1982-12

Architectural guidelines for multimedia and hypermedia datainterchange : Computer Aided Acquisition and Logistics Support/Concurrent Engineering (CALS/CE) and Electronic Commerce/Electronic Data Interchange (EC/EDI).

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https://hdl.handle.net/10945/27996

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

ARCHITECTURAL GUIDELINES FOR MULTIMEDIA
AND HYPERMEDIA DATA INTERCHANGE:
COMPUTER AIDED ACQUISITION AND LOGISTICS
SUPPORT/CONCURRENT ENGINEERING (CALS/CE)
AND ELECTRONIC COMMERCE/ELECTRONIC DATA
INTERCHANGE (EC/EDI)

by

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SEPTEMBER 1991

Thesis Advisor: Myung Suh

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No 0704-0188

1a. REPORT SECURITY CLASSIFICATION: Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release: Distribution is unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: Naval Postgraduate School; 6b. OFFICE SYMBOL *(If applicable)*: AS	7a. NAME OF MONITORING ORGANIZATION: Naval Postgraduate School
6c. ADDRESS *(City, State and ZIP Code)*: Monterey, CA 93943-5000	7b. ADDRESS *(City, State, and ZIP Code)*: Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBER: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
Architectural Guidelines for Multimedia and Hypermedia Data Interchange: Computer Aided Acquisition and Logistics Support/Concurrent Engineering (CALS/CE) and Electronic Commerce/Electronic Data Interchange (EC/EDI)

12. PERSONAL AUTHORS
ALEXANDER D. KORZYK

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Master's Thesis	FROM ____ TO ____	SEPTEMBER 1991	107

16. SUPPLEMENTARY NOTATION
The views expressed are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block numbers)*
FIELD	GROUP	SUB-GROUP	multimedia, hypermedia, CALS, CE, EC, EDI, DSI, X.400, X.435, paperless office

19. ABSTRACT *(Continue on reverse if necessary and identify by block numbers)*
This study proposes the best strategy to integrate information systems to effectively support several common Department of Defense initiatives, in line with Corporate Information Management and Total Quality Management principles. This research examines Computer-aided Acquisition and Logistics Support/Concurrent Engineering, Electronic Commerce/Electronic Data Interchange, Modernization of Defense Logistics Standard System, and the Defense Information System. The study proposes an interchange architecture on top of the OSI-compliant Defense Information System, which serves as a telecommunications infrastructure, for multimedia and hypermedia data interchange. This interchange architecture is necessary to successfully implement the functions and applications of DOD activities.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: XX UNCLASSIFIED/UNLIMITED __ SAME AS RPT __ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION: unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL: Myung Suh	22b. TELEPHONE *(Include Area Code)*: (408) 646-2637	22c. OFFICE SYMBOL: AS/Su

DD Form 1473, JUN 86 — *Previous editions are obsolete.* — SECURITY CLASSIFICATION OF THIS PAGE: Unclassified

S/N 0102-LF-014-6603

Approved for public release: Distribution is unlimited

Architectural Guidelines for Multimedia and Hypermedia Data Interchange: Computer Aided Acquisition and Logistics Support/Concurrent Engineering (CALS/CE) and Electronic Commerce/Electronic Data Interchange (EC/EDI)

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Submitted in partial fulfillment of the
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MASTER OF SCIENCE
IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL

SEPTEMBER 1991

ABSTRACT

This study proposes the best strategy to integrate information systems to effectively support several common Department of Defense initiatives, in line with Corporate Information Management and Total Quality Management principles. This research examines Computer-aided Acquisition and Logistics Support/Concurrent Engineering, Electronic Commerce/Electronic Data Interchange, Modernization of Defense Logistics Standard System, and the Defense Information System. The study proposes an interchange architecture on top of the OSI-compliant Defense Information System, which serves as a telecommunications infrastructure, for multimedia and hypermedia data interchange. This interchange architecture is necessary to successfully implement the functions and applications of DOD activities.

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LIST OF ABBREVIATIONS

ANSI	American National Standards Institute
ASC	Accredited Standards Committee
BOA	Basic Ordering Agreement
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CALS	Computer-Aided Acquisition Logistics Support
CBD	Commerce Business Daily
CCITT	Consultative Committee International Telegraph and Telephone
CE	Concurrent Engineering
CGM	Computer Graphics Metafile
CIM	Corporate Information Management
CITIS	Contractor Integrated Technical Information Systems
DDN	Defense Data Network
DIS	Defense Information Systems
DISA	Defense Information Systems Agency
DLA	Defense Logistics Agency
DLSS	Defense Logistics Standard Systems
EC	Electronic Commerce
EDI	Electronic Data Interchange
EFT	Electronic Funds Transfer
EPSS	Electronic Performance Support System
FDDI	Fiber Optic Distributed Data Interface
FTAM	File Transfer Access Method

FTP	File Transfer Protocol
FTS-2000	Federal Telecommunications Services-2000
GOSIP	Government Open Systems Interconnection Profile
IDC	Indefinite Delivery Contract
I-EDI	Interactive Electronic Data Interchange
IFB	Invitation For Bid
IGES	Initial Graphic Exchange Standard
IGP	Intelligent Gateway Processor
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
IWSDB	Integrated Weapon Systems Database
LSAR	Logistic Support Analysis Record
MODELS	Modernization of Defense Logistics Standard Systems
MHS	Message Handling System
MTA	Message Transfer Agent
NIST	National Institute of Standards and Technology
ODA/ODIF	Office Document Architecture/Office Document Interchange Format
OSI	Open Systems Interconnection
PDES	Product Data Exchange Specification
PDL	Page Definition Language
PEDI	Protocol for Electronic Data Interchange
P&L	Production and Logistics
PKE	Public Key Encryption
PLUS	Protection of Logistics Unclassified/Sensitive
ROI	Return on Investment
RFP	Request For Proposal
SGML	Standard Generalized Markup Language
SMTP	Simple Mail Transfer Protocol

STEP	Standard for Exchange of Product Model Data
TCP/IP	Transport Control Protocol/Internet Protocol
UA	User Agent
UN/EDIFACT	United Nations/EDI For Administration Commerce and Trade
VAN	Value Added Network

ACKNOWLEDGEMENTS

The author wishes to thank his daughters, Michelle and Kelly Jean, for the support he received during the research and writing of this thesis.

In addition, I am especially grateful to the following persons who provided invaluable information, attended conferences, and supplied documentation without which this study would have been impossible: Myung Suh, Daniel Drake, Malcolm White, Bruce Haberkamp, and Tom Ullrich.

I. INTRODUCTION

Department of Defense (DOD) is promoting Total Quality Management (TQM) at the executive levels. However, as in the case of implementing Electronic Commerce/Electronic Data Interchange (EC/EDI) and Computer Aided Acquisition and Logistics Support/Concurrent Engineering (CALS/CE), there is a need to practice more TQM on a more formal basis. As Verity (1991) suggests, customers have automated virtually all the easy tasks they can find: payroll, financial accounting, inventory, etc. In DOD, even these easy tasks have not been done efficiently or effectively. Instead of automating the way DOD had done business for many years, DOD should have re-engineered the process, and then applied computer technology to the system. A Corporate Information Management (CIM) principle states that you must first simplify the business process before you computerize. Technology should not be applied until you are sure the organization can implement the changes, according to Strassman (June, 1991). DOD is not alone in having failed to re-engineer processes before automating them over the last two decades. Re-engineering of the processes is what the high-level executives have been searching for during the past 20 years. After re-engineering the entire way daily business is done, productivity may go up or sales may increase. According to Verity (1991), the re-engineering market will reach $15 billion in 1995. In the past

DOD has let technology be the driver instead of the workflow. It is not too late to rethink EC/EDI and CALS/CE in the much bigger environment instead of treating them as other islands of automation that have persisted for the last decade. DOD should impose the CIM principles on the initiatives discussed in this research immediately by speeding up the adoption of Open Systems Interconnection (OSI) and the introduction of multi-level security into the information systems standards, according to Strassman (June, 1991).

When we look at the diversity of the DOD and the number of initiatives started, you cannot help but wonder how anyone can understand what is going on with information resources. This research will attempt to define the underlying infrastructures to effectively support several of DOD's initiatives, especially CALS/CE, EC/EDI, MODELS, and DIS. All businesses actually rely on various types of information which are conveyed on documents. The multimedia presentations one can see from high technology computer companies demonstrating their products are just a taste of what is to come in the future.

Business processes have evolved over the past 30 years but have only just begun to be re-engineered as technology matures. Unfortunately, DOD is already several years behind industry and with current policies will fall even further behind unless some strategic changes are made soon and strictly enforced.

This research examines these common DOD initiatives and tries to show how an interchange architecture conforming to OSI can provide an effective telecommunications infrastructure and define multimedia and hypermedia interchange standards to support necessary functions and applications for EC/EDI, CALS/CE, and MODELS. The primary research questions this study are:

- What is the best strategy in terms of standards to successfully implement EC/EDI and CALS/CE?
- What protocols are the best to use in order to communicate with industry and within DOD?
- Is it feasible to use DDN for multimedia data interchange or is ISDN necessary?
- Is the intelligent gateway solution feasible or is there a better platform or solution?

II. CALS/CE: TECHNICAL AND MULTIMEDIA DATA INTERCHANGE

A. BACKGROUND

1. Paperless Environment

The dream of a paperless office surfaced nearly 20 years ago. Information system professionals tried their best to progress towards the paperless office with the technology they had available. The dream has never died but keeps eluding business and the Government. CALS/CE is the integration of manufacturing, engineering, and logistics support to a near paperless environment. The reduction of the life cycle cost of weapon systems through competitive parts production and reduced lead times can be effected by implementing CALS. Maintaining configuration data in near real-time will provide support of the major weapon systems like the Seawolf submarine and B2 stealth bomber.

2. Policy Direction

Completely isolated islands of automation need to be interfaced to form integrated systems. The changes made by CALS will involve enterprise wide models/architecture of computing and communications. The re-engineering of workflows will involve changing both the DOD and business environment. This research consolidates information resource initiatives such as CIM, CALS, EC/EDI, and MODELS in the spirit of Corporate Information Management and Total Quality Management. Although the islands of automation are to be integrated in the weapons systems area, many CALS proponents were creating another island of automation called CALS/CE. Many more individuals, both in business and DOD, realize now that CALS is applicable to much more than acquisition and procurement. Expanding global markets and shrinking DOD markets have reduced the need for new weapon systems and called for more modification and maintenance of old weapon systems. Strassman (July, 1991) states that the Technical Integration Manager of the DISA will develop and maintain technical and data architectures which impact the Functional Integration Manager and ensure technical integration throughout functional areas with the technical and data architectures. Unfortunately, CALS/CE technical and data architectures are being developed, maintained and integrated without regards to other similar DOD initiatives. What began as CALS several years ago should now be looked upon as Computer-Aided Acquisition Logistics Support Migration Systems and not just CALS.

3. CALS/CE Objectives

The objectives of CALS/CE from Dobey (1989) are:

- Develop and test data interchange and access standards to create a shared information environment
- Provide high risk technology development funding

- Establish contract requirements and incentives for industry
- DOD-wide implementation

B. REQUIREMENTS

1. MIL-HDBK-59 CALS Program Implementation Guide (1988)

The Handbook (1988) gives "guidance to personnel responsible for the acquisition and use of weapon system technical data to assist in transitioning from paper-intensive processes to digital data delivery and access." There are two methods for digital delivery or digital access to the IWSDB: data transfers are currently done by magnetic tape or DDN. Generic guidance is given in the following application areas: 1) technical manuals; 2) engineering drawings, specifications, and book-form drawings; 3) LSAR (Logistic support analysis record data MIL-STD-1388-2B); and 4) training materials. The Handbook also addresses database and telecommunications security.

2. Contractor Integrated Technical Information Service (CITIS)

A critical portion of CALS is the establishment of distributed data bases between DOD and contractors. DOD will have access to contractor generated and contractor maintained databases of weapon system data.

3. Joint Uniformed Services Technical Information System (JUSTIS)

DOD will also have distributed databases storing, retrieving, and processing technical data. The Interactive Electronic Technical Manual (IETM), with multimedia (or hypermedia) capability, will have access to these engineering drawing repositories. The drawings will extensively use CAD to integrate design and design analysis processes. Such technical information integration will be called JUSTIS (Joint Uniformed Services Technical information system). It will provide the infrastructure for managing technical manual data in all formats in the integrated weapon system data base.

4. CE/PIE (Concurrent Engineering/Parallel Integrated Engineering)

This is a process for continuously refining and defining the product by considering all elements of product life cycle management. The last phase of Life Cycle Management uses the Total Quality Management techniques of continously reviewing the process according to DOD Directive 7920.1 (1988). This helps insure a successful product.

C. DATA INTERCHANGE STANDARDS AND PROTOCOLS

CALS standardization includes three areas that will not be examined here: functional requirements, data management and access standards, and application guidance. The two areas that will be discussed in detail are data interchange standards and communication protocols. Data interchange standards are common rules for digital interchange of technical information and will be the focus of CALS Phase I.

1. MIL-STD-1840A Automated Interchange of Technical Information (1987)

This is the master document for all military specifications through which the CALS standards will be published. The original MIL-STD-1840 was published by the Air Force in 1986 and the MIL-STD-1840A by NIST in 1987 through an interagency agreement. It is updated annually. The main technical concept is that of a digital envelope which organizes files of digital data into a deliverable document. A document can be complex. For example, technical manuals contain SGML text files, raster and CGM illustration files. The original MIL-STD-1840 contained the IGES, SGML, RASTER, and CGM which have since developed into standards by themselves.

2. MIL-D-28000 Initial Graphics Exchange Specification Computer Aided Design (IGES CAD) Vector Graphics

This standard defines the digital representation for communication of product data between dissimilar computer aided design systems. It is also known as ANSI Y14.26M. It defines the interchange format between CAD systems into four classes: 1) engineering drafting Class II; 2) mechanical three dimension models Class IV; 3) electronic circuit design Class III; and 4) technical publication illustrations Class I. The graphics are represented in ASCII format and already supported by 30 CAD vendors. The Navy EDMICS (Engineering Data Management Information and Control System), Air Force EDCARS (Engineering Data Computer Assisted Retrieval System), Army DSREDS (Digital Storage and Retrieval Engineering Data System) are current projects (Smith, 1990). This standard is developing into the Product Data Exchange Specification (PDES).

3. MIL-D-28001 Standard Generalized Markup Language (SGML)

This standard is for automated publishing of page oriented text, meets markup requirements, and generic style specification for electronic printed output and exchange of text and hypertext. SGML is critical for hypermedia data interchange. The standard is also known as ISO 8879 Information Processing-text and Office Systems-Standardized Markup Language (SGML). Other standards used with SGML are: DSSSL (Document Style Semantics and Specification Language) for output specifications; SPDL (Standard Page Definition Language) for data delivery; and FOSI (Formatting output specification instance). SGML is used for printing technical publications, composition processing functions, defining output specifications of typographic tags and format rules, and displaying the composed document.

4. MIL-R-28002 GROUP 4 RASTER Facsimile

This standard sets requirements for raster graphics representation in binary format or bit map graphics that have been compressed to reduce file size and transmission time. There are two types of raster graphics. In Type I (untiled, which is FIPS 150), the default mode is 200 pels per inch with Group 4 encoding.

Type II (tiled) defines a tile as a rectangular region in a layout object in which all such regions have the same dimensions. No part of any tile overlaps any other tile. Group 4 raster permits compression and decompression in parallel on the drawing tiles or portion of the drawing tiles. The division of tiles can be individually processed to reduce the size of the transmission line and reduce terminal storage requirements. Type II is used for oversize documents such as large engineering drawings.

5. MIL-D-28003 Computer Graphics Metafile (CGM)

This standard is for the digital representation for communication of illustration data between high resolution graphics workstations. Unlike IGES, which is for CAD workstations, it is based on line segments. The metafile includes allowable output primitives and attributes used to compose illustrations. The standard is also known as ANSI X3.122, FIPS 128, and ISO 8632. This standard is for picture descriptions and illustrations in technical manuals.

6. Communication Protocols

a. Short Term

In the short run, DDN will be used for transmission of CALS data. Most large drawings, which are stored on magnetic media such as tapes, floppies, or optical disks, will have to be compressed as much as possible to reduce file size and transmission times. Unfortunately most engineering drawings are very large, and even with compression techniques still require several hours to transmit over DDN.

b. Long Term

According to Lycas (1989), CALS data will be interchanged using OSI protocols such as X.400 Message Handling System (MHS) and File Transfer Access and Management (FTAM). Chapter IV will discuss all protocols in detail. The underlying network will have to be a broadband switched network, not a traditional packet-switched network like DDN.

D. NEW INFRASTRUCTURES

1. CALS Test Network (CTN)

The CTN was created to demonstrate CALS standards and test their effectiveness under the U.S. Air Force Logistic Command leadership. It is a joint DOD-Industry program for applications testing, prototype computer product conformance testing, and prototype data acceptance testing. The testing is done in laboratories and uses controlled live data. The standards discussed previously will be required for contractors, subcontractors, and vendors desiring to do business in the Industrial-Military Complex. Selected defense contractors, laboratories, the Army CALS testbed, and other Government sites make up the CTN.

2. Industrial Networks

General Motors Corporation developed a global data communications network internally and has thousands of trading partners internationally. GM has always been one of the major driving forces in the Industrial-Military Complex. GM developed its command and control network from a baseline much like DOD developed DDN, but GM has committed many more resources into networking than DOD. Connectivity between DOD and large industrial networks has the potential to totally change the way business is done.

3. FTS-2000 and ISDN

DeLaura (1986) first analyzed data communication requirements for CALS. DeLaura (1987) concluded that DDN could not provide adequate support for the very large documents that CALS contractors and Government users would transmit. Payne (1990) further confirmed that bulk transfers could not be adequately performed using DDN. CALS data, being multimedia and hypermedia information, requires very high speed which must include FDDI and ISDN.

4. CALS Operational Resource Information System (CORIS)

CORIS, like CTN, is based on a distributed database that logically integrates engineering, logistics, and manufacturing databases. A data communications infrastructure other than DDN will be necessary to implement

CALS. A CALS Information Manager will provide directory services, data dictionaries, and indexing. (CALS Exposition, 1990)

E. OTHER STANDARDS FOR CALS

Several other international standards will be implemented in CALS Phase II. Most of the following are application specific:

- EDIF (Electronic Design Interchange Format) for integrated circuit design.
- ODA/ODIF (Office Document Architecture/Office Document Interchange Format) for presentation and layout.
- SPDL (Standard Page Description Language) for image delivery of technical publications.
- IRDS (Information Resources Dictionary System) for data elements.
- SQL (Structured Query Language) for data access.
- STEP (Standard for the Exchange of Product model data ISO TC 184/SC4.

F. SUMMARY

The strategy of implementing CALS must be reexamined. This research has shown many of the current standards that have paved the way for industry and defense during the initial years of the CALS initiative. It is imperative that DOD use CALS to prevent existing systems from becoming islands of automation and integrate them into the Corporate Information Management systems as soon as possible. In fact, Strassman (June, 1991) states that one of needed actions in speeding up the business process redesign of different functional processes is to impose CIM principles on existing systems.

III. EC/EDI ELECTRONIC COMMERCE/ELECTRONIC DATA INTERCHANGE

A. BACKGROUND

1. EDI Definition

EDI is the computer to computer transmission of transactions primarily between external organizations computers in a format agreed upon by all trading partners. EDI is used as a means of eliminating the mail lag time into a matter of minutes to speed electronic commerce. Industry has used EDI for direct deliveries and just-in-time inventory techniques for several years. Organizations will not really benefit from EDI until it is integrated internally into the entire organization structure.

Businesses use many types of transactions in their day to day operations to buy and sell goods and services from each other. The volume of Government business necessitates EDI, especially for small purchases. There were 12 million actions under $25,000 for FY90 according to Drake (1991). The acquisition and procurement system can use EC/EDI to send solicitations, awards, invoices, payments, delivery orders, contract accounting, etc. Transactions must conform to standards agreed upon by all trading partners because many forms of business documents exist in the business environment. DOD should consider evolving toward publicly available transactions so that

DOD may trade with all trading partners conforming to the ANSI X12 standard. EDI formats define all possible fields, arrangement, and use. For example, ANSI X12 has defined the EDI transaction set for CALS data.

MODELS addresses the DOD internal transaction processing. MODELS began in 1984 as a modernization of the DLSS (Defense Logistics Standards Systems). DOD revised MODELS transactions to become more like EDI syntax.

Deputy Secretary of Defense Taft directed that DOD make maximum use of EDI for the paperless process of all business related transactions in May 1988. Assistant Secretary of Defense (Production and Logistics) received responsibility for establishing guidance that will result in "..acceptance of EDI as the normal way of doing business with DOD by the early 1990s." The Assistant Secretary of Defense (P&L) designated the DLA (Defense Logistics Agency) as DOD's Executive Agent for EDI and Data Protection. However, the entire excecutive agent procedure may change as a result of Corporate Information Management Reviews. In fact, Strassman (July, 1991) states that DISA will manage DOD-wide standards for information technologies and architecture in November 1990, Defense Management Report Decision 941, Implementation of EDI in DOD proposed milestones and a level of investment for EDI.

2. EC Definition

Electronic Commerce is the integration of EDI, E-mail, bulletin boards, EFT, and similar techniques into an electronically based system for all DOD business functions to include government procurements and acquistion, payment, supply management, transportation base operations, contract administration, maintenance, and fuels. EC will put in place necessary systems, capabilities, and procedures that will fundamentally alter the business processes and daily operations from a paper intensive environment to a nearly paperless environment. CIM systems data standards and architectures must be developed rapidly and applied to EC before much further work is done according to Strassman (July, 1991).

EC will rely on subsystems which will resemble many of the CALS subsystems. According to Drake (1991) the first subsystem will be an electronic market consisting of an electronic information broker, electronic classifed ads and advertising, electronic product and corporate profiles, and electronic common bulletin boards. The second subsystem will be an integrated distributed database with an interorganizational database and electronic report programs. The third subsystem will use EDI transaction sets for accessing and ordering and exchanging technical data.

B. REQUIREMENTS

EC/EDI has many requirements that this research will examine together with the CALS/CE requirements to form a basis for multimedia data interchange.

1. DLA Tasks

The Electronic Commerce: A Strategic Plan for DOD (1990) specifies the tasks for DLA as follows:

- Use established industry transaction standards, readily accessible technology, and commercially available products and services.
- Develop and maintain implementation guidelines, establish support agreements, and provide configuration management translation software.
- Provide common-user support for all DOD activities, including central directories and PLUS (Protection of Logistics Unclassified/Sensitive) initiatives.
- Establish pilot applications for testing new Electronic Commerce concepts and products.
- Participate in industry standard committees.
- Provide a "single face to industry" on all EDI and PLUS activities.
- Establish a nucleus of expertise to promote and aid early implementation of Electronic Commerce.
- Accessability to proven, cost-effective, and standardized Electronic Commerce software, hardware, and communications, and accessability to clear, standard guidance on implementing Electronic Commerce.
- Effective, knowledgeable representation in national and international standards development processes.
- Dynamic, highly competent focal point on all matters related to EC.

- Automate the generation, processing, coordination, distribution, and reconciliation of every business transaction, from requistioning to base operations, throughout the DOD without need for hard-copy media.

2. Business and Technical Data

EC will provide prospective business offerors the business and technical data needed to make decisions and to prepare cost estimates. Businesses may transmit engineering drawings and specifications electronically when the procurement requires a shortened solicitation cycle. This research will show how most businesses may eventually transmit EDI transactions and accompanying data files in an E-mail envelope (X.435) to vendors in the electronic directory service (X.500).

3. Interactive EDI

Interactive EDI provides the mechanism for trading partners' applications to communicate in a direct on-line manner beyond that of fast batch communications, according to the X12C Subcommittee (1991).

a. Definition

I-EDI is the ability for two computing devices to exchange X12 information in a direct, conversational, and negotiable mode. Under batch EDI, transactions are transferred in an asynchronous mode going the other way. The transaction one partners sent is not synchronized with the transaction. However a transaction is very likely to be in response to previous transaction going the other way. Fast batch retains the communication connection in anticipation of a transaction being returned by a partner in response to another partner. I-EDI contains blocks of EDI data in a peer-to-peer session performing the translation function between each peer's application.

b. Benefits

Benefits of the interactive approach depend on the ability of the user to act quickly. The extent to which the trading partner is automated, the greater the reduction in connection time. The best case would be an interactive user agent that would react to results of searches on predefined rules rather than wait for human reaction. During multi-level searches I-EDI lets the user start from a previous point so that the search process does not need to start from the beginning again.

4. Document Translation System Requirements

a. EDI Translation Software

EDI translation software reformats application data into an acceptable EDI standard format, as defined by X12. EDI standards change every six months and the means to update these easily is by maintaining translation tables separately from the applications. Vendors for most EDI software provide translation table updates to keep the system current. Generic interface files between the corporate applications and EDI software need customization for the specific user and can be customized for more than one user. The actual translation process modules may perform the integration of

1) the raw data; 2) trading partner information, and 3) the standards tables into a formatted EDI transmission ready to pass to the communication software.

b. Data Mapping

Data Mapping is essential to the successful operation of the EDI applications. Data mapping is required at the interface between EDI translation software and applications. A small translator which prints out a paper copy for action and accepts input from a keyboard can be the foot in the door for starting EDI, with a manual data mapping. The small translator can become integrated at a later time with the corporate database. Data mapping maps values between an intermediate flat file generated by EDI translation software and the appropriate locations in the database. The ultimate goal is application-to-application EDI in which data mapping is integrated in the initial design of the database or corporate information system. This will only be possible by using the CIM principle of providing interoperable vendor-independent systems assembled from standard components with distributed databases.

c. EDI software alternatives

DOD can make or buy EDI software. The Lawrence Livermore National Labs has developed Ascent software in cooperation with Control Data Corporation. This software is now offered on an U.S. Air Force contract as off-the-shelf software. Many vendors have developed off-the-shelf EDI software which DOD could use by simply deciding on parameters for the fields. The off-the-shelf software allows a user to create his own transaction. Finally, value added network or third party networks support EDI gateways to multivendor platforms of trading partners throughout the world. These VANs are much more capable than only using one type of vendor software because the translation process is performed by the VAN. VANs are one of the most popular methods--approximately 25% of all EDI users use VANs, according to Drake (1991).

d. *EDI hardware alternatives*

Microcomputer stand-alone systems are usually used by a small company with a small amount of data, or by an EDI system not integrated with the applications. The cost of an adequate PC 286 AT compatible is now approximately $700; 2400 baud modem $100; 24-pin dot matrix printer $250; communication software $100; and EDI translation software $400-1000. So the total cost of an adequate system can be approximately $2,000-2,500 depending on the type of EDI software purchased.

Microcomputer interfaces with outside communications, contain EDI translation software and can have direct hardwire interfaces with a mainframe. A mainframe receives all EDI data through one communication port in the communication processor and processes the raw data. Using the mainframe provides greater growth potential as EDI committments increase.

e. EDI Communications Options

(1) Direct, point-to-point connection. This option was used initially until more companies began using EDI. When multiple trading partners exist establishing and maintaining many secure communication channel connections among them greatly increase costs.

(2) Value Added Networks (VAN). Value added networks address the cost issues of a point-to-point connection by minimizing compatibility issues, scheduling problems, and providing control of the environment. Costs vary depending on the network, volume of transactions, and services used by the trading partners. VANs provide the following:

- Store and forward services in which mailboxes store inbound transactions for the recipient.
- Compliance checking services to determine if transactions are formatted as agreed upon by the trading partners.
- Translation/conversion services into the format agreed upon by the trading partners.
- Interconnection services to allow customers to deal with trading partners in other networks through gateways.

f. EDI Implementation Problems

Several problems may affect the implementation of EDI:

- Using proprietary formats instead of international or national standards.

- Promising more than you can deliver. EDI is very limited in scope at this time.
- Prescribing EDI as a do all.
- Converting existing systems to EDI without analyzing the process or re-engineering following CIM principles and TQM methods.

5. Electronic Contracting

According to Drake (1991) EDI in procurement should be one of the first functional areas within the Federal Government to greatly benefit from EDI in a very short period of time.

a. EDI/EFT

General Electric (GE) Information Systems provide a large portion of EDI/EFT services for DOD. Payments from 66 payment offices to 10 different GE businesses totalled $8 Billion in 1990, according to the Electronic Contracting Conference (1990). Of the $8 Billion, GE electronically collected $3 Billion and provided electronic remittance advice on an additional $3 Billion. The major trading partners are the Defense Contract Administration Service Payment Centers and Kirtland Air Force Base. GE used ANSI standards not consistent with existing DOD EDI efforts.

b. Paperless Contracting

The goal of electronic contracting is to integrate paperless processing to include wordprocessing, spreadsheets, databases, expert systems, and EDI at the contract specialist's desk. The main hurdles for paperless processing are the efficient processing of multimedia data, digital signature and multi-level security. A digital signature is a symbol, generated through electronic means to verify the sender's identity and the integrity of the information received from the sender. It may represent a person or organization. GSA has accepted digital signatures which use Public Key Encryption (PKE) as legally binding, according to the InfoSec Conference (1991).

Networking is essential to successfully provide connectivity between contract offices and the customers. The contract office receives the procurement request from the customer and creates an electronic file folder placed in an electronic filing cabinet. A decision support system which is menu driven will serve as the procurement process guide to follow. Coordination with technical representatives, legal counsel, small business specialists, and with the customer will occur through EDI and E-mail.

EDI applications in the Federal Government are few compared to numerous commercial applications. Two current EDI applications are: 1) Defense General Supply Center's Paperless Ordering Placement System; and 2) GSA Federal Supply Service use of purchase orders. Their main objectives are to eliminate duplication of work, speed up the procurement process, and eliminate paper.

Expert systems should assist the contract manager in preparing the solicitation, evaluating the proposals, advising about regulations, source selection, contract selection, and warranty analysis. Electronic contracting also assists the program manager in generating the acquistion package documentation, tracking a purchase request through the process, accessing acquistion regulations, and utilizing acquisition planning tools. Paperless contracting is nearly possible with the integration of contracting subsystems over networks using EDI.

C. STANDARDS AND STRATEGY

Different standards in the U.S. compared to the international standards may cause some difficulty in worldwide enterprises.

1. ANSI X12

The ANSI ASC (Accredited Standards Committee) X12 was chartered in 1979 to develop uniform standards for inter-industry electronic interchange of business transactions. X12 operates under the procedures of ANSI with the subcommittees listed in the Appendix. The ANSI ASC full committee has a membership of approximately 500 members who vote on issues. The ASC has a formal process for drafting standards for trial use. This process includes the following: 1) planning phase; 2) development phase; and 3) ASC X12 review and approval phase.

a. X12 Transmission Concept

(1) Data Segments. Each X12 message consists of data segments, data elements, and a transmission envelope to form a transaction set. A data segment begins with its identification code, is followed by a specific sequence of mandatory and optional segments, and ends with a segment terminator character. Data segments must be selected from the X12 Data Segment Directory which specifies the make up of each transaction set by data segment. Each data segment consists of a sequence of data elements of variable length separated by a separator character. Data elements are classifed as identifiers, numeric, decimal, character, string, date, time, and binary found in the X12 Data Element Dictionary. See Figure 1.

(2) EDI Envelope. An envelope contains a transaction set header which identifies the type of transaction set and a trailer which contains information verifying the number of segments in the transaction set. Similar type transaction sets may be transmitted as one functional group in a single envelope.

(3) X12 Infrastructure. According to the X12 Information Manual (1991), the X12 standard consists of basic functions to make up a standard operating procedure and format which consists of the following:

- Start and end validation.
- Sender and destination identification.

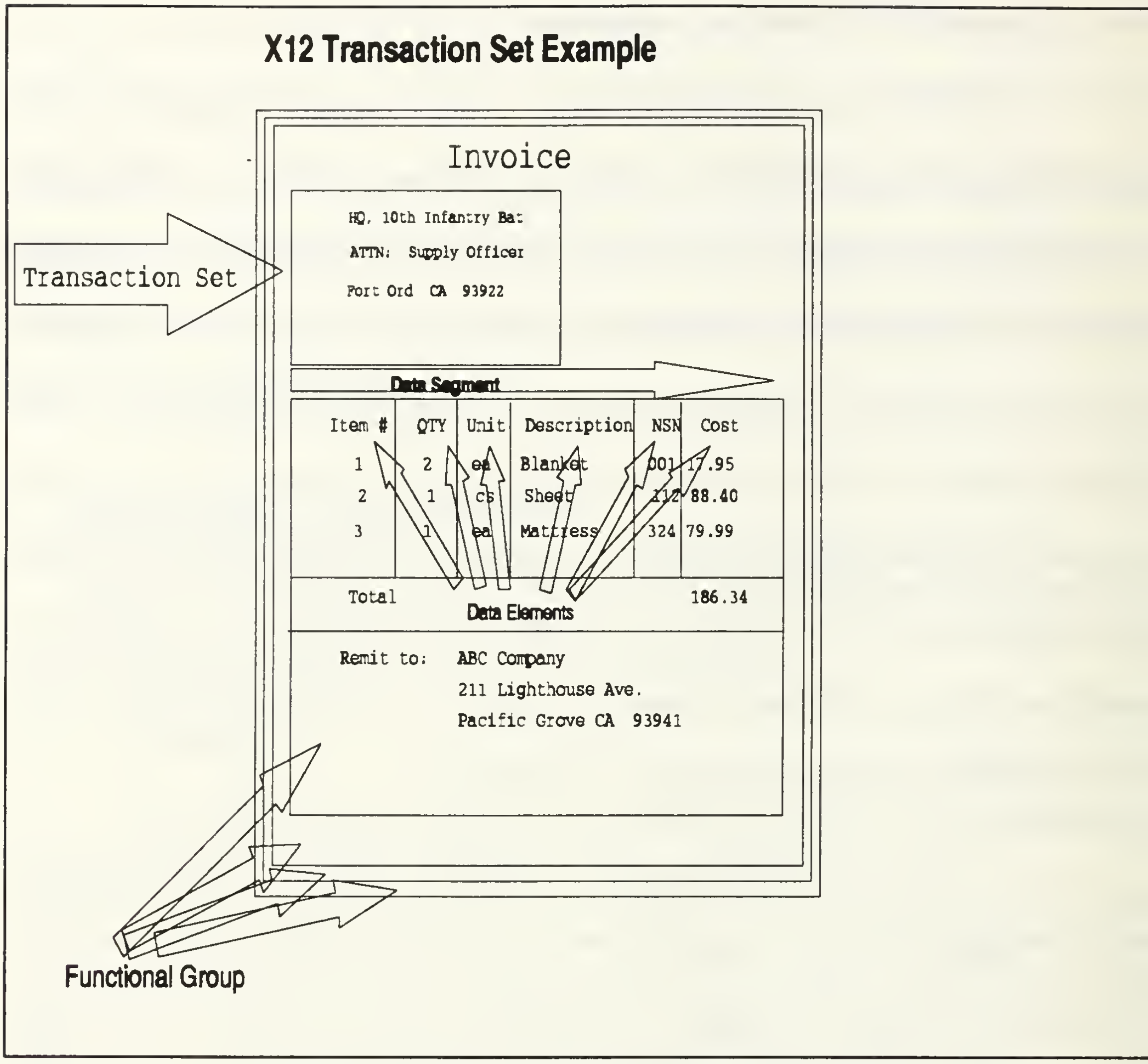

Figure 1. X12 Transaction Set Example

- Senders control number.
- Separators and terminators.
- Data set identification.
- Time and date stamp.
- Exchange message count.
- Telecommunications protocol interfaces.

- Value added networks.
- Off-the-shelf applications software.

b. X12 Standard

The X12 standard consists of four main parts (Sokol, 1989). The X12.3 Data Element Dictionary specifies the name, description, type, and minimum/maximum lengths of each data element. The X12.5 defines Interchange Control Structures which is the EDI envelope. The X12.6 Application Control Structures which are the formal descriptions of the EDI architecture. The X12.22 Segment Directory defines segments which are lists of related data elements.

2. UN/EDIFACT United Nations For Administration Commerce and Transport

X12 is the most prevalent standard in the U.S. However, some industries have found X12 inefficient. Some want additional fields while others would like to delete extra fields unnecessary for their industry. Even though the intra-industry committees have tried to address special needs, a strong international support developed for an international standard. A few United Nations projects to unite all standards around the world exist. The most popular worldwide standard is EDIFACT. DOD has adopted X12 as the EDI standard but supports the convergence of X12 with EDIFACT.

3. CALS MIL-STD-1840A Data Through Transaction Set 841

a. The X12 Transaction Set 841

The "Specification/Technical Information Transaction Set" merges Transaction set 839 Technical Information and 841 Specifications together according to Saltman (1990). ASC X12 added a special Government segment for CALS to use MIL-STD-1840A in 1989. The process described in Subsection C.1 resulted in a 1989 ballot vote and again in 1990 by ASC X12. Currently, the X12 Procedure Review Board approved 841 as a draft standard.

b. File Restructuring

File restructuring of an 1840A includes the declaration file in the header area and the data files in the detail area. Multiple files forming a single document would allow repetition of detailed data. The trailer area will be used for verification and authentication.

c. Government (GOV) Segment

The GOV segment added to the 841 transaction set consists of three main data elements: (1) The item description qualifier which if coded MS means that the following data elements contain a record of the declaration file or the header of data files based on 1840A; (2) The record/file qualifier which contains the name of the record in the declaration file; and (3) The record format data which contains codes such as T2 for two text files, Q2 for two IGES files, and C2 for two CGM files in the transmitted document.

Saltman (1990) proposes that a total of 10 GOV segments will be in 841. The records not provided in the GOV segment (1,2,6,9, and 13) will not be transmitted. Five additional GOV segments must be added and the data repeated along with the record names to transmit them.

d. Transaction Set

Data mapping of MIL-STD-1840A records to transaction set 841 segments exist for IGES, Raster, CGM, PDL, gray scale, and special words files. Each transmitted document uses its own 841 transaction set which follows the one before. The envelope around one or more transaction sets in sequence consists of the functional group header, GS, and the functional group trailer, GE. The outer envelope outside the start of the first functional group and the end of the last functional group consists of the Interchange Control Header, ISA, and Interchange Control Trailer, IEA, according to Saltman (1990).

e. Data Types for 841

The types of technical data which will require 841 are:

- Engineering, quality, and test specifications.
- Design analysis and review packages.
- Technical proposals and support packages.
- Product definition data.

- Technical orders and manuals.
- Electrical and mechanical interface documents.

f. Interim Solution

The X12 841 transaction set is an interim solution because transmission costs are very high due to excessive overhead. A successor to the X12 841 transaction set will be the X.435 standard which is discussed in detail in Chapter IV.C. It will allow E-mail messages to carry EDI data, CAD/CAM data, and text data in the same envelope. It can separate these different data types and still organize the electronic message into body parts which makes it less expensive to process. Many of these compound documents may be over one gigabyte in length.

4. Electronic Commerce: A Strategic Plan for DOD

DLA proposed a very high level implementation plan with very long completion dates for the following implementation activities: (DLA, 1990).

a. Business case preparation

This justified the return on investment for EC.

b. Implementing authority development

DLA prepared memorandums for Secretary of Defense Offices which gave official support to EC initiative.

c. *Implementation Baseline*

DLA compiled a list of all DOD components with on-going EDI projects. This was done to identify any duplication of effort, share experiences with other components, and prevent further duplication.

d. *Identification and Removal of Impediments*

DLA reviewed all regulations and statutes to identify impediments to the use of Electronic Commerce. They then developed a plan of action and schedule to remove the obstacles

e. *Implementation Guidelines Development*

DLA prepared standards, rules, and conventions for EDI between DOD and trading partners.

f. *Operational Concepts Development*

DLA prepared operational concepts for the following functional areas because they offered greater return on investment than other areas:

- Finance Centers
- Procurement and Contract Administration
- Transportation
- Supply Management
- Maintenance
- Fuels
- Base Operations

g. Configuration of Research and Development Network

DLA formed the Electronic Commerce Experimental Network to test new translation software, hardware, data communications, data security techniques, and other technological advances to enhance the EC program.

h. Installation of Pilot Applications

DLA is in the process of selecting pilot applications from the functional areas in Section f above to develop and implement in a real-world environment.

i. Preparation of Data Dictionary

DLA is in the process of preparing and publishing an EC data dictionary based on the Logistics Data Resource Management System, ANSI X12, and EDIFACT data dictionaries to insure the use of standard data elements.

j. Development of Translation Software

DLA is investigating the possibility of buying a translation software package off-the-shelf or developing it in- house after determining DOD's translation software requirements.

k. Procurement of Hardware

DLA is surveying the market to determine what computer hardware will best meet EC users needs and will publish a preferred products list.

l. Development of Communications Plan

DLA is designing a communication network for EC which must determine the type of protocols and standards to use. This research will help DLA determine the best strategy to follow.

m. Development of Security Plan

DLA is researching how to incorporate multi-level security and manage the crytographic keys required for the systems.

n. Development of Small Business Plan

As part of the developing plan DLA conducted a small business fair in Dayton, Ohio, in April 1991 and demonstrated the Government Acquisition Through Electronic Commerce (GATEC) EDI project sponsored by the Wright Patterson Contracting Center. One of the first functional areas in which a very high ROI is expected is procurements under $25,000. Small businesses are big providers of products and goods for small procurements.

o. Formulation of Marketing and Training Plans

DLA is developing training materials on EC and is also releasing official articles on the DOD EC program for publication in Government and industry trade journals.

D. OBSERVATIONS

1. EC/EDI Increases Competition

All interested parties can receive notices of all opportunities and have access to the solicitation electronically if they have computers and EDI software. The Government increases the amount of the market which has a chance to look at the solicitation. Small businesses may use EDI with PCs. However, only EDI translation software is readily available and only a few business software packages provide EDI capability. CIM initiatives in procurement and contract payment should be integrated with EC techniques. CIM should establish a target date for all DOD transactions to use EDI based on commercially available software.

2. EC/EDI Changes The Way We Do Business

The main goal of EC is to achieve end-to-end paperless commerce. EC facilitates just-in-time inventory, direct vendor delivery, and use of nondevelopmental items. The biggest cost saver is the elimination of large stockpiles.

3. Types of Procurements

Indefinite Delivery Contracts (IDC) and Basic Ordering Agreements (BOA) have become a very popular means for rapid purchase requirements. IDCs attract greater market interest because the size of the solicitation may be larger than normal. For example, Desktop III and Desktop IV microcomputer contracts allow any DOD agency to order computers from the contract. The IDC is completed with the assumption that the maximum order limit probably will not be reached. Invitation For Bid (IFB) contracts could also give a good ROI, but the volume compared to IDCs and BOAs is much lower.

4. Electronic Bulletin Boards

Electronic bulletin boards used to publicize contract actions, integrated vendor databases, and third party information brokers should be part of the procurement environment. An electronic CBD (Commerce Business Daily) divided by amount and type of supply would require less than half the time when compared to the hard copy CBD item to appear to the public (Drake, 1991). One format of the bulletin board would be X12 and the other in plaintext. Vendors could respond with EDI transactions to the DOD address in the CBD. One copy of the bulletin board could be only in the DOD environment and another copy on a commercial bulletin board because of security reasons. The commercial bulletin board could be managed by a contractor according to government regulations as a master copy.

If the industrial infrastructure exists, then a distributed multi-vendor database could reside on a commercial mainframe accessed through a gateway. A request for quote for particular items from a DOD user to a vendor could be a query to the database thru the gateway. The need for a multi-level secure database exists for certain procurements. Oracle, Inc. for example provides a trusted database. These same considerations are present in the CALS initiative.

5. Industrial EDI Base

DOD should build upon the large installed base of EDI software in the private sector to easily access DOD. FTS2000 would provide access to the private DOD wide area network. Autodin and the messaging part of DDN will be replaced by the year 2000 with DIS. DOD networks should become linked with Prodigy, Compuserve, Telenet, and Tymnet to provide wide access to all firms.

a. Information Superhighways

The information superhighway systems will be essential infrastructures for commerce and defense. The interstate superhighways will consist of individual statewide systems, metropolitan area beltways, with access to individuals and companies no matter where the location. Interchanges will be crucial to successful information transport particularly for traffic flow and accidents thru electronic gateways. DOD may make a strategic error if they choose not to use the industrial base interstate system and continue to use the military base system (DDN). Industrial information superhighways will provide the large links necessary for compound documents routine travel (FTS 2000). The US air transport system provides ultra fast long distance transport of small packages or bundles of information. Similarly, an electronic messaging system for small bundles from point to point will be part of the information superhighway system. This information superhighway, in fact, has become global with the installation of fiber optic cables across the Atlantic and Pacific Oceans. DOD must recognize that the cost of maintaining and supporting a military infrastructure which tries to duplicate the industrial infrastructure is already cost prohibitive and will become more so. The duplication of the industrial infrastructure on a global scale would be futile. The Air Force has already had cost overruns while operating the Worldwide Military Command and Control Systems.

b. EDI X12 For Document Translation.

DOD should use X12 because it is a North American standard and most of DOD's business contracts are within the United States. However, over half of the private sector does not use X12. But all vendors wishing to do business with DOD will have to purchase X12 software because DOD adopted X12 as the DOD standard. DOD's internal formats in the DLSS are being updated to nearly X12 in the MODELS program because of some unique labels and contents of DOD fields. If no X12 field exists for DOD unique information, it can be placed in an optional field and still retain its format. DOD will develop X12 implementation guidelines so that VANs can offer X12 translation service with those particular DOD parameters.

6. EDI Network Architectures

Several EDI network architectures are available to exchange information between DOD and the 300,000 plus vendors currently doing business with DOD (Drake, 1991).

Mixed media such as a diskette or magnetic tape could be mailed between trading partners and only requires a standard format.

Users could dialup via a modem and establish a dedicated link for the duration of the session. If the same EDI software resides on both computers no translation is necessary. If there is different E-mail software, then the electronic messaging standard X.400 could create an envelope around the X12 transactions with addressing information. The new standard X.435 approved in June 1991, called PEDI, retains the EDI identification within the message header. This allows the routing of the EDI message without the need to check the contents of the message between various E-mail systems.

E-mail with mailboxes provided by the trading partner computer or by a VAN would require the sender to place the message in the receiver's mailbox and be notified at a later time that the receiver retrieved it. Both parties do not need to be on-line at the same time. This would facilitate the Electronic bulletin board availability to all vendors. Most private networks use X.400 as their E-mail standard and unless DOD adopts X.400 as their E-mail standard, problems with allowing messages from DOD's proprietary protocols to X.400 will prevent widespread use. Private networks also use the OSI standard X.500 to provide an electronic directory with electronic addresses of vendors and by function or business. DDN's addressing scheme is archaic and does not interface with X.500. DOD's Defense Automated Addressing System (DAAS) would provide minimum addressing services required until X.500 is adopted by DOD which would again eliminate another DOD proprietary system. DAAS is not scheduled to begin functioning completely until the year 2000.

Will DDN provide sufficient bandwidth to support EDI transactions? From Payne (1990) initial estimates based on 1988 volumes would produce 25 gigabits of data per day from the procurement system alone. Transportation, fuels, etc., will also have the same amount of data. By 1992, at least one terrabit of data will be transmitted per day, if CALS data is shipped in an EDI envelope. Payne (1990) was very conservative in her estimate and also liberally assumes that very high speed lines (gigabits/second) will be available by 1995. A backbone infrastructure may approach these speeds but until the local subscriber loops upgrade to ISDN, it will not matter how high the speed is for the backbone because the chokepoint will be the local access line. Any thoughts about DDN being upgraded to a broadband network will be delayed because of budget constraints. Even a T-1 network will not be sufficient to transmit thousands of terrabits of data. A compound CALS document containing 500 engineering drawings with text, video and other graphics may contain nearly one-half terrabit of data. It may not be uncommon to have electronic video teleconferences reviewing this type and volume of data by 1993.

E. SUMMARY OF FINDINGS

1. EC and Different Solicitation Methods

Current EDI processing could support IFB for sealed bids because each item in the IFB has precise terms; part number, quantity, ship-to address, etc., but the ROI would be small because of relatively low volume of IFBs, according to Drake (1991). EC support for RFPs for competitive proposals are currently difficult because of the large volumes of text, technical data, and the lack of an architecture for multimedia data interchange required for video teleconferencing. BOA sole source orders and indefinite delivery contract orders could receive the best support from current EC and are very high volume (Drake, 1991).

2. OSI Standards Are the Solution

a. OSI

OSI will make EC with large complex documents consisting of text, engineering specifications and drawing possible without regard to the platform and allow multimedia and hypermedia data interchange. CALS is developing data interchange formats and networks to exchange complex documents. Use of X.400 now will force compliance with OSI and provide global interconnectivity and not just connectivity to US firms. Addresses in the X.500 directory would work with other OSI standards.

b. FTAM/FTP Gateway

FTAM (ISO 8571) is another published standard used by a few VANs and carriers to transfer files. It is an alternative to X.400 which is often the vehicle of choice for EDI, but in certain regions there is a tendency to use FTAM. For example, French banks chose to use FTAM for a major system because of electronic security issues in Europe. DOD uses FTP as standard for file transfer. An FTAM/FTP gateway would provide OSI compatibility to DOD at layer seven but this would require considerable overhead according to Henshall (1989).

3. Digital Signatures

Statutes and laws need to be revised to make the use of digital signatures acceptable in court should the need arise. NIST has adopted ANSI X9.9 to provide an effective means to authenticate the integrity of messages (InfoSec Conference, 1991). Operating systems, databases, application software, and access control software do not provide adequate data integrity to stand up in court. Crytographic authentication such as PKE is needed for most applications.

4. Electronic Contracting

Users could negotiate contracts through the use of E-Mail by providing queries, messages, and discussions with archiving or electronic file cabinet. ASC X12 841 Specification/Technical Information transaction set combines graphics and text into a compound document. CCITT X.435 standard is designed for EDI using the X.400 Message Handling System. EDI transactions would be placed in an E-mail envelope to move large files. Reliance on DDN will place DOD further behind than it is now with its proprietary protocols. With the end of the Cold War, the role of DOD may shrink rapidly while the role of businesses will increase logarithmically. Vendors will have a difficult time trying to access DOD information if it remains in the DDN environment. It will be hard for the commerical community to interface with DOD if the IGP is not fielded until 1994 because industry is well on the way to OSI. X.400 is projected for beta testing by early 1992. DOD cannot afford to wait until 1994 for development of the DOD Intelligent Gateway Processor (IGP). Commercial equivalents of the IGP exist today and should be used instead of developing an IGP in-house.

5. Re-engineering

DOD should re-engineer workflows before implementing EDI into existing systems, according to Strassman (1991). If DOD simply substitutes an electronic transaction for a paper one or a phone call, then EDI may cost the Government more than it does now in an automated paper based environment.

IV. OSI OPEN SYSTEMS INTERCONNECTION

A. BACKGROUND

1. Older Networks

Some networks are interconnected physically but not designed to allow transparent exchange of data. Only basic physical connectivity between points existed a few years ago. Many examples of floppies being mailed around the country or world still exist today. The size of the floppy has changed and the amount of data on the floppy increased, but the fact that the mail transports the data remains. According to the CALS Implementation Plan (1987), DOD suggests keeping this modus operandi in place and not to fully pursue the electronic solution to transport multimedia and hypermedia data until after 1995. At that time, according to the Defense Message System Plan (1991),, the messaging part of DDN will be replaced by a much more robust system based on OSI standards.

Even though two platforms may be wired together, the same communications protocol must be used to transmit data to each other. The growth of LANs in the late 1980s caused the need for interconnectivity of workgroups in the matrix organizations. Businesses and the DOD changed the way they do business from heirarchial organizations to matrix organizations which provide support horizontally rather than duplicate themselves vertically.

Even if these matrix departments added PCs, LANs, or mini-computers they still may require connectivity to a central computing center and to each other. In a geographically distributed network it may be difficult to funnel data through the central computer because of the amount and volume of traffic.

2. Open Systems Networks

Open systems networks are not only interconnected physically but also allow transparent exchange of data throughout the world. The primary goal of OSI is to provide interoperability between computers in different countries and corporations using a common communications infrastructure. OSI is a set of standards published by ISO and CCITT for data communications. Henshall (1989) discusses the ISO seven layer reference model. Multi-platform and multi-vendor environments in which all machines interoperate globally is the goal of OSI.

Interoperable platforms can exchange data through a distributed application. For example, a user could send an E-mail message to a user on another network through a gateway. A client-server relationship allows cooperation among several connected computers. A user could access a distributed database or groupware. Groupware includes spreadsheeting, electronic meetings, multimedia messaging and compound documents, workflow automation, and mail-enabled applications.

The movement to open systems began with proprietary protocols of single vendors such as IBM, DEC, Xerox, and HP. Next the DOD pioneered the

TCP/IP protocol suite. Multi-vendor support of TCP/IP produced the ability to send E-mail between different organizations by installing the TCP/IP software on routers. The E-mail standard for TCP/IP is SMTP which is very basic and lacks sophisticated transfer capability according to Delaura (1987).

B. OSI REQUIREMENTS

Many capabilities of OSI may require the use of an intelligent gateway which could exist on many different platforms. These capabilities include: 1) a layered peer-to-peer architecture with service infrastructures; 2) client-server applications using virtual resources; 3) multi-vendor and multi-platform; and 4) being adaptable and seamless. Distributed networks may need intelligent gateways which have network control engines to manage the network. One of the main intents of OSI is to have different operating systems like DOS, Windows, OS/2, MacIntosh, and Unix systems able to perform similar services with each other. The applications running on the different platforms should be integrated seamlessly. This research concentrates on the Message Handling System and its capability to support multimedia multi-platforms with text, facsimile, full motion video, and graphics. OSI should have the ability to grow to several million users in thousands of locations around the world. The Federal Government developed a subset of ISO standards selected by NIST to meet the needs of the government agencies called GOSIP.

C. OSI STANDARDS FOR MESSAGE HANDLING SYSTEM AND DIRECTORY SERVICES

1. X.400 1984 and 1988

a. Upper Layer Functions

The application layer at the top of the OSI reference model in Henshall (1989) realizes the goal of OSI. The lower layers simply exist to provide support for the application layer. It makes services available to computer system users. The main functions of the seventh layer are file transfer access management and file directory operations; message handling; virtual terminal protocol; and job transfer, manipulation and remote job management (Henshall, 1989).

b. X.400 Development

Development of X.400 began in 1980 with the formation of the CCITT X.400 Protocol Committee. It took four years to complete the initial standards which were released in 1984 and as part of the Red Book. The first commercial products conforming to X.400 of 1984 appeared in 1986. According to Scott (1990), the initial products were primarily OEM source code. The committee produced a later version of the standards in 1988 which incorporated the message store, multimedia messaging, and security. Most X.400 1988 package products were released in early 1990.

c. 1984 Standards

The 1984 standards included many basic features. According to Gifkins (1988), this version only met approximately 50 percent of the requirements in Logica's Report to Vanguard on EDI and X.400. The basic features are:

- Delivery notifications
- Message tracing
- Integrated messaging
- Secure session establishment
- Binary and encrypted data
- Multi-destination delivery
- Uniform, global addressing
- Distribution lists
- Grades of service
- Deferred delivery

d. 1988 Standards

The 1988 standards added two additional features and introduced the concept of a message store which will be discussed later in this chapter (CCITT X.400, 1988). According to Gifkins (1988), this version met approximately 70 percent of the requirements in Logica's Report to Vanguard on EDI and X.400. The two added features are:

- Generic advanced security
- Latest delivery time

e. *X.400 Model*

The X.400 model contains user agents and message transfer service. The user agent defines the contents of the message which can be sent. The 1984 version was designed to send several different types of messages but only one type called interpersonal message (IPM) is specified in the 1984 standard. IPM resembles a regular office memo (i.e., To:, From:, CC:, Subject:, Priority:, In reply to:, text, drawings, graphics, and voice) and is generally defined by the P2 protocol. P2 defines a header and a body. The header consists of addressing information. The body consists of one or more body parts which each have specific formats. The message transfer agent determines how to route messages from sender to receiver. The MTA provides for store and forward service as defined by the P1 protocol. More than one user agent can use the services of a single message transfer agent. The MTA routes messages to the destination and delivers for their local user agents. MTA addressing uses a facility called originator/receiver name which is designed to provide all the necessary information to send a message internationally.

2. X.435 PEDI

a. Development

The CCITT recognized that EDI would require a basis for storing and forwarding messages around the world with grades of service and support of binary message contents. The committee therefore began development of X.435 in early 1988. Until 1988, EDI and X.400 standards pursued separate development. CCITT recently approved the 1990 X.435 standard in June 1991 and, according to Eckerson (1991), industry analysts predict that the 1990 standard will not be implemented until 1993. Vendors are in the process of implementing agreements on how to implement X.435 and should complete the agreements by the end of 1991. Eckerson (1991) states that it will take 6-9 months to create beta versions to field in late 1992. Meanwhile, the DOD will be pursuing EDI over DDN through an intelligent gateway which is not scheduled for implementation until 1994 as stated in DLA (June, 1990). According to Sweeney (1991), the DOD does not plan to include X.400 in GOSIP until 1994.

b. Features Added in the 1990 X.435 Standards

(1) Advanced security specifically for EDI. Each part of the path of an EDI message can be protected by using encryption of data, verification of message sequence integrity, authentication of message originator

and receiver, non-repudiation, and authentication of the delivered message contents according to the CCITT X.435 (1991).

(2) Message body parts. X.435 defines EDI messages to have at least one body part which is a place within the message where EDI interchange is carried. The first body part is always the part that contains EDI data. Subsequent body parts may carry different types of data (Figure 2). A CAD/CAM drawing, 1840A engineering graphic, PDES, or just text related to the EDI data could be contained in the other body parts. The alternative approach is similar to the CALS data in an 841 transaction proposed by Saltman (1990). It is more difficult for the communication software to perform the CAD/CAM processing because the X12 overhead data must be stripped away first before the binary data can be processed.

(3) Cross-referencing table. The X.435 EDI message has a table which may allow several CAD/CAM drawings to be linked to a separate body part which contains the EDI interchange. Each page of the interchange may reference one of several CAD/CAM drawings using the table.

(4) Forwarding of EDI messages and EDI responsibility. A user may request notification on whether the recipient's software accepted, refused, or forwarded the message he sent. The issuance of the notification report is a function of the UA. With this action, the software takes responsibility for the message and informs the users of who has responsibility at any specific time.

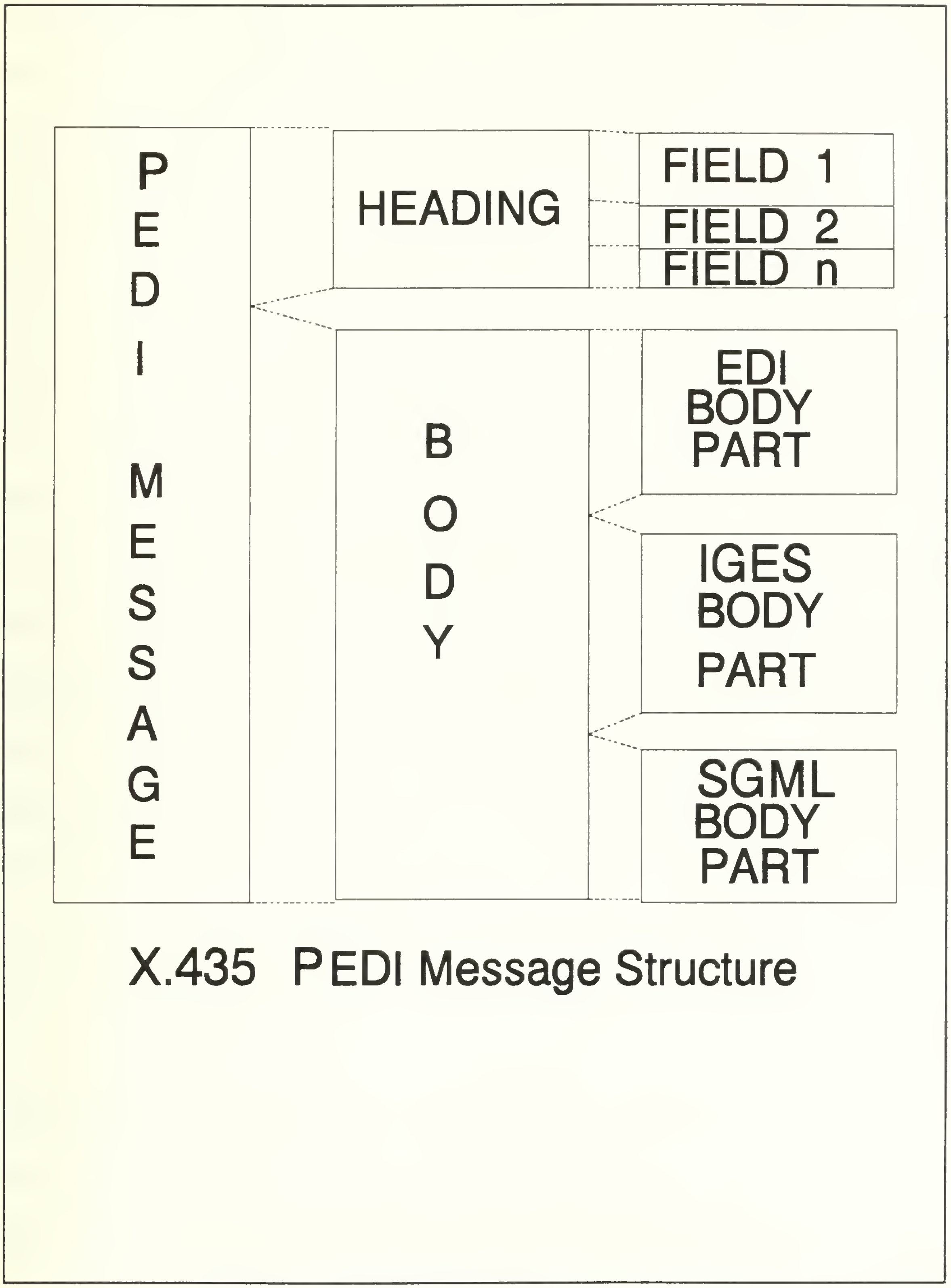

Figure 2. X.435 PEDI Message Structure.

If the user has a central X.400 gateway through which all messages are screened and audited, the X.435 software examines the message and determines if it will be able to pass the message to the recipient's application. A user from Japan may send an EDIFACT message to DOD which uses X12. The X.435 software then determines that the formats are incompatible and if the gateway does not contain multiple protocol converters will refuse to take EDI responsibility for the EDIFACT message and return a negative notification to the sender if requested.

(5) EDI notifications. Three types of EDI notifications provide extra tracking capabilities beyond the simple notification of delivery. First, a positive EDI notification lets the sender know that the software accepted EDI responsibility for the message after examining it and determining that the interchange can be processed by the recipient's application. Second, a negative EDI notification lets the sender know that the software refused EDI responsibility for the message after examining it and determining that the interchange cannot be processed by the recipient's application. The third is a forwarding notification that tells the sender that the message was forwarded along with the EDI responsibility to another user.

(6) Message store. The combination of database functions such as queries, retrievals, deletions, searches, and sorts of a mailbox allow users to have the full functionality of an X.400 VAN or network without the

overhead of having to completely implement X.400 or X.435 on their computer. The message store assists the smaller EDI users because they do not have the computing resources or financial resources to fully implement X.435. Incoming messages would be placed into the user's message store. When the user logs on, they can be alerted about new messages or other optional criteria that was selected. Other messages may also be retrieved from the mailbox according to these criterion. For example, the U.S. Army Tank Command may want to look at just EDI messages from General Motors for the month of July 1991 that contain invoicing information.

3. X.500 Directory Service (ISO 9594 or CCITT X.500)

Since the growth of networking started, there has been an increasing demand to maintain information about what kind of computers are on the network. The information includes application programs, people using the computer, and a physical address. E-mail directories provide look up services. DDN provides a Unix like command "Whois" to give directory type information on individuals using DDN. However, the DDN Network Information Center can only provide this information for DDN hosts only. Similar to most proprietary networks, these applications cannot be used on interconnected heterogenous networks. For example, AT&T Starmail and MCI Mail are interconnected and a user from one system may send mail to a user on the other system if he knows the address. However, if the address is unknown, a

Starmail user cannot check for an MCI E-mail address or vice versa and the Starmail user cannot send the E-mail to the MCI user.

There is a great need for a globally interconnected directory which provides links to individuals, distribution lists, MTAs, application entities, and all UAs. Either the directory name or the originator/recepient address must be contained in the user's message. The directory name will be more user friendly than the address which may change because of the physical configuration of the Message Handling System. A message with just a directory name will cause the Message Handling System to consult the directory to find the corresponding address. If the message contains the address, the Message Handling System will use the address provided to route the message. A user can use the directory service to verify a given address or find out additional information about a specific user. The address is an ordered list of attributes. It can be private or administration domain defined, a personal name, distribution list name, organizational unit name, and mneumonic addresses and called relative distinguished name.

X.500 allows user friendly naming of objects and name-to-address mapping which supports the binding of objects and their locations. The directory is a specialized database supporting management and telecommunication processes in a standardized format jointly developed by ISO and CCITT. The directory will be logically one directory but physically distributed with a unified name space. Directory user agents and system agents will provide the application or human user with the ability to query the directory information database. This is done by using the directory access protocol between user agents and directory system protocol between system agents.

4. Defense Message System (Program Plan)

DOD tried to satisfy all messaging requirements in a single system procurement with the InterService/Agency Automated Message Processing Exchange (AMPE) in 1987. Do to severe budget constraints, a rapidly changing technology and new international standards, AMPE was cancelled and replaced with an evolutionary process to modernize the messaging system. AUTODIN and DDN form the baseline and will be replaced by off-the-shelf products conforming to international standards forming a distributed messaging system based upon X.400 and X.500. Phase 1 ends in 1994 and includes transitioning from TCP/IP to TP4 and from SMTP to X.400. AUTODIN traffic will switch to DDN and by the end of Phase Two, all Telecommunication Centers will begin phasing out. (Draft Defense Message System Plan, 1991)

D. ANALYSIS

1. Defense Message System

An X.400 based solution is proposed in the Defense Message System Program Plan for DOD communication requirements. The schedules for this transition all indicate that the X.400 conversion will start in late 1991 for some services and be completed by mid 1992. Based upon commericially available packages, this conversion will implement 1988 X.400 standards. However, when the 1990 X.435 standards become commercially available, it should be easy to upgrade because customers will have had experience with X.400 products.

Several corporations have developed platforms capable of performing at least the same requirements as the Lawrence Livermore National Laboratories Intelligent Gateway Processor. Off-the-shelf EDI translation software allows parameter changes which could accomodate DOD fields for processing. If DOD simply wants to automate existing processes then it would be extremely cost efficient to purchase a specific software package which is multi-platform capable on a PC. However, DOD should completely rethink how it performs its processes before implementing any EDI applications over X.435. Automating what a paper based system performs should be done after an analysis of how to electronically perform the work by rethinking the process.

2. X.435 Versus Non-X.400

There are several advantages of using X.435 versus non- X.400 based EDI according to Lyons (1991). First, X.400 allows audit trails to track each message through delivery notification and message tracing. The two types of delivery notifications are: 1) positive which tells whether the message was placed in the receiver's mailbox successfully or 2) negative which also tells why the message could not be delivered. X.400 users can even find out if a message was delivered to a receiver on a different network because the last X.400 network generates the delivery notification. Each envelope documents the path that the message takes from the sender to the receiver. Each time the message transfers between X.400 networks, the envelope is updated with the name of the X.400 network through which it is passing.

Second, EDI and E-mail may be integrated on one network instead of two because X.400 provides both services in the same protocol. A trading partner may use a VAN if he does not have X.400 capability. X.400 can even be used to send and receive facsimile messages.

Third, since X.400 is an international standard, it is just as easy to send an E-mail message to a foreign receiver as it is to call them because most X.400 networks are international or interconnect to other foreign X.400 networks. More and more EDI users who are part of a global enterprise are moving to X.400.

Fourth, one security feature of X.400 establishes a secure session and the other allows the envelope to encrypt EDI data. Secure session establishment uses a logon ID and a password. Since binary data can be carried, users can transmit encrypted data which prevents the sender or receiver from reading that data. CAD/CAM data, spreadsheet files, faxed images also require binary data and can be encrypted.

Fifth, like most E-mail systems X.400 allows a single message to go to multiple recipients with the use of distribution lists. These addresses are unique in the entire world because they include user's name, company, X.400 VAN, and country. Neither EDIFACT nor X12 use a uniform global addressing scheme. The distribution list is created only once.

Finally, unlike most E-mail systems X.400 offers three grades of service which determine how quickly a message is delivered and the cost of delivering the message. Many types of junk mail could be sent non-urgent. Some invoices or purchase orders may be sent normally and mistakes in payment may be sent urgently. A user can even set up a specified date and time of delivery several weeks into the future.

E. SUMMARY

Since X.400 can distinguish between the envelope and its contents, it is well suited for store-and-forward messaging such as EFT and EC/EDI.

Since X.400 can support all earlier technologies such as E-mail, telex, facsimile, and exchange binary formatted data it is also well suited for CALS and other technical data interchange requirements.

Commercially available software implementing the 1988 X.400 standards is available for intelligent gateways. These software packages could be used to handle most CALS requirements. Software implementing the 1990 X.435 standards will be commercially available in less than one year. It could potentially benefit DOD to rapidly re-engineer processes. After completion of the re-engineering new products could be available that will support multimedia and hypermedia interchange required in CALS and EC/EDI.

A second option available to DOD is to use a VAN which will have the 1990 standard implemented in mid 1992. Linking to a VAN which provides all the required services may be more economic. VANs have intelligent gateways and could be used as soon as parameters became established by DOD.

With the adoption of X.435 in June 1991 as an international standard, the Message Handling System will become even more necessary to EDI and CALS users and should become the global standard for EDI messaging as more X.435 products become available. According to Scott (1990), research indicates that the market for X.400 based gateways will grow by 60 percent over the next three years, reaching close to $100 million by 1993. Vendors that want to sell to a global market see X.400 as a platform with worldwide appeal. In 1992, after the European trade barriers will be lifted, open system standards will greatly increase trade in Europe.

V. MULTIMEDIA AND HYPERMEDIA DATA INTERCHANGE ARCHITECTURE

A. BACKGROUND

The evolution of multimedia data involved three types of documents: 1) dumb documents; 2) compound documents; and 3) intelligent documents. The dumb document exists on only one type of media and must be manipulated in its entirety. The compound document combines different types of media and may be flexibly distributed and assembled. The intelligent document functions as a hypermedia system supported by expert systems to solve problems and to enhance user performance.

1. Dumb Documents

The dumb document can also be called the paper based document. It can be either in traditional hard copy conforming to standard formats or data item descriptions in a contract. The dumb document can be mailed through the postal system, Federal Expressed, etc., but always exists on permanent paper. Before the next step in the evolution of multimedia, technology developed to make images of the dumb document. Data processors became obsessed with image processing and the need to access archived documents. The microfiche technology used for over the past 20 years is gradually being replaced by optical storage technology. Large documents which are complex may be stored more easily on an optical disk which may then be mailed. These large documents require lengthy transmission times across networks and in today's networking environments have great difficulty traversing through gateways. Point to point transmissions may take hours depending on the length and complexity of the document. However, for relatively short page based documents, Group 4 raster graphics allow the use of telecommunications to make a facsimile of the document and send it electronically to another facsimile machine either from a stand alone computer or from a network facsimile server, or a stand alone fax which prints out a paper document.

2. Compound Documents

The compound document consists of data components of different types which a computer may process individually. Electronic scanners have added the dimension of converting handwritten text to word processed text. The word processing of text files began the evolution to hypertext. Standards such as SGML are in the process of evolving to guide the integration of multimedia with text to form compound documents. Plain text documents are rapidly becoming obsolete. Graphics files have several standards depending on the type of graphic used. CGM, IGES, and raster graphics discussed in Chapter II form the basis for the graphic metafiles required for compound documents. Database queries using SQL present views of objects. Audio/visual files are part of multimedia kits and business presentations in forms of animation, 3D, photos, combined with graphics and text. These integrated files pose the biggest challenge to interchanging data in electronic commerce and CALS/CE.

3. Intelligent Documents

The intelligent type of document is a virtual document. It does not really exist. There is no need for archiving just for the information provided by virtual document. Certain applications may have predefined queries to multimedia databases which the virtual document may execute to obtain certain data from other multimedia databases. Other applications allow ad hoc queries to the multimedia databases. For example, an expert system conducts a hypersearch of several multimedia databases after a user asks a speech recognition neural network which in turn consults the expert system for information. Accessing hypermedia across networks will be difficult with low speed lines. Current solutions indicate that the hypermedia be physically transmitted through the mail or, if small enough, transmitted electronically as a binary file. X.400 allows the different data types to cross networks. Hypersearches of multimedia databases located in different networks will require high speed lines and X.400. After the system or user finishes with the information created by the hypersearch they can produce a new hypermedia document and store it by creating a virtual intelligent document that knows where to locate the information the next time it is needed.

B. REQUIREMENTS

1. Hypermedia

Hypermedia incorporates many complex information types that may exist on multiple platforms across a network. They are semantically interdependent and synchronized. Hypermedia allows cross-reference of all relevant works and lets the user browse to look for other relationships. They may contain full-motion including video and voice annotations. Thus, hypermedia interchange will require high resolution displays, high volume mass storage, and high speed data communications. No one specific document contains what the person wants but, after learning and getting new ideas from browsing around they may find what they want. Few corporations can afford hypermedia interchange at this level and must settle for much less. Currently, it is possible to send different types of information in one message using X.400 but there are practical limits to the size of the files, according to Asgher (1991).

2. Intelligent/Compound Documents

Desktop publishing of forms represents over a third of all business documents, accounting for $6 billion and wasting nearly $2 billion of it, according to Skapinker (1991). Distribution, storage, and processing account for $100 billion because for every $1 spent on paper, it costs $60 to process it (Skapinker, 1991). Even though the forms are created, distributed, and filled electronically, businesses usually need a desktop publishing capability. There is usually a need for signatures particularly in DOD. By signing the paper form, the form fillers take responsibility for the contents of the form. Once the form is filled out, the inputted data needs to be stored and the form used again. The forms must be indexed because these forms or images are dumb without tagging them with additional and searchable information.

Compressing and decomposing large complex documents helps with routing but each end user must construct and reconstruct the images in a compatible way. If the users are on networks and are a part of a larger organization, its impact on the network is very significant. In fact, optical disk storage called jukeboxes are often used to handle the massive amounts of storage required. Unfortunately, jukeboxes, laser printers, faxes, scanners, and electronic tablets greatly clog up any current network which forces a reduction in the user/server ratio. OSI is attempting to define standards for the future business office to gain control of all the merging technologies in the intelligent document.

3. Electronic Document Staffing

Groupware allows computer-supported cooperative work whether people are seated next to each other or in different countries. For example, when the Army Combat Developers field a new piece of equipment, they may need software that manages the component parts of the big single document that comes from 26 different sites around the country. This software should allow one member to make comments on another's document. The author could review the comments and either accept or reject them before forwarding them to an approving authority for review and signature.

4. Electronic File Cabinet

Distributed multimedia database may involve many forms of information located in many locations. For example, offices and organizations keep standard file drawers, desk files, notes, reminders, cassette tapes, copies of faxes, pictures, videos, microfiche, compact discs, floppy disks, and even removeable hard drives.

Cost estimates for manually filling a five drawer file cabinet, assuming $5 per piece of paper, range up to $50.00 per drawer of 1000 sheets. Maintaining that drawer could cost approximately 10% or $5.00 per year. The worst part is that approximately 5% or 50 documents will become misfiled and thus lost unless a complete search of each file is done at great time and expense which may double the cost of the piece of paper to $10 or more. The manager waiting for the misplaced documents may lose large contracts or potential profits.

One cabinet may hold up to a tenth of a gigabit of data assuming that the average document size is 50 kilobits per page. Hard disks alone cannot handle this requirement but may be used in conjunction with optical technologies for indexing and temporarily retrieving working documents from the optical disk. WORM media automates and centralizes annotations, histories of the document, and proposed revisions to the document. Current technology allows the creation of virtual WORM on a rewriteable drive. However, only a copy of a document on a WORM drive is considered a legal copy. Passing this information currently is done by the *sneakernet*. A good candidate for multimedia data interchange would be exchanging massive amounts of data over fiberoptic infrastructures such as FDDI.

5. Document Imaging

The central technology for a paperless office is document imaging. Paper documents are scanned into document image files which may be stored on an optical disk for retrieval, viewing, and printing. A typical industry model of a document image management system includes scanning and retrieval workstations connected to a laser printer, a document image processor server connected to a large optical jukebox and laser printer, workstations connected to laser printers, and a link between the corporate mainframe and the electronic archival system. A database holds the current day's scanning activity. The master database holds all the documents in the system after the images are scanned, compressed by Group 4 standards and sent to the jukebox. The retrieval of a document allows keyword searches, multiple document displays, and the ability to zoom in on a particular area.

One of the best examples of a paperless corporation is the United Services Automobile Association which provides insurance for active duty and retired officers of the armed forces and their dependents. According to Harvey (1991), over 1,000 graphics terminals connected to a large IBM 3090 MVS/EVA system and separate dedicated IBM 4381s show the document, its history log and notes on file. The terminal allows the viewer to turn pages, zoom, rearrange pages, enter certain page numbers, and handle the document as though it was horizontal instead of 3D. Their storage system consists of five optical jukeboxes and 30 stand-alone optical WORM drives capable of containing over 2 terrabytes of data. (Harvey, 1991)

6. Electronic Videoconferencing and Teleconferencing

Sometimes instead of holding a meeting at one location, significant traveling expenses and time can be saved by reviewing the same documents in real time by holding a video teleconference. During a typical videoconference, paper documents are shown to the camera and seen in multiple locations. Future conferences should have the capabilities of having the identical screen at all locations with changes made to any screen seen simultaneously on all the terminals. The waste of time to postpone and reconvene a conference for lack of information that exists in a different format will be eliminated by gaining access to databases with the necessary information.

C. CAN DATA COMMUNICATIONS BE BASED ON DDN?

Most DDN backbone circuits between packet switch nodes are 56 Kilobits with a few T-1 lines. The access lines to the terminal access controllers are normally 9,600 bits/second. DDN has limited connectivity to other networks.

For example, E-mail can be sent to an SNA network through a Softswitch gateway, but at a very slow rate. As discussed in Chapter III, the amount of data sent over the network will greatly increase with the use of compound documents. Compression techniques exist but the volume of messages and the size of graphics files, even when compressed, may be one megabit. Sending one engineering drawing could take at least two minutes if sent within DDN and could take all day if sent through the gateway depending on the queue of all other messages trying to get through the gateway to an SNA network. Organizations have reverted to asynchronous modem connections to transfer the files point to point when there is a network boundary to cross. X.400 will eliminate the chokepoint that exists when passing through a gateway to another network. If the workstation is on a highspeed LAN running at 10 Megabits per second and the LAN is linked through an FDDI backbone or broadband backbone the throughput to another user could conceivably be 10 Megabits per second which would transmit the engineering drawing in less than one second. DDN is incapable of attaining these high speeds. The upgrade to the Bolt, Baranek, and Neuman processors only made them capable of handling more ports at 56 Kilobits/second.

D. INTERCHANGE ARCHITECTURE FOR MULTIMEDIA AND HYPERMEDIA DATA

1. EDI and X.400 for Multimedia Data Interchange

In Chapter III, we discussed the requirement for including graphics along with text to form an electronic commerce transaction. For example, a picture with a Request For Proposal would not be be possible in a conventional EDI transaction because a conventional EDI transaction allows text only. Even worse, not all companies support EDI or are not fully EDI ready. It may take years to convert an entire business and all of its trading partners to EDI. Some data may have to exist in printable form for human intervention because some company will still rely on paper based systems. On the otherhand, X.400 can accept facsimile, E-mail, IGES, PDES, and other data types to transmit to the receiving partner's mailbox.

2. Hypermedia and Multimedia Interchange Architecture

The telecommunication infrastructure for hypermedia and multimedia data interchange can best be served by ISDN and FDDI. The Government's multi-billion dollar FTS 2000 contract supports ISDN and is available for use immediately. On top of this telecommunications infrastructure, the OSI protocol suite will be used including TP4, FTAM, X.400, X.500, and VT to form the infrastructure for the Defense Information System which includes the Defense Messaging System discussed in Chapter III. The most crucial part of the architecture (Figure 3) is the multimedia and

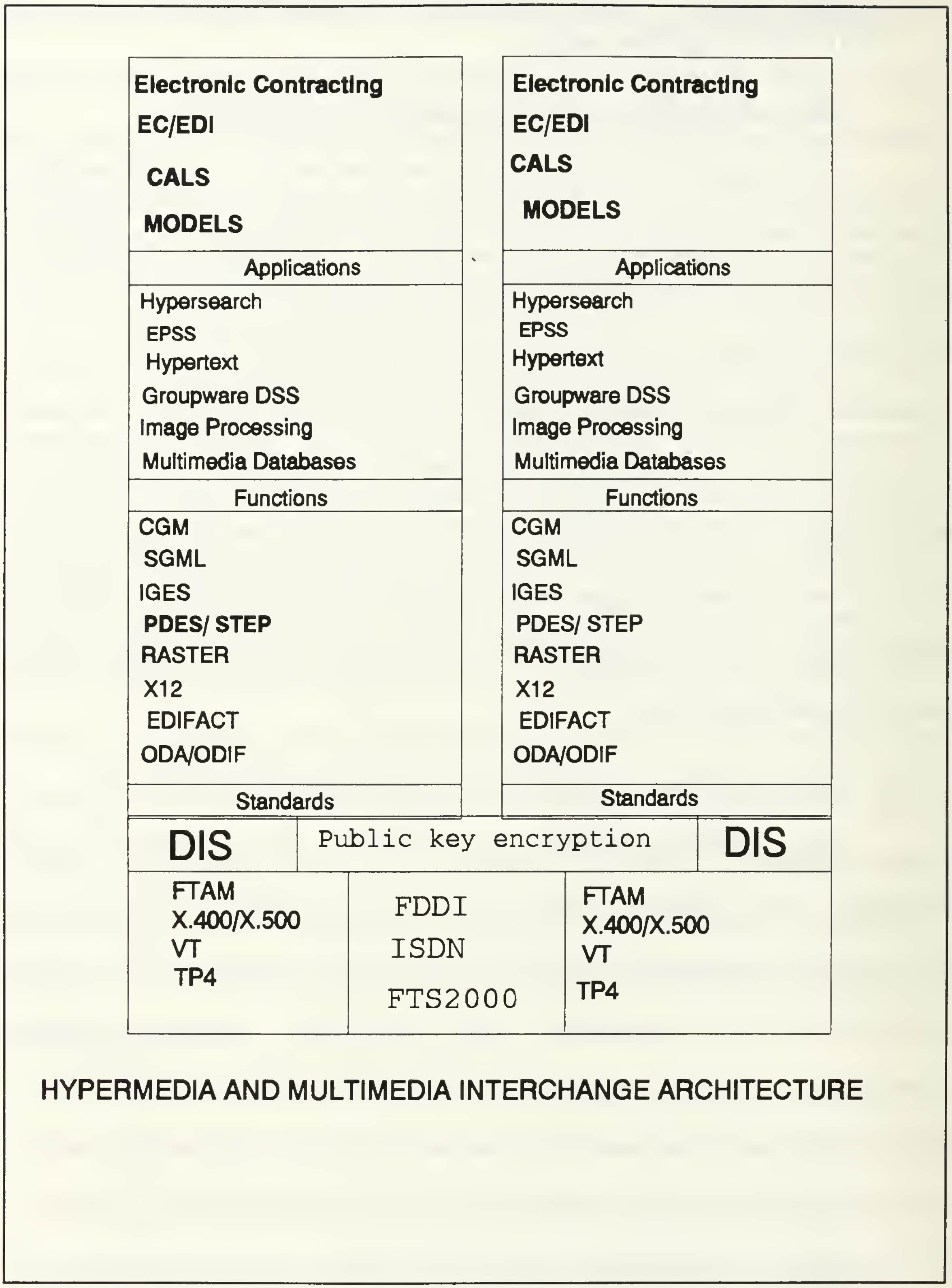

Figure 3. Hypermedia and Multimedia Interchange Architecture

hypermedia data interchange standards. These standards include all the ones discussed in this thesis, especially Chapter I for CALS: CGM, SGML, IGES, PDES/STEP, and Group 4 Raster; and EC/EDI: EDIFACT, X12; and ODA/ODIF. The applications to use these standards include hypersearch and hypertext, groupware DSS, forms processing, multimedia databases, hand written character recognition, electronic performance support systems, electronic contracting, document image processing, logistics, and neural networks. Public key encryption and embedded encryption along with trusted databases and operating systems will allow the existence of multi-level security in this environment.

3. Multi-level Security and Public Key Encryption

a. Multi-level Security

DOD could save a significant amount of money if classified documents could be electronically stored and transmitted between sites along with unclassified documents. Documents most often are unclassified with the exceptionof one or two pages which may contain confidential data, and one paragraph of secret data which makes the entire document secret. DOD has spent billions of dollars maintaining separate systems for the unclassified environment and the top secret and higher environment. Thousands of classified documents are still manually controlled and locked in large classified containers just as they were 50 years ago. Researchers and industry have attained multi-level security systems but the costs are still tremendous. The Worldwide Military Command and Control System installed many Gemini Computers running GEMSOS in front of large IBM mainframes each processing different types of classified and unclassified documents at a very significant cost compared to what most corporations could afford.

Industry is developing trusted databases, trusted networks, and trusted computer security controls which will be present in the Secure Data Network System. Although still in the research and development phase, SDNS may become a great jump forward for security. Embedded encryption internal to PCs with automated public key administration will provide the basis for a totally new way of operating with classified data.

b. Public Key Encryption

An important part of the architecture is the ability to transmit encrypted data. According to Barker (1991), a hybrid of the secret key and public key techniques is recommended when secrecy, integrity, and authenticity are desired because secrecy can best be provided by using a secret key but authenticity is best provided using a public key. E-mail and EFT require non-repudiation of origin, which occurs when authenticity can be proven to a third party and to the receiver of the data. Presently organizations wish to use public key techniques for both non-repudiation of origin and for the distribution of secret keys. NIST is developing EDI data elements and segments to allow the use of the public key for EDI, according to Barker (1991).

The public key algorithms provide non-repudiation of origin of the message by computing digital signatures. Digital signatures are a function of the signed data and the key used to sign the data. The private key calculates the digital signature and the public key verifies the digital signature. A signed message contains both the signed data and the digital signature. The originator of the message computes the digital signature by using his private key. The receiver of the message uses the public key to verify the signature. If the receiver verifies the signature then he knows that the sender of the message is really that person because no one else could have calculated the digital signature since only the sender knows the private key.

The third party used to verify the digital signature is the certification authority. The certificates used by the authority contain the identity and the public key of the certificate's owner and the digital signature on the data computed using the Certification Authority's private key. The certification authority is trusted to not alter or falsify certificates exchanged between users. Each user gives his public key to the certification authority which gives its public key to each user. The certification authority then signs and issues a certificate to each user using its private key.

c. *Neural Networks For Script Entry or Voice Entry*

Optical character recognition can make sense of text on the page with approximately 80% degree of accuracy, but near 100% accuracy can be expected with a neural network, according to the International Joint Neural Network Conference (1991). Hand-writing recognition lets you put annotations on documents and notes. OCR is best for printed text as long as the OCR system recognizes the dissimilar typefaces and vocabularies or two letters touching each other. Most U.S. companies cannot perform handwriting recognition except for hand printed block letters. However, Tazelaar (1991), states that a small Soviet company, ParaGraph, has a product called CalliGraph that dissects handwriting into component parts such as loops, curves, angles, and their sequence. The product is pen based using a graphics tablet. The components are compared to different letters made up of similar components and compared to a word list to find a valid word. As long as the word is on the list, CalliGraph will recognize the word.

In the USAA example cited earlier under document imaging, the use of a neural net to fully automate the task of sorting documents by type will result in documents and faxes being routed to their destinations even faster and more economically because another human can be taken out of the workflow. As the network trains the accuracy will improve until no human intervention will be needed. Using neural networks for business document forms would be most benefical because using a process called forms subtraction would eliminate the storage of billions of forms and just keep the data used with the form. According to Wright (1991), in the future, intelligent systems will be able to determine what is data and what is background on the form. Hand printed information or hard to recognize machine print will be separated from the background by the intelligent system. Fifth generation languages use natural language processing and sixth generation languages will use voice itself to execute commands and process data. Entry into forms databases by voice will greatly speed up forms entry. For example, an individual could call his bank and instead of waiting for the Voicemail selections and entering a number on the touchtone phone the individual may talk to the Voicemail just as if a human had been there processing data and keying it into a computer system.

E. EXAMPLE PROJECTS

During the course of the author's research, several projects involving CALS/CE and EC/EDI were competing for funding from DLA. This research will examine three of those projects which demonstrate the need for the proposed interchange architecture.

1. DLA X.400 On The IGP Platform

DLA System Automation Center Central Design Activity in Columbus, Ohio, is working closely with the Retix Corp. to develop a 1984 X.400 Implementation on the IGP platform. According to Asgher (1991), on

June 6, 1991, a successful test was conducted using a 386 PC running Interactive UNIX, AT&T 3B2/600G running AT&T UNIX, and a Gould X12 running a LINX EDI program. The test demonstrated that an EDI transaction can be sent from a DOD environment with TCP/IP to the IGP and translated to an X.400 protocol as a user agent, then sent to a message transfer agent 386 PC, then sent across an X.400 EDI VAN network to an ABC program which delivered the EDI message (Figure 4). The next phase in this project calls for eliminating or substituting for the 386 PC by running the LINX EDI program and the Message Handling System software on the 3B2 connecting it to the X.400 network. Asgher (1991) stated that X.400 will have a practical limit on the size of the file transmitted but that it will be very large and should handle most Government functions. White (1991) similarly stated that for the very large files exceeding 10 megabytes FTAM maybe better to use than X.400. Retix has based its Message Handling Software on Unix based platforms but will be porting it to DOS based platforms in the near future according to White (1991). The Gould minicomputers in DLA were procured in 1986 and are obsolete. The AT&T 3B2 minicomputers in the Air Force and DLA were procured in 1989 and are two generations of hardware behind industry. The focus of this project for the future should be portability to any hardware platform to support the OSI environment.

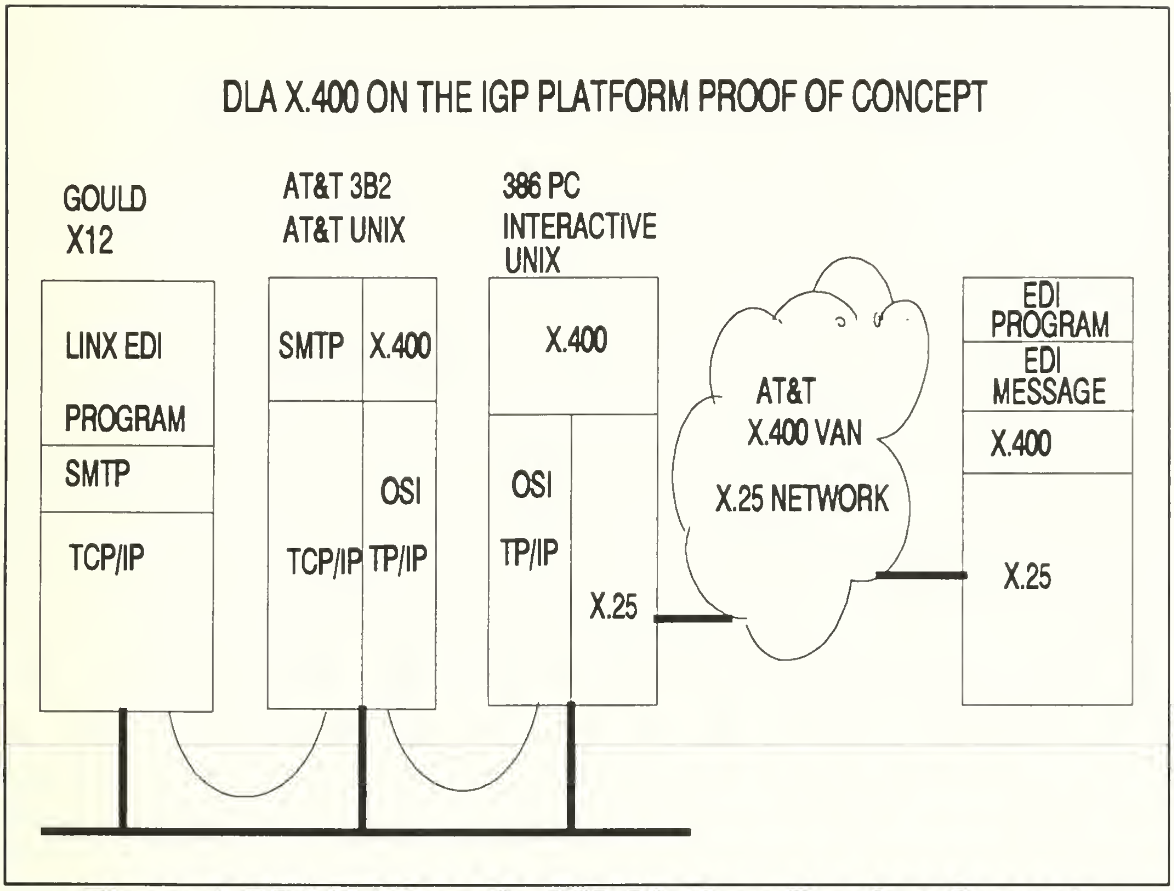

Figure 4. DLA X.400 on the IGP Platform Proof on Concept.

2. National Procurement Pilot Project

The second project this research discusses involved the U.S. Army Materiel Command Systems Integration and Management Activity in St. Louis, Missouri. The name of the project is National Procurement Pilot Project. According to Thrash (1991), the main thrusts are: integrate X12 850, 841, and 858 transaction sets at the Tank Command with several commercial trading partners; perform a single MODELS file transfer and generate system modules for in/out MODELS processing; OSI architecture implementation on multi-platforms; and overlay modular EDI as Procurement Early Development System is implemented. The software platform at DLA Central Design Activity, Columbus, Ohio will be a primary consideration because it has already been conceptually proven and is OSI based. The availability of the Lawrence Livermore National Laboratories IGP and its lengthy development schedule would essentially delay this project for an unacceptable period. The schedule given by DLA for the development of the Lawrence Livermore National Laboratories IGP shows that it will be three more years until it should be ready for fielding.

3. Highly Automated Office

The final project discussed contains most of the multimedia and hypermedia issues this research presented. The U.S. Army Corps of Engineers (USACE) proposes a project entitled "A Proposal to Enhance Electronic Commerce Through Creation of an Automated Office Environment." According to Tisel (1991) the project keys on an application called Knowledge Worker System (KWS) which will operate under Windows. KWS is an electronic performance system support groupware product that is based on expert systems, multimedia databases, and hypertext through dynamic data exchange. KWS has a unified interface that integrates the whole set of productivity tools used by knowledge workers. The entire workflow will be re-engineered and coordinated throughout the organization by automating access and retrieval of multimedia information through a distributed environment and EDI.

F. IMPLICATIONS

The long awaited paperless office may be attainable by the year 2000 in DOD if the proposed interchange architecture is adopted. If technological breakthroughs occur at the same rapid pace as in the 1980s, and standardization through open systems accelerates, the goal of completely changing the way we do business or the paperless office may finally become reality. New products called multimedia development kits or hyperwriters will become widely available. For example, Microsoft will use multimedia PCs and Windows with multimedia to provide a platform for developing multimedia applications and title developers. Several functions can occur such as recording voice and music, creating training manuals online, adding voice annotation features to a business application, and editing color bitmaps and palettes. The application programming interface allows the applications to perform even more functions such as waveform audio recording and playback, musical instrument digital interface music played on internal or external synthesizers, media control interface for controlling peripherals like videodisc and videotape players, animation playback, managing multimedia data, and high resolution timer services. The Viewer and Viewer Author's Toolkit let the developer prepare text, images, audio, hyperjump from text to graphics, search hypertext documents, and hyperjump from bitmap images to text.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Advances in interoperability and connectivity have changed our way of doing business by going from islands of automation to application-to-application processing. Physical connectivity and file transfers between computers are no longer enough to satisfy the needs of the ever growing number of users and organizations. This will provide a foundation upon which TQM of IS is implemented. TQM of IS dictates that technology must be applied to the workflow not the workflow to the technology. The OSI architecture and standards allow applications to interface seamlessly across homogenous networks. The use of the interchange architecture proposed by this research will allow multimedia and hypermedia applications to seamlessly interface across heterogeneous networks worldwide.

B. RECOMMENDATIONS

Adoption of the standard interchange architecture for multimedia and hypermedia data is the best strategy to follow to successfully implement EC/EDI and CALS/CE. Anything short of using OSI protocols from the start will be a waste of dollars and place DOD further behind industry. All on going projects should be examined for use of OSI protocols and, if they cannot use them within a short period, should be reconsidered. All projects should be re-engineered first before trying to apply technology to the solution. The DOD suite of protocols should no longer be supported and the transition to GOSIP should take place as soon as possible. Industry has made the switch to OSI and unless the Government follows quickly they will fall further behind. DOD cannot afford to wait for the IGP solution to add X.400 in 1994 to a specific platform. The best option currently is to use 1988 X.400 VANs which support EDI from various PC platforms. Continuing support for TCP/IP and SMTP/X.400 gateways will only prolong the use of a proprietary protocol and delay the transition to OSI. DCA should grant waivers to any organization needing EC/EDI and let them pay for a dedicated leased high speed access line to an X.400 VAN.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

1. Electronic Performance Support System

The next logical step beyond the interchange architecture for multimedia and hypermedia is to develop an information software system to use the capabilities provided by the architecture. The EPSS can harness high powered workstations, super mainframes, touchscreens, multimedia platforms, object oriented platforms, authoring systems, databases which stores data, various kinds of text, scanned photographs, etc. Hypertext, expert systems, and multimedia integration can provide users with immediate access to information, advice, guidance or assistance, training, and other tools using just the computer without any other human assistance. Smart systems that are problem solvers for users may provide the return on investment that executives have been yearning for and hoping that information systems would have provided long ago. EPSS demonstrates the TQM of information systems.

2. Object Oriented Programming

The hypermedia interchange architecture allows the user to function at the application level without being concerned with the lower level functions, standards, and telecommunications infrastructures. This architecture may provide the necessary infrastructures to facilitate true object oriented programming in application development.

The object oriented document approach uses object linking and embedding for documents allowing data type independence.

APPENDIX: X12 SUBCOMMITTEES

1. X12C Communications & Controls
2. X12D Education & Implementation
3. X12E Product Data
4. X12F Finance
5. X12G Government
6. X12H Materials Management
7. X12I Transportation
8. X12J Technical Assessment
9. X12K Purchasing
10. X12L Industry Standards Transition
11. X12M Distribution & Warehousing

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