
- User Interface - graphics based interactions with users
- Workflow Manager - management of task planning, execution and related data
- Security - provision of multilevel security

Applications that build on the core functions to support CALS requirements for management of technical information in order to support acquisition and logistic support functions:

- Legacy Data Capture
- Logistic Support Analysis
- Program management
- Electronic Publications
- Data Import and Export

- Concurrent Engineering
- **EDI**
- Acquisition
- Office Automation
- File Management

In addition, the JCALS Workbench provides the following tools:

- Data Capture
- Local File System Management
- Office Automation Applications (e.g. word processing and spreadsheets)
- Electronic Mail
- Computer Aided Design and Engineering
- Integrated Logistic Support Analysis.

Issues concerning JCALS Technology

- **User Interface** - JCALS has designed its own interface using X-Windows/Motif. Adapting the interface to the user environment requires considerably more expertise than other interfaces, such as Microsoft Windows, which offer similar capabilities.
- **Integration between GDMS and DDRS** - Both the GDMS and the DoD software repository the DDRS provide mechanisms for locating data required by users to perform tasks. It will be necessary to establish an interface or other means for integrating data access via the DDRS and the GDMS.
- **Wide-area Network Communications** - While the FDDI backbone for the LAN is sufficient to support transfers of large document and graphics files, the capabilities of the FTS 2000 WAN may inhibit rapid access to data at remote sites.
- **Reliance on DEC Workstations and Servers** - FAA use of the technology will require evaluating performance in the PC environment and the requirements for adapting the technology to OATS platforms for data access and delivery.

JCALS Pilots

The first of 248 JCALS sites will be at Fort Monmouth, NJ the location of JCALS Program Management. The Marine Corps is planning to focus on management of technical manuals in their first JCALS implementation at Albany, GA. The major initial application for the Army is uncertain as of March 1993.

Site surveys were performed by CACI to determine how JCALS implementations would have to be adapted to site requirements.

ECALS Implementations

CSC is actively marketing the ECALS for use in federal agencies outside the DoD. A number of commercial organizations are evaluating the CSC technology to meet

requirements for technical information management. Commercial implementations include the following:

Rockwell Corp.

The company is implementing a version of JCALS for enterprise-wide aerospace and DoD applications. The company wants to make the standards for documentation data a standards for the aerospace industry.

Caterpillar, Inc. Technical Information Division

CSC is supporting the development of a system to provide electronic access to service and diagnostic information for the world-wide network of dealerships. Caterpillar is using ECALS for the following functions:

- Documentation management, modification and production
- Parts database
- Management of photographic information.

The Caterpillar program is being financed by the dealers who can reduce the costs of the paper documentation.

Future Plans for Data Integration - Documentation and Drawings

The CSC JCALS Program has begun to work with the DoD lead program for managing engineering drawings, JEDMICS (Joint Engineering Data Management Information and Control System). The objective is to achieve integrated access to both documents and drawing information. Responsibility for data management, including configuration management will be retained by JCALS for document data and by JEDMICS for drawings. The GDMS will maintain links between documents and JEDMICS drawings contained in the documents. When a drawing is changed in the JEDMICS repository, a message will be sent to update affected documents under JCALS configuration control. *This capability may be applicable to the FAA for the management of NAS technical documentation and engineering drawings.*

Data Standards

JCALS has demonstrated the application of existing and proposed DoD CALS standards to the management of electronic documents and other types of technical information. The key standards that support data exchange in the POSIX-based open systems environment are listed in Table 1.

Table 1. - JCALS Data Standards

Standard Domain	Standard
Data Interchange	
Vector Graphics	IGES MIL-D-28000
Text	SGML MIL-M-28001
Raster Graphics	CCITT GR4 MIL-D-28002
Technical Illustrations	CGM MIL-M-28003
Logistics Data	LSAR MIL-STD-1388
Electronic Forms and Transactions	EDI ANSI X.12, Trans. set specs. (840, 841, 843...)
Engineering Product Data	PDES/STEP
Communications	TCP/IP GOSIP (OSI)
Database Query	SQL - FIPS 127-1
Display	X-Windows MOTIF MS Windows
Compound Documents	MIL-D-IETM DB, MIL-STD-1840A
Operating System	POSIX
Language	ADA for JCALS, C for ECALS

IETMs

For future production of integrated documents, the Interactive Electronic Technical Manual (IETM) specifications will provide standards for database management of document content. *For the FAA, IETMs would be apply to technical documentation for new NAS systems*. The standards include:

- MIL-M-87268 (GCSFUI) - provides for general content, style format and user interaction requirements
- MIL-M-87269 (DB) - provides for database for the support of Interactive Electronic Technical Manuals
- MIL-M-87270 (QA) - provides for quality assurance program for IETMs and associated technical information.

CITIS

The standard for interchange of technical information with and among contractors is known as Contractor Integrated Technical Information System (CITIS). The proposed standard MIL-STD-974, draft dated November 16, 1992 was released for review and comment. The revised standard will be published this summer. *CITIS could enable FAA program offices to access NAS equipment CDRL information including documentation, plans, and proposed changes.*

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA

Caterpillar, Inc. has implemented a document management system using JCALS. The system is now in the process of loading data. While detailed data on benefits is considered proprietary, some of the types of potential benefits that motivated Caterpillar to adopt JCALS are listed below:

- Reduce document cycle times for revisions from 10 weeks to 4 weeks
- Reduce paper production from 100 tons per month to 40 tons per month
- Ensure 48-hour world-wide delivery of replacement parts
- Reduce cost of production and management of paper documents
- Improve quality of technical documentation.

The Caterpillar program has currently installed a pre-cursor electronic document program and has carried out business process analysis in relation to impact of ECALS on business operations for Caterpillar and its associated dealers.

3.2.2. Lessons Learned

JCALS integrates publishing with other processes that depend on the use of technical information. The JCALS program is carrying out Business Process Improvement (BPI) analysis for technical publishing operations in the DoD. The program is following the DISA/CIM approach to define the process by means of IDEF models and recommend appropriate process changes.

The modeling effort built upon the previous effort by CACI for the Army and is being extended to potential sites for JCALS implementations. One goal of business process analysis is the definition of standard workflows that can be used by multiple organizations.

Key Lesson Learned: Integrate tools for Workflow Management with applications that provide access to technical information.

JCALS provides for a tool for defining and managing tasks called the Workflow Mana_ (see below under Technology Transfer). This approach, and the supporting tools, link information access to task execution. *The FAA may find this approach useful as means to address requirements of BPI.*

3.3.3. Technology Transfer/Procurement Vehicles

In addition to the analysis of process requirements for electronic publication, JCALS provides a number of tools to support Business Process Improvement.

Workflow Management Technology

JCALS is implementing a tool for linking task definitions to information requirements. The **JCALS Workflow Manager** is a project management tool that permits managers to define tasks and resources required to carried out a defined job. The information flows and tasks are tracked by a Sybase database. The Workflow Manager is currently based on a text file. A graphical interface will be provided in future versions of the tool.

Related to the Workflow Manager is a **Task Manager** which provides "to-do" lists for users for a given job. The Task Manager also associates particular objects with the tasks and permits accessing the objects by "clicking" on the object in the task folder.

While the current Workflow Management tool has been developed by CSC, it is possible that JCALS will use a commercially available product in the future. There are at least 20 commercial workflow products available. *The FAA should evaluate these products in relation to the suite of tools it will use to support BPI analysis and implementation.*

3.1. DATA MANAGEMENT

3.3.1 CBA

3.3.2 Lessons Learned

Document Data Management

Key Lesson Learned: Document management offers a low risk means to demonstrate the benefits of integrated management of technical data.

The management of technical information has received a high-priority in DoD automation strategies because of the substantial business efficiencies to be obtained from the paperless environment, including avoiding the rapidly escalating costs of managing paper-based information.

The competitive evaluation of potential contractors for JCALS and subsequent development and demonstration of JCALS prototypes has demonstrated the viability of using existing technology to automate the document production process and manage maintenance and delivery of electronic technical documents and related information. JCALS has reduced implementation risk and cost by making use of COTS products and existing standards.

Standard Generalized Markup Language (SGML) Expertise Requirements

Management of document data will be facilitated by the use of *content tags* in SGML. The tags provide a means to identify the subject content of parts of documents (document components). This identification enables the content to be managed in a database that can classify and relate the document components. The standard SGML tags also support formatting and interchange of documents and document components.

Key Lesson Learned: There is a need to train FAA and contractor personnel in techniques required for applying SGML to FAA document requirements.

The use of SGML requires development of Document Type Descriptions (DTDs) and Formatted Output Specification Instance (FOSI). While tools to support the use of SGML are becoming available, considerable expertise is required to define DTDs that support SGML tagging of document format and content. An alternative to the normally complex typing of document structures is the procedure followed by NASA, which uses simpler DTDs for standard word-processing products. The FAA will have to establish policies for the generation and use of DTDs. FAA staff will have to be trained to develop and modify DTDs for FAA applications. The FAA (ASE-630) has a current effort to develop an FAA

order, Electronic Technical Information Standards Guidance. This order will provide FAA Program Managers with guidelines to acquire technical information in standardized electronic formats.

Active Information Retrieval

> ***Key Lesson Learned: JCALS has demonstrated the viability of an active repository, the use of a locator to "gather" information required for task execution.***

The Global Data Management System, in combination with other JCALS components such as the Workflow Manager and Auto-Gather tools, permits active assembling of information required for execution of acquisition and logistics tasks that depend on technical information.

3.3.3. Technology Transfer/Procurement Vehicles

Global Data Management System (GDMS) - Potential Support for FAA Repository

One of the major non-COTS systems developed for JCALS is the Global Data Management System (GDMS). The GDMS permits the operation of what JCALS calls the "Reference Library." This capability provides for integrated management of data that may reside on multiple distributed databases. The reference library retrieves information on the basis of user selected categories and delivers the objects form distributed sources to a folder on the user's desktop system. The Reference Library also provides viewers for displaying objects that conform to differing data storage standards. These capabilities provide for the beginnings of the DoD concept of an Integrated Weapon System Database (IWSDB).

The GDMS could provide much of the capability for integrating access to distributed data that is required for the FAA repository (Data Management Initiative). The JCALS program has a working prototype of the GDMS that can be demonstrated at the CSC facility in Moorestown, NJ.

Interface between Repositories for Document Data and Repository for Engineering Drawings

The GDMS for JCALS will be linked to the index for engineering drawings developed by PRC under the Navy-led JEDMICS program. *This corresponds to the FAA (ADDM) requirement to link repository management of document data and engineering graphics.* The naming conventions used for the GDMS will be consistent with the definitions in the DISA/CIM repository, the DDRS (Defense Data Repository System).

JCALS Data Model

JCALS is building on the original data model developed by CACI for ACALS. The FAA may want to examine the process and results of JCALS data modeling for application to its own environment.

Electronic Document Management Capabilities

The FAA (ASE-630) has a current effort to develop an FAA order, *Electronic Technical Information Standards Guidance*. This order will provide FAA Program Managers guidelines to acquire technical information in standardized electronic formats.

While JCALS intends to manage a the broad scope of technical information, the first applications will be to the management of technical documentation (technical manuals). *The DoD requirements for integrated management of Documents and Engineering Drawings corresponds in many ways to FAA requirements for integration of documentation (ADDM) and drawings (CAEG).* Capabilities provided by JCALS that address requirements for document management include:

- Global locator for documents in distributed repositories
- Implementation of standards for document content identification, format specification, and data interchange
- Integration of document management with project management tools (Workflow Manager and Task manager)
- Support for the document production process, including authoring, editing, review, production, distribution, and user query and access.

Tools supporting document publishing capabilities include the following:

- **ArborText SGML Editor** - The ArborText product supports editing and review of the SGML document. When a document is released for review, the document is displayed in a different mode when a user retrieves the document. This display process is administered by controlled by the Controlled Access Folder Executive (see below). Reviewers' notes are inserted as specially marked text in the document. The original author, or the responsible authority for the document, can then combine the individual fragments into a completed document.
- **Datalogics JCALS Composer** - The composer takes the SGML document file and provides output in correct order and format to a standard PostScript printer. Graphics contained in the document file are automatically converted for PostScript output. In the process of conversion, the composition tool checks the SGML file for correctness, paginates the document and arranges graphics according to the output specifications, and resolves cross-references within and external to the document.

JCALS Use of CALS Standards for Electronic Documents

SGML Document Standards

JCALS representation of electronic documents conforms to the standard for SGML, MIL-M-28001A. Content tagging enables managing the content of documents using a relational database. The program will also conform to the new documentation standard, MIL-M-28001B and the DTD standard for technical manuals, MIL-M-38784B.

So far DTDs have been defined for technical manuals and depot maintenance work records using the MIL-M-38784B standard. Additional DTDs have been created for statements of work and other manuals not already defined by CALS standards. *Many of the DTDs developed by the DoD could be tailored for adoption by the FAA.*

Multimedia Standards - Hypertext Links and Extensions in HyTime

In addition to traditional document applications, SGML is used for a wide variety of documents including procurement forms, parts lists, and specifications. JCALS is also using SGML to provide hypertext links among document elements. InfoDesign is the contractor that is supporting DTDs for documents. The definitions also provide for links to the Task Manager.

Content Data Model

One of the requirements for JCALS is the implementation of a content data model (CDM) that provides for hypertext links among documents. The model must also address requirements of legacy paper documents, currently produced electronic documents and future documents. The standard that InfoDesign is using for this purpose is HyTime, the Hypermedia/Time-Based Structuring Language. While HyTime originated as a means to describe time-based data such as musical scores in a device-independent language, it has been extended to include multimedia information and hyperlinks among data objects. HyTime is a draft international standard (ISO 10744), that provides a means for describing the required hypertext addressing scheme. In the future HyTime can be used to extend the scope of JCALS data to multimedia without radically changing the underlying database structure.

JCALS and the IETMs Standard for Electronic Documents

IETMs is the standard, based on a content data model, that has been developed to newly produced DoD technical information. The IETMs standard provides a database model of technical manual content addresses a finer level of detail than the current JCALS models. The IETM database also includes information such as software and diagnostics which are associated with technical manual content. The JCALS data model will include identifiers that permit documents to be included in databases that conform to the IETMs standard.

CALS SGML Library

As part of the DoD CALS program, a SGML resources are being collected and made available to the DoD and industry. The CALS SGML Library will include:

- Baseline tags and attributes
- CALS DTDs and FOSIs
- DTD and FOSI fragments to be applied to new DTDs and FOSIs
- Boilerplate text and other reusable fragments for DTDs.

The CALS SGML Registry will maintain a standard set of approved SGML tags and attributes.

Strategy for Legacy Data

One of the primary requirements for JCALS was to address the problem of legacy data, data that requires conversion to an standard electronic format. Among the proposed solutions is to provide for raster representations of certain classes of legacy documents. Although SGML tagging would not be as complete as for newer documents in the database, tagging of certain content features, such as tables of contents, would provide categorization and access to document content.

Tools to Support Data Access - Navigational Aids

Controlled Access Folder Executive

Built on the X-Windows desktop is a layer of code that facilitates access of users to commonly used applications. Based on characteristics of the user, the Controlled Access Folder Executive (CAFE) associates objects in a user's folder with applications normally used to operate on the data or deliver data to the user. For example, pointing to an IGES standard graphic will access the Rosetta Preview application. Reference to a PostScript graphic will automatically invoke a PostScript viewer.

One desirable and innovative feature of the CAFE is its capability to create a virtual representation of the information the user requires. A user can see pictures of parts in a parts catalogue instead of lists of files. The folder contains pointers to information needed by the user. The actual physical location of the information is normally hidden from the user's view. In addition, the CAFE filters information according the user profile at the time of log-on. Information is selected for view depending on the task at hand. The filter can also be used to hide classified information from users without proper access authorization. The information displayed in a folder is under the control of the Workflow Manager, which aims to provide the user with the information required to perform current tasks. While the user has control over display of information the CAFE and Workflow Manager filters extraneous data and constrains access.

It should be noted that the MacIntosh operating system, Microsoft Windows and other Windows products provide a number of capabilities similar to those offered by the CAFE. Where JCALS excels is managing the binding of object methods in an environment where large numbers of users are accessing common methods.

Graphical Query Tool

General Research Corporation (GRC) provided the data modeling tools for developing data models for the SGML, graphics and LSAR data that is stored in the JCALS relational databases. GRC also developed an application that permits users to define queries graphically for accessing any type of data in the JCALS databases. The query tool then translates the user query into a SQL script for a particular relational database implementations. The query is then portable among databases. The Application Program Interface also permits the queries to be executed by other products such as Basisplus from Information Dimensions, Inc. Queries can be stored as icons in a work folder for later use.

All of the tools discussed above that support JCALS document management should be evaluated in relation to FAA requirements. The FAA can build upon the testing and evaluation processes that have already been carried out by the JCALS program.

3.4. Corporate Software Engineering

3.4.1. CBA

N/A

3.4.2. Lessons Learned

JCALS Development Tools

The JCALS program is employing CADRE Teamwork to design and develop JCALS integration modules.

Software Reuse

The JCALS Program promotes the reuse of several different types of software products:

- **JCALS Software Components** - JCALS software components are being written for possible inclusion in the DoD repository for software reuse, the DSRS.
- **Workflow Definitions** - Workflows descriptions employed by the workflow manager are applied to the many tasks that are performed repeatedly
- **Query Library** - SQL queries that are used repeatedly are being identified and stored for reuse.
- **Macro Library** - Software macros (abbreviated identifiers for a series of commonly used software operations) are being stored for reuse at multiple JCALS sites.

3.4.3. Technology Transfer/Procurement Vehicles

Reusable JCALS Components

JCALS methods are written for inclusion in the DISA reuse library, the Defense Software Repository System (DSRS). The JCALS program plans to address requirements for linking the GDMS to the locator in the DSRS.

3.5. EDI

3.5.1. CBA

N/A

3.5.2. Lessons Learned

3.5.3 Technology Transfer

Interface to EDI Value-Added Networks (VANs)

JCALS program provides an interface to commercial VANs that support EDI. The FAA should evaluate the use of this interface to support the implementation of EDI with NAS contractors, vendors, and aviation industry partners.

Use of EDI Transaction Sets to Support Mission and Business EDI Applications

The JCALS program uses multiple standards and technologies to support the exchange of data between distributed data sources and between different applications. JCALS will use EDI standards, in addition to other CALS standards, to support exchange of data with DoD contractors. Transaction Set 841 is specifically designed to support transfer of documents and engineering data required for business functions such as contracting and supply.

EDI transaction sets (e.g. 836, 840, 841, 843, 850, 856) can be used to combine business transactions with transfers of electronic documents and engineering data. The EDI CALS Transaction Set 841 supports the exchange of technical documents, engineering drawings, and specifications in support of spares procurement, bid sets, and provisioning.

3.6. Security

3.6.1 CBA

3.6.2. Lessons Learned

JCALS has demonstrated multi-level security in a secure digital network linking DoD and contractor sites. One of the tasks to be addressed is the implementation of a secure relational database. CSC is evaluating Oracle and Informix with respect to security requirements.

The current capability supports management of secure, but not classified, data. JCALS provides for a B1 secure system, with B3 to be implemented in the future.

3.6.3 Technology Transfer

Multilevel Security

JCALS provides support for MLS Plus security levels. CSC has been collaborating with DEC to provide for a distributed security capability for JCALS sites. Because of DoD requirements, JCALS is likely to make significant progress in the implementation of secure relational databases in a POSIX environment. *The FAA may want to evaluate this implementation for its own applications.*

4. Summary - Key Conclusions from Survey

JCALS has shown the feasibility, at least in terms of pilot demonstrations, of providing an integrated set of capabilities for managing and delivering technical information. Similarly the FAA may find it valuable to use the management of technical information a a focus for a pilot application of data management in an open systems environment.

A major lesson to be learned from JCALS is that most of the tools required for managing data in a distributed environment are available in commercial products. The major task is testing and integrating the tools to provide the required range of functionality to users.

JCALS has made a significant contribution by defining the required set of functional requirements, demonstrating their technical and organizational feasibility, evaluating and testing commercial products that can satisfy those requirements, and providing for component integration. The JCALS Global Data Management System, in particular, may be a useful foundation for building the capabilities required for the FAA repository. The JCALS program has also demonstrated the utility and existing standards for the management and exchange of technical information.

Table 2. - JCALS Relationships to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicles
Core Architecture		• OSE enables use of commercial software and hardware products.	• Use of Unix,/POSIX standards in an OSE • Client-server architecture • Use of FDDI LAN and interface to FTS 2000 for WAN • Use of workstations and PCs in X-Windows/ MOTIF environment • ***JCALS Workbench tools for document authoring, review, distribution , and access to support FAA technical information infrastructure*** ◆ ***ArborText SGML Editor*** ◆ ***Datalogics Composer*** ◆ ***GRC Graphical Query tool*** • Integrated access to documentation and graphics • Implementation of CALS standards
Business Process Improvement	• Reduced cycle times for document changes • Reduced costs of paper production • Improved quality of technical documentation • Improved data access		• ***Project management tools - Workflow Manager, Tasks Manager***
Data Management		• Document mgt. is a low-risk means to demonstrate integrated data mgt. capabilities. • SGML requires additional support for DTD definition and implementation. • SGML requires disciplined consistency in tagging and data naming conventions.	• ***Global Data Management System for integrated repository functions*** • Integrated configuration management of documentation and graphics • ***JCALS Data Model*** • ***JCALS implementations and extensions of CALS standards and HyTime for hypertext links among documents.*** • Anticipated use of IETMs standard • CALS SGML Library and Registry
Corporate Software Engineering		• Use of CADRE Teamwork for CASE requirements definition and design.	• Use of JCALS components designed for DoD reuse library (DSRS)
Electronic Data Interchange			• Interface to EDI VANs • ***Both business and mission EDI can be supported through JCALS use of EDI Transaction Sets*** • ***Use of EDI Transaction Set 841 for exchange of technical documents and engineering data (applications to bidsets, reprocurement , etc.)***
IT Security			• ***Use of DEC Multi-Level Security products*** • ***Use of JCALS implementations of secure relational databases***

****Documentation, software, and other resources that the FAA may be able to leverage are highlighted.***

Section 4

Integrated Computer-Aided Software Engineering (I-CASE)

Table of Contents

Report on
Integrated Computer-Aided Software Engineering

1. Program Description

Originating in the 1970s, CASE tools emerged to aid procedural applications by automating the structured analysis and design techniques . While upper CASE tools focused on the early phases of the systems-development life cycle, lower CASE tools addressed code generation during the later stages. Integrated Computer-Aided Software Engineering (I-CASE) tools cover the whole systems life cycle from planning through generation. The FAA requirements for I-CASE tools and accompanying methodology will need to be flexible to accommodate the many different application environments used in the agency (e.g. Tandems, IBM, NAS/ATC, etc)

2. Method of Investigation

The sources of data for this investigation came from published sources.

3. Relationship to CIE Initiatives

3.1. CORE ARCHITECTURE

3.1.1. Lessons Learned

Most I-CASE tools and repositories were originally designed to support new applications development or forward engineering (e.g. Yourdon Structured Method and Information Engineering). The repository is populated as a by-product of analyzing business areas and developing applications.

Single-vendor I-CASE products exist that are based on repository concepts, but their conceptual repository model is usually proprietary and not extensible. Few I-CASE tools provide an application programming interface (API) language for establishing on-line interaction between CASE encyclopedia and third-party tools; therefore, batch 'bridge' technology must be used to upload and download repository data. More alliances and additional techniques will likely emerge over the next few years. In the long-term future vendors will be producing integrated tools that automate the complete life cycle. This trend promises developers a broader and stronger arsenal of tools with which they can build applications

> ***Key Lesson Learned: Current repositories and CASE tools do not meet user's expectations. Since data is redundantly maintained across multiple workstations, the synchronization of updates can be a major effort.***

The DoD I-CASE Program, a seven-year contract worth between $250 million and $1 billion, is intended to provide an integrated environment that supports the development and maintenance of DoD information systems applications. Reuse of domain knowledge and objects is a fundamental premise which I-CASE will adhere in order to further reduce manual development.

3.2. Business Process Improvement

3.2.1. Lessons Learned

DoD

The DoD and the National Institute of Standards and Technology (NIST) joined forces to institute open systems architecture for I-CASE tools, the core enabler for heterogeneous software environments.

The effort to develop open standards for software tools has unfolded in the midst of increasing frustration by both vendors and users with continuing delays in the DoD's I-CASE procurement.

Kurt Fischer, DoD Deputy Director for Information Technology, said the proposed North American Portable Common Tool Environment (PCTE) "is a key core technology for the...I-CASE Program as well as for other DoD software engineering projects."

PCTE will allow tools developed by different vendors to access the data contained in a CASE repository easily. This standard will allow tools to work across different CASE environments. Right now all vendors have a different way of handling this, the standard will allow for the interchange of tools.

The DoD estimates it will cost $10 million to establish the PCTE standard. DoD and NIST will work with the Object Management Group, a non-profit company that provides standard object-oriented technology, in developing the North American PCTE initiative. The standard will be based on an existing European Computer Manufacturers Association (ECMA) standard, known as ECMA-149, that is also accepted in draft form as an International Standards Organization standard.

This standard provides a set of basic services for software tools, and each of these sets of services supply capabilities referred to as "framework."

Key Lesson Learned: PCTE will provide users a standard mechanism for access into and out of a data repository and also will define standards for the repository.

3.3. Corporate Software Engineering

3.3.1. Lessons Learned

CASE and Front Ends

One of the hallmarks of client/server development is the astonishing variety of front-end application development tools. For mainframe systems, COBOL has mostly been the dominant selection for applications programming, which facilitated the development of I-CASE products. Because I-CASE tools integrate upper and lower CASE functions by generating source code from the design specifications.

I-CASE becomes economically feasible when a single language monopolizes (e.g. C++, COBOL, or ADA) almost all application development. The variety inherent in the client/server world complicates this level of integration, but vendors have found at least two strategies to deliver I-CASE for client/server systems.

- One strategy links up with the most popular front ends, while the other requires vendors to deliver application generators of their own. PowerBuilder (a front end tool) from Powersoft has attracted integration support from a number of CASE vendors.
- The second approach to providing client/server I-CASE involves application generators provided by CASE vendors. Two vendors pursuing this strategy are Intersolv and Intellicorp.

DoD I-CASE Environment

The implementation of I-CASE is viewed as a key component of the DoD strategy to enhance productivity for software development and maintenance and improve the quality and reusability of the software products.

DoD Implementation Policy -- I-CASE will be required for "each military department and defense agency for all in-house, government development automated information systems." (DoD I-CASE Policy Letter, 27 Feb. 1992)

The I-CASE procurement, an I-CASE Readiness Program will be implemented to prepare the sites. CIM will carry out an assessment to identify site requirements for training and to identify other obstacles that may inhibit the movement toward a CASE environment.

3.3.2. Technology Transfer/Procurement Vehicle

DoD

The I-CASE acquisition is a major vehicle for DoD to implement standard software development production environment for all DoD developed information systems. Current CASE technology is not mature enough to establish the kind of open environment DoD wants.

The I-CASE contract award is slated in September 1993 with 19 pilot implementations to begin approximately 6 months after contract award. The I-CASE contract award was initially scheduled for May, but program officials said they needed more time because the bids are complex resulting in a longer evaluation than anticipated. The contract is being managed by the Air Force Standard Systems Center for all services and DoD agencies.

The I-CASE requirements provide for a Software Engineering Environment (SEE) that will provide a migration path toward an open systems environment.

The procurement is structured so that the vendor will need to meet minimum requirements in the first year and define a migration path to meet a broader set of requirements. For example, the I-CASE procurement will allow for a proprietary environment at the time of contract award. Within three years of the award, however, the contractor will be required to migrate to an open systems environment. The migration strategy path towards integration of the requirements tool and the development tool (upper and lower CASE). Initial implementations are not likely to support such integration.

Key Lesson Learned: The General Services Administration (GSA) has made I-CASE a Federal acquisition contract open to all government agencies (limited to 10% of the delegated procurement authority). Specifically, the FAA has the opportunity to:

- Purchase DoD I-CASE tools to support the FAA IT systems development and maintenance.
- Use the I-CASE contract (RFP, evaluation criteria, etc.) as a model for a future acquisition of I-CASE tolls by AIT.

Internal Revenue Service (IRS)

The IRS is preparing an I-CASE procurement that will provide the agency with a standard toolkit for its $23 million Tax Systems Modernization (TSM) program. The agency hopes to field a comprehensive suite of tools--from reverse engineering to software maintenance.

The IRS's pending procurement parallels the Air Force's I-CASE project. But the IRS has decided to award its own contract because of special requirements for CASE tool integration.

Key Lesson Learned: Industry experts believe that the IRS will have to employ a minimum of six tools for each software "problem set." Multivendor integration, therefore, will be crucial to the IRS.

3.4. DATA MANAGEMENT

Integration of CASE, Reuse and Data Repositories

Key Lesson Learned: Effective implementation of software process improvement will require integration of processes and supporting technologies of CASE, Reuse and Data Management.

DISA/CIM plans to develop a strategy for integrating CASE, Reuse, Data Administration, and a Concept of Operations. It is recognized that the I-CASE tools must be connected to the data repositories, e.g. Defense Data Repository System (DDRS) and the Defense Software Repository System (DSRS). The I-CASE tools must support the full-suite of process and system engineering tools, including process simulation, functional decomposition, and data-oriented information engineering approaches.

4. Summary: Key Conclusions from Survey

The FAA has several options regarding an I-CASE Acquisition that will require analysis and evaluation to reach a decision point:

1. Buy off the DoD I-CASE procurement.
2. Tailor I-CASE RFP to FAA requirements.
3. Develop a multivendor vehicle similar to IRS that is specialized to many different problem sets (e.g. environments).
4. Allow FAA Program Offices to acquire I-CASE tools individually to meet requirements.

The following provides a summary of key conclusions referenced to CIE Initiatives.

Summary Table of I-CASE Relationship to CIE Initiatives

	Cost benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles
Core Architecture		• Current repositories and CASE tools do not meet user's expectations. Since data is redundantly maintained across multiple workstations, the synchronization of updates can be a major effort.	• DoD I-CASE Program is intended to provide an integrated environment that supports the development and maintenance of information systems applications.
Business Process Improvement		• DoD and NIST have joined forces to institute opens systems architecture for I-CASE tools, the core enabler for heterogeneous software environments. • Portable Common Tool Environment (PCTE) will give users a standard way of getting into and out of a data repository and also will define standards for the repository.	
Corporate Software Engineering		• I-CASE becomes economically feasible when a single language monopolizes (e.g. COBOL, C++, or ADA) almost all application development. • Vendors have found at least two strategies to deliver I-CASE for client/server systems: - One strategy links up with the most popular front ends, while the other requires vendors to deliver application generators of their own. PowerBuilder (a front end tool) from Powersoft has attracted integration support from a number of CASE vendors. - The second approach to providing client/server I-CASE involves application generators provided by CASE vendors. Two vendors pursuing this strategy are Intersolv and Intellicorp.	• DoD I-CASE contract award is slated for September 1993, with 19 pilot implementations to begin approximately 3 months after contract award, and is open to all government agencies (limited to 10% of the delegated procurement authority). • IRS is preparing their own CASE procurement because of special requirements for CASE tool integration (a minimum of six tools for each software "problem set) for its TSM program. • FAA could purchase DoD I-CASE tools to support FAA IT systems development and maintenance. • FAA could use the I-CASE contract (RFP, evaluation criteria, etc.) as a model for a future acquisition of I-CASE tools by AIT.
Data Management		• DISA/CIM plans to develop a strategy for integrating CASE, Reuse and Data Management.	

Section 5

Air Transport Association/Aerospace Industries Association (ATA/AIA)

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Report on
Air Transport Association/Aerospace Industries Association Initiatives

1. Program Description

The Air Transport Association(ATA) of America represents the major airlines of North America. ATA provides technical expertise, develops solutions to problems and builds specifications for its members and -- the industry at large. ATA also provides technical liaison with the FAA and other government agencies.

The Aerospace Industries Association of America (AIA) is comprised of manufacturers of accessories, parts, materials and components used in construction, operation, and maintenance of aerospace products. AIA provides technical expertise, develops solutions to problems, and represents the industry before Congress, governmental agencies, and the public.

2. Method of Investigation

The primary source of information has been aviation-related periodicals. Published information sources were supplemented with interviews by FAA representatives and interviews and presentations by ATA and working group representatives:

- Steve Erickson, Director of Materiel and Maintenance, ATA
- John Anderson, Boeing, ATA/AIA Digital Data Steering Committee

3. Relationship to CIE Initiatives

3.1. CORE ARCHITECTURE

The ATA and AIA began, in 1984, forming joint standards committees to address general issues associated with the use of electronic maintenance information. It was evident that there was a great potential to improve productivity but major changes to the technical documentation process would be required. Growing mountains of paper provided an incentive to move forward quickly. The first milestone, *ATA SPEC 100, Manufacturers Technical Data*, was the restructuring of airframe and jet engine shop manuals as a set of tasks to more closely relate to the process and to facilitate electronic processing. ATA 100 is a key specification which establishes recommended standards for the presentation of certain data procured by aircraft engine and component manufacturers to support their respective products.

Organizational Infrastructure

Technical Information and Communications Committee (TICC) oversees the strategy, direction and ATA resources needed to develop and implement standards and specifications for the Technical Communication process. TICC is the arm of the ATA that interfaces with the FAA on regulatory issues for communications.

TICC coordinates standards development in the maintenance, operations, engineering, reliability, training, provisioning, and supply areas. TICC attempts to designate

International Standards (ISO) wherever it can and uses other standards when International standards are not available.

ATA/AIA Digital Data Steering Panel (DDSP) is chartered to manage the ATA/AIA standards plan for building capability as an evolutionary process. The DDSP reviews all airline manufacturing technical data and other pertinent airline carrier/manufacturer data (existing data as well as data that is expected to change). The DDSP produces the requirements for digital data for cooperative data sharing, exchange and use between the airlines, suppliers, manufacturers, and FAA.

3.1.1. Lessons Learned

ATA SPEC 2100

Background

The concept of *ATA SPEC 2100, Digital Data Standards for Aircraft Support*, has been accepted by industry associations at the international level. Implementation entails continued validation with the process owners, the digital information providers and users as well as computing suppliers.

Definition

ATA SPEC 2100, defines authoring technical content/structure, interchange formats, and delivery/use in the digital data process from increased use of automation. More definitive specifications are needed to design systems that will allow operators to implement information systems, they are:

- Authoring - content/structure includes the technical information requirements for processing print files, retrieval and database information to assure entity consistency and semantic context. ATA 88-3 Maintenance Engineering is an example of a standard needed to design a database authoring/access system.
- Interchange formats - includes the text and graphic expressions from which ideas for aircraft support are created. Multimedia for...s such as audio and video are requirements for Training activities. ATA 89-9A development of SGML DTD's for text and ATA 89-9B CGM vector and CCITT Group 4, raster formats are examples of standards used for neutral file exchange.
- Delivery/presentation - includes information user standards to accept digital media in magnetic, optical or electronic form for re-authoring, access, presentation and/or printing. ATA 89-9C Retrieval for optical media is an example of standards for the user, 89-9C also contains Structured Full Text Query Language (SFQL).

Key Lesson Learned: The FAA may be able to leverage the ATA standards for FAA technical documentation and/or flight standards certification applications.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. Lessons Learned

Data Modeling

ATA meetings have been held with Bill White of FAA Flight Standards Training and Automation Committee, for partnering with industry (the ATA). The flight certification arena has not been very well developed with industry. ATA wants to develop standards with the FAA on aircraft engine certification, etc. ATA would also like the FAA to be involved with *next generation data modeling* which the ATA is implementing. Mr. Erickson sees several problems with the FAA creating their own systems and databases. This is especially a problem if the FAA needs level III drawings for an aircraft engine to certify return for flight or the ATA needs access to FAA's information.

> ***Key Lesson Learned: Why not just have one data system which both the FAA and the ATA can access? (This question is the main driving force behind the Master Minimum Equipment List [MMEL] project for SGML).***

The more unique databases there are implemented, the more problems for data access or building applications to retrieve the data. In fact, Mr. Erickson would like to have a summit meeting to include the FAA on this topic. ATA recognizes the importance of the FAA and industry (ATA) working together to solve common problems and to exploit mutual opportunities/technologies.

Interactive Electronic Technical Manual (IETM)

The commercial airlines through the ATA and AIA have developed an architecture for advanced retrieval technology which can meet the needs of interactive document databases.

An IETM operates more interactively and its user interface is more like an ATM machine, a kiosk or a video game - that is, it's "interactive." An IETM works with unformatted information, selecting only that which is needed for the tasks at hand, formats the response in compliance with the standard client/server interface, and then sends the information to the users display device.

There are many parallels in the ATA and CALS standards development efforts. In both efforts, digital data standards for maintenance documents are being developed to address requirements for electronic document *interchange* and for *interactive retrieval*. Standards for document interchange provide a common mechanism to re-use information, to reauthor, or to load portions into data repositories, for example. Standards for interactive retrieval permit the publication of information in an electronic book form employing full search capabilities and sophisticated browsing techniques such as *hypertext* links, which let the user view relevant material in another part of the document simply by pointing to its reference.

Further, both CALS and ATA incorporate many of the same industry standards in their implementation profiles. For example, both utilize SGML for interchange of text, and CGM for vector graphics. And both use CCITT Group Compression for raster images (although with different header formats).

Although there are many similarities between the ATA and CALS approaches, the focus of the interactive retrieval efforts is different. Whereas the IETM effort within CALS has emphasized data content and presentation issues, the **ATA has focused on interoperability requiring that an application used to access a particular vendors engine or airframe maintenance manual can access all other vendors maintenance manuals.**

John Anderson, co-chair of the CALS IETM Study, stated that in the very near future (within the next three years) IETMs will be a common application for the airline industry.

Technical Mail (T-Mail)

T-Mail is the term which includes E-Mail, EDI, notifications such as service bulletins, regulatory advisories, and other forms of text and graphics under the umbrella of a single set of standards and protocols. ATA's objective is to identify an interim standard that would allow T-Mail to function in 1993.

Technical Publications

An AIA open question is whether technical publications will be adequately funded under the new, tighter budgets. Documenting the design, operation and maintenance of a new airplane is a major expense, yet the cost for documentation is approximately the same whether one builds 20 units or 200. (In other words, reducing the number of planes ordered does not significantly reduce the cost of documentation.)

Airlines face an even bigger problem. For various reasons, almost every aircraft is unique in some respect: therefore, the maintenance procedures must also be unique. Many airlines therefore rewrite the documentation they receive from manufacturers to reflect these differences. **Northwest Airlines, for example, revises 40 percent of each maintenance manual before distribution to its mechanics**. Other airlines contract with the manufacturers themselves or with a third-party firm to produce manuals customized to its specifications.

The shift from paper documents to "electronic" documents represents an enormous investment on the part of airlines and their suppliers, at a time when they are under intense pressure to cut costs (**Airlines spend as much as 25% of their money on maintenance, and documentation is a large portion of the maintenance cost.**)

Today the objective is to go 'pageless' and to describe the underlying data in a more meaningful way that will enable new types of electronic manuals. The airlines have even developed a specification for separating the full-text indexing and retrieval of their documents from the information itself. This specification, The Structured Full-text Query Language (SFQL), will enable airlines to buy their own full-text retrieval packages yet still get the source material electronically from a variety of airframe and engine suppliers.

Interoperability Solution

ATA's solution was to develop an open systems architecture where the publication of a CD-ROM is independent of the end-user's presentation software. The architecture

divides the traditional single-process CD-ROM access software into a *Server* and a *Client.*

- The *Server*: provided with each CD-ROM, presents a standard interface to the information disc, concealing any vendor-specific formats, indexing or data organization.
- The *Client* is the end-user application, which may be obtained independently of the CD-ROM, to present or utilize the data. The ATA standard rests between the client and the server, determining the nature and format of the transactions.

Data Standards

The envelope in which the server returns data; however, the contents (e.g. SFQL) must still be interpreted by the client software. At a minimum, this requires standardization of the data types and the representation of these types and the presentation of these types (the data format), so that the client may display or process the data. To build intelligent clients that are capable of using the data in an analytic or decision making process, the relationship among data elements and the semantics of the elements, the *schema* must also be standardized.

To develop schema's, ATA and AIA working groups analyze each document type (e.g., maintenance shop manual, illustrated parts catalog, service bulletin) and design a specification of tables containing the document elements and structure needed to meet the ATA functional requirements for an IETM.

3.3. EDI (BUSINESS)

3.3.1. Lessons Learned

ATA SPEC 2000/ANSI X12:

ATA administers and maintains an automated information system known as the Specification 2000 Program. SPEC 2000 is an international specification covering procurement transactions for aircraft material acquisition, support and repair which enables airlines and their suppliers to exchange information using a common language. More specifically, SPEC 2000 covers:

- initial provisioning
- spares procurement
- order administration
- invoicing
- inventory forecasting
- performance reporting
- repair administration
- bar coding

SPEC 2000 is an advanced system designed in part to succeed SPEC 200 for administering and processing procurement data. The Program enables suppliers to list

for sale, and purchasers to obtain access to information about those components and parts of aircraft, engine and supporting equipment parts and materiel that suppliers offer for sale. Both International and Domestic Airlines and Suppliers participate in the program by being a member of the ATA and paying nominal fees for the services and systems managed by the ATA. The software used for the SPEC 2000 program was created by Multilink EDI, Ltd. (a British software company).

Two of the functions of the Specification are widely used today to increase efficiency in the exchange of business information. These are:

- central procurement database -is a centralized electronic catalog composed of parts data from airframe, engine avionics and component manufacturers, suppliers and distributors.
- order administration and invoice processing (EDI)

Implementation Guide

The *ATA SPEC 2000/ASC X12 Implementation Guide for Electronic Data Interchange* was developed by a joint EDI Task Force of the ATA and AIA. The Task Force consisted of representatives from the North American and international airlines and aerospace manufacturers, including users of both ATA SPEC 2000 and ANSI ASC X12 standards.

The Implementation Guide, which was developed as a companion to SPEC 2000, deals specifically with the format for electronically exchanging order administration, invoicing, and payment order/remittance advice information between trading partners. In order to comply with the Implementation Guide, it must be used in conjunction with the ATA SPEC 2000 Main Document and Data Dictionary, which defines the business practices and data definitions used in the procurement of aircraft spare parts.

The SPEC 2000/ASC X12 EDI Task Force effort worked to maintain comparability of information contained in the two standard formats; the Implementation Guide applies to the communications between trading partners regardless of their internal application systems. The aim of the Implementation Guide is to make execution of EDI in either or both standards straightforward and nearly transparent to the user.

Key Lesson Learned: The FAA may be able to leverage some of the ATA 200/2000 EDI guidelines and infrastructures for their EDI applications.

3.4. EDI (MISSION)

3.4.1. Lessons Learned

Master Minimum Equipment List (MMEL)

The MMEL describes the equipment that needs to be functional before an aircraft is dispatched. The FAA generates a MMEL for each type of aircraft. This is updated frequently based on input from the airlines, manufacturers, and flight inspectors. Notification of updates is made by computer-generated post cards. The actual MMEL is posted to an electronic bulletin board and to COMPUSERVE where it can be retrieved

by the airlines. The bulletin board pages are not in the multi-column tabular form that can be used by the airlines and reformatting by each recipient is necessary.

The MEL (Minimum Equipment List) is the tailoring of the MMEL by the aircraft operators.

There are two different types of updates to the MMEL. Unrestricted updates do not require a change to the operator's MEL. Restrictive updates require changes to the MEL.

Ancillary documents that could be converted to SGML -- Flight Standards Board, Maintenance Review Board, and Configuration Maintenance documents.

Key Lesson Learned: The MMEL program would benefit from CSA guidelines on SGML and other related standards.

Service Difficulty Reports (SDRs)

Aircraft operators and repair stations submit SDRs and Malfunction Defect Reports to the FAA. The SDR program objective is to help airline and FAA personnel to promptly correct conditions that could adversely affect air safety. Most of these are submitted in hard copy. The consolidated SDR's are published on a weekly basis in hard copy. Some key problems identified with the current procedures are:

- Information that one airline considers reportable may go unreported by another airline;
- Useful information does not reach subscribers for over 6 weeks because of delays in manual data processing through a paper-based system; and
- FAA does not analyze the data, as required by FAA policy, to detect malfunctions trends in specific aircraft models or focus the efforts of FAA's inspection workforce because of insufficient staff and unreliable data.

Currently 8 carriers submit SDRs electronically, using a template developed at The Aeronautical Center. The FAA does not have the capability to transmit SDR's back to the airlines. Every week, 2 versions of the SDR are sent out to the 1,500 subscribers.

Key Lesson Learned: If the FAA could transmit SDRs electronically -- it is likely that the other carriers would be willing to submit their SDR electronically. SDRs provide the FAA an opportunity as a "mission" EDI application.

4. Summary: Key Conclusions from Survey

The following table provides a summary of key conclusions referenced to the CIE initiatives.

Summary Table of ATA/AIA to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicles
Core Architecture		• SPEC 2100, Digital Data for Aircraft Support, defines authoring technical content/structure, interchange formats, and delivery/use in the digital data process.	• The FAA may be able to leverage the ATA standards for FAA technical documentaion and/or flight standards certification applications.
Business Process Improvement	• Airlines spend as much as 25% of their money on maintenance, and documentation is a large portion of the maintenance cost.	• Why not have just one data system which both the FAA and the ATA can access? (This question is the main driving force behind the Master Minimum Equipment List [MMEL] project for SGML.) • ATA would like the FAA to be involved in ATA's next generation data modeling to see one data system which both the ATA and FAA can access. • It is expected that IETMs (within 3 years) will be legacy data for the airline industry. • ATA's objective is to identify an interim standard that will allow T-Mail to function in 1993.	
Electronic Data Interchange (Business)		• ATA SPEC 2000 administers and defines the ANSI ASC X12 program. • SPEC 2000 is an intenational specification covering procurement transactions for aircraft material acquisition, support and repair which enables airlines and their suppliers to exchange information using a common language. • Two of the functions of the SPEC that are widely used are the central procurement database and the order administration and invoice processing (EDI).	• The FAA may be able to leverage some of the ATA 200/2000 EDI guidelines and infrastructure for their EDI applications.
Electronic Data Interchange (Mission)		• The MMEL program would benefit from CSA guidelines on how to store images on the mainframe, the integration of systems, and standards. • If the FAA could transmit SDRs electronically - it is likely that the other carriers would be willing to submit their SDR electronically.	

Section 6

Veterans Administration (VA)

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Report on
Department of Veterans Affairs Initiative

1. Program Description

The Veterans Administration's (VA's) Directives Management Task Force was established to review the Department wide policy directives process and to develop a strategy to improve the organization, format, development, issuance, and management of VA directives.

The VA's goal is to develop a flexible Information Technology (IT) infrastructure that supports interconnectivity and interoperability within the Department and a standards-based Open Systems Environment (OSE).

Additionally, like many other organizations in the public and private sectors, the VA is responding to the important business benefits of Electronic Data Interchange (EDI) by expanding its application of this important business tool. The purpose of their program as identified in *Electronic Data Interchange: A Business Case for the Department of Veterans Affairs*, is to identify candidate opportunities of using EDI to support the VA's mission.

2. Method of Investigation

The primary source of information has been reports produced in support of the VA's development of an Open Systems Environment(OSE), EDI Business Case project and discussions with the Open System/EDI Project Manager and the Director, Information Resources Management Policies and Standards Service.

3. Relationship to CIE Initiatives

3.1. CORE ARCHITECTURE

The Department's multi-million dollar contract for the acquisition of a Department-wide office automation, the Nationwide Office Automation for VA (NOAVA) is an indication of VA's strategy for moving to a comprehensive OSE. VA's Statement of Direction clearly commits to this environment by embracing the National Institute of Standards and Technology (NIST) Applications Portability Profile (APP). The intent of the APP is to provide a standards-based framework for addressing functional interoperability across a wide range of computer systems.

Development of an OSE involves more of a mindset and philosophy than simply utilizing standards-based components. Simply buying standards-based hardware and software does not ensure interoperability and interconnectivity.

> ***Key Lesson Learned: Implementing OSE will begin to decrease dependency on large proprietary systems and their associated high operation and maintenance costs.***

The VA recognizes that automated tools are useful for managing the large volume of interrelated information associated with the information engineering phase of architecture development, Figure 1.

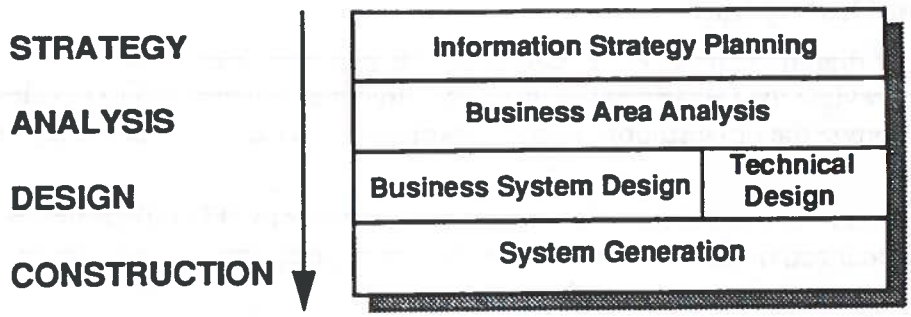

Figure 1. - Information Engineering Approach

3.1.2. Lessons Learned

OSE

The NOAVA contract is similar to the OATS contract, but it is also more than just procuring hardware and software. The NOAVA contract also provides the "services", e.g. ability to generate task work orders for development of a migration strategy for reaching an OSE. The VA feels the NOAVA contract gives them the means to provide a fully integrated solution, e.g., the ability to also build the gateways between systems, that supports an OSE infrastructure.

Key Lesson Learned: Develop a migration strategy for reaching an Open Systems Environment.

OSE emphasizes data consolidation through the use of common data definitions and formats, transparent access to data through a common GUI, systems interoperability through the use of a common network protocol and interfaces, and protection of software investment through an emphasis on software portability and reuse. The use of the following standards will facilitate the interoperability of information systems, software portability, data interchange, access to information, and vendor independence:

- Open System Architecture: will provide users with a broad range of applications across a wide variety of commercially available computer systems.
- GOSIP: is designed to connect the Government's many multi-vendor networks and systems.
- SQL: is a language used to manipulate data in a relational database management file.
- POSIX: facilitates the transfer of applications between hardware architecture.

Key Lesson Learned: Implementation of an Architecture is an evolutionary process. Moving to an OSE extends beyond the

architecture and associated technology and represents a paradigm shift in the mindset of the organization.

EDI

ANSI X12: is the standard for external electronic business transactions (EDI). **Moreover, X12 should be used for exchange of internal business information unless another standard format is found to be more appropriate.**

3.2. BUSINESS PROCESS IMPROVEMENT

VA Corporate Information Management (CIM) project is to apply business process analysis and reengineering principles across VA and establish information partnerships with Defense Department and other agencies, FY 1992 to 1997, $5.4 million. The project concentrates on reengineering business processes followed by an analysis of the extent to which technology can play a role.

Key Lesson Learned: BPI initiatives should be client-focused. The initial projects should be the ones your customer(s) will benefit the most from.

3.3. CORPORATE SOFTWARE ENGINEERING

3.3.1. Lessons Learned

The Veterans Benefits Administration (VBA) is using the information methodology and CASE tools from KnowledgeWare in its business process improvement effort. The VBA used the models to help identify the information required to perform various business activities and chart the utilization of current information resources.

Once the process and data models were established, the VBA used a statistical analysis software package to determine the "degree of association" between the models. This identified problems with the data and processes.

Key Lesson Learned: Using the re-engineering tools and methods, the VBA was able to eliminate redundant or unnecessary processes and data.

The agency reduced processes from more than 300 to 165 and data entities from 219 to 86.

3.4. EDI

3.4.1 CBA

Benefits

VA CBA reports were developed for the EDI program. The reports present findings and recommendations concerning EDI opportunities and initiatives in financial management at the VA Finance Center. Specifically in the work processes that the Commercial Accounts and Government Accounts divisions perform to improve effectiveness and efficiency of these processes.

- For processing commercial invoices using EDI.

- For processing government-to-government billings and transportation billings through the use of EDI.

The assumptions underlying the analysis were:

- The costs already incurred for initiating the EDI invoice initiative and in purchasing EDI management and telecommunications software are "sunk" costs (funds already invested that can not be recouped) and are not included when calculating cost/benefit ratios for EDI initiatives;
- The services of a VAN would be used to send and receive EDI transactions;
- There will be no net loss of employees as a result of any recommended EDI initiatives;
- The project anticipates a five year life cycle; and
- By the end of the project's life cycle, it is expected that 50% of invoices and 80% of GBLs will be handled by EDI.

Key Lesson Learned: As indicated in Table 1, the cost benefit analysis indicated that the VA could reduce the cost of processing an invoice from $3.48 in the paper processing environment to an estimated $1.55 in an EDI processing environment. Similarly, the cost of processing a GBL is reduced from $10.07 to $4.52.

TABLE 1

Comparison of Per Transaction Charges

	Annual Volume	Total Current	Cost EDI	Cost Current	Per EDI	% Savings
Invoices	1,637,568	$5,703,028	$2,539,278	$3.48	$1.55	55.47%
GBLs	36,486	$ 367,474	$ 132,004	$10.07	$4.52	55.10%

It is estimated that by expanding the EDI invoicing initiative to encompass 50% of the paper invoices **processed** annually, the VA will realize additional benefits of at least 50%, or $1,180,164 of the dollars lost due to uncaptured discounts. It is also estimated that the VA could realize benefits of about 33% of the interest paid in the current environment, which equals $338,626..

GBL audit savings are based on the number of billings received each year from government transportation carriers.

3.4.2 Lessons Learned

Costs

Table 2 lists the hardware and software costs for EDI system installation at the VA's Finance Center. Data processing center costs are actual and personal computer (PC) are estimates.

Costs Associated with using a VAN:

Costs, at the government rate, associated with using a VAN (General Electric Information Services-GEIS), are listed in Table 3. The one time charge refers to the installation fee which GEIS charges when a trading partner joins the GEIS VAN. An interconnect occurs when a trading partner initiates and EDI transaction through a different VAN service. Whether the VAN service company is private or public also distinguishes interconnect charges. GEIS assesses a flat monthly rate, for the first of each type of interconnect, public or private; subsequent interconnects from the same type of VAN service are free for the month.

TABLE 2

	Item	Unit Cost	Maint	StartUp	Unit Total
Data Processing Center (Actual)	Mainframe Translation Software	$29,100	$6,800		$35,900
	Communications Software	$57,200	$6,750		$63,950
	Total	**$86,300**	**$13,550**		**$99,850**
PC (estimates)	PC Software	$1,500	$240	$2,500	$4,240
	486-33 PC w/4MB	$4,260	$682		$4,942
	Hard drive w/1.25 GB	$3,233	$517		$3,750
	Memory Upgrade	$1,448	$232		$1,680
	Transceiver	$215	$34		$249
	Repeater	$1,341	$215		$1,556
	Deck server	$2,829	$453		$3,282
	Comm Software	$300	$48		$348
	Total	**$15,126**	**$2,420**		**$20,046**
	Maintenance Total		**$15,970**		

TABLE 3

	Charge Description	GEIS Charges	Estimated Monthly Charges	Estimated Annual Charges
One-time	Initiation Fee*	300		$300
Monthly	First Interconnect - Public	25	$25.00	$300.00
	First Interconnect - Private	25		
	Monthly Mailbox (each)	40	$40.00	$480.00
Total (Admin)	*First year Only		$65.00	$780.00

The VA has worked closely with the Office of Management and Budget (OMB) in the pre-review/approval for funding process for their EDI projects. The VA IRM does not control funding, which makes their task more difficult as they must convince the applicable program office(s) that would benefit from the proposed EDI project to submit the appropriate paperwork.

KEY LESSON LEARNED: One of the most significant impacts EDI will have is its ability to improve the work flow through an organization. It is not uncommon for a document to be the genesis for two or more unrelated processes which could be performed "simultaneously" by different functional groups.

Key Lesson Learned: Functional users must be actively involved in EDI planning, testing, and implementation projects.

VA, using EDI transactions, has taken the middle man out of the acquisition process and they have their prime vendors 'drop ship' goods (e.g. medical supplies) directly to the VA field office. VA has eliminated the need for the vendor to deliver the goods to their depot for inchecking and for the depot to reship the item(s) to the field office(s).

Regarding mission EDI, Bob Woods (worked in AT-10 for 6 years before moving to AMS/IRM and his present position at VA) thought that 'weather data' would be an excellent opportunity for the FAA.

Using EDI to streamline invoice processing offers improved efficiency in work processes, improved data accuracy, and significant savings through increased capture of vendor-offered discounts and improved compliance with the Prompt Payment Act (PPA).

In addition to workflow improvements, significant benefits should be realized in:

- Avoiding mispayments;
- Eliminating Bills of Collection; and
- Eliminating invoice processing backlogs.

Benefits associated with using EDI to process GBLs include reduced postage and paper-processing costs, improved payment audits, and improved ability to meet PPA time frames.

The Federal Government faces many of the same processing problems as does private industry and can learn from private industry's experience.

Analysis of root causes, or performance drivers, for customer dissatisfaction and waste in existing processes contributes to an assessment of current effectiveness.

EDI Opportunity Descriptions:

VA EDI initiatives identified that could be relevant to the FAA are electronic invoicing and payment information for goods and services and the exchange of Government Bills of Ladings (GBLs).

Exchange Purchasing Information with Suppliers

VA issues requests for quotations, purchase orders, and delivery orders to suppliers of goods and services. Suppliers respond by acknowledging receipt of those documents and indicating whether they can supply the goods and services at a price within a time frame that meets the requester's needs. Applicable EDI X12 standards are listed in Table 4.

TABLE 4

Related Transaction Sets	Title
832	Price Sales Catalog
836	Contract Award
840	Request for Quotation
843	Response to Request for Quotation
850	Purchase Order
855	Purchase Order Acknowledgment

Exchange Invoice Payment Information with Suppliers of Services

Benefits - Elimination of the majority of interest and penalties paid for non-compliance with the PPA and increased ability to capture discounts.

Costs - Include integration of EDI components with existing systems, data transmission, and ongoing operations. Applicable EDI X12 standards are listed in Table 5.

TABLE 5

Related Transaction Sets	Title
810	Invoice
820	Payment Order/Remittance Advice
825	Payment Status Report

Exchange Bills of Lading with Transportation Carriers

Major Benefits - EDI could facilitate traffic management of inbound and outbound shipments. General Service Administration (GSA) transportation audit staff estimate that electronic matching/audits of GBLs result in savings of .60 to a $1 for each GBL audited.

Major Costs- Integrating EDI components into existing systems, data transmission costs, other ongoing costs. Applicable EDI X12 transaction sets are listed in Table 6.

TABLE 6

Related Transaction Sets	Title
602	Transportation Services Tender
853	Routing and Carrier Instruction
854	Shipment Delivery Discrepancy Report
858	Shipment Information
859	Freight Invoice

VA Directives (Mission EDI)

Over time, the VA Manuals of Policies (MP's) have become unwieldy and their content and format are nonstandard, duplicative and inconsistent. The Directives Management Task Force's objective is to streamline and simplify, to the extent possible, the issuance and use of the Department policies and procedures in electronic media.

> ***Key Lesson Learned: A directives management system should be responsive to the changing requirements and directions of the organization. Review and concurrence system should be accomplished "electronically."***

4. Summary: Key Conclusions from Survey

EDI is only one component in VA's overall effort to improve quality, cost, service, etc. EDI makes no business sense as an objective in and of itself. Hence, benefits attributed to EDI are really the results of programs like Total Quality Management, BPI, information architecture integrating, strategic partnering, and customer service that have been made more effective through the use of EDI.

The following provides a summary of key conclusions referenced to CIE Initiatives.

Summary Table of VA Relationship to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicle
Core Architecture	• Implementing OSE will begin to decrease dependency on large proprietary systems	• The need to develop a migration strategy for reaching an OSE • ANSI X12 should be used for exchange of internal business information •	
Business Process Improvement		• CIM program designed to establish partnerships with other Federal Agencies • Reengeneering of business processes is paramount • BPI initiatives should be client-focused	
Corporate Software Engineering		• Using re-engineering tools and methods the VBA was able to illiminate redundant or unnecessary processes and data flows • The agency reduced processes from more than 300 to 165 and data entities from 219 to 86	• The VBA is using the information engineering methodology and CASE tools from KnowledgeWare in its business process improvement effort
Electronic Data Interchange	• VA CBA was done for the program and not the overall architecture • Identified the need to include interoperability needs and solutions in CBA • Cost of processing an invoice could be reduced from $3.48 to $1.55 and a GBL is reduced from $10.07 to $4.52 • FAA should expect similar savings in invoice processing and GBL's	• Improved workflow through the organization, data accuracy, and significant savings • Functional users must be involved in projects • A responsive directives management system	

Section 7

GTE Data Services (GTEDS)

Table of Contents

Report on
GTE Data Services (GTEDS)

1. Program Description

Overview

GTE Data Services (GTEDS) provides data management services to GTE corporate divisions, especially in support of telephone business operations. In the early 1980's, GTEDS undertook a program to improve the management of information systems and services within the company. The GTE "Corporate Information Management" (CIM) Program, similar in some respects to the DoD CIM Initiative, was part of an overall corporate effort to reduce operational costs. The result will be an reduction of total employees in telephone operations from 105,000 in 1985 to 86,000 in 1995 and a $1B cut in annual spending out of a total of $19B. The program has been carried out in three phases. The first phase addressed what GTE believed to be the opportunity for the highest dollar impact programs that could be executed in a short period of time. The succeeding phases implemented changes in data management and applications development that required longer periods for implementation.

- **Phase I - Data Center Consolidation** - The first phase of the program reduced the number of Data Centers from 16 to a combination of 9 Regional Data Centers and 4 Mega Centers. A major requirement of the consolidation effort was minimizing the risk of service interruptions.
- **Phase II - Standardization of Data and Applications** - The second phase of the program aimed to standardize data and applications and to improve the business processes involved in GTEDS applications development and service delivery. Goals included the elimination of duplicate:
  - Management and staff
  - Application programs and data
  - Support staffs
- **Phase III - Application Efficiency and Software Productivity Improvement**- The third phase of the program has aimed to reduce maintenance costs and applications development cycle times while improving the quality of newly developed software applications. The improvements are being carried out by means of implementing standard software development methodologies, CASE tools, and the establishment of a software reuse library.
- **Phase IV - Business Process Improvement/Re-engineering** - GTE is currently addressing ways of changing business processes that take advantage of new approaches to applications development.

Relation to FAA Environment

There are many similarities between the problems confronted by GTEDS and the problems that the FAA must address in the CIE Initiative. Like the FAA, a telecommunications

company, such as GTE, must maintain continuous operations in a fail-safe and secure environment. In both organizations, the probability of service interruptions must be negligible. Moreover, in the course of implementing a standard development methodology, GTE also needed to address the diversity in cultures for business operations and software development that had evolved within the GTE business units. The result of the GTE effort is the implementation of a corporate-wide process for software development and supporting tools, including a repository for software reuse, an enterprise model, and a data repository. FAA initiatives in the areas of Core Architecture, Data Management, and Corporate Software Engineering may be able to benefit from the GTEDS experience and the technologies that the company has implemented to improve information management and applications development.

2. Method of Investigation

The principle sources of information were discussions with managers of the GTEDS CIM Initiative to improve the process of applications development at the GTEDS facility in Tampa, Florida. GTE also provide briefing materials on the results the efforts to improve the efficiency and quality of GTEDS.

- GTE point-of-contact - Mr. Sheldon Danto, Business Manager for Outsourcing, 703-818-4849

3. Relationship of GTEDS to CIE Initiatives

3.1. CORE ARCHITECTURE

3.1.1 CBA

Data Center Consolidation

There overall impact of the Data Center consolidation was to double capacity at reduced cost and $149M was saved over a period of five years. This represents 20% of the total expenditure on the Data Centers. Personnel were reduced by approximately 25% (300 people). CPU costs per billable transaction were reduced by 51%.

Client-Server Architecture Impact

The motivation for transitioning from a heavy emphasis on mainframe-based applications to a client-server architecture is moving the applications closer to the user community. The goal is to gain savings in the end-user environment to compensate for costs of hardware (workstations and mini-computers) and networking. The expected impacts are faster development times for functional improvements and more rapid identification of opportunities for functional enhancements. GTEDS anticipates that at least over the short-term the client-server structure will be more expensive than retaining existing applications on the mainframe. Sources of increase costs include increased:

- costs training for users/developers -
- hardware costs for servers and workstations
- costs for network improvements and operations.

3.1.2. Lessons Learned

Structure of the Information Management Organization

GTE found considerable benefit from consolidating information management functions into a single organization in place of the previously established seven support organizations that served telephone company operations. The reorganization also realigned business leadership according to functional responsibilities instead of geography and created a "national" information management support organization.

Lessons-Learned from the Process of Data Center Consolidation

- Establishment of a high-performance reliable network is the first and most critical step
- Security implementation must by synchronized with network building
- Major Data Center consolidations can be accomplished without negative impact on users. - There were no interruptions of service during the consolidation process.

Process of Applications Consolidation

In addition to the physical consolidation of the information processing infrastructure, GTEDS initiated a process (Phase II) for consolidation of applications. To eliminate duplication, the company evaluated existing systems and identified "best-of-breed" applications. The applications (GTEDS systems) were then mapped into business functions to identify how consolidations could be carried out while maintaining required services to users.

Client-Server Evolution

GTEDS is planning a gradual evolution to a client-server environment. The new architecture will have three tiers. Mainframe applications will still serve centralized large-scale functions, including the software and data repository. Because of the size of the application databases and transaction processing requirements, there was no option to downsize from the current mainframe. Mid-level servers will support group applications and development. The current plan is to use HP 9000s as the hardware platform for the middle tier. Workstations and PCs will provide platforms for users and developers.

Client-Server Dependence on Software Reuse

> ***Key Lesson Learned: The implementation of client-server can be greatly assisted through the use of reusable components.***

In the GTEDS strategy, the server infrastructure is based on the use of reusable software components. The components support user interfaces, interfaces between the three tiers in the architecture, and interfaces to the communications networks.

Communications in the Open-Systems Environment

GTEDS plans to migrate from the current SNA communications environment to TCP/IP. A major impediment to the adoption of TCP/IP is the availability of software to perform network management functions. Such applications are currently more mature for SNA networks.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.2 Lessons Learned

GTEDS followed a somewhat different strategy than that followed by the DoD CIM Initiative. The CIM Initiative has placed primary emphasis on implementing process changes with parallel programs in data management and other areas. GTEDS, on the other hand, began to define data management requirements, including data models and definitions, before a detailed analysis of business processes had been carried out. The reasons for this strategy included the following:

- There was more expertise within GTEDS in data analysis than in BPI.
- The company felt it had a high-level understanding of the fundamental business processes and their requirements.
- Data standardization was considered a prerequisite for other improvement efforts.

GTEDS reuse of large software components has saved the company as much as $500K per application.

3.1. DATA MANAGEMENT

3.3.2 Lessons Learned

Key Lesson Learned: The primary requirement is understanding the data needed for the business.

As part of the process of consolidating applications across the business units, GTEDS recognized that it would be necessary to establish a repository of standard data definitions and business rules. The process of defining the standard data elements helped define the key data required by the business operations.

Requirements for the GTEDS repository and Data Administration capability include:

- Establishment of a single, centralized source of information on data elements and rules employed in the business.
- Ability to perform impact analysis for proposed changes in system functionality.
- Ability to use metrics to track reuse versus definition of data elements (goal is to radically reduce the need to define new data elements).
- Ability to share data and reference tables across applications.

The FAA may be able to adopt a similar strategy for data management.

3.3.3 Technology Transfer/Procurement Vehicles

PACBASE (CASE Tool) is being used to support the development of an enterprise model and associated standard data descriptions.

Data Repository Support

LEVERAGE and PACBASE are software packages which GTE uses to maintain the corporate data repository. The repository contains 25,000 data elements. The repository is linked to the software development process by means of the CASE tools. The

LEVERAGE tool is employed in support of the "Upper-CASE" steps in the development process. PACBASE is used to support "Lower-CASE" development.

The company is evaluating the possibility of moving to a PC based tool for the repository.

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. CBA

Maintenance Costs for Core Applications

Approximately $50-60 million was avoided in maintenance costs, which represents 20% of the total maintenance expenditure.

Impact of Standard Software Development Methodology and Tools

For applications that make use of the new software development methodology GTE has experienced the following benefits:

Software Development Cycle Time -30% reduction in Time-to-Market

Software Maintenance - 50% reduction in life cycle maintenance costs

Software Reuse - 17% of a base of 20 million lines-of-code is reused

Software Development Cycle - Time spent on Lower-CASE part of software development process (system production and testing) has been reduced from 60% to 35%.

Measures of CASE Impact

Table 1. - CASE Impact on Software Production

	Traditional Environment	CASE Environment
Development Hours	20,000	12,000
Lines of System Code	89,230	36,568
Avg. Hours to Fix Defect	11.4	5.6

Benefits of Software Reuse

- Reduced application development costs
- Improved quality and reduced maintenance costs because of ability to maintain fewer components to achieve the same or greater functionality

3.4.2. Lessons Learned

Software Process Improvement

The GTEDS effort to improve the process of software development and maintenance involves a number of coordinated efforts including:

- Definition of a standard methodology for both new development and re-engineering
- Introduction of software process metrics (see description under Technology Transfer)

- Establishing policies and tools for software reuse

One important focus for the process improvement effort was the process of requirements gathering and definition. GTEDS has implemented a new process which they call the Requirements Gathering Technique. It adapts the IBM Joint Application Development (JAD) model to the GTEDS CASE environment.

Standard Methodologies

Key Lesson Learned: Adopt a standard software methodology for the entire enterprise and enforce its implementation.

The methodology adopted for GTEDS adapted the commonly used process defined by Yourdon to the GTE environment. Process elements include the following:

Upper-CASE

- Initiation
- Technology Planning
- Module Planning Requirements
- Service Provider Selection

Lower-CASE

- Development
- User Acceptance/Test
- Implementation

Other Supporting Methodologies

The software development process is also affected by methodologies that are employed to support Data Administration and Total Quality Management.

Case Implementation Requirements

Key Lesson Learned: Establish corporate-wide policy for CASE.

GTEDS management instituted a policy that required the use of CASE tools for all new development. Other elements of the policy included:

- establishment of a standard methodology
- establishment of a repository for data definitions and business rules
- establishment of a repository for software reuse
- an incentive program for meeting goals for implementing process and technology changes

The GTEDS experience demonstrates the interdependence among the FAA initiatives, i.e. the need to coordinate the development of a data repository with software process improvement methodologies, software reuse, and implementing business process changes.

Key Lesson Learned: Avoid storing source code in the software repository.

What is reusable in a "software factory" is not the computer code, but the sets of requirements that define the component that is replicated in the system design. While COBOL is still the primary language for the dominant mainframe applications, CASE tools are viewed as a means to make the develop processes independent of specific language requirements.

The GTEDS software repository contains the requirements and specifications needed to generate the source code and executables incorporated into implemented systems. Combined with the GTEDS policy requiring production and use of reusable components, the policy of only storing requirements in standard CASE format encourages both the use of both CASE tools and reusable components. The policy has the additional benefit of encourage software maintenance to focus on extending functionality with the CASE tool as opposed to improving source code in small increments.

Re-engineering

Key Lesson Learned: Re-engineering reduces the risk of missing essential functionality in a new application.

GTEDS has emphasized the value of re-engineering as opposed to new development. One of the major advantages of re-engineering is the reduced risk of missing functionality that was present in the original application. Properly structured the re-engineering process will generate repository resources, including data models and reusable components. Such products would be similar in utility to those produced by new development.

Impact of Client-Server Technology on Software Development Process

It is necessary to retrain people in the C programming language. Client-server also involves a major cultural change in the relationship between business requirements and applications development. More is demanded of the developers in terms of responding to market changes.

Software Reuse

Reuse Policy

The establishment of a reuse repository is no guarantee of success for the application of that capability. GTEDS established a policy to promote reuse based on the following priorities:

- **The corporation invests in the maintenance of reusable components.** - A separate group has been established at GTEDS for the maintenance of reusable components.
- **Reusable components are a required product of new applications development.** - One of the requirements of the new CASE based development process is the production of reusable components, both software functions and macros.
- **Reusable assets will be integrated into legacy systems.** - The major purpose of re-engineering legacy systems to enhance functionality to meet new requirements. An added benefit is the introduction of reusable components in

the re-designed system. This will enable easier maintenance and enhancement of the systems in the future.

Nature of Reusable Assets

GTEDS takes a broad view of the scope of reusable assets. Most reusable components are small scale modules that can be incorporated into re-engineered or new applications. Examples include:

- Terminal emulation modules
- Data extraction processes
- Memory services
- Application macros

Other reusable assets are much larger systems that can be replicated in multiple environments.

Object-Oriented Technology (OOT)

There is a pilot project at the GTE Labs for OOT. The intent is to refine the methodology for applications within the company. GTEDS does not believe that OOT is mature enough for large-scale applications development. The company believes that a lot of the benefits from OOT can be achieves when date requirements are addressed in relation to business requirements.

3.4.3. Technology Transfer/Procurement Vehicles

Process of CASE Tool Selection - GTEDS Use of PACBASE

GTEDS established a weighted evaluation of the tools in relation to business requirements. After the top three tools were selected, GTEDS evaluated the tools in relation to their ability to grow with the architecture. Requirements considered for evaluation of the CASE tools included:

- Tool integration
- Compatibility with client-server environment
- Capability to manage centralized repository
- Support for asset reusability

The CASE tool GTEDS selected was PACBASE. The CGI product provided for a repository, integrated upper and Lower-CASE, plans for reverse engineering capabilities, and for client-server support. It also met GTEDS architectural requirements through its support of applications development for IBM mainframes, DEC and RISC 6000 workstations in a UNIX environment, PC DOS, and Tandem platforms. IDE and Knowledgeware had not demonstrated adequate capabilities for Lower-CASE functionality.

As of March 1993, eleven major applications have been re-engineered in PACBASE.

Software Reuse

PACBASE is being used to manage the GTEDS repository for software reuse.

GTE Federal Systems is a participant in the DARPA funded Domain Specific Software Architecture Program. (*Crosstalk*, Software Technology Support Center, Oct. 1992)

Objectives of Software Process Metrics

- Identify areas of excellence within the company
- Manage resources more efficiently in relation to project requirements and history
- Implement function point analysis to control complexity
- Implement continuous improvement program for software quality
- Identify candidates for re-engineering

One of the key components of the GTEDS effort to improve the software production process is the implementation of process metrics. They have implemented a system of measures that are tied to the hierarchy of enterprise and project management (see Figure 1). So far the process of tracking the hierarchy of metrics has not been automated. Such a product would be the equivalent of an Executive Information System (EIS) for software production. Some of the sources of data, such as project tracking and scheduling are derived from existing systems for project control and time-reporting.

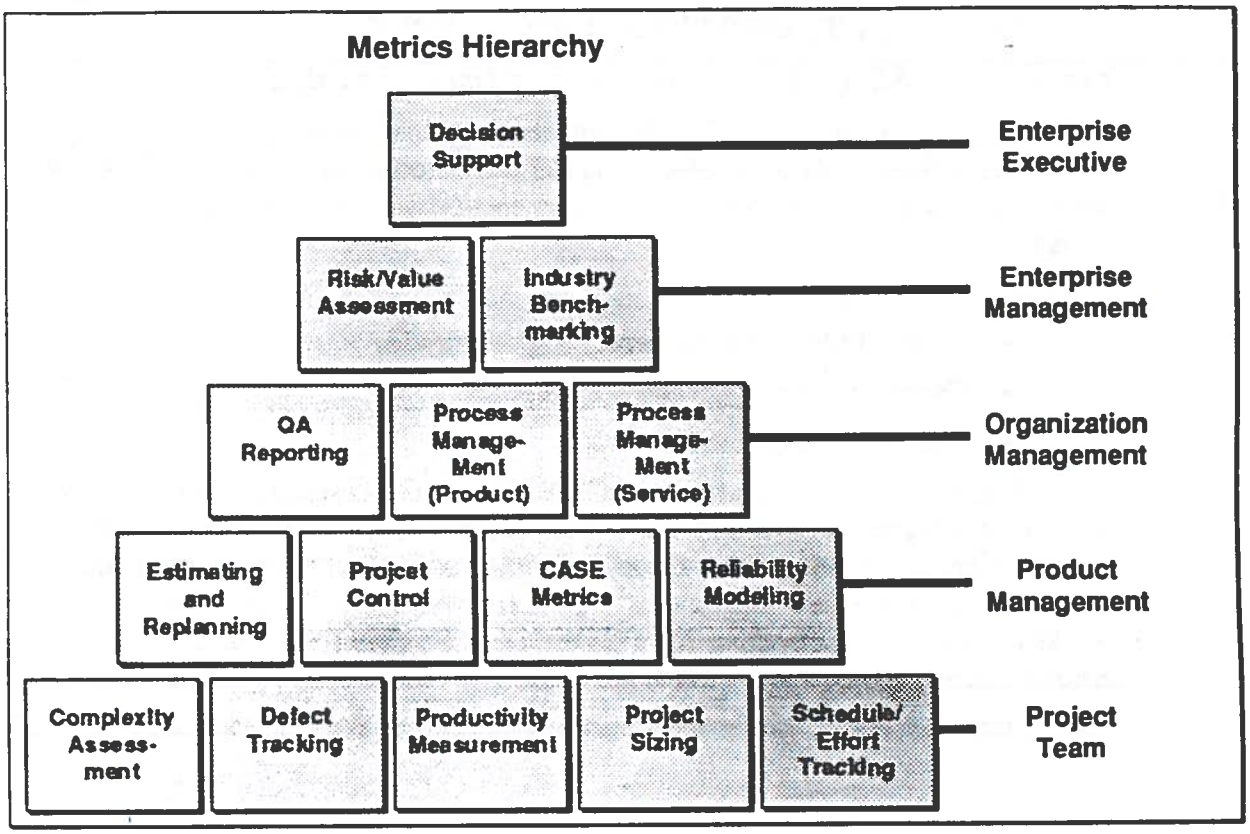

Figure 1. - GTEDS Metrics Hierarchy for Software Process

Specific measures that feed into the metrics hierarchy include the following:

- Development Metrics
  - Productivity Index
  - Estimate Error
  - Defect Containment Ratio
  - Mean Time to Defect
  - Lines of Code
  - Number of Inspection/Test Defects
  - Productive Staff Hours
  - Actual versus Estimated Schedule
- Production Metrics
  - Mean Time to Defect
  - Lines of Code
  - Equivalent Lines of COBOL Code
  - Basic Support Hours
  - Basic Support Hours per Defect
  - Defects per KLOC / (external) KLOC
  - % External Defects Completed on Time
  - % Defects Re-opened
- Other CASE Metrics (number of)
  - Graphical Entities
  - Graphical Components
  - Text Entities
  - Lines of Documentation
  - Parametrized Input Aids Defined / Reused
  - Data Elements Defined / Reused / Referenced
  - Reports and Screens Defined
  - Programs Generated
  - Lines of Code Manually Written

Complexity Matrix for Targeting Re-engineering Efforts

GTEDS has used the measured metrics for software process tracking to assess maintenance requirements for existing systems. The GTEDS Complexity Matrix displays different systems in relation to *Product Defects per KLOC* and *Project Support Hours per KLOC*. Systems that require a high number of hours to fix a defect and which have large numbers of defects that require maintenance are candidates for re-engineering. The Complexity Matrix provides a means for re-engineering opportunities that will have the greatest effect on reduce maintenance costs. The matrix is also used to track the effects of the re-engineering efforts.

4. Summary - Key Conclusions from Survey

GTEDS represents one of the few large corporations that have implemented CASE tools and repositories on a company-wide basis. The GTEDS experience has demonstrated the value of coordinating the repositories, tools and strategies that support data management and software applications development. From the FAA perspective, this implies that there should be a close coordination between the Data Management and Corporate Software Engineering Initiatives. Other conclusions from the GTEDS investigation are identified in Table 2.

Table 2. GTE Relationships to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicles
Core Architecture	• 20% savings as a result of data center consolidation (approx $50 mil./yr.) • The benefits of a client-server arch. are faster development cycles and enhanced functionality • Client-server implementations will incur increased costs due to training, hardware, software and network requirements.	• Establish a reliable network as a first step toward data center consolidation. • Use software metrics to identify "best-of-breed" applications. • Use reusable components to implement client-server architecture.	
Business Process Improvement			
Data Management		• Understand the data required for the business operations • Establish a single source of information on data (repository) • A key objective is to reuse and share (not create) data elements.	• ***Use of LEVERAGE and PACBASE to maintain the GTEDS data repository.***

Corporate Software Engineering	• 20% savings ($50-60 mil.) saved through use of CASE and reuse
	• 30% reduction in s/w development cycle time
	• 50% reduction in life cycle maintenance costs
	• 17% reuse (base of 20 mil. lines-of-code)
	• Example of CASE impact
	  • Dev. hours - 30% reduction
	  • LOC - 53% reduction
	  • Hrs. to fix defect - 51% reduction
		• Key requirements for software process improvement:
		  • Define and implement a single s/w process methodology
		  • Establish and monitor software process metrics
		  • Institute policies and tools for reuse
		• Use metrics to identify candidates for re-engineering
		• Do not store source code in reuse repository
		• Re-engineering reduces risk of missing key functions in application development
			• Use of LEVERAGE for upper-CASE software process
			• Use of PACBASE for lower-CASE software process
			• Use of PACBASE for software reuse repository
			• ***Use of GTEDS Software Process Metric Hierarchy***
			• Complexity Matrix for selecting re-engineering candidates

****Documentation, software, and other resources that the FAA may be able to leverage are highlighted.***

Section 8

Air Force Computer Acquisition Center (AFCAC) 300 Supermini Acquisition

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Report on
Air Force Computer Acquisition Center (AFCAC) 300 Initiative

1. Program Description

AFCAC 300 is the Department of Defense's (DoD) Supermini megacontract, estimated at $2.5 billion, won by PRC Inc, and the program manger is the Department of the Navy. The Supermini is an Indefinite Delivery-Indefinite Quantity (IDIQ) procurement vehicle available to DoD, Coast Guard and Federal civilian agencies. Industry analysts believe this contract could become the basic integration vehicle for the reorganization and modernization of the DoD based on their Corporate Information Management Initiatives.

2. Method of Investigation

Data extracted from PRC Supermini program documentation, articles in government periodicals and the NAS Program Initiative (NPI) 132 for FAA Advanced Information Management Systems (AIMS).

3. Relationship to CIE Computer Initiatives

3.1. CORE ARCHITECTURE

There is a need to provide the FAA with the capability to accommodate the growing disparity between the widely deployed Office Automation Technology and Services (OATS) desktop computer environment and the centralized mainframe capabilities of Computer Resource Nucleus (CORN), as well as to facilitate centralized oversight of acquisitions in this area.

FAA organizations have already identified or initiated programs such as Computer Aided Engineering and Graphics (CAEG), Instrument Approach Procedures Automated (IAPA), Obstruction Evaluation (OE), Airport Airspace Analysis (AAA), Automated Documentation Development and Maintenance (ADDM), Operational Database Management System (ODMS), Aviation Safety Analysis System (ASAS), Enhancements to Computer Based Instructions (CBI), NAS Management Automation Program (NASMAP), Integrated Flight Quality Assurance (IFQA), and Telecommunications Information Management System (TIMS) which require computing and advanced information management system alternatives exceeding the capabilities of OATS products. The computing requirements of these programs and much of this decade's evolving IT, while beyond OATS, are not practically accommodated by the CORN mainframe environment.

> ***Key Lesson Learned: The void at the mid- and high-level distributed systems level is a significant and ever increasing deficiency within the FAA's agency wide IT management strategies.***

3.1.1. Lessons Learned

The AFCAC 300 Supermini Computer Program Buy appears to be the most encompassing and comprehensive procurement vehicle to-date. A key point is how this acquisition contract is mapped to the DISA/CIM Technical Reference Model (TRM), Figure 1.

Technical Reference Model

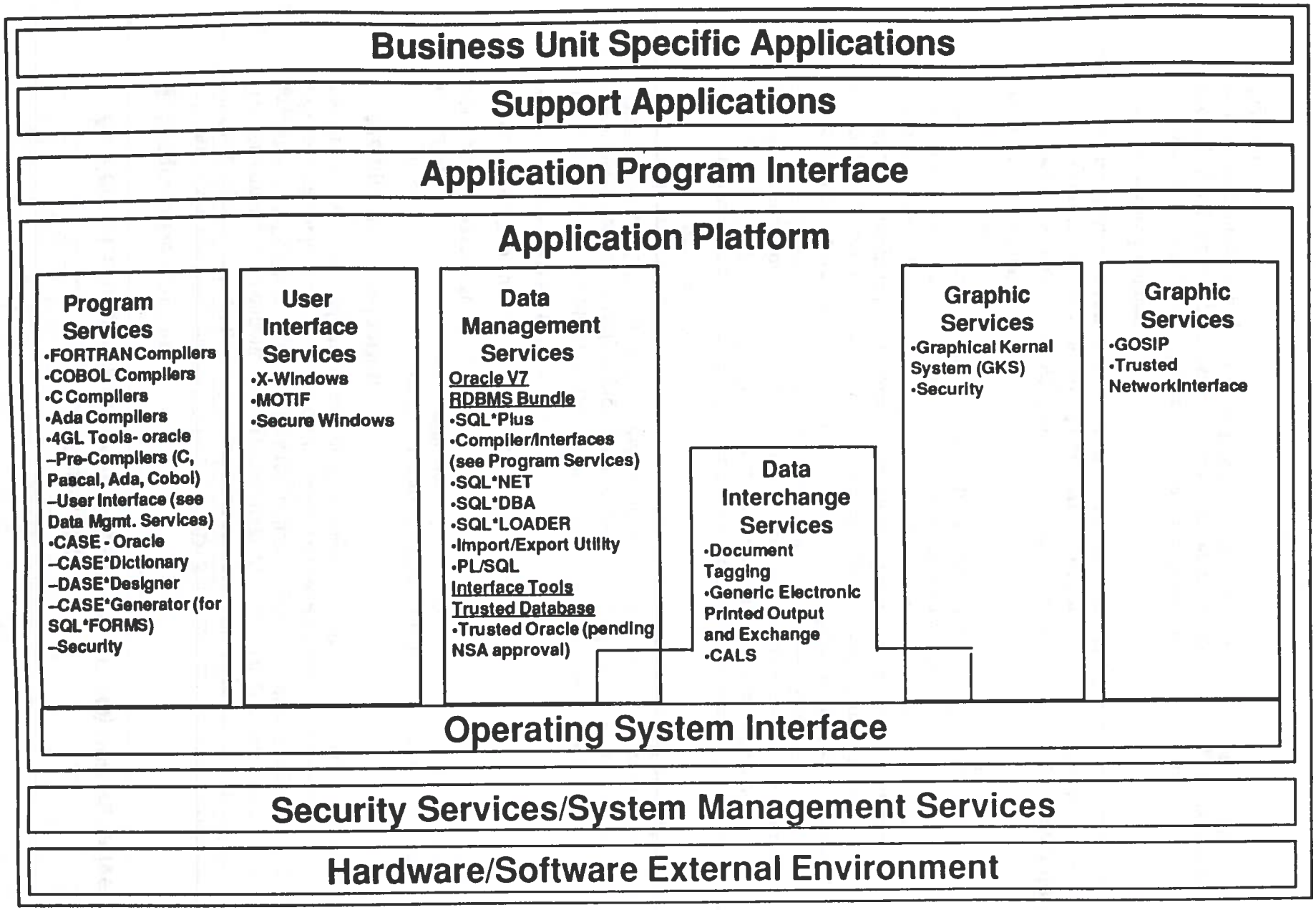

Figure 1

Key Lesson Learned: TRM configuration (Data Interchange Services component) supports CALS standards, scanning, electronic publishing, etc.

Additionally, it appears this contract would meet the mid-range 'void' that exists between the FAA's OATS and CORN contracts. Specifically, AFCAC 300 could potentially support the Core Architecture activity titled "Functional Technology Services."

- This effort will generate a paper-based product which assesses the different platforms and sizes for OATS, CORN, and AIMS. It will also include a hardware and software technology assessment to test and validate the software and hardware design. (In a more robust alternative, this effort will consist of actually performing demonstrations for proof of concept.)

3.1.2. Technology Transfer/Procurement Vehicle

Over the nine-year life of the Supermini contract it is estimated that 130,000 computers, file servers, terminals, and workstations as well as distributed-processing equipment, including 1.4 million local-area network cables and 50,000 network cards, will be delivered. **Purchasing limitations for civilian agencies (Coast Guard is not included in civilian limitation) are 10% of the delegated procurement authority (DPA - $250 million), 2% of DPA for any one agency ($50 million).** Purchasing limitations are imposed by GSA and requests for an increase in purchasing authorization would be submitted through GSA. All products and services can be ordered up to September 1997 and services and maintenance is available to September 2001.

Equipment available on the contract includes: Hewlett-Packard high-powered Model 800 workstations to serve as file servers for groups of 64 to 256 users; Human Design Systems Inc. RISC X terminals; and Everex Federal System Inc 386DX/33 and 486 PCs. Inside the government, X terminals have traditionally been used for engineering applications, now they will be used for office automation and database applications. Supermini is supported by approximately 85 subcontractors, 50% of the products support communications, and over 1200 products are available.

Because civilian agencies can buy equipment and technical services (training, LAN/WAN communications, security, etc.) off Supermini, this contract has the potential of becoming the cornerstone of government efficiency. The systems offered clearly support distributed multi-user systems, therefore there is the potential that they will reduce or eliminate some of the older systems in place.

Key Lessons Learned: The AFCAC 300 Supermini contract provides the FAA the opportunity to either:

- Purchase state of the art equipment to support the FAA infrastructure (mid-level equipment range to fill gaps in OATS and CORN) to support the AIMS initiative.
- Use AFCAC 300 contract (RFP, evaluation criteria, etc.) as a model for the acquisition documents for AIT-500 Advanced Information Management Systems (AIMS) initiative.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. Lessons Learned

One of the alternative solutions identified in the AIMS NPI to close the computing capability gap between OATS and CORN is to seek out and use another agencies procurement vehicle, e.g., AFCAC 300. This may still be a viable alternative because it will support AIMS "multiple source acquisition" strategy.

As technology matures and evolves new products can be added to this contract. In fact the first technology refresher to the contract took one month to complete.

4. Summary: Key Conclusions from Survey

Supermini (AFCAC) is likely to compete with other federal government contracts in place today. The key difference is that the products offered on Supermini are sufficiently advanced and there are no similar contracts in place today where such a broad spectrum of products can be purchased.

The following provides a summary of key conclusions referenced to CIE Initiatives.

Summary Table of AFCAC 300 Relationship to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicle
Core Architecture		• FAA has a void at the mid- and high-level distributed systems level • AFCAC is mapped to the DISA/CIM Technical Reference Model (TRM) • TRM configuration supports CALS standards,scanning, electronic publishing, etc. • AFCAC 300 could potentially support the Core Architecture activity titled "Functional Technology Services"	• Provides the FAA the opportunity to purchase state of the art equipment (mid-level range) • Use AFCAC 300 contract as a model for developing acquisition documents • A single integration vehicle for hardware, software, and services • AFCAC 300 equipment supports distributed multi-user systems
Business Process Improvement		• AFCAC 300 may be a viable alternative to "multiple acquisition strategy" • The first technology refresher to AFCAC 300 only took one month to complete	
Data Management			
Corporate Software Engineering			
Electronic Data Interchange			
IT Security			

Section 9

American Airlines (AA)

Table of Contents

Report on American Airlines

1. Program Description

SABRE Computer Services (SCS) is the major organization for computer applications development and information services for American Airlines (AA - AMR Corporation).

A vice president, Charles Clark, under the SCS president, Thomas J. Kiernan, oversees applications development. The three major system areas include:

1. Flight Operating System (FOS) -- This major system provides for all major real-time applications involved in flight operations and control.
   - centralized dispatch
   - load control and weight balancing
   - crew schedules
2. SABRE (an array of mainframes) - the American Airlines Passenger Sales and Service System (PSS).
3. Maintenance Operations Control - linked to FOS.

Additional system support is provided in the areas of Inventory Control and System Operations and Control.

2. Method of Investigation

In addition to published sources, Volpe Center and FAA personnel (Roger Cooley and Paul Evans, AIT-300) met with the following representatives of American Airlines:

- Mr. Charles E. Clark, VP for Demand, Planning and Management Services
- Mr. Robert Offutt, Architecture Planning.

3. Relationship to CIE Initiatives

3.1. CORE ARCHITECTURE

American Airlines business strategy to date has been based on home growth. They have kept away from mergers because they did not want to inherit disparate union contracts. American is a centrally run organization (14 - 15 people report directly to Robert. Crandall, Chief Executive Officer) in which the core planning committee meets each week to discuss Corporate Strategy.

3.1.1. Lessons Learned

American has large IBM mainframe operation employing MVS and TPF environments. DEC and Unisys are supporting telecommunications requirements. The reservation system and other applications generate 3000 messages a second. FOS on the other hand has a lower transaction rate but a much higher processing rate.

A number of their applications, particularly System Operations and Control, are moving toward a distributed environment.

Client/Server Plans

American has initiated a process for establishing a client-server architecture. The mainframe computers will provide major data management services, while applications, where appropriate, will be moved to smaller platforms such as workstations.

American is using Powerbuilder from Powersoft to construct client-server applications.

Organizational Infrastructure

Applications development is supported by one VP, communications by another, and common resources by a third. The Development Resources VP oversees the following groups:

- Knowledge Engineering
- Data Management
- Development Services
- Methods & Standards
- Business Process Re-design

American Airlines Architecture Framework

American is following a process of defining business and technology requirements that produces the following "generic architecture's:"

- Business Architecture - How the company organizes the business.
- Applications Architecture - How the company identifies, prioritizes, plans for integration of systems.
- Technology Architecture - How the company builds and integrates applications and technology products. Where systems cannot be designed to meet open system standards they will be designed to facilitate migration to open systems. Technology Architecture is comprised of three elements:
  1. *Principles* are fundamental beliefs regarding the planning, implementation and support of IT. **Principles are values made explicit and tangible.** They are intended to direct behavior and set the context for technology discussions.
  2. *Standards* identify both specific systems components and operating procedures that are supported by the organization.
  3. *Frameworks* provide a composite guideline for matching customer requirements to solution templates. The solution templates are comprised of compatible standards that provide full working solutions.
- Vendor Product Architecture - Whose technology products the company applies to meet the Technology Architecture standards.

Standard User Environment

The company is implementing an Office Automation concept based on HP 3000 workstations, which also supports MS Windows. The company is evaluating the use of MS Workgroups for Windows. When fully implemented, there will be 5000 stations

on-line via a Novel token-ring LAN. The standard user environment consists of 386 PCs connected to a Novel token-ring LAN.

Certification Process

Certifying equipment for integration into the American Airlines technology architecture is becoming increasingly cumbersome and costly. The company has to certify all computer equipment is connected to the network, including all the 30K travel agents that use SABRE.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA*

3.2.2. Lessons Learned

Characteristics of the AA Competitive Environment

A number of circumstances are putting a pressure on American's profitability. These include:

- Competition with small specialty carriers. American is competing with a number of companies that are targeting specialty markets, for example Southwest Airlines.
- American's policy is to provide a mainstream (uniform) product. The same level of service is provided on both short-haul and long-haul flights.

Consequently, there is a great deal of pressure to reduce costs in order to improve profitability.

Opportunities for Business Process Improvement

According to Max Hopper, Senior VP of Information Systems at American, systems that are useful are becoming too big and expensive for any one company to build. More and more, it makes sense to share network, share customer data, and share the costs of developing a commonly needed application. **More and more, companies need to work closely with various other aviation partners to solve commonly held problems and exploit mutual opportunities. And more and more, technology makes such relationships feasible.**

Document Management

SCS considers electronic documentation to be a major opportunity for reducing costs and improving core functions. American already has a great deal of documentation in electronic form. *FAA requirements to deliver notices and other data in manual (paper) form has inhibited the use of electronic documentation.*

American is in the process of defining their own documentation standards. The company plans to develop expert system applications that will deliver information from technical manuals that is required by maintenance mechanics.

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* NOTE: An attempt was made to collect information on AA's input on potential benefits, but due to the level of the AA representatives interviewed this information was not available.

Opportunities for Common Access to Data Needed for Flight Operations

Many of the airlines manage information required for flight operations that is also tracked by the FAA. Such data includes weather and other data required for aircraft situation displays.

Improved access by Pilots to Critical Data

AA would like to provide visual displays of all information the pilot needs to assess current status and options.

3.3. DATA MANAGEMENT

3.3.1 CBA

Data Management is supported by about 150 people out of a total of 2000 development personnel.

3.3.2 Lessons Learned

The Data Management function has been removed from the organization responsible for applications development and put under the VP for Development Resources. This area is functioning as a "Center of Excellence."

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. Lessons Learned

Software Process Improvement

The Methods and Standards Group has responsibility for the establishing and support of the company's Standards Development Process. The group oversees CASE tools and training requirements.

Changes in the Process of Applications Development

American is attempting to introduce fundamental changes in the way in which applications development personnel support the business operations. The rapid growth of personnel from 30K to 100K employees has produced an applications development organization in which 2000 developers support the operations of 50 corporate officers. The (stovepiped) nature of the operations has resulted in inefficient use of development resources and applications that fail to take advantage of opportunities for data and process integration.

Improvement in the process focuses on two areas:

- Prioritization of applications in relation to strategic business goals. - The company's resources hadn't been allocated in relation to corporate objectives. SCS found, for example, that some projects situated in the top twenty in terms of strategic priority had as few as six staff members assigned.
- Breaking the organizational bonds that inhibit access to developers with required skills. -- In the past developers had been "owned" by the functional organizations and the corporate VPs responsible for the functional area. In the new environment, American is following the model of a consulting organization. The developers are assigned on the basis of matching required skills and availability (e.g. a matrix organization).

3.4.2. Technology Transfer/Procurement Vehicles

Use of New Applications Technologies

American is exploring the use of:

- Artificial Intelligence (AI) Technologies: knowledge engineering, neural nets and other AI applications to be run on RISC-based platforms.
- Massively parallel processor technology

American eventually wants to transition to a gate link system. Digitized sensor data (e.g. engine performance, "black box" data, etc.) recorded during flight operations could be downloaded at the gate when the aircraft arrives. This would provide nearer real-time access to vital data to whomever needs it.

3.5. EDI

Qualitative Benefits of AA Access to FAA Data

Mission EDI

American Airlines anticipates that significant benefits would result from electronic access to FAA data. As mentioned below, there is considerable duplication of functions related to production and management of weather data, notices of rule changes, exchange of Maintenance Equipment Lists (MELs) and Service Difficulty Reports (SDRs). Quantification of anticipated benefits has not been carried out by the airline.

3.6. SECURITY

3.6.1. Lessons Learned

Electronic Signatures

American Airlines regards the implementation of electronic signatures as a major opportunity to support business transactions with the FAA and other organizations. The definition of an appropriate standard will have to be an industry-wide effort.

4. Summary: Key Conclusions from Survey

The following provides a summary of key conclusions referenced to CIE Initiatives.

Summary Table of AA Relationship to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles
Core Architecture		• American is a centrally run organization, 14-15 people make up the core planning committee • American has large mainframe operations but is in the process of developing a transition strategy toward a client/server environment for a number of major applications • American is in the process of defining their own documentation standards • American is defining business and technology requirements	
Business Process Improvement		• Companies need to work closely with various partners to solve commonly held problems and exploit mutual opportunities • SCS considers electronic documentation to be a major opportunity for reducing costs and improving core functions • Opportunities for common access to data needed for flight operations	
Data Management		• The data management function has been removed from the applications development area and placed under the VP for Development Resources	
Corporate Software Engineering		• American has a single group that oversees CASE tools and training requirements • American is breaking the organizational bonds that inhibit access to developers with required skills and are building a matrix organization	• American is exploring the use of AI technologies to run on RISC-based platforms • American is interested in downloading digitized sensor data recorded during flight at the aircraft arrival gate
Electronic Data Interchange	• American anticipates that significant benefits would result from electronic access to FAA data, e.g. weather data, MELs, and SDRs		
IT Security		• American regards the implementation of electronic signatures as a major opportunity to support business transactions with the FAA and other organizations • The definition/development of an appropriate standard will have to be an industry-wide effort	

Section 10

Federal Express (FEDEX)

Table of Contents

Report on the Federal Express Initiative

1. Program Description

Federal Express (FEDEX) has built an integrated and very competitive company on an enterprise architecture. Integrated systems at FEDEX enable tracking of a parcel in *real time* and provide detailed information regarding minute-by-minute parcel movements.*

2. Method of Investigation

The sources of data for the FEDEX investigation came from published sources and interviews with FEDEX personnel*:

- Dennis H. Jones, Sr, VP Information and Telecommunications
- Jon T. Ricker, VP, Corporate Systems Development - 901-397-4247
- Rich Wohleber, Managing Director, Strategic Systems Development, 901-375-6414
- Steve Steiling, Managing Director, Air Operations Support, 901-922-2334
- Frank J. Ginnett, Managing Director, Corporate Systems Development, 901-922-2408

3. Relationship to CIE Initiatives

3.1. Core Architecture

FEDEX is overhauling their information technology (IT) infrastructure. The plan is to move from the current mainframe environment to a client-server architecture, based on open systems standards.

Through pursuing and measuring quality and adopting an enterprise strategy of innovative and integrated systems, FEDEX has become the dominant force in the package delivery business.

The need to track packages creates a need for large-scale transaction processing capabilities. In all, 420 airplanes, 30,000 trucks, and 96,000 people work in synchronization to deliver over 1.5 million packages a day. Today basically, FEDEX is a series of networks, and it takes about 17 hours for a package to move from shipper to receiver. During the 17 hours every time that parcel changes status, information is recorded through sensors and entered into the database (called COSMOS). The database contains all the basic customer information and it communicates with a number of other systems and devices to maintain a complete record of every shipment that FEDEX handles, from beginning to end.

FEDEX will scan the 1.5 million shipments, at least nine times each, as they move through the network. The bulk of the IT requirements processing takes place during two periods of four hours each day. By the end of 1993, business expansion in international markets will increase the daily load to 36 million transactions.

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* Volpe Center staff were not able to attend this meeting due to travel problems.

A great deal of attention is paid to using IT for improving the operation of the business. FEDEX regards itself as "an information processing company which moves packages."

Common Features between Federal Express and FAA Environment

- Need for integration of real-time systems and administrative databases
- Need to provide systems that can be rapidly modified to meet changing customer needs

3.1.1. CBA

Benefits of Moving to Open Systems

The move to open systems is driven by the need to provide corporate-wide information for decision making and new competitive enterprise applications that transcend autonomous business units. Overcoming dependence on a single information systems vendor is becoming significantly important for IS managers, since the market competition is triggered by multivendor purchasing policies that often result in greater product selection and lower prices.

3.1.2. Lessons Learned

Current Systems Environment

- Redundant systems are implemented for all critical operations

FEDEX Open Systems Environment (OSE)

Characteristics of the FEDEX OSE:

- Use object-oriented Unix, with C++ as the main development language
- Workstations types include Hewlett Packard, Sun, and IBM RS-6000
- Network protocol standard for OSE - TCP/IP
- Communications - FEDEX is moving from an SNA communications architecture to X.25 (packet switching). As the technology becomes available, the company plans to implement frame relay and ATM (Asynchronous Transfer Mode) for data communications. The requirement is to support 600 MBits/sec. This is substantially greater than currently available LAN or WAN technologies.

Relational Databases Tests

A number of relational databases were tested, included Sybase, Oracle, Informix, and Ingres. All four failed the initial tests. Sybase and one other database vendor were retested and passed.

Process for IT Investment Decisions

FEDEX follows a two-step process similar to IT investment disciplines followed at other major companies such as Xerox and Kodak. The first stage applies a rough set of criteria to qualify candidate initiatives in relation to potential impact of the investment on critical business objectives. The second stage applies a more detailed analysis to compare merits of competing investment programs.

3.2. Business Process Improvement

3.2.1. CBA

Focus on Command and Control

Business strategy is developed in relation to three areas: Air Operations, Ground Operations, and Command and Control (C&C). IT is the key instrument for improving C&C functions. Benefits of improved C&C include

- More accurate tracking of packages
- Improved capacity to perform routing functions

3.2.2. Lessons Learned

Key Lesson Learned: Build systems to support the major business processes and IT staff works for the functional managers.

The entire company is oriented to improving the processes that support the main business of reliable delivery of packages. IT is designed to support the business mission.

While the Systems Development has its own organizational identity, the IT staff also works for the functional managers in Air Operations and Ground Operations.

Key Lesson Learned: Understand the business and the data needed by the business.

FEDEX has a well-defined mission and set of business processes that support the mission. They believe that they have a very good understanding of the data required for the business operations.

Monitoring Processes in relation to Customer Satisfaction

FEDEX has a customer dissatisfaction index that measures process deficiencies from a customer perspective. For example, if FEDEX loses a package, this is rated a "10" because it is likely to cause the permanent loss of a customer. A late package receives a lesser rating.

All of this is based on integrated technology - in this case, integrating three classes of systems, physical systems that scan or monitor physical events, transaction-oriented systems that use database technology to manage financial information, and end-user systems that directly support users.

3.3. Data Management

3.3.1. Lessons Learned

- FEDEX recognizes the need for a data administration program, but is finding it difficult to implement in their distributed environment.

3.3.2. Technology Transfer/Procurement Vehicles

- Planned implementation of information warehouse that will include historical data.

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. Lessons Learned

Limitations of Object-Oriented (O-O) CASE Tools

FEDEXs' experience is that O-O case tools have not matured sufficiently to support their development process. The current state of CASE has not addressed the requirements of O-O Technology (OOT) in a distributed environment.

FEDEX has experimented with the use of CASE tools, but they did not realize the productivity gains they expected and discontinued the tests. OOT was considered an alternative to the use of CASE as a means to speed development and reduce future maintenance costs.

Training Requirements

The use of O-O techniques will require intense retraining of personnel to new methods of analysis and application development.

Objects as Enterprise Assets

FEDEX is building an enterprise wide set of objects to define the business and support development of required applications. The company considers the object models as a corporate asset just like the aircraft. In keeping with that view, FEDEX is using an accounting approach to tracking and maintaining the object-assets.

The recognized importance of the definition of the class hierarchy has led to intense debate on the characteristics of the object classes.

Objects and Reuse

FEDEX is developing a faceted classification scheme to support access to objects and their reuse in software development.

Use of OOT in Mission Critical Applications

The pilot project for the use of OOT is in the area of load-balancing of aircraft. Maintaining proper weight distribution is a mission critical area for FEDEX because of the sensitivity of the Airbus (the major transport medium) to weight imbalances.

Achieving Rapid Development Cycles

FEDEX has achieved quick cycle times for software development. Factors that contribute to the rapid development cycle include:

- Focus on business requirements
- Constant attention to process improvement

FEDEX Strategy for Implementing OOT

- **Training** - The use of O-O techniques will require intense retraining of personnel to new methods of analysis and application development. FEDEX found it was easier to retrain COBOL programmers than analysts trained in the C language. FEDEX allows for about one-year for training and integration of personnel into the software production process.

Section 11

US Coast Guard Systems to Automate and Integrate Logistics (USCG/SAIL)

Report on
U.S. Coast Guard (USCG)
Systems to Automate and Integrate Logistics (SAIL)

1. Program Description

The U.S. Coast Guard (USCG) Systems to Automate and Integrate Logistics (SAIL) Initiative was established as a process to modernize and integrate USCG logistics.[1] SAIL is based on the assumption that improved logistics requires modernization of the logistics information system. The major system that will support improved management of logistics information is the Fleet Logistics System (FLS), which is currently being designed for deployment by the end of the decade. The scope of FLS as an integrating concept for USCG logistics data is illustrated in the following context diagram (see Figure 1).

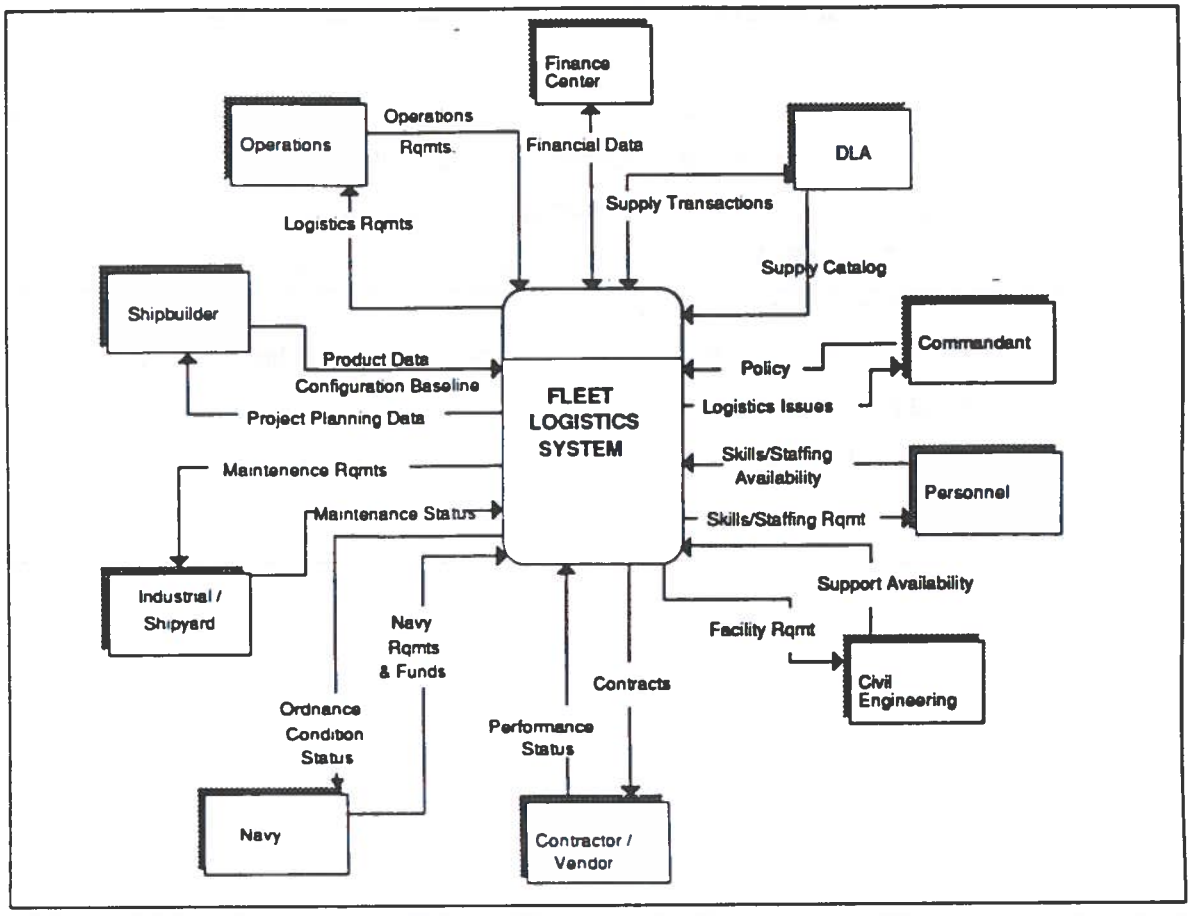

Figure 1. FLS Context Diagram

[1]For an overview of the SAIL Initiative, see VNTSC, *Systems to Automate and Integrate Logistics: Information Systems Plan (July 1991)* developed for the USCG Office of Engineering (G-ELM).

Complementing the FLS is the CM-Plus Program, which is developing comprehensive configuration management support for USCG fleet assets.

2. Method of Investigation

The investigation was based on briefings that have been produced in support of the SAIL Initiative and the FLS program. This information has been supplemented by interviews with VNTSC staff responsible for supporting the SAIL initiative.

3. Relationship of SAIL to CIE Initiatives

Like the DoD JCALS Program, an objective of SAIL is to provide capabilities for managing technical information related to USCG logistics operations. SAIL also supports the management of physical assets of the USCG. These capabilities overlap with requirements and capabilities of FAA systems. For example, the Systems Support Computer Complex (SSCC) of the Advanced Automation System (AAS) is intended to track the configuration and systems environment of AAS components, as well as related technical information. As the FAA moves toward use of CASE and Object-Oriented technologies, FLS may offer useful models and technologies that can be adapted to FAA applications.

3.1. CORE ARCHITECTURE

3.1.1 CBA

3.1.2. Lessons Learned

3.1.3. Technology Transfer/Procurement Vehicles

Architecture Framework

The framework used to define the FLS architecture is similar to the FAA corporate systems architecture. The Fleet Logistics System (FLS) Conceptual Architecture Draft Report addresses the same architectural components that have guided the definition of the CIE framework. The architectural components are Organization, Work Process, Data, Applications and Technology (see Figure 2).

Figure 2. - FLS Architectural Components

	Work Process	Organizations & Roles	Applications	Data	Technical Infrastructure
Conceptual					
Logical					
Physical					

Client-Server Architecture Implementation

The physical technology anticipated for the FLS implementation is based on a client server model in which file and database servers will be distributed at the Fleet Logistics Center, Shore Support Units, and Maintenance Centers. The wide-area communications network will link the centers which are themselves supported by LANs. FLS has not yet developed a detailed technical architecture.

Use of Federal Procurement Vehicles

FLS is considering the DoD Super-mini Acquisition (AFCAC-300) and FEDCAC-101 procurements as vehicles for fulfilling FLS hardware and software requirements. These contracts conform to a client-server model.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA

N/A

3.2.2. Lessons Learned

N/A

3.3.3. Technology Transfer/Procurement Vehicles

BPI in the SAIL Program - The Engineering Logistics Center Business Process Redesign Task

The FLS Program has carried out an analysis of USCG business processes in terms of function sets that are required for logistics operations. The analysis process involved the following steps:

- Analysis of current organizations, processes, and data classes and data flows
- Definition of a Concept of Operations (CONOPS) that defines a vision for the future
- Construction of function sets that define capabilities to be implemented by FLS
- Definition of a conceptual architecture to support the vision
- Cost /Benefit Analysis to identify priorities for implementation strategy
- Systems engineering to convert concepts to Implementable capabilities

The FLS Program is now analyzing the detailed data flows that are associated with the function sets.

In contrast to the formal processes of BPI established within the DoD CIM program, the SAIL Initiative has thus far followed a less formal methodology that grows out of requirements for systems engineering. That process has, however, identified ways in which business processes for logistics can be improved.

The SAIL Program is currently initiating a new task to more systematically identify and implement required changes in the conduct of business processes related to logistics. The Engineering Logistics Center Business Process Redesign Task will develop a model of the ideal organization and business processes for the Engineering Logistics Center (ELC). The

Volpe Center and the Coast Guard Quality Action Team representing a cross-section of ELC functions will develop a model for future business operations, identify proposed changes and agree to a plan for phased implementation. The team will also identify opportunities for near-term improvements that do not involve development of major applications.

The FAA may benefit from examining efforts in the FLS program for business process redesign that parallel its own efforts in BPI.

3.1. DATA MANAGEMENT

3.3.1 CBA

3.3.2 Lessons Learned

3.3.3. Technology Transfer/Procurement Vehicles

FLS Data Repository

FLS intends to establish a common data dictionary (repository) to maintain consistency of data among the distributed FLS databases.

Logistics Information Management

Much of the data that FLS manages in support of USCG operations has analogs in the FAA. In particular, configuration management, supply, maintenance, and technical information are categories of information that also fall under FAA data management responsibilities. *For the FAA, the solution that FLS offers in relation to technical data management may be of particular interest as an alternative government solution to that provided by JCALS.* The FAA may be able to build upon the FLS and CM Plus experience in data and process modeling.

The process models divided the FLS work processes into three functional areas:

- Fleet Logistics Management
- Configuration Planning and Management
- Administrative Support

A high-level breakdown of the key processes that FLS supports is provided in Figure 3.

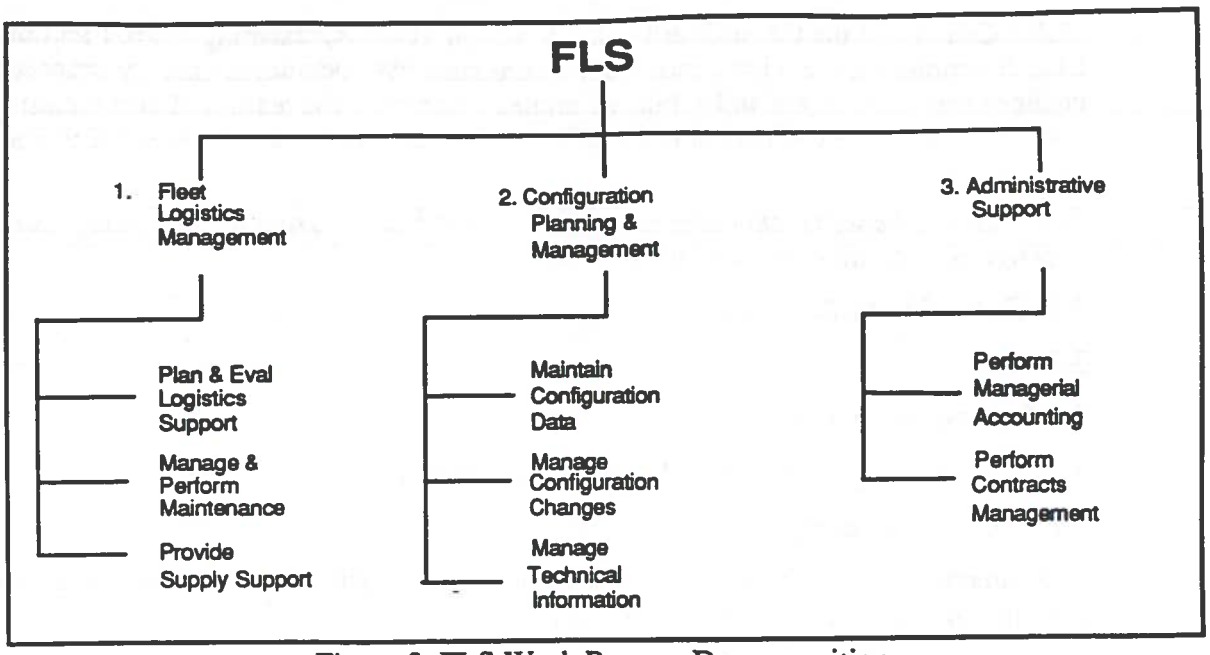

Figure 3. FLS Work Process Decomposition

In order to identify appropriate data classes, the development team produced data-flow diagrams (DFDs) at several levels of depth for FLS processes. A high level DFD showing the relationships between FLS and data from external sources is shown in Figure 4.

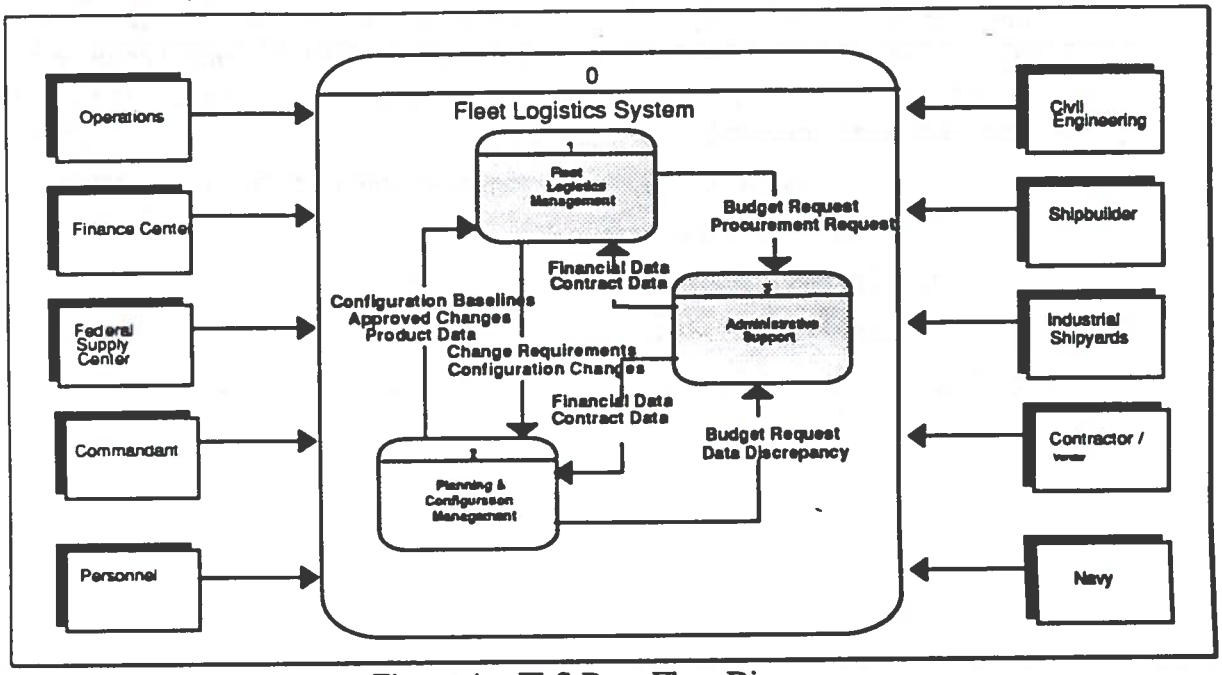

Figure 4. - FLS Data Flow Diagram

FLS Data Models

The FLS program used the DEFT analysis tool (see below under Corporate Software Engineering) to produce the process and data models. The data analysis has so far identified 89 entity types divided into the following entity classes:

- Maintenance Data
- Supply Data
- Configuration and Product Data
- Case data (problem identification and change proposals)
- Project Data
- Infrastructure Data
- Procurement Data.

The FAA may find it beneficial to examine the FLS data models and experience with modeling tools in relation to the requirements of the Data Management Initiative.

Data Management Systems Applications

FLS is developing a number of IS applications that serve needs that are also present in the FAA. Some of these applications address requirements for data management and delivery of data stored in repositories to users. Applications that may be of interest to the FAA include:

- Case Management - manages files and cross-references to data that relate to actionable events, such as incidents, change requests, and other tasks.
- Change Development - manages changes in data fields and consequent actions that must be taken to update related data.
- Configuration Management - maintains configuration baselines and interrelationships among configuration items, support requirements, item versions, physical items, and references to supporting documentation.
- Engineering Data Management - stores and provides indexed access to graphical technical information contained in technical manuals, engineering drawings, and other technical illustrations.
- Integrated Publishing - provides scanning, editing, authoring, modification capabilities to produce digital documents in support of USCG fleet logistics.

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. CBA

3.4.2. Lessons Learned

3.4.3. Technology Transfer/Procurement Vehicles

FLS Life Cycle Management Methodology

The FLS program has developed a methodology for managing development of applications for the entire life cycle. Similar to the FAA development environment, FLS must coordinate the development and implementation of a number of interrelated systems and functions with changes in the business processes that make use of the (logistics) information. The FLS process for life cycle management must also conform to DOT requirements for the acquisition cycle (the Key Decision Point process). The FAA may benefit from evaluating the FLS development process and experience in relation to its own requirements.

The FLS Program is also constructing a methodology for managing the development of system components and functionality. The FLS Life Cycle Management Methodology (see Figure 5) focuses on the design and implementation of CSCIs that support defined "function sets". The function sets are well defined capabilities that are required to carry out logistics business operations. The objective is to be able to manage the development and implementation of multiple function sets which will gradually achieve the required total suite of FLS capabilities.

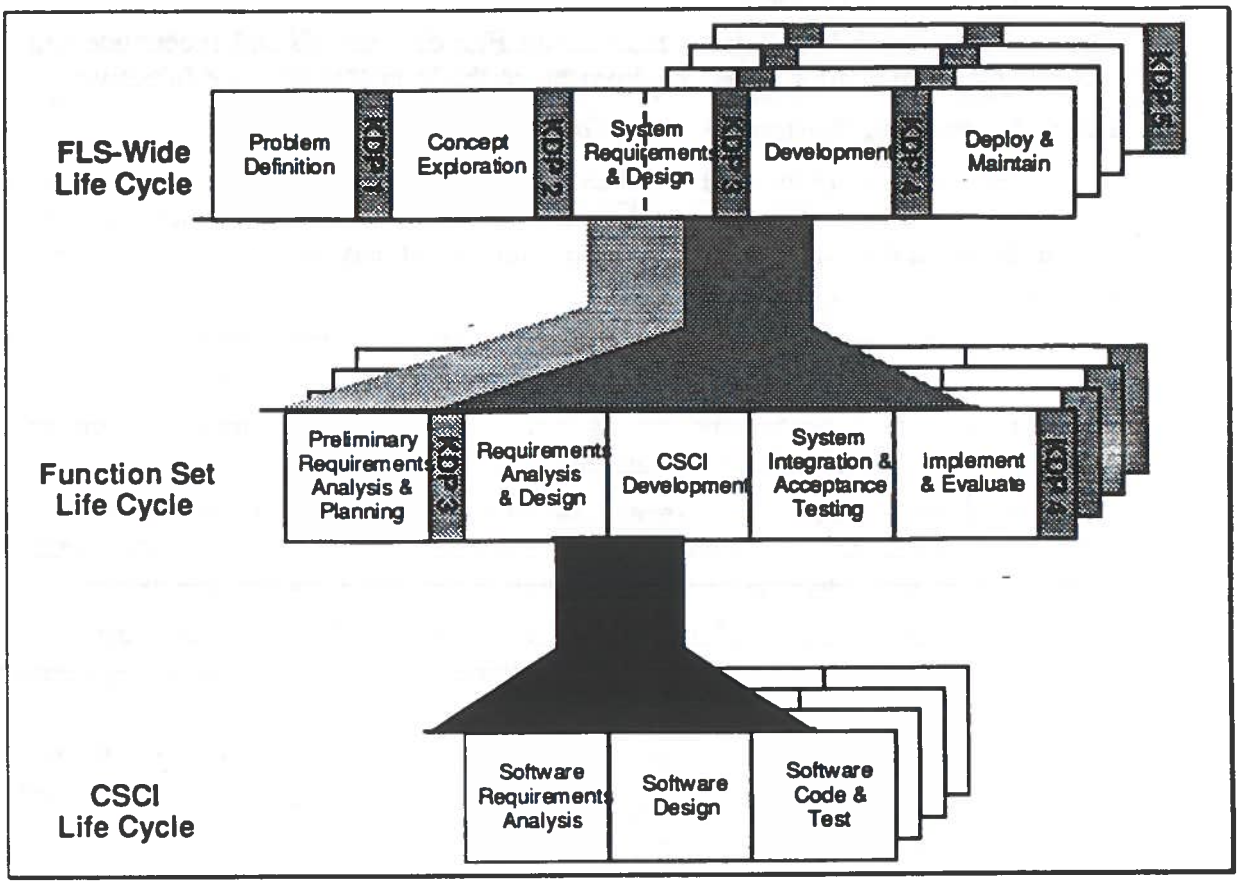

Figure 5. FLS Life Cycle Framework

Process and Data Modeling Tools

The FAA may find it useful to evaluate the tools used to perform process and data modeling by the FLS program. The Macintosh-based DEFT CASE tool has been used extensively in the analysis process. The SAIL Initiative is currently examining other tools for application to system development.

Object-Oriented Technology (OOT)

The FLS program is investigating potential uses of OOT for applications. At the present time, the program expects to limit OOT to analysis tasks involved in FLS applications.

The CM-Plus Program will employ the ProKappa Plus OO environment for developing applications for managing configuration of fleet assets.

3.5. EDI

N/A

3.6. SECURITY

N/A

4. Summary

	Cost Benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles
Core Architecture			• Client-server implementation - (future) • Use of DoD Super-mini procurement vehicles
Business Process Improvement			• Methodology for BPI used in Engineering Logistics Center Redesign
Data Management			• Experience with FLS Data Repository (future implementation) • Logistics Information Management technology (alternative to JCALS) • Data Management Applications ◆ Configuration Management ◆ Engineering Data Mgt. ◆ Integrated Publishing • FLS Data Models
Corporate Software Engineering		CM-Plus Program experience with ProKappa -Plus	• ***FLS Life Cycle Management Methodology*** • Use of Object-Oriented Technology
Electronic Data Interchange			
IT Security			

Documentation, software, and other resources that the FAA may be able to leverage are highlighted.

Section 12

National Cash Register (NCR)

Table of Contents

Report on National Cash Register (NCR) Initiatives

1. Program Description

The Enterprise Information Architecture (EIA) is a comprehensive set of Information Systems (IS) business and technology strategies needed to provide consistency in designing, constructing, and deploying business information systems within National Cash Register (NCR). The EIA recognizes IS activities occur throughout the enterprise regardless of functional organization definitions. The EIA is a high-level strategic plan to:

- link enterprise planning with IS strategies to accomplish objectives, and
- provide a concrete example of how and organization can establish an enterprise vision and implement IS according to the overall Open, Cooperative Computing strategy and architecture.

2. Method of Investigation

The sources of data for this investigation came from NCR published sources.

3. Relationship to CIE Initiatives

3.1. CORE ARCHITECTURE

3.1.2. Lessons Learned

NCR Architecture Framework

The EIA identifies many opportunities NCR faces in doing business today. The architecture itself is divided into four sections:

- Business Principles -- are the criteria for establishing and maintaining the business infrastructure.
- Business Model -- is the framework for defining the relationships between business process and information.
- Technology Model -- defines the parameters for building the information processing environment and new business applications.
- Organization Model -- establishes the interrelationships of organizations with respect to the information needed to run NCR's business.

Together, these components provide a cohesive enterprise IS solution that is linked to NCR's business needs. NCR recognizes that many business processes are cross-functional in nature and their underlying information infrastructure is equally cross-functional. The EIA provides the framework for meeting their IS needs with a consistent approach to worldwide IS.

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. Lessons Learned

Changes Driving the Business Environment

- The need for flexible and easy access to global data, applications, and services.

- Immediate access to business information is critical to building and maintaining a competitive advantage, providing "the right information to the right people at the right time."
- The one constant of the information technology industry is change -- rapid change.

Key Lesson Learned: The success of business and information systems will be in how an organization can accept and adapt quickly to changes.

IS Role

IS and user management are jointly responsible for the identification and successful implementation of information systems.

- IS is responsible for identifying and managing the uses of information system technology that enables business users to achieve their mission in a cost-effective and timely manner.

A well-defined "blueprint" or "roadmap" needs to be established that will factor the items listed below, and provide a framework for future systems:

- Use information as a strategic resource.
- Empower people at all levels of the organization by giving them access to information scattered through the enterprise.
- Re-engineer processes that have become hindrances on productivity, service, and customer satisfaction.
- Define the enterprise architecture vision to support the business objectives.

Key Lesson Learned: There is a delicate balance in cost-effectively supporting enterprise-level requirements while providing a platform for user-driven innovation in the application of technology across an organization.

The IS function at NCR is managed on an company-wide basis:

- There is central responsibility for establishing strategic direction, policies, and guidelines for the IS functions.
- Technical resources are pooled where common technologies and economies of scale permit.

3.3. Data Management

3.3.1. Lessons Learned

NCR data is a strategic resource and is managed as such on an enterprise-wide basis.

- Data that is used by more than one group (e.g FAA Division) is classified as Enterprise Data.
- There is an organization-wide function responsible for establishing strategic direction, policies, and standards for the management of data.

Enterprise Data has common, consistent definitions throughout the organization.

- Physical databases are based upon the standard data definitions.
- Data is captured and validated once, at its source.
- A common information infrastructure is used for data access.

Data is owned by the organization and is assigned to designated Data Trustees for developing standard definitions.

- An enterprise-wide classification of data by subject area is used.
- The Data Trustee is responsible for determining the standard definitions for "Enterprise Data" for each subject area.
- Business experts will establish the standard names, definitions, formats, structures, domains, and business rules for Enterprise Data.

Information processing conforms to a set of established infrastructure standards, which includes hardware, software, and network products.

- The enterprise infrastructure consists of open, industry-standard products and interfaces.
- Computing is distributed to the most practical location.
- The enterprise architecture provides a robust set of applications and services. to support the business requirements.

Data application and infrastructure services are designed so that each component can be implemented independently of the underlying infrastructure.

- Client-server applications will provide the optimum solutions in processing, design, portability, and interoperability as a result of independence of the components.
- Empower the end-user to develop application solutions.

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. Lessons Learned

The enterprise infrastructure consists of open, industry-standard products and interfaces that provide easy, transparent access to strategic business information. Product life-cycle management is an integral part of the product evaluation process. The use of industry-wide standards maximizes the number and quality of products.

Key Lesson Learned: The FAA should review the NCR Architecture material for applicability to Architecture guidance being developed by AIT.

4. Summary: Key Conclusions from Survey

The following provides a summary of key conclusions referenced to CIE Initiatives.

Summary Table of NCR Relationship to CIE Initiatives

	Cost Benefit Analysis	Lessons Learned	Tech. Transfer/ Procurement Vehicle
Core Architecture		• NCR recognizes that many business processes are cross-functional in nature and their underlying information infrastructure is equally cross-functional. • NCR's Enterprise Information Architecture provides the framework for meeting their IS needs with a consistent approach to worldwide IS.	
Business Process Improvement		• The success of business and information systems will be on how an organization can accept and adapt quickly to changes. • IS and user management are jointly responsible for the identification and successful implementation of information systems. • There is a delicate balance in cost-effectively supporting enterprise-level requirements while providing a platform for user-driven innovation in the application of technology across an organization.	
Data Management		• NCR data is a strategic resource and is managed as such on an enterprise-wide basis. • Data application and infrastructure services are designed in such a way that each component can be implemented independently of the underlying infrastructure.	
Corporate Software Engineering		• The enterprise architecture consists of open, industry-standard products and interfaces that provide easy, transparent access to strategic business information. • The FAA should review the NCR Architecture material for applicability to Architecture guidance being developed by AIT.	

Section 13

The Department of Defense Computer-aided Acquisition and Logistic Support (CALS) Program

Report on the DoD Computer-aided Acquisition and Logistic Support (CALS) Program

1. Program Description

Overview

The Computer-aided Acquisition and Logistic Support (CALS) Program of the DoD is the major DoD initiative to support the development of standards, architecture, and infrastructure by which electronic technical information for weapon systems can be exchanged, shared, and integrated. CALS is a major DoD-wide effort to move to a "paperless" environment. Other related initiatives include Concurrent Engineering, Electronic Data Interchange (EDI), and Corporate Information Management (CIM). While focused on DoD requirements, the program has promoted the development of standards for logistics data, technical documentation, engineering data, product data and other types of information that will have applicability to industry as well as the FAA. A key requirement of CALS has been the capability to exchange information with industry contractors. *In many cases, the same contractors support both the DoD and FAA.*

The overall CALS program is coordinated by the Defense CALS Executive, MGEN. E.R. (Russ) Baldwin of the OSD (Production and Logistics). The major implementing organization for CALS is the Joint Logistics Systems Center (JLSC) in Dayton, Ohio. The DISA/Joint Interoperability Engineering Organization (JIEO) is also concerned with CALS implementation especially in regard to standards testing and implementation of EDI.

One of the major objectives of CALS has been to foster parallel development of CALS approaches and technologies within the DoD and in industry. DoD representatives for CALS have actively participated in the Industry Steering Group (ISG) and in the activities of standards bodies. However, the combination of declines in defense expenditures and a general recession have threatened the financial health of many aerospace contractors, diminishing industry support for CALS development. With the decline of aerospace efforts, the DoD role in CALS has become more critical. JCALS is now the major vehicle for DoD CALS implementation (see the Report on JCALS).

The other joint program of potential interest to the FAA is the Joint Engineering Data Management and Information Control System (JEDMICS). It is an outgrowth of the original Navy EDMICS program which developed an architecture for management of engineering drawings. The program continues to be supported by the DoD as a vehicle for managing engineering graphics for the services. The are plans to provide interfaces between JCALS and JEDMICS. under development.

The major responsibility for administering CALS logistics functions has been transferred from the Defense CALS Executive (DCE) to the Joint Logistics Systems Center (JLSC) in Dayton, Ohio. The retains responsibility for developing policy and procedures for CALS. Finally, the DISA Joint Information Engineering Organization plays a role in the evaluation and testing of technologies and standards that involved in the implementation

of CALS objectives. The DISA Center for Standards is taking over responsibility for existing and emerging DoD CALS standards.

THE FAA AND CALS

While the implementation of CALS standards would be a major focus of the Core Architecture Initiative, there have already been a number of significant efforts within the FAA to assess requirements for applying CALS approaches to FAA requirements. These initiatives are summarized in Appendix A.

2. Method of Investigation

The Volpe Center has been a major contributor to the DoD CALS effort since the inception of the program in 1986. The Volpe Center has supported the DoD Services (and the FAA) on a wide variety of CALS tasks such as:

- Air Force - development of automation plans, functional requirements, and CBAs for technical manuals, LSA/LSAR, and product definition data. In addition, the Volpe Center developed and demonstrated a prototype of the original requirements for an automated technical manual system (AFTOMS). (The original AFTOMS requirements are now being implemented under JCALS.)
- Navy - definition of CALS functional requirements, acquisition guidelines for CALS standards, CBAs, and an assessment of flexible manufacturing technology.
- OSD - development of CALS strategic plans and architecture for Congress.
- *FAA - definition of the concept, functional requirements, system architecture, program plan and CBA for Automated Documentation Development and Maintenance (ADDM). ADDM is a proposed NAS Program Initiative to develop and implement the capability to create, manage, and distribute electronic NAS technical documentation and FAA directives.*

This perspective provided the background for the analyses of CALS and JCALS. This report is intended to supplement the discussion of the JCALS Report in relation to the potential impact of CALS on the FAA. It should be noted that the JCALS implementation of CALS was the major focus of the Survey research. This report on CALS represents an overview of some areas in which CALS will impact the CIE Initiative.

3. Relationship of CALS to CIE Initiatives

3.1. CORE ARCHITECTURE

3.1.1 CBA

3.1.2. Lessons Learned

3.1.3. Technology Transfer/Procurement Vehicles

Documents on CALS Policy

Key documents that define objectives and policy for the DoD CALS program include the following:

- DoD Instruction 5000.2 - "Defense Acquisition Management Policies and Procedures"
- MIL-HDBK 59B

Data Standards

One of the major objectives of the CALS program is to define a set of standards that can facilitate exchange of data among automated systems. A starting point for CALS was the adoption of MIL-STD 1388 2B as the standard for logistics data. This defined the content for Logistics Support Analysis Record (LSAR) data. The DoD then adopted a number of standards that had been developed by industry for information exchange. These included MIL-D-28000 for engineering graphics, MIL-M-28001 (SGML) for text, MIL-D-28002 for raster (bit-mapped) graphics, MIL-M-28003 (CGM), and ANSI X.12 for Electronic Data Interchange.

While these standards provide a great deal of functionality for transfers of data in a common format, the standards are of limited value for more general engineering applications involving integrating CAD systems and software development. CALS supports the international PDES/STEP effort to define integrated specifications for engineering and logistics data.

Table 1. - CALS Data Standards

Standard Domain	Standard	
Data Interchange		
Vector Graphics	IGES	MIL-D-28000
Text	SGML	MIL-M-28001
Raster Graphics	CCITT GR4	MIL-D-28002
Technical Illustrations	CGM	MIL-M-28003
Logistics Data	LSAR	MIL-STD-1388
Electronic Forms and Transactions	EDI	ANSI X.12, Trans. set specs. (840, 841, 843...)
Engineering Product Data	PDES/STEP	ISO STD 10303 (STEP)
Compound Documents	MIL-D-IETM DB, MIL-STD-1840A	

IETMs

For future production of integrated documents, the Interactive Electronic Technical Manual (IETM) specifications will provide standards for database management of document content. *For the FAA, IETMs would be apply to technical documentation for new NAS systems.* The standards include:

- MIL-M-87268 (GCSFUI) - provides for general content, style format and user-interaction requirements
- MIL-M-87269 (DB) - provides for database for the support of Interactive Electronic Technical Manuals

- MIL-M-87270 (QA) - provides for quality assurance program for IETMs and associated technical information.

CITIS

The standard for interchange of technical information with and among contractors is known as Contractor Integrated Technical Information System (CITIS). The proposed standard MIL-STD-974, draft dated November 16, 1992 was released for review and comment. The revised standard will be published this summer. *CITIS could enable FAA program offices to access NAS equipment CDRL information including documentation, plans, and proposed changes.*

The CITIS standard is defined in terms of a set of services that are required for accessing and using technical information.

CALS Shared Resource Centers

The DoD has established a mechanism to provide education and outreach in CALS approaches to government agencies and small business. These CALS Shared Resource Centers (CSRCs) are managed by the Air Force. Each focuses on CSRC Specialized Technology Areas. *The FAA could use the concept of the CSRCs to support automated business processes such as EDI transactions, automated bidsets, RFPs, etc.* Locations of the CSRCs and areas of specialization are given in the Table 2.

Table 2. - CALS Shared Resource Centers

Location	Area of Specialization
Johnstown, PA	Metalworking
Palestine, TX	Scanning and Conversion
Fairfax, VA	Information Technology
Cleveland, OH	Automated Manufacturing
Dayton, OH	Automated Design
San Antonio, TX	Automated Business Practices
Orange, TX	Commercial Technology

3.2. BUSINESS PROCESS IMPROVEMENT

3.2.1. CBA

3.2.2. Lessons Learned

3.3.3. Technology Transfer/Procurement Vehicles

3.1. DATA MANAGEMENT

3.3.1 CBA

3.3.2 Lessons Learned

3.3.3. Technology Transfer/Procurement Vehicles

3.4. CORPORATE SOFTWARE ENGINEERING

3.4.1. CBA

3.4.2. Lessons Learned

3.4.3. Technology Transfer/Procurement Vehicles

3.5. EDI

3.5.1. CBA

3.5.2. Lessons Learned

Key Lesson Learned: EDI and CALS approaches should be merged to address the information required to carry out business transactions.

"No doubt whatsoever, EDI promises high levels of savings in business transactions. Beyond that I see a need to progressively merge CALS and EDI initiatives." -- MGEN. Baldwin, Defense CALS Executive.[1]

While CALS and EDI have different origins, one in the DoD and the other in the commercial environment, the objectives of both are to improve business processes by facilitating exchange of data among individuals and organizations involved in business transactions. The strategies for CALS and EDI should, therefore, be coordinated to achieve the business objective as opposed to implementing existing or proposed standards.

3.5.3 Technology Transfer

Use of EDI Transaction Set 841 to Support Mission EDI Applications

The range of application of EDI standards for data exchange has been extended from the traditional business forms. Transaction Set 841 for Specifications/Technical Information is specifically designed to support transfer of documents and engineering data required for business functions such as contracting and supply. The detail area of the transaction set can include graphic, text, parametric, tabular, image, spectral, or audio data. A transmission includes information to assist the receiver in interpreting and utilizing the information included in the transaction.

The transaction set provides a structure which allows for the exchange of a variety of specification information. For example, if the transaction contains information describing a complete assembly, it would be necessary to include the assembly model, the models for each of the individual parts, and the associated specifications. This transaction set can also be linked to other transaction sets.

EDI transaction sets (e.g. 836, 840, 841, 843, 850, 856) can be used to combine other business forms such as RFQs and contracts with transfers of electronic documents and engineering data. The EDI extensions provided by 841 permits EDI transaction sets to be used to support data interchange required for key logistics functions such as such as

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[1] *CALS/CE Report*, vol. 6, no.1, January 1993, Knowledge Base International, p.4.

spares reprocurement, bidsets, provisioning, and supply by transferring CALS data between the Logistics Center and aviation industry partners such as NAS contractors and vendors. *The use of these transaction sets integrates both business and mission EDI capabilities*

3.6. SECURITY

3.6.1 CBA

3.6.2. Lessons Learned

3.6.3 Technology Transfer

4. Summary

	Cost Benefit Analysis	Lessons Learned	Technology Transfer/ Procurement Vehicles
Core Architecture			• ***Use of DoD CALS policy documents, e.g. MIL-HDBK 59, and DoD. Inst. 5000.2*** • ***Use of CALS stds. - MIL-28000 series, MIL-STD-1840A*** • Evaluation of PDES/STEP stds. and models • Use of IETMs stds. and content data model for compound docs. • Access to CALS Shared Resource Centers
Business Process Improvement		• Develop an FAA CALS Resource Centers to support application of CALS to BPI	
Data Management			
Corporate Software Engineering			
Electronic Data Interchange		• CALS and EDI strategies should be merged to address business requirements	• ***Use EDI Transaction Set 841 to support transfer of document and engineering data.*** • EDI Transaction Sets can integrate Mission and Business EDI applications.
IT Security			

****Documentation, software, and other resources that the FAA may be able to leverage are highlighted.***

Appendix A

CALS-RELATED EFFORTS IN THE FAA

The potential importance of CALS standards and related technologies is becoming widely recognized with the FAA. The following are current and future efforts within the FAA that are related implementation of CALS functional capabilities and standards.

1. Current CALS Efforts

1.1. Development of Functional Capabilities

- NAS Documentation Services, ACN-600A, at the FAA Technical Center has developed an input and maintenance system for NAS documentation using the Interleaf V document management system and Worldview documentation viewing tools.
- The CAEG (Computer-aided Engineering and Graphics) system supports engineering graphics on a proprietary platform at a number of FAA sites (FAA HQ, regions, Aeronautical Center, etc.)
- The Engineering Specialties and Configuration Management Division, ASE-600, has developed a configuration control and electronic access/distribution capability for NAS system requirements and design documentation for the AND organization using the Interleaf V document management system and Worldview documentation viewing tools.
- The Air Traffic Procedures Service (ATP) organization has developed an automated text management and retrieval system that contains all the Air Traffic handbooks, manuals, and directives. This system allows users to update AT procedures and alert FAA facilities to changing rules and guidelines.
- Flight Standards, AFS-530, has developed a Policy Subsystem (PS) as part of Aviation Safety Analysis Subsystem that provides storage and retrieval capabilities for 8000 series orders/directives.

1.2. Standards

- An AML-400 Working Group is developing a FAA Order which specifies requirements for contractor delivery of electronic technical information using CALS standards.[2]
- As a follow-on effort to the Automated Documentation Development and Maintenance (ADDM) Program, ASE-630 is supporting the development of a FAA standard that provides guidelines for FAA Program Managers for acquisition of technical information in standardized electronic formats. (The

[2]Mr. Clayton Raines, AML-462, is the POC.

development of guidelines for NAS documentation was a major recommendation in the *ADDM Requirements Analysis Report*, January 1993). (Note: This effort to define standards for technical information overlaps with the task under AML-400 to develop an FAA Order effort for electronic technical information (see above).

- A National Standards Committee for CAEG was formed (chaired by Joe Miller, AMP-410) to address electronic delivery formats, drafting standards, documentation standards, and software development standards for CAEG applications. (The standards group was formed in 1990).
- The Voice Switching Control System (VSCS) Program had identified a requirement to modify the current contract to specify CALS standards (October 1992). (The effort was deferred because of a lack of CALS support within the FAA.)

1.3. General

- A joint effort by ANS-400 and AOS-300 is designed to support efforts by the National Airspace Logistics Support (NAILS) program to comply with CALS policy and standards. This "CALS Development Strategy (CDS)" aims to coordinate/monitor CALS activities between the FAA and DoD agencies and define requirements for converting current data to CALS standards.

2. Future CALS Efforts

2.1. Development of Functional Capabilities

- The ADDM Program is system that will provide a FAA-wide capability for electronic management and distribution of documentation. The ADDM Program is being managed by ANA-200 and ASE-630. The ADDM user needs, system concept, functional/interface requirements, implementation strategy, and cost/benefit analysis are defined in the *ADDM Requirements Analysis Report* (Volumes I - III). *The current scope of ADDM is limited to support of the Airway Facilities, Air Traffic, and FAA Academy organizations. There is, however, a need for a FAA-wide document management capability*
- The CAEG Replacement Program is a CIP Program sponsored by ANS and AF that will enhance and expand the availability of CAEG automated support for engineering graphics. The new systems will be based on industry accepted standards for both graphics data and platforms.
- The Flight Standards Information Systems Strategy (FSIS), December 1992, identifies two related projects:
  - A Flight Standards Automated Document Distribution and Maintenance (ADDM) system strategy (FSIS control number - ISS-IR-11)

- A CD-ROM based ADDM system for Aviation Safety Inspectors reference material. (FSIS control number - ISS-IR-12)

- The FAA (AML and AMI) has examined the possibility of developing a capability similar to the Navy Rapid Automated Manufacturing Program (RAMP) to support the FAA Logistics Center (AML-400). A system concept was defined by the South Carolina Research Association (SCRA). This system would provide a transition to PDES/STEP within the FAA and would be a technology transfer initiative with DoD CALS. (Mr. Clayton Raines, AML-462 and Sally Sheridan, AMI-230 are POCs).

2.2. GENERAL

- The new NAS Implementation Support Contract (NISC) has a CLIN to provide a "CALS Implementation Strategy" for the FAA.
- In the future, AIT will need to manage, control and distribute the FAA orders/directives in an "electronic format".

3. Summary: Key Conclusions from Survey

All of the above efforts are related to CALS and contain overlaps that could benefit from "corporate" (AIT) coordination, direction, leverage, and guidance. There is a current effort by ANS-400 to develop a CALS Development Strategy (CDS) and a CALS Working Group. The proposed structure of the CALS Working Group is the following:

- FAA Management Team (AOS-3, ANS-400, AOS-200-500) - Co-chairs are AOS-3 and ANS-400
- Main CALS Working Group (AOS-30, ANS-410, ACN-600A, ASE-600, AOS-200, AOS-500, AIT-300 and ANS-420)