



SFA Modernization Partner
US Department of Education

**Project EASI/ED Standards and Products
Not Considered or Selected**

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Project EASI/ED Standards and Products Not Considered or Selected

This document presents the architecture services, standards, and products from section 4 of the Project EASI/ED COE Document that were either not selected or considered during the identification of the Internet, Data Warehouse and Enterprise Application Integration architectures. It describes each service and its associated components; correlates the components to business functionality; specified standards and products to be used when each service component is considered.

The remainder of this document is organized into the major subsections identified below. Strategic findings for the service are discussed at the beginning of each major subsection. These findings provide an integrated summary of architecturally significant standards for that service's components and discuss such factors as how the standards align with current industry and technology trends, how the standards in different services inter-relate to support an integrated architectural framework, and how the standards fit with high-level architecture objectives.

- Subsection 4.1 - Data Interchange Services
- Subsection 4.2 - Data Management Services
- Subsection 4.3 - Document Management Services
- Subsection 4.4 - Distributed Computing Services
- Subsection 4.5 - Middleware Services
- Subsection 4.6 - Network Services
- Subsection 4.7 - Software Engineering Services
- Subsection 4.8 - User Interface Services
- Subsection 4.9 - Operating System Services
- Subsection 4.10 - Security Services
- Subsection 4.11 - System and Network Management Services
- Subsection 4.12 - Communication Services

Each service component is briefly defined and correlated to business requirements to illustrate how it might be used to implement desired functionality. Following each business requirement, a number in parentheses refers to the functional requirement number in the *BARD*. Each subsection also contains tables documenting the standards and products to be used when the service component is implemented.

- **Standards Table**. Each standards table presents the title(s) of applicable standard(s), the abbreviated name and sponsoring organization, a brief description of the standard's scope or purpose, and comments.

Products Table. Each products table identifies the name(s) of mandated product(s), the product vendor, the product functionality type (e.g., DBMS), and the standards that the product implements.

4.1 Data Interchange Services

Data interchange services provide specialized support for the exchange of information between application software on the same or different platforms. For Project EASI/ED, data interchange services include the following components.

- Electronic Data Interchange (EDI)
- Facsimile (Fax)
- Multimedia
- Graphics interchange
- Data compression
- Document interchange
- Character and symbols

Subsection 4.1.1 presents the strategic findings for data interchange services. Subsections 4.1.2 through 4.1.8 briefly describe each service component identified above. Subsection 4.1.9 concludes the data interchange services subsection with a discussion of component interrelationships and preferred standards.

4.1.1 Strategic Findings

Within EASI/ED, one of the fundamental purposes of data interchange is to support information transfer into and out of the system. In all other service areas, the *COE* strategy is to limit EASI/ED standards to a small, manageable number of selections with minimal overlap between functional areas covered by the selected standards. In the data interchange area, however, this strategy is relaxed to provide the ability to exchange a wide variety of information with a wide variety of external systems. By supporting many mainstream data format standards, this interchange will be possible with a wide variety of external systems and organizations without overburdening these systems or organizations with requirements to translate data to an EASI/ED format.

EDI, which is already in common use, is an important data interchange standard for EASI/ED. EDI will serve a key role in defining many transactions for exchange between EASI/ED and its trading partners.

The focus for selecting multimedia standards was compliance with commonly used Internet standards. Although Graphics Interchange Format (GIF) and Joint Photographic Experts Group (JPEG) are both used to describe graphical objects, both are common in industry use; therefore, it makes sense for EASI/ED to accommodate data in both formats.

Data interchange also includes document format standards. The dilemma with these is that there are no true vendor-independent standards for document formats. A large percentage of documents, particularly in the federal government, are either in Corel WordPerfect or in Microsoft Word formats. A reasonably open standard is specified for this area: Portable Document Format (PDF). Although Adobe Inc. owns PDF, it is a widely used, industry de facto standard that provides good, platform-independent exchange qualities.

Several Internet-derived standards for documents are also selected: Hypertext Markup Language (HTML), eXtensible Markup Language (XML), and Standard Generalized Markup Language (SGML). HTML is a very widely used Web document presentation standard, but does not include page formatting features. XML extends HTML to provide page formatting, but is a fairly new standard with much less industry support. SGML is a robust publishing standard that may be a little too complex for day-to-day document production and exchange.

4.1.2 Electronic Data Interchange

Description. EDI services support the computer-to-computer exchange of business information in a standardized format. Standards governing EDI specify formats -- comprising transaction sets, data segments, and data elements -- for transmitting data between trading partners. There are a number of advantages to EDI, including those listed below.

- Eliminates processing delays and data entry by replacing manual data entry with electronic data entry.
- Reduces errors and improve error detection by replacing manual data entry with machine-to-machine exchange of data.
- Achieves savings by reducing paperwork, supporting one-time data entry, automating reconciliation, reducing clerical workload, and increasing productivity without adding staff.
- Increases speed and timeliness of management reporting.
- Supports uniform communications between trading partners, assuring transaction completion and providing additional security while data is being exchanged.

Correlation to EASI/ED. Within Project EASI/ED, EDI services might be used to support the following example business requirements.

- Accommodate standard formats for origination, disbursement, adjustment, and cancellation records for all Title IV student financial assistance programs. (1240)
- Provide student disbursement rosters to schools. The disbursement rosters shall list the students for whom the disbursement being made to the school was intended, and the award amount that each student is expected to receive. (1600)
- Receive loan holder interest and special allowance invoices from loan holders. (1610)
- Receive disbursement records, origination records, adjustments, and cancellations from schools and from fund sources. (1224)

Applicable Standard. Table 4-1 presents the standard that is to be followed when implementing EDI services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Electronic Data Interchange (EDI)	NIST FIPS Pub 161-2:1996 (ANSI X.12)	This publication announces the adoption, as a Federal Information Processing Standard, of recognized national and international standards for EDI. In EDI, data that would be traditionally conveyed on paper documents are transmitted or communicated electronically according to established rules and formats.	Architecturally Significant

Table 4-1. EDI Standard

In addition to the overall standard governing EASI/ED implementation of EASI/ED, a number of American National Standards Institute (ANSI) X.12 transaction sets have been identified as being relevant to the student financial aid business. These transaction sets are listed in Table 4-2 below.

Transaction Set ID	Standard Title
130	Student Education Record (Transcript)
135	Student Loan Application
139	Student Loan Guarantee Result
144	Student Loan Transfer and Status Verification
189	Application for Admissions to Educational Institutions
190	Student Enrollment Verification
191	Student Loan Pre-Claims and Claims
194	Grant or Assistance Application
198	Loan Verification Information
200	Mortgage Credit Report
205	Mortgage Note
501	Vendor Performance Review
810	Invoice
820	Payment Order/Remittance Advice
821	Financial Information Reporting
828	Debit Authorization
838	Trading Partner Profile

Table 4-2. EDI Transaction Sets Relevant to Student Financial Aid

Representative Products. Table 4-3 lists representative products that support EDI services.

Product Name	Vendor	Product Type	Applicable Standards
CONNECT: Express	Sterling Commerce, Inc.	Electronic Data Interchange	ANSI X.12
GE Internet Gateway Solution	General Electric Information Services	Electronic Data Interchange	ANSI X.12
Templar	Premenos Technology Corporation	Electronic Data Interchange	ANSI X.12
EDI/Open	Premenos Technology Corporation	Electronic Data Interchange	ANSI X.12

Table 4-3. Representative EDI Products

4.1.3 Facsimile

Description. Fax services allow users to transmit and receive document facsimiles via traditional telephone lines, electronic mail (e-mail), or the Internet.

Correlation to EASI/ED. Within Project EASI/ED, fax services might be used to support the following example business requirements.

- Provide information contained in the ED Student Aid Handbook and in the Student Guide, and information about school participation in the Title IV programs. (1050)
- Provide information to aid organizations about individuals looking for financial assistance opportunities, when authorized by the individual. (1070)

Applicable Standards. Table 4-4 presents the standards that are to be followed when implementing fax services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Standardization of Group 3 facsimile terminals for document transmission	ITU T.4:1996	This specification provides transmission protocols for facsimile machines that use Group 3 compression.	Architecturally Significant

Standard Title	Organization and Standard Name	Description	Comments
Facsimile coding schemes and coding control functions for Group 4 facsimile apparatus	ITU T.6:1988	This specification provides transmission protocols for facsimile machines that use Group 4 compression.	Architecturally Significant
Procedures for Document Facsimile Transmission	ANSI/TIA/EIA 466-A:1966	It provides procedures that facsimile machines follow to ensure proper transmission and reception of data.	

Table 4-4. Facsimile Standards

Representative Products. Table 4-5 lists representative products that support facsimile services.

Product Name	Vendor	Product Type	Applicable Standards
WinFax PRO 5.0	Symantec Corporation	Facsimile	ITU T.4 ITU T.6
Fax Broadcast	Xpedite Systems, Inc.	Facsimile	ITU T.4 ITU T.6
Fax-On-Demand	Castelle	Facsimile	ITU T.4 ITU T.6

Table 4-5. Representative Facsimile Products

4.1.4 Multimedia

Description. Within computer systems, multimedia is the presentation of information on a computer using sound, graphics, animation, and text in conjunction with one another, and using various I/O devices. Interactivity -- synchronous electronic manipulation, integration, and reconstruction of two or more media types (e.g., audio, video, text, data) -- is the key distinguishing characteristic of multimedia. Through interactivity, the user is able to make decisions or selections that alter the type and sequence of information or communication presented. Multimedia services include the elements listed below.

- **Electronic publishing** - is the capability to incorporate photographic quality images, color graphics, and advanced formatting and style features into printed documents. Examples of these advanced formatting features include kerning (changing the spacing between text characters) and wrapping text around graphic objects or pictures.
- **Video processing** - is the capability to capture, compose, and edit video information.

- **Audio processing** - is the capability to capture, compose, and edit audio information.
- **Multimedia processing** - is the capability to compress, store, retrieve, modify, sort, search, and print two or more audio, video, and text media simultaneously. Multimedia processing also encompasses hypermedia processing, which provides the capability to create and browse documents for users to interactively navigate using information embedded in the document.

Correlation to EASI/ED. Within Project EASI/ED, multimedia services might be used to support the following example business requirements.

- Maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties. (1052)
- Provide statistical sampling and modeling capabilities to support Title IV program oversight functions. (2930)

Applicable Standards. Table 4-6 presents the standards that are to be followed when implementing multimedia services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Synchronized Multimedia Integration Language (SMIL) 1.0	W3C SMIL:1998	A new markup language is developed by the World Wide Web Consortium (W3C) that would enable Web developers to divide multimedia content into separate files and streams (audio, video, text, and images), send them to a user's computer individually, and then have them displayed together, as if they were a single multimedia stream.	Emerging
Digital Video Interactive (DVI)	Intel DVI	Based on the regioning coding technique, each picture is divided into regions which in turn is split into sub-regions and so on, until the regions can be mapped on to basic shapes to fit the required bandwidth and quality. The chosen shapes can be reproduced well at the decoder.	Emerging
Standard for compressed video and audio - Moving Pictures Experts Group (MPEG)	ISO/IEC 11172:1992	This moving image format is used on the Web. Provides a compressed moving image file that may be used in interchange.	Architecturally Significant

Standard Title	Organization and Standard Name	Description	Comments
File structure for multimedia resources - Resource Interchange File Format (RIFF) Waveform Audio Format	Microsoft RIFF:1993	Family of file structures rather than a single format. RIFF file architecture is suitable for playing back multimedia data, recording multimedia data, exchanging multimedia data between applications and across platforms.	
Audio File Information Format (au)	The Open Group au:1992	File format for audio data with a 24-byte header, a variable-length annotation block, and a contiguous segment of audio data.	
WAV	Microsoft WAV	Support for WAV files is built into leading operating systems. WAV sound files can be played by nearly all applications that support sound.	De Facto
Virtual Reality Modeling Language (VRML) 2.0	ISO/IEC 14772	VRML is a specification for displaying 3-D objects on the Web. It produces a 3-D space that appears on the display screen.	Emerging
RealAudio	COMSOL RealAudio	RealAudio allows for compressed audio files to be transmitted efficiently.	
RealVideo	COMSOL RealVideo	RealVideo allows for compressed video files to be transmitted efficiently.	
QuickTime 3	Apple QuickTime	It provides advanced video, music, and voice compression technologies. It is widely used on the Internet.	
Audio Video Interleave	Microsoft AVI	The format is interleaved such that video and audio data are stored consecutively in a file.	
Generic Coding of Moving Pictures and Associated Audio Information (MPEG2)	ISO/IEC 13818:1996	MPEG2 is designed for encoding, compression, and storage of studio-quality motion video and multiple CD-quality channels at bit rates of 4 to 6 Mbits/s.	
Multimedia Teleconferencing Standards	ITU H.320 and H.323:1990	H.323 is a logical and necessary extension of the H.320 standard to include Corporate Intranets and packet-switched networks generally. Because it is based on the RealTime Protocol (RTP/RTCP) from the IETF. H.323 can also be applied to video over the Internet.	
Musical Instrument Digital Interface (MIDI)	IAB MIDI:1988	MIDI files contain one or more MIDI streams, with time information for each event. This format supports multiple tracks and multiple sequences so that if the user of a program which supports multiple tracks intends to move a file to another one, this format can allow that to happen.	

Table 4-6. Multimedia Standards

Representative Products. Table 4-7 lists representative products that support multimedia services.

Product Name	Vendor	Product Type	Applicable Standards
Publisher 98	Microsoft Corporation	Document Publishing	W3C PR-xml-971208
Pro Audio 7	Cakewalk	Audio Software	IAB MIDI
AudioStation 2	Voyetra Technologies	Audio	IAB MIDI, Microsoft WAV
Desktop Video Conferencing	IBM Corporation	Video Conferencing	ITU H.323
Internet Phone Release 4 with video	VocalTec Communications	Telephony and Video Conferencing	ITU H.323

Table 4-7. Representative Multimedia Products

4.1.5 Graphics Interchange

Description. Graphics interchange services provide schemes to store picture elements and to ensure their availability for later viewing and/or manipulation. Several standard formats exist, each of which use unique, though often related, techniques for storing image data. Graphics interchange services are supported by device-independent descriptions of picture elements for vector-based graphics and by descriptions for raster-based graphics.

Correlation to EASI/ED. Within Project EASI/ED, graphics interchange services might be used to support the following example business requirements.

- Allow participants to request a lender from a list of available lenders. (1710)
- Publish results on the feedback received from schools, other organizations, and participants. (1190)

Applicable Standards. Table 4-8 presents the standards that are to be followed when implementing graphics interchange services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments

Standard Title	Organization and Standard Name	Description	Comments
Tagged Image File Format (TIFF) Revision 6.0	TIFF	TIFF helps link scanned images with the popular desktop publishing applications. TIFF provides a way to store and exchange digital image data. Provides a compressed image file that may be used in interchange.	Architecturally Significant, De Facto
Interfacing techniques for dialogues with graphical devices (CGI)	ISO/IEC 9636:1991	It establishes the conceptual model, functional capability, and minimum conformance requirements of the Computer Graphics Interface (CGI). It specifies design requirements for encoding of the CGI.	
Computer Graphics Metafile (CGM)	ISO/IEC 8632	CGM is a graphical data interchange format that facilitates the transfer of picture description information between different graphical software systems, different graphical devices, and different computer graphics installations.	
Joint Photographic Experts Group (JPEG)	ISO/IEC 10918:1994	Digital compression and coding of continuous-tone still images. A multi-part International Standard that collectively defines the JPEG standard.	Architecturally Significant
Protocol for interchange of raster graphic data - Graphics Interface Format (GIF)	CompuServe GIF v.89a:1989	This standard defines a protocol intended for the on-line transmission and interchange of raster graphic data in a way that is independent of the hardware used in their creation or display. The major advantage of GIF is that it compresses the image (photograph, drawing, etc.), thus making it transmit faster across phone lines.	Architecturally Significant, De Facto
Image Processing and Interchange (IPI) - and Programmer's Imaging Kernel System (PIKS)	ISO/IEC 12087:1994	The main component is the definition of a data format for exchanging arbitrarily structured image data. It defines a format that can be used across application boundaries and that can easily be integrated into international communication services.	
Initial Graphics Exchange Specification (IGES)	NIST FIPS Pub 177-1:1996	The standard specifies file structure and syntactical definition, and defines the representation of geometric, topological, and non-geometric product definition data.	
Programmer's Hierarchical Interactive Graphics System (PHIGS)	ANSI/ISO 9592:1989	It specifies the control and data interchange between an application program and its graphic support system. It provides a set of functions and programming language bindings for the definition, display and modification of two-dimensional and three-dimensional graphic data.	

Table 4-8. Graphics Interchange Standards

Representative Products. Table 4-9 lists representative products that support graphics interchange services.

Product Name	Vendor	Product Type	Applicable Standards
PEX and PHIGS for AIX 4.2.1	IBM Corporation	Graphics	ANSI/ISO 9592
Adobe Photoshop 5.0	Adobe Systems, Inc.	Graphics	ISO/IEC 10918, CompuServ GIF v.89a
PowerPoint 97	Microsoft Corporation	Graphics	CompuServ GIF v.89a Aldus TIFF
CorelDRAW 8	Corel Corporation	Graphics	CompuServ GIF v.89a, Aldus TIFF

Table 4-9. Representative Graphics Interchange Products

4.1.6 Data Compression

Description. Data compression services specify algorithms for compressing data for storage and exchange over a network. These services can reduce communications loads by as much as 80 percent without affecting the form of transmitted data. Data compression is used to reduce the amount of data used to store and to transmit audio, video, still images, and/or text. This reduction is accomplished by discarding redundant data bits, while retaining sufficient bits to be able to recover the data in a form that is exactly the same as, or close to, the original. Text, image, and audio and video compression services are described more below.

- **Text and data compression** - support compression of data, including text files, data files, and executable programs. For these applications, compression must be "loss-less" so that the expanded output exactly matches the original input.
- **Still image compression** - provides the capability to reduce storage needed for raster graphics files. Compression of still images may be either "loss-less" or "lossy," where some data is discarded, but the expanded output is not noticeably different from the original input. The choice of exact or approximate data compression techniques depends upon the image type and business needs for use of the reversed image.
- **Audio and video compression** - provides the capability to reduce the size of sound and motion picture data files. As with still images, audio and video compression may be either exact or approximate. Development of standards and products for audio and video compression has accelerated in recent years due to the enormous advancements in multimedia applications and in computing power.

Correlation to EASI/ED. Within EASI/ED, data compression services might be used to support the following example business requirements.

- Provide information contained in the ED Student Aid Handbook and the Student Guide, and information about school participation in the Title IV programs. (1050)

- Send all Perkins Loan schools a copy of the low-income-school directory annually. (1258)

Applicable Standards. Table 4-10 presents the standards that are to be followed when implementing data compression services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Data Compression for Information Interchange - Binary Arithmetic Coding Algorithm	ISO/IEC 12042:1993	It is an algorithm for binary information, coded representation, data compression, and data-processing information interchange.	
PKZIP 2.60	PKWARE's PKZIP	Enables users to save disk space and valuable time when transferring files over a modem or network by compressing and decompressing any format file.	De Facto
Joint Photographic Experts Group (JPEG)	ISO/IEC 10918:1994	Digital compression and coding of continuous-tone still images. A multi-part International Standard that collectively defines the JPEG standard.	Architecturally Significant
RealAudio	COMSOL RealAudio	RealAudio allows for compressed audio files to be transmitted efficiently.	
RealVideo	COMSOL RealVideo	RealVideo allows for compressed video files to be transmitted efficiently.	
Audio Video Interleave (AVI)	Microsoft AVI	The format is interleaved such that video and audio data are stored consecutively in a file.	
QuickTime 3	Apple QuickTime	It provides advanced video, music, and voice compression technologies. It is widely used on the Internet.	
Protocol for interchange of raster graphic data - Graphics Interface Format (GIF)	CompuServe GIF v.89a:1989	The Graphics Interchange Format defines a protocol intended for the on-line transmission and interchange of raster graphic data in a way that is independent of the hardware used in their creation or display. The major advantage of GIF is that it compresses the image (photograph, drawing, etc.), thus making it transmit faster across phone lines.	Architecturally Significant, De Facto
Standard for compressed video and audio - Moving Pictures Experts Group (MPEG)	ISO/IEC 11172:1992	MPEG defines a bit-stream representation for synchronized digital video and audio, compressed to fit into a bandwidth of 1.5 Mbit/sec. This corresponds to the data retrieval speed from CD ROM and DAT, and a major application of MPEG is the storage of audio visual information on this media. MPEG is also gaining ground on the Internet as an interchange standard for video clips.	Architecturally Significant

Standard Title	Organization and Standard Name	Description	Comments
GZIP File Format Specification version 4.3	IETF RFC 1952	This specification defines a lossless compressed data format that is compatible with the widely used gzip utility. The format includes a cyclic redundancy check value for detecting data corruption.	

Table 4-10. Data Compression Standards

Representative Products. Table 4-11 lists representative products that support data compression services.

Product Name	Vendor	Product Type	Applicable Standards
WinZip 6.3	Nico Mak Computing, Inc.	Data Compression	PKZIP 2.60
gzip	Free Software Foundation	Data Compression	IETF RFC 1952
PKZIP 2.60	PKWARE, Inc.	Data Compression	PKZIP 2.60

Table 4-11. Representative Data Compression Products

4.1.7 Document Interchange

Description. Document interchange services support the exchange of formatted messages and of electronic forms between homogenous and heterogeneous computer systems. They are also used for publishing and managing mixed mode documents. Through document interchange services, formatted documents can be transferred across a network and be exactly reproduced at any location.

Correlation to EASI/ED. Within Project EASI/ED, document interchange services might be used to support the following example business requirements.

- Provide information contained in the ED Student Aid Handbook and in the Student Guide, and information about school participation in the Title IV programs. (1050)
- Send all Perkins Loan schools a copy of the low-income-school directory annually. (1258)

Applicable Standards. Given the wide variety of users the EASI/ED must support, a number of industry-standard document interchange formats should be supported by the EASI/ED system. However, the preferred standard is the open standard Portable Document Format (PDF).

Table 4-12 presents the standards that are to be followed when implementing document interchange services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Portable Document Format (PDF)	Adobe PDF	PDF provides for the final form of information delivered electronically in a standardized platform-independent format. PDF is a final form format specification and cannot be directly edited, unlike revisable form documents in word processor applications.	Architecturally Significant
Post Script (PS)	Adobe PS:1985	PS is device independent. A Post Script image (text and/or photo and/or drawing) can be created and printed on a relatively cheap, low quality printer, like a laser printer or a magazine-quality printer like a Linotronics.	

Table 4-12. Document Interchange Standards

Representative Products. Table 4-13 lists representative products that support document interchange services.

Product Name	Vendor	Product Type	Applicable Standards
FrameMaker+SGML 5.5	Adobe Systems, Inc.	Document Publishing	ISO 8879
Adobe Acrobat 3.0	Adobe Systems, Inc.	Document Publishing	Adobe PDF, Adobe PS
Front Page	Microsoft Corporation	Document/Web Publishing	HTML 3.2

Table 4-13. Representative Document Interchange Products

4.1.8 Character and Symbols

Description. Character and symbols services provide for interchange of character sets and fonts and for standardized date and time representation within a system. These services include the capabilities to input, store, manipulate, retrieve, communicate, and present data independent of the coding scheme (e.g., Unicode) used. Character and symbols services also provide the capability to maintain and to access a central character-set repository of all coded character sets used throughout the application platform.

Correlation to EASI/ED. Within Project EASI/ED, character and symbols services might be used to support the following example business requirements.

- Allow participants to query their aid status. (2240)
- Allow the participant to request consolidation information. (2290)

Applicable Standards. Table 4-14 presents the standards that are to be followed when implementing character and symbols services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Font information interchange - Part 1: Architecture	ISO/IEC 9541	This is a procedure for registration of glyph and glyph collection identifiers. A glyph is one of the characters or symbols available within a font. Usually used in reference to outline fonts, in particular TrueType.	
Representation of Dates and Times	ISO 8601:1988	It specifies the representation of calendar dates, data representation, documentation, and hours (time), for information interchange.	
The Unicode Standard, Version 2.0	Unicode:1998	The rapid growth of the Internet is pushing the demand for software to be simultaneously internationalized and localized. Encompassing the principal scripts of the world, the Unicode Standard provides The foundation for the internationalization and localization of software.	Architecturally Significant
Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane	ISO/IEC 10646-1:1993	Its design is based on the simplicity and consistency of ASCII, but goes far beyond ASCII's limited ability to encode only the Latin alphabet. The Unicode Standard provides the capacity to encode all of the characters used for the major written languages of the world.	Architecturally Significant

Table 4-14. Character and Symbols Standards

Representative Products. Table 4-15 lists representative products that support character and symbols services.

Product Name	Vendor	Product Type	Applicable Standards
Adobe Font Folio	Adobe Systems Inc.	Fonts	ISO/IEC 9541
WordPerfect Language Module	Corel Corporation	Fonts	ISO/IEC 10646-1

Table 4-15. Representative Character and Symbols Products

4.1.9 Inter-relationships and Preferred Standards

The seven data interchange service components (i.e., EDI, facsimile, document interchange, character and symbol, graphics interchange, data compression, and multimedia) are independent of one another. There are no standards dependencies among these components. However, within several of the service components there are multiple, and in some cases overlapping or competing, standards. Competing and overlapping standards are included in the *EASI/ED COE* in situations where there is no clear, dominant choice and/or it is desirable to support more than one standard. In most of these cases, there is a preferred standard. When all other factors are equal, EASI/ED application system implementers should adopt the preferred standard or demonstrate why an alternative must be used. The following paragraphs address the service components where overlap exists.

- **Facsimile**. The *EASI/ED COE* recommends both Group 3 and Group 4 facsimile compression standards. Both standards are in common use and are widely supported by facsimile hardware and software products. There is no single preferred standard for this service component.
- **Document Interchange**. Many of the document interchange standards selected are competing. Each has advantages and disadvantages. HTML is the most commonly accepted standard, but lacks page formatting capabilities. The PDF standard is currently the preferred *COE* standard for document interchange. It provides complete page formatting and is widely supported. However, this standard is owned by Adobe. When XML gains more industry acceptance, ED should consider replacing PDF with XML as the preferred standard. EASI/ED is expected to receive documents in any of the standards specified for this service component and should have the capability to read or import all of them.
- **Graphics Interchange**. The *COE* includes many graphics standards with significant overlap among them. There is no compelling reason to adopt any one of these standards as a preferred standard. Selection among the standards should be based upon implementation-specific requirements of EASI/ED applications.
- **Data Compression**. Data compression standards tend to be data-type specific. For example, there are different standards specified for voice data and for text data. Some overlap does exist among binary data compression standards in the *COE*, but PKZIP is the preferred standard because of its widespread use throughout the industry.
- **Multimedia Standards**. Similar to the data compression component, most of the *COE* multimedia standards are specific to a data type. Where there is overlap, the preferred standard is the one that is open, non-proprietary, and dominant among Internet standards. With this in mind, MPEG is preferred over RealVideo and AVI.

4.2 Data Management Services

Data management services provide access to data, store data, monitor data storage, and control data I/O operations. Through the use of features such as data locking and replication these services also ensure that data is consistent and available throughout distributed system environments. Within Project EASI/ED, data management services are central to one of the core objectives for the vision -- to allow users ready, flexible, understandable access to data (within security constraints). For Project EASI/ED, data management services include the following components.

- Database Management System (DBMS)
- Data dictionary
- Data warehousing

Subsection 4.2.1 presents strategic findings for data management services. Subsections 4.2.2 and through 4.2.4 briefly describe each service component identified above. Subsection 4.2.5 concludes the data management services subsection with a discussion of component interrelationships and preferred standards.

4.2.1 Strategic Findings

Historically, data management service standards were driven by two camps of DBMS product vendors: (1) mainframe software vendors such as IBM (DB2), Computer Associates (IDMS), Software AG (Datacomm/DB), and (2) the three major relational DBMS vendors – Oracle, Sybase, and Informix. There is little standardization and interoperability between vendor product lines, with the exception of the Structured Query Language (SQL) standard and some cross-product support by Sybase. Recently, industry trends and developments have begun to change this situation. One example of this is the entry of Microsoft's SQLServer product line and their promotion of the Open Database Connectivity (ODBC) standard. A second example is the emergence of data warehousing technology, which offers the capability to extract information from multiple DBMS sources.

The DBMS market in recent years has also witnessed the emergence of Object Oriented Database Management Systems (OODBMS) (e.g., Jasmine by Computer Associates, ObjectStore by Object Design). OODBMSs take the concepts of object oriented programming and apply them to a database management system. Currently, OODBMSs are lacking a widely accepted set of standards and are relegated to niche status in the DBMS market. Moreover, traditional relational DBMS vendors have adopted useful ideas for the world of object orientation and are marketing object/relational DBMSs as a best of both worlds solution (e.g. Oracle 8 by Oracle).

For EASI/ED, current mainstream data management standards are specified; however, the majority of technology and standards adopted within this service will be driven by selection of specific DBMS products during the system's implementation.

4.2.2 Database Management System

Description. A DBMS provides controlled access to structured data to meet the primary goal of providing an environment that facilitates convenient, efficient information usage. Through a DBMS, a user has an abstract view of actual data. This view hides the complexities of data storage, retrieval, modification, etc., from the user. Basic DBMS services are summarized below.

- **Data storage** - includes storing, updating, and retrieving large volumes of data, while maintaining data integrity and managing security and controlled access to the data.
- **Data definition** - includes creating, altering, and deleting tables, views, record, fields, classes, objects, instances, attributes, and data.
- **Data manipulation** - encompasses inserting, selecting, updating, and deleting data records stored in tables, views, objects, and instances.
- **Data query** - provides the ability to specify search conditions comprising a combination of select lists, predicates (e.g., expressions that are either true, false or undetermined), and comparison operators.
- **Data integrity** - provides data locking (to varying degrees of granularity), data consistency, transaction control to specify commit and rollback commands and to guarantee the ability to serialize database transactions, referential constraints to help ensure data consistency, and synchronous writing of data.
- **Data distribution** - allows for distribution of a database. It includes facilities for remotely updating records, locating and caching data, and performing remote data management. Distributed database services allow partitioning (logical and physical), and may also support partial replication of a database so that a partitioned database distributed to different physical sites still behaves as a single, coherent database. In a distributed database, when redundant data are stored in separate physical databases to meet performance requirements, updates to one set of data will update the additional sets automatically in a timely and controlled manner.

DBMS services are accessed via a programming language interface (e.g., Pro-C), an interactive data manipulation language interface (e.g., Structured Query Language [SQL]), or an interactive fourth-generation language (4GL) interface (e.g., Oracle Designer/2000, Informix 4GL).

Correlation to EASI/ED. Within EASI/ED, DBMS services might be used to support the following example business requirements.

- Maintain school disbursement ledgers to show a complete record of all disbursements to, and collections from, a school. (1300)
- Maintain an audit trail of all student aid origination and payment records by aid program by student. (1350)
- Maintain the association between the multi-year promissory notes belonging to a participant and each occurrence of financial aid that participants receive. (1717)

- Allow auditors and program reviewers, as well as those with the need for self audit, such as lenders and schools, the necessary access to transaction histories by school, student, and program, in order to perform audits and reviews. (1150)

Applicable Standards. Table 4-16 presents the standards that are to be followed when implementing DBMS services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Open Database Connectivity (ODBC) v3.0	Microsoft ODBC	Microsoft's interface between applications and databases. Provides connectivity to call for data consistently regardless of the database which is accessed.	Architecturally Significant
Database Language - SQL2	ANSI X3.135:1992	Defines the syntactic and semantic rules for database definition and data manipulation in a relational database management system. One of the database management system standards provided for use by all Federal departments and agencies, in accordance with FIPS Pub 127. FIPS SQL is suited for use by applications that employ the relational data model. SQL3 is an emerging standard that should be considered when mature.	Architecturally Significant

Table 4-16. DBMS Standards

Representative Products. Table 4-17 lists representative products that support DBMS services.

Product Name	Vendor	Product Type	Applicable Standards
INFORMIX-SE	Informix Software, Inc.	Database Management System	ANSI X3.135
SQL Server 6.5	Microsoft Corporation	Database Management System	Microsoft ODBC , ANSI X3.135
Oracle 8	Oracle Corporation	Database Management System	ANSI X3.135
Adaptive Server 11.5	Sybase, Inc.	Database Management System	ANSI X3.135

Table 4-17. Representative DBMS Products

4.2.3 Data Dictionary

Description. Data dictionary services provide extensive facilities for recording, storing, and processing descriptions of an organization's significant data and data processing resources. Data

dictionary services also often provide facilities to use metadata (i.e., information about data). These comprise utilities and systems needed to catalog, document, manage, and use the metadata. Beyond this, data dictionary services allow users and application software to define and obtain data available in a database.

Correlation to EASI/ED. Within EASI/ED, data dictionary services might be used to support the following example business functions.

- Maintain school disbursement ledgers to show a complete record of all disbursements to, and collections from, a school. (1300)
- Maintain an audit trail of all student aid origination and payment records by aid program by student. (1350)

Applicable Standards. Table 4-18 presents the standards that are to be followed when implementing data dictionary services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Information technology -- Information Resource Dictionary System (IRDS) framework	ISO/IEC 10027:1990	A standard for data processing, information interchange, information network, information resources, and organization of data.	
Open Information Model (OIM)	Microsoft OIM	OIM is a set of published Common Object Model (COM) interfaces, and a metadata repository built on top of SQL Server. Any third-party tool that writes to the OIM and COM interfaces will be able to input metadata into the repository or export from it.	De Facto
Metadata Exchange (MX) Architecture	Informatica MX	MX lets vendors create links between their data access and query and reporting tools. MX also offers access to metadata via a visual Web browser.	De Facto

Table 4-18. Data Dictionary Standards

Representative Products. Table 4-19 lists representative products that support data dictionary services.

Product Name	Vendor	Product Type	Applicable Standards
PLATINUM Repository	PLATINUM technology,	Metadata Repository	Microsoft OIM

	Inc.		
POWERCENTER 1.0	Informatica	Metadata Repository	MX Architecture
Warehouse Directory	Prism	Metadata Repository	Microsoft OIM

Table 4-19. Representative Data Dictionary Products

4.2.4 Data Warehousing

Description. Data warehouses are special-purpose DBMSs in which extracts of operational data are specially pre-processed (i.e., indexed, partitioned, and aggregated) to provide a unified repository of known facts. Information in data warehouses is subject-oriented, integrated, time-variant, and non-volatile. It is an effective way to transform data into information, providing critical repositories of timely, accurate information for decision making and management. Several technology components are required for data warehousing. These are categorized as warehouse generation (getting data in), data management (storing data), and information access (getting data out).

Correlation to EASI/ED. Within EASI/ED, data warehousing services might be used to support the following example business requirements.

- Provide authorized parties visibility to Title IV participant information at varying levels of detail, and associate Title IV participant information across functional areas (e.g., application, disbursement, repayment). (2900)
- Provide statistical sampling and modeling capabilities to support Title IV program oversight functions. (2930)
- Monitor key performance indicators and flag those indicators whose values are outside predetermined parameters. (2950)
- Maintain performance measurements for each aid organization, school, and the EASI/ED system itself. Provide relevant information on these performance measurements to authorized external organizations and individuals. (2952)
- Provide what-if analysis capability to support formulation of program legislation and policy. (2960)
- Receive financial aid simulation modeling information (e.g., average salaries for various professions) from state departments of labor. (1960)

Applicable Standards. Various groups within the data warehousing vendor and user community advocate a broad range of emerging standards; however, no widely accepted data warehousing standard exists yet. The Metadata Coalition, a group of more than 50 data warehousing vendors and users, is a leader in metadata standards development. Relational database vendors are also trying to establish de facto standards for metadata. Microsoft is positioning its Repository product as a focal point for its data warehousing initiative.

Table 4-20 presents the standards that are to be followed when implementing data warehousing services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Metadata Interchange Specification	MDIS 1.0:1996	To comply with MDIS 1.0 a tool's metadata import and export mechanisms must conform to a standardized read and write procedures that uses this standard naming syntax and carries along the proprietary metadata as required.	
Open Information Model (OIM)	Microsoft OIM	OIM is a set of published Common Object Model (COM) interfaces, and a metadata repository built on top of SQL Server. Any third-party tool that writes to the OIM and COM interfaces will be able to input metadata into the repository or export from it.	De Facto

Table 4-20. Data Warehousing Standards

Representative Products. Table 4-21 lists representative products that support data warehousing services.

Product Name	Vendor	Product Type	Applicable Standards
Enterprise Miner	SAS Institute Inc.	Data Mining Tool	MDIS 1.0, Microsoft OIM
Oracle 8	Oracle Corporation	Database Management System	MDIS 1.0, Microsoft OIM
Red Brick Warehouse	Red Brick Systems, Inc.	Data Warehouse	ANSI X3.135
COGNOSuite	COGNOS Inc.	OLAP Tool	MDIS 1.0
Teradata	NCR Corporation	Data Warehouse	MDIS 1.0, Microsoft OIM
InfoBeacon and InfoRefiner	PLATINUM technology, Inc.	OLAP Tool	MDIS 1.0

Table 4-21. Representative Data Warehousing Products

4.2.5 Inter-relationships and Preferred Standards

There is considerable dependence among standards and products in the three data management service components (i.e., DBMS, data dictionary, data warehousing). The final selection of standards to be implemented in this service area will be driven by the DBMS product selected for EASI/ED. Compatibility with the selected DBMS product will drive the standards for data dictionary and data warehousing components.

4.3 Document Management Services

Document management services encompass technologies that enable organizations to disseminate information to internal resources, clients, and suppliers. Document management technologies, such as imaging and forms processing, allow organizations to input and retrieve paper-based documents electronically. For Project EASI/ED, document management services include the following components.

- Imaging
- Workflow

Subsection 4.3.1 presents strategic findings for document management services. Subsections 4.3.2 and 4.3.3 briefly describe these service components. Subsection 4.3.4 concludes the document management services subsection with a discussion of component interrelationships and preferred standards.

4.3.1 Strategic Findings

Document management services historically have been dominated by product vendors, such as FileNet and PC DOCS, that provide ways to more rigorously control and track information stored in file systems. These vendors focused on adding value to industry de facto standard file systems, such as those in Unix and in Microsoft Windows NT. More recently, these leading vendors formed industry consortia and are formulating standards to govern workflow and imaging system formats and operations. However, the document management industry is still in the early stages of standards finalization and widespread adoption.

For EASI/ED, leading standards promoted by these industry consortia standards bodies are specified. However, as with the data management services, document management standards will be very much influenced by product selection during EASI/ED implementation.

4.3.2 Imaging

Description. Paper documents can be captured as computer images by using high-speed, high-resolution image scanners. Imaging services provide facilities such as image processing and full-text Optical Character Recognition (OCR) to convert digitized images from faxed or scanned input into computer-related characters and forms processing.

Correlation to EASI/ED. Within EASI/ED, imaging services might be used to support the following example business requirement.

- Maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties. (1052)

Applicable Standards. Table 4-22 presents the standards that are to be followed when implementing imaging services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Recommended Practice for the Requirements and Characteristics of Original Documents Intended for Optical Scanning	ANSI/AIIM MS52:1991	This specification describes the physical characteristics of original documents which will facilitate scanning of the documents. It also identifies those characteristics that will make scanning difficult or impossible.	
Selecting an Appropriate Image Compression Method to Match User Requirements	AIIM TR33:1998	This specification addresses some of the applications of image compression methods and standards that are used for continuous tone (color and gray scale) images and for bi-level (line art and text) images.	
The Document Management Alliance (DMA)	AIIM DMA 1.0	The DMA 1.0 Specification creates the industry's first standard enabling document management systems from different vendors to interoperate.	
Compilation of Test Targets for Document Imaging Systems	AIIM TR38:1996	The most commonly used test charts and test patterns used in document imaging applications, such as electronic document imaging, facsimile, micrographics, or photocopying document imaging components.	

Table 4-22. Imaging Standards

Representative Products. Table 4-23 lists representative products that support imaging services.

Product Name	Vendor	Product Type	Applicable Standards
Image Management Services (IMS)	FileNET Corporation	Imaging	AIIM TR33, AIIM DMA 1.0, AIIM TR38
Imaging for Windows	Eastman Kodak Company	Imaging	AIIM TR33, AIIM DMA 1.0, AIIM TR38
FormWorks	Recognition Research, Inc.	Imaging	ANSI/AIIM MS52
DOCS Imaging	PC DOCS, Inc.	Imaging	AIIM TR33, AIIM DMA 1.0, AIIM TR38

Table 4-23. Representative Imaging Products

4.3.3 Workflow

Description. Workflow services automate business processes and manage information through a sequence of steps making up a work procedure. Workflow also tracks progress of imaged documents from entry into a system through various departments of an organization to a final destination. Using software that runs on one or more workflow engines, these services define, create, and manage execution of workflows. Workflow software is able to interpret process definition, interact with workflow participants, and, where required, invoke other information technology tools and applications within a system.

Correlation to EASI/ED. Within EASI/ED, workflow services might be used to support the following example business requirements.

- Receive and process change of ownership approvals. (3510)
- Allow participants to submit combined billing requests for Direct Loans and for those loans assigned to ED for debt collection. (2300)
- Receive requests from participants to refinance their loans. (2580)

Applicable Standards. Table 4-24 presents the standards that are to be followed when implementing workflow services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
The Document Management Alliance	AIIM DMA 1.0	The Document Management Alliance (DMA) 1.0 Specification creates the industry's first standard enabling document management systems from different vendors to interoperate.	
Audit Data Specification	AIIM WFMC-TC-1015	The purpose of WFMC-TC-1015 is to specify what information needs to be captured and recorded from the various events occurring during a workflow enactment.	
Workflow Standard - Interoperability	AIIM WFMC-TC-1012:1993	A Workflow Management Coalition Standard providing an abstract specification, which defines the functionality required to support interoperability between different workflow engines.	

Table 4-24. Workflow Standards

Representative Products. Table 4-25 lists representative products that support workflow services.

Product Name	Vendor	Product Type	Applicable Standards
Staffware 97	Staffware Corporation	Workflow Management	AIIM WFMC-TC-1015, AIIM WFMC-TC-1012
DOCS Open	PC DOCS, Inc.	Workflow Management	Adheres to all AIIM standards
FormFlow 2.0	JetForm Corporation	Workflow Management	AIIM DMA 1.0, AIIM WFMC-TC-1015, AIIM WFMC-TC-1012
Visual WorkFlo	FileNET Corporation	Workflow Management	AIIM DMA 1.0

Table 4-25. Representative Workflow Products

4.3.4 Inter-relationships and Preferred Standards

Document management services are a relatively new area from a standards perspective. This service area historically was dominated by proprietary standards in industry leading products, such as those from FileNET and PC DOCS. Recently, these vendors cooperated to develop standards through organizations such as the Workflow Management Coalition and Association for Information and Image Management (AIIM). Because of the newness of this area and because relatively few standards exist, there are few issues related to dependencies and overlap between standards.

4.4 Distributed Computing Services

Distributed computing services enable various tasks, operations, and/or information transfers to occur on multiple, physically or logically dispersed computer platforms while maintaining a cooperative processing environment. These services allow users and application developers to maximize network computing power by transparently assigning tasks to the most appropriate processors. For Project EASI/ED, distributed computing services include the following components.

- Distributed time
- Distributed file system
- Remote procedure call
- Directory services

Subsection 4.4.1 presents strategic findings for distributed computing services. Subsections 4.4.2 through 4.4.5 briefly describe the service components listed above. Subsection 4.4.6 concludes the distributed computing services subsection with a discussion of component interrelationships and preferred standards.

4.4.1 Strategic Findings

Until recently, three battling factions reigned in distributed system standards.

- Distributed Computing Environment (DCE) from The Open Group
- Common Object Resource Broker Architecture (CORBA) from the Object Management Group
- Distributed Component Object Model from Microsoft

Many factors, especially the dominance of the Internet, led DCE and CORBA to align and, in many ways, interoperate. DCE does not include any object standards. CORBA benefits from some of the mature distributed system management functions in DCE. Thus, CORBA and DCE have become more complementary, although competition between the two continues.

Subsection 4.4 focuses on distributed computing services only, i.e., DCE. The closely related distributed object standards (CORBA, DCOM) are addressed in subsection 4.5, Middleware Services.

In addition to DCE, this *COE* includes Internet-sourced standards helpful in building a geographically dispersed information system. Since distributed systems are comparatively new on the technology landscape, some emerging standards also show promise, but are too immature to include in current implementation plans. For example, Web NFS (Network File System) promises to provide a way to implement a single, coherent file system over a very large distributed environment such as the World Wide Web. However, Web NFS is still more of a research topic than it is a viable implementation tool.

Directory services are another key component of distributed computing. Directory services are strongly related to many other areas. For example, security depends upon a well-defined and well-maintained directory of users and resources. Unfortunately, several standards are competing

in the directory services market, and the interoperability problem is not completely solved. The three main competing standards are:

- Lightweight Directory Access Protocol (LDAP)
- X.500
- Distributed Computing Environment (DCE) Directory Service Standard

EASI/ED should encompass all three of these dominant industry standards, with a preference for LDAP if requirements for a specific EASI/ED application do not drive selection of an alternative. LDAP is simple, addresses a wide range of applications, and is well-supported by products.

4.4.2 Distributed Time

Description. With a distributed environment, keeping clocks on various system components synchronized presents a major challenge. Even if all clocks could be set to precisely the same time at some point, they would gradually drift apart in time at different rates from one another. As a result, each component would "believe" the time to be different, which causes problems when distributed programs have dependencies upon event ordering. For example, it would be difficult to determine whether Event A on System Component 1 occurred before Event B on System Component 2 because 1 and 2 may have different notions of the current time.

Distributed time services enable system resources to access a host that provides the "correct" time for all resources on a network. In addition, these services synchronize the host clocks, using either one machine or a "committee" of machines to provide the "correct" time for all other resources. These services are also essential to support time-dependent distributed processing activity, such as the maintenance of session keys for security purposes.

Correlation to EASI/ED. With EASI/ED, distributed time services may be used to support the following business functions.

- The system shall prompt the participant to authorize the disbursement of funds to a school for the participant's loan. The prompt shall occur when the participant has not authorized the disbursement to the school within 30 days of the effective date of the disbursement request made by the school. (1390)
- The system shall send the participant a disclosure statement 60 days prior to the end of the grace period. (2004)
- The system shall notify schools of participants' delinquency within 90 days of a missed loan repayment due date. (2550)

Applicable Standard. Table 4-26 presents the standard that is to be followed when implementing distributed time services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
DCE 1.1: Time Services Specification	The Open Group CAE Specification C310	CAE C310 specifies the Distributed Time Service (DTS) time representations, RPC interfaces to the DTS, and application programming interfaces to the DTS. It provides a portability guide for DTS application programs and a conformance specification for DTS implementations.	Architecturally Significant

Table 4-26. Distributed Time Standard

Representative Products. Table 4-27 lists representative products that support distributed time services.

Product Name	Vendor	Product Type	Applicable Standards
DECnet-Plus Version 7.1 for OpenVMS VAX	Digital Equipment Corporation	Distributed Computing	The Open Group CAE Specification C310
HP 55400A Network Synchronization Unit and HP 55450A SmartView	Hewlett-Packard Company	Network Synchronization	The Open Group CAE Specification C310
Encina	IBM Corporation	System Management	The Open Group CAE Specification C310
Adaptive Server 11.5	Sybase, Inc.	Database Server	The Open Group CAE Specification C310

Table 4-27. Representative Distributed Time Products

4.4.4 Remote Procedure Call

Description. In a client/server environment, two applications on two different physical system components must be able to communicate across a network. Remote Procedure Calls (RPCs) are a model for implementing communications between the client and server sides of an application. RPCs give programs the ability to express an interaction between the client and server sides of an application as if this interaction was a local procedure call. RPCs provide a high-level programming model for distributed application programs, and shield the application from details of network communications between client and server applications.

Correlation to EASI/ED. Within EASI/ED, RPC services may be used to support the following business functions.

- The system shall confirm participant enrollment and eligibility prior to the disbursement of Pell Grant funds to a school. (1420).
- The system shall maintain reinsurance fee information received from guaranty agencies. (1654)

Applicable Standard. Table 4-30 presents the standard that is to be followed when implementing RPC services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
DCE 1.1: Remote Procedure Call (RPC)	The Open Group CAE Specification C706:1997	DCE RPC Services specifies both portability and interoperability for the RPC mechanism. The specification contains material directed at two audiences: It provides a portability guide for application programmers and It provides both portability and interoperability specifications for those who are implementing or porting RPC or who are testing an RPC implementation. This document may be thought of as an implementation specification, covering both portability and interoperability, that contains within it an application.	

Table 4-30. Remote Procedure Call Standard

Representative Products. Table 4-31 lists representative products that support RPC services.

Product Name	Vendor	Product Type	Applicable Standards
DECnet-Plus Version 7.1 for OpenVMS VAX	Digital Equipment Corporation	Distributed Computing	The Open Group CAE Specification C706
Encina	IBM Corporation	System Management	The Open Group CAE Specification C706
Global Sign-On	IBM Corporation	Security	The Open Group CAE Specification C706

Table 4-31. Representative Remote Procedure Call Products

4.4.5 Directory Services

Description. Directory services maintain dynamic lists of all application services available throughout a system. This directory is akin to an electronic telephone book that helps network clients find objects and services. When a client machines makes a request, the directory service locates the application service that can handle the request and tells the client how to communicate with the application service.

Correlation to EASI/ED. Within EASI/ED, directory services may be used to support the following business functions.

- The system shall allow participants to request simulations of possible financial aid packages and financing options, including:
 - Simulating the participant's likely eligibility for Federal financial aid
 - Simulating costs that would be incurred in attending a particular program at a given school
 - Simulating the financial aid package options that may be available to the participant

Simulating the financing options that may be available to the participant. (1060)

- The system shall apply disbursements, adjustments, and cancellations to achieve an accurate daily net settlement. (1220)

Applicable Standards. Table 4-32 presents the standards that are to be followed when implementing directory services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Domain Names - Implementation And Specification	IETF RFC 1035:1987	Provide a mechanism for naming resources in such a way that the names are usable in different hosts, networks, protocol families, internets, and administrative organizations.	Architecturally Significant
DCE 1.1: Directory Services, Authentication and Security Services	The Open Group CAE Specification C705:1988	Specifies the Directory Services for DCE using the concepts of global name space and cell name space. Defines the DCE security model, services, interfaces and protocols.	Architecturally Significant
The Directory - Overview of Concepts, Models and Services - Data Communications Networks Directory	ITU X.500	The X.500 protocol supports individual and organizational directory services and is mandated for use with DMS. X.500 supports directory services that may be used by users or host applications to locate other users and resources on the network. X.500 also supports security services used by DMS-compliant X.400 implementations.	Architecturally Significant

Table 4-32. Directory Standards

Representative Products. Table 4-33 lists representative products that support directory services.

Product Name	Vendor	Product Type	Applicable Standards
DECnet-Plus Version 7.1 for OpenVMS VAX	Digital Equipment Corporation	Distributed Computing	The Open Group CAE Specification C706

Product Name	Vendor	Product Type	Applicable Standards
DS Series	IBM Corporation	Metadirectory	ITU X.500, Planned implementation of IETF RFC 1777

Table 4-33. Representative Directory Products

4.4.6 Inter-relationships and Preferred Standards

The four distributed computing service components (i.e., distributed time, distributed file system, remote procedure call, directory services) are very closely linked. Three fundamental sets of standards work in this service area: DCE, NFS, and Internet-technology. The selection of DCE as the implementation base for distributed applications implies that DCE-compatible standards will be used in all four service area components. However, it is very likely that DCE services alone will not address all functional requirements for a distributed implementation of EASI/ED. For example, the expected use of Internet technology servers will require the Internet Domain Name standard. Further, use of NFS for file and print services is not necessarily compatible with DCE DFS.

These seemingly incompatible standards sets are all included in the *COE* because no individual set provides the complete distributed system functionality required for EASI/ED. EASI/ED implementers will be responsible for developing interoperability approaches, where required, when using these sets of related standards. Since the distributed service standards were selected from the industry mainstream, many interoperability tools and approaches are available to EASI/ED application designers and integrators.

4.5 Middleware Services

Middleware services are network-aware services that layer between an application, the operating system, and the network transport layers. Middleware services also provide the network connectivity required for multi-tiered distributed computing. For Project EASI/ED, middleware services include the following components.

- Transaction processing
- Object services

Subsection 4.5.1 presents strategic findings for middleware services. Subsections 4.5.2 and 4.5.3 briefly describe these service components. Subsection 4.5.4 concludes the middleware services subsection with a discussion of component interrelationships and preferred standards.

4.5.1 Strategic Findings

The object services industry is dominated by two competing standards: The Object Management Group's CORBA and Microsoft's DCOM. DCOM's roots are in desktop software objects. Its predecessor, Common Object Model/Object Linking and Embedding (COM/OLE) is the fundamental tool used to build Microsoft Windows applications. CORBA's stronghold is the network; the Internet Inter-ORB Protocol (IIOP) is very powerful and is a widely accepted mechanism to allow software objects to interoperate over the Internet. Although DCOM and CORBA attacked the industry from different starting points, they rapidly are gaining each others strengths. CORBA has strong backing from vendors such as Netscape, Oracle, IBM, and Sun Microsystems. DCOM has strong Microsoft backing.

The distributed system and distributed object standards battle is far from resolved. This technology is very important to the design and implementation of new distributed systems. As a result, both CORBA and DCOM are specified as standards for EASI/ED--using each for its own particular strengths and using available tools to integrate implementations of the two standards. If there is no strong argument for using either CORBA or DCOM in a specific application, CORBA is the preferred standard because of its vendor independence.

4.5.2 Transaction Processing

Description. A transaction is a complete unit of work. A transaction is termed "completed" when it either is committed (i.e., all changes applied) or rolled back (i.e., all changes undone). Transaction processing services support distributed processing of transactions over multiple local or remote processors. These services ensure transactional data integrity across a distributed computing environment. This typically is accomplished via predetermined sequences of data entry, validation, display, and update or inquiry against a file or database. Transaction processing services ensure that the four properties of a transaction -- Atomicity, Consistency, Isolation, and Durability (ACID) -- are maintained for each unit of work. Transactions are also prioritized and tracked via transaction processing services.

Correlation to EASI/ED. Within EASI/ED, transaction processing services might support the following example business requirements.

- Allow individuals to authorize the release of specified data to specific schools and fund sources. (1090)
- Generate payment requests to pay off component loans as a result of refinancing into a Direct Loan or consolidating into a Direct Consolidation Loan. (2172)
- Provide information to aid organizations about individuals looking for financial assistance opportunities, when authorized by the individual. (1070)

Applicable Standards. Table 4-34 presents the standards that are to be followed when implementing transaction processing services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Distributed TP: The XA Specification	The Open Group CAE Specification C193:1992	X/Open definition of a model for DTP. This model envisions three software components in a DTP system and this specification defines the interface between two of them, the transaction manager and local resource manager.	
Distributed TP: The XA+ Specification, Version 2	The Open Group CAE Specification S423:1994	The XA interface is the bidirectional interface between a transaction manager and resource managers. This document extends the XA interface (C193) to support communication resource managers. XA+ is a superset of XA.	Architecturally Significant
The TX (Transaction Demarcation) Specification	The Open Group CAE Specification C504:1995	CAE C504 defines the TX interface, the application programming interface (API) by which the application program calls the Transaction Manager to demarcate global transactions and direct their completion.	
Distributed TP: The TxRPC Specification	The Open Group CAE Specification C505:1995	CAE C505 defines the TxRPC interface, which is the interface between an application program and a Communications Resource Manager (CRM) that uses transactional remote procedure calls.	
Distributed TP: Reference Model - Version 3	The Open Group CAE Specification G504:1996	Functional description of the X/Open Distributed Transaction Processing (DTP) model, a software architecture that allows multiple application programs to share resources provided by multiple Resource Managers, and allows their work to be coordinated into global transactions.	
Distributed TP: The XATMI Specification	The Open Group CAE Specification C506:1995	Definition of the XATMI interface, which is the interface between an application program and a Communications Resource Manager (CRM) that uses a client/server paradigm.	

Standard Title	Organization and Standard Name	Description	Comments
Distributed Transaction Processing (DTP) - Part 1: OSI TP Model	ISO/IEC 10026-1,2,3	OSI services and protocols for transaction mode communications in an OSI environment.	Architecturally Significant

Table 4-34. Transaction Processing Standards

Representative Products. Table 4-35 lists representative products that support transaction processing services.

Product Name	Vendor	Product Type	Applicable Standards
BEA Jolt/TUXEDO	BEA Systems, Inc.	Transaction Processor	The Open Group CAE Specifications
Transaction Server	Microsoft Corporation	Transaction Processor	Proprietary
Encina	IBM Corporation	Transaction Processor	The Open Group CAE Specifications
CICS Application Server	IBM Corporation	Transaction Processor	Proprietary industry standard

Table 4-35. Representative Transaction Processing Products

4.5.3 Object Services

Description. An object is an identifiable, encapsulated entity that provides one or more services that a client may request. Clients request an object service by invoking the appropriate method associated with the object; the object then carries out the service on the client's behalf. Object services are used to create, locate, and name objects, and to allow them to communicate in a distributed environment. Object services include common object services and Object Request Brokers (ORB). Common object services provide basic functions for object use and implementation, and are necessary to construct any distributed application. ORBs enable objects to transparently make and receive requests and responses in a distributed environment.

Correlation to EASI/ED. Within EASI/ED, object services might be used to support the following example business requirements.

- Calculate income contingent repayment terms for Direct Loans and for those loans assigned to ED for debt collection. (2360)
- Notify schools of participants' delinquency within 90 days of a missed loan repayment due date. (2550)

Applicable Standards. Table 4-36 presents the standards that are to be followed when implementing object services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Distributed Component Object Model (DCOM)	Microsoft DCOM	DCOM (Distributed Component Object Model) is a set of Microsoft concepts and program interfaces in which client program objects can request services from server program objects on other computers in a network.	Architecturally Significant

Table 4-36. Object Standards

Representative Products. Table 4-37 lists representative products that support object services.

Product Name	Vendor	Product Type	Applicable Standards
Transaction Server	Microsoft Corporation	Transaction Processor	Proprietary
Component Broker	IBM Corporation	Middleware	OMG CORBA 2.1
Orbix	Iona Technologies, Ltd.	Middleware	OMG CORBA 2.1

Table 4-37. Representative Object Products

4.5.4 Inter-relationships and Preferred Standards

Three groups of standards are represented in the middleware services area: CAE transaction processing standards, CORBA object model, and DCOM object model. CORBA and DCOM are competing standards. Because CORBA is an open standard supported by a large group of vendors, it is preferred; however, the influence of Microsoft on object standards cannot be overlooked. In addition, DCOM has definite advantages as the object standard for desktop applications. For this reason, the *COE* adopts DCOM in addition to CORBA. When either CORBA or DCOM is selected, a long list of related, supporting standards for each must be adopted as well.

4.6 Network Services

Network services provide connectivity and basic services to facilitate communications across workgroups and among sites. Network services comprise the network infrastructure required to support distributed data access and interoperability in a heterogeneous environment. For Project EASI/ED, network services include the following components.

- Internet
- Electronic mail (e-mail)
- File transfer

Subsection 4.6.1 presents strategic findings for network services. Subsections 4.6.2 through 4.6.4 briefly describe the service components listed above. Subsection 4.6.5 concludes network services subsection with a discussion of component interrelationships and preferred standards.

4.6.1 Strategic Findings

In most cases, network services rely on the Internet to provide standard protocols for functions such as file transfer and multimedia document transfer (i.e., FTP and HTTP, respectively). Most of the fundamental protocols to support network services have been stabilized by the Internet's influence. Basic file transfer and other high-level network functions are well-supported by mature standards and widespread interoperability can be achieved. An exception to this rule is e-mail. Within EASI/ED, e-mail may play an important role not as an office automation tool, but rather as a message handling protocol. However, although e-mail is an important network service, it has resisted full standardization and interoperability. Vendor-specific implementations still dominate e-mail protocols, with the principal industry products being Microsoft Exchange, Lotus Notes Mail and cc:Mail, Novell GroupWise, and an array of Internet-sourced products such as Eudora and Netscape E-mail Client.

The area where e-mail standards are strongest is the backbone -- i.e., the network connection between electronic post offices. In this area, Simple Mail Transfer Protocol (SMTP) and Multipurpose Internet Mail Extensions (MIME) (used for attachments) provide a well-supported set of standards to establish interoperability. Other related Internet standards -- Post Office Protocol (POP) (for the post office) and Interactive Mail Access Protocol, Version 4 (IMAP4) (for the client) -- are working their way into products that are currently proprietary. Use of SMTP

and MIME will provide sufficient product support and interoperability to build a messaging system to meet EASI/ED functional requirements.

4.6.2 Internet

Representative Products. Table 4-39 lists representative products that support Internet services.

Product Name	Vendor	Product Type	Applicable Standards
Netscape Communicator 5.0	Netscape Communications Corporation	Web Browser	IETF RFC 2068
Internet Explorer 4.0	Microsoft Corporation	Web Browser	IETF RFC 2068, InterNIC Internet Standard 0003
Enterprise Server 3.51	Microsoft Corporation	Internet Server	IETF RFC 2068, InterNIC Internet Standard 0003

Table 4-39. Representative Internet Products

4.6.3 Electronic Mail

Description. E-mail provides the capability to send, receive, forward, store, display, and retrieve messages electronically. E-mail may also contain multimedia information that, along with simple text, may be translated into standard data interchange formats. Today, e-mail is the most commonly used electronic communication technology on the Internet and on intranets. It offers a global, inter-enterprise communication service that is widely available, reliable, practical, scalable, and high speed.

Correlation to EASI/ED. Within EASI/ED, e-mail services might be used to support the following example business requirements.

- Prompt the participant to authorize the disbursement of funds to a school for the participant's loan. The prompt shall occur when the participant has not authorized the disbursement to the school within 30 days of the effective date of the disbursement request made by the school. (1390)
- Request annually low-income school information from state education offices, based on the screening criteria sent to them. (1254)

Applicable Standards. Within EASI/ED, e-mail software should implement three mail transfer protocols to deliver electronic messaging services most effectively.

- **Simple Message Transfer Protocol** - is a commonly used protocol to transfer mail between servers, which are commonly referred to as "mail hubs."
- **Post Office Protocol** - is a batch protocol almost universally used to collect mail from Internet Service Providers (ISPs). POP is widely used to move mail from mail hubs to system providing user agent (UA) services, i.e., electronic mail clients.
- **Interactive Mail Access Protocol, Version 4** - is a client-to-server protocol used to transfer descriptive mail message headers between a mail hub and UAs. IMAP4 reduces network overhead associated with transferring entire mail files, which often include unwanted content, between a mail hub and an UA. Users can use IMAP4 to review, select, and delete mail file contents without first downloading an entire mail file from the mail server.

By adopting all three standards, communication is facilitated among heterogeneous systems and e-mail server solutions.

Table 4-40 presents the standards that are to be followed when implementing e-mail services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Post Office Protocol - Version 3 (POP3)	InterNIC Internet Standard 0053:1994	POP3 is the most widely implemented protocol for retrieval of Internet Mail messages by a mail client and is supported by all major Internet Mail clients. It is used in conjunction with Simple Mail Transfer Protocol (SMTP), which is used to enable a mail client to send (submit) messages.	Architecturally Significant
Multipurpose Internet Mail Extensions (MIME) Part One: Mechanisms for Specifying and Describing the Format of Internet Message Bodies	IETF RFC 1521:1993 (MIME)	RFC 1521 redefines the format of message bodies so to allow multi-part textual and non-textual message bodies to be represented and exchanged without loss of information.	Architecturally Significant
Multipurpose Internet Mail Extensions (MIME) - Message Header Extensions for Non-ASCII Text	IETF RFC 1522:1993	Describes an extension to the message format defined in RFC 1521. It can be used to send images, audio, word processing documents, programs, or plain text. Message parts can also be labeled to identify to the recipient or to the mail software the type of data contained within the attachment to determine how it should be handled.	
Internet Message Access Protocol - Version 4rev1 (IMAP4)	IETF RFC 2060:1996	This specification allows a client to access and manipulate electronic mail messages on a server.	
Simple Mail Transfer Protocol (SMTP)	InterNIC Internet Standard 0010	SMTP is a Transmission Control Protocol/Internet Protocol (TCP/IP) that facilitates transfer of electronic mail messages. It specifies how two systems are to interact, and the message formats used to control the transfer of electronic mail.	Architecturally Significant

Table 4-40. Electronic Mail Standards

Representative Products. Table 4-41 lists representative products that support e-mail services.

Product Name	Vendor	Product Type	Applicable Standards
Sun Internet Mail Server (SIMS) 3.2	Sun Microsystems, Inc.	E-mail	InterNIC Internet Standard 0010
Lotus Domino Server	IBM Corporation	E-mail	IETF RFC 1521, IETF RFC 1522, IETF RFC 2060
Outlook 98	Microsoft Corporation	E-mail	IETF RFC 1521, IETF RFC 2060
Exchange Server 5.5	Microsoft Corporation	E-mail	IETF RFC 2060
Eudora Pro Email v4.0	QUALCOMM Inc.	E-mail	IETF RFC 2060

Table 4-41. Representative Electronic Mail Products

4.6.4 File Transfer

Description. File transfer services provide remote access to files stored on physically different computers. These services include the capability to move whole files to and from computers, to access files and insert or delete data, and to manage files (including creation, deletion, renaming, opening, closing).

Correlation to EASI/ED. Within EASI/ED, file transfer services might be used to support the following example business requirements.

- Notify the school when the system authorized disbursement of funds to the school. (1440)
- Obtain federal employment confirmation by matches with the Department of Defense and the US Postal Service for those participants who are deemed eligible for federal wage garnishment. (2330)
- Send all Perkins Loan schools a copy of the low-income-school directory annually. (1258)

Applicable Standard. Table 4-42 presents the standard that is to be followed when implementing file transfer services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
File Transfer Protocol (FTP)	InterNIC Internet Standard 0009:1985	A client-server protocol which allows a user on one computer to transfer files to and from another computer over a TCP/IP network.	Architecturally Significant

Table 4-42. File Transfer Standard

Representative Products. Table 4-43 lists representative products that support file transfer services.

Product Name	Vendor	Product Type	Applicable Standards
WS_FTP Pro	Ipswitch, Inc.	File Transfer	InterNIC Internet Standard 0009
teemcollection	Pericom Software Plc.	File Transfer	InterNIC Internet Standard 0009
Netscape Communicator 5.0	Netscape Communications Corporation	Web Browser	InterNIC Internet Standard 0009
Internet Explorer 4.0	Microsoft Corporation	Web Browser	InterNIC Internet Standard 0009

Table 4-43. Representative File Transfer Products

4.6.5 Inter-relationships and Preferred Standards

All standards in the network services area are Internet based. As a result, there is little overlap among standards in the three components (i.e., e-mail, file transfer, Internet) and all standards are fully interoperable.

4.7 Software Engineering Services

Software engineering is defined by the IEEE as the application of a systematic, disciplined, quantifiable approach to developing, operating, and maintaining software. Software engineering services provide developers with tools appropriate to developing and maintaining applications using engineering discipline. For Project EASI/ED, software engineering services include the following components.

- Software development services
- Programming language services

Subsection 4.7.1 presents strategic findings for software engineering services. Subsections 4.7.2 and 4.7.3 briefly described the software engineering service components identified above. Subsection 4.7.4 concludes the software engineering services subsection with a discussion of component interrelationships and preferred standards.

4.7.1 Strategic Findings

Current ED Title IV systems are dominated by languages such as COBOL. Because continued maintenance and enhancement of the current systems is anticipated during the transition to EASI/ED, COBOL will be a tactical programming language standard for ED for years to come. However, the *COE* focuses on strategic architecture targets; therefore, C and its object-oriented variant, C++, are the preferred strategic programming languages. In addition, because of its platform-independent nature, Java offers great promise for building open, transportable applications. Java is also the principal technology for developing thin-client, network-centric applications.

Within ED, parallel and complementary efforts to EASI/ED are underway to establish a SFAP-wide software development life cycle methodology and companion tool set. New technologies, such as those defined by Rational Unified Modeling Language (UML), provide smooth integration between techniques for design conceptualization and implementation. Tools such as UML are compatible with the standards in this service area, as well as with those cited in the distributed system and middleware service areas.

Selection of an Integrated Computer-Aided Software Engineering (ICASE) tool is a critical step for EASI/ED, since ICASE tool technology is primarily driven by proprietary design and implementation support products. Because of this, the Computer-Aided Software Engineering (CASE) Data Interchange Format standard was selected to facilitate interoperability and data exchange among proprietary ICASE tools.

4.7.2 Software Development

Description. Software development tools are essential enabling technologies used to develop application software. These tools help people more productively and effectively design, build, and modify applications. Software development services are used to support analysis, design, and automated construction and maintenance of software. CASE tools (e.g., COOL:Gen, Software Through Pictures) and rapid application development tools are examples of software development tools.

Software development tools offer a number of benefits, some of which are listed below.

- Enable developers to more quickly and accurately plan, build, and maintain flexible applications.
- Increase developer productivity once developers are knowledgeable of the tool(s).
- Help reduce overall software maintenance costs.

Correlation to EASI/ED. Within EASI/ED, software development services will be used to develop EASI/ED subsystems.

Applicable Standards. Table 4-44 presents the standards that are to be followed when implementing software development services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
CASE Data Interchange Format (CDIF)	EIA CDIF PN-30	A set of model and emerging standards used to describe different subject areas related to the CASE environment. These models may be used to represent metadata about subject areas. Implementation of these models provides information to users about specific instances of the subject area; i.e., an entity attribute diagram.	Architecturally Significant and Emerging
Guidelines for Evaluation and Selection of CASE Tools	IEEE 1462	Defines a process for evaluating and selecting a CASE tool for a software development or maintenance activity. The standard addresses the evaluation and selection of tools supporting software engineering processes including: project management processes, development processes, and integral processes.	

Table 4-44. Software Development Standards

Representative Products. Table 4-45 lists representative products that support software development services.

Product Name	Vendor	Product Type	Applicable Standards
Designer/2000 Release 2.1	Oracle Corporation	CASE Tool	IEEE 1462
Seer*HPS	Seer Technologies, Inc.	CASE Tool	IEEE 1462
Software through Pictures	Aonix	CASE Tool	IEEE 1462
COOL:Gen and COOL:Enterprise	Sterling Software, Inc.	CASE Tool	IEEE 1462

Table 4-45. Representative Software Development Products

4.7.3 Programming Languages

Description. Programming languages are specifications that allow programmers to instruct computers to execute tasks according to prescribed logic. Programming language service provide basic syntax and semantic definitions used by programmers to describe application software functions. The major types of programming languages are described briefly below.

- **First- and second-generation languages** - are called machine and assembly language, respectively. These languages were tied closely to the computer hardware itself, making them difficult for people to learn and use since they required programmers to have an intimate knowledge of the underlying hardware. Examples of these languages are SPARC V8 and Assembler.
- **Third-generation languages (3GL)** - are closer to English than earlier languages were. Consequently, programmers require less specialized skills to use these languages to write software. 3GLs provide the capability to manipulate data and text; to store, retrieve, and print information; and to accept input from computer terminals. Although 3GLs were abstracted from hardware, they typically are dependent upon a specific hardware and software platform. Examples of 3GLs are COBOL, FORTRAN, C, Ada, Pascal, and LISP.
- **Fourth-generation languages (4GL)** -are products that minimize low-level programming by providing a powerful, high-level, English-like language. They provide a fast way to code business transactions through event-oriented procedures, and feature data dictionaries to store definitions of various application components and to encourage reuse. Examples of 4GLs are Focus, Forte, Oracle Developer/2000.
- **Object-oriented languages** - allow developers to combine program algorithms and data structures in objects that hide internal operations and data representation. Objects are entities that encapsulate both the data describing the object and the instructions for operating on this data. Objects enable software to be assembled as a series of separate components that interact with one another in known ways while hiding internal details. Examples of object-oriented languages include C++, Java, and SmallTalk.

Correlation to EASI/ED. Within EASI/ED, programming language services will be used to develop application software or to customize COTS or GOTS applications used for specific business functions.

Applicable Standards. Table 4-46 presents the standards that are to be followed when implementing programming language services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Java Virtual Machine Specification	Sun JAVA	JAVA provides a platform independent programming language environment.	De Facto
Programming Language -- COBOL	ANSI X3.23:1985	Establishes the form for and the interpretation of programs expressed in FIPS COBOL, reflects corrections and clarifications to the COBOL specifications.	
Programming Language - C	ANSI/ISO/IEC 9899:1:1990	Specifies the form and establishes the interpretation of programs written in the C programming language.	Architecturally Significant

Table 4-46. Programming Language Standards

Representative Products. Table 4-47 lists representative products that support programming language services.

Product Name	Vendor	Product Type	Applicable Standards
JAVA	Sun Microsystems, Inc.	Programming Language	Sun JAVA
Visual C++	Microsoft Corporation	Programming Language	ANSI/ISO/IEC 9899:1
COBOL Developer Suite for UNIX 4.0	Micro Focus	Programming Language	ANSI X3.23

Table 4-47. Representative Programming Language Products

4.7.4 Inter-relationships and Preferred Standards

The two components of the software engineering services area (i.e., programming language, software development) are largely independent of one another, but provide standards choices within components.

In the programming languages component, choices range from leading edge technology (e.g., Java related Sun Microsystems-sourced standards), to new, but mature technology (e.g., C and its related variants), and to legacy or foundation standards (e.g., COBOL). All of these standards are needed to build EASI/ED and to transition from legacy and foundation Title IV systems. The choice among programming languages will be made entirely on the basis of application system requirements. Therefore, it is inappropriate to identify a preferred standard at this time. However, it can be stated that no new standalone applications should be developed in COBOL.

Software engineering services will largely be driven by ED's selection of a life-cycle methodology and the supporting tools. While software development life cycle methodology is outside the *COE's* scope, a preferred set of standards to facilitate exchange of data regardless of ED's choices is included in this area.

4.8 User Interface Services

A user interface combines menus, screen design, keyboard commands, command language, and help screens to create a way for a user to interact with a computer. User interfaces represent the sum total of all design decisions made regarding how individuals will be able to access a system. The unique environmental requirements of the many devices that can interact with a system are handled through the user interface, which is the only way for a user to interact with a system's functions. For Project EASI/ED, user interface services include the following components.

- Graphical User Interface (GUI)
- Character-based interface
- Interactive Voice Response (IVR)
- Special needs

Subsection 4.8.1 presents strategic findings for user interface services. Subsections 4.8.2 through 4.8.5 briefly describe each of the component services listed above. Subsection 4.8.6 concludes the user interface services subsection with a discussion of component interrelationships and preferred standards.

4.8.1 Strategic Findings

User interface services define how users interact with an application. They provide a consistent way for individuals who develop, administer, or use a system to gain access to application programs, operating systems, and system utilities. Architecturally, user interface services provide a series of device drivers that interact directly with each device in a system to provide a common interface and consistent view to a user.

Open, but proprietary, products dominate user interfaces. Microsoft Windows (95 and NT) are expected to be installed on over 90 percent of all new microcomputers purchased. In the browser market, Microsoft Internet Explorer and Netscape Navigator control more than 95 percent of the market. Given this situation, EASI/ED will need to support these dominant user interfaces in addition to several important non-proprietary user interface standards.

- **Telephony Application Programming Interface (TAPI)**, which is controlled primarily by Microsoft, specifies the interface between information systems and interactive voice response (IVR) systems. IVR systems make information available to anyone with access to a telephone, and are planned as a user interface for EASI/ED.
- **X Window**, which is not to be confused with Microsoft Windows, is a widely supported interface standard used to connect to UNIX hosts.
- **H.323 Video Teleconference (VTC)** represents technology that has experienced rapid cost reductions and more widespread use in recent years. EASI/ED may incorporate a variety of multimedia data types, including video. H.323 specifies standards for a very wide range of video environments, including transmission over local area networks and

inclusion of documents as part of a video conference. H.323 standards are widely accepted throughout the industry, with most VTC products adhering to this standard.

4.8.2 Graphical User Interface

Description. GUIs are presentation interfaces between users and application software, and are designed to present information to users in graphical form. GUI services define how users interact with a system, define the screen appearance, and simplify information presentation. GUIs commonly comprise the components listed below.

- **Desktop.** The area on a computer screen where icons are grouped and displayed.
- **Windows.** The area in which various programs run or files are displayed. More than one window may be displayed on a screen at one time, and window sizes and shapes may be varied.
- **Menus.** Command choices made available through a bar or list displayed on a screen.
- **Icons.** Small graphic representations of commands, files, or windows that, when "pressed," execute the desired action.
- **Pointer.** A symbol on the display screen that a user can move to select objects or commands.
- **Object Definition.** Specifications that define display components in terms of color, shape, size, movement, graphics context, and interaction with other components.
- **Window Management.** Specifications that define how windows are created, moved, stored, retrieved, removed, and related to one another.
- **Dialogue Support.** Specifications that define the relationship between information displayed on a screen and changes to the display depending upon data entered.

Modern client workstations are able to combine the above components with images, full-motion video, sound, optical character recognition, and interactive multimedia to create effective, intuitive application interfaces.

Correlation to EASI/ED. Within EASI/ED, GUIs might be used to support the following example business requirements.

- Allow participants to request a lender from a list of available lenders. (1710)
- Require that the participant authorize the disbursement of funds to a school before the disbursement is made on a Stafford, PLUS, or Perkins Loan for that participant. (1380)

Applicable Standards. Table 4-48 presents the standards that are to be followed when implementing GUI services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
MS Window 95/NT	Microsoft Window 95/NT	The graphical user interface of Windows 95/NT makes computing easier and more natural for all users.	De Facto
The X Window System.	X Window System	A network-transparent window system that runs on a wide range of computing and graphics machines. Current X Window System development is done through the X Consortium. The X Window System software, written in C, has proven to be highly portable between various hardware platforms and operating systems. Virtually all major hardware vendors have produced implementations of the X Window System for their product lines.	
Multimedia Teleconferencing Standards	ITU H.320 and H.323:1990	H.323 is a logical and necessary extension of the H.320 standard to include Corporate Intranets and packet-switched networks generally. Because it is based on the RealTime Protocol (RTP/RTCP) from the IETF. H.323 can also be applied to video over the Internet.	

Table 4-48. Graphical User Interface Standards

Representative Products. Table 4-49 lists representative products that support GUI services.

Product Name	Vendor	Product Type	Applicable Standards
Windows 95 and Windows NT 4.0	Microsoft Corporation	Operating System	Microsoft Windows 95/NT
MozWin	Mozart Systems Corporation	GUI Development	Microsoft Windows 95/NT
TeleUSE	Sun Microsystems, Inc.	GUI Development	The X Window System

Table 4-49. Representative Graphical User Interface Products

4.8.3 Character-Based Interface

Description. Character-based interfaces are used for non-graphical terminal operating environments. These interfaces are of two types:

- Command-line which includes mechanisms for services at the operator level, such as:
 - Printing, and displaying file contents
 - Editing files
 - Searching patterns
 - Moving files between directories
 - Sorting data
 - Executing command scripts
- Menu-driven interfaces are similar to GUIs, but do not use graphics and may depend solely on a keyboard for user input.

Character-based interface services address character-based displays, where a processor uses a fixed-font screen to display characters sequentially as they are received from an application.

Correlation to EASI/ED. Modern systems and applications are based on GUIs and the associated standards for such systems. However, due to the large variability in technology access among the EASI/ED user population and due to the possible need to interface with legacy systems, character-based interfaces must also be supported. Within EASI/ED, character-based interfaces might be used to support the following example business requirements.

- Allow participants to select and request repayment options on their aid at any time. (2010)
- Require that the participant authorize the disbursement of funds to a school before the disbursement is made on a Stafford, PLUS, or Perkins Loan for that participant. (1380)

Applicable Standard. Table 4-50 presents the standard that is to be followed when implementing character-based interface services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Telnet Protocol	InterNIC Internet Standard 0008:1983	This specification provides a standard method of interfacing terminal devices and terminal-oriented processes to each other.	

Table 4-50. Character-Based Interface Standard

Representative Products. Table 4-51 lists representative products that support character-based interface services.

Product Name	Vendor	Product Type	Applicable Standards
Windows NT	Microsoft Corporation	Operating System	InterNIC Internet Standard 0008
HP-UX 10.20	Hewlett-Packard Company	Operating System	InterNIC Internet Standard 0008

Table 4-51. Representative Character-Based Interface Products

4.8.4 Interactive Voice Response

Description. IVR services provide an interface between telephones and computer systems. IVR services enable computers to translate data provided via a telephone call into instructions for application software to execute. IVR technology is also used to send information from a computer to a user or calling source. An IVR protocol is used to link telephone network switch technologies, voice response technology, and application servers hosting IVR application software.

IVR technologies are typically integrated with Computer Telephony Integration (CTI) technologies to deliver comprehensive telephony-driven information management solutions. Automatic call distribution may be used to provide a queuing resource that can be used with IVR to sequence and distribute calls among multiple internal resources.

Correlation to EASI/ED. IVR services provide organizations opportunities to improve the application of technology to areas such as customer service, client support, and voice notification of business information processing events. Within EASI/ED, IVR services might be used to support the following example business requirements.

- Allow participants to notify the system of intent to change their enrollment status (e.g., transfer or drop out of school). (1487)
- Allow participants to de-obligate a loan or grant disbursement (i.e., reduce the amount of a disbursement). (1486)

Applicable Standards. Although IVR technology is rapidly maturing, there is no formal standard yet for voice-based interface services. Available specifications are proprietary in nature, leaving IVR services with a high portability risk.

Table 4-52 presents the standards that are to be followed when implementing interactive voice response services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Telephony Application Programming Interface (TAPI)	Microsoft TAPI:1993	TAPI links the PC to the telephone at the desktop level.	
User-System Interfaces and Symbols committee: Working on a VMUIF.	ANSI X3V1.9:1995	Voice recognition standard.	Emerging
Digital audio signal interchange: Uncompressed digital audio systems	ISO/IEC JTC 1/SC18/WG9	The audio Engineering Society's working group 9 is working on a VMUIF.	Emerging

Table 4-52. Interactive Voice Response Standards

Representative Products. Table 4-53 lists representative products that support interactive voice response services.

Product Name	Vendor	Product Type	Applicable Standards
Internet Phone Release 4 with Video	VocalTec Communications	Telephony	TAPI
InfoPress Voice Response	Castelle	Telephony	TAPI
Voicetek Generations	Voicetek Corporation	Telephony	TAPI

Table 4-53. Representative Interactive Voice Response Products

4.8.5 Special Needs

Description. The EASI/ED user community is expected to include individuals with special needs (e.g., some users may be unable to use keyboards or display screens). Special needs are an explicit part of the external environment description, which must be translated into special need user interface services. Special needs user interface services may provide support for additional user interfaces, including those listed below.

- Hardware, software, and firmware to interface with a workstation via voice recognition and input. The voice input device must be a commercially available device compatible with offered workstations.
- Text to be displayed on a standard workstation monitor may be enlarged from two to eight times its normal size (minimum range). If application software includes graphics, then the enlargement of the graphic display must also be supported.
- Braille hardcopy output (Grade I and Grade II) generation must be supported from a printer that is fully compatible with the offered systems.
- Hardware and appropriate extra equipment must be supported to permit disabled employees the same access to and use of the system as any other employee.

Correlation to EASI/ED. Within EASI/ED, special needs services may be used to:

- Allow participants to de-obligate a loan or grant disbursement (i.e., reduce the amount of a disbursement). (1486)
- The system shall request financial aid simulation modeling information (e.g. average salaries for various professions) from state departments of labor. (1950)

Applicable Standards. Table 4-54 presents the standards that are to be followed when implementing special needs services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Telecommunications accessibility for hearing and speech impaired individuals	GSA FIRMR Bulletin C10	This bulletin provides guidelines for acquiring products and services that provide telecommunications accessibility for hearing and speech impaired individuals for communication with and within Federal agencies. This bulletin also provides general information regarding responsibilities for accommodating the needs of those with hearing and speech impairments.	
Web Accessibility Initiative	W3C WAI	This initiative is aimed at increasing the accessibility of the Web for all users, including those with disabilities. The WWW offers the promise of transforming many traditional barriers to information and interaction among different peoples.	
Electronic Office Equipment Accessibility for Handicapped Employees	U.S. Congress Public Law 99-506, Section 508:1986	Mandates that guidelines be established to ensure that handicapped individuals may use electronic office equipment with or without special peripherals and that agencies comply with these guidelines in acquiring electronic equipment.	

Standard Title	Organization and Standard Name	Description	Comments
TTY and TDD	NXi: Teletype and Telecommunications Devices for the Deaf	TDDs are the class of machines used for telecommunications for the hearing-impaired. TTY's are machines which allow two users to communicate in a text format over phone lines.	
Information accessibility for employees with disabilities	GSA FIRMR Bulletin C8	This bulletin provides information and guidance regarding agencies' responsibility to meet the special Federal information processing (FIP) resource accommodation needs of individuals with disabilities.	

Table 4-54. Special Needs Standards

Representative Products. Table 4-55 lists representative products that support special needs services.

Product Name	Vendor	Product Type	Applicable Standards
Braille 'n Speak 2000	Blazie Engineering, Inc.	Braille Notetaker Speech Synthesizer	U.S. Congress Public Law 99-506, Section 508, GSA FIRMR Bulletin C8 and C10
Braille Lite	Blazie Engineering, Inc.	Braille Notetaker Speech Synthesizer	U.S. Congress Public Law 99-506, Section 508, GSA FIRMR Bulletin C8 and C10C10
Type 'n Speak	Blazie Engineering, Inc.	Speech Synthesizer	U.S. Congress Public Law 99-506, Section 508, GSA FIRMR Bulletin C8 and C10C10
VoiceType Dictation	IBM Corporation	Speech Recognition	U.S. Congress Public Law 99-506, Section 508, GSA FIRMR Bulletin C8 and C10C10

Table 4-55. Representative Special Needs Products

4.8.6 Inter-relationships and Preferred Standards

The standards for this service (which includes graphical user connectivity, character-mode connectivity, voice-based access, and handicap-friendly access) are independent of one another. In meeting the objective of providing access to a wide range of users, selection of a single preferred standard is inappropriate. EASI/ED must provide the fullest functionality achievable under each standard to ensure that users can access information regardless of location, technical sophistication, or other limitations.

4.10 Security Services

Security services provide cross-platform management control over who can do what within a computer system and network. Security services support secure distribution and integrity of information, and protect the computing infrastructure from unauthorized access. Application-coupled security is usually provided by applications with specific security requirements, and is typically implemented as a transport layer technology, such as Netscape Secure Socket Layer (SSL). For Project EASI/ED, security services include the following components.

- Confidentiality
- Integrity
- Availability

Subsection 4.10.1 presents strategic findings for security services. Subsections 4.10.2 through 4.10.4 briefly describe these service components. Subsection 4.10.5 concludes the security services subsection with a discussion of component interrelationships and preferred standards.

4.10.1 Strategic Findings

A fundamental EASI/ED objective is to make information more readily accessible to a wide range of users. This objective increases the importance of information security and of the need to ensure data confidentiality, integrity, and availability. EASI/ED is not expected to contain national security information (i.e., Top Secret, Secret, or Classified); rather, most EASI/ED data is considered Sensitive, But Unclassified (SBU). Despite this, the task of securing EASI/ED resources and information is not necessarily easier, even though formal national security information clearance and handling procedures don't apply to the system. Security procedures and protocols for EASI/ED must provide adequate protection for SBU information.

Information security technology is a very active area. Although there are many mature standards, just as many new standards are emerging. The central government standard for information security is Federal Information Processing Standard (FIPS) 46-2, Data Encryption Standard (DES). This FIPS references many other standards and defines protocols to be applied for a wide range of security applications within the federal government. FIPS 140-1 includes many well-accepted and stable standards, such as Data Encryption Standard (DES) for data encryption and Digital Signature Algorithm (DSA) for digital signatures. However, FIPS has been unable to keep up with the rapid pace of change in information security technology. Many standards that EASI/ED may require are not addressed in FIPS 140-1, and many federal agencies are discovering the need to go outside FIPS to implement appropriate information security policies. For EASI/ED, FIPS 140-1 is used as an initial guiding standard to be supplemented by other mainstream information security standards.

Additional security standards for EASI/ED originated primarily from two sources: (1) the Internet, and (2) a long-time leader in information security—RSA Secure Data, Inc. The Internet has spawned numerous useful security standards, including Secure Hypertext Transfer Protocol (S-HTTP) and SSL. However, the motivation behind these standards primarily has been to support electronic commerce on the WWW. By themselves, these protocols are not broad enough

to implement even the most basic information system security policy. They must be supplemented by other FIPS 140-1 standards and, in some cases, by RSA.

RSA publishes a list of specifications, each labeled "Public Key Cryptography Standard (PKCS)," that describe methods and protocols for using public key encryption technology to secure information systems. Although these standards are owned by RSA, they have come into common use in many vendor products and are used throughout the federal government.

Also added to the standards list are Secure/MIME (S/MIME) and Internet Protocol Security (IPSEC). S/MIME secures e-mail attachments. IPSEC is used to create Virtual Private Networks (VPNs), which allow use of unsecured, public telecommunications facilities to build private sub-networks that keep information protected from unauthorized access.

4.10.2 Confidentiality

Description. Confidentiality services prevent the unauthorized disclosure of information. They are provided via mechanisms such as those listed below.

- **Identification and authentication** - is the verification of a user's claimed identity. This service ensures system entities (e.g., processes, hardware, personnel) are uniquely identified and authenticated. Authentication is employed when users initially identify themselves (i.e., log in) to the system and when a process is transferred to, or initiated on, someone's behalf on another system in a network.
- **Authorization** - is the process of determining how an authenticated user is permitted to use specific system resources (e.g., data files, operator commands, I/O devices). An authorization mechanism automatically enforces management policies governing resource use.
- **Encryption** - provides a means to encode data so that it only can be decoded by a party who possesses the appropriate key.

Correlation to EASI/ED. Within EASI/ED, confidentiality services might be used to support the following example business requirement.

- Receive a signature or authentication from participants to endorse an aid application, multi-year promissory note, or waiver to release information to or from external databases. (1742)

Applicable Standards. Table 4-62 presents the standards that are to be followed when implementing confidentiality services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Secure Hypertext Transfer Protocol (S-HTTP)	EIT S-HTTP	Secure HTTP provides secure communication mechanisms between an HTTP client/server pair in order to enable spontaneous commercial transactions for a wide range of applications.	Architecturally Significant
Secure Hash Standard (SHS)	NIST FIPS Pub 180-1:1995	Widely used hash function used by security products to encode digital messages which cannot be decoded, in a reasonable amount of time, without using the encoding key, or its orthogonal pair.	
Escrowed Encryption Standard (EES)	NIST FIPS Pub 185:1994	Provides an encryption algorithm and a Law Enforcement Access Field (LEAF) creation method that may be implemented in electronic devices and may be used at the option of government agencies to protect government telecommunications.	
DCE 1.1: Directory Services, Authentication and Security Services	The Open Group CAE Specification C705	Specifies the Directory Services for DCE security using the concepts of global name space and cell name space. Defines the DCE security model, services, interfaces and protocols.	Architecturally Significant
S/MIME Version 2 Message Specification	IETF RFC 2311:1998	S/MIME (Secure/Multipurpose Internet Mail Extensions) provides a consistent way to send and receive secure MIME data.	Architecturally Significant
Data Encryption Standard (DES)	NIST FIPS Pub 46-3:1999	This publication provides a complete description of a mathematical algorithm for encrypting (enciphering) and decrypting (deciphering) binary coded information.	Emerging
Generic Security Service API (GSSAPI)	The Open Group CAE Specification Kerberos, DCE-SS 1.1	Defines the syntactic and semantic rules for database definition and data manipulation in a relational database management system.	
Public Key Infrastructure	ITU X.509	Specifies the format for the certificate containing public key information.	
Security Architecture for Internet Protocol	IETF RFC 1825	Describes the security mechanism for IP Version 4 (IPv4) and IP Version 6 (IPv6) and the IP layer security service they provide.	

Table 4-62. Confidentiality Standards

Representative Products. Table 4-63 lists representative products that support confidentiality services.

Product Name	Vendor	Product Type	Applicable Standards
BSAFE 4.0	RSA Data Security, Inc.	Cryptography Engine	RSA Data Security, Inc. RSA, IETF RFC 2311, The Open Group CAE Specification SSL_3, IPSEC IEEE 802.11
Certificate Server	Network Associates, Inc.	Public Key Infrastructure	ITU X.509, The Open Group CAE Specification SSL_3, EIT S-HTTP

Table 4-63. Representative Confidentiality Products

4.10.3 Integrity

Description. Integrity services prevent unauthorized modification of data within a system. Integrity services commonly are provided via digital signatures, which allow a receive of a digitally signed electronic message to authenticate who the message sender is and to verify the message's integrity.

Correlation to EASI/ED. Within EASI/ED, integrity services might be used to support the following example business requirement.

- Receive a signature or authentication from participants to endorse an aid application, multi-year promissory note, or waiver to release information to or from external databases. (1742)

Applicable Standards. Table 4-64 presents the standards that are to be followed when implementing integrity services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Distributed Security Framework (XDSF)	The Open Group CAE Specification G410:1994	Identifies information security requirements required to meet the needs of distributed information systems, and provides guidance on the integration of these services.	
Digital Signature Standard	NIST FIPS Pub 186:1994	The DSS defines a cryptographic system for generating and verifying digital signatures. The private key is randomly generated.	
The Digital Signature Algorithm (DSA)	ANSI X9.30.1	This standard shall be used in designing and implementing public-key based signature systems that federal departments and agencies operate or that are operated for them under contract.	
Computer Data Authentication	NIST FIPS Pub 113:1985	Specifies a Data Authentication Algorithm (DAA) that, when applied to computer data, automatically and accurately detects unauthorized modification, both intentional and accidental.	
RSA Laboratories' Public-Key Cryptography Standards	RSA PKCS: 1991	These standards cover RSA encryption, Diffie-Hellman key agreement, password-based encryption, extended-certificate syntax, cryptographic message syntax, private-key information syntax, and certification request syntax, as well as selected attributes.	

Table 4-64. Integrity Standards

Representative Products. Table 4-65 lists representative products that support integrity services.

Product Name	Vendor	Product Type	Applicable Standards
BSAFE 4.0	RSA Data Security, Inc.	Cryptography Engine	RSA PKCS
Certificate Server	Network Associates, Inc.	Public Key Infrastructure	ITU X.509
Entrust	Entrust Technologies	Public Key Infrastructure	ITU X.509
Digital ID	VeriSign, Inc.	Digital Certificate Server	ITU X.509

Table 4-65. Representative Integrity Products

4.10.4 Availability

Description. Availability services prevent unauthorized withholding of data or resources. Availability services commonly are implemented via firewalls, which are dedicated hardware and software systems that screen network traffic and validate the flow of information among networks. A firewall provides both a perimeter defense and a control point for monitoring access to services, both from inside and outside a private network. The use of a firewall is essential when connecting a network to a non-trusted or public network, especially the Internet.

Representative Products. Table 4-67 lists representative products that support availability services.

Product Name	Vendor	Product Type	Applicable Standards
Gauntlet Firewalls	Trusted Information Systems Inc.	Firewall	IETF RFC 1825

Table 4-67. Representative Availability Products

4.11 System and Network Management Services

System and network management services provide mechanisms to monitor and control operation of individual applications, databases, operating systems, platforms, telecommunications and data communications systems, networks, and user interaction with these resources. For Project EASI/ED, systems and network management services include the following components.

- Backup and recovery
- Fault management
- Performance and usage management
- Software distribution and configuration
- User and group management

Subsection 4.11.1 presents strategic findings for system and network management services. Subsections 4.11.2 through 4.11.6 briefly describe the service components listed above. Subsection 4.11.7 concludes the system and network management services subsection with a discussion of component interrelationships and preferred standards.

4.11.1 Strategic Findings

Information systems' total cost of ownership (TCO) is receiving a lot of industry attention. Information technology managers recognize that operations and maintenance costs for client/server and distributed architectures follow a different model from traditional, centralized information systems. TCO can grow beyond expectations if not explicitly addressed during system conceptualization and design. Enterprise management is a tool for controlling TCO in a distributed environment, and will play an important role in EASI/ED. Two important standards support TCO: SNMP and Management Information Base (MIB) II. These are Internet-sourced protocols that specify monitoring and control protocols for network devices and that specify the structure that describes the particular device being monitored. Enterprise management includes many functions not covered by Simple Network Management Protocol (SNMP) and MIB; EASI/ED implementers are anticipated to select an enterprise management tool (e.g., IBM Tivoli, Hewlett Packard OpenView, or Computer Associates Unicenter) that includes MIB and SNMP as underlying standards.

To be consistent with the preferred EASI/ED operating system standard, POSIX, system management standards within POSIX are included in the system and network management services.

4.11.2 Backup and Recovery

Description. Backup and recovery services provide the capability to backup data to, and recover data from, a variety of storage mediums based upon access requirements necessary for distributed data. Backup services use a batch process to store a pre-defined set of historical data to alternative access media (typically magnetic tape). Backup services also identify where files are located, may compress information so that it is stored more efficiently, and may include techniques for restoring corrupted files.

Correlation to EASI/ED. Within EASI/ED, backup and recovery services will be used to ensure ED can quickly recover from catastrophic loss of data with a minimum disruption of operations.

Applicable Standards. Table 4-68 presents the standards that are to be followed when implementing backup and recovery services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
N/A	N/A	Backup and Recovery products implement highly proprietary standards.	

Table 4-68. Backup and Recovery Standards

Representative Products. Table 4- 69 lists representative products that support backup and recovery services.

Product Name	Vendor	Product Type	Applicable Standards
ARCserve	Computer Associates, Inc.	Backup Software	N/A
Desktop Management Suite (DMS) 3.0.1	Seagate Software-Information Management Group	Backup Software	N/A
UltraBac	Sunbelt Software Distribution, Inc.	Network Management	N/A
Solstice Backup	Sun Microsystems, Inc.	Network Management	N/A

Table 4-69. Representative Backup and Recovery Products

4.11.3 Fault Management

Description. Fault management services handle system problems by alerting system administrators and help desk staff when a device or application fails. These services recognize alert conditions, generate alerts, and forward alerts to appropriate system management resource(s). Efficient fault management services may repair fault conditions without requiring human interaction.

Correlation to EASI/ED. Within EASI/ED, fault management services may be used to provide EASI/ED services 24 hours a day, 7 days a week.

Applicable Standards. Table 4-70 presents the standards that are to be followed when implementing fault management services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
N/A	N/A	Fault Management products are generally implemented with proprietary standards	

Table 4-70. Fault Management Standards

Representative Products. Table 4-71 lists representative products that support fault management services.

Product Name	Vendor	Product Type	Applicable Standards
HP OpenView	Hewlett-Packard Company	Network Management	N/A
Trusted Enterprise Manager	Sunbelt Software Distribution, Inc.	Network Management	N/A
SunSoft Solstice Domain and Site Managers	Sun Microsystems, Inc.	Network Management	N/A
Tivoli Management Framework	IBM Corporation	Network Management	N/A
Trusted Enterprise Manager	Sunbelt Software Distribution, Inc.	Network Management	N/A
SunSoft Solstice Domain and Site Managers	Sun Microsystems, Inc.	Network Management	N/A

Table 4-71. Representative Fault Management Products

4.11.4 Performance and Usage Management

Description. Performance and usage management services examine how well a system is operating and determine the source of any bottlenecks. Performance and usage management services include server management, network monitoring, and user management, described below.

- **Server management** - monitors servers to ensure they are operating and their applications are available. Server management also monitors hardware elements such as disk volume and processor utilization ensure server availability.
- **Network monitoring** - tracks network statistics at the port and device levels. Tools support notification of management applications of workstation and server availability,

supplying port and device status and configuration views, trend analysis for problem prevention, activating alarms for pre-defined events, assessing bandwidth utilization, detecting errors, diagnostics, and monitoring power supplies.

- **User management** - may provide chargeback support.

Correlation to EASI/ED. Within EASI/ED, performance and management services might be used to support the following example business requirement.

- Permit reimbursement for access and usage of the system. (887)

Applicable Standards. Table 4-72 presents the standards that are to be followed when implementing performance and usage management services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Simple Network Management Protocol (SNMP)	InterNIC Internet Standard 0015:1990	This specification provides the protocol for collecting operational and management information from a wide range of network devices.	Architecturally Significant
Universal Measurement Architecture (UMA)	The Open Group C427:1997	This specification defines a system for collecting and managing performance data in a distributed open systems environment.	
Structure of Management Information for TCP/IP-based Intranets	InterNIC Internet Standard 0016:1990	This specification provides the common definitions for the structure and identification of management information for TCP/IP-based intranets.	
Management Information Base - II (MIB-II)	InterNIC Internet Standard 0017:1991	This specification defines the second version of the Management Information Base (MIB-II) for use with network management protocols in TCP/IP-based intranets.	Architecturally Significant

Table 4-72. Performance and Usage Management Standards

Representative Products. Table 4-73 lists representative products that support performance and usage management services.

Product Name	Vendor	Product Type	Applicable Standards
Cabletron's SPECTRUM For Open Systems	Cabletron Systems Inc.	Network Management	InterNIC Internet Standard 0015 MIB-II

Product Name	Vendor	Product Type	Applicable Standards
Unicenter TNG	Computer Associates, Inc.	Network Management	InterNIC Internet Standard 0015 MIB-II
HP OpenView	Hewlett-Packard Company	Network Management	InterNIC Internet Standard 0015 MIB-II
Desktop Management Suite (DMS) 3.0.1	Seagate Software-Information Management Group	Network Management	InterNIC Internet Standard 0016
Tivoli Management Framework	IBM Corporation	Network Management	InterNIC Internet Standard 0015 MIB-II

Table 4-73. Representative Performance and Usage Management Products

4.11.5 Software Distribution and Configuration

Description. Software distribution and configuration services move applications from a central computer to remote servers or desktops. Current releases of software may be delivered and installed in large, distributed environments to ensure that users have access to the correct version and to help avoid version compatibility issues. Software distribution services also support effective enforcement of software licensing agreements.

Configuration services assure easy and accurate configuration of application software distributed throughout a system. Configuration services collect configuration information about all network resources. The configuration of these resources is then controlled to ensure that changes are made only through defined processes.

Correlation to EASI/ED. Within EASI/ED, software distribution and configuration services may be used to provide the following support.

- The system shall provide statistical sampling and modeling capabilities to support Title IV program oversight functions.
- The system shall receive aid award package information from schools, including participation budget information (tuition and fees, room and board, books and supplies), residency, class level, enrollment status, and Federal aid awarded to the participant.

Applicable Standards. Table 4-74 presents the standards that are to be followed when implementing software distribution and configuration services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments

Standard Title	Organization and Standard Name	Description	Comments
Distributed Software Administration - DCE Interoperability (XDSA-DCE)	The Open Group CAE Specification C430:1997	This specification's use of the DCE RPC technology to provide interoperability between implementations, where a full distributed software administration environment is defined. It is based on IEEE 1387.2 and adds enhanced update and patch facilities for software distribution.	
Systems Management: Distributed Software Administration (XDSA)	The Open Group C701:1998	This specification defines a software- packaging layout, a set of information maintained about software, and a set of utility programs to manipulate that software and information. XDSA specifies distributed operations without specifying the mechanism for how it is to be achieved. It is based on IEEE 1387.2 and adds enhanced update and patch facilities for software distribution.	
Portable Operating Systems Interface (POSIX) System Administration	IEEE 1387.2	This specification describes user and group databases, user and group account administration, concept of user's home directory, and utilities to manage these entities. IEEE 1387.2 is a subordinate of IEEE 1387.	Architecturally Significant

Table 4-74. Software Distribution and Configuration Management Standards

Representative Products. Table 4-75 lists representative products that support software distribution and configuration services.

Product Name	Vendor	Product Type	Applicable Standards
HP OpenView - Software Distributor	Hewlett-Packard Company	Software Distribution	IEEE 1387.2
PLATINUM AutoXfer	PLATINUM technology, Inc.	Software Distribution	IEEE 1387.2
Systems Management Server	Microsoft Corporation	Software Distribution	Microsoft Proprietary
SunSoft Solstice Domain and Site Managers	Sun Microsystems, Inc.	Network Management	IEEE 1387.2

Table 4-75. Representative Software Distribution and Configuration Management Products

4.11.6 User and Group Management

Description. User and group management services provide traditional system administration interfaces. These tools are mechanisms for network and system administrators to use when implementing management policies across a system.

Correlation to EASI/ED. Within EASI/ED, user and group management services may be used to authorize ED users access to the system, grant file and resource permissions and manage applications across multiple platforms.

Applicable Standard. Table 4-76 presents the standard that is to be followed when implementing user and group management services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Portable Operating Systems Interface (POSIX) System Administration	IEEE 1387	This administration describes user and group databases, user and group account administration, concept of user's home directory, and utilities to manage these entities.	Architecturally Significant

Table 4-76. User and Group Management Standard

Representative Products. Table 4-77 lists representative products that support user and group management services.

Product Name	Vendor	Product Type	Applicable Standards
HP Openview - IT Administration	Hewlett-Packard Company	Network Management	IEEE 1387
SunSoft Solstice Domain and Site Managers	Sun Microsystems, Inc.	Network Management	IEEE 1387

Table 4-77. Representative User and Group Management Products

4.11.7 Inter-relationships and Preferred Standards

The fundamental underlying protocol for network management is SNMP. All network devices and all mainstream enterprise management applications adhere to this standard. Other standards in this area of the *COE* are compatible with SNMP. There are other related protocols in the systems and network management services area that specify higher levels of management and are also important (e.g., MIB-II). Beyond this, systems and network management is dominated by a small group of product vendors (e.g., Computer Associates, Inc., IBM Corporation, Hewlett Packard Company). EASI/ED enterprise management product selection will likely be influenced more by operational features and third party product support than by compliance with a list of standards.

Software distribution standards are also included in this service area. Software distribution is a very difficult problem for which the industry is still seeking a good solution. The dominant products for this purpose include Microsoft's SMS and IBM's Tivoli. The *COE* specifies a related set of DCE standards, but acknowledges that products such as SMS and Tivoli will dominate practical solutions for some time.

4.12 Communication Services

Communication services are part of the external environment interface within the EASI/ED TRM. These services provide the communications infrastructure needed to move information across systems and to support data access and interoperability among distributed applications working in homogenous or heterogeneous networked environments.

Subsection 4.12.1 presents strategic findings for communications services. Subsection 4.12.2 briefly describes communications services, EASI/ED standards for this service, and representative products. Subsection 4.12.3 concludes the communication services subsection with a discussion of component interrelationships and preferred standards.

4.12.1 Strategic Findings

Communications services and their associated standards are fundamental to establishing interoperability. These services will form the primary interface among EASI/ED subsystems, between EASI/ED and its users, and between EASI/ED and external systems. Most mainstream communications service standards are mature and are well supported by the industry. Internet popularity has bolstered interoperability between different products and platforms based upon Transmission Control Protocol / Internet Protocol (TCP/IP) and related standards. EASI/ED will benefit from this effect.

TCP/IP is recommended as the transport service standard for wide area networks (WANs) and local area networks (LANs). The Internet positioned TCP/IP as a leading standard for end-to-end connectivity for both LANs and WANs. The current version of IP, IP version 4, is widely supported, and the upcoming version (IP version 6) provides a future growth path that should be monitored for future adoption by EASI/ED. It is anticipated that IP version 6 will not become the dominant standard until well into the next century.

At the lower level of the LAN protocol stack, the Ethernet family of standards is selected for EASI/ED. Ethernet is flexible in terms of wiring requirements and throughput capacities. All new LANs should be configured to support both 10 megabits per second (Mbps) and 100 Mbps Ethernet. The high-end 1 gigabit per second (Gbps) Ethernet is still a very new standard, but should be monitored by EASI/ED for future adoption. Protocols rejected for LANs include Token Ring and Asynchronous Transfer Mode (ATM) (although ATM is recommended for WANs). Token Ring has not received industry support, in comparison to Ethernet, resulting in substantially higher implementation costs in general. ATM as a desktop or LAN standard is still very new. Although it has been touted by some as promising a single end-to-end protocol (stretching over LANs and WANs to connect two desktops or a desktop to a server), there are still technical and practical obstacles to fulfilling its promise.

Two principal protocols are recommended for WANs: Frame Relay, for low to medium speeds fractional to T1 (1.55 Mbps), and ATM, for high speeds (155 Mbps-2.4 Gbps).

4.12.2 Communications

Description. Communications services are based upon the Open Systems Interconnection (OSI) model, which provides a framework for defining standards that can link heterogeneous systems.

Correlation to EASI/ED. Within EASI/ED, communications services will be used to connect users to EASI/ED, allow EASI/ED to connect with other systems, share common resources and allows applications or COTS to access data.

Applicable Standards. Table 4-78 presents the standards that are to be followed when implementing communications services for EASI/ED.

Standard Title	Organization and Standard Name	Description	Comments
Internet Protocol (IP)	InterNIC Internet Standard 0005:1981	The function or purpose of Internet Protocol is to move datagrams, blocks of data, through an interconnected set of networks. This is done by passing the datagrams from one Internet module to another until the destination is reached.	Architecturally Significant
User Datagram Protocol (UDP)	InterNIC Internet Standard 0006:1980	This protocol provides a procedure for application programs to send messages to other programs with a minimum of protocol mechanism.	
Transmission Control Protocol (TCP)	InterNIC Internet Standard 0007:1981	The TCP provides for reliable inter-process communication between pairs of processes in host computers attached to distinct but interconnected computer communication networks.	Architecturally Significant
Simple Network Management Protocol (SNMP)	InterNIC Internet Standard 0015:1990	SNMP is used to communicate management information between the network management stations and the agents in the network elements.	
Nonstandard for transmission of IP datagrams over serial lines: Serial Line IP (SLIP)	InterNIC Internet Standard 0047:1993	SLIP is commonly used for point-to-point serial connections running TCP/IP.	Architecturally Significant, De Facto
The extensions required to a host implementation of the Internet Protocol (IP) to support multicasting. - IP Multicasting	IETF RFC 1112:1992	IP multicasting is the transmission of an IP datagram to a host group, which is a set of zero or more hosts identified by a single IP destination address. A multicast datagram is delivered to all members of a destination host group.	Emerging

Standard Title	Organization and Standard Name	Description	Comments
Point-to-Point Protocol (PPP)	IETF RFC 1661	The Point-to-Point Protocol is designed for simple links, which transport packets between two peers. These links provide full-duplex simultaneous bi-directional operation, and are assumed to deliver packets in order.	
Resource ReSerVation Protocol (RSVP) - Version 1 Functional Specification	IETF RFC 2205:1997	Resource reservation setup protocol designed for an integrated services Internet	
Multi-Protocol Over ATM Specification v1.0	ATM Forum MPOA v1.0	This standard enables switches to perform routing, and thereby simplifies ATM's connection to legacy networks.	Emerging
Next Generation Internet Protocol	IETF IPng	IPng is a new version of the Internet Protocol, designed as a successor to IP version 4. The formal name of this protocol is IPv6.	Emerging
X.25 Packet Layer Protocol	ITU X.25:1996	This standard specifies the protocol to be used between a Data Terminal Equipment (DTE) and a Packet Switched Public Data Network (PSPDN), when the access is made by a dedicated circuit.	Architecturally Significant
Protocols for X/Open PC Interworking: (PC) NFS	The Open Group X/Open D030:1990	This specification covers networking between PCs running DOS and Open Systems running PC-NFS.	
Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method	IEEE 802.3:1985	Provides standard for Ethernet.	Architecturally Significant
Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mb/s Operation	IEEE 802.3u:1995	Provides standard for Fast Ethernet.	Architecturally Significant
Local Area Networks: Architecture and Overview	IEEE 802.1:1985	This standard/document provides an overview to the family of IEEE 802 Standards, and defines compliance with the family of IEEE 802 Standards.	

Standard Title	Organization and Standard Name	Description	Comments
Profiles for Open Systems Internetworking Technologies (POSIT)	NIST FIPS Pub 146-2:1995	POSIT provides for use of several protocol suites that are widely available in U.S. and international markets, including GOSIP and TCP/IP.	
Integrated Services Digital Network (ISDN)	NIST FIPS Pub 182:1993	Defines the generic protocols necessary to establish transparent ISDN connections among government networks and between government and conformant common carrier networks.	
Dynamic Host Configuration Protocol	IETF DHCP:1997	The Dynamic Host Configuration Protocol (DHCP) provides a framework for passing configuration information to hosts on a TCP/IP network.	
Asymmetric Digital Subscriber Line (ADSL)	UAWG ADSL:1998	ADSL is a technology that uses existing phone lines for high-speed communications up to 30 times faster than today's modems.	Emerging
ATM Adaptation Layer for Constant Bit Rate Services Functionality and Specification	ANSI T1.630:1993	This standard is for the Adaptation Layer. The ATM Forum is developing standards for the Physical layer and the network interface.	
Frame Relaying Bearer Service - Architectural Framework and Service Description	ANSI T1.606:1990	This standard establishes an architectural framework within which frame-relaying service is described. This standard specifies a framework for frame-relaying service in terms of user-network interface requirements and general interworking requirements.	Architecturally Significant

Table 4-78. Communications Standards

Representative Products. Table 4-79 lists representative products that support communications services.

Product Name	Vendor	Product Type	Applicable Standards
Routers, switches, and other networking hardware	Bay Networks, Inc.	Communication	InterNIC Internet Standard 0006, 0007, and 0015, ATM, IEEE 802.3

Product Name	Vendor	Product Type	Applicable Standards
Routers, switches, and other networking hardware	Cisco Systems, Inc.	Communication	InterNIC Internet Standard 0006, 0007, and 0015, ATM, IEEE 802.3
Routers, switches, and other networking hardware	3Com Corporation	Communication	InterNIC Internet Standard 0006, 0007, and 0015, ATM, IEEE 802.3
Routers, switches, and other networking hardware	Cabletron Systems, Inc.	Communication	InterNIC Internet Standard 0006, 0007, and 0015, ATM, IEEE 802.3

Table 4-79. Representative Communications Products

4.12.3 Inter-relationships and Preferred Standards

The communications services area defines a long list of standards that map to a number of LAN and WAN capacity options for EASI/ED. The unifying standard is TCP/IP -- a fundamental transport protocol that spans the entire enterprise. The preferred standards can be summarized by looking at each piece of the prospective EASI/ED communications architecture.

- **WAN.** The legacy protocol for wide area networking is X.25 -- a limited standard in terms of functionality, capacity, and performance. New networks are not being implemented with this protocol. Frame relay and router networks are the most frequent choices now based upon cost and ease of operations. This is the preferred standard. A fundamental decision for the EASI/ED WAN will be if and when to adopt ATM technology. ATM has been termed the "future proof" communications standard because of the almost unlimited capacity it can provide. However, this capacity comes at dramatically increased cost and technical complexity. The decision to migrate to an ATM-based WAN should be made based upon EASI/ED traffic and growth requirements, as they are better known.
- **LAN.** Currently there are few communications applications that cannot be handled by a properly configured 10 Mbps Ethernet LAN. This is the preferred standard. However, because building infrastructure is so resource-intensive, EASI/ED LANs should be designed with the objective of easy upgrade to 100 Mbps capacity.

Telephone-based Connectivity. This is the area where there are many standards choices, emerging technologies, and risks. The preferred method of telephone connectivity is public switched telephone network (also known as the local telephone company). Current modem standards support up to 56 Kbps data rates and provide adequate performance for a large percentage of expected EASI/ED applications. When the public switched telephone network is not fast enough, ISDN is preferred. Other emerging standards such as Asynchronous Digital Subscriber Line (ADSL) promise to provide extremely high data rates and functionality superior

to ISDN; however, ADSL is still very much a future technology with very limited service currently available.

4.7 Summary

Taken together, the services and standards identified in the preceding subsections comprise the substance of the EASI/ED TRM. Figure 4-2 presents the architecturally significant standards within the *COE*, correlated to their associated services.

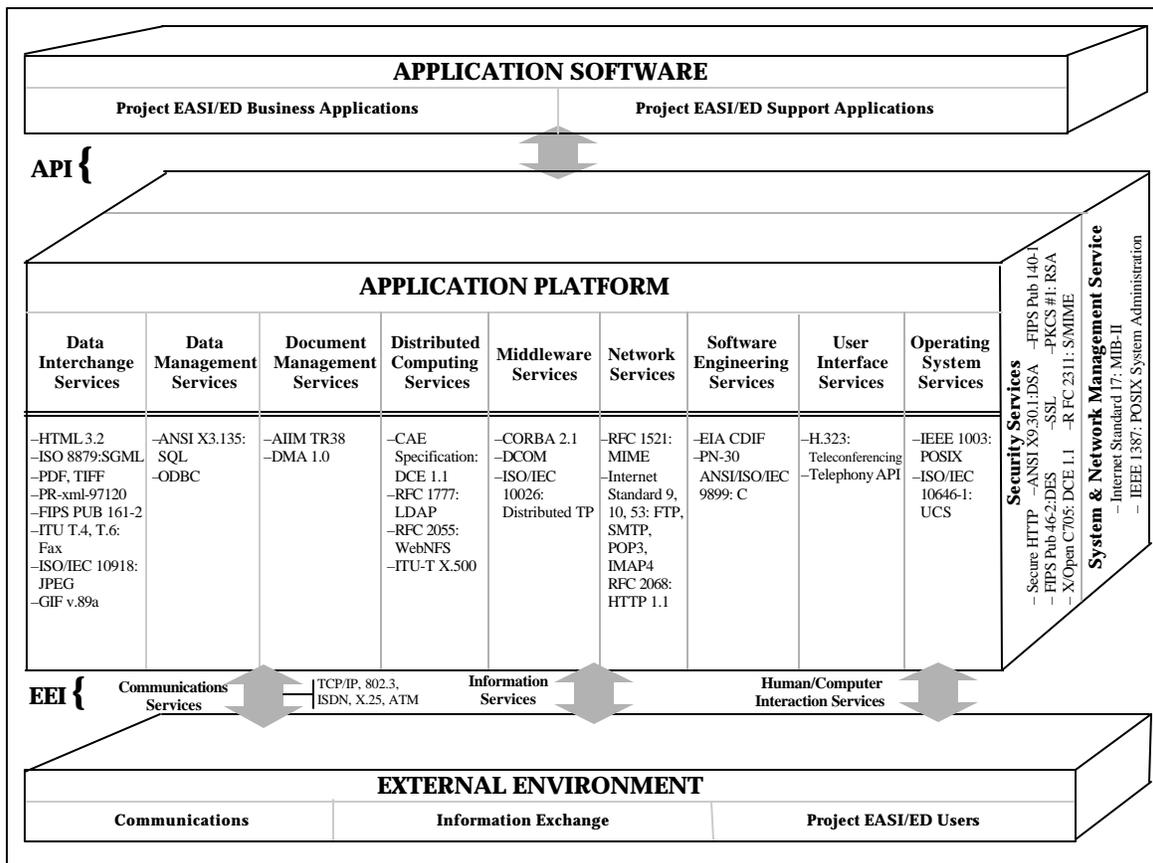


Figure 4-2. Architecturally Significant Standards in the EASI/ED TRM

5. EASI/ED ARCHITECTURE TOPOLOGY

This section provides an overview of a notional architecture topology for the EASI/ED system. An architecture topology identifies the basic physical components (e.g., servers, modems) that make up an architecture, and describes the way in which they are connected. The architecture topology shown in Figure 5-1 is based upon the process and data distribution principles presented in Section 2, the services described in Section 4, and the distribution strategy recommended in the *Project EASI/ED TVTA Report*. It is a notional topology in the sense that it is not the only

possible architecture topology that could implement the Project EASI/ED requirements. It is however a reasonable topology to use as an example, because it includes the major physical components required to provide the services defined in the EASI/ED TRM, and it connects them in ways that are representative of modern information systems design. A definitive topology for the EASI/ED architecture will only be identified at the point that the architecture is designed.

The topology shown in Figure 5-1 can be used to:

- Help tie the EASI/ED services to a real-world physical representation.
- Aid in validating standards and products research by making the interconnection of the various components of the architecture more explicit. The interoperability of standards and products can be more easily judged when viewed in the context of a physical layout.
- Connect the *EASI/ED COE* more recognizably back to the Project EASI vision. It shows how the *COE* components can come together to provide the single point of interface and universal access to information that is central to Project EASI's charter.

Each of the components making up the architecture topology will be described in this section, with the name of the component as presented in Figure 5-1 underlined in the text. Subsection 5.1 describes those components of the topology that lie outside the boundary of the EASI/ED system. Subsection 5.2 describes the components that make up the EASI/ED system itself. While Figure 5-1 provides a diagram of just the topology, Figure 5-2 connects the topology to the services described in Section 4 by identifying which services would be provided by which architectural components.

5.1 External Environment

The External Environment represents the non-ED users of the EASI/ED system and the mechanisms they use to access the system.

The following external users will interact with EASI/ED:

- Individuals include students, parents, financial aid counselors, guidance counselors and other individual users.
- Institutions include traditional schools, community colleges, proprietary schools, and other providers of postsecondary education.
- Other organizations comprises lenders, guarantors, external government agencies, and other members of the community.
- The Outsourcing symbol represents organizations that perform an outsourced function on behalf of ED.

External environment users of the EASI/ED system will access the system using the following mechanisms:

- Telephone and Fax access via the ED Public Branch Exchange (PBX) telephone switch will establish connections between the external environment users and the public-switched telephone network.
- Internet Service Providers (ISP) and Virtual Private Networks (VPN) will let external environment users connect to EASI/ED using the Internet.
- Direct dial to the EASI/ED Modem pool will assist users that do not have Internet access to connect to EASI/ED.
- Authorized community and outsourcing organizations may use a Secure Dedicated Line to connect directly to the EASI/ED WAN for the purpose of data transfer and batch transaction processing.

5.2 EASI/ED

The EASI/ED segment of the topology represents all the architecture components that comprise the EASI/ED system. This segment is divided into three distinct areas:

- DMZ
- Central Site
- Regional Site

Subsection 5.2.1 discusses the DMZ and subsection 5.2.2 discusses the central and regional sites.

5.2.1 DMZ

The acronym, DMZ, is derived from “demilitarized zone” -- a military term for the geographical area between two opponents in which fighting is prevented. The DMZ is an extension of firewall services and is a service provided by most leading firewall products. It allows information (from the private side of the firewall) to be posted outside the firewall so that external environment users can access the information without entering into the private side. It provides protection for servers in the DMZ to help ensure the integrity of information posted to them.

Mobile/Remote ED Users may access EASI/ED via direct dial Modem pools. The modem pools lie outside the firewall but are protected from the external environment by the DMZ.

External environment users who attempt to access EASI/ED will first have their identity authenticated by an authentication server. If ED is making use of a trusted third party (e.g., Verisign) to authenticate user’s identities through such mechanisms as digital certificates, then a Public Authentication Server will authenticate the user. If ED is providing its own authentication services (digital certificate or otherwise) then a Private Authentication Server will authenticate the user. Once users have been authenticated, they are given access to the Internet Servers.

The Internet servers host EASI/ED applications (e.g., EASI/ED Web pages and applications), execute or collect user inquiries, and allow user data entry. Data would be distributed to these servers from EASI/ED databases behind the firewall on an interim basis -- this data would held for short periods of time to support local processing. Alternately, data might be entered by a user and stored on these servers until it is ready to be forwarded to EASI/ED applications lying behind the firewall. This allows convenient access to heavily requested information without risking

unauthorized access to EASI/ED databases. In addition to hosting Web-enabled applications, the Internet servers could also support traditional client/server applications.

5.2.2 Central and Regional Sites

It is anticipated that EASI/ED will have a large number of widely geographically distributed users. To effectively support these users, it may be necessary to create regional computing sites to house replicated copies of EASI/ED data. Regional sites allow the distribution of data closer to its users, have the potential to reduce communication costs and user response times, and offer a high level of scalability and availability. The regional sites will contain all the security, data, and application processing components necessary to support access by users to replicated copies of EASI/ED data via the Internet, LAN, or telephone.

While the regional sites are focused on satisfying external environment user inquiries and on-line updates, the central site is also dedicated to supporting the basic EASI/ED business processes, including large scale imaging and batch transaction processing. It also houses the main data warehousing and decision support functionality. To this end, the central site contains all the types of architectural components that reside at the regional sites, but also has components that provide imaging, central database update, and data warehousing functionality, as well as interfaces to any current Title IV systems that are coexisting with the *COE*.

The components of both the central and regional sites can be grouped into five categories:

- Security components
- Communications components
- Data components
- Processing and applications components
- Support functions components

Each of these categories is described below.

Security

- The Firewall provides EASI/ED with a trusted processing system that permits only selected communication sessions to pass through, including those initiated by authorized remote ED users and by the DMZ Internet servers. With very few exceptions, access to EASI/ED data or equipment from the external environment must be filtered through the firewall. In contrast, ED internal users (at either the central or regional sites) are behind the firewall and do not have to go through it to access the system.

Only carefully controlled information flow is permitted around the firewall. This is limited to voice and fax information, and to carefully selected, trusted, external organizations accessing EASI/ED via a secured dedicated line.

Communications

- The EASI/ED LAN connects internal ED users and computer systems at a single site, either central or regional.

- The EASI/ED WAN provides high-speed connections between LANs, so that for example an ED user at a regional site can access data stored at the central site, or at another regional site.

Data

- The Central Database Server is the single, normalized, non-redundant source of authoritative EASI/ED data. All EASI/ED user and business data resides at this location. Updates to EASI/ED data are made by this server and replicated to EASI/ED regional sites and Internet servers.
- Replicated Database Servers host and control access to data replicated from the central database server. The replicated database servers support queries and reports from all EASI/ED users.
- The Data Warehouse is a data store fed from the central database that is optimized to support Executive Information Systems (EIS) and Decision Support Systems (DSS). It includes derived and aggregated data, and may be supplemented by data from other, external, data stores.

Processing

- Transaction Processors monitor and manage transactions, ensuring integrity and consistency of updates to the central database. They can also balance workloads across servers to most efficiently process transactions where there are multiple requesters competing for computing resources.
- Internet Servers connected to the ED LAN host intranet applications for use by central and regional ED users. Because these servers are providing services to ED users only, they are located behind the firewall.
- Application Servers host the EASI/ED sub-systems and also host support applications.
- The EDI/Encryption Server will support all EDI data interchange and transaction transmission between EASI/ED and its trading partners.

Support functions

- All external environment telephone and fax interactions with EASI/ED will be handled by Fax, Interactive Voice Response (IVR), and Computer Telephony Integration (CTI). The IVRU will provide automated voice response, call routing, and telephony-based application invocation services support. The CTI Application Server will collect transaction and caller identification/profile information from the IVRU and route this information (and the call) to customer service representatives or transaction processors.
- Postal mail correspondence will be digitized by the Scanner and converted to machine readable form using the Imaging Server.
- Servers are provided to support E-mail, File , Telnet, and Print Server functionality.
- As explained earlier, authorized community and outsourcing organizations may use a secure dedicated line to connect directly to the EASI/ED WAN for the purpose of data

transfer and batch transaction processing. These data transfers and batch processing requests will be received by the External Organizations Interface Server.

- The System and Network Management Server supports the functionality to monitor and control operations of the individual applications, databases, operating systems, platforms, telecommunications and data communications systems, networks, and user interactions with these resources including system backup and recovery functions, software distribution and configuration, performance, and usage management.
- If Current Title IV Systems coexist with the *EASI/ED COE*, either because Project EASI/ED is still in a transition phase or because a current system is to be retained permanently as part of EASI/ED, then these systems will integrate with the rest of the EASI/ED system through a set of interfaces.