

## Appendix C

### Candidate Architecture Technologies

This appendix describes the architecture technologies that are common to each of the candidate Project EASI/ED candidate framework architectures. It describes commercially available product offerings for the following architecture components:

- EDI Server Software
- E-mail Server Software
- RDBMS Software
- OLTP Monitor Software
- Internet/World Wide Web Server Software
- Interactive Voice Response Software
- X Window System Server Software
- Data Warehouse Server Software
- Executive Information/Decision Support Software
- Output Management Server Software

The candidate architectures described in Subsection 5.4 are comprised of the components recommended within this subsection. Please refer to Appendix B for more detailed information regarding the technologies described within this subsection.

Each component description comprises the following elements:

- **Component overview.** A brief overview of the component.
- **Vendor information.** The vendor product recommended to implement the component.
- **Features.** Major design features of the recommended product.
- **Logical software interfaces.** A description of how the component will be used within the candidate framework architectures.
- **Supported requirements.** The *Project EASI/ED BARD* (July 1997) requirements that the component could support.

## Component: Electronic Data Interchange Server Software

### Component Description:

EDI, defined as "the transmission of business transaction information in computer-readable form between organizations in a standard format," is an electronic means to improve the quality and availability of business information. Today more than 100 different types of transactions can be exchanged via EDI. The American National Standards Institute (ANSI) Accredited Standards Committee X12 (ASC X12) estimates that 14,000 organizations use the EDI standard. EDI benefits are:

- Reduction of paperwork and associated savings.
  - One-time data entry.
  - Reduced errors, improved error detection.
  - Higher productivity without increasing staff.
  - Reduced clerical workload.
  - Reduced postage and handling costs.
  - Reduced printing costs of forms.
- More timely communications.
  - Rapid exchange of data.
  - Reduced mail/delivery time.
  - Increased customer service quality.
- Uniform communications with trading partners.

EDI is facilitated by a technology infrastructure, Figures C-2 and C-3, which permits standardized information exchanges between computer-based processes. EDI Server Software, which transforms data to and from a defined EDI standard format (e.g., ANSI ASC X12 standard), is a fundamental part of this technical infrastructure.

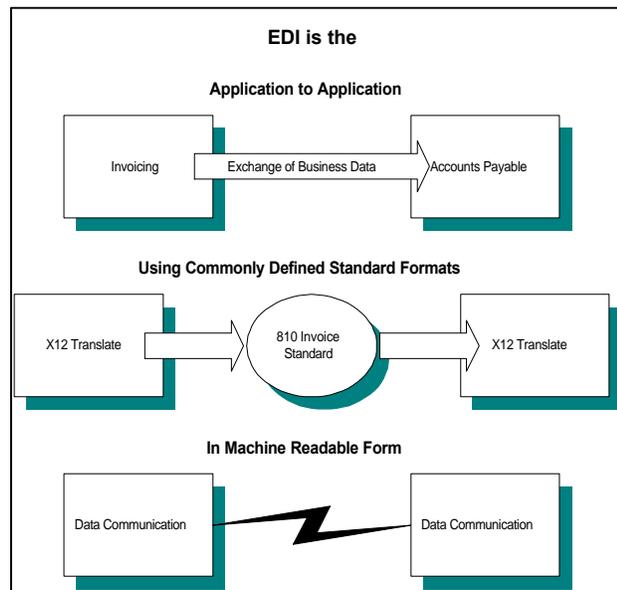


Figure C-1. EDI

Within the Project EASI/ED candidate framework architectures, EDI Server Software could be used to implement the business requirements listed within Exhibit C-1.

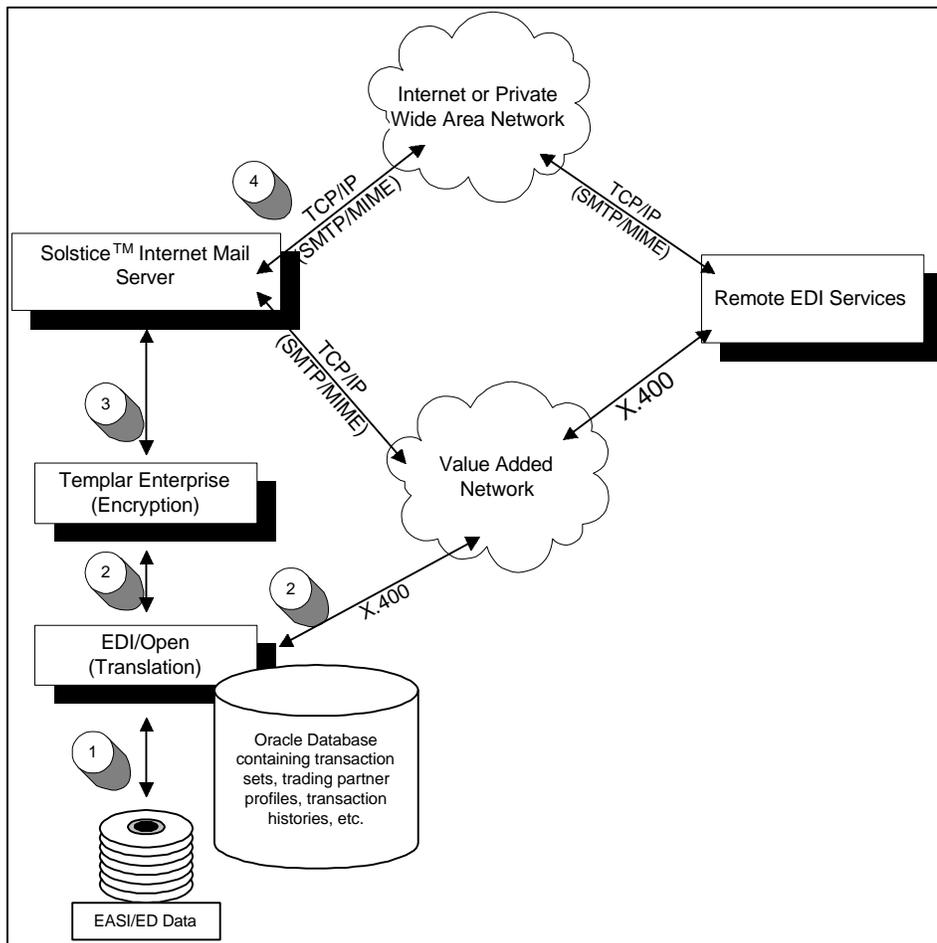
Vendor	Product	Operating Environment
Premenos Corporation	Templar Enterprise 2.0	IBM OS/400, AIX (RISC System/6000 & PowerPC), Hewlett-Packard HP-UX (9000/800, 9000/700, and Series K), Sun Solaris (SPARC), Windows NT (Intel)
Premenos Corporation	EDI/Open	IBM OS/400, AIX (RISC System/6000 & PowerPC), Hewlett-Packard HP-UX (9000/800, 9000/700, and Series K), Sun Solaris (SPARC), Windows NT (Intel)

Figure C-2. EDI Architecture Implementation Technology

<b>Feature</b>	<b>EDI/Open</b>	<b>Templar Enterprise</b>
Completely supports all versions of ANSI X12 standardized transaction sets	✓	
Provides reliable data management services for managing and storing trading partner configurations, EDI standards, and document tracking information	✓	
Provides GUI-based business data translation services and utilities	✓	
Provides a published application programming interface (API) for integrating EDI translation technologies with business applications	✓	
Facilitates EDI-based electronic commerce over TCP/IP Network transport technologies		✓
Provides secure electronic commerce via encryption services that utilize: <ul style="list-style-type: none"> <li>- Secure/Multipart Internet Mail Extensions (S/MIME) protocol (the Internet standard for secure electronic mail)</li> <li>- RSA (512 and 1024 bit) public key cryptography</li> <li>- Secure Sockets Layer (SSL) 3.0 protocol</li> </ul>		✓
Facilitates EDI-based electronic commerce via the Simple Mail Transport Protocol (SMTP) – the Internet standard for electronic mail		✓
Interoperates with and Post Office Protocol (POP3 compliant) electronic mail servers via SMTP		✓
Provides document non-repudiation and origination confirmation services via digit signature services based on RSA public key encryption technologies		✓
Provides TCP/IP-to-Value Added Network (VAN) Gateway services – allowing asynchronous communication with trading partners subscribing to VAN services		✓
Provides system, data, and multi-user security administration and management services that control access and modification of trading partner profiles, and other important system configuration resources		✓
Allows documents to be posted to Web sites via the Hypertext Markup Language (HTTP) and Secure HTTP protocols		✓

**Figure C-3. EDI Technology Features**

Figure C-4 illustrates logical software interfaces and describes how the Premenos EDI/Open and Templar Enterprise technologies will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-4. Logical Software Interfaces for EDI**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to the Project EASI/ED user community:

- Streamlines, simplifies, and improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Reduces costs associated with the management and delivery of postsecondary education student financial aid services.
- Delivers reliable and timely student financial aid assistance to students, prospective students and enterprises associated with postsecondary education.
- Allows trading partners without subscriptions to Value Added Network (VAN) services or significant information technology resources to communicate EDI transactions via public networks and electronic mail.
- Improves the quality and speed in which transactions can be communicated and processed by postsecondary student financial aid delivery systems.
- Allows ED, government agencies, schools, guarantee agencies, lenders, and others within the postsecondary student financial aid delivery community to efficiently and effectively diminish fraud, waste, abuse, and mismanagement.
- Reduces complexity and allow trading partners – many of whom have invested in disparate information technology – to work together.

- Provides EDI users with a single point of interface with the postsecondary education community.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Premenos EDI/Open and Templar Enterprise technologies to deliver improved student financial aid delivery services:

- ① EDI transaction data will be received and sent by ED using the EDI/Open and Templar Enterprise solution suite. Specifically, when sending information to trading partners, EDI/Open will import transaction data from flat file sources. Once imported, EDI/Open will use X12 transaction sets and trading partner profiles (stored within an Oracle relational database) to organize the data into standardized formats and direct the output of the translator (exchange data) to the correct delivery mechanism and trading partner.
- ② Once EDI/Open has translated the data, resulting exchange data can be delivered to trading partners. This data transmission can be accomplished via VAN facilities, many of which are directly supported by EDI/Open. Alternatively, exchange data can be transmitted via public networks, like the Internet. In cases where the Internet is selected as the delivery medium, Templar Enterprise is used to secure transaction exchange data, confirm transaction delivery, perform non-repudiation, and coordinate delivery.

Templar Enterprise maintains data confidentiality via cryptography<sup>1</sup>. Digital signatures are used by Templar Enterprise to verify data integrity and guarantee nonrepudiation. Specifically, when Templar Enterprise receives an EDI exchange, the trading partner profile is inspected to determine whether encryption is required prior to transmission. If the trading partner profile indicates that encryption is required, Templar uses Secret-key cryptography<sup>2</sup> to encrypt the data with a randomly generated DES key. Once the exchange data has been encrypted, Templar Enterprise encrypts the DES key using Public/Private-Key cryptography<sup>3</sup> and the trading partners RSA public key.

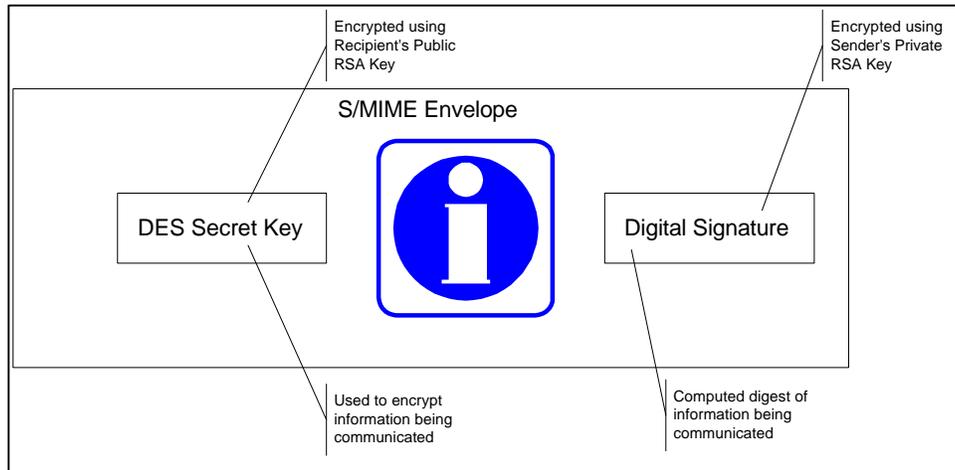
- ③ To further ensure the security of the exchange data, Templar Enterprise creates a message digest, which is a mathematical summary of the exchange data. Message digests guarantee data integrity, as the receiving trading partners will only be able to recalculate the digest if the contents of the message remain unchanged. Finally, the message digest will be encrypted with ED's RSA private key. Nonrepudiation is guaranteed when the receiving trading partner successfully decrypts the message digest with ED's RSA public key.

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<sup>1</sup> Involved encryption and decryption of data. Encryption is the transformation of data, using algorithms, into a form that is indecipherable by anyone who does not have a key to decrypt the data.

<sup>2</sup> Referred to as symmetric-key cryptography, requires both the sender and receiver to have the key that is used to both encrypt and decrypt the data. The Data Encryption Standard (DES) is the standard for single-key cryptography. DES is defined, endorsed, and regulated by the U.S. Federal Government. RSA (RC2 and RC4) are proprietary standards that are commonly used when one or more trading partners are outside the U.S.

<sup>3</sup> Referred to as asymmetric cryptography, requires two keys. Each trading partner publishes and exchanges a public key, which is used to encrypt data. The other key remains secret and is used to decrypt data that has been encrypted with the corresponding public key. RSA is the standard for public/private key encryption as well as digital signatures.



**Figure C-5. Components of S/MIME Envelope**

- ④ Finally, Templar packages the encrypted EDI exchange data, encrypted DES key, and digital signature within an S/MIME<sup>4</sup> envelope and forwards the package to the Solstice Internet Mail Exchange Server, where it is transmitted via electronic mail, as described in the Electronic Mail Server Software section and shown in Figure C-5.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1224	The system shall receive disbursement records, origination records, adjustments, and cancellations from schools and from fund sources.
1240	The system shall accommodate standard formats for origination, disbursement, adjustment, and cancellation records for all Title IV student financial assistance programs.
1484	The system shall transfer Direct Loans among direct loan servicers.
1510	The system shall provide disbursement records, adjustments, and cancellations to ED Regional Offices for schools that have been placed on ED's reimbursement program (i.e. the schools that must disburse funds to students prior to ED transferring any funds to the schools).
1520	The system shall receive accepted/rejected disbursement records, adjustments, and cancellations from ED Regional Offices.
1600	The system shall provide student disbursement rosters to schools. The disbursement roster shall list the students for whom the disbursement being made to the school intended and the award amount that each student is expected to receive.
1610	The system shall receive loan holder interest and special allowance invoices from the loan holders.
1640	The system shall receive administrative expense allowance (AEA) invoices from guarantee agencies.
1650	The system shall receive reinsurance fee data from guarantee agencies.

**Exhibit C-1. EDI Requirements**

<sup>4</sup> Secure Multipurpose Internet Mail extension, an e-mail security specification. S/MIME encrypts and authenticates e-mail messages for transmission over Simple Mail Transfer Protocol (SMTP) networks. S/MIME allows digital signatures. Keys, and encrypted data into one message envelope.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1692	The system shall provide the ability to register participants for the Selective Service if the participant requests to do so.
1750	The system shall verify with Federal, state, and other organizations, through retrieval and matching of applicant information, the eligibility of an applicant for Title IV financial aid.
1870	The system shall receive aid award and funding information from state agencies.
1920	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.
1960	The system shall receive financial aid simulation modeling information (e.g. average salaries for various professions) from state departments of labor.
2178	The system shall receive information on underpayments made when paying off a component loan of a Direct consolidation Loan and authorize payments to the loan holder.
2179	The system shall send refunds to participants in case of overpayments made by the participant's on the final payment of a Direct Loan or of a loan assigned to ED for debt collection.
2182	The system shall receive information on Direct Consolidation Loan payoff overpayments made by ED to loan holders and reduce the balance of the Direct Consolidation Loan by the overpayment amount.
2191	The system shall provide lenders who are consolidation agents with FFELP consolidation requests made by participants.
2192	The system shall receive the acceptance or rejection of consolidation requests from lenders.
2252	The system shall receive loan payment information and update loan principal, interest, collection charges, and late payment fee information as appropriate for direct Loans and those loans assigned to ED for debt collection.
2320	The system shall verify the unemployment status of participants through matches with state departments of labor.
2330	The system shall obtain federal employment confirmation by matches with the Department of Defense and the U.S. Postal Service for those participants who are deemed eligible for Federal wage garnishment.
2340	The system shall provide assistance in skip-tracing to guarantee agencies, lenders, and schools, through matches with the IRS, Postal Service, and state agencies.
2350	The system shall provide assistance in skip-tracing by allowing loan holders, loan servicers, and collection agencies to update address information for participants whose loans they service.
2370	The system shall verify participant income with the IRS when the participant selects income contingent repayment terms.
2390	The system shall receive notification of a deferment and/or forbearance initiated by a lender.
2430	The system shall notify all of the participants loan holders of a participant's request for a deferment or a forbearance on a loan.
2440	The system shall notify all of the participant's loan holders of a participants deferment or forbearance decision made by an individual loan holder.
2522	The system shall provide automatic payroll deduction information to the participant's bank for loans held by ED.

**Exhibit C-1. EDI Requirements (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
2590	The system shall notify the lender of a participant's request to refinance their loans.
2620	The system shall receive updated loan balance information from schools and lenders for the loans that they hold.
2645	The system shall refer debts (i.e. defaulted loans assigned to ED, grant overpayments assigned to ED, and defaulted Direct Loans) to collection agencies and to Treasury, Financial Management Service for collection.
2660	The system shall provide information on participants with defaulted loans to credit bureaus.
2670	The system shall provide defaulted loan information to debt collection agencies collecting on defaulted loans on behalf of ED.
2680	The system shall provide defaulted loan alerts to the Department of Housing and Urban Development.
2700	The system shall receive grant overpayment from schools.
2730	The system shall request state and Federal offsets of monies due to participants who have one or more defaulted loans being serviced by the system.
2800	The system shall provide claims collection litigation reports (CCLR) to the Department of Justice litigation for loans that ED holds.
2820	The system shall require their servicers to report enrollment data, such as percentage enrollment, credit hours, and clock hours on all enrolled students.
2850	The system shall provide loan holders the participant enrollment changes that affect aid status.

**Exhibit C-1. EDI Requirements (cont'd)**

## Component: Electronic Mail Server Software

### Component Description:

E-mail processing is facilitated via user agents (UA) and message transfer agents (MTAs). User agents are used to interact with users and arrange for user requests to be handled by a network of MTAs. Once a user's message has been created and queued via a UA, the MTA network is responsible for delivering the mail to the recipient. Electronic Mail Server Software is primarily responsible for providing MTA services, but can also provide UA facilities.

To effectively deliver electronic messaging services via the Internet, Electronic Mail Server Software should support three mail transfer protocols: Simple Message Transfer Protocol (SMTP), Post Office Protocol (POP), Interactive Mail Access Protocol version 4 (IMAP4). These standardized protocols facilitate communication among heterogeneous systems and Electronic Mail Server Solutions. In particular, SMTP is commonly used to transfer mail between servers – commonly referred to as mail hubs. POP, is a batch protocol that is almost universally used to collect mail from Internet Service Providers (ISPs). POP is also widely used to move mail from mail hubs to the systems providing UA services – electronic mail clients. IMAP4 is a client-to-server protocol that is used to transfer descriptive mail message headers, between the mail hub and UAs. IMAP4 is used to reduce network overhead associated with transferring entire mail files, which often include unwanted content, between the mail hub and the UA. That is, using IMAP4 users can review, select, and delete mail file contents without having to first download the entire mail file from the mail server.

Electronic mail is the most commonly used electronic communication technology currently in use within the Internet marketplace today. This is largely the case because organizational requirements for global, inter-enterprise communication services can often be satisfied via widely available, reliable, practical, and scalable, high-speed electronic mail solutions, described in Figures C-6 and C-7. With this in mind, the Project EASI/ED candidate framework architectures, could use Electronic Mail Server Software to implement the business requirements listed in Exhibit C-2.

Vendor	Product	Operating Environment
Sun Microsystems Inc.	Solstice Internet Mail Server v2.0	Sun Solaris 2.5 or higher (SPARC, Intel)

Figure C-6. E-Mail Architecture Implementation Technology

Feature	Solstice
Operates as a native Internet standards-based solutions that supports SMTP and MIME server-to-server communication	✓
Supports the POP3 Internet standard – facilitating communication with the vast POP3 user community, who numbered more than 8.5 million in 1996 <sup>5</sup>	✓
Supports the IMAP4 specification, allowing: <ul style="list-style-type: none"><li>- Telecommuting and nomadic users to operate (compose messages, etc.) in disconnected mode</li><li>- Messages and attachments to be selectively downloaded</li></ul>	✓

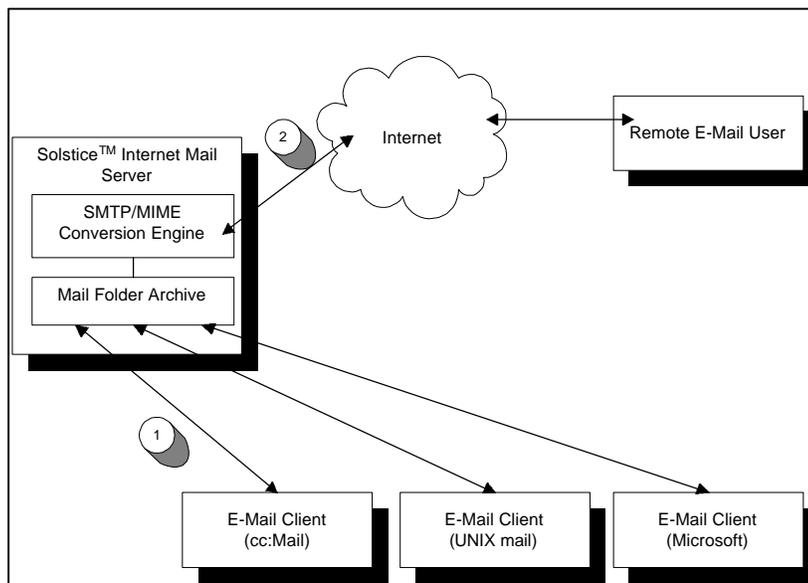
Figure C-7. E-Mail Technology Features

<sup>5</sup> According the International Data Corporation, as reported by Sun Microsystems

Feature	Solstice
Provides a highly scalable solution <sup>6</sup> capable of supporting 1,800 simultaneous, active users <sup>7</sup>	✓
Supports all client types for all users simultaneously – allowing a single user to use a POP3 e-mail client on a laptop, an IMAP4 client on a desktop, and /var/mail via a UNIX system without administrative assistance or configuration changes.	✓
Interoperable with a heterogeneous e-mail client software base, including: <ul style="list-style-type: none"> <li>- Lotus Mail 4.5</li> <li>- Qualcomm Eudora Pro 3.0</li> <li>- Microsoft Exchange</li> <li>- Microsoft Outlook</li> <li>- Netscape Navigator™ 3.01</li> <li>- Netscape Communicator</li> <li>- Sun HotJava™ Views™</li> <li>- Microsoft Internet Explorer</li> <li>- UNIX sendmail clients</li> </ul>	✓

**Figure C-7. E-Mail Technology Features (cont'd)**

Figure C-8 illustrates logical software interfaces and describes how the Solstice Internet Mail Server will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-8. Logical Software Interfaces for Email**

<sup>6</sup> Hardware used in benchmark: Sun Microsystems Ultra 1 server, with 448 MB RAM running on a single CPU at 143 Mhz.

<sup>7</sup> According to Sun Microsystems, an active e-mail user is one who accesses the server at least every 5 minutes, reading messages continuously, and making necessary changes and updates. The number of simultaneously supported active users should not be compared with other figures that may simply quote the number of user accounts on a server.

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to Project EASI/ED user community:

- Improves the postsecondary education community's ability to effectively reach and support a wider range of customers.
- Streamlines, simplifies, and improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Delivers reliable and timely student financial aid assistance to students, prospective students and enterprises associated with postsecondary education.
- Reducing costs, such as postage, associated with the management and delivery of postsecondary education student financial aid services.
- Allows ED, trading partners, institutions, and students – many of whom use disparate electronic mail technologies – to effectively and efficiently communicate.
- Reduces operations and maintenance costs associated with managing the multiple electronic mail vendor solutions that would be required without a standard-based electronic mail solution.
- Allows ED to notify, provide, and solicit information from postsecondary education student financial aid providers, administrators, and recipients.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Solstice Internet Mail Server to deliver improved student financial aid delivery services:

- ❶ Local, remote, and mobile electronic mail users, regardless of client e-mail technology, will retrieve and submit correspondence to/from the Solstice Internet Electronic Mail Server. Specifically, e-mail clients will use the post office protocol (POP3) to access the mail server and download all stored messages. Once downloaded messages can be manipulated (edited, deleted, and responded to) by the e-mail client and saved locally.

POP3 is a widely used industry-standard, for example in 1996 there were an estimated 8.5 million<sup>8</sup> users, so almost any client e-mail technology will interoperate with the Solstice Internet Mail Server. However, POP3 has limitations. For example, because POP3 downloads and saves entire messages to the client, users who work from more than one system will have inconsistent and often unsecured local mail folders. What is more, because all mail messages are downloaded (in their entirety) users cannot control which messages get downloaded. This often results in unnecessarily high network resource utilization. To alleviate some of the limitations associated with POP3, the Solstice Internet Mail Server supports the Internet Message Access Protocol (IMAP4).

IMAP4 allows users to operate in disconnected mode, which enables e-mail clients to download specific messages (not all messages). Once downloaded, the client can disconnect from the server, manipulate messages as desired, and then resynchronize the locally cached messages with those stored on the server. This facilitates secure, server-based messages management and provides users with consistent mail folder contents, regardless of e-mail client location.

- ❷ The Solstice Internet Mail Server accepts, stores, and delivers messages submitted via heterogeneous e-mail clients, as well as from other servers. That is, the Solstice Internet Mail Server, is capable of accepting and delivering proprietary message formats from e-mail clients such as cc:Mail or Microsoft Mail. This removes the need and costs associated with proprietary e-mail server solutions, while allowing continued use of currently deployed e-mail clients.

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<sup>8</sup> According the International Data Corporation (#12957, February 1997), as reported by Sun Microsystems

In addition to client-to-server message transfer, the Solstice Internet Mail Server also delivers and accepts messages (originally submitted in proprietary formats) to/from remote e-mail servers via the server-to-server Simple Mail Transport Protocol (SMTP) and Multipurpose Internet Mail Extensions (MIME). This allows messages can be delivered via the Internet – greatly enhancing communication channels with customers.

SMTP is a server-to-server protocol that is widely used throughout the Internet to transfer e-mail messages between computers. The MIME protocol, which specifies uniform methods for handling data objects and rich text formatting within e-mail messages, is used to extend SMTP services. That is, because SMTP only supports the transfer of ASCII text and does not allow file attachments to be communicated, MIME is used, in conjunction with SMTP, to facilitate the communication of messages containing voice, graphics, video, and EDI file attachments.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1050	The system shall provide information contained in the ED Student Aid Handbook, Student Guide, and information about school participation in the Title IV programs.
1052	The system shall maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties.
1080	The system shall provide participants with information on long term debt management, including: <ul style="list-style-type: none"> <li>- Projected potential earnings after graduation by school program</li> <li>- Projected monthly payments after graduation, based on different types of aid packages available</li> </ul>
1150	The system shall 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/reviews, based on: <ul style="list-style-type: none"> <li>- Independent student samples</li> <li>- Statistical sampling</li> <li>- Exception reports</li> <li>- Self auditing</li> <li>- Performance based standards and measures</li> </ul>
1180	The system shall solicit feedback from participants, schools and other organizations on services offered by organizations associated with the Title IV aid programs.
1254	The system shall request annually low income school information from state education Offices, based on the screening criteria sent to them.
1390	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.
1420	The system shall confirm participant enrollment and eligibility prior to the disbursement of Pell Grant funds to a school.
1440	The system shall notify the school when the system authorizes disbursement of funds to the school.

**Exhibit C-2. E-Mail Requirements**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1445	The system shall notify schools and participants when two or more Pell Grant Origination records are received from different schools for the same academic period and the same participant.
1460	The system shall inform the school, the participant, and the fund source of the results of edits applied to disbursement records, origination records, adjustments, and cancellations
1497	The system shall send quarterly interest statements to participants during the grace period for Direct Loans that are unsubsidized, or that are consolidated while the student is still in school and have an unsubsidized or a PLUS portion.
1495	The system shall notify the participant and the school of the credit check result for a Direct PLUS Loan.
1600	The system shall 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.
1614	The system shall send approval/rejection notices to the loan holder for interest and special allowance invoices received from that loan holder.
1720	The system shall notify lenders and schools of an applicant's request for a Federal Family Education Loan Program (FFELP) lender.
1860	The system shall receive updated information on participant's aid applications from school where schools are submitting aid applications on behalf of participants.
1950	The system shall request financial aid simulation modeling information (e.g. average salaries for various professions) from state departments of labor.
2001	The system shall provide the maximum loan interest rate to the participant prior to the disbursement authorization.
2002	The system shall provide standard repayment options by program to the participant.
2050	The system shall provide participant's repayment option preferences to fund sources.
2172	The system shall generate payment requests to pay off component loans as a result of refinancing into a Direct Loan or consolidating into a Direct Consolidation Loan.
2190	The system shall notify loan holders of the acceptance or rejection of consolidation requests they have submitted on behalf of participants.
2220	The system shall request verification of loan existence and balance from schools (for Perkins Loans) and lenders (for FFELP Loans) based upon the consolidation application provided by the applicant or loan holder.
2420	The system shall notify participants if they are eligible for in-school deferment when they enter repayment status.
2550	The system shall notify schools of participants' delinquency within 90 days of a missed loan repayment due date.
2570	The system shall inform the participant if the servicer for their loan changes for loans held by ED.
2746	The system shall notify private sector employers of intent to commence wage garnishment for loans held by ED.

**Exhibit C-2. E-Mail Requirements (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
2750	The system shall provide debt collection agency assignment notices to participants when their debts are sent to a collection agency for loans held by ED.
2752	The system shall provide deletion letters to credit bureaus when participants have been erroneously reported to a credit bureau for loans held by ED.
3180	The system shall notify schools of the determination of their eligibility to participate in Title IV programs.

**Exhibit C-2. E-Mail Requirements (cont'd)**

**Component:** Relational Database Management System Software

**Component Description:**

A database management system (DBMS) consists of a collection of interrelated data and the programs required to access and manage this data. The primary goal of a DBMS is to provide an environment that facilitates convenient and efficient information usage. That is, database systems provide users with an abstract view of the data, which hides complexities associated with the data storage, retrieval, modification, and other mechanisms.

Relational DBMSs (RDBMS) make use of data structures that are based on the relational model. The relational model describes data and data relationships in terms of collection of tables (entity types), each of which is defined in terms of columns (attributes) and rows (entities). Within this framework, a relationship is defined through the association of multiple entities. These relationships are specified via keys, which are the principal means for identifying entities within and entity type.

Today, all commercially available RDBMS products (or at least those with measurable market share) utilize some variant of the Structured Query Language (SQL) – a powerful, highly flexible, set-oriented language – for manipulating, defining, and controlling data. That is, SQL has become the predominant database management language for mainframe, minicomputer, enterprise & workgroup server, and even PC based RDBMS applications.

In addition to managing the control and execution of SQL commands, RDBMSs also manage data recovery, concurrency, security, and consistency – allowing multiple applications and users to share the database. Additionally, RDBMSs provide a variety of administrative and programmatic utilities and procedural extensions. Two such procedural extensions are stored procedures and triggers.

Within the Project EASI/ED candidate framework architectures, RDBMS Software could be used to implement the business requirements listed in Exhibit C-3. A product description and a list of features are provided in Figures C-9 and C-10.

<b>Vendor</b>	<b>Product</b>	<b>Operating Environment</b>
Oracle Corporation	Oracle 8, Oracle Net8, Oracle 8 Parallel Server, Oracle 8 Symetric Replication Server, Oracle Enterprise Manager	Available for more than 100 operating environments, including: IBM AIX, OS/400, and MVS, Hewlett-Packard HP-UX, <b>Sun Solaris</b> (SPARC & Intel), Microsoft NT (Intel & DEC Alpha), NCR MP-RAS, Silicon Graphics IRIX, Pyramid DC/OS, SCO OpenServer & UnixWare, DEC Alpha UNIX, Sequent DYNIX/Ptx, Data General UNIX (Intel and M88k), Unisys SVR4, Tandem Non-Stop UNIX

**Figure C-9. RDBMS Architecture Implementation Technology**

Feature	Oracle 8.x
Leverages server clustering configurations, where multiple computers operate as a single logical processing “complex” that can tolerate individual machine and/or node failures without loss of data availability	✓
Provides user/client connection management services that: <ul style="list-style-type: none"> <li>- Are based on the memory management queuing strategy (as described in Appendix B)</li> <li>- Are capable of coordinating thousands of simultaneous user requests through a multithreaded, multiserver architecture</li> <li>- Multiplex multiple user sessions over network connections, reducing resource requirements especially for multi-tier application architectures</li> <li>- Provide direct support for queuing operations, which enables asynchrony and eliminates the dependency on external systems</li> </ul>	✓
Provides the ability to enforce business rules and data integrity and implement “server-side” application logic via compiled stored procedures and triggers – without recompilation or parsing.	✓
Provides concurrency control that employs: <ul style="list-style-type: none"> <li>- Row-level locking for data and indexes to maximize data access availability</li> <li>- Scalable sequential number generation technologies to eliminate application contention to obtain unique numeric key values, a common requirement in transaction processing applications</li> </ul>	✓
Provides query processing services that are based on a cost-based optimizer that: <ul style="list-style-type: none"> <li>- Dynamically selects the fastest available access path, and satisfies query requests directly from indexes where possible</li> <li>- Incorporates query transformation technology that automatically ‘rewrites’ queries generated by end-user tools for efficient query execution</li> <li>- Tracks statistics and constraints which impact query processing and uses this data to determines the most efficient access paths and join methods for every query</li> <li>- Considers the availability of parallel resources when choosing the execution strategy</li> </ul>	✓
Provides table and index partitioning services that: <ul style="list-style-type: none"> <li>- Allow large tables and indexes to be managed separately, which provides scalable performance with large datasets</li> <li>- Decreases the length of administrative tasks by applying the operations to smaller units of storage</li> <li>- Increases parallelism and improves availability by encapsulating failures within partition boundaries</li> </ul>	✓

**Figure C-10. RDBMS Technology Features**

Feature	Oracle 8.x
Provides a parallel SQL architecture that: <ul style="list-style-type: none"> <li>- Leverages Symmetric Multi-processing (SMP), Massively Parallel Processing (MPP), and hybrid hardware platforms</li> <li>- Increases the performance of queries and updates by dynamically subdividing operations into distinct tasks, and distributing the workload across all multiple processors</li> <li>- Performs bulk insert, update, and delete operations in parallel, utilizing all hardware resources</li> <li>- Provides load balancing and dynamic load distribution</li> <li>- Offers parallel index creation and support for automatic index maintenance with update operations</li> <li>- Is capable of executing queries, inserts, updates, deletes, sorts, aggregations, table creation, data loading, and recovery operations in parallel</li> </ul>	✓
Provides an extended backup/recovery subsystem that: <ul style="list-style-type: none"> <li>- Allows tablespace point-in-time recovery, which restores one or more tablespaces while the remainder of the database is running</li> <li>- Is managed through a native graphical user interface</li> </ul>	✓
Provides high-availability support that: <ul style="list-style-type: none"> <li>- Allows administrators to perform backup activities while the database is running</li> <li>- Supports read-only tablespaces, saving time by eliminating backup and recovery of static data</li> <li>- Mirror and multi-segment logs to ensure log data remains available if a log device fails</li> <li>- Maintains data accessibility during node failure by allowing users access to another node while transactions on the failed node are recovered or rolled back</li> <li>- Increasing data availability through replication of data on one or more alternative sites</li> </ul>	✓
Provides user-defined datatypes that: <ul style="list-style-type: none"> <li>- Allow users to define custom object types, which may contain multiple fields or attributes</li> <li>- Allow users to create methods, which perform typical operations on the object type</li> </ul>	✓
Provides Java support that allows Java code execution at the client or middle tier, which may access the database through JDBC or JSQL	✓
Provides server-based business rules that: <ul style="list-style-type: none"> <li>- Enforce constraints, either for database integrity purposes or business-related rules, at the database level</li> <li>- Use declarative integrity constraints, database procedures, and database triggers to enforce business rules</li> <li>- Use stored procedures, functions, and database triggers to enforce business rules at the server level, improving performance, scalability, and security</li> </ul>	✓

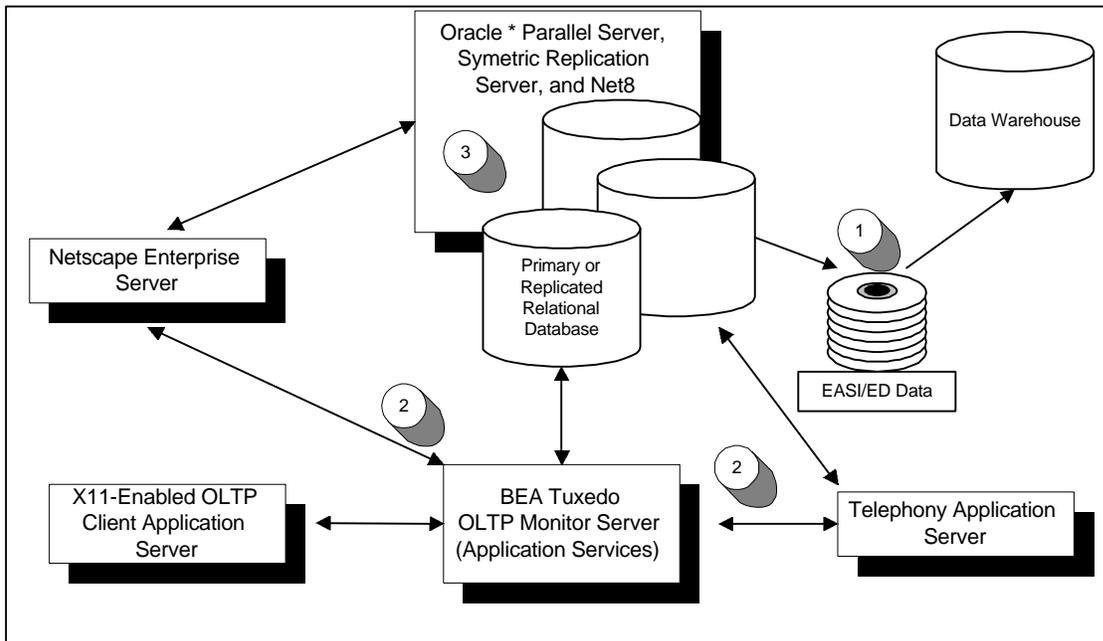
**Figure C-10. RDBMS Technology Features (cont'd)**

Feature	Oracle 8.x
Provides transparent distributed transactions processing services that: <ul style="list-style-type: none"> <li>- Allow queries to execute across multiple servers without knowledge of data location</li> <li>- Leverage existing networks and protocols to efficiently transmit data between servers and return results to clients</li> <li>- Ensure the integrity of distributed update transactions with a two-phase commit mechanism</li> <li>- Update data using remote or distribute SQL statements, or through remote procedure calls (RPCs)</li> <li>- Integrate the RDBMS with heterogeneous data sources through and industry-standard gateway</li> </ul>	✓
Provides ISO SQL-92 compliant structured query language (SQL) support, including support for: <ul style="list-style-type: none"> <li>- SQL client/server connections and sessions</li> <li>- Embedded SQL support for the C, Ada, and other programming languages</li> <li>- Binary large object (BLOBs), timestamp, varchar and other new and user defined data types</li> <li>- Dynamic SQL, which may be generated at system runtime</li> </ul>	✓
Provides enterprise data security that: <ul style="list-style-type: none"> <li>- Performs user authentication internally with password verification</li> <li>- Performs user authentication externally through the operating system, network security services, or authentication devices (e.g., smart cards)</li> <li>- Authorizes (e.g., GRANT/REVOKE) users to perform certain SQL operations</li> <li>- Implements role based security schemes, which allow administrators to set security privileges for large groups of users simultaneously</li> <li>- Collects and organizes audit information for administrators</li> <li>- Encrypts sensitive information which travels over the network</li> </ul>	✓
Supports replication configurations, including: <ul style="list-style-type: none"> <li>- Data Replication for Publication, in which one updateable master replica (primary site) is distributed as many read-only copies, which may contain all or only a portion of the master dataset.</li> <li>- Data Replication for Consolidation, in which multiple updateable master replicas (primary sites) are consolidated as a single read-only copy.</li> </ul>	✓

**Figure C-10. RDBMS Technology Features (cont'd)**

Feature	Oracle 8.x
Provides scalable data management services capable of supporting terabyte size datasets via: <ul style="list-style-type: none"> <li>- Modular data management, which allows administration activities to be executed on only portions of the dataset, while transactions are concurrently processed in unaffected portions of the dataset</li> <li>- Parallel management, which allows the same operation to be concurrently executed on different portions of the dataset</li> <li>- Utilization of Symmetric Multi-Processing (SMP) environments</li> <li>- Logical data partitioning, which decomposes large table structures into several smaller tables to speed data loading and improve data access</li> </ul>	✓
Provides enterprise systems management that: <ul style="list-style-type: none"> <li>- Provides a central point of control for administrators</li> <li>- Supports the Simple Network Management Protocol (SNMP), a de facto standard that supports the monitoring and administration of components in a distributed computing environment</li> <li>- Provides tools to manage performance, tuning, and diagnostics</li> </ul>	✓
Provides Transaction Processing (TP) monitor support to increase performance for multitier applications with industry-standard XA-compliant TP monitors	✓

**Figure C-10. RDBMS Technology Features (cont'd)**



**Figure C-11. Logical Software Interfaces for RDBMS**

Figure C-11 illustrates logical software interfaces and describes how the Oracle 8 RDBMS technologies will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software

components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to the Project EASI/ED user community:

- Ensures that data being collected and maintained within ED is accessible, understandable, and useful to the organization and the organization's trading partners.
- Eliminates redundant data storage and reporting.
- Facilitates standardized data definitions and eliminating inconsistent data formats and nomenclature.
- Provides a integrated and consistent data source for user support.
- Enables efficient data communications between student financial aid functions.
- Reduces administrative and operational costs associated with the management of data associated with postsecondary education student financial aid services .
- Streamlines, simplifies, and improves the accessibility of meaningful and consistent cross-program data associated with postsecondary student financial aid delivery and policy support.
- Provides ED, schools, guarantee agencies, students, and lenders with the accurate, complete, and timely information required to diminish fraud, waste, abuse, and mismanagement.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Oracle 8 RDBMS technologies to deliver improved student financial aid delivery services:

- ① Most of the architectures being considered isolate transaction processing activities, from those associated with decision support. This is done largely to distribute processing workloads and reduce data access contention. For similar reasons, the data affected by disparate OLTP and decision support operations are also segregated. With this in mind, the Oracle 8 Parallel RDBMS will be used, along with BEA Tuxedo, to control and manage the transaction processing of data. However, once committed to the OLTP database, data must be regularly made available so that it can be leveraged by decision support functions. To facilitate these operations the data managed within the primary OLTP (production) database will be:

- Exported to a flat file for loading into the Red Brick Data Warehouse
- Replicated as "snapshots" to one or more decision support databases

Data replication will be performed asynchronously. That is, decision support databases will not be updated within the same "commit scope" as the production OLTP database from which they are derived. Rather, copies of the production database will be refreshed (updated in batch) at regular intervals (nightly, weekly, monthly), as deemed necessary.

- ② Like the BEA Tuxedo transaction processing monitor, the Oracle RDBMS will provide highly leveraged data management services, which will be essential, in every way, to the successful delivery of almost every system service. As such, the Oracle RDBMS will be used, at least indirectly, by all system users – whether directly accessed through telephony-based technologies, LAN-based X Window System applications, or the Internet.

All users will invoke Oracle's data management services either via embedded SQL (ESQL), Oracle's Call Level Interface (OCI), or through stored procedures. As the name implied ESQL involves embedding SQL statements within programs written in languages, such as C and COBOL. This strategy requires running the SQL source code through a precompiler to generate a source code file that the language compiler can

understand.

As already mentioned, one alternative to ESQL requires using Oracle’s “callable” SQL application programming interface (API). This has the benefit of reduced development complexity and enhanced flexibility, as SQL statements do not have to be precompiled and can be created and executed at runtime. However, because CLI invoked queries must be compiled at run time, the flexibility offered by this strategy comes at a price: weaker performance.

Stored procedures offer another alternative for users wishing to access the Oracle database. Stored procedures are remote, compiled, and named procedures (functions) that are stored, accessed, and managed via the RDBMS. Stored procedures are typically used to enforce business rules and data integrity; however, the primary use of stored procedures is to implement “server-side” application logic within distributed system architectures. To use a stored procedure, the user (via the client application component) issues a remote function call, which invokes the stored procedure. This results in reduced network traffic and better performance because:

- Stored procedures, and the SQL statements therein, are precompiled
- Only the client’s function call and a fixed set of results traverse the network

However, because stored procedures are managed within the database, data management and application logic are not logically isolated from each other. As described within Section 2, this results in a less flexible architecture that is highly dependent upon a single vendor’s (Oracle’s) technology.

- ③ In addition to managing the control and execution of SQL commands, Oracle will also manage data recovery, concurrency, security, and consistency – allowing multiple applications and users to share the database. Additionally, Oracle will provide a variety of process and concurrency management services, as well as administrative and programmatic utilities and procedural extensions, such as stored procedures and triggers. Using these features, Oracle will transparently provide those fundamental data management services required to empower all management information systems.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1310	The system shall maintain records of financial aid receivables due from schools to ED.
1654	The system shall maintain reinsurance fee information received from guaranty agencies.
1660	The system shall maintain information on ACA payments made by ED.
1670	The system shall maintain information on interest and special allowance payments made by ED.
3020	The system shall maintain Fiscal Operations Report and Application to Participant (FISAP) data.
3022	The system shall maintain hold status information for schools that are eligible for Campus Based Program funds.
3094	The system shall maintain school calendar information.
3100	The system shall maintain school limitation, suspension, and termination (LST) notices data.
3160	The system shall maintain information on third-party audits of schools.
3164	The system shall maintain accreditation board and state licensing business information.

**Exhibit C-3. RDBMS Requirement**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
4000	The system shall maintain data about individuals participating in Title IV Federal financial aid programs, including participant income, status, address, authorization, and personal information.
4100	The system shall maintain aid data, including aid holder request information, repayment terms, interest rate, and status.
4200	The system shall maintain aid application data, including aid application, school application, and application status
1052	The system shall maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties.
1220	The system shall apply disbursements, adjustments, and cancellations to achieve an accurate daily net settlement.
1300	The system shall maintain school disbursement ledgers to show a complete record of all disbursements to, and collections from, a school.
1310	The system shall maintain records of financial aid receivables due from schools to ED.
1350	The system shall maintain an audit trail of all student aid origination and payment records by aid program by student.
1572	The system shall manage school and state authorization amounts.
1602	The system shall maintain warehoused payment authorizations and, at the appropriate time, generate payment requests.
1652	The system shall confirm reinsurance fee data received from guaranty agencies, generate payment requests, and send them to ED/CFO for payment.
1654	The system shall maintain reinsurance fee information received from guaranty agencies.
1658	The system shall offset AEA and reinsurance payment amounts for receivables due to ED for those receivables that could not be collected by other means.
1660	The system shall maintain information on ACA payments made by ED.
1670	The system shall maintain information on interest and special allowance payments made by ED.
1717	The system shall maintain the association between the multi-year promissory notes belonging to a participant and each occurrence of financial aid that participants receive.
2030	The system shall track whether participants have received repayment counseling, and which organization provided it.
2060	The system shall maintain repayment option decision information by participant and loan.
2116	The system shall calculate the payment due on a loan and bill the participant for that amount for Direct Loans and those loans that are assigned to ED for debt collection.
2172	The system shall generate payment requests to pay off component loans as a result of refinancing into a Direct Loan or consolidating into a Direct Consolidation Loan.
2360	The system shall calculate income contingent repayment terms for Direct Loans and those loans that are assigned to ED for debt collection.
2634	The system shall track the repayment history of participants with defaulted loans and, if appropriate, move their loans into repayment status for those loans that have been assigned to ED for debt collection.

**Exhibit C-3. RDBMS Requirement (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
2744	The system shall track employment status, garnished wage status changes, and movement to new private sector employers for defaulted participants currently in wage garnishment for loans held by ED.
2920	The system shall provide to authorized staff visibility to audit trail information (backward and forward from the point of origination through repayment) to ensure that for each Title IV program, the correct Federal funds reach the right recipient at the appropriate time.
2942	The system shall maintain Title IV program information received from ED/OPE/Policy, Functional High Training, and Analysis Service (PTAS). This shall include general information about each program in addition to specific rules and regulations applying to each program.
2952	The system shall maintain performance measurements for each aid organization school, and the EASI/ED system itself. Relevant information on these performance measurements shall be provided to authorized external organizations and individuals.
2960	The system shall provide what-if analysis capability to support the formulation of program legislation and policy.
3020	The system shall maintain Fiscal Operations Report and Application to Participant (FISAP) data.
3022	The system shall maintain hold status information for schools that are eligible for Campus Based Program funds.
3094	The system shall maintain school calendar information.
3100	The system shall maintain school limitation, suspension, and termination (LST) notices data.
3160	The system shall maintain information on third-party audits of schools.
3164	The system shall maintain accreditation board and state licensing business information.
3510	The system shall receive and shall process change of ownership approvals.
3550	The system shall calculate and provide school cohort default rates to IPOS.
4000	The system shall maintain data about individuals participating in Title IV Federal financial aid programs, including participant income, status, address, authorization, and personal information.
4100	The system shall maintain aid data, including aid holder request information, repayment terms, interest rate, and status.
4200	The system shall maintain aid application data, including aid application, school application, and application status
4300	The system shall maintain school data, including school demographic information, enrollment criteria, school performance rating, and participant enrollment status.
4400	The system shall maintain promissory note data.
4500	The system shall maintain package data.
4600	The system shall maintain program management document data.
4700	The system shall maintain data on aid organizations, such as legal entities, commercial or government, external to ED, which participate in the delivery and collection of financial aid to the community. This information will include aid organization type, organization address, organization status, and performance rating data.

**Exhibit C-3. RDBMS Requirement (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
4800	The system shall maintain aid program data, including aid program version, aid program fund source, school eligibility, program allotment, and program authorization.
4810	The system shall maintain the length of the grace period for each type of loan.
4900	The system shall maintain the different financial transactions that are applicable to accounting for aid.
4950	The system shall maintain full financial accounting data, including ledger account data, accounting journal entry transaction, and ledger relationship information.
5010	The system shall maintain aid program allotment information.
5080	The system shall maintain budgetary account balances at the level of detail required to meet program reporting requirements.
5110	The system shall maintain a record of interface transactions sent to and received from AFMS.
5120	The system shall maintain a record of interface transactions sent to and received from ED/CFO.
5130	The system shall maintain a record of interface transactions sent to and received from ED Budget.
5170	The system shall maintain valuation of loans and for accounts receivables at net realization value.
5200	The system shall record the receipt of payment against receivables.

**Exhibit C-3. RDBMS Requirement (cont'd)**

## Component: Online Transaction Processing Monitor Software

### Component Description:

Systems that specialize in managing the operations of many users as they retrieve, insert, update, and delete database records are commonly referred to as on-line transaction processing (OLTP) systems. OLTP systems have been in use for more than thirty years – within large mainframe and proprietary mid-range information systems. For example, IBM's mainframe-based Customer Information Control System (CICS) is a very popular OLTP technology. More recently, TP monitors – the software components that facilitate OLTP – have become available for the UNIX-based, open system environments commonly used within client-server and distributed systems.

Like mainframe-based TP monitors, open system TP monitors are designed to provide centralized transaction management and control. However, unlike many of the more mature OLTP technologies, TP monitors are now being designed to work within the framework of modern distributed process and data strategies, shown in Figure C-12. That is, TP monitors are now being used to:

- Facilitate interprocess communication between distributed application components.
- Provide load balancing, priority scheduling, and process management services.
- Manage transactions that involve data stored within multiple, heterogeneous database management systems.

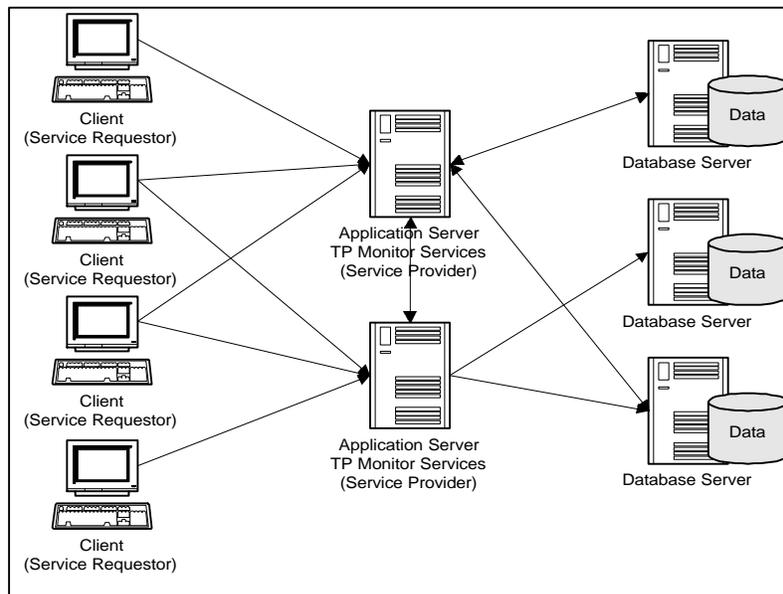


Figure C-12. TP Monitors

Within the Project EASI/ED candidate framework architectures, OLTP Monitor Software could be used to implement the business requirements listed in Exhibit C-4. A product description and a list of features are provided in Figures C-13 and C-14.

<b>Vendor</b>	<b>Product</b>	<b>Server Operating Environment</b>
Novell Inc./BEA Systems Inc	BEA Jolt® 1.1	IBM AIX, OS/400, and MVS, Hewlett-Packard HP-UX, <b>Sun Solaris</b> (SPARC & Intel), Microsoft NT (Intel & DEC Alpha), NCR MP-RAS, Silicon Graphics IRIX, Pyramid DC/OS, SCO OpenServer & UnixWare, DEC Alpha UNIX, Sequent DYNIX/Ptx, Data General UNIX (Intel and M88k), Unisys SVR4, Tandem Non-Stop UNIX
Novell Inc./BEA Systems Inc.	BEA Tuxedo® 6.x, HA Extensions (including HA monitor and HA Client)	IBM AIX, OS/400, and MVS, Hewlett-Packard HP-UX, <b>Sun Solaris</b> (SPARC & Intel), Microsoft NT (Intel & DEC Alpha), NCR MP-RAS, Silicon Graphics IRIX, Pyramid DC/OS, SCO OpenServer & UnixWare, DEC Alpha UNIX, Sequent DYNIX/Ptx, Data General UNIX (Intel and M88k), Unisys SVR4, Tandem Non-Stop UNIX

**Figure C-13. OLTP Monitor Software Architecture Implementation Technology**

<b>Feature</b>	<b>BEA Jolt®</b>	<b>BEA Tuxedo®</b>
Provides remote users with Java-enabled Web browsers access to distributed transactional services with out using CGI.	✓	
Provides Java-interface to distributed online transaction processing services.	✓	
Provides server-side session management services that maintain conversation and state <sup>9</sup> between Java enabled clients and transaction servers – allowing complex transactions, requiring multiple service requests, to be processed without requiring the retransmission of previously communicated data (as described in Appendix B).	✓	
Allows transactional system components to be implemented separately from Internet-related system components – allowing transaction-processing resources to be leveraged by Internet clients, as well as other system users.	✓	
Provides fault tolerant transaction processing services that operate with highly available (HA) clustered server environments.		✓
Provides transaction server recovery services that are capable monitoring database availability, automatically connecting to secondary database server in cases of failure, and transparently rolling back and resubmitting transactions, as necessary.		✓
Provides conditional support for asynchronous and synchronous communication – allowing transactions to be asynchronously processed when portions of the system are not simultaneously available		✓
Supports asynchronous communication via reliable (persistent) message queues		✓
Facilitates synchronous communication via request/response messaging and remote procedure call facilities		✓
Provides an X/Open XATMI <sup>10</sup> compliant library-based application programming interface (API) support		✓

**Figure C-14. OLTP Monitor Software Technology Features**

<sup>9</sup> CGI-based solutions do not maintain state between clients- and servers-based processing. As a result, CGI-based solutions are often performance constrained, as described within Appendix B.

<sup>10</sup> Documented within the XATMI Specification, X/Open CAE Specification, November 1995.

<b>Feature</b>	<b>BEA Jolt®</b>	<b>BEA Tuxedo®</b>
Provides an X/Open TxRPC <sup>11</sup> compliant language-based programming interface that supports transactional synchronous and asynchronous remote procedure calls (RPC), as well as pipelined <sup>12</sup> remote procedure calls.		✓
Facilitates transactions management communication over TCP/IP Network transport technologies	✓	✓
Fully supports XA-complaint databases including DB2, Informix, ISAM-XA, Microsoft SQL Server, Oracle, Sybase		✓
Allows queue processing via FIFO, LIFO, assigned priority, and time release ordering methods		✓
Provides dynamic application tuning services <sup>13</sup> , which balance processing loads across available resources as application processing and throughput demands change		✓
Integrates with Kerberos <sup>14</sup> security which authenticates users, secures user names and passwords, and controls access to system resources		✓
Provides transaction and Error Logging facilities		✓
Supports transaction management involving multiple, distributed, heterogeneous data stores via Two-Phase Commit protocol		✓

**Figure C-14. OLTP Monitor Software Technology Features**

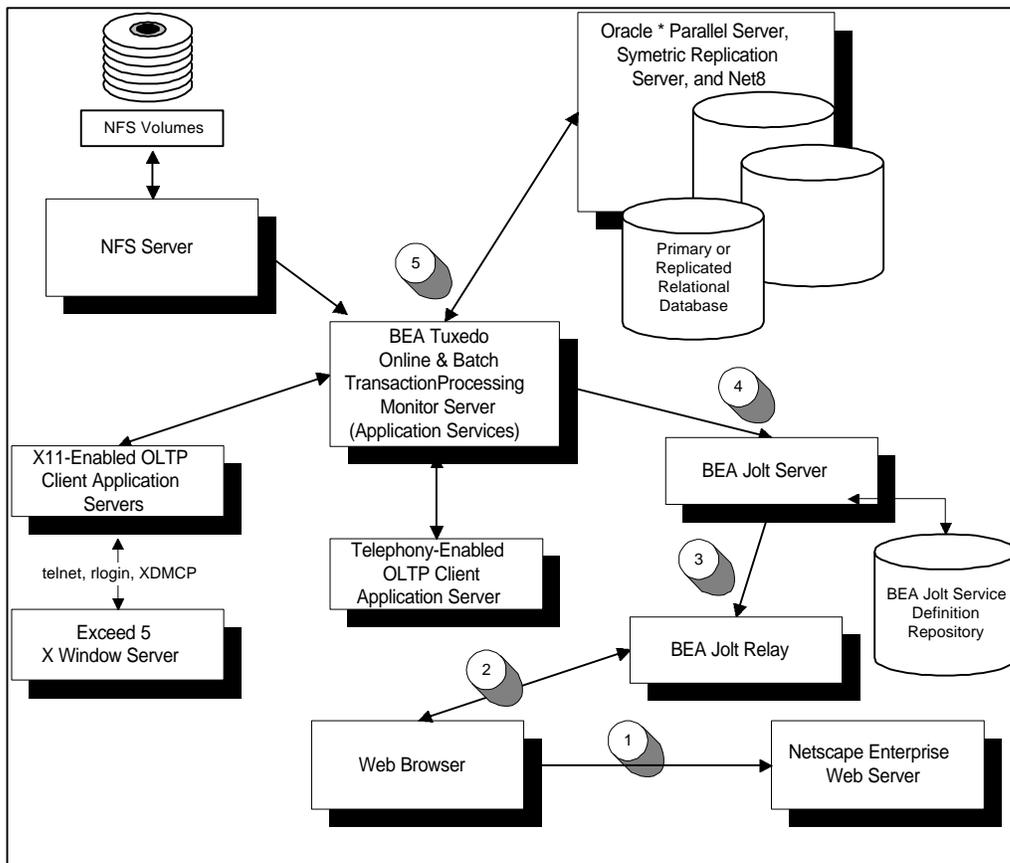
Figure C-15 illustrates logical software interfaces and describes how the BEA Tuxedo OLTP technologies will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustrations. Hardware allocations are described in Subsection 5.4.

<sup>11</sup> TxRPC is a standardized remote procedure call interface that a transactional extension to the Open Software Foundation's Distributed Computing Environment (OSF DCE) RPC facility.

<sup>12</sup> Pipelined RPCs invoke other RPCs. Pipelined RPCs are organized and managed as a single transaction by transaction managers (OLTP servers). This is similar to facilities provided by many relational database technologies, which allow one stored procedure to invoke another. The primary differences are that RPCs are generally implemented independent of the database. What is more, stored procedures within a "pipeline" are typically managed as individual units of work and not as a cohesive transaction.

<sup>13</sup> OLTP tuning services automatically load new transaction processing server processes, as processing loads increase and destroy processes as processing demand diminishes – insuring consistent application performance. Similar services are provided for database load management by RDBMS technologies that utilize the message queuing memory management strategy (as described in Appendix B).

<sup>14</sup> Kerberos is a product of the Athena project at the Massachusetts Institute of Technology and is the foundation security technology within the Open Software Foundation's Distributed Computing Environment (OSF DCE). Kerberos is a network authentication protocol that provides secret-key cryptography services.



**Figure C-15. Logical Software Interfaces for OLTP**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to the Project EASI/ED user community:

- Streamlines, simplifies, and improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Ensures that data being collected and maintained within ED is accessible, understandable, and useful to the organization and the organization's trading partners, as appropriate.
- Reduces costs associated with operations, and maintenance by allowing a common set of transaction-processing server resources to be leveraged by a variety of users and access methods.
- Ensures that data associated with postsecondary education student financial aid is consistently, reliably, predictable, and accurately managed on behalf of the organization and the organization's trading partners.
- Eliminates the need to develop redundant transaction management services for telephony users, X Window System users, and Web users.
- Provides flexible and highly available, asynchronous business solutions that allow ED and ED's trading partners to work independently.
- Provides flexible technical solutions that can be modified to meet the evolving functional needs of the post secondary student financial aid community.
- Improves the postsecondary education community's ability to effectively reach and support a wide range of customers.
- Allows common transaction processing services to be integrated and managed with a consistent set of security policies, procedures, and capabilities.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the BEA Tuxedo and Jolt OLTP technologies to deliver improved student financial aid delivery services:

- ① Transaction processing application services will be developed as "component-based" application software. As illustrated in Figure C-25, this will allow multiple, disparate user access methods, for example telephony or X Window System clients, to invoke a common set of application services. Furthermore, this will ensure that system services are consistently delivered to all users, regardless of access method.

Component-based transaction processing services will be implemented using BEA Tuxedo, an online transaction processing monitor, and BEA Jolt, which will allow EASI/ED users to leverage new and existing Tuxedo applications via the Internet. Specifically, Jolt is a set of software components that extend application access by allowing BEA Tuxedo requests to be issued via Java<sup>15</sup>. Specifically, BEA Jolt provides an implementation of the BEA Tuxedo Client library<sup>16</sup> that is specifically suited for the requirements of Java applets. This implementation serves as a proxy for the native BEA Tuxedo Client, which is typically used to submit service requests to the Tuxedo Server.

The BEA Jolt processing model takes full advantage of Java – avoiding the use of CGI<sup>17</sup> entirely. That is BEA Jolt uses the web server to download the Java applet using BEA Jolt embedded in an HTML page. Once the page is loaded, the Web browser activates the applet, which then becomes an autonomous program running within the browser's virtual machine. Once instantiated, the BEA Jolt does not attempt to communicate with the BEA Tuxedo services via the Web server. Rather, the BEA Jolt client opens a direct connection to the BEA Jolt Server.

- ② Service requests submitted by the BEA Jolt Client are accepted by the BEA Jolt Server, which then invokes BEA Tuxedo services via the ATMI API. Specifically, the BEA Jolt client, running within a virtual machine in the user's browser, packages the user's request into a message buffer and delivers the request to the Jolt Server, which in turn, unpacks the data, performs required data conversions, and makes the appropriate service request to the BEA Tuxedo Server.

Once BEA Tuxedo Server accepts a service request<sup>18</sup>, it is executed in the same manner as any other BEA Tuxedo request. After processing is completed, the results are returned via the ATMI interface to the BEA Jolt Server, where they are packaged into a message and sent to the BEA Jolt Client. Upon receipt, the BEA Jolt Client displays the message contents, completing the request.

- ③ An intermediary process – the BEA Jolt Relay, will facilitate communication between the BEA Jolt Client and BEA Jolt Server. This proxy service is required largely because of restrictions imposed by many browsers on downloaded Java applets. Namely, most browsers only allow downloaded applets to open network connections (sockets) to the same machine (the Web Server) from whence they were downloaded. Given this restriction, the Web server and Jolt Server would have to be on the same machine, as the

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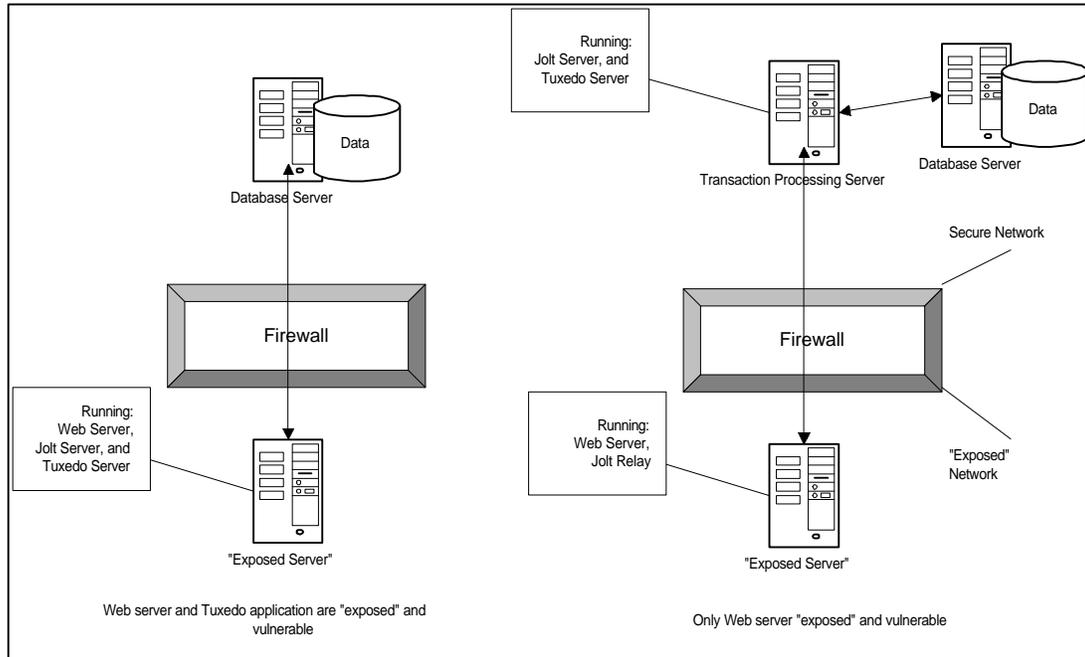
<sup>15</sup> Java includes a programming language and portable environment for executing that language. This portable execution environment, which can be embedded in other programs, such as a Web browser, is often referred to as a "virtual machine" and is used to interpret Java-based instructions.

<sup>16</sup> The client library is used in client/server applications. Specifically, the library is used by "client-side" applications to invoke "server-side" transaction processing services provided by the Tuxedo Server.

<sup>17</sup> CGI and associated limitations are described within Appendix B.

<sup>18</sup> Jolt Servers examine incoming messages and discard those that are not recognized. This serves to further improve security provided by the architecture.

BEA Jolt Client is downloaded from the Web server, but opens network connections to the BEA Jolt Server. However, as illustrated in Figure C-16, this configuration is inadequate, as the Jolt and Tuxedo Servers, which should be protected resources, would have to be publicly “exposed” along with the Web server.



**Figure C-16. Architecture Implementations with Firewall Integration**

BEA Jolt Relay resolves inadequacies with this configuration and allows Tuxedo Servers to be implemented within the confines of a secured network. Additionally, Jolt Relay, allows the firewall to be configured to allow communication between exactly one machine outside the firewall (the Jolt Relay) and exactly one machine inside the firewall (the Jolt Server) on exactly one IP port. This simplifies firewall administration and improves security.

- ④ As previously explained the BEA Jolt Server submits requests to the BEA Tuxedo Server on behalf of the BEA Jolt Client. This is accomplished through the use of two cooperative processes – the Jolt Listener Process (JSL) and the Jolt Handler Process (JSH). Specifically, the JSL process is used to “listen” for Jolt Client requests and load balance requests across multiple JSH processes, where as the JSH processes are used to “pipe” client requests to the BEA Tuxedo Server.

Once the JSL accepts a request, the process will determine if a JSH process is available, generate a timestamp<sup>19</sup>, return the timestamp and Jolt Relay network address to the Jolt Client, close the client connection, and begin listening for new client requests.

Once the Jolt Client receives the timestamp and Jolt Relay network address, a “challenge key” is generated and sent along with the timestamp to the JSH that will service the client’s request. This message is submitted via the Jolt Relay.

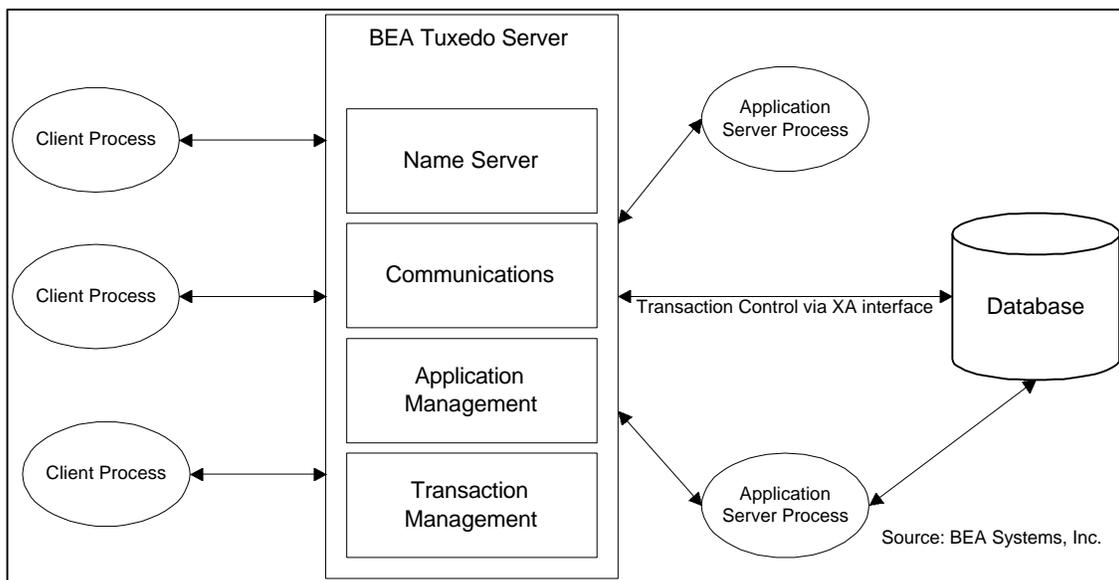
Upon receipt of the client’s request, the JSH process will use the timestamp to determine whether or not the user’s “service access rights” have expired. If the client’s access rights

<sup>19</sup> The timestamp is used to indicate how long the client’s requests are to be honored by the JSH process.

have not expired, the JSH process will use the challenge key to generate a “ticket,” which will be used to authenticate clients invoking Tuxedo Server services. The JSH process will also generate a random “session key,” which will be used to encrypt, via RSA public encryption technology, all future communication between the Jolt Client and the Tuxedo Server.

Once created the ticket, session key and challenge key are encrypted with private key encryption technology, a la the Data Encryption Standard (DES)<sup>20</sup>, and returned to the Jolt Client. Upon receipt, the session key and ticket are decrypted and the session key is used to encrypt further communications with the Tuxedo Server, while the ticket is submitted with all future service requests and used by the JSH process to authenticate the Jolt Client.

- ⑤ The BEA Tuxedo will service requests that are submitted via telephony, X window System, batch, or, as previously described, Web (Jolt) clients. As illustrated in Figure C-17, the BEA Tuxedo Server provides transaction, communications, application, and name server services.



**Figure C-17. BEA Tuxedo Services**

The BEA Tuxedo Server and client processes execute as a group of cooperative processes. Specifically, the processes illustrated in Figure C-17 work together as follows:

- Step 1.** A client process, such as BEA Jolt, requests a service that is managed by the BEA Tuxedo Server.
- Step 2.** The service request is formatted and passed over the network to the BEA Tuxedo Server process.
- Step 3.** As part of the client-server communication process, the BEA Tuxedo Bulletin Board (BB) name server is accessed and used to locate an available server process that is capable of satisfying the client request. To facilitate load balancing, the BB process uses resource utilization information to spread the assignment of client requests across multiple server process.

<sup>20</sup> The DES key used to encrypt and decrypt data is based on the password to the requested Tuxedo Server service.

- Step 4.** The bulletin board process returns the address of the server process' message queue to the client process
- Step 5.** The client then submits the service request directly to the server process' message queue for processing
- Step 6.** The server process reads the message from the queue and invokes the requested application server process. These processes, typically, accesses a resource manager, such as a database, and performs some operation – update, delete, add, etc.
- Step 7.** Upon service completion, a reply message is returned to the client process and the application server process begins “listening” for subsequent service requests.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1052	The system shall maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties.
1300	The system shall maintain school disbursement ledgers to show a complete record of all disbursements to, and collection from, a school.
1310	The system shall maintain records of financial aid receivables due from schools to ED.
1350	The system shall maintain an audit trail of all student aid origination and payment records by aid program by student
1572	The system shall manage school and state authorization amounts.
1602	The system shall maintain warehoused payment authorization and, at the appropriate time, generate payment requests.
1654	The system shall maintain reinsurance fee information received from guaranty agencies.
1660	The system shall maintain information on ACA payments made by ED.
1670	The system shall maintain information on interest and special allowance payments made by ED.
1690	The system shall enable participants to apply for Federal financial aid with application mechanisms available 24 hours a day, 7 days a week
1717	The system shall maintain the association between the multi-year promissory notes belonging to a participant and each occurrence of financial aid that participants receive.
2060	The system shall maintain repayment option decision information by participant and loan.
3020	The system shall maintain Fiscal Operations Report and Application to Participant (FISAP) data.
3022	The system shall maintain hold status information for schools that are eligible for Campus Based Program funds.
3094	The system shall maintain school calendar information.
3100	The system shall maintain school limitation, suspension, and termination (LST) notices data.
3160	The system shall maintain information on third-party audits of schools.
3164	The system shall maintain accreditation board and state licensing business information.
4000	The system shall maintain data about individuals participating in Title IV Federal financial aid programs, including participant income, status, address, authorization, and personal information.

**Exhibit C-4. OLTP Requirements**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
4100	The system shall maintain aid data, including aid holder request information, repayment terms, interest rate, and status.
4200	The system shall maintain aid application data, including aid application, school application, and application status
4300	The system shall maintain school data, including school demographic information, enrollment criteria, school performance rating, and participant enrollment status.
4400	The system shall maintain promissory note data.
4500	The system shall maintain package data.
4600	The system shall maintain program management document data.
4700	The system shall maintain data on aid organizations, such as legal entities, commercial or government, external to ED, which participate in the delivery and collection of financial aid to the community. This information will include aid organization type, organization address, organization status, and performance rating data.
4800	The system shall maintain aid program data, including aid program version, aid program fund source, school eligibility, program allotment, and program authorization.
4810	The system shall maintain the length of the grace period for each type of loan.
4900	The system shall maintain the different financial transactions that are applicable to accounting for aid.
4950	The system shall maintain full financial accounting data, including ledger account data, accounting journal entry transaction, and ledger relationship information.
5010	The system shall maintain aid program allotment information.
5080	The system shall maintain budgetary account balances at the level of detail required to meet program reporting requirements.
5110	The system shall maintain a record of interface transactions sent to and received from AFMS.
5120	The system shall maintain a record of interface transactions sent to and received from ED/CFO.
5130	The system shall maintain a record of interface transactions sent to and received from ED Budget.
5170	The system shall maintain valuation of loans and for accounts receivables at net realization value.
5200	The system shall record the receipt of payment against receivables.

**Exhibit C-4. OLTP Requirements (cont'd)**

## Component: Web Server Software

### Component Description:

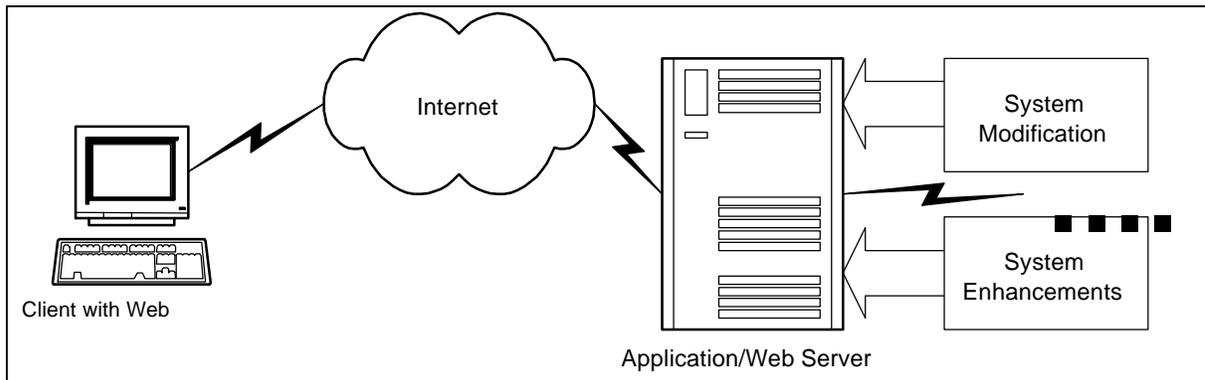
In recent years distributed systems have evolved from “fat client” Remote Data Access architectures, where only the DBMS services were distributed, to Remote Presentation architectures<sup>21</sup>, where application and data management logic are distributed to specialized hardware environments. Today these architectures continue to evolve – largely because of the proliferation of the Internet, the World Wide Web, and related technologies.

Web-based distributed system architectures are finding widespread acceptance with organizations for a variety of reasons, not least of which is the promise of:

- Reduced communication costs that may result as organizations leverage public networks – the Internet – to create instantaneous global communication channels with users, customers, etc.
- Enhanced system openness and application platform independence.
- Simplified software deployment, system control, and configuration management.

Web-based architectures are facilitated by a technology infrastructure that permits globally distributed clients to access and use the services provided by a variety of back-end services and resources, such as RDBMSs, TP monitors, middleware, workflow, file systems, data warehouses, etc. Web Server Software, which is an enabling technology for globally distributed information management systems that are based on the Web and Internet paradigm, is a fundamental part of this technical infrastructure.

Web Server Software uses the HTTP<sup>22</sup> protocol to transfer Web pages to a client program, usually to a Web browser. In the simplest case, the server program locates and delivers the contents of a file requested by a client, seen in Figure C-18. The file that is located this way need not be a Hypertext Markup Language (HTML) page. The page can be any file type because the HTTP protocol allows for the returning stream of data to be prefixed with a header that tells the receiver what type of data is contained.



**Figure C-18. Web Server Interacting with Client over Internet**

Web browser and server software programs were first developed by the National Center for Supercomputing Applications (NCSA) and the World Wide Web Consortium (W3C). NCSA developed

<sup>21</sup> Architecture types are described in Section 2.1.

<sup>22</sup> HTTP is an application and network protocol developed in 1990 at CERN by Tim Berners-Lee. It is a relatively simple, stateless protocol that governs how content is obtained across the Web. For more information on HTTP and Web-based technologies, please refer to Appendix B.

the first freeware HTTP server, httpd, and there are many UNIX Web server hosts based on this implementation. In 1996, the W3C also made a Java server available to its members. Although there are a number of low-cost shareware or even freeware Web Server solutions available, most corporate customers have opted for commercial solutions that offer additional features, support, and integration with other applications. Today, Web Server Software is available for nearly any platform, including Windows, Macintosh, Windows NT, UNIX, and mainframe environments.

Recognizing the promise and benefits of Web technologies and the Internet paradigm, increasingly, organizations are deploying globally distributed information management systems that are based on Web and Internet technologies. With these benefits in mind, the Project EASI/ED candidate framework architectures, could use Web Server software to implement the business requirements listed in Exhibit C-5. A product description and a list of features are provided in Figures C-19 and C-20.

Vendor	Product	Operating Environment
Netscape Communications Corporation	Netscape Suite Spot 2.1	Digital OSF/1 (Alpha), Hewlett-Packard HP-UX, IBM AIX on RISC System/6000, Silicon Graphics IRIX (MIPS), Sun Solaris (SPARC)

**Figure C-19. Web Server Software Architecture Implementation Technology**

Feature	Netscape Enterprise Server
Provides multi-vendor relational database connectivity via Open Database Connectivity (ODBC) and native Call Level Interfaces (CLI).	✓
Provides support for RDBMS stored procedures <sup>23</sup> , database cursors, and Binary Large Objects (BLOBs – allowing web application to leverage previously implemented database-centric business solutions.	✓
Configured with native client/server connectivity drivers for Oracle and other RDBMS technologies and allows simultaneous connections to multiple databases.	✓
Supports SQL passthru techniques, which all database specific commands to be sent directly to the database for processing.	✓
Supports the Simple Network Management Protocol (SNMP) and the HTTP protocol allowing network administrators to manage and control multiple remote server instances from a central location.	✓
Provides GUI-based (graphical user interface) server administration and configuration tool sets.	✓
Provides session management facilities that are integrated with database access functionality – allowing complex business operations that span multiple web requests to be managed as a single transaction <sup>24</sup> .	✓
Capable of supporting more than 100 million “hits” per day <sup>25</sup> .	✓

**Figure C-20. Web Server Software**

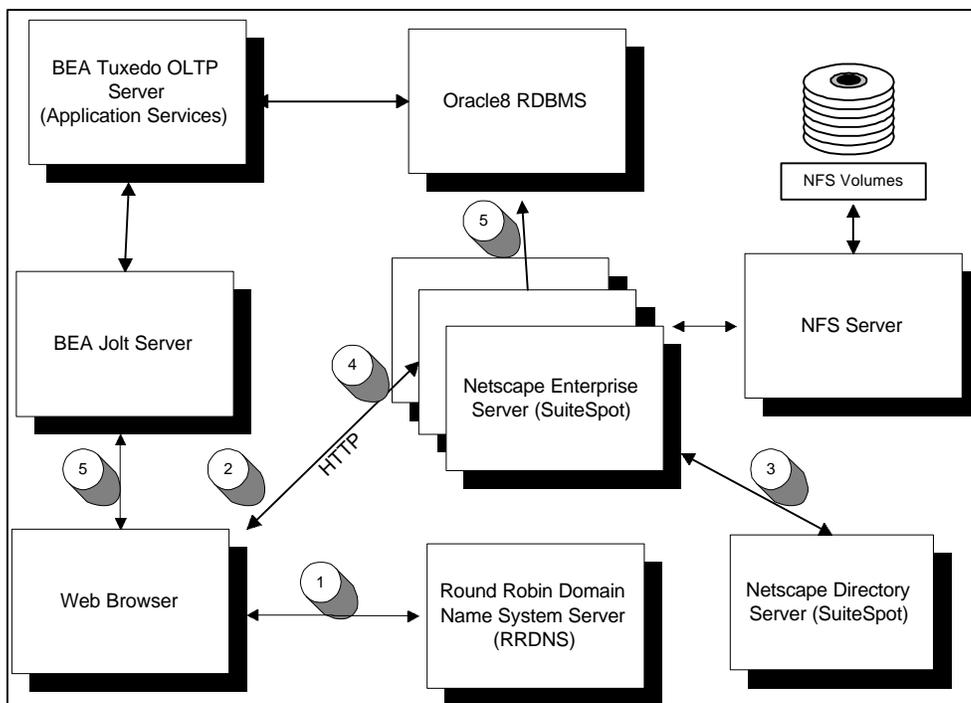
<sup>23</sup> Stored procedures are described in Appendix B.

<sup>24</sup> This feature mitigates limitations associated with CGI-based web server processing, as described in Appendix B.

<sup>25</sup> The Netscape Enterprise Server 3.0 powers Netscape Communication Corporation’s web site. According to Netscape, this web site services more than 140 million user requests (“hits”) every 24 hours.

Feature	Netscape Enterprise Server
Provides intelligent agents that can be triggered based on time and event related criteria allowing users to specify actions such as sending email, updating a web page, or triggering an application.	✓
Provides document publishing, content revision control, version control, and management facilities that allow administrators and users to update and validate managed server content, services, information assets, and configurations.	✓
Provides simplified user administration via a centralized repository of users, groups, and associated privileges that can be shared by multiple servers.	✓
Provides real-time performance measurement and statistical analysis tools for use in monitoring server effectiveness and efficiency.	✓
Provides Internet Foundation Classes (IFCs) that serve as building blocks for application development, provide reusable, turnkey solutions for commonly used capabilities, such as database access services.	✓
Provides support for use of Java, JavaScript and plug-ins allowing developers to extend development functionality.	✓
Supports Secure Sockets Layer (SSL) public-key cryptography and digital signature services that provide message privacy via encryption, message integrity via message mathematical authentication operations (keyed hash functions), and mutual authentication (non-repudiation) via X.509 digital certificates	✓

**Figure C-20. Web Server Software (cont'd)**



**Figure C-21. Logical Software Interfaces for the Web**

## Technology Features

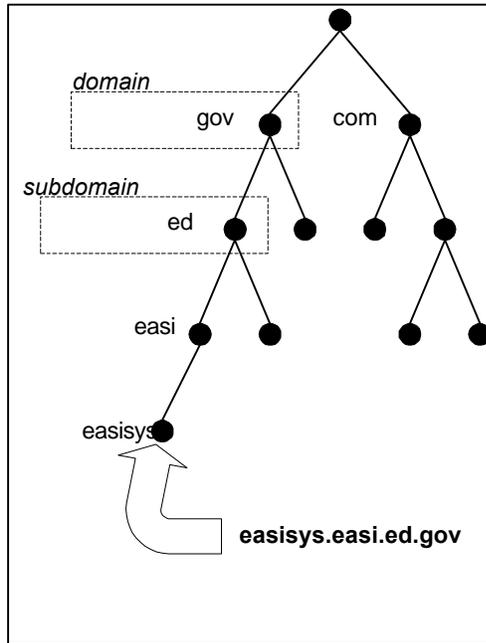
Figure C-21 illustrates logical software interfaces and describes how the Netscape Enterprise Server will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to the Project EASI/ED user community:

- Allows ED to leverage public network resources to create global communication channels with trading partners, students, prospective students, government agencies and other associated with postsecondary education student financial aid.
- Improves the postsecondary education community's ability to effectively reach and support a wider range of customers.
- Accommodates technically sophisticated trading partners, such as large universities and lending institutions, as well as small schools, students, and other groups with insignificant information technology resources.
- Enables users to access the Project EASI/ED architecture from a wide variety of disparate operating environments, for example Windows95, Macintosh, UNIX, and Windows NT.
- Facilitates access to the Project EASI/ED architecture that is not restricted by the user's location, system access time, or uncommon, highly specialized technical requirements.
- Enables organizations to establish and execute more successful business relationships with students and financial aid recipients.
- Streamlines, simplifies, and improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Reduces – through the use of public networks – costs associated with the management and delivery of postsecondary education student financial aid services.
- Delivers reliable and timely student financial aid to students, prospective students, and enterprises associated with postsecondary education.
- Reduces cost associated with publishing and “white mail” paper-based transaction processing, including imaging, document management, etc. through electronic publishing and transaction management services.
- Improves the quality and speed with which transactions can be communicated and processed by the postsecondary student financial aid delivery system.
- Provides Web users with a single point of interface with the postsecondary education community.

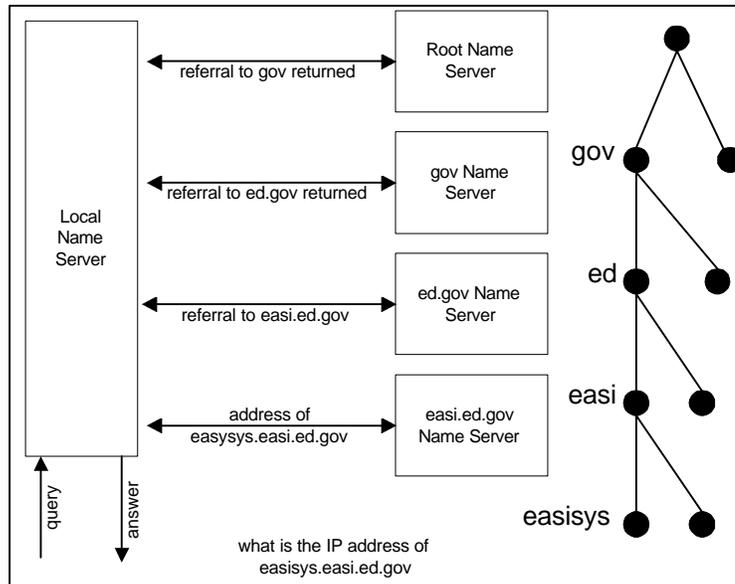
These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Netscape Enterprise Server to deliver improved student financial aid delivery services:

- ❶ The Domain Name System is a distributed, hierarchical database that includes address information for host machines that are “exposed” to the Internet. Users wishing to access and use Project EASI/ED will, most likely, use DNS to search for and navigate to the Project EASI/ED Web Servers.



**Figure C-22. Domain Name System**

As illustrated in Figure C-22, DNS organizes host machines within logical domains, which are represented as “labels” that can be further partitioned into subdomains. In DNS, the full domain name for a host machine is the sequence of labels beginning with the host machines logical name and ending with the DNS root. In the case of the example illustrated in Figure C-22, the fully qualified (absolute) domain name for the host machine within the “easi” domain would be easisys.easi.ed.gov. This logical name would be used by name servers throughout the network to “resolve” (determine) the IP address of the host machine. For example, consider the IP resolution process used by a student attempting to visit the Web site hosted on easisys.easi.ed.gov. Based on his/her request, as expressed as the URL “easisys.easi.ed.gov,” a local name server will query a root name server for the required address and will be referred to the “gov” name server. At the “gov” name server, the user’s local name server will submit the same query and will be referred to the ed.gov name server, which will in turn refer the student’s local name server to the easi.ed.gov name server. Finally, the local name server will query the easi.ed.gov name server, and will be provided the IP address of the machine being searched for. This process is illustrated in Figure C-23.



**Figure C-23. Domain Name System Name Resolution Process**

Taking advantage of the DNS name resolution process, the EASI/ED Target System Candidate Architectures will implement a Round Robin Domain Name System (RRDNS) Name Server. As the name implies this name server will cyclically resolve DNS queries to multiple host addresses, and in doing so distribute Web server processing workloads across, for example, three separate machines. For instance, if the `easi.ed.gov` name server, from the previous example, was implemented as a RRDNS server, it would map each client (student) request to one of many identical Web Server hosts, on a rotating basis.

② Once Project EASI/ED Web Server IP address has been resolved, the student will use this address to initiate a session with the Web server. During session initiation, the Web Server and browser will cooperatively work to establish a secure channel of communication that is capable of:

- **Authentication** – the user’s identity and message authenticity must be guaranteed
- **Access Control and Authorization** – the protection of information from unauthorized access
- **Confidentiality** – the protection of information from unauthorized disclosure
- **Integrity** – the protection of information from unauthorized modification or accidental loss
- **Non-repudiation** – the ability to prevent users from denying they have sent or received information

To this end, all communications with Project EASI/ED Web servers will be conducted through the Secure Socket Layer SSL<sup>26</sup>, which provides transport layer<sup>27</sup> security.

<sup>26</sup> SSL is an open, nonproprietary protocol that was originally proposed by the Netscape Communications Corporation. SSL has been submitted to the World Wide Web Consortium (W3C)-working group on security for consideration as a standard security approach for World Wide Web browsers and servers on the Internet. Netscape is working with the W3C on developing and standardizing common, robust security mechanisms and protocols for the Internet, and it intends to give full support to such mechanisms and protocols as they are standardized. SSL is currently implemented commercially on several different browsers, including Netscape Navigator, Secure Mosaic, and Microsoft Internet Explorer, and many

Specifically, SLL provides 1) server authentication, 2) confidential client/server communications using encryption, and 3) guaranteed data integrity and non-repudiation via digital signatures.

Continuing the previously introduced example, when the student's web browser begins to initiate a session with Project EASI/ED Web server, the client and server will agree on an SSL protocol version, select cryptographic algorithms, authenticate each other, and use public-key encryption techniques to guarantee data confidentiality. Specifically, once the browser and server have agreed to communicate via SSL, the Web Server will facilitate server authentication by submitting a digital certificate<sup>28</sup> to the browser. Once received, the certificate will be compared to the browser's certificate database. If the server certificate is already in the browser's database, or if the server certificate is signed by a Certificate Authority whose certificate is in the browser's database, SSL initiation can proceed. However, if the browser receives a certificate that it does not already trust, the user will be notified and required to either accept (trust) or reject the certificate. If the certificate is accepted, it is added to the browser's certificate database and the server is considered authenticated.

- ③ Once the server has been authenticated, the browser submits its own digital certificate to the Netscape Enterprise Web Server, which in turn, compares the certificate with those already stored within the Netscape Directory Server. If the certificate is identified as "trusted" within the Netscape Directory Server, then SSL communication can begin. However, if the certificate is not recognized within the Directory Server, it must be interrogated, accepted, and installed<sup>29</sup> as a prerequisite for SSL communication.

Once the browser (student) has been identified as "trusted" by the server, the student's certification information, as well as related data within the Directory Server, can be used to determine access controls and privileges regarding system data and functions.

- ④ After both the browser and server have exchanged digital certificates and been authenticated, the public keys, distributed via the certificates, will be used to secure further communications. That is, the browser will use the web server's public key to encrypt communications that are sent to the server. Correspondingly, the web server will use the student's public key to encrypt data delivered to the browser. Once received, encrypted data will be decrypted using the private keys maintained by the both the student and web server. This process will help to ensure data confidentiality.

To further ensure the security of the transmitted data, both the server and browser will create message digests, which are mathematical summaries of the data being communicated. Message digests guarantee data integrity, as the receiving party will only be able to recalculate the digest if the contents of the message remain unchanged. As a last step in the security process, message digests will be encrypted with the senders (student's or web server's) private key. Nonrepudiation is guaranteed when the receiving party successfully decrypts the message digest with the public key distributed via the digital certificates.

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different servers, including those from Netscape, Microsoft, IBM, Quarterdeck, OpenMarket and O'Reilly and Associates.

<sup>27</sup> For more information regarding the OSI Transport Layer, refer to the TCP/IP abstract in Appendix B.

<sup>28</sup> Digital certificates are issued by trusted third parties (certificate authorities) such as VeriSign. Digital certificates are password-protected, encrypted data files that include: identification information of the certificate holder (including e-mail address), a public key (for digital signature verification), Certification Authority name, and certificate validity period.

<sup>29</sup> The Netscape Enterprise Server includes the ability to install new X.509v3 Certificate Authority ("root") certificates, so that users who connect to a server using certificates that have been signed by a root CA will be accepted and the connections that are established will be encrypted.

- 5 Once the authentication process has been completed and SSL-communication has been enabled, the Netscape Enterprise Web Server will provide the student with access to system resources, as appropriate. These resources may include Web content, as well as data managed within the Oracle 8 RDBMS. That is, decision support oriented queries will be proxied to an Oracle RDBMS via Netscape's database connectivity library (previously marketed as LiveWire). Specifically, Netscape's database library enables direct connections to the database via Oracle's Call Level Interface. Alternatively, the web server can be used to proxy OLTP requests to the BEA Tuxedo transaction processing monitor, via BEA Jolt, as described within the following Online Transaction Processing Monitor Software section.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1050	The system shall provide information contained in the ED Student Aid Handbook, Student Guide, and information about school participation in the Title IV programs.
1060	The system shall allow participants to request simulations of possible financial aid packages and financing options, including: <ul style="list-style-type: none"> <li>- Simulating the participant's likely eligibility for Federal financial aid</li> <li>- Simulating costs that would be incurred in attending a particular program at a given school</li> <li>- Simulating the financial aid package options that may be available to the participant</li> <li>- Simulating the financing options that may be available to the participant</li> </ul>
1070	The system shall provide information to aid organizations about individuals looking for financial assistance opportunities, when authorized by the individual.
1080	The system shall provide participants with information on long term debt management, including: <ul style="list-style-type: none"> <li>- Projected potential earnings after graduation by school program</li> <li>- Projected monthly payments after graduation, based on different types of aid packages available</li> </ul>
1090	The system shall allow individuals to authorize the release of specified data to specific schools and fund sources.
1150	The system shall 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/reviews, based on: <ul style="list-style-type: none"> <li>- Independent student samples</li> <li>- Statistical sampling</li> <li>- Exception reports</li> <li>- Self auditing</li> <li>- Performance based standards and measures</li> </ul>
1170	The system shall allow participants to provide feedback on services offered by organizations associated with the Title IV programs. This feedback shall include comments on: <ul style="list-style-type: none"> <li>- The performance rating of schools, lenders, guaranty agencies and the ED</li> <li>- EASI/ED system software service and performance</li> </ul>

**Exhibit C-5. Web Server Software Requirements**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1180	The system shall solicit feedback from participants, schools and other organizations on services offered by organizations associated with the Title IV aid programs.
1190	The system shall publish results on the feedback received from the schools, other organizations and participants.
1280	The system shall provide a single point of interface for receiving student aid data and payment history for Federal loans.
1380	The system shall 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.
1486	The system shall allow participants to de-obligate a loan or grant disbursement (i.e. reduce the amount of a disbursement).
1487	The system shall allow participants to notify the system of intent to change their enrollment status (e.g. transfer or drop out of school).
1492	The system shall allow the participant to request an endorser in the case of a failed credit check for a Direct PLUS Loan.
1497	The system shall send quarterly interest statements to participants during the grace period for Direct Loans that are unsubsidized, or that are consolidated while the student is still in school and have an unsubsidized or a PLUS portion.
1600	The system shall 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.
1690	The system shall enable participants to apply for Federal financial aid with application mechanisms available 24 hours a day, 7 days a week.
1710	The system shall allow participants to request a lender from a list of available lenders.
1742	The system shall receive a signature/authentication from participants to endorse an aid application, multi-year promissory note, or waiver to release information to or from external databases.
2000	The system shall notify the participant of repayment terms and conditions when they receive repayment counseling.
2010	The system shall allow participants to select and request repayment options on their aid at any time.
2070	The system shall provide repayment option modeling capabilities to participants. This shall include modeling the effects of loan consolidation, income contingent repayment, and other repayment plans on the number and amount of payments required of participants.
2110	The system shall allow participants to sign up for automatic payroll and/or other debits (e.g. direct debit from the participant's bank, automatic scheduled payment to the loan holder).
2180	The system shall allow participants to submit a request for consolidation of existing loans into a Direct Loan or FFELP Loan.
2240	The system shall allow participants to query their aid status.
2250	The system shall allow authorized parties to query a student's aid status.
2260	The system shall provide a listing of those loan holders that are authorized to be consolidation agents to participant's upon the participant's request.
2270	The system shall receive a consolidation agent decision from the participant.

**Exhibit C-5. Web Server Software Requirements (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
2280	The system shall allow the participant to request consolidation information.
2290	The system shall provide consolidation information to the participant.
2300	The system shall allow participants to submit combined billing requests for Direct Loans and those loans that are assigned to ED for debt collection.
2560	The system shall allow the participant to request a change in FFELP lender

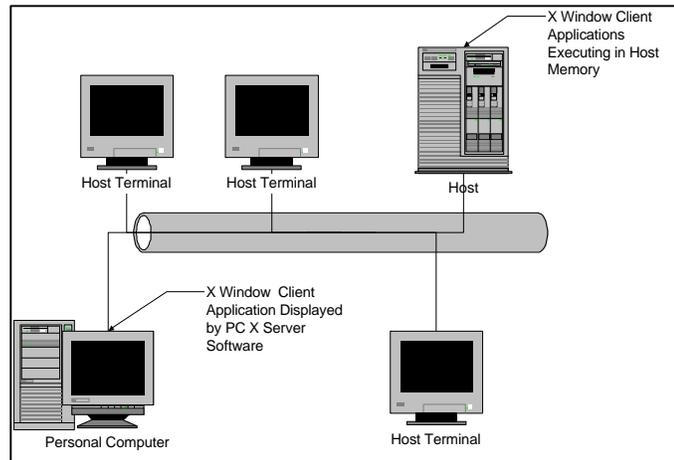
**Exhibit C-5. Web Server Software Requirements (cont'd)**

## Component: X Window System Server Software

### Component Description:

The X Window System is a network-based graphics engine that allows users to connect to, and execute applications (with graphical user interfaces) on, remote systems while handling/managing local I/O (mouse, keyboard, display etc.) interaction.

X11 allows the user to execute and display many applications simultaneously, each within one or more windows. The display is controlled by software that is referred to as the X “Server.” Applications, which are referred to as X “Clients,” do not interact with the user’s display directly. Rather, X clients transmit requests to the X server, which manages the display on behalf of the X Client. That is, unlike the traditional client/server paradigm, with X11, the client process executes on the application “back-end,” handles all application data processing except user I/O interaction, and is a shared resource that typically runs on a server class machine. Whereas, the X Server manages I/O and user-interface services, typically executes on a client platform, comprises the application “front-end,” and controls the user’s display (including the screen, keyboard, and mouse). These components are illustrated in Figure C-24.



**Figure C-24. Components of X Window System**

X clients can operate with any display (without recompiling or relinking the application), as long as there is a suitable communications link and an X11 compliant server available to manage the user’s display. This openness allows users to access applications running on heterogeneous operating environments and provides users with a rich and flexible work environment – where all applications can be delivered to users regardless of X Client or X Server operating environment heterogeneity.

Another advantage the X Window System offers is improved manageability. The X Window System allows the Remote Presentation system distribution strategy to be used. With this strategy, only the X server software is located and executing on the client platform. This simplifies system modification, configuration management, and software distribution, as application software does not reside on the users machine (the client). This configuration also helps to minimize client platform operating resource requirements, as only a minor portion of the application (the X Server) executes on the client platform.

Within the Project EASI/ED candidate framework architectures, X Window System Server Software could be used to provide PC and terminal users with efficient and manageable access to application services. Specifically, X Window System Server software will be used to implement the business requirements listed in Exhibit C-6. A product description and a list of features are provided in Figures C-25 and C-26.

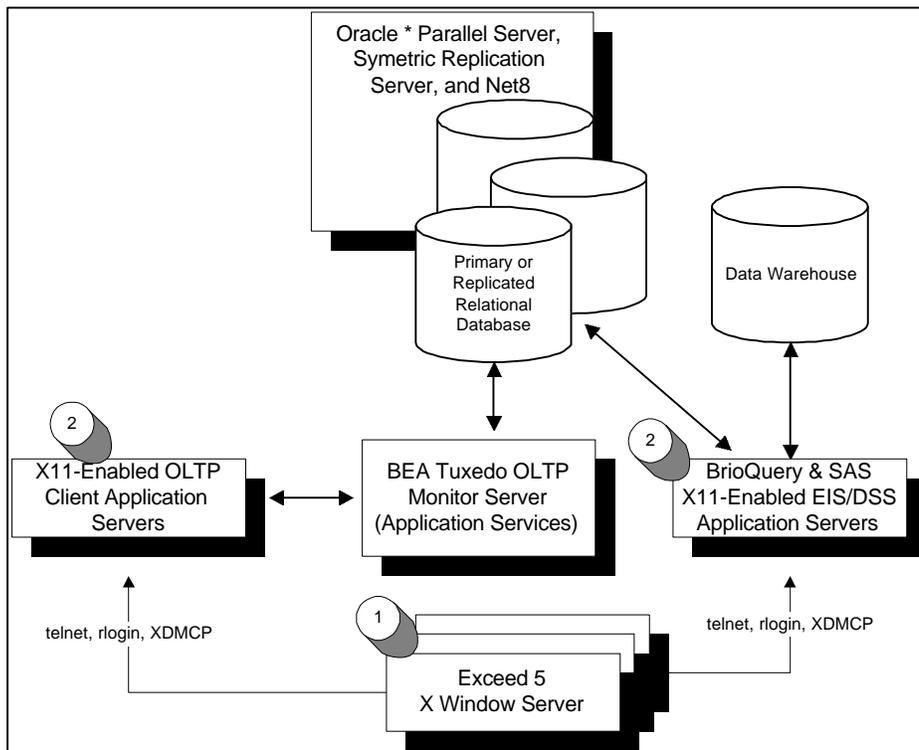
Vendor	Product	Operating Environment
Hummingbird Communications LTD.	Exceed 5-XDK	Microsoft Windows95 and Windows NT

**Figure C-25. X Window System Architecture Implementation Technology**

Feature	Exceed 5 - XDK
Complies fully with the X11R5 standard	✓
Provides local X window manager services <sup>30</sup>	✓
Supports the Motif window manager (mwm)	✓
Provides X Display Manager Control Protocol services, including XDMCP <sup>31</sup> -query, XDMCP-indirect, and XDMCP-broadcast	✓
Provides the capability to access remote X Window clients via the Point to Point Protocol (PPP) and the Serial Line Internet Protocol (SLIP) dial-up connections	✓
Provides X client application startup over TCP/IP via rexec, rsh, rlogin, and Telnet	✓

**Figure C-26. X Window System Technology Features**

Figure C-27 illustrates logical software interfaces and describes how the Exceed 5.0 PC X server will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-37. Logical Software Interfaces for X Window System**

<sup>30</sup> X Server technologies that provide local window manager services will allow X Window Manager processes to be executed using local (the user's) processing resources, thus reducing Project EASI/ED's processing workloads.

<sup>31</sup> XDMCP is an acronym for X Display Manager Control Protocol that can be used to automate invocation of X clients. XDM facilitates centralized control over the X environment and provides an X-based login function that generates authorization information that can be used by X servers to control access to a display.

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to the Project EASI/ED user community:

- Improves the accessibility and usability of processes and data associated with postsecondary student financial aid delivery.
- Improves the postsecondary education community’s ability to effectively use the student financial aid delivery and management services associated.
- Enables users to access the Project EASI/ED architecture from a wide variety of disparate operating environments, for example Windows95, Windows NT, UNIX, and graphics terminals.
- Reduces costs associated with software deployment and configuration management by distributing only the PC X Server Software to the users workstation.
- Reduces costs associated with software development by leveraging a common set of transaction processing and decision support server resources, such as those provided via the BEA Tuxedo OLTP Monitor and the BrioQuery decision support technologies).
- Provides X Window System users with a single point of interface with the postsecondary education community.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED’s trading partners will use the Exceed 5.0 PC X Server to deliver improved student financial aid delivery services:

- ❶ X Window System Application users, for example student financial aid administrators, will invoke Project EASI/ED applications via an X Server. That is, using an X Server, users will attempt to remotely access specific application servers via telnet, rlogin, XDMCP, rexec, and rsh.
- ❷ Once the user has been remotely authenticated, he/she may execute distributed server-based applications (X clients) and transparently “export” the application’s display to a local desktop or terminal, where the application may be used as if processing was being performed locally (rather than on the server). This configuration allows remote users with minimal processing resources to use any Project EASI/ED X Window System-based application for which they have adequate security permissions, without requiring local installation or processing of application components.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1060	The system shall allow participants to request simulations of possible financial aid packages and financing options, including: <ul style="list-style-type: none"> <li>- Simulating the participant's likely eligibility for Federal financial aid</li> <li>- Simulating costs that would be incurred in attending a particular program at a given school</li> <li>- Simulating the financial aid package options that may be available to the participant</li> <li>- Simulating the financing options that may be available to the participant</li> </ul>

**Exhibit C-6. X-Window System Server Software Requirements**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1150	The system shall 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/reviews, based on: <ul style="list-style-type: none"> <li>- Independent student samples</li> <li>- Statistical sampling</li> <li>- Exception reports</li> <li>- Self auditing</li> <li>- Performance based standards and measures</li> </ul>
1380	The system shall 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.
1495	The system shall notify the participant and the school of the credit check result for a Direct PLUS Loan.
1585	The system shall receive profile information from state grant agencies.
1592	The system shall receive information about unused drawdown funds returned by schools to ED.
1600	The system shall 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.
1690	The system shall enable participants to apply for Federal financial aid application mechanisms available 24 hours a day, 7 days a week.
1710	The system shall allow participants to request a lender from a list of available lenders.
1720	The system shall notify lenders and schools of an applicant's request for a Federal Family Education Loan Program (FFELP) lender.
1780	The system shall enable schools to obtain and to update student eligibility appeal results.
1800	The system shall make a participant's eligibility determination available to authorized fund sources.
2130	The system shall provide automatic payroll deduction information to the participant.
2150	The system shall provide routing information for automatic payroll deductions to authorized parties.
2180	The system shall allow participants to submit a request for consolidation of existing loans into a Direct Loan or FFELP Loan.
2250	The system shall allow authorized parties to query a student's aid status.
2260	The system shall provide a listing of those loan holders that are authorized to be consolidation agents to participants upon the participant's request.
2270	The system shall receive a consolidation agent decision from the participant.
2280	The system shall allow the participant to request consolidation information.
2290	The system shall provide consolidation information to the participant.
2300	The system shall allow participants to submit combined billing requests for Direct Loans and those loans that are assigned to ED for debt collection.
2380	The system shall provide a facility for participants to request deferment or forbearance on loans.

**Exhibit C-6. X-Window System Server Software Requirements (cont'd)**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
2560	The system shall allow the participant to request a change in FFELP lender.
2580	The system shall receive requests from participants to refinance their loans.
2730	The system shall request state and Federal offsets of moneys due to participants who have one or more defaulted loans being serviced by the system.
2900	The system shall provide authorized parties visibility to Title IV participant information at varying levels of detail and shall associate Title IV participant information across functional areas (e.g., application, disbursement, repayment).
2920	The system shall provide to authorized staff visibility to audit trail information (backward and forward from the point of origination through repayment) to ensure that for each Title IV program, the correct Federal funds reach the right recipient at the appropriate time.
3024	The system shall provide information to IFMD on school applications for waivers related to Campus Based program requirements.

**Exhibit C-6. X-Window System Server Software Requirements (cont'd)**

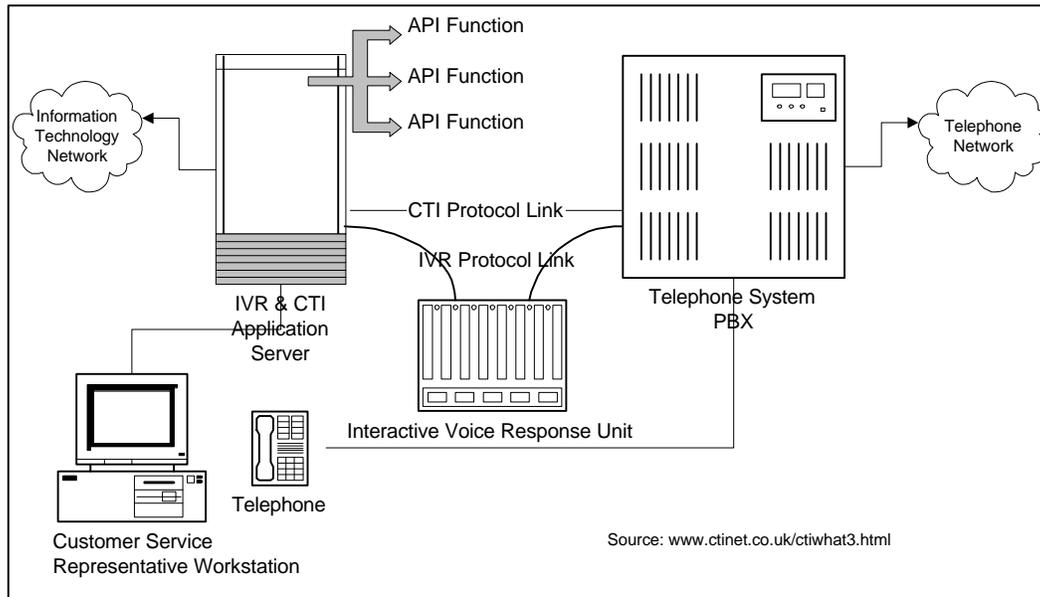
## Component: Interactive Voice Response Software

### Component Description:

Interactive Voice Response (IVR) involves merging the advanced call processing capabilities of digital telephone systems with modern management information system technologies to create an intelligent computer-to-telephone system interface.

IVR-aware application programs typically interface with telephony technologies via an IVR protocol. Specifically, an IVR protocol is used to link telephone network switch technologies, voice response technology, and application servers hosting IVR application software. As illustrated in Figure C-28, IVR technologies are typically integrated with Computer Telephony Integration (CTI) technologies to deliver comprehensive telephony-driven information management solutions.

IVR technologies provide automated voice response, call routing, and telephony-based application invocation services. CTI technologies, on the other hand, manage transactions that cannot be satisfied by the IVR solution. That is, CTI technologies collect transaction and caller identification/profile information from the IVR solution and route this information (and the call) to customer service representatives.



**Figure C-28. IVR Protocol**

Within Project EASI/ED candidate framework architectures, IVR Server Software could be used to provide users with efficient and manageable access to the application services. Specifically, IVR Server software will be used to implement the business requirements listed in Exhibit C-7. A product description and a list of features are provided in Figures C-29 and C-30.

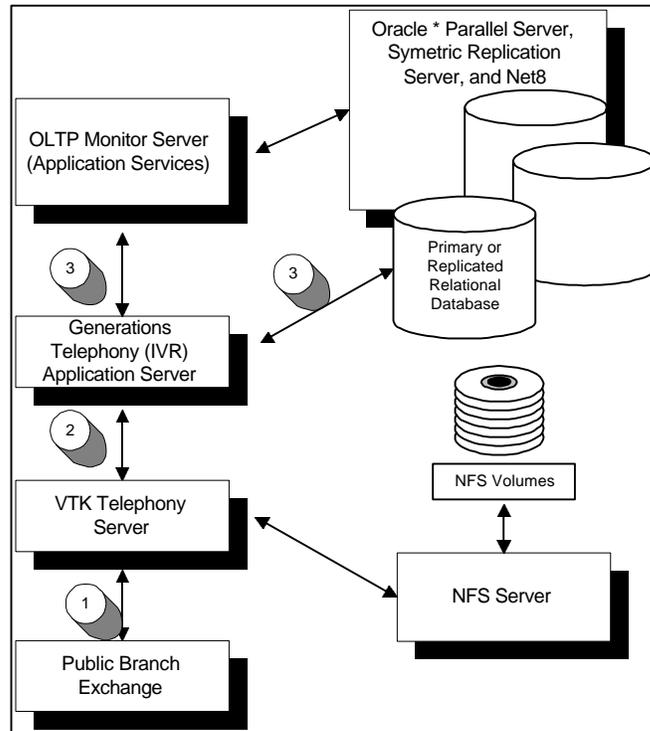
Vendor	Product	Operating Environment
VoiceTek Inc.	Generations® ESP with VTK/3000 Telephony Server	SCO UNIX (Intel), Sun Solaris (SPARC), Hewlett-Packard HP/UX (HP 9000 700/800), DEC OSF/1 (Alpha)

**Figure C-29. Interactive Voice Response Architecture Implementation Technology**

Feature	VoiceTek Generations
Capable of supporting 120 concurrent caller access lines through a single telephony server.	✓
Provides voice response, call routing, telephony-based application invocation services.	✓
Capable of interfacing with the Oracle RDBMS via the call level interface and the Open Database Connectivity protocol.	✓
Provides the ability to operate within a symmetric multiprocessor server environment.	✓
Provides support for interactive facsimile, text-to-speech synthesis, voice-activated dialing, teletypewriter, intelligent (caller profile-based) routing, and automatic speech recognition services.	✓
Provides highly available IRV application services, such as call routing, application invocation, etc., through coordinated redundant configurations.	✓
Allows IRV application software services to be served from a general-purpose operating environment, such as a common UNIX server.	✓
Provides system performance and utilization monitoring tools capable of real-time statistical analysis and reporting.	✓
Provides centralized GUI administration tools that are capable of providing real-time display of system resource utilization and system configuration and status information.	✓
Translates incoming call information into intelligent routing instructions on a call-by-call basis, insuring calls are handled by the optimal resources.	✓
Manages inbound and outbound communications with the IRV technologies available through a wide variety of computer and telecommunications equipment manufacturers.	✓
Integrates with CTI technologies that are capable of using caller Automatic Numbering Identification (ANI), Dialed Number Identification Service (DNIS), and Personal Identification Numbers (PINs), to identify callers and provide user profile management services.	✓
Provides system configuration, administration and management services, as well as prompt management and system monitoring facilities that can be remotely accessed via X Window System client software.	✓
Provides diagnostic warning and alarm services that provide multi-level system failure and malfunction notification.	✓
Provides Simple Network Management Protocol (SNMP) based remote system diagnostic, setup, and maintenance facilities.	✓
Provides voice prompt recording, editing, loading and administration facilities that can be used to maintain caller response dialogs.	✓
Provides a GUI-based rapid application prototyping and development environment that provides turnkey application services, including SQL database functions, call management functions, text-to speech functions, facsimile functions, etc.	✓

**Figure C-30. Interactive Voice Response Technology Features**

Figure C-31 illustrates logical software interfaces and describes how the Generations telephony technologies will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-31. Logical Software Interfaces for IVR**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in the previous figure offers the following functional benefits to Project EASI/ED user community:

- Simplifies and improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Improves the postsecondary education financial aid customer's ability to effectively use the services associated with postsecondary student financial aid delivery.
- Ensures that data being collected and maintained within ED can be accessed by student financial aid customers.
- Delivers reliable, equitable, effective, and timely student financial aid assistance and related services to students and other enterprises associated with postsecondary education.
- Improves the postsecondary education community's ability to effectively reach and support a wider range of customers.
- Accommodates technically sophisticated trading partners, such as large universities and lending institutions, as well as small schools, students, and other groups with insignificant information technology resources.
- Facilitates access to the Project EASI/ED architecture that is not restricted by the user's location, system access time, or uncommon, highly specialized technical requirements.
- Improves the quality and speed with which transactions can be communicated and processed by the postsecondary student financial aid delivery system.
- Provides telephone users with a single point of interface with the postsecondary education community.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Generations IVR technologies to deliver improved student financial aid delivery services:

- ① Telephony users will access Project EASI/ED applications through integrated telephone and management information system technologies. Specifically, calls from users attempting to invoke application servers will be routed through ED's public branch exchange<sup>32</sup> (PBX) to a VTK/3000 Telephony Server, where prerecorded interactive voice prompts will respond to the caller's input, as entered on the telephone keypad.

The telephony server plays prerecorded prompts and coordinates the transfer of user calls to customer service representatives or other telephone extensions; however, these interactive voice response services are managed by the Generations RSP component, which runs on the IVR Application Server.

- ② As calls are received and routed through the PBX to the VTK/3000, the Telephony Server initiates a dialog (via a proprietary IVR protocol) with the Generations RSP application server. Through this dialog, the caller's input (keypad instructions) are communicated to the Generations RSP component, which in turn directs the VTK/3000 Telephony Server to respond with a prerecorded prompt. Alternatively, Generations RSP can be configured to accept the caller's instructions and invoke applications services, such as the BEA Tuxedo OLTP monitor or Project EASI/ED network user authentication and security services. Generations RSP is even capable of directly querying a remote Oracle RDBMS via the Oracle Call Level Interface (CLI).
- ③ Once the callers service request have been processed, result-sets and associated programmatic instructions are communicated by the Generation RSP application server to the Telephony Server, where interactive prompts are dynamically constructed from prerecorded voice files and played for the user.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1060	The system shall allow participants to request simulations of possible financial aid packages and financing options, including: <ul style="list-style-type: none"> <li>- Simulating the participant's likely eligibility for Federal financial aid</li> <li>- Simulating costs that would be incurred in attending a particular program at a given school</li> <li>- Simulating the financial aid package options that may be available to the participant</li> <li>- Simulating the financing options that may be available to the participant</li> </ul>
1170	The system shall allow participants to provide feedback on services offered by organizations associated with the Title IV programs. This feedback shall comments on: <ul style="list-style-type: none"> <li>- Performance rating of schools, lenders, guaranty agencies and the ED</li> <li>- EASI/ED system software service and performance</li> </ul>
1486	The system shall allow participants to de-obligate a loan or grant disbursement (i.e. reduce the amount of a disbursement).

**Exhibit C-7. Interactive Voice Response Software Requirements**

<sup>32</sup> *The Voice & Data Communications Handbook*, which was written by Bud Bates and Donald Gregory, defines a PBX as "as large organization's typical telephone system... a stored-program, common-controlled device... a resource sharing system that provides the ability to access dial tone and outside trunks for the end user."

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1487	The system shall allow participants to notify the system of an intent to change their enrollment status (e.g. transfer or drop out of school).
1492	The system shall allow the participant to request an endorser in the case of a failed credit check for a Direct PLUS Loan.
1495	The system shall notify the participant and the school of the credit check result for a Direct PLUS Loan.
2130	The system shall provide automatic payroll deduction information to the participant.
2250	The system shall allow authorized parties to query a student's aid status.
2260	The system shall provide a listing of those loan holders that are authorized to be consolidation agents to participants upon the participant's request.
2270	The system shall receive a consolidation agent decision from the participant.
2280	The system shall allow the participant to request consolidation information.
2300	The system shall allow participants to submit combined billing requests for Direct Loans and those loans that are assigned to ED for debt collection.
2380	The system shall provide a facility for participants to request deferment or forbearance on loans.
3455	The system shall provide refund information to the participant in the case of a school closure.
3740	The system shall provide program and financial oversight data to lenders.
3750	The system shall provide program and financial oversight data to servicers.
3850	The system shall provide lender default rates to lenders.

**Exhibit C-7. Interactive Voice Response Software Requirements (cont'd)**

## **Component: Data Warehouse Server Software**

### **Component Description:**

A data warehouse is an orderly and accessible repository of known facts and related data that can be used as a basis for making better management decisions. The data warehouse provides a unified repository of consistent data for decision-making that is subject-oriented, integrated, time-variant, non-volatile, accessible, transformed, and management-oriented.

Today, data warehousing is considered the most effective way to transform "data" into "information" – providing critical repositories of timely and accurate information for decision-making. This information is increasingly important, as organizations need to adapt continually to changes resulting from competitive pressures, shrinking business cycles, a global market, and a transforming business environment.

The value of data warehousing lies in its ability to help users efficiently make well-informed decisions through analysis of the important organizational trends. As a result, users spend less time finding and accumulating data, and more time analyzing relevant information and working to implement solutions. That is, data warehousing provides management with access to the right information in the right format, at the right time.

To realize the benefits of data warehousing, data is extracted from operational (OLTP) systems and external information providers, then cleansed, aggregated, integrated, and transformed into a read-only database that is optimized for decision-making. That is, a data warehouse is a special-purpose database system where extracts of operational data are pre-processed (indexed, partitioned, and sometimes pre-aggregated) to improve query performance significantly. Once the data is appropriately stored in a data warehouse, it can be accessed and used through a wide range of access, analysis, and presentation software tools, including decision support systems (DSS), executive information systems (EIS), and analysis tools, such as data mining, statistical software, forecasting software, and simulation.

Data Warehouse Management Tools are typically based on parallel database management system and multidimensional database technologies and are used to help manage operations of the data warehouse throughout its operational life cycle. These operations include data quality assurance, systems management, performance management, and security (security is of particular importance, as data warehouses, by design, make data easier to understand and access). However, the most important service provided by data warehouse management tools is database management.

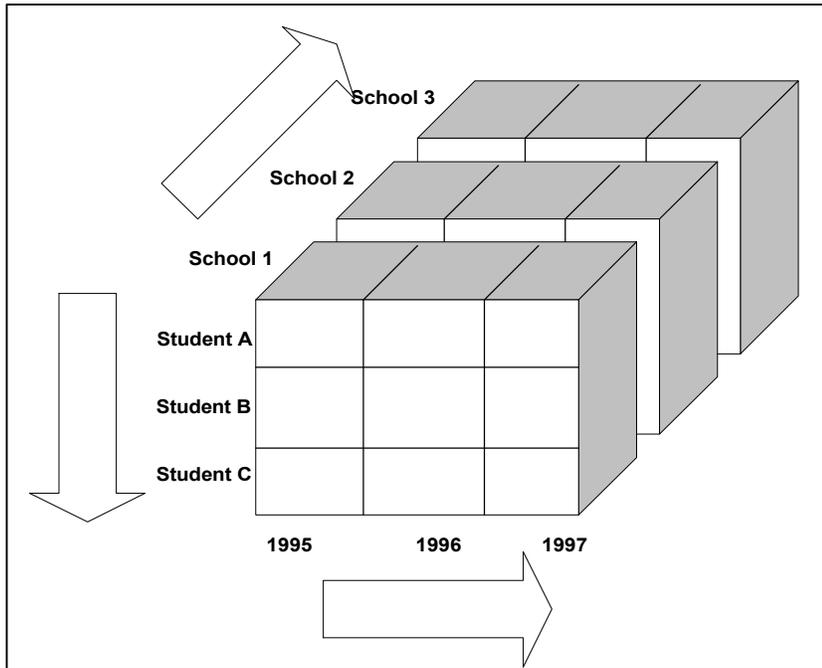
The data warehouse database server software stores, manages, and stages data for end-user access. It is the core component of a data warehouse and is often referred to as an online analytical processing (OLAP) database.

As Figure C-32 illustrates, an OLAP database can be visualized as a multidimensional cube, where the dimensions represent business data organization. For example, using an OLAP database, the Education Department could review data via multiple dimensions such as time, student, school, and disbursement. Like a spreadsheet, an OLAP database stores related data in blocks or cells. These blocks inside the cube are where the measures of the business are archived. For example, a block in the 3-D cube could be defined as the disbursement of a specific loan, to a student at a specific school, on a certain date (time). As a result of this organization, OLAP databases allow users to "slice-and-dice" along each of the dimensions of the data and "drill down" or "roll-up" several layers of consolidated data.

OLAP databases are typically implemented via multidimensional database technologies (also known as MOLAP, for Multidimensional OLAP) or via analytical engines, which provide virtual multidimensional views from data stored with relational database technologies (commonly referred to as ROLAP, for Relational OLAP). However, despite these implementation differences, the generalization can be made that database products must include multidimensional functionality in order to support OLAP.

The key attraction of an OLAP database is its design, which facilitates intuitive data navigation, analysis, and presentation. Specifically, OLAP databases provide the ability to:

- Define aggregation hierarchies and interrogate all aggregation levels at any dimensional intersection
- Built-in analytical and computational features such as roll-up and drill-down capabilities
- Deliver improved/optimized complex ad hoc query performance



**Figure C-32. Multidimensional Cube**

Within Project EASI/ED candidate framework architectures, Data Warehouse Server Software could be used to implement the business requirements listed Exhibit C-8. A product description and a list of features are provided in Figures C-33 and C-34.

<b>Vendor</b>	<b>Product</b>	<b>Operating Environment</b>
Redbrick Systems Inc.	Red Brick Warehouse 5.0	Windows NT (Intel), IBM AIX, NCR MP-RAS, Unisys SVR4, Digital UNIX (Alpha), Hewlett-Packard HP-UX (PA-RISC), Sun Solaris (SPARC), Silicon Graphics IRIX, Sequent DYNIX/Ptx

**Figure C-33. Data Warehouse Server Architecture Implementation Technology**

Feature	Red Brick Warehouse
Provides integrated data import and load utilities that: <ul style="list-style-type: none"> <li>- Preserve referential integrity as data is imported</li> <li>- Perform data conversion, as necessary, i.e., character set translations, time format standardization, etc</li> <li>- Maintain data hierarchies as new data is loaded into the warehouse – thus calculating and updating derived summary and aggregate data values</li> <li>- Automatically update internal data index structures as the data warehouse is populated</li> </ul>	✓
Provides parallel index building, referential integrity checking and load processing capabilities that: <ul style="list-style-type: none"> <li>- Allow multiple indexes to be simultaneously built as new data is loaded</li> <li>- Reduce disk I/O overhead (read/write processing) by sorting data and building indexes in memory before committing changes to disk</li> </ul>	✓
Provides data import and load services that prepare the data for the data warehouse by simultaneously: <ul style="list-style-type: none"> <li>- Filtering data to eliminate unnecessary details or fields</li> <li>- Cleansing data to eliminate incorrect or duplicate data</li> <li>- Converting and translating data into the warehouse database format</li> <li>- Consolidating and aggregating data from multiple sources, as necessary</li> </ul>	✓
Provide data quality management facilities that: <ul style="list-style-type: none"> <li>- Clean and filter input data by checking their validity at load-time to reject invalid data values</li> <li>- Enforce local data consistency<sup>33</sup> and detect discrepancies from overall global consistency<sup>34</sup></li> </ul>	✓
Provides data storage capabilities that: <ul style="list-style-type: none"> <li>- Utilize compressed index structures to minimize the disk space required to store indexes</li> <li>- Reduce the space requirements for numeric data through the use of compact binary numeric datatypes</li> </ul>	✓

**Figure C-34. Data Warehouse Server Technology Features**

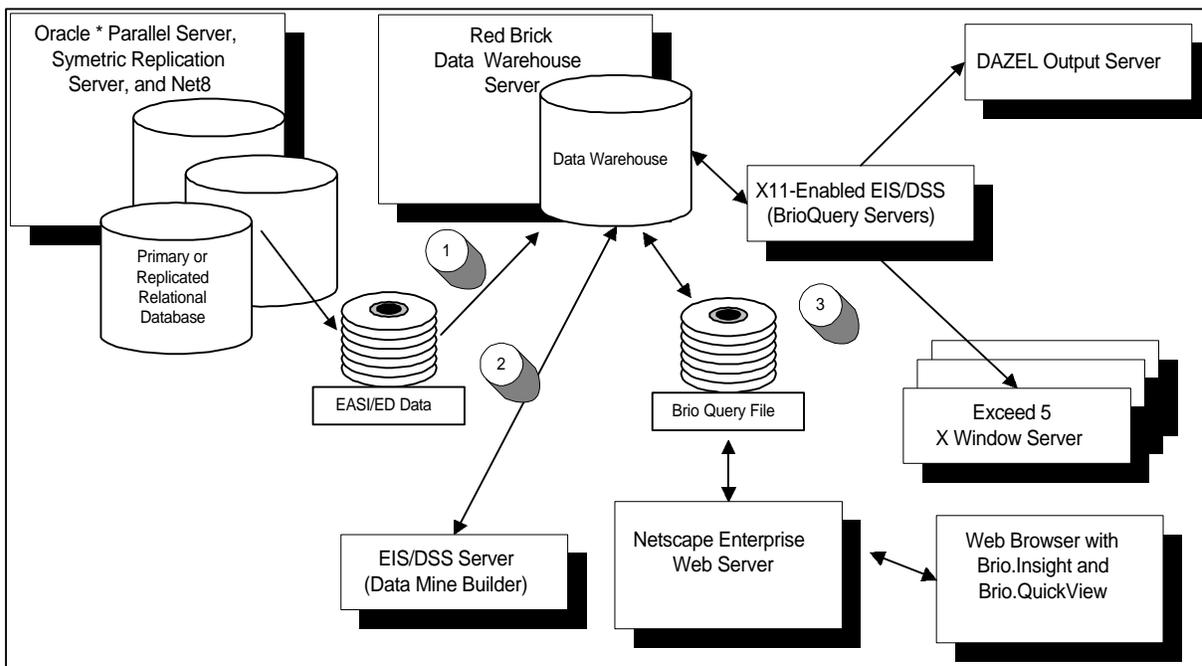
<sup>33</sup> Local consistency ensures that permissible and boundary values are not exceeded when storing values within the database. For example, local consistency would ensure that “Saskatchewan” is not stored within a table containing U.S. state names. Similarly, local consistency would ensure that negative values are not stored within a table containing inventory data.

<sup>34</sup> Global consistency requires that various data items across the data warehouse be self-consistent. For example, it might be a global consistency error if aid disbursement data from were missing for the 1<sup>st</sup> quarter period from the student aid disbursement detail table.

Feature	Red Brick Warehouse
Provides scalable data management services capable of supporting terabyte size datasets via: <ul style="list-style-type: none"> <li>- Modular data management, which allows administration activities to be executed on only portions of the dataset, while maintaining global consistency</li> <li>- Parallel management, which allows the same operation to be concurrently executed on different portions of the dataset</li> <li>- Utilization of Symmetric Multi-Processing (SMP) environments</li> <li>- Logical data partitioning, which decomposes large table structures into several smaller tables to speed data loading and improve data access</li> </ul>	✓
Provide integrated dimensional analysis capabilities that: <ul style="list-style-type: none"> <li>- Define aggregation hierarchies and allow interrogation of all aggregation levels</li> <li>- Offer analytical and computational features such as roll-up and drill-down capabilities</li> </ul>	✓
Provides parallel query processing capabilities that reduce query execution latency by utilizing all available resources	✓

**Figure C-34. Data Warehouse Server Technology Features (cont'd)**

Figure C-35 illustrates logical software interfaces and describes how the Red Brick data warehouse will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-35. Logical Software Interfaces for Data Warehousing**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in Figure C-35 offers the following functional benefits to the Project EASI/ED user community:

- Facilitates providing comprehensive, integrated management information to ED, institutions, and trading partners as appropriate.
- Ensures that data being collected and maintained within ED is accessible, understandable, and useful to the organization and the organization's trading partners.
- Improves the accessibility of processes and data associated with postsecondary student financial aid delivery.
- Provides ED, schools, guarantee agencies, students, and lenders with the accurate, complete, and timely information required to diminish fraud, waste, abuse, and mismanagement.
- Enables efficient and insightful analysis of program management information, system usage information, and other information regarding postsecondary student financial aid delivery and management.
- Improves the accuracy and speed with which the policy, managerial and financial decisions can be evaluated, qualified, and rationalized.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED and ED's trading partners will use the Red Brick Data Warehouse Server to deliver improved student financial aid delivery services:

- ① Most of the architectures being considered isolate transaction processing activities, which require update, commit, and rollback facilities, from those associated with decision support, which typically execute read operations and queries. This is done largely to distribute processing workloads and reduce data access contention. For similar reasons, the data affected by disparate OLTP and decision support operations are also segregated. With this in mind, the Oracle 8 Parallel RDBMS will be used, along with BEA Tuxedo<sup>35</sup>, to control and manage the transaction processing of data. However, once committed to the OLTP database, data must be regularly made available so that it can be leveraged by decision support functions. To facilitate these operations a batch process will export subsets of the data managed within Oracle to a flat file. Using this file, the Red Brick Warehouse Loader will populate a Red Brick Data Warehouse. This warehouse will be used to support decision support and executive information systems services. Specifically, the Red Brick Warehouse Loader will:
  - Read data from an input source and write data into the data warehouse
  - Perform data conversions, as necessary (time formats, byte ordering, etc.)
  - Automatically maintain derived, summary level data and data hierarchies within the warehouse
  - Ensure that referential integrity is not violated by incoming data (for example, if application data for a student is to be loaded then that student must already exist within the warehouse)
  - Maintain and create required indexes as new data is loaded into the warehouse
  - Optimize the sorting of data and indexes in memory prior to writing data to persistent storage
- ② Once data has been loaded into the Red Brick Warehouse, it can be queried via decision support and executive information systems (EIS/DSS). To this end, several EIS/DSS technologies have been included within the Project EASI/ED Candidate Framework Architectures. As described in Executive Information/Decision Support Software section of this appendix, these tools include Red Brick's Data Mine Builder, which is a data

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<sup>35</sup> The BEA Tuxedo Online Transaction Processing Monitor is described in Online Transaction Processing Monitor Software section of this appendix.

mining tool, and Brio Technology's BrioQuery tool suite, which is a set of online analytical processing tools.

As described in Appendix B, data mining tools are used to search for data patterns and groups within expansive data sets. Unlike the Query/Analysis and OLAP technologies, Data Mining tools do not respond to low-level queries formulated by the decision-maker. Rather, Data Mining tools use search methods, such as data associations and sequence patterns, to discover and present information.

To "mine" the Red Brick Data Warehouse, Data Mine Builder will export a statistical sampling of the warehouse's contents to the user's desktop. Using this result-set, Data Mine Builder will derive analytical models for discovering unintuitive, but important data trends, associations, and corollaries. Once the tool has developed an analytical model from the warehouse sample, the model will be used to query, typically as a batch process, the entire Red Brick Warehouse. For example, using data mining techniques ED might be able to predict, for example, that only 3% of female students, who are married, are likely to default on student loan debts.

In addition to data mining technology, Project EASI/ED Candidate Framework Architectures will also include online analytical processing (OLAP) tools. As described in Appendix B, OLAP tools create, organize, and format multi-dimensional data views. Typically these views are based on data that is maintained within SQL-based relational database management systems (RDBMS), specialized OLAP SQL databases, or, more recently, multi-dimensional DBMSs. For example, using OLAP technologies, the administrators could review data via multiple dimensions such as time, student, school, and disbursement. This would allow ED to ask the following question: What are the disbursements – by year, by student, by school?

Within the Project EASI/ED Candidate Architectures, OLAP capabilities are provided via the BrioQuery tool suite, which can be used by X Window System<sup>36</sup> users, as well as via the Web. Specifically, BrioQuery can be used by X Window System-based application users to directly interrogate the Red Brick Data Warehouse and provides support for GUI-based ad hoc query and multi-dimensional analysis, as well as chart and report generation.

- ③ In addition to X Window system users, BrioQuery can also be used by individuals accessing the EASI/ED Target System via the Web. This is facilitated via Brio.Insight and Brio.Quickview – software "plug-in/helper programs" that integrate with the user's web browser<sup>37</sup>. These components allow Web users to analyze BrioQuery files (result-sets) that are generated from the Red Brick Data Warehouse in batch. That is, once authenticated, Web users can use Brio.Quickview to review standardized reports based on the BrioQuery file. Alternatively, users can employ Brio.Insight to perform ad hoc query analysis of available BrioQuery files.

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<sup>36</sup> The X Window System is described in Appendix B. X Server technology is described in X Windows System Server Software section of this appendix.

<sup>37</sup> These components are dynamically downloaded to the user's platform if not already installed when the user opens a session with the Project EASI/ED Web server.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1060	<p>The system shall allow participants to request simulations of possible financial aid packages and financing options, including:</p> <ul style="list-style-type: none"> <li>- Simulating the participant's likely eligibility for Federal financial aid</li> <li>- Simulating costs that would be incurred in attending a particular program at a given school</li> <li>- Simulating the financial aid package options that may be available to the participant</li> <li>- Simulating the financing options that may be available to the participant</li> </ul>
1150	<p>The system shall allow auditors and program reviewers, as well as those with the Functional 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/reviews, based on independent student samples, statistical sampling, exception reports, self auditing, and performance based standards and measures.</p>
1542	<p>The system shall simulate Campus Based award amounts at the request of IFMD, using the school information stored in the system at the time of the request.</p>
1960	<p>The system shall receive financial aid simulation modeling information (e.g. average salaries for various professions) from state departments of labor.</p>
1970	<p>The system shall receive financial aid simulation modeling requests from participants.</p>
2070	<p>The system shall provide repayment option modeling capabilities to participants. This shall include modeling the effects of loan consolidation, income contingent repayment, and other repayment plans on the number and amount of payments required of participants.</p>
2900	<p>The system shall provide authorized parties visibility to Title IV participant information at varying levels of detail and shall associate Title IV participant information across functional areas (e.g., application, disbursement, repayment).</p>
2930	<p>The system shall provide statistical sampling and modeling capabilities to support Title IV program oversight functions.</p>
2950	<p>The system shall monitor key performance indicators and shall flag those indicators whose values are outside predetermined parameters.</p>
2952	<p>The system shall maintain performance measurements for each aid organization, school, and the EASI/ED system itself. Relevant information on these performance measurements shall be provided to authorized external organizations and individuals.</p>
2960	<p>The system shall provide what-if analysis capability to support the formulation of program legislation and policy.</p>

**Exhibit C-8. Data Warehouse Server Software Requirements**

## Component: Executive Information/Decision Support Software

### Component Description:

EIS and DSS technologies are used by executives and decision-makers to improve decision-making, planning, communications, personal efficiency, and organizational control. Specifically, these technologies can be characterized as systems that:

1. Are used directly by decision makers and leaders without the assistance of intermediaries
2. Provides easy on-line access to current information about the plans of the organization
3. Are designed with management's critical success factors (CSF) in mind
4. Use state-of-the art-graphics, communications, and data storage and retrieval methods.

Specifically, EIS and DSS technologies provide:

- Easy to use and maintainable graphical user interface requiring minimal or no training to use
- Integrated capabilities for electronic communications and data access, security and control
- On request “drill down” capability to lower levels of detail and data analysis
- Depiction of organizational health indicators using graphical, tabular, and/or textual information
- Functionality for decision support, ad hoc queries and “what-if” analysis
- Data analysis, on-line status, trend analysis, statistical analysis, exception reporting
- Extraction, filter, aggregation, and tracking of critical data
- Access and integration of a broad range of internal and external data sources, including data warehouses, data marts, and databases

Within the Project EASI/ED candidate framework architectures, Executive Information/Decision Support Software could be used to implement the business requirements listed in Exhibit C-9. A product description and a list of features are provided in Figures C-36 and C-37.

Vendor	Product	Operating Environment
Red Brick Systems, Inc.	Red Brick Data Mine Builder	Windows PC (95 or NT)
Brio Technology, Inc.	BrioQuery	Windows 16-bit or 32-bit (3.1, 95, and NT), Macintosh Mac OS, System 7, Sun Solaris (SPARC or Intel), IBM AIX (RISC System/6000), Hewlett-Packard HP/UX (HP 9000 700/800)

Figure C-36. EIS/DSS Architecture Implementation Technology

<b>Feature</b>	<b>Data Mine Builder</b>	<b>BrioQuery</b>
Allows users to search for data patterns and groups within expansive data sets without requiring the decision-maker to formulate complex queries.	✓	
Uses search methods, such as data associations and sequence patterns, to discover and present information to the decision-maker.	✓	
Provides a graphical interface that unifies query, analysis and reporting functions	✓	✓
Provide graphical query output in the form of bar charts, pie charts, histograms, and line graphs.		✓
Provides easy access to complex analysis functions with one-touch pivot, drill-down, quick data sorts, ad hoc custom groupings, local calculations, and weighted averages.		✓
Provides interactive multi-dimensional analysis by pivoting rows to columns and columns to rows		✓
Provides memory and performance optimization by creating compact, dynamic datasets allowing desktop analysis-on-line or off.	✓	✓

**Figure C-37. EIS/DSS Technology Features**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in Figure C-35 offers the following functional benefits to the Project EASI/ED user community:

- Improves the accuracy and speed with which the policy, managerial and financial decisions can be evaluated, qualified, and rationalized.
- Simplifies, and improves the accessibility of processes and associated analyzing postsecondary student financial aid delivery and management.
- Ensures that data associated with postsecondary education student financial aid delivery can be accurately interpreted, reviewed, and used to make informed policy and management decisions.
- Ensures that data being collected and maintained within ED is accessible, understandable, and useful to the organization and the organization's trading partners, as appropriate.
- Provides ED, schools, guarantee agencies, students, and lenders with the accurate, complete, and timely information required to diminish fraud, waste, abuse, and mismanagement.
- Provides the ability to recognize obscure, unintuitive, but important trends associated with postsecondary education student financial aid delivery and management.

These functional benefits will be realized through the activities defined in the Data Warehouse Server Software section of this appendix, which describes how the Data Mine Builder and BrioQuery technologies will be used, along with the Data Warehouse Server, to deliver improved student financial aid delivery services.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1060	<p>The system shall allow participants to request simulations of possible financial aid packages and financing options, including:</p> <ul style="list-style-type: none"> <li>- Simulating the participant's likely eligibility for Federal financial aid</li> <li>- Simulating costs that would be incurred in attending a particular program at a given school</li> <li>- Simulating the financial aid package options that may be available to the participant</li> <li>- Simulating the financing options that may be available to the participant</li> </ul>
1150	<p>The system shall allow auditors and program reviewers, as well as those with the Functional 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/reviews, based on independent student samples, statistical sampling, exception reports, self auditing, and performance based standards and measures.</p>
1542	<p>The system shall simulate Campus Based award amounts at the request of IFMD, using the school information stored in the system at the time of the request.</p>
2070	<p>The system shall provide repayment option modeling capabilities to participants. This shall include modeling the effects of loan consolidation, income contingent repayment, and other repayment plans on the number and amount of payments required of participants.</p>
2930	<p>The system shall provide statistical sampling and modeling capabilities to support Title IV program oversight functions.</p>
2960	<p>The system shall provide what-if analysis capability to support the formulation of program legislation and policy.</p>

**Exhibit C-9. Executive Information/Decision Support Software Requirements**

## Component: Output Management Server Software

### Component Description:

As local area networks are interconnected with global enterprise networks, the need to access and share workgroup and departmental output resources becomes critical. In addition to printers, which have traditionally been used to produce hardcopy output, organizations implementing applications must consider several other output destinations including, fax, e-mail, file transfer, and the Web.

Output Server Software fulfills a critical need within distributed system architectures by providing comprehensive server-centric output management services that:

- Reliably deliver system output to a variety of widely distributed, heterogeneous output devices
- Provide unified approach to printing, faxing, file transfer, and Web publishing
- Centralize management and control of, and unifies access to enterprise-wide output resources

Within the Project EASI/ED candidate framework architectures, Output Management Server Software could be used to implement the business requirements listed in Exhibit C-10. A product description and a list of features are provided in Figures C-38 and C-39.

Vendor	Product	Operating Environment
Dazel Corporation	DAZEL Output Server	IBM AIX (RISC System/6000), Sun Solaris (SPARC), Hewlett-Packard HP/UX (HP 9000/700 and 800), NCR SVR4

**Figure C-38. Output Management Architecture Implementation Technology**

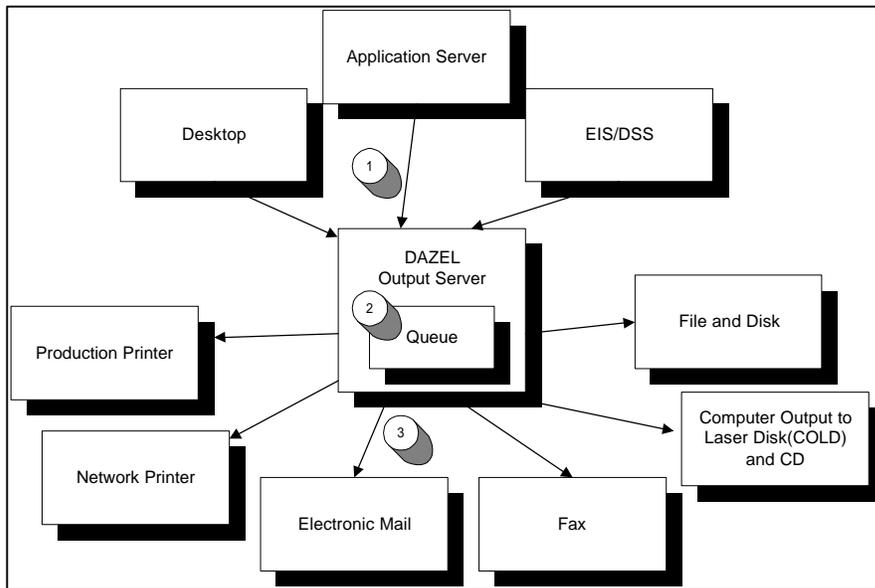
Feature	Dazel
Provides a Job and Queue management functions including <ul style="list-style-type: none"> <li>- Control over jobs (pause, delete, resume, move etc.)</li> <li>- Automatic job retires upon busy, failure, or no answer</li> <li>- Restarting jobs from point of job failure</li> <li>- Automatic job retention with user-definable retention time</li> <li>- Queue maintenance across system failure/reboot</li> <li>- Multiple logical destination for a single physical destination</li> </ul>	✓
Provides delivery management function including: <ul style="list-style-type: none"> <li>- Multiple dissimilar document types to be sent as a single job</li> <li>- Documents to be sent to multiple dissimilar destinations as a single job</li> <li>- On-demand or time-based job submission</li> </ul>	✓
Provides destination management functions including: <ul style="list-style-type: none"> <li>- Automatically transforms input document format to destination(s) output format.</li> <li>- Supports black and white and color printing</li> <li>- Accepts input format such as: FrameMaker, EBCDIC, Postscript, ASCII and other formats</li> <li>- Supports output formats such as: PCL, Postscript, ASCII, Fax G3 and other formats.</li> </ul>	✓

**Figure C-39. Output Management Technology Features**

Feature	Dazel
Provides configuration management tools to allow: <ul style="list-style-type: none"> <li>- Centralized administration and control of queues, servers, jobs, and other objects.</li> <li>- Electronic private and public phone books for location of destinations by person or company</li> </ul>	✓
Provides event management functions including: <ul style="list-style-type: none"> <li>- Real-time, automatic feedback of destination malfunctions</li> <li>- Notice routing to e-mail and system management consoles</li> <li>- On-demand display of output delivery updates</li> </ul>	✓
Provides security manager functions including: <ul style="list-style-type: none"> <li>- Ability to define who can deliver to which destinations</li> <li>- Ability to control delivery process based on size-of-job, day-of-week, time-of-day, etc.</li> <li>- Ability to define who can administer output destinations, queues, jobs, etc.</li> </ul>	✓

**Figure C-39. Output Management Technology Features (cont'd)**

Figure C-40 illustrates logical software interfaces and describes how the DAZEL Output server will be used within the Candidate Framework Architectures. It should be noted that the following illustration describes interfaces between software components only. That is, the allocation of software components to hardware is not represented within the following illustration. Hardware allocations are described in Subsection 5.4.



**Figure C-40. Logical Software Interfaces for Output Manager**

In addition to the enhanced technical services and benefits described within the previous list of product features, the logical software configuration illustrated in Figure C-40 offers the following functional benefits to the Project EASI/ED user community:

- Streamlines, simplifies, and improves the accessibility of data associated with postsecondary student financial aid delivery.
- Ensures that data being collected and maintained within ED is accessible to the organization and the organization's trading partners.
- Improves the postsecondary education community's ability to effectively reach and support a wider range of customers, including those with insignificant information technology resources.

- Delivers reliable and timely student financial aid assistance information to students, prospective students, schools, lenders, guarantee agencies, and other enterprises associated with postsecondary education.
- Allows ED to notify, provide, and solicit information from postsecondary education student financial aid providers, administrators, and recipients.
- Improves the quality and speed with which transactions can be communicated and processed by the postsecondary student financial aid delivery system.
- Reduces costs by centralizing the management, control, and administration of remotely distributed output devices, such as printers, facsimile machines, etc.
- Improves the reliability of output through automated redelivery, delivery failure detection, and delivery confirmation services.

These functional benefits will be realized through the following list of activities. These activities correspond with the previous figure and describe how ED will use the Dazel Output Server to deliver improved student financial aid delivery services:

- ❶ Project EASI/ED users will access print, facsimile, and similar output functions through an application programming interface (API). This API will invoke, manage, control, and access centralized output management services. Specifically, when directed to do so, the application being used (for example an X Window System or batch application) will format the output contents and, using the API, forward these contents to the DAZEL Output Server.
- ❷ The DAZEL Output Server will provide centralized output management services. In doing so, the Output Server will simultaneously reduce management complexity and enhance the accessibility and reliability of output resources. Specifically, the DAZEL Output Server will:
  - Control all output jobs, queues, output destinations/devices, and associated user privileges. For example, the DAZEL Output Server will provide “checkpointing” services, which, in cases of system failure, ensure that large jobs are restarted appropriately. For instance, if an ED administrator submits a request to print 5,000 promissory notes and a failure occurs while promissory note number 3,150 is being printed, the Output Server will ensure that the printer resumes at promissory note number 3,150, rather than restarting at promissory note number 1.
  - Manage delivery of output to disparate output devices and destinations. For example, the DAZEL Output Server can be used to deliver multiple, dissimilar documents, in a variety of formats, to many, disparate devices, at several geographically dispersed locations. For instance, if a batch process submits a request to print 100 promissory notes on three different types of printers, at four different schools, the DAZEL Output Server will ensure that this request is successfully processed. In cases of failure or device unavailability, the Output Server will automatically resubmit the “job” and notify system operators, as necessary.
  - Automatically transform output contents into the destination and device formats required for delivery. For example, if a user submits a postscript file for delivery, the DAZEL Output Server will reformat the file, as necessary, for output to Group III facsimile machines, SMTP electronic mail servers, ASCII, postscript, and PCL printers, or other devices.
  - Centralize the configuration management of printers, facsimile machines, and other output devices. For example, if an administrator of ED’s headquarters in Washington D.C wishes to send (via facsimile) disbursement records, adjustments, and cancellations to ED Regional Offices, he/she can query the DAZEL Output

Server's central repository for available facsimile machines at the desired locations.

- Monitor and provide notification of output processing and devices status. For example, the DAZEL Output Server will allow users and administrator to “subscribe” to output status information. For instance, administrators can be notified anytime a destination event (printer paper jam, printer out of paper, busy facsimile line, etc.) occurs. Likewise, users can be notified when, for example, a job completes or fails.
- Maintain an inventory of all output resources and related usage statistics. For example, the DAZEL Output Server will collect output device utilization data, which can be used by system operators, managers, and planners for system capacity planning and load balancing purposes.

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1050	The system shall provide information contained in the ED Student Aid Handbook, Student Guide, and information about school participation in the Title IV programs.
1052	The system shall maintain and provide access to original and/or copies of original correspondence and/or communications to authorized parties.
1080	The system shall provide participants with information on long term debt management, including: <ul style="list-style-type: none"> <li>- projected potential earnings after graduation by school program</li> <li>- projected monthly payments after graduation, based on different types of aid packages available</li> </ul>
1150	The system shall 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/reviews, based on: <ul style="list-style-type: none"> <li>- Independent student samples</li> <li>- Statistical sampling</li> <li>- Exception reports</li> <li>- Self auditing</li> <li>- Performance based standards and measures</li> </ul>
1180	The system shall solicit feedback from participants, schools and other organizations on services offered by organizations associated with the Title IV aid programs.
1190	The system shall publish results on the feedback received from the schools, other organizations and participants.
1254	The system shall request annually low income school information from state education Offices, based on the screening criteria sent to them.
1258	The system shall send all Perkins Loan schools a copy of the low-income school directory annually.
1370	The system shall produce specified reports that meet Federal account requirements and Federally mandated school reporting requirements from data in the transaction histories.
1390	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.
1440	The system shall notify the school when the system authorizes disbursement of funds to the school.

**Exhibit C-10. Output Management Server Software Requirements**

REQUIREMENT IDENTIFIER	REQUIREMENT DESCRIPTION
1445	The system shall notify schools and participants when two or more Pell Grant Origination records are received from different schools for the same academic period and the same participant.
1460	The system shall inform the school, the participant, and the fund source of the results of edits applied to disbursement records, origination records, adjustments, and cancellations
1497	The system shall send quarterly interest statements to participants during the grace period for Direct Loans that are unsubsidized, or that are consolidated while the student is still in school and have an unsubsidized or a PLUS portion.
1420	The system shall confirm participant enrollment and eligibility prior to the disbursement of Pell Grant funds to a school.
1440	The system shall notify the school when the system authorizes disbursement of funds to the school.
1495	The system shall notify the participant and the school of the credit check result for a Direct PLUS Loan.
1495	The system shall notify the participant and the school of the credit check result for a Direct PLUS Loan.
1790	The system shall notify participants of their eligibility determination.
2003	The system shall provide formal loan disclosures to the participant, which indicates the actual interest rate for the loan.
2004	The system shall send the participant a disclosure statement 60 days prior to the end of the grace period.

**Exhibit C-10. Output Management Server Software Requirements**