

# Standards for Enterprise Information Systems and Solutions

## Version 1.0

Information Technology Services  
Louisiana State University  
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### PURPOSE

The following standards address the process of developing enterprise systems at Louisiana State University. The full definition of an “enterprise system” would undoubtedly be long and complex, but a working definition for LSU might be as follows: “A software application serving all or most of the community of a large organization, housing a large amount of critical or protected information, and in many cases integrated in some manner with other enterprise software applications both internal and external to the institution.” The purpose of these standards is to structure the interaction and integration of enterprise software acquired and developed by central computing and other campus units.

Whether or not limits exist to Moore’s Law which, in general, states that technology capability will double every ten years, technology will continue to evolve at a rapid rate. Consequently, these standards are subject to change at any time. Please review them periodically for the latest information on developing systems that interact with enterprise systems at LSU.

### DEFINITIONS

**“Authentication”** is the act of an individual identifying themselves to a computer system in conjunction with some measure of proof that they are, in fact, who they say they are.

**“Authorization”** is the act of a computer system validating that an individual is permitted to access a particular computer application or resource.

**“Business Process Management System”** is defined as a software tool or environment that facilitates the implementation of a business process by combining heterogeneous elements within and across units of an organization.

**“Change Management”** is the process of controlling the movement of new software applications and changes to software applications, from a development environment into a production environment so that the impact of changes are minimized or managed.

**“Current technologies”** are defined as technologies or software solutions that are currently being used to support the enterprise systems of the University. Current technologies may include legacy systems that will either be evolved or replaced in the future, existing technologies that are actively being adopted, and technologies that have a presence within the enterprise system infrastructure due to the requirements of a purchased proprietary system, but which have only limited internal support.

**“Database Administration”** is the activity of creating, changing, and maintaining data collections, the containers they are stored in, and the relationships between those containers.

**“Data Modeling”** is the process of capturing the logical groupings of information that are of interest to an organization.

**“Distributed Application”** is defined as an application that executes on multiple server instances.

**“Emerging technologies”** are those that represent a significant shift in the technological methods used to support the enterprise systems and that are being actively adopted by UIS, but that have not yet reached the stage where they are ready to be universally utilized and supported by UIS and other campus constituents.

**“Evolving technologies”** are defined as mature technologies that are currently in use that are being expanded and enhanced.

**“Future technologies”** are defined as technologies that are not currently in use that have been identified as potential integration enablers or replacements for legacy technologies.

**“Legacy technologies”**, or systems, are defined as mature hardware or software components in which the University has invested in significantly over a long period of time. These technologies are potential candidates for replacement or upgrade where cost or time efficiencies presented by newer technology make a compelling case for that replacement.

**“Limited technologies”** are those that have a presence within the enterprise system infrastructure due to the requirements of a purchased proprietary system, but which have only limited internal support, usually by an external vendor.

**“Load Testing”** is defined as the process of testing the performance of a software application.

**“Programming Language Framework”** is defined as a specific programming language and the unique combination of tools used by an organization to develop software or other computer-related content.

**“Quality Assurance”** is the process of validating the logic and suitability of an application.

**“Systems Integration”** is the process of linking together different computing systems and software applications physically or functionally. The system integrator brings together discrete systems utilizing a variety of techniques such as computer networking, enterprise application integration, business process management or manual programming.

**“Transaction Processing”** is defined as the division of information processing operations into discrete units or operations with a distinct beginning and end. Each unit or set of operations must completely succeed or completely fail. This set of logical operations is called a “unit of work”. In practical terms, transaction processing systems provide this service as well as workload management via queuing, and transaction security and logging.

**“Unit Test”** is defined as a set of input values for a software application that represent a discrete test for the application and can be applied to an application when it is written and every time it is changed to

insure that it functions correctly in all respects. Typically, a number of unit tests might be required to fully test an application.

**“Use Case”** is a single unique scenario or a logical set of interactions between an actor or a person and a computer system that accomplish a goal of the system.

**“Unsupported technologies”** are those that are not part of the current enterprise system development framework and that UIS has neither the in-house expertise to support, nor plans to support in the near future. New technology is evolving constantly While UIS monitors these changes and advances in technologies and solutions that support higher education systems, only those technologies that fulfill the critical enterprise system needs of the University can be supported. UIS does not support technologies that duplicate the functionality of the solutions we have already adopted. This does not imply that units external to UIS may not adopt these technologies for themselves, simply that UIS cannot provide support for those technologies.

**“Web Content Management System”** is a software application and specialized database for creating and housing components or files for Internet sites.

## STANDARDS

### I. Enterprise Systems Frameworks

#### a. Authentication

The large majority of computer and Internet-based services deployed by the University require that the identity of a specific patron be established in order to deliver the relevant set of services to that person and to secure their personal information. This process of identifying an individual to a computer system is called “authentication”. Accomplishing the authentication function while ensuring that the associated processes and tokens are secure, and that identity information is accurate, is a complex undertaking. On top of that, Web single sign on represents another higher level of authentication functionality. Single Sign on (SSO) is authentication to a central authority which is then communicated to a range of computer systems and applications thus reducing the number of times that an individual must enter their account name and password. To insure the secure and correct use of identity at LSU, access to authentication sources and methods are closely guarded. LSU utilizes the following tools and protocols (languages) in this area.

1. Active Directory (native/LDAP)
2. Domino (native/Web SSO/LDAP/custom 3<sup>rd</sup> party integration)
3. CAS (Web SSO)

#### b. Authorization

In accessing a computer resource, once a person’s identity has been established the next step is to determine whether they are specifically allowed to use that service, application, or data resource. This is the process of authorization. It involves looking at the role a person plays in an organization, the groups they belong to, the specific rules that have been put in place that name

that person, and then performing the gate keeping operation that protects information resources. At LSU, the following systems and methods are used to accomplish the authorization function.

1. SAM/DRA Profiles
2. AIS.RESOURCE table (attribute-level masking)
3. Lotus Domino Access Control Lists (ACL's)
4. Active Directory
5. ACF2 (transaction source groups, application groups)
6. LDAP (in design stage)

c. Code/Language Frameworks

Today, there are many computer languages, environments, and tools available for developing software in support of critical processes at the University. Each has its own strengths, weaknesses, and specific focus in terms of the types of solutions it is best suited for. An organization must have a technology environment diverse enough to provide the variety of solutions required without creating an excessive burden in terms of the number of skills that IT staff must maintain expertise in. Development of enterprise solutions at LSU are currently being conducted with the following underlying technologies.

1. COBOL(IBM Enterprise) utilizing IMS Transaction Manager
2. Java utilizing Struts2, Spring, Hibernate, and JIMS (Java/IMS Bridge)
3. Lotus Domino utilizing DIMS (Domino/IMS Bridge)
4. SAS statistical language
5. CSS, xhtml, Ajax
6. JSP
7. PHP

d. Database Management Systems

Full featured database management systems are an essential ingredient to enterprise systems to house the large amounts of critical data generated and required by a large institution. In addition to a specific DBMS for institutional purposes, third party solutions may mandate that other types of DBMS be maintained. LSU currently uses the following database management systems in connection with enterprise systems.

1. DB2 for zOS
2. DB2 LUW
3. SQL Server (Limited through NI)

e. Document Conversion Services

For the purposes of these standards, document conversion will be defined as any action in which electronic documents are altered, converted, or merged via software. This process is often an intensive one for computers to accomplish. LSU currently uses the following software in this area.

1. Active PDF

- f. Web Portal / Workspace

A Web portal is typically a secured site on the Web that is used to organize a related set of applications that are targeted to a distinct user community. A portal may also provide personalization features that allow community members to customize the way that applications and services in the portal are presented. The University Web portal is currently supported by the following custom applications developed in-house.

1. PAWS Intranet (currently evolving)

- g. Server Frameworks

In general, a server framework can be thought of as the operating system (OS) and major software components that control the computer hardware and serves as an interface between a computer user and the software and functions contained in the computer. Straightforward examples of a server framework would be Windows Server/IIS or Red Hat Enterprise Server/Apache. With the introduction of server virtualization though, the landscape has become a bit more complex with operating systems now able to run as guests within another OS. LSU currently uses the following server frameworks.

1. zOS
2. Windows Server / Lotus Domino / .NET (limited)
3. Red Hat / Apache / TomCat
4. VMWare

- h. Transaction Processing

A transaction processor is a supporting software system that governs access to critical data and processes that may be in high demand. It provides a number of functions including workload management via queuing, security, logging, and coordinated units of work. LSU currently utilizes the following transaction processing system(s).

1. IMS Transaction Manager (in conjunction with COBOL)

- II. Collaborative Development

- a. Business Process Management

Organizations typically contain many distinct software application systems and services that can be leveraged to support a business process. Business Process Management Systems (BPMS) are software environments that seek to provide business users and IT staff a simple way to automate a business process using those disparate systems and services by serving as a common integration point for those systems and services through which automated business processes can be deployed via the Web. LSU is currently evaluating the following software for use in automating business processes.

1. MetaStorm BPM (in pilot stage)

- b. Enterprise Content Management

According to Wikipedia, enterprise content management “is a set of technologies used to capture, store, preserve and deliver content and documents and content related to organizational processes.” LSU currently uses the following tools in this area.

1. IBM Content Manager via InputAccel

- c. Reporting and Distribution

Since information and its dissemination is the life blood of any organization, the development of reports is a constant and necessary activity. LSU currently uses the following tools to deliver standardized and custom reports.

1. SAS for zOS
2. Enterprise Information System (EIS)
3. Filestogaux (secure file distribution)
4. SAS Web (in acquisition stage)

- d. Web Content Management

Web site support and content management can range from site hosting to the creation of a simple Web page to a full featured application delivered via a browser. A plethora of tools exist which campus units can use to build and maintain Web sites. The following hosting, development and Web content management tools are currently used for Web development at LSU.

1. Web Hosting Accounts/traditional/FTP
2. Web hosting accounts/Rhythmyx WCMS (in development/deployment stage)
3. StudioWeb (new development is not being encouraged)
4. Lotus Domino (new development is not being encouraged)

### III. Database Administration and Modeling

- a. Data Modeling

Data Modeling is the process through which specific groups of data, the relationships between those groups, and the rules governing the way software interacts with those data groups are identified. While a database can certainly be built without a data model, the absence of a model increases the likelihood that the database will be subject to extensive changes in the future. In addition, data modeling presents an opportunity for discussions in greater depth about the processes that the database will ultimately support. The following methodologies and tools for database modeling are used for database design.

1. Entity-Relationship Modeling (Methodology)
2. ERWin (Tool)

b. Database Administration

In addition to the creation of databases, database administration includes ensuring that backup and recovery are provided for, that data integrity is preserved, that appropriate security can be maintained, and that databases are kept in good order to maximize performance of applications accessing them. For security and audit purposes, these activities are conducted by and reserved to a small group of individuals within the UIS IS Architecture group for the benefit of the University.

c. Business Process Modeling

Wikipedia, the free Web-based encyclopedia, defines business process modeling as “the activity of representing both the current ("as is") and future ("to be") processes of an enterprise, so that the current process may be analyzed and improved.” Processes identified by modeling may be implemented in one or more of the various technology paradigms discussed in this document. This activity is managed and conducted by business analysts in the University Information Systems group in conjunction with, and separately by, business analysts resident in campus administrative units.

IV. Quality Assurance (QA)

a. Coding Best Practices

Industry and LSU standards for program code in various languages are subject to periodic shifts. Individuals engaged in the development of computer program code should contact UIS application development managers to understand the latest standards and best practices in algorithms and code development practices.

b. QA review

All enterprise applications developed for LSU by UIS in-house or by other parties must undergo a QA review before it can be approved to be moved into a production setting. QA reviews are conducted or commissioned by one or more of the technical managers responsible for developing enterprise software applications.

c. Load and Unit Testing

All enterprise applications developed by UIS in-house or by other parties should undergo testing utilizing a pre-defined set of unit tests developed from an analysis of the use cases specific to an application. Evidence of the conduct of unit tests, or the ability to demonstrate such tests are required before an application can be approved to be moved into a production setting. Some of the tools used by UIS are listed below.

1. Jmeter

2. COBOL Debug Tool
3. Expeditor tool by Computer Associates

## V. Documentation

### a. Program documentation

Enterprise software developed for LSU by UIS in-house, or by other parties, must have the following information documented at a minimum

1. Program description
2. Data inputs
3. Program output

It is highly recommended that the following additional documentation be prepared as well.

1. Detailed program specifications or description of logic flow
2. Use cases
3. Unit tests

### b. User documentation

In order to capture institutional knowledge, documentation of enterprise applications should be developed in collaboration with the functional department on whose behalf the system was developed. This documentation should be retained and updated by both the developing organization and the functional unit.

## VI. Change Management

### a. Enterprise Server Process

The change management and auditing processes for enterprise applications supported on the IBM mainframe server are fairly complex due to the number of application component types, supporting software systems, and functional systems involved. Requests for promoting mainframe application programs from a development or test environment should be made by the author through the Transfer Request System and through the manager responsible for the affected application system. Change management processes are a focal point in reviews by both LSU and legislative auditors.

### b. Lotus Domino Process

The change management and auditing process for applications developed and supported in the Lotus Notes/Domino environment is handled through the "Application Inventory" database located in the ESGAPPS folder on the APPL003 server. To move an application from a test server to a production server the application must be defined in the application inventory registry if it does not already exist and a transfer request entered. The manager responsible for that

application area approves or disapproves that application. As with the enterprise server process, this process is a focal point in reviews by both LSU and legislative auditors.

c. Distributed Server Process

Requests for the promotion of distributed applications from a development or test environment to a production environment should be routed to UIS system administrators. In the near future, automated processes to accept requests for transfer and to handle the actual promotions of distributed application components to production will be put in place.

## VII. System Integration

### 1. Enterprise System Integration

Today, the primary method used to integrate legacy applications at LSU is point-to-point application integration. Other methods, including distributed database integration, are used in limited cases. The University's enterprise systems are divided into the following categories. The methods of integration are outlined for each category.

- a. Custom code (COBOL, SAS, JCL) and databases (IMS, DB2) that reside on a single technology platform (zOS mainframe). Examples of these systems include the University's course registration and payroll systems.

These systems are accessed/integrated via the following methods:

- i. Directly on the native platform via mainframe terminal emulators ("green screens") connected through IBM's IMS TM (Information Management System Transaction Manager) using COBOL and embedded cross-application SQL queries/joins (inquiry and update for operational transactions).
- ii. Directly on the native platform using Base SAS for zOS and embedded SQL. Base SAS is used for operational reports (printer and file exports), operational batch processing (inquiry and update), and for periodic extracts to summary data sets (inquiry). SAS is mainly initiated online or in a scheduled manner using IBM Job Control Language (JCL).
- iii. In a single-tiered Web-based client-server arrangement directly on the native platform via SAS IntrNet (inquiry).
- iv. In a multi-tiered Web-based client-server arrangement via Lotus Notes scripts housed on Lotus Domino Web servers that connect using:
  1. IBM WebSphere MQ (previously MQ Series) software to IBM IMS TM (inquiry and update).
  2. ODBC through DB2 Connect (inquiry only).

Note: Other systems that do not reside on the same platform with these applications are integrated via custom batch feed programs that may employ secure file transfer protocols (FTP/SSL or FTP over SSH) across computer networks and secure Web-based links to temporary secure file repositories (FilesToGeaux).

- b. Purchased proprietary third party systems that are hosted either on or off site. These systems have both internal and external support components. Examples of these systems include the University's recruiting system (off-site) and the Blackboard Commerce software that supports the student identification cards system (on-site). These systems are accessed/integrated via the following methods:
  - i. Directly on the native platform via an online application interface or file export utility. Files are then either manually processed or picked up via scheduled secure FTP across computer networks for integration with other enterprise systems.
  
- c. "Borrowed" open source systems that are either hosted on- or off-site. These systems may have both internal and external support components, depending on the system. An example of this type of system is the University's Moodle learning management system. In this system the software is developed and supported by both LSU developers and external developers, and the system is hosted and the hosting support is external. These systems are accessed/integrated via the following methods:
  - i. Directly on the native platform via an online application interface or file export utility. Files are then either manually processed or picked up via scheduled secure FTP across computer networks for integration with other enterprise systems.

**Information Technology Services  
Reference Architecture Summary  
As of 10/20/2008**

legacy	evolving	emerging	limited
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Collaborative Development		Current	Future	Unsupported
	Business Process Mgt	MetaStorm <sup>1</sup>		
	Enterprise Content Mgt	FMS/IBM Content Mgr/Input Accel	Xythos	
	Reporting & Distribution	Base SAS / SAS IntrNet FilesToGeaux SAS Web <sup>1</sup>		
	Web Content Mgt	StudioWeb Lotus Domino Server Hosting / FTP Server Hosting / Rhythmyx <sup>1</sup>		

Enterprise Systems Framework	Authentication	Lotus Domino v7.1 Microsoft Active Directory CAS v3.2.1 LDAP	InfoSys2010 <sup>2</sup>	
	Authorization	SAM/DRA Profiles AIS.RESOURCE table Lotus Domino ACL LDAP Microsoft Active Directory	InfoSys2010 <sup>2</sup>	
	Code/Language Frameworks	COBOL (IBM Enterprise) Lotus Domino CSS, XHTML, AJAX SAS Java v1.4 – Struts 2/Spring/Hibernate JSP PHP	C# SpringBatch VB .NET Web Services	Atlas EJB Flash Python Ruby on Rails Silverlight
	Database Mgt Systems	DB2 for zOS v7.1 DB2 LUW Microsoft SQL Server	DB2 LUW v8 Microsoft SQL Server xKoto	MySQL Postgres
	Document Conversion	Active PDF		
	Portal/ Workspace	PAWS/Domino	PAWS/LifeRay	Sharepoint Server
	Server Frameworks	zOS Windows XP / Lotus Domino v7.1 VMWare Red Hat v5.1 / Apache v2.2.3 TomCat v6.0.14	.NET VMWare Clusters	Java/IMS Regions Sharepoint Services v3
	Transaction Mgr	IMS Transaction Mgr	InfoSys2010 <sup>2</sup>	JBOSS JTM WebLogic WebSphere

<sup>1</sup> To be determined as part of the InfoSys2010 initiative in FYE 2009

<sup>2</sup> To be determined as part of the InfoSys2010 initiative