Department of Energy - Information Architecture Project (DOE-IAP)

DOE Corporate Systems Information Architecture (CSIA)

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U. S. DEPARTMENT OF ENERGY

Office of the Chief Information Officer (CIO)
Office of the Associate CIO for Architecture, Standards, and Planning

DOE-IAP BUSINESS AREA REPRESENTATIVES' CONCURRENCE

April 26, 2000

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Executive Summary

The Department of Energy Information Architecture Project (DOE-IAP) is the latest step in the development of an architecture-based process for making corporate information technology (IT) investment decisions. DOE-IAP follows the path developed over the past 5 years to define the foundations, baseline, guidance, standards, and vision for such a process. DOE-IAP is a strategic planning effort, not a detailed design endeavor. The project's purpose is to (1) identify DOE's corporate business functions and the cross-cutting information needed to carry out these functions; (2) define automated capabilities (called applications) and the technology needed to store and manage the information; and (3) recommend a specific plan to move forward.

These products, collectively referred to as the DOE Corporate Systems Information Architecture, provide the framework for evolving from DOE's aging Corporate applications portfolio and diverse technology base into a cohesive, business-driven IT environment. The vision is that common, reliable data will be available for sharing Department-wide and redundant and duplicative systems will be minimized. There are other incentives. Both Congress–via the Clinger-Cohen Act of 1996–and the Office of Management and Budget (OMB) stipulate that financial decision-making for information technology investments be linked to agency strategic plans via an information architecture.

DOE-IAP was initiated by the Deputy Secretary of Energy in April, 1999. DOE Headquarters representatives from 14 organizations were appointed to form a broad-based project team. The team followed a proven methodology, based on strategic business requirements, to produce a Business Model, Data and Applications Architectures, and recommendations, which are described in this document. Specific recommendations to move forward relate to initiating the highest priority applications projects, instituting an information architecture-based decision- making process, establishing a corporate data management capability, and completing the Technology Architecture. Implementation of the DOE-IAP recommendations will provide the means to effectively link information technology investments to DOE's strategic goals and business operations. This linkage has not been possible with the current fragmented and uncoordinated approach to information management.

There are significant implications for moving forward with an information architecture-based planning process. All corporate IT projects should be derived from architecture-based plans. Existing systems will have to be analyzed for alignment with established architectures. New operating procedures, management systems, and controls will be required. Senior management commitment and support will be essential to ensure that the requisite financial and staff resources are made available.

The DOE-IAP Corporate Systems Information Architecture established that corporate cross-cutting business functions, data requirements, and applications could be defined; that a framework to develop a Technology Architecture could be agreed on; and that specific implementation tasks could be identified. These are significant accomplishments. Following the path forward outlined in DOE-IAP should put the Department in a far stronger position of being able to support its future funding requests before Congress and OMB.

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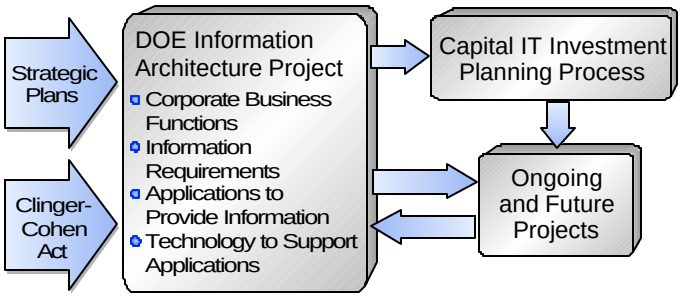
Overview

The products developed in the Department of Energy Information Architecture Project (DOE-IAP) provide a framework for strategic information technology (IT) planning, an initial IT strategic plan, and a gold standard against which to measure ongoing and proposed corporate IT projects. For the first time, the Department of Energy has defined, at a high level, the totality of corporate DOE business functions, the resultant information requirements to perform those functions, the applications needed to provide that information, and the approach for identifying the technology required to support the applications. These products are collectively referred to as the DOE Corporate Systems Information Architecture.



Implementing architecture-based planning has three overarching goals:

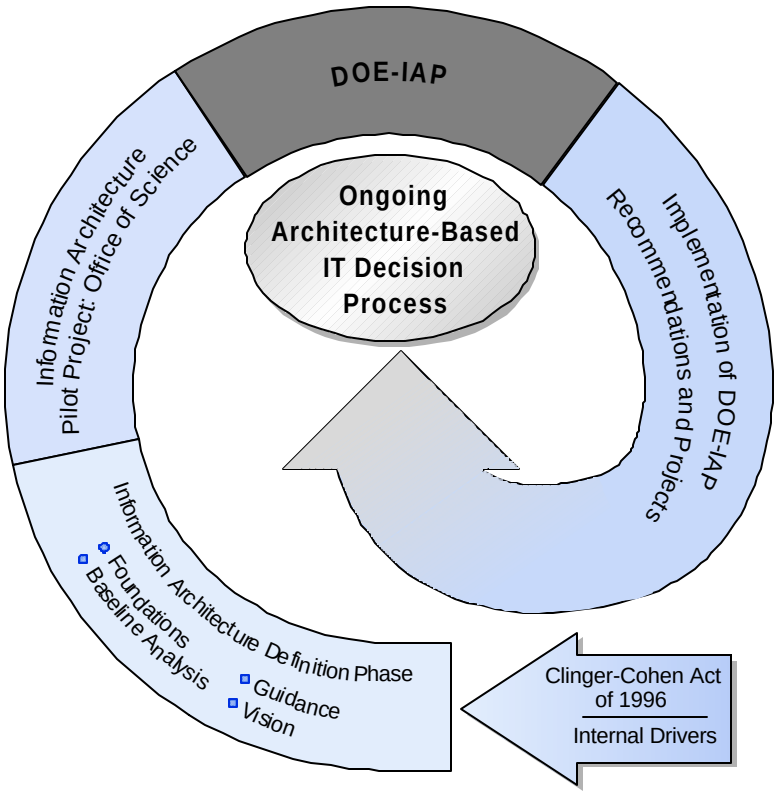
- Fundamentally restructure how decisions are made for corporate IT systems
- Change the way DOE manages its information technology
- Justify IT investments based on a corporate view and rigorous methodology

The DOE-IAP project was driven by legislative requirements specified in the Clinger-Cohen Act of 1996, as well as internal needs to manage corporate data more effectively and better align corporate IT investments with the Department's missions and functions. Implementation of the architectural framework established by DOE-IAP has significant impact on the way DOE now makes IT investment decisions. Further, the Department will be in a far stronger position to defend proposals for IT funding with the Office of Management and Budget (OMB) and with Congress.

The purpose of this document is to provide an executive-level summary of the project, its products, accomplishments, and recommendations for next steps. The full details are found in the DOE-IAP Project and Products report, located on the DOE Information Architecture Program home page at the following location: *http://cio.doe.gov/iap/projnav.htm*.

Background

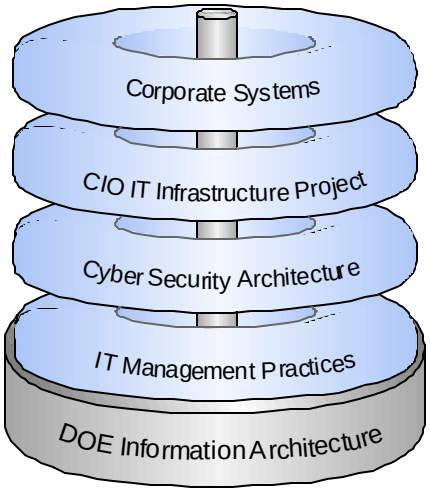
The DOE Information Architecture Program, developed over the past five years, defines the foundations, baseline, guidance, standards, and vision to serve as the basis for establishing an information architecture and a supporting strategic information technology plan. In early 1999, the Headquarters Information Architecture Project (HIAP) established a business case, or justification, for preparing the architectures and a plan for implementation.



As a result, the Executive Committee for Information Management (ECIM), consisting of top level DOE managers, approved the DOE Information Architecture Project on March 10, 1999. In a memo dated April 14, 1999, the Deputy Secretary of Energy initiated the project and requested the commitment of knowledgeable senior staff to actively participate in creating and validating the project's products. The kickoff memo, *Support for the DOE Information Architecture Project*, stated:

> *Achievement of many of the Department's strategic mission goals requires carefully focused application of information technology (IT) solutions. As the Department moves toward new ways of managing our responsibilities, the DOE Information Architecture Project provides an excellent vehicle for the Department to analyze our crosscutting information needs and processes and to ensure our information technology investments support these needs.*
>
> *In the past, information technology solutions have been narrowly focused to meet the needs of individual organizations. As a result, we often find that seemingly simple questions from senior management and Congress cannot be answered easily or quickly. An integrated architecture approach to business systems is intended to address this situation by specifically focusing first on the strategic objectives and needs of the Department and then on addressing the needs of subordinate organizations within a common information architecture framework...*

The Corporate Systems Information Architecture produced by DOE-IAP is one of four major IT strategic initiatives. The others, as depicted in the graphic, are: 1) the CIO IT Infrastructure Project (now in the pilot phase); 2) the Cyber Security Architecture; and 3) improved IT management practices (including investment and project management, standards adherence, capability maturity, and quality software systems engineering practices). The alignment of these strategic initiatives with the Corporate Systems Information Architecture is expected to occur over time via implementation of policies, procedures, modifications to the governance process for IT investment decision-making, and other actions.



Vision

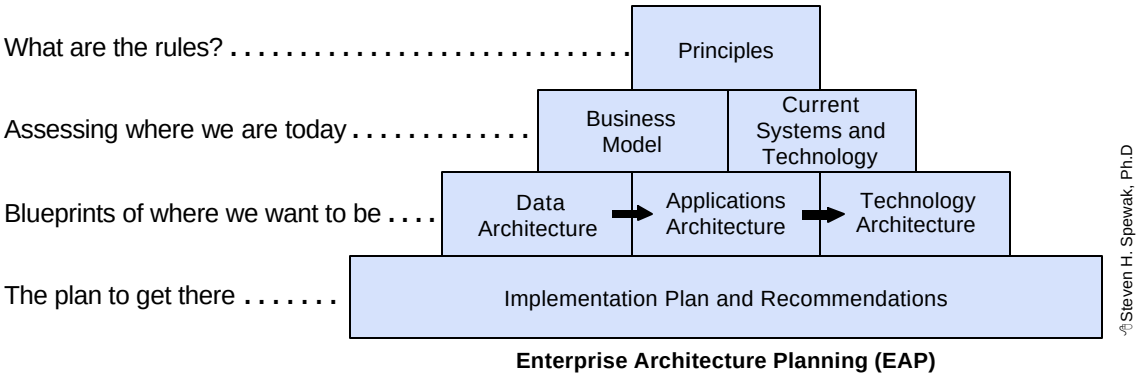
An architecture-based plan and ongoing planning process introduce an orderly, repeatable method to identify systems and technology needed to support the Department's cross-cutting business information needs. An information architecture planning approach provides the means for evolving from an aging applications portfolio and diverse technology base into cohesive, business-justified, modern technology-based corporate systems for the future. Implementation of an architecture plan will:

- Effectively link information technology investments to DOE's strategic goals, objectives and plans, as well as to the Department's business functions
- Help assure that unnecessarily redundant and duplicative systems are not developed or preserved after corporate applications are deployed
- Make common, reliable data available for sharing throughout the Department
- Promote technology decision-making based on business requirements
- Lead to sound investment decisions and cost savings
- Put DOE in a stronger position to defend budget requests to OMB and Congress
- Achieve compliance with the Clinger-Cohen Act of 1996

Methodology and DOE-IAP Approach

The methodology used for DOE-IAP is adapted from an approach called Enterprise Architecture Planning (EAP), developed by Dr. Steven H. Spewak. The EAP methodology has been successfully used by the DOE Office of Science, Air Force Headquarters, Air Mobility Command, FedEx, and other governmental and private sector organizations. EAP is a time-limited, strategic planning process for making IT investment decisions. DOE-IAP was chartered as a 6-month effort.

The major components of the methodology are illustrated in the diagram on the following page and correspond to the DOE-IAP products described in the next section.



Enterprise Architecture Planning (EAP)

The EAP methodology provides a high-level portrait of the totality of an organization from a business function and information requirement perspective. It is a planning tool, not a detailed design specification. The products are used to guide and integrate the development of applications and technologies to support the business and information needs.

This architectural planning approach differs from traditional IT planning efforts in that it is:

- Business-driven rather than technology-driven
- Data-driven rather than process-driven
- Focused on information needs
- Performed by business representatives rather than IT specialists alone

The DOE-IAP project team consisted of Business Area Representatives (BARs) selected from a broad spectrum of 14 DOE Headquarters organizations. BARs were selected for their DOE-wide perspective as well as knowledge of their own organizations' missions and operations. The Department's Chief Information Officer and the Director of the Office of Science co-championed the project. The Office of the Chief Information Officer, with contractor support, provided project management. The BARs produced the DOE-IAP products via a series of facilitated, consensus-building meetings. See Appendix 1 for details.

Scope of Project

The scope of DOE-IAP was discussed several times by the BARs before they reached consensus. It was agreed that the scope would be limited to the Department's corporate, cross-cutting activities, mainly in order to complete the project within the time constraints. While some effort was spent identifying categories of programmatic products and services produced by DOE staff and contractors (e.g., perform cleanup, dispose of nuclear waste, conduct research and development, perform stockpile stewardship), no attempt was made to include them in the architectures. It was assumed that subsequent architectural efforts would address these activities, including their interface with the DOE-IAP architectures.

As part of the charter for the project, the BARs were advised not to include specific functions for the following DOE organizations: Power Marketing Administrations, Federal Energy Regulatory

Commission, Office of Naval Reactors, Naval Petroleum and Oil Shale Reserves, and the Strategic Petroleum Reserve.

DOE-IAP Products

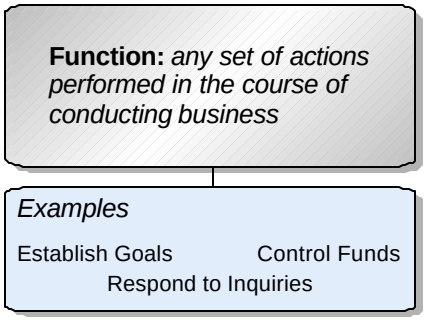
The products developed during the course of this project, comprising the DOE Corporate Systems Information Architecture, are explained in this section with more detailed information included in the appendices. Refer to http://cio.doe.gov/iap/projnav.htm for complete supporting documentation.

Principles

Principles serve as a set of rules or guides to making information technology decisions. They relate to such matters as the need for architectures to be driven by DOE's missions and goals, the use of standards to guide IT investments, and employing systems that are easy to use. See Appendix 2 for details.

Business Model

The corporate Business Model consists of 39 business functions that describe, at a high level, DOE's day-to-day corporate activities. The BARs conducted a comprehensive review of the Department's missions as enumerated in the Department's Strategic Plan and defined the cross-cutting business activities. This step is the primary building block for developing the Data and Applications Architectures.



The Business Model identifies **what** activities are performed, not **who** does them, **how** they are accomplished, **when** they are done, **where** they are performed, or how **important** they are. Even with changes in Departmental mission or organizational structure, the model should remain stable. Despite the different missions and operating practices among their varied organizations, the BARs found they could agree on the common functions performed. This model becomes the framework for identifying data to be shared across the Department's business activities.

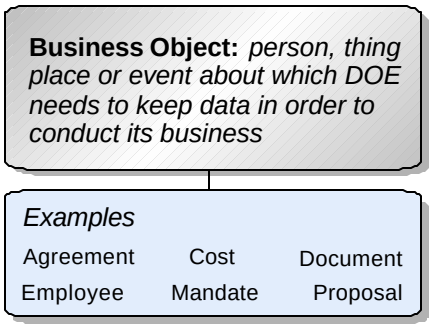
Some of the business functions identified in the model include *Establish Goals*, *Control Funds*, and *Respond to Inquiries*. Note that the primary form is simple with a verb and a noun to make the model clear and non-redundant. The BARs described each function in more detail to support the development of the Data and Applications Architectures. Appendix 3 contains the full Business Model.

Current Systems and Technology

The Information Resources Catalog (IRC) documents and describes 142 Headquarters applications (and their associated technologies) in use or planned, that support crosscutting business activities within DOE. This catalog was prepared prior to the start of the project. The preliminary analysis of IRC data identifies opportunities to address data and application redundancy and inaccuracy, over and/or under

utilization of technology, lack of information resources sharing, and use of obsolete technology. This valuable tool should be updated and maintained regularly in order to support maintenance of the architectures and architecture alignment. Appendix 4 contains a list of the 142 current systems.

Data Architecture



The Data Architecture describes the 41 data groupings or business objects of corporate information needed to carry out the Department's functions. It provides the framework to manage and share data, and it ensures that business-driven data needs are supported by applications.

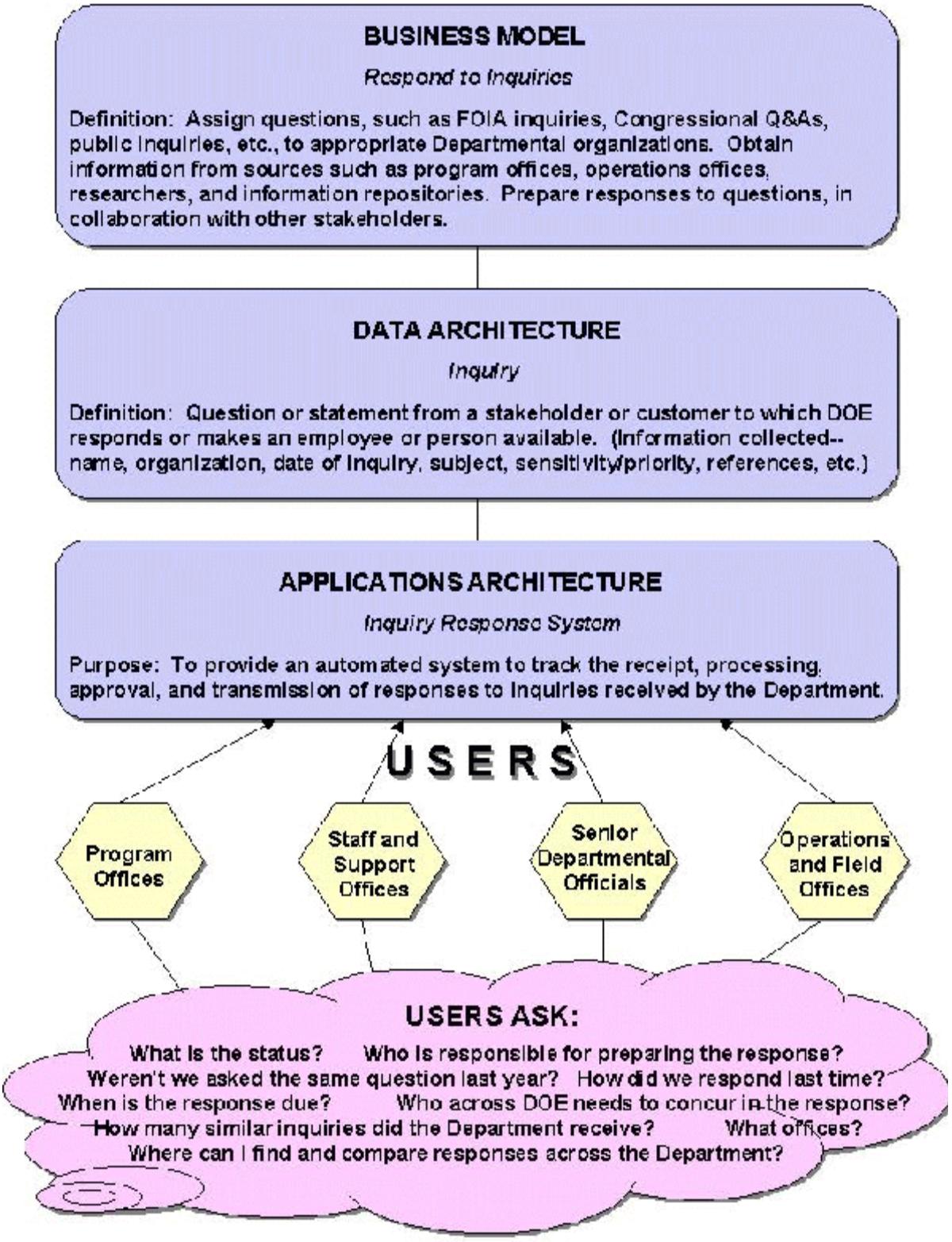
The BARs analyzed the primary nouns in the Business Model to develop the business objects. They created a new vocabulary to name and describe them. Examples include: *Agreement, Employee, Cost, Mandate, Document,* and *Proposal*. They consolidated known concepts via generalization (e.g., *Agreement* consolidates grant, contract, MOA, MOU, etc.). They split known concepts (money became *Budget, Funds, Cost, Payment).* They created new meanings for known concepts (e.g., *Document* has a more narrow meaning).

The BARs also came to consensus on definitions for each business object, including additional detail, such or identifiers. For instance, the business object *Agreement* would contain contract numbers, types, dates, titles, contractor names, periods of performance, funding, etc. The intent is to clearly define and aggregate similar data into broad categories of corporate information as a first step in reducing data redundancy. Appendix 5 contains the Data Architecture.

Applications Architecture

The Applications Architecture, consisting of 35 applications and repositories, defines the automated capabilities required to support the entire Business Model without regard to whether adequate applications already exist or are being planned. Eleven repository applications were defined to store common data to be shared by many Departmental system applications. Examples include *Agreement, Employee,* and *Project* repositories. The other 24 applications support core corporate business functions, such as *Document Management, Funds Management,* and *Procurement and Financial Assistance*. The Applications Architecture provides the basis for (1) defining technology requirements to support the automated capabilities and (2) preparing the prioritized and costed implementation plan. A description of each of the applications is included in Appendix 6.

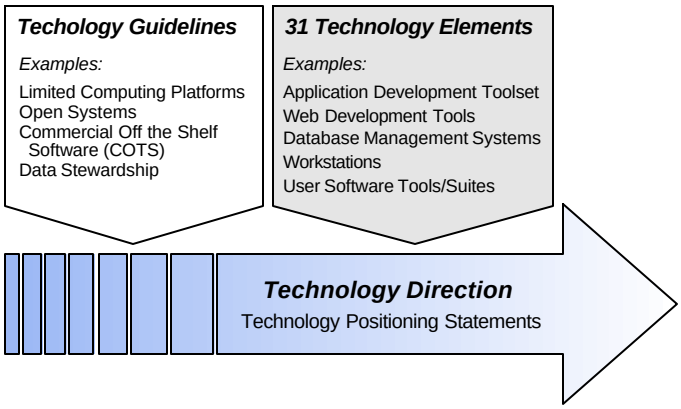
The accompanying graphic illustrates the relationship among the Business Model, the Data Architecture, and the Applications Architecture by taking a single business function and showing both data and an application that derive from it.


BUSINESS MODEL
Respond to Inquiries
Definition: Assign questions, such as FOIA inquiries, Congressional Q&As, public inquiries, etc., to appropriate Departmental organizations. Obtain information from sources such as program offices, operations offices, researchers, and information repositories. Prepare responses to questions, in collaboration with other stakeholders.
DATA ARCHITECTURE
Inquiry
Definition: Question or statement from a stakeholder or customer to which DOE responds or makes an employee or person available. (Information collected--name, organization, date of inquiry, subject, sensitivity/priority, references, etc.)
APPLICATIONS ARCHITECTURE
Inquiry Response System
Purpose: To provide an automated system to track the receipt, processing, approval, and transmission of responses to inquiries received by the Department.
USERS
Program Offices
Staff and Support Offices
Senior Departmental Officials
Operations and Field Offices
USERS ASK:
What is the status? Who is responsible for preparing the response?
Weren't we asked the same question last year? How did we respond last time?
When is the response due? Who across DOE needs to concur in the response?
How many similar inquiries did the Department receive? What offices?
Where can I find and compare responses across the Department?

The example relates to the handling of inquiries that the Department receives every day from a wide variety of sources: Congress, OMB, the media, interest groups, state and local governments, contractors, proposers, and the general public. The BARs identified this important corporate activity that every DOE organization performs as one of the 39 business functions in the Business Model. Named *Respond to Inquiries*, this function is shown in the top box along with its definition. In the second box, the Data Architecture element *Inquiry* is depicted. It was derived from the Business Model and it represents the kind of data about inquiries that needs to be collected and stored. These include identification of who sent the inquiry, that person's organization, the date of the inquiry, its subject, reference to another inquiry or document, etc. The third box represents the automated corporate system that needs to be developed to assist users in tracking inquiry status and processing responses.

The graphic also includes typical questions asked about inquiries that frequently cannot be answered quickly and accurately. Departmental users would include personnel at all levels of both Headquarters and field organizations. The Department currently tracks inquiries via a number of systems, each with a specific scope. There is currently no one mechanism to aggregate or manage all inquiry information across the Department. By implementing the *Inquiry Response System*, the Department would have such a cross-cutting capability for managing all types of inquiries.

Technology Architecture Framework



The DOE-IAP Technology Architecture Framework provides a DOE-level view of information important for IT management. The components include: (1) a set of proposed **technology guidelines**; (2) a **standard taxonomy** of 31 technology elements; (3) a repository of **baseline information** about technology products currently in use at Headquarters; (4) **technology positioning statements** that include detailed planning guidance for the eight technology elements not addressed by the CIO IT Infrastructure Project and directly related to the system development environment; and (5) a comparison of the **technology elements to the proposed architected applications**. Sample technology projects needed to further define requirements for the architected applications were also defined and documented.

This Technology Architecture was prepared by DOE-IAP support staff and reviewed by the BARs team. Its scope was limited, in order to avoid overlap with the ongoing CIO IT Infrastructure Project, and also due to time and resource constraints.

The BARs endorsed the use of a rigorous, structured methodology for defining the DOE Technology Architecture, but felt they were not in a position to judge specific technical recommendations. The BARs recommended that the DOE-IAP Technology Architecture serve as the framework for a future,

more comprehensive effort involving both technical and non-technical DOE personnel. When completed, the Technology Architecture will define a high-level, strategic view of the infrastructure of hardware, software, and connectivity needed to implement the approved applications. Appendix 7 contains more details.

Implementation Plan and Recommendations

The Implementation Plan for the Corporate Systems Information Architecture includes a proposed sequence for the 35 architected applications, recommendations for transitioning to an architecture-based IT environment, and a high-level planning estimate for IT investments over a 5-year period.

The plan focuses on the Applications Architecture. Applications were first arranged in priority order based upon efficiency of development, i.e., building applications that *create* data before those that *use* that data. The BARs then developed evaluation criteria based on business requirements and prioritized the applications from that perspective. Consolidating these two steps yielded the final priority order for applications development. A preliminary analysis of current applications and projects underway identified those which have the potential of being used partially or completely to provide the functionality called for in the architected applications.
A schedule with cost estimates for each application project was prepared for a 5-year planning horizon. Most of the top priority applications are repositories of fundamental data that would be needed by other systems. This methodology provides management with a powerful tool for scheduling corporate applications projects based on Departmental priorities.

The BARs made a number of recommendations, which are summarized below. See Appendix 8 for more details including the rationale for and the implications of these recommendations.

- Establish a DOE policy in which future information technology decisions align with established information architectures.

- Institute an architecture-based information technology decision-making process to support policy implementation.

- Expand the architectures with a more comprehensive analysis of DOE's programmatic business functions that could not be fully addressed during the DOE-IAP project.

- Establish a corporate data management capability, including the development and maintenance of data dictionaries, standards, policies, configuration management processes and other infrastructure requirements. Identify corporate and programmatic responsibilities.

- Conduct an independent analysis of the Cyber Security Architecture, DOE-IAP architectures and the CIO IT Infrastructure Project and make recommendations to resolve any inconsistencies.

- Prepare plans and funding estimates for the highest priority applications identified in DOE-IAP in coordination with on-going projects.

- Complete the Technology Architecture. As the foundation, employee the guidelines, process, and approach used in DOE-IAP.

- Prepare a costed and scheduled technology deployment plan to implement the Technology Architecture to assure that technologies are in place when required.

In order to give decision-makers an idea of the magnitude of the funding required, a five-year planning figure of $220 million is projected. This consists of $125 million for applications development, $60 million for technology investments, and $35 million for management processes. The estimate for application development was based on the approximate cost of implementing all 35 architected applications projects over the five years. The estimate for technology investments is a "ball park" figure until the Technology Architecture is completed. The projection for management processes includes those activities to support the architectures and provide for data administration.

The Implementation Plan and Recommendations include activities to make the transition from the DOE-IAP project to the establishment of an on-going DOE-wide process for making information technology investment decisions.

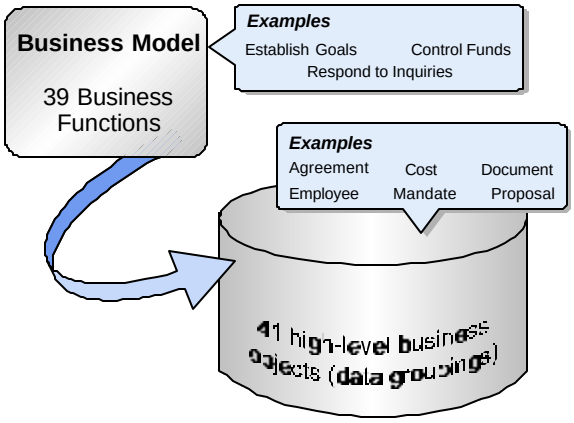
Accomplishments

Corporate Business Model and Information Needs Documented

For the first time, DOE has developed a corporate view (50,000 feet) of:

- **DOE's cross-cutting business functions**
- **High-level information requirements for these functions**
- **Documented relationships between the business functions and information requirements**

Business Model - Data Architecture Relationship Examples



What the BARs have developed is a tool that shows that there are a relatively small number of basic, common business functions that define DOE's activities. Although DOE organizations vary widely in the way they carry out these activities, the functions themselves are very similar.

The team also discovered that a relatively small number of data groupings categorize the types of data used throughout the Department in order to carry out the business functions. Identifying and agreeing on the words to describe common activities was an iterative process to reach consensus. This streamlined, but complete, view of the Department has never before been developed, and it provides the essential starting point for developing a shared data environment.

For example, activities related to the business function *Establish Agreements* (e.g., contracts and grants) are performed by a broad range of DOE employees from Secretarial officials to technical program managers to contracting officers across the complex. The business objects including *Agreement* (e.g., terms and conditions), *Organization* (e.g., contractor), and *Person* (e.g., principal investigator) identify the kind of corporate data required to support this business function *Establish Agreements.* Recognizing the relatively small number of disparate yet common cross-cutting business activities at DOE is the first step to accepting the corporate nature of the information required to run the enterprise.

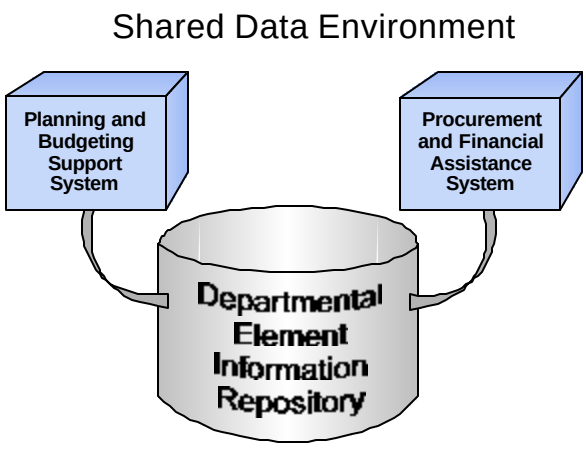
Vision for Sharing Information Established

DOE has established a vision for managing and sharing core information corporately. The BARs defined specific information repositories that will maintain information commonly and consistently, rather than in many disparate systems as is now often the case.

These repositories will be independent of applications that use their information. This independence can ensure that data are not "stovepiped" or locked in non-shareable form and allows common use across many applications. Each piece of data is created once and used by many applications. Over time, this approach reduces duplicative, redundant data and systems. It divides application development into manageable pieces, speeding the delivery of usable applications, reducing risks, and saving time and money.

One example is information about DOE organizations. This type of data is used by virtually every current corporate application; however, it is currently dispersed among many data files and is not easily available for sharing throughout the Department. Every reorganization, for example, forces updates to all these files and applications, causing expense, loss of productivity, and risk of inaccuracies.

To address this issue, the Applications Architecture includes an application, called *Departmental Element Information Repository (DEIR)*, as the corporate source of reliable and timely data about DOE organizations. This repository would contain such information as organization name, identification code, mission, organization chart, etc. Other architected applications will use the data contained and managed in the *DEIR*. For example, *Planning and Budgeting Support System*, another architected application, uses *DEIR* data in preparation of annual budgets; the *Procurement and Financial Assistance System* uses *DEIR* data in processing contracts and grants.



It should be noted that this shared ease of access would incorporate, by design, the proper levels of protection for information. Security measures would be imposed to prevent access except to those with a business need to know.

This accomplishment implies instituting a data management capability that could begin to treat information (data) as the critical corporate resource it is. In order to realize this vision, DOE must develop a corporate data management program, with appropriate management best practices.

New Approach for Defining Corporate Systems Defined

DOE has defined a new way to examine corporate IT requirements and make investment decisions. Applications projects defined by DOE-IAP have resulted from a top-down look at the totality of the Department's business functions, and the resulting information needs grouped as business objects. For the first time at DOE, applications have been defined as the vehicles to create and store information about a particular business object and its closely related data. Therefore:

- There is an overall framework showing how applications interrelate
- The scope of each application development project is a well-defined manageable piece, thereby speeding the delivery of usable applications and reducing the risk of failure.
- There is a framework for making decisions on application development priorities, based on a logically structured sequence, tempered with a methodology that weighs business need.

Traditionally, corporate systems were implemented by one organization defining a need for a system to automate their portion of what they may or may not have realized were corporate functions. Systems were developed and implemented for that organization and often with only their input.

Recognizing stovepiping problems arising from this practice, the CIO has initiated the Strategic Information Management (SIM) process. Putting a potential system investment project through this process helps assure that affected organizations are involved in the process, but there are still concerns:

- Until now, there has been no overall framework to see how a single set of requirements relates to the entirety of information needed throughout the Department.
- Scope is very difficult to define in these single focused projects, resulting in continually expanding requirements.
- Priorities among “sets of requirements” are difficult to determine and duplication of technology solutions and non-standardized components tend to result.

The DOE Corporate Systems Information Architecture, as established by DOE-IAP, can begin to addresses these issues in partnership with the SIM process. The methodology established provides management with a powerful tool for scheduling the development of corporate applications projects based on Departmental priorities.

IT Budget Justification Strengthened

DOE has successfully initiated a fresh, structured, and business-driven, management approach to IT investments. This approach is in compliance with OMB policy and Congressional intent within the law. DOE will be in a far stronger position to defend IT funding requests to OMB and Congress.

The need for instituting architected, strategically-driven information technology planning is driven by legislation and policy guidance, including the Clinger-Cohen Act of 1996, the Government Performance and Results Act (GPRA) of 1993, Office of Management and Budget's (OMB) recently revised A-130 Circular, and changes to the original Freedom of Information Act (FOIA) concerning electronic records and agency obligations. These mandates have a common thread requiring greater agency accountability for IT investments. They link financial decision-making on IT investments to effective strategic planning and business outcomes. OMB has recently issued draft Circular A-130, *Management of Federal Information Resources,* for agencies to follow to implement the requirements of the Clinger-Cohen Act of 1996. The following is an excerpt:

> *An IT architecture in compliance with the Clinger-Cohen Act and OMB guidance will contain an Enterprise Architecture... The Enterprise Architecture is the explicit description of the current and desired relationships among business and management processes and information technology. It describes the "target" environment which the agency wishes to create and maintain by managing its IT portfolio. The Enterprise Architecture must also provide a strategy that will enable the agency to transition from the current to the targeted environment. Within the Enterprise Architecture it is important that agencies identify and document: 1) the business processes, 2) the information flow and relationships, 3) applications, 4) data descriptions, and 5) technology infrastructure.*

The architecture established by DOE-IAP maps explicitly to the A-130 description. OMB and Congress are increasingly using these criteria to measure an agency's readiness and ability to justify funding for IT investments. The corporate systems architectures and implementation plan created by DOE-IAP puts DOE in a strong position to demonstrate both OMB and Congress that the Department of Energy is well on our way to compliance. Specific budget requests for IT investments can be defended as integral and logical requirements coming from a prioritized, rigorous, corporate decision-making process that looks across all of DOE's corporate information needs.

The Path Forward Defined

DOE has outlined an aggressive approach to move forward. DOE has recommended specific actions necessary to make the transition from the DOE-IAP project to the integration of an architecture-driven corporate process for making information technology investment decisions. The recommendations are intended to keep the momentum going by undertaking an incremental series of steps.

Next Steps

The DOE-IAP represents a real step forward moving DOE towards an architecture-based information technology environment. It provides documented high-level guidance such as the Principles, Business Model, the Data and Applications Architectures as a blueprint for a more integrated applications and technology environment. Based on the corporate systems Implementation Plan and Recommendations, the BARs team requests the Department initiate the following actions as soon as possible:

- Endorse the architectures developed and the methodology used in DOE-IAP as the basis for moving forward to implement an architecture-based, corporate IT decision-making process

- Authorize the preparation of plans and funding estimates for:

  - Initiating projects to develop the following five highest-priority new applications while continuing to develop on-going applications:
    - Departmental Element Information Repository
    - Information Structure Repository
    - Employee Information Repository
    - Organization Information Repository
    - Agency Information Repository

  - Establish a corporate data management function

  - Identify the next steps to institute an Information Architecture process DOE-wide for corporate needs, including:
    - A policy statement announcing the decision to institute an architecture based, corporate IT investment decision-making process.
    - Completion of the Technology Architecture, including incorporation of the IT Infrastructure Project and Cyber Security activities.

Implications

Carrying out the recommendations of DOE-IAP will have significant implications. The framework established by DOE-IAP is a corporate, centralized approach for dealing with crosscutting functions. The current governance process for corporate IT decisions needs to be examined; some changes may be required. The framework implies that some portion of IT investments in the future must be implemented, funded, and controlled centrally, hopefully in a spirit of cooperation that builds consensus. The new way of making investment decisions for corporate IT projects will need to apply to all corporate projects if DOE is to claim an architecture-based IT environment.

A great deal of analysis of existing systems will be required before moving into a shared data environment. New systems development will require the evaluation of current corporate systems to identify overlaps and the path to alignment.

Strong leadership from senior management will be required to achieve a climate of Departmental acceptance and ownership to the new approach. Ongoing architectural maintenance and a corporate data management capability become critical path items. Significant resources will be required to develop the policies, procedures, and repositories needed to maintain the architectures and integrate their use into the system development life cycle and other Departmental processes.

It is recognized that there is a substantial cost to institute and maintain an architecture-based IT decision-making process. However, inherent in the Corporate Systems Information Architecture are opportunities for eliminating stove-piped systems, managing data more effectively, and consolidating technologies. This makes it equally clear that there is even a higher cost in both financial and performance terms of continuing a fragmented, uncoordinated approach to information management.

Appendices

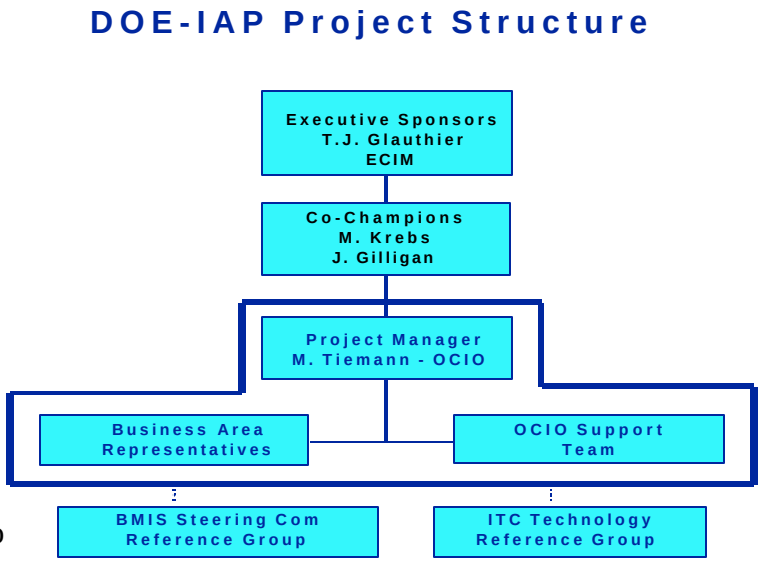
The material in these appendices are summaries of the most important architecture products created by DOE-IAP. More comprehensive supporting materials are found in the DOE-IAP Project and Products report, located on the DOE Information Architecture Program home page at the following location: *http://cio.doe.gov/iap/projnav.htm*.

Appendix 1

Project Structure

Project Structure

The project structure diagram, shown in the following figure, outlines the relationships of the participants involved in DOE-IAP.



The Co-Champions, Mr. John Gilligan, Chief Information Officer (SO-3) and Dr. Martha Krebs, former Director of the Office of Science (SC-1), provided executive direction and served as a liaison with the ECIM. Michael Tiemann, Director, CIO Office of Information Architecture and Standards, served as DOE-IAP Project Manager to provide overall guidance, remove project obstacles, and keep the Co-Champions apprized of progress and issues.

Business Area Representatives for DOE-IAP, named by their organizations, were as follows.

BAR Membership			
Curtis Bolton	SC	Barbara Mandley	EE
Jim Colsh	NE	John Panek	FE
Bill Dorsey	EIA	Steve Simon	EH
Bob Franklin	MA	John Greenhill	NN
Marc Hollander	DP	Sandy Stiffman	WT
Travis Hulsey	MA	Leroy Valentine	CFO
Paul Lewis	GC	Stephen Warren	EM

The BARs brought an understanding of their business areas' strategic directions, challenges, and processes. They shared their corporate knowledge of DOE missions and strategic directions along with the business view from their own organizations. BARs defined the principles, scope, and objectives for DOE-IAP. They created the models and architectures necessary to understand business activities, corporate data, and applications requirements. They developed the business priority sequencing of applications for the Implementation Plan.

The Business Management Information System-Financial Management (BMIS-FM) Steering Committee and the Information Technology Council served as reference groups to review products.

Appendix 2

Principles for Information Management

The Principles are high level statements of the fundamental values that guide IT decision making. As value statements guiding IT decision making, the Principles should be universally accepted by those DOE organizations covered by the DOE corporate information architecture. They should be stable so as to withstand changes in information management technologies, processes, and products. They should maintain a clear relevancy with policy changes in DOE programs and management approaches as well as reflect the general policy directions and framework of the Federal Government.

The Principles are accompanied by rationales that explain their importance and business implications. While the statement of each Principle should remain constant, the rationales and implications will evolve over time, as they respond to factors such as the current information management environment within DOE, internal initiatives, external forces, and changes in the DOE mission, vision, and strategic plan.

Principles for Information Management

1. Business Oriented

DOE IT architectures must support mission and strategic business objectives. IT services must support timely and effective decision making at all organizational levels.

Rationale

Information products and services must address DOE's long term business needs and priorities. Designing IT solutions with a full understanding of the strategic business goals ultimately decreases costs and increases the probability of developing effective and usable solutions.

Implications

- The architecture and plan are owned by and apply to DOE organizational elements. Information management principles apply to all DOE organizations.
- DOE organizational elements participate in decision-making about and implementation of the plan and architectures. System/solution managers must obtain DOE business unit participation in and acceptance of the creation of corporate IT solutions.
- IT investments and solutions must conform to the approved architectures.
- Data, applications and technology must be structured and implemented to accommodate DOE's diverse business areas and a constantly evolving business and management environment.
- Changes to applications and technology are made only in response to business needs.
- Required changes to the DOE information environment are made in a timely manner.

2. Value Added

IT investments must promote/enhance effectiveness, efficiency, functional capabilities, and/or cost reduction/avoidance to the business of DOE.

Rationale

Limited resources and DOE's asset stewardship role dictate that IT investments should demonstrate a net positive impact on doing business. Spending on short-term solutions consumes resources needed for long term goals.

Implications

- Information management decisions are made to provide maximum benefit to DOE as a whole.
- Development of applications used across DOE is preferred over development of similar or duplicative applications which are only provided to a particular organization.
- Retention or development of organizational element-specific functional capabilities is not precluded.
- Corporate IT investments must have their value to DOE measured. Decisions about the relative importance of corporate IT investments (i.e., priorities) will take into account the measured business value.
- The design of corporate applications, data, and technology projects will include business value measures and evaluation mechanisms.
- Total cost of ownership will be evaluated when making IT investment decisions.
- Corporate IT investment decisions are not made solely on the requirement to address technology trends.
- IT investments should be made to promote a high degree of integration and compatibility among the components and facilitate resource sharing.
- The quality of IT services must be measured against a "baseline" to recognize deviations and make adjustments to improve their value added.

3. Access to information

DOE staff, customers, and stakeholders can access the information they require, subject to appropriately-defined security and proper utilization policies.

Rationale

Open sharing of corporate information must be balanced against the need to restrict the availability of and access to classified, proprietary, and sensitive information. Existing laws and regulations require the safeguarding of national security and privacy data. Systems, data, and technologies must be protected from unauthorized access and manipulation. On the other hand, wide access to accurate, reliable and consistent corporate information leads to greater efficiency and effectiveness in decision-making. It improves DOE's ability to respond to information requests from customers and stakeholders and the delivery of information-based services. Time is wasted and considerable effort is spent in overcoming organizational hurdles in the quest for information.

Implications

- For unclassified and non-sensitive corporate information, the right-to-know should be presumed unless policy or law specify otherwise. However, wide access to information carries risks that data could be misinterpreted or misused.
- The business necessity for sharing corporate DOE data must be established and accepted throughout DOE.
- DOE management should decide on information access policies as conditions change and based on the need to balance issues of security and access.
- Corporate data sharing should lead to an environment where data is not re-keyed. Each piece of data is created once, reducing the costs and lack of reliability of maintaining multiple applications that store similar data.

- Corporate information and data security concerns must be addressed by all components of DOE's corporate IT program. They must be integrated into the IT project life-cycle and not addressed as a separate component.
- Data that is being transmitted must be protected from interruption, interception, or alteration. A DOE-wide solution for secure access to multiple networks is necessary.
- Corporate data security needs must be identified at the data level. Access to summarized, analyzed, processed, or combined information must be controlled.
- In order to promote ease of access and improve security mechanisms, the applications and data that comprise corporate IT solutions will be designed so that they can be maintained largely independently of each other and the underlying technology.

4. Ease of Use

Ease of use facilitates communication, productivity, and the efficient use of corporate IT resources.

Rationale

Corporate IT solutions must be appropriate for the user's working environment in order to realize gains in efficiency and effectiveness. The way information is accessed and displayed must be sufficiently adaptable to meet a wide range of internal and external customers, located in many different places.

Implications

- Corporate IT solutions must be designed considering the full range of probable users and their environments.
- User interfaces should guide the human thinking process in discovering, analyzing, and resolving issues.
- Terms and definitions should be standardized as much as possible.
- Common solutions minimize training requirements.
- Service providers and customers have a mutual understanding of services to be provided.

5. Standards-based

A DOE profile of adopted standards and other industry standards guide IT implementation decisions.

Rationale

Publicly available technical specifications and the products that support them provide a higher degree of stability, flexibility and inter-connection than proprietary or concealed specifications. A vendor-neutral set of standards and resulting procurement decisions provide long-term potential cost savings through enhanced competition. A standards-based approach helps prevents vendor "lock-in", which can reduce flexibility and potentially increases risk. Adherence to industry standards meets a legal mandate.

Implications

- Standards-based IT strategies and plans do not prescribe specific implementation strategies or products. These types of decisions are made by the DOE organizations given responsibility for implementing the corporate system or technology infrastructure initiative.
- When considering otherwise equal alternatives, a corporate IT investment that conforms to the DOE standards profile should be selected. A non-standard investment will be made only if a

compelling business justification can be made as to why the standards-based approach will not result in the expected benefits.
- A standards-based approach encourages the use of "off-the-shelf" products that conform to standards.
- Standards should be adopted using a process that is consensus based and encourages compliance through buy-in.

6. Data is an Asset

Data is an asset that has value to DOE and is managed accordingly. The quality, integrity, and sharing of data is managed.

Rationale:

Data in DOE is inconsistently defined, re-keyed or re-entered into systems redundantly, and maintained in redundant systems, resulting in the inability to make accurate, cross-cutting queries. Ambiguities resulting from multiple parochial definitions of data must give way to accepted DOE-wide definitions and understanding if data is to be available for Departmental use. This is one of the benefits of an architected environment. As the degree of data sharing grows, and business units rely on common information, it becomes counter-productive for one organization to make unilateral decisions about the definitions, content or structure of data that may affect another organization.

Implications:

- Corporate data is defined consistently throughout DOE, and the definitions are understandable and available to all users. DOE organizations participate in the definition of common data.
- Each data element has a trustee accountable for data quality.
- Management of DOE's data must comply with external laws, and external and internal policies and regulations.
- The role of DOE Data Administrator must be created to coordinate consistent use among systems.
- Data is managed under the umbrella of a DOE data architecture.

Appendix 3

Business Model

The BARs team met in multiple facilitated sessions to develop a common understanding and structure for describing DOE's business functions. The Business Model underwent multiple iterations to improve the descriptions of business functions and to make the model complete, understandable, and consistent. Creating the Business Model required the BARs to understand, describe, and agree on a set of business activities that portray what activities DOE performs **without regard** to:

- **Who** does the activity
- **How** the function is accomplished via the use of specific processes
- **Where** the function is performed
- **When** it is done
- A function's perceived **importance or priority**

The BARs made a conscious decision to define only cross-cutting corporate business functions. Therefore, program-specific functions will be defined in subsequent architectural efforts. The function *CF Deliver Products and Services* serves as a placeholder for program-specific functions.

The Business Model was continuously revised as the BARs worked on later products, especially the Data Architecture.

DOE Corporate Business Model

A Communicate with Stakeholders and Customers

AA Advocate DOE positions

Use the Department's mandates, procedures, mission-specific information, achievements, etc. to develop positions that may be used to represent the Department. Communicate mission, goals, objectives, budgets, strategies, and progress to persons, organizations, and agencies. Describe and explain the content and benefits of DOE mission areas, positions, budgets, and progress to the public, Executive and Legislative branches. Represent DOE in standards bodies, inter-agency groups, and professional organizations.

AB Issue awards

Identify candidates (persons and employees, organizations, departmental elements) for scientific, technical, Departmental and other (e.g., Lawrence and Fermi) awards. Define selection criteria. Select awardees in collaboration with internal and external reviewers. Arrange and execute award ceremonies.

AC Respond to inquiries

Assign questions such as FOIA inquiries, Congressional Q & As, public inquiries etc., to appropriate Departmental organizations. Obtain information from sources such as program offices, operations offices, researchers and information repositories. Prepare responses to questions, in collaboration with other stakeholders.

AD Conduct outreach events

Sponsor, arrange, and execute media events, competitive events (such as Science Bowl), and meetings of interest groups and other fora (forums) for public participation and community relations. Consult with public and private organizations and agencies.

AE Utilize advisory committees

Establish and charter advisory committees. Arrange and publicize meetings. Solicit and receive advisory committee advice and recommendations.

B Plan Business Lines

BA Analyze impact of mandates and advice on Departmental missions, programs, and projects

Assess legislation, laws, regulations, policies, directives and advice (including from advisory committees and public comment) to determine where and how they influence the Department's current mission, operations and programs. Prepare comments and recommendations. Identify gaps and areas where policy, new direction or vision is needed or requires revision.

BB Issue mandates

Develop mission statements, policies, procedures, proposed legislation, standards, budget calls, directives, and programmatic guidance in support of the Department's mission, functions, and operations, including safety and security concerns. Obtain concurrence and approvals on the newly developed or modified guidance, policy, mandates and procedures. Communicate approved mandates and procedures throughout affected organizations.

BC Establish goals

Identify desired outcomes for DOE business lines, programs, projects, or tasks. Set goals.

BD Determine strategies

Identify opportunities for program initiatives, research, joint projects, collaborations, and other activities. Set objectives. Establish an approach (including funding, such as contract, grant, award) or course of action to fulfill mandates; achieve a goal or mission; accomplish a program, project, or process; or acquire resources. Decide which proposed programs and projects to implement. Set priorities. Define scope. Identify assumptions and constraints. Determine the charter, membership, and structure of workgroups, task forces, boards, etc. needed to support programs.

BE Establish measures

Analyze requirements. Identify appropriate metrics and other standards of evaluation. Set the standards of evaluation, performance, and quality that will be used to evaluate the Department, programs, projects, and tasks.

BF Determine risks

Examine the possibility and potential degree of loss, failure, threat, or other undesirable consequences associated with Departmental missions, programs, projects, or tasks (including visits by foreign nationals to DOE sites, the tracking of nuclear materials and other safety and security concerns). Determine the impact of that risk on goals, strategies, budgets, and schedules.

BG Establish Departmental elements

Structure DOE's functions based on mandates, missions, and goals. Establish reporting hierarchy, roles, and responsibilities. Assign authorities.

BH Establish budgets

Estimate employees, persons, funds, and resources (e.g., equipment, supplies, facilities) needed to accomplish missions and goals. Identify available resources, funds, employees, and persons. Identify required additional resources, persons, employees, and funds (i.e., gap analysis). Make budget decisions. Prepare budget narrative, justification, tables, and performance measures.

Consolidate and verify input (e.g., compare to targets); publish and distribute budget request and supporting data. Defend budgets through presentations, testimony, and supporting material. Prepare appeals and negotiate programmatic issues and amounts. This function consists of all budget activities, including CRB, OMB and Congressional budget requests.

C Conduct Programs

CA Determine tasks

Specify tasks. This includes defining actions to address safety, health, and security (e.g., tracking of nuclear materials) as well as actions needed to mitigate risk, remedy non-compliance situations, and comply with mandates. Assign persons, employees, resources, and services needed to implement tasks. Establish the critical path, dependencies, and schedules. Define and approve domestic and foreign trips and travel requirements.

CB Issue solicitations

Develop solicitations, such as requests for proposals and program announcements for acquisitions of goods and services and for financial assistance, including the annual request for Field Work Proposals from laboratories. Define requirements and selection criteria. Issue requests to vendors, laboratories, and other providers.

CC Evaluate proposals

Receive, log, and acknowledge submissions. Review offers against selection criteria. Rank proposals. Select proposals: decide on/approve which proposals will be accepted, including what portions of the proposal will be accepted. Notify organizations and persons who have submitted proposals.

CD Establish agreements

Reach agreements, such as international agreements, contracts, financial assistance agreements, permits, visas, certifications, technical exchange plans, CRADAs, labor management agreements, etc. with other parties for the purpose of establishing work to be accomplished, goods and services to be delivered, or set parameters for specific elements required for Departmental program execution or business operation. Identify the roles and responsibilities of each party to include such elements as legal requirements, scope of work, terms and conditions, goals and objectives, milestones, delivery dates, performance measures, price and payment, and similar conditions.

CE Protect intellectual properties

Identify products of the mind or intellect of value to the Department. Establish ownership and use rights (e.g., acquire patents, copyrights, trademarks). Request action (e.g., patent, copyright, trademark) to protect intellectual property. Manage royalty use of patents, copyrights, trademarks.

CF Deliver products and services

Note: The business functions here refer to the direct production of the products and services associated with DOE's mission. While DOE-IAP will not define architectures for them, they are included here as a critical part of the Business Model. The assumption is that subsequent architectural efforts will interface with the DOE-IAP architectures. The following list of DOE mission-related products and services is representative, but not meant to be all inclusive.

Conduct research and development (e.g., fundamental science, efficient energy sources, materials research, environmental cleanup, nuclear reactors);

Perform cleanup;
Produce reports, forecasts, and data analyses (e.g., scientific, technical, economic, energy);
Conduct studies (e.g., epidemiological, non-proliferation);
Manufacture products (e.g., nuclear materials, security);
Deploy technologies (e.g., energy sources, computing, technology transfer);
Perform stockpile stewardship;
Maintain oil reserves;
Dispose of nuclear waste;
Conduct educational programs;
Conduct emergency operations;
Safeguard mission-critical expertise;
Maintain and dispose of facilities, equipment, and other resources;
Protect the environment

CG Assess progress against goals

Determine movement towards the goals and objectives using measures. Evaluate achievements and milestones against schedule, using methodologies such as earned-value. Identify variance and provide feedback.

CH Assess compliance with mandates

Review programs, projects, tasks, or activities of Departmental elements to ensure that they conform to mandates. This includes the conduct of audits, independent reviews, and self-assessments and other financial, environmental, safety, health, and security (e.g., review of nuclear materials tracking and control of visits by foreign nationals) oversight actions. Identify incidents (i.e., occurrences of injury, property loss, illness, security violations, accidents, etc.). Analyze variance and/or non-compliance. Recommend corrective actions.

CI Evaluate costs

Measure and evaluate actual costs against planned costs. Identify variance and provide feedback.

D Manage Funds

DA Distribute funds

Receive allotments. Reconcile allotments. Receive funds available from collections, payments, investments, and refunds; and/or collections from other Government accounts.
Allocate funds. Provide instructions and/or restrictions on use of funds. Commit and obligate funds.

DB Control funds

Establish control and accounting systems. Maintain control levels. Assure that control amounts are not violated. Verify that funds are available before obligations are made. Analyze uncosted obligations and unobligated amounts to validate carryover balances and to identify balances exceeding program, project or other funding requirements.

DC Process payments

Issue payment instructions, based on validated and approved invoices received from contractors, grantees, vendors, etc.

DD Manage investments

Identify source of funds to invest (e.g., Nuclear Waste fund from electric utilities, oil producer overcharge settlements). Invest funds in minority financial institutions.

E Support Programs

EA Manage resources

Designate use of and responsibility for facilities, buildings, vehicles, and grounds to Departmental elements. Allocate furniture, computer and communications equipment, and supplies. Accept delivery and conduct regular inventories of physical resources to determine number, location, condition, status and other relevant factors. Dispose of excess property.

EB Provide facility services

Provide facility and site maintenance services. Provide utilities (e.g., water, sewer, heat, electricity, etc.).Provide telecommunication services (e.g., telephone/fax numbers, mail routing symbols, and communications addresses).Distribute office space and schedule moves. Make travel arrangements to include reservations for hotel, airlines, vehicle and arrange for travel documents (e.g., travel authorizations, passports, visas).

EC Manage authorities

Empower employees or persons with rights and permissions to act in support of programs, projects and tasks. Grant, maintain, and terminate authority to employees to transfer authority to another. Grant, maintain, and terminate authority to employees to enter into agreements on behalf of DOE. Grant, maintain, and terminate authority for employees and persons to represent DOE positions. Grant, maintain, and terminate permission to employees and persons for physical access to facilities and equipment. Determine, grant, maintain, and terminate permission to access information, data repositories, and secure resources. Determine, grant, maintain and terminate personnel security clearances.

ED Provide expert opinion and advice

Collect and evaluate data, information, and other opinions and advice from various sources including advisory committees. Develop opinion and advice. Communicate opinion and advice. Opinion and advice includes all areas of interest to DOE including legal, technical, financial, procurement, human relations, ES&H, congressional and public affairs, and international relations.

EE Resolve disputes

Receive and accept notices of disputes (e.g., claims, complaints, lawsuits, personnel grievances and actions, security clearances, whistle blower cases, labor relations issues, contracting issues, etc.). Negotiate, mediate, and arbitrate disagreements . Interview affected employees and persons. Conduct hearings and issue decisions. Represent DOE in judicial and quasi-judicial proceedings (e.g., conduct litigation/representation).

EF Protect employees and persons

Ensure that employees and persons are provided safe and healthful working conditions. Perform monitoring of employees and persons to assess levels of exposure to harmful agents such as radiation, lead, asbestos, etc. Perform analysis of employee work activities to identify potential hazards, need for personal protection equipment, engineering controls and requirements for training. Perform medical evaluation of employees to assess bodily injury from hazardous agents (i.e., lead, beryllium, etc.).

F Manage Employees

FA Fill jobs

Prepare description including duties and responsibilities. Classify job and determine grade level. Determine staffing approach, e.g., hire from within DOE, or search outside. Establish salary range and incentives. Determine selection criteria. Post vacancy announcement. Log applications and evaluate applicants. Interview applicants. Select preferred candidate and make offer. Establish reporting date. Notify other applicants.

FB Compensate employees

Track time and attendance. Calculate deductions, overtime pay, and awards.

FC Furnish benefits

Determine benefit entitlement (e.g., health, retirement, life insurance, counseling). Assist employee in obtaining benefits.

FD Develop employees

Assess training needs; prepare individual development plans. Identify training sources from within DOE and from outside organizations. Deliver training and career development services (including tuition reimbursement).

FE Evaluate employees

Set performance standards; communicate expectations with employee. Evaluate employee performance. Communicate evaluation to employee recognizing noteworthy performance and areas for improvement. Establish performance improvement plan. Reward excellence; initiate disciplinary actions. Counsel employee.

G Manage Information

GA Establish information structures

Determine which DOE activities require standard information identifiers (e.g., B&R Codes, official file structure). Establish definitions of terms and requirements (e.g., data dictionary, audits and edits). Distribute information structures. Assign identifiers.

GB Manage documents

Create documents, i.e., renderings of data in physical, electronic, or other media. Determine review and concurrence process. Track, store, retrieve, distribute, and dispose of documents. Identify documents that require sensitive handling. Take measures to protect sensitive documents. Identify documents required to be retained as records. Determine and comply with record retention schedules and requirements. Transfer records to archival storage. Dispose of records.

GC Implement information systems

Design, build, acquire, deploy, and support information systems -- hardware and software (e.g., operating system, telecommunications, and business applications).

Appendix 4

Current Systems and Technology Information Resources Catalog (IRC)

The Information Resources Catalog (IRC) documents and describes information systems and technology platforms in use, or planned, within DOE. It provides a snapshot of the current applications environment, based on a survey focused on systems pertaining to DOE corporate functions and other DOE business functions of national interest.

The scope of the effort included systems that would result from enterprise-wide efforts underway or planned; systems with data shared among DOE offices; or key business functions as defined in the corporate Business Model. Field and Operations Office systems supporting program-specific operations or containing data unique to a specific site were not within scope. Non-Federal, laboratory, and contractor systems were also not within scope.

The IRC provides a reference to all corporate information sources. It documents the distribution of information resources among organizations. It also highlights opportunities to address such issues as: data redundancy and accuracy, application redundancy, over and/or under utilization of technology, degree of information resources sharing, and obsolete technology.

IRC Process

Information about current systems and technology platforms was gathered initially through the use of a questionnaire distributed to all Departmental elements in late 1998, as part of the Headquarters Information Architecture Project (HIAP) business case effort. The information is stored in a database and includes the following components: name, organization, system owner, technical contact, technology, age, cost, long range and short range plans. A current inventory of the 142 systems is shown on the following pages.

During the DOE-IAP process, the IRC was updated as additional data became available from the BARs, especially about IT corporate investments. The questionnaire developed for the HIAP effort was used again to collect limited update information in July 1999 as part of the DOE-IAP.

Current Inventory of Systems in the IRC

Advisory Committee Management Status System
Authorized Classifier Tracking System
Albany Internet Web Server
Annual Operating Plan
APPLIX Enterprise
Budget and Reporting Code System
Budget Execution Finance System
Business Management Information Systems for Financial Management
Business Management Information System (BMIS - Net)
Budget Ranking System
Budget Table System
Computerized Appraisal Followup System
Consolidated Accounting and Investment System
Call-up Online Locator System
Condition Assessment Survey Program
Correspondence and Action Tracking System
Computerized Action Tracking System
Classified Document Control System
Classification Guidance System for Windows
Corporate Human Resources Information System
Contract CloseOut
Collaborative Management Environment
Communications Security
Consent Order Tracking System
Consent Order Tracking System Investment System
Corporate Executive Information System
Correspondence Tracking System
Congressional Transcripts and Testimony System
Departmental Audit Report Tracking System
Drug-Free Workplace Program
Departmental Inventory Management System
Departmental Integrated Standardized Core Accounting System
DOE Integrated Safeguards and Security
Document Online Coordination System
Department of Energy Home Page
DOE Info
DOE Information Bridge
Departmental Training Information System
DP Management Reporting System
Electronic Freedom of Information Act
Electronic Commerce Web
Electronic Document Management System
Electronic Funding Administration System
Executive Information System
Enterprise Information System
EM - Procurement Assistance Data System
EM Commitment Tracking System
Employee Separation energy Pollution Prevention Info Clearinghouse
Electronic Standard Forms
Environment, Safety and Health Management Plan
ER Calendar System
Executive Secretariat Executive Commitments Information System
Employee Self Service
Energy Time and Attendance
Explorer, DOE Directives On-Line
Foreign Access Records Management System
Fossil Energy WebPub
Functional Cost Reporting System
Financial Disclosure System
Funds Distribution System
Financial Data Warehouse
Facilities Information Management System
Financial Information System
Financial Information Variance Reporting System
Financial Management Information System
Frequency Management System
FOIA Tracking System
Fossil Research Energy Database
Foreign Travel Management System
Foreign Trip Reports Database
General Counsel Tracking System
Government Information Locator System
Headquarters Telephone Work Order Control System Helpline
HQ Security Badging System
Headquarters Security Office
Integrated Document and Records Management System
Industry Interactive Procurement System
Information Management for SC
Innovative Research Mailing List
Inventory
Interagency Personnel Act (IPA) Funding System
Integrated Planning, Accountability and Budgeting System Information System
Information Products Database
Integrated Procurement System
Industrial Relations Reporting System
ITIPS
Integrated Technology Information System
Laboratory Database
LAN Registration
Laboratory Appraisal System
Lab Directed Research and Development System
Labor Distribution System management Analysis Reporting System
Nuclear Materials Management and Safeguards System
NS Cluster FOIA Database
Office of Management and Administration Controlled

Correspondence
OpenInfo
Occurrence Reporting and Processing System
Personnel Action Tracking System
Plant Acquisition and Construction System
Procurement and Assistance Data System
Program Activity and Location System
Property Accounting and Management System
Procurement and Assistance Tracking System
Payroll System
PC-Master
PCDOCS
Personnel Security Case System
Phone Listing
Proliferation Information Network System
Payroll Modeling Application
Past Performance Data Base
Procurement Request and Authorization Tracking System
Project Management Information System
Progress Tracking System
Prior Year Construction Project Reporting
Question and Answer / Testimony Library System
Research and Development Tracking System
Research and Development Project Summaries
REPTRACK
Research Information Management System
Records Management Information System
Systems Applications Program
Small Business Innovative Research System small Business
Status of Sensitive Compartmented Information Clearance
Safety Environment Management Information System
System Management for Annual Requested Training
Subcontracting Reporting System
Small Business Technology Transfer System
Timecard
Timecard
Timecard - Labor Distribution - OR
Timecard - Labor Distribution - SR
Technical Information Monitoring System
Tracking System for the Secretary's Performance Agreement
with the President
Travel Manager
Vital Statistics Personnel Tracking
Weapons Data Access Control System
Workflow Information System

The IRC from the 1998 survey is currently published on the web as the HIAP Enterprise Model through the Metis Visual Enterprise Architecture Planning (VEAP) toolset. The model displays a graphical representation of DOE's "as-is" application environment with visual links to technologies in use and organizational ownership. Searches can provide answers to such questions as: "What systems at DOE use a specific technology, e.g., Visual Basic?" or "What systems are associated with budget data?"

Initial analysis conducted on the IRC supports issues that DOE-IAP addresses, e.g., evidence of data duplication and system redundancy, aging application portfolio, and a complex, diverse, and continuously aging technology base.

Appendix 5

Data Architecture

The Data Architecture supports the objective that all mission critical data are accounted for, well-managed, and appropriately shared. It provides a data model and common terminology for corporate data elements to be developed and will add value to future system development initiatives.

The BARs analyzed the Business Model and identified primary nouns to identify candidates for business objects. Each business object is a person, thing, place or event about which DOE needs to keep data in order to conduct its business. The BARs then crafted a definition that reflected their understanding of each business object. The objects and definitions could serve as the primary source for a corporate data dictionary.

DOE Corporate Data Architecture

Name	Definition	Identifiers	Attributes/ Characteristics	Examples and Notes
Advice	Opinion or informal recommendation regarding a decision or course of conduct.	source, date, time, subject	description, scope, purpose,	Comments made by an external expert on a proposed research project in a telephone call; response from a DOE lawyer to a question from another DOE employee about a possible employee relations issue.
Agency	Department or administrative unit of a government.	Title, acronym, type, ID Number	Description, role, address, contact numbers (telephone, fax, web address)	Executive and legislative branches (Congress, HUD, DoD, Dept of State, State Gov't bodies; international entities
Agreement	Arrangement between two or more parties as to a course of action, including identifying the roles and responsibilities of each party.	ID #, Title, Date, Parties, type (MOA)	Subject, Scope, Period of Performance, Funding; terms and conditions	Contract, grants, permits, MOU, treaty, collective bargaining; visas, certifications, CRADAs, labor management agreements
Authority	Official, specific rights/permissions (other than those normally contained in a job description) assigned to an employee, person, and/or job.	type, date, name, number/code	source, duration, level, scope	rights, warrants, delegation orders, access rights to information, facilities, data, personnel clearances, electronic signature and authentication, credit card
Award	Monetary and non-monetary honor given to organizations, persons, and DOE employees.	name, type, date	description, purpose, frequency, competition	Lawrence, Fermi, scientific and technical
Benefit	Package of services and programs provided to employees.	date, name, type, grade	description, duration, terms and conditions	Includes: Health and life insurance, counseling services.
Budget	Estimated funds required for goods and services, work to be performed, or other financial requirements.	year, type, organization	amount	examples: planning estimates, budget recommendations, budget proposals.
Compliance	Conformity with formal or official requirements.	date, type, mandate, Departmental element, name	methodology, result	audit report, certification validation, incident report
Cost	Dollar value of goods and services received, work performed, or other financial responsibilities that result in a commitment to expend Federally appropriated or other funds.	Date, name, type	amount, fiscal year, period covered, currency, estimated, historical	employee salary, etc.
Departmental element	Organizational unit of the Department of Energy (DOE).	Name, codes, acronym	function, mission	S-1, Operations Offices

Name	Definition	Identifiers	Attributes/ Characteristics	Examples and Notes
Dispute	Disagreement or controversy among interested parties.	type, date, number, title	description, resolution, status	personnel grievances and actions, security clearances, whistle blower cases, labor relations issues, contracting issues, etc.
Document	A rendering of data in physical, electronic, or other media.	name, number, type, date	Content, description, format, media, sensitivity, record indicator	These renderings can take various forms such as hard copy, analog or digital recordings, electronic files
Employee	Person who holds an appointment to a position in DOE.	ssn, position control #	physical description, name, types, grade, job title, KSA (knowledge, skills, and abilities)	Does not include contractors
Facility service	Business functions that support or are auxiliary to program and project goals/operations.	name, type	description, level,	Utilities, telecommunication, site maintenance, building security, copy and transcript services, travel services
Funds	Dollars available for expenditure for a specific objective or program, project, or task.	code, title, fiscal year	amount, reserve, obligated, authorized	
Goal	Desired outcome.	Title, type, date	source, content	
Incident	Significant event or required reportable occurrence	type, date, location	sensitivity, severity, associated program, duration	Injury, accident, nuclear/chemical release, security violation
Information structure	Set of identifiers of entities that the Department manages, including: projects, processes, persons, resources, funds, organizations.	code, title, date, type	definition, effective date, status	Resource identification number, B&R Number, organization code, employee number, position number, task and project numbers; general ledger; chart of accounts
Information system	Hardware and software (e.g. operating systems, communications, and business applications) that support management of DOE data and business functions.	Name, type, acronym	Description, status, components	LANs, SQL, servers, Windows NT, CHRIS
Inquiry	Question or statement from a stakeholder or customer to which DOE responds or makes an employee or person available.	Identifier, type, date, source	Content, description, format, sensitivity	FOIA inquiries, Congressional Q&As, public inquiries
Intellectual property	Rights in products of the mind or intellect (intangibles) as defined by law.	name, date, type, number	concept, description, formulae, process, value	patents, copyrights, trademarks, trade secret
Investment	Commitment of funds with a view to safeguarding them while earning a return.	date, type,	amount, rate of return, organization, duration	deposits in minority banks
Job	Duties and responsibilities of a future or existing employee.	Title, Position Control Number, date of creation, grade	position description, job series, type, role, status	Computer Specialist, Management Analyst

Name	Definition	Identifiers	Attributes/ Characteristics	Examples and Notes
Mandate	Specific instruction or requirement.	Order Number, Date, Topic/Subject Matter	Authorization Reference, Authorizing Office, Text, Times, Type, Concurrence and Approvals	Program/project guidance, law, regulation, directives, orders, policy, budget calls, programmatic guidance issued to contractors and labs, management principles; legislation (e.g. Clinger-Cohen Act); requirements (reporting, financial, procurement, personnel, operational, programmatic).
Measure	Standard of evaluation.	type, organization, date	unit, scale, dimension, period, description	performance measure; personnel performance standards;
Mission	Purpose of an Departmental element or organization, which sets the direction and boundaries of its activities.	code, date	statement, scope	
Organization	A group of people that has ongoing membership, a body of officers, and a set of regulations.	ID #, Name, Acronym, type	Purpose, scope, description, governance,	Indian nations, international organizations; standards bodies, inter-agency groups, professional organizations; formal review bodies such as Advisory Committees
Outreach event	Public gathering of persons or organizations of interest to DOE.	Date, name, type, location	Description, duration, importance, participants	Meetings, conferences, competitions, e.g., Science Bowl, media events.
Payment	Cash disbursement to liquidate costs.	date, name, type	amount, description	Checks issued by Treasury.
Person	Individual who is of interest to DOE because of expertise, influence, status, and/or relationship to program area.	Name, type	address, phone, e-mail, role, nationality, employer, ID, gender	Representatives from other Government agencies (e.g., OMB staff, members of Congress), candidates for Departmental awards, persons contacted for expert advice, persons located at institutions where work is or proposed to be performed, members of the public, individual stakeholders
Position	Official view on matters of interest to DOE.	date, name, type	description, concurrence and approvals	Comments on proposed legislation, public statements, news articles, expert recommendations provided by DOE employees during project oversight, responses to inquiries, testimony.
Products and Services *	Results of a program, project, or task.	date, name	description	Research, cleanup, technologies, stockpiles
Program	Grouping of projects and/or processes with common attributes, associated with one or more program, project or task.	name, code, acronym	scope, subject, content	Fusion Energy, EM Privatization, Cyber Security, Financial Management
Progress	Movement towards a goal or objective.	date, name, type,	Description	
Project	Set of activities discretely managed, funded, coordinated, and carried out over a prescribed period of time that results in a prescribed end product.	name, code, acronym, type	scope, description, content, schedule, management planning and control.	Examples: NIF, ASCI, SNS, BMIS, Classified LAN, Human Genome

Name	Definition	Identifiers	Attributes/ Characteristics	Examples and Notes
Proposal	Offer to do work, or provide products and services, which is submitted to DOE for consideration.	title, number, date, type	dollar value, technical approach, business management, key personnel, exception/deviation	May result in contract, grant, cooperative, or international agreement or other agreement.
Resource	Physical property used to accomplish a mission, program, project, task, or goal.	type, identifier	description, location, age, quantity; availability	equipment, facilities, space, supplies, buildings
Risk	Possibility of loss, failure, threat or other undesirable consequences.	name, type	probability, description, impact/evaluation, consequences	market, financial, litigation, security, contracts, management, safety, energy, national security, environmental quality, contingency
Solicitation	Request for an offer to do work.	name, number, date, code, type	Method of announcement, statement of work, terms and conditions, area of interest, duration, schedule, deliverables	Request for Proposals (RFPs), Program Announcement, letter requesting Field Work Proposals (FWPs)
Strategy	Proposed approach to accomplish a project or process, or to achieve a goal or mission.	name, number, date, type	subject, description, duration, scope, assumptions, constraints	acquisition strategy; technical strategy, implementation strategy, funding strategy, risk mitigation strategy. NIF.
Task	A discrete unit of a project or process.	title, number, date	work description, schedule, *milestones*	The lowest level of work for the DOE-IAP data model. Prepare a plan, evaluate a proposal, interview candidate

Appendix 6

Applications Architecture

The DOE Applications Architecture defines a set of applications that will support the shared data environment and provide the automated capabilities to store, share, and use data needed to conduct the Department's business efficiently. The Applications Architecture does not design systems or collect detailed requirements. The Applications Architecture addresses capabilities of existing, planned, and future applications to form a complete picture of the vehicles needed for delivering data resources and accomplishing business activities. The Applications Architecture is a key component in building the Implementation Plan.

In defining the applications in a shared data environment, it is beneficial to plan for managing data separately from the applications that actually process the data. Repositories enable multiple applications to use the same data without duplicative maintenance. The BARs reviewed the Data Architecture and defined a number of repository applications to manage data. The BARs then reviewed the business functions to identify specific automated capabilities to support the functions outlined in the Business Model and defined the systems applications needed for those purposes.

Corporate DOE Applications Architecture - 35 Proposed Applications

Name	Purpose
Agency Information Repository (AIR)	To provide one source of basic information about governmental bodies that DOE does business with.
Agreements Information Repository (AGIR)	To provide a uniform file of basic data on all of DOE's contractual and other agreements to enable efficient aggregation and availability of important information.
Authority Management System (AMS)	To support the granting and withdrawing of the full range of authorities of DOE employees and others with whom DOE does business
Award Support System (AWSS)	To provide an automated system to facilitate the processing of the full range of awards that DOE bestows on individuals and organizations and to have a complete record of such honors.
Departmental Element Information Repository (DEIR)	To maintain a uniform and current file of basic data on all of DOE's headquarters and field organizations and subunits to support other automated systems across the enterprise and to assist in communication both within DOE and with its customers.
Departmental Position Repository (DPR)	To provide a reliable and complete source of official stands taken by DOE officials to help assure consistent views and understandings on important public and operational matters.
Departmental Position Support System (DPSS)	To provide a comprehensive mechanism to develop and track the formulation of DOE official views and to provide an historical record of how those views were reached.
Dispute Tracking System (DTS)	To provide a system to facilitate the processing of dispute actions and provide the ability to track such actions and collect basic data about them.
Document Management System (DMS)	To maintain a current and comprehensive electronic library of the full range of documents generated by, or of interest to, the Department and to facilitate their identification and access.
Employee Information Repository (EIR)	To provide a uniform, complete, and current source of basic information about all DOE employees that can be readily accessed and is properly protected from the release of sensitive material.

Name	Purpose
Employee and Job Management Information System (EJMIS)	To provide an automated process to assist in the processing and tracking of information related to the filling of DOE vacancies; and the compensation, evaluation, and training of DOE employees.
Executive Information System (EIS)	To provide high level DOE officials with current and accurate summary information on important Departmental policies, programs, operations, issues and initiatives.
Exposure and Medical Monitoring System (EMSS)	To provide a comprehensive and uniform system to track and help analyze health related information about DOE employees, contractor personnel and the public; provides reliable and up-to-date record of medical related data.
Facility Services Information System (FSIS)	To provide a mechanism to access fundamental data about utility, maintenance, and other support services at DOE facilities to assist in analyzing trends, identifying opportunities to reduce costs, improving operations and responding to questions from outside DOE.
Funds Management System (FMS)	To provide comprehensive, uniform, accurate, and complete system to track and account for the allocation, obligation, and expenditure of funds available to DOE; available at all program levels to allow consistent management of financial resources with ease of use.
Incident Reporting System (INRS)	To provide a uniform, DOE-wide system to assure the timely, complete and accurate reporting and storing of information on operating incidents at DOE and contractor facilities.
Information Structure Repository (ISR)	To provide a comprehensive, official and current file of the name and code identification of important categories of information such as B&R codes, contractor identification, and employee categories.
Information System Investment System (ISIS)	To provide a comprehensive, current and widely available source of information about information management systems under consideration, in development, and already implemented.
Information Technology Architecture Repository (ITAR)	To provide the official, comprehensive inventory of a variety of data related to DOE's information architectures.
Inquiry Response System (IRS)	To provide an automated system to track the receipt, processing, approval and transmission of responses to inquiries received by the Department.
Intellectual Property Index System (IPIS)	To provide source of DOE-wide, current information on a wide range of intellectual properties such as patents and copyrights that will permit DOE-wide access and aggregation of data.
Internal Audit/Assessment Management Support System (IAAMSS)	To provide the automated capability to assist in the preparation of audits and assessments; and to access audit/assessment status information and historical data.
Investment Tracking System (ITS)	To provide an automated system to record data about the investment of funds in various financial institutions as required by law; provides access to complete, accurate, and up-to-date information.
Mandate Information Repository (MIR)	To develop an automated and categorized system of information concerning various nature, content and applicability of laws, regulations, guidance, directions, and orders affecting DOE programs and operations whether imposed by outside bodies or promulgated internally.
Mandate Issuing System (MIS)	To provide a system to track and record the development and issuance of DOE guidance, policies, directives, orders and other forms of internal mandates.

Name	Purpose
Organization Information Repository (OIR)	To provide an easily accessible, accurate, complete and current source of basic information about non-governmental organizations with whom DOE does business such as contractors, grantees, public interest groups and suppliers.
Person Information Repository (PIR)	To provide a readily accessible and reliable source of basic information about non-employees who are of interest to DOE because of their positions, interest, authority, or roles such as advisory committee members, researchers, members of Congress, Administration officials and contractor personnel.
Physical Property (Resources) System (PPRS)	To provide a comprehensive and complete DOE-wide repository of information about government-owned property that is readily accessible, can be aggregated, and is available for a wide variety of analyses such as condition, assessment, age, value, and maintenance requirements.
Planning and Budget Support System (PBSS)	To provide a comprehensive system, capable of being used at all Departmental levels, to facilitate tracking and recording of information about the analysis, development, decision making, and establishment of plans and budgets.
Procurement and Financial Assistance System (PFAS)	To provide a department-wide system to facilitate the processing of contracts and grants and to provide uniform data for aggregation and analysis.
Program Information Repository (PMIR)	To establish an official comprehensive and current file of basic information about DOE programs to be readily available within the Department and to outsiders.
Progress and Cost Assessment System (PCAS)	To provide a DOE-wide comprehensive system to help evaluate and record actual work progress and costs compared to establish goals, schedules, and projections.
Project Information Repository (PJIR)	To establish a comprehensive, consistent and current source of basic information about the Department's projects that is readily accessible both within and outside the Department.
Task Approval System (TAS)	To provide a flexible, automated system to record the assignment of tasks to DOE employees and contractor personnel and track the progress in accomplishing those tasks.
Travel Arrangement System (TRAS)	To provide a system to facilitate the arrangement of official travel by DOE employees.

Appendix 7

Technology Architecture Framework

A technology architecture framework provides a DOE-level view of information important for IT management via a variety of products. Each serves an important supporting purpose within DOE-IAP.

- **A set of proposed technology guidelines**. These guidelines serve as unifying principles to guide decision-making and implementation of technologies at DOE. They provide more specific guidance than the principles established for DOE-IAP, but are fully consistent with them.

- **A standard taxonomy of technology elements**. For high-level planning activities, having clearly defined technology elements makes it easier to grasp the totality of the technical infrastructure. Having a standard taxonomy of technology elements institutionalized and used Department-wide ensures that IT planners are working to the same overall plan, thus facilitating interoperability and standardization of the planning process.

- **A repository of baseline information about products currently in use within each technology element.** Knowing what products are in use facilitates effective technology lifecycle management, making it easier to target specific products for retirement or to begin migration to new platforms and standards.

- **Detailed planning guidance for each technology element via technology positioning statements**. Having guidance for tactical (1 to 3 years) and strategic (more than 3 years) deployment and support options, as well as product containment and retirement guidance, facilitates project planning, purchasing decisions, and interoperability analysis.

- **Association of technologies to business needs as expressed in the architected applications**. For planning the details of technology deployment, each architected application is linked to the technology elements it requires. Each application project further defines the details of those requirements. Linking the technologies to applications ensures that technology is deployed at the right time and that the technical infrastructure anticipates and meets business requirements. DOE-IAP recommendations address this need for coordinated deployment and potential projects that should be considered.

This appendix contains the technology guidelines and the taxonomy.

DOE Information Architecture Technology Guidelines

1. **Business Model Basis** - The DOE information technology architecture will be based on a distributed, event-driven, networked model that mirrors the DOE business model.

2. **DOEwide IT Service** - The DOE infrastructure for information technology will enable DOE customers and business units to use IT as a generally available utility that provides generic information services. Technologies and systems will be deployed that will provide DOE with an integrated IT infrastructure (e.g., a standard computing environment).

3. **High Reliability** - Technology systems will provide the highest possible reliability. Reliable systems are defined as those that are free of disabling defects and meet business-driven availability and performance requirements.

4. **Minimal Complexity** - Interdependencies among systems and technologies will be minimized to reduce complexity, where possible.

5. **Limited Computing Platforms** - Technical diversity will be controlled to minimize the cost of maintaining expertise in and connectivity between multiple processing environments. The number of computing platforms will be limited to those required to support DOE business activities in a cost-effective manner.

6. **Open-Systems** - Applications are independent of specific technology choices and therefore can operate on a variety of technology platforms. Implemented technologies should have the following capabilities.
   - Portable: run across multiple platforms
   - Scalable: operate on higher- or lower-performance platforms; handle significant increases in processing or storage volumes
   - Interoperable: run in a heterogeneous environment
   - Compatible: preserve the investment in existing software and enable technology advances to be integrated with other components

7. **System Development Methodology** - A System Development Methodology (SDM) that reflects best current industry practices will be implemented.

8. **COTS** - To the maximum extent possible, DOE will buy commercial, off-the-shelf software application systems (COTS) to meet DOE business objectives.

9. **Data Stewardship** - Data and information will be managed as a DOE resource. Data quality and integrity will be assured.

10. **Data Validation and Distribution** - Data should be captured and validated once at its source. Data will be distributed or replicated such that users' information needs are met, consistent with the defined requirements for system performance and availability and security.

11. **Data Sharing Across Systems** - The computing environment at DOE will enable cross-functional (business unit) data to be shared across DOE legacy systems and new data systems.

12. **Enterprisewide Security** - An enterprise security infrastructure will exist at all levels: software, hardware, and network. Security solutions will be as transparent as possible. Data security will be designed into all architectural elements, balancing accessibility and ease of use with requirements for the protection of data.

13. **Access Security** - Access to DOE data and technologies will be controlled. The control policies and mechanisms will ensure free flow of information within DOE without putting the Department's or its customers' business at risk.

Technology Element Definitions

1. **Application Development Toolset** - Suite of tools used for development of corporate applications.

2. **Application Development Languages** - Programming languages for development of corporate applications.

3. **Data Mining** - Tools for the analysis of data for relationships that have not previously been discovered.

4. **Decision Support Tools** - Search, summarization, and presentation tools that perform analysis of information to discover meaningful correlation and trends in large repositories with what-if scenario capabilities.

5. **CASE Tools** - Computer-aided software engineering (CASE) tools use computer-assisted methods to organize and control the software development process. CASE tools provide capabilities for modeling database structures, applications, and business processes. Repositories store metadata to facilitate reuse and possibly sharing among tools.

6. **Web Development Tools** - Tools used to produce applications or products via the world wide web.

7. **Application Delivery - Tools** - Centralized deployment of software applications.

8. **Storage, Backup and Recovery Tools** - Data storage, retrieval, and loss prevention.

9. **Document Management Tools** - Storage, indexing, and retrieval of electronic files.

10. **Digital Multimedia Management** - Capture, indexing, storage, and retrieval of photographic, video, and audio files.

11. **Middleware** - Three main classes of software provide basic data transport from source to destination
    - < Communications Middleware - facilitates program-to-program communication.
    - < Data Management Middleware - facilitates reading and writing to distributed databases or files.
    - < Platform Middleware - provides an execution environment for application logic.

12. **Remote Access Client** - Client services software for laptops, hand held computers, and Personal Data Assistants (PDAs) to access the DOE network from remote sites.

13. **Browsers** - Client programs that employ W3C standards to access and display information.

14. **User Software Tools/Suites** - Commercial off the shelf (COTS) applications used to create, read, and manipulate the electronic documents common to most enterprises.

15. **Directory Services** - Cross-platform system which permits secure access to network-wide services.

16. **Network & Systems Management** - Software which provides asset management, problem tracking/escalation and resolution, and desktop configuration management services.

17. **Database Management Systems** - Provide access and control of data and include enterprise-wide database management systems (DBMS) and workgroup DBMS.

18. **Workstations** - Microcomputer systems (including laptops and PDAs) that are used by end-users.

19. **Servers** - Scalable computers supporting enterprise applications.

20. **Transport Infrastructure** - The cabling, hubs, switches and routers which form the interconnection of network nodes. They include twisted pair, coaxial, fiber, and wireless technologies.

21. **Telecommunications Carrier Services** - Information service provider services and protocols for the transmission of data over a transport infrastructure. Telecommunications encompasses all types of data transmissions: voice, video, phone, fax, and dial-in services that enable access to DOE network and information services from remote sites.

22. **Network Protocols** - Standards for the packaging of information streams for all types of telecommunications.

23. **Workstation Operating System** - Software for the workstation computer that manages all the other programs running on a computer.

24. **Server Operating Systems** - Software for scalable enterprise servers, and special purpose servers (e.g., CD-ROM, application, and proxy servers) that manages all the other programs running on a computer.

25. **Access Control Security Service Tools** - Assurance of appropriate user access to network-based applications, including intrusion prevention and detection.

26. **Virus Protection** - Software that detects and removes viruses. Part of the security service tools suite to safeguard computer based corporate information security at the desktop with its vulnerability to viruses and at the network level.

27. **Data Encryption** - Another security service tool that secures data before, during, and after transmission.

28. **Digital Signature/Authentication** - A robust security service tool to safeguard computer-based corporation information security. Identifies both the origination and destination points of an electronic message, providing guarantees of authorship and guarantee against forgery.

29. **Messaging, Calendar, and Scheduling** - Collaborative services providing multi-user interaction through enterprise-based electronic mail and calendar systems.

30. **Multi-point Conferencing** - Ability to deliver teleconferencing at the desktop integrated with interactive workgroup applications and network transmission of audio and video. These collaborative services may include videoconferencing, collaborative editing and document sharing.

31. **Workflow** - Automated structuring, organization, and movement of work to conform to actual business processes. Another collaborative service supporting interactive work-group sharing.

Appendix 8

Implementation Plan and Recommendations

Implementation Plan and Recommendations

The Implementation Plan and Recommendations provides an overall framework to move from a planning exercise to a Departmental practice. It is a high level blueprint for transitioning to a new way of determining IT direction and making IT investments. The plan covers a 5-year horizon for applications projects. It is recognized that the Business Model and the architectures will need to be periodically updated to assure that they reflect the Department's changing priorities and advances in IT products. The plan also reflects that architectures will be implemented incrementally in consideration of resource restrictions.

Since DOE-IAP had a specific scope, the plan is not complete in all aspects, principally regarding the implications of a comprehensive Technology Architecture. The plan focuses on the Applications Architecture and provides a valuable tool for prioritizing the development of applications projects, estimating their development costs, and providing a means of determining the impact of rescheduling project development and implementation.

The plan envisions the completion of the Technology Architecture as a future activity. When completed, the Technology Architecture would be used to define technology projects to provide the hardware, software, and connectivity needed to support the applications projects. As with the applications projects, the technology projects, grouped as a technology deployment plan, would be costed and scheduled so that they could be in place when required by the applications projects.

In addition, the team's recommendations identify a number of additional activities as part of the overall strategy. Preparation of detailed descriptions, cost estimates, and schedules for these activities are beyond the scope of DOE-IAP, but should be undertaken as a priority following the submission of this report.

Finally, this section provides a cost estimate for implementing a Departmental corporate IT architecture to give decision-makers a general idea of the costs involved. Costs for developing each of the applications projects were made based on a widely-used estimating tool. In order to provide a total cost estimate for strategic planning purposes, assumptions were made for the other project elements. The figures need to be verified after the Technology Architecture is completed and the other activities are defined in greater detail. Also, a great deal of analysis of existing systems will be required before moving into a shared data environment. New systems development will require the evaluation of current corporate systems to identify overlaps and the path to alignment.

It must be emphasized that the numbers presented here are initial estimates for planning purposes only. Some team members expressed concern that the numbers presented may be substantially low. In addition costs may rise if the development of the applications is stretched out from the example given. Further, there is concern that the rough estimate for technology investments and management processes is highly uncertain until the technology architecture is completed and detailed implementation plans are prepared. The preparation of budget quality estimates can only be developed after completing the tasks described above.

A 5-year budget estimate (in FY2000 constant dollars) has been derived that is indicative of the level of funding needed for implementation of the DOE corporate IT architecture as established by DOE-IAP as follows:

Application development		$125 million
Technology investments	60	
Management processes	35	
		$220 million

The estimate for application development costs was developed by the DOE-IAP support staff using an industry-recognized estimating tool (i.e., KnowledgePlan from Software Productivity Research, Inc.) and was discussed with the BARs. The estimates for technology and management processes were derived by CIO staff using the applications and DOE-IAP recommendations as a basis for costing. These estimates do not include the cost of Federal staff.

Developing the application priority sequence was accomplished in three steps. Initially, applications were ordered on the basis of identifying those which create, before those that use data. This produces a sequence that, as a whole, is the least costly to develop. In addition, the team ordered the applications based on four business factors: complexity of developing the application, readiness of the responsible organization to undertake the application development, capability of existing systems, and potential added value of the new system. Consolidating these two steps yielded the final priority order for applications development. Most of the top priority applications are repositories for basic data relating to such subjects as DOE organization structure, employee information, contractors and proposers, DOE programs and projects. In addition, a high level evaluation of existing systems identified those which have the potential of being used partially or completely to provide the functionality called for in the architected applications.

Development costs and schedules for the proposed applications are shown in the following chart and were based on an optimum schedule for a 5-year planning horizon. Assumptions consistent with DOE practice and policy were important factors, such as a preference for COTS deployment and web-enabled applications. The costs only cover application development; no maintenance, operation or equipment costs are included. These estimates should provide a starting point for considering alternatives. However, it should be noted that deviation from this optimum schedule will increase the total cost.

Applications Projects: Schedule and Estimated Costs
Constant FY2000 Dollars in Millions)

Application Name	FY01	FY02	FY03	FY04	FY05	Total
Departmental Element Information Repository	0.7	0.3				1.0
Information Structure Repository	1.0	0.7				1.7
Employee Information Repository	0.5	0.4				0.9
Employee and Job Management Information System	3.4	1.8	1.8	1.8	1.8	10.6
Organization Information Repository	1.0	1.0				2.0
Agency Information Repository	0.8	0.8				1.6
Funds Management System	2.2	1.7	1.2	1.0	1.0	7.1
Executive Information System	0.4	0.6	0.2	0.4	0.4	2.0
Document Management System	2.3	2.3	3.0	3.0	2.0	12.6
Mandate Issuing System	0.2	0.5	0.5			1.2
Mandate Information Repository	0.9	0.5	0.5	0.5	0.5	2.9
Authority Management System	0.5	1.0	1.0	1.0	0.5	4.0
Program Information Repository	0.3	0.7	0.3			1.3
Project Information Repository	0.2	0.7	0.3	0.1	0.1	1.4
Planning and Budget Support System	1.0	2.7	2.6	2.0	2.0	10.3
Progress and Cost Assessment System	1.5	2.0	2.2	0.7	0.5	6.9
Agreements Information Repository	2.0	1.3	1.1	1.3	1.1	6.8
Procurement and Financial Assistance System		1.4	3.4	4.4	2.2	11.4
Incident Reporting System		1.5	1.5	1.5	0.2	4.7
Departmental Position Repository			0.6	0.8	0.8	2.2
Exposure and Medical Monitoring System			0.5	2.1	1.4	4.0
Departmental Position Support System			0.3	0.5	0.5	1.3
Dispute Tracking System				0.5	0.5	1.0
Person Information Repository				0.6	0.5	1.1
Inquiry Response System			0.9	0.9	1.0	2.8
Information System Investment System			0.7	0.4	1.0	2.1
Information Technology Architecture Repository			0.4	1.0	1.5	2.9
Travel Arrangement System				0.8	0.7	1.5
Internal Audit/Assessment Management Support System			0.6	0.8	1.5	2.9
Physical Property (Resources) System			0.7	1.1	1.5	3.3
Facility services Information System			1.0	1.1	1.2	3.3
Task Approval System				1.2	1.0	2.2
Intellectual Property Index System				1.2	1.1	2.3
Investment Tracking System					0.6	0.6
Award Support System					1.3	1.3
Application Development Total	$18.9	$21.9	$25.3	$30.7	$28.4	$125.2

Recommendations

The products completed in DOE-IAP reflect a high level view of DOE's business activities, information requirements, and a planning direction. They offer a strategic assessment and provide a road-map for implementation. The task now is to turn the DOE-IAP project into a DOE process for information technology decision making. There is a significant cost of instituting and maintaining such a process. However, it seems clear that there is even a higher cost in both financial and performance terms of continuing a fragmented, uncoordinated approach to information management. Further incentive for change is the need to comply with Congressional and Administration directives to institute an architecture-based decision making process to justify information technology investments. It is

recognized that a period of transition is required before the recommendations developed in the DOE-IAP project can be implemented.

The specific recommendations that follow are intended to keep the momentum going and to undertake, in an incremental series of steps, essential tasks required to move the process along. These recommendations fall into several categories. The first two relate to instituting, Department-wide, an architecture-based information technology decision-making process, the first step in moving to a new paradigm. The third recommendation identifies follow-on work to extend the scope of the DOE-IAP project beyond what was possible in DOE-IAP. Next, it is recommended that fundamental data management capabilities, long overdue, be put in place which would be needed for any Department-wide information system. Recommendation 5 concerns analyzing some possible inconsistencies among the DOE-IAP plan, the CIO IT Infrastructure Project, and the Cyber Security Architecture. The next recommendation, number 6, is made to initiate the highest priority applications projects. Lastly, two final recommendations concern completion of the technology architecture.

1. Institutionalize the principle that future information technology decisions must conform to established information architectures

Rationale

- Responds further to Congressional legislation and Administration policy concerning the need to an institute architecture-based decision making process to support information technology investment proposals.
- Leads to the establishment of a systematic and logical process to identify, develop and acquire the information needed to carry out DOE's business activities.
- Provides a mechanism for establishing a needs- and performance-based approach to prioritizing applications developments and acquisitions.

Implications

- Changes the way DOE develops and acquires information technology; requires clear top level direction and support. Changes include the following.
    - A structured, architecture-based planning process needs to be established and enforced for the development and management of information architectures and systems, and for acquiring requisite technologies.
    - The DOE-IAP architectures need to be maintained and updated on a regular basis.
    - All DOE organizations' information technology investments must not conflict with established architectures and development priorities.
    - The DOE capital planning process must be integrated with established architectures.
    - The culture of the Department needs to change to achieve buy-in, driven by a broad program of training, education, and management leadership.

2. Institute a process to ensure that all on-going and future corporate information technology projects and investments are consistent with established information architectures

Rationale

- Carries out Congressional and Administration directives.
- Provides the formal mechanism to assure that investments and architectures are aligned.
- Helps assure that the most important information technology projects and investments are prioritized; duplications and unnecessary overlaps are avoided, and funds are expended efficiently and wisely.
- Provides the mechanism for architectures and plans to be modified to respond to new information and circumstances.

Implications

- The Department needs to establish a formal, DOE-wide process.
- On-going projects need to be reviewed against established architectures and priorities to determine whether there are significant conflicts.
- Requisite human and financial resources need to be provided to establish and manage the process.
- The process must be coordinated with DOE budget process.
- There needs to be a mechanism to provide feedback from corporate projects to the architectures as part of an architectural update process.
- Program offices, with assistance from the CIO, are responsible for assuring that their non-corporate information technology projects and investments are not in conflict with established architectures.

3. Extend the scope of the DOE-IAP project to include business functions that could not be sufficiently addressed

Rationale

- The DOE-IAP project developed a high level strategic plan based on a model of DOE's business functions and various information architectures.
- A more comprehensive analysis of DOE's business functions and their impact on the architectures, particularly regarding field operations and contractor activities is required.
- Further analysis will help assure a DOE-wide understanding and "buy-in"of the purpose, methodology, and value of instituting a structured architecture approach to guide information technology investments.

Implications

- Requires the support of efforts by Lead Program Secretarial Offices to extend the DOE-IAP information architectures for their particular Headquarters and field requirements.
- Careful planning is needed to establish objectives, performance measures, realistic schedules, resource requirements.
- Requires the commitment of resources by LPSOs, field organizations and the CIO in supporting role.
- Requires coordination among DOE Headquarters and field organizations to incorporate findings into the corporate architectures.

- Recognizes the necessity of establishing non-corporate architectures in program organizations to meet their own information requirements.

4. Establish a corporate data management function, including operating procedures. Identify corporate and programmatic responsibilities .

Rationale

- The HIAP project found that there no effective data management process in place
- There is no current, comprehensive system in DOE to manage the identification, definition, collection, stewardship, and control of data.
- It will not be possible to institute an architecture-based information technology planning and implementation system without creating and establishing these critical capabilities.

Implications

- It is necessary to establish and maintain data dictionaries, standards policies, control and approval processes, control management procedures and similar infrastructure requirements. They need to be aligned with the architectures.
- Policies and procedures need to be prepared to ensure that these capabilities are in place and functioning well.
- A data management capability needs to balance the need for appropriate participation by affected organizations with the need for timely closure on issues.
- It is important to identify corporate and programmatic responsibilities.
- This is a high priority requirement needing top level support and the commitment of the necessary resources.

5. Conduct an independent analysis comparing the DOE-IAP architectures and implementation plan, the Cyber Security Architecture, and the plans to implement the CIO IT Infrastructure Project; recommend steps to resolve any inconsistencies.

Rationale

- There are concerns that these three initiatives may contain incompatible or conflicting recommendations.
- The DOE-IAP project is to provide the framework for all information technology investments in DOE.
- It is therefore necessary to identify and resolve possible conflicts, gaps and inconsistencies among planning efforts.
- This would demonstrate that DOE has instituted an architected information technology planning and decision making process, and would serve as an early model of how to address potential conflicts.

Implications

- An independent analysis should be prepared to examine these plans, identify issues and problem areas, and recommend resolutions.
- Because of the need to address any possible problems quickly, this analysis should be completed as soon as possible.

6. Prepare plans and funding estimates for the highest priority applications identified by the DOE-IAP project

Rationale

- HIAP found evidence of data duplication, system redundancy, and a significant number of systems requiring replacement or enhancement.
- The DOE-IAP architectures and implementation plan provide a sufficiently complete strategic view of DOE's business activities and shared corporate data requirements.
- To keep up the momentum of the DOE-IAP process, work should be started on detailed planning in order to implement development for the highest priority applications.
- Preliminary work, such as the updating of methodologies, can be initiated, even while further examination of the business functions and applications is undertaken and the Technology Architecture is completed.
- Starting these projects will initiate the implementation of specific DOE-IAP applications project recommendations and demonstrate top level support for the work done.

Implications

- This effort will have to be well planned and thoroughly coordinated with on-going systems development projects; methodologies will have to be reviewed and updated for consistency with the architectures.
- Additional examination of the business model and data architecture is required to define these products in greater detail.
- Sufficient human and financial resources will have to be committed.
- On-going or planned systems development projects will need to be reviewed to determine whether there are any significant conflicts with established architectures and priorities.

7. Complete the Technology Architecture, including preparing technology positions, for all technology elements required to support the business model, and data and applications architectures developed in DOE-IAP

Rationale

- The HIAP project found that there was a complex and diverse technology base in DOE, which tended to increase support costs and impair easy access to data.
- DOE-IAP developed a sound approach to preparing a Technology Architecture, which should be used as a "strawman" to complete the Technology Architecture.
- DOE-IAP resources, scope, and schedule did not permit as comprehensive and complete examination of the technology areas as is required to substantiate conclusions and recommendations.
- The preliminary analysis used to develop a taxonomy of Technical Architectural elements is a reasonable approach to follow to complete the technology architecture.

Implications

- A detailed plan, including funding requirements and schedules, needs to be prepared to conduct this work.

- It will be necessary to support a working group, including a broad representation of DOE business function experts as well as information technology specialists, to carry out this work.
- The Technology Architecture needs be consistent with the overall methodology used in DOE-IAP and support the Business Model, Data and Applications Architectures developed in the project.
- Specific guidelines to complete the Technology Architecture need to be established consistent with the DOE-IAP principles; suggested technology guidelines developed during the DOE-IAP project should be further examined for completeness.
- The 31 technology elements identified in DOE-IAP should be considered as strawmen for the preparation of this architecture; likewise, the 8 technology positioning statements for the system development environment should be used as strawmen for technology direction.
- Ongoing activities, such as the CIO's IT Infrastructure Vision effort and standards committees deliberations, should be coordinated with the Technology Architecture effort.

8. Develop a costed and scheduled technology deployment plan to implement the requirements implied by the Technology Architecture

Rationale

- All technology requirements must be viewed as a whole to assure completeness.
- A deployment plan is required to assure that technologies are in place when needed by the applications projects.
- When completed, this step will provide a prioritized description of technology projects, scheduled and costed, required to directly support the architected applications projects defined in other phases of the DOE-IAP project. This step will set the high level technical direction to guide specific product and vendor selection at a later time.
- The plan serves as the basis for analyzing the impact of possible changes in priorities and schedules.

Implications

- A complete information baseline of technologies currently in use needs to be prepared and maintained.
- The following candidate projects have been identified as required to establish a technology infrastructure. The need for these projects and others should be analyzed, and then implemented:
    - Corporate public key–data access system and digital signature capability
    - Virtual private network–user access control and data encryption capability
    - Seamless corporate communication environment–workflow collaboration and sharing capability
    - Logical data base management system environment–DOE-wide data dictionary development and database management infrastructure
    - CASE-based repository tools–configuration management system
    - Central management of basic application–basic technology infrastructure to support a common applications operating environment
    - Standardized application development environment–software tools evaluation and standardization process

Appendix 9

Comment of Business Area Representative

Comment from BAR

* I do not support including in the report the schedule and costs that are detailed in Appendix 8. I feel that they should not be included because people knowledgeable in how much it costs to develop corporate software have not reviewed them, and because the technology piece of the architecture has not been completed. The Office of Sciences' policy is that all large projects should undergo rigorous review by experts before asking for funds for the project, and this has not been done with the cost and schedule shown in Appendix 8. Also the cost of developing the applications will almost surely depend on the technologies used to create these applications and upon the technology/hardware that is used to run and deliver the applications to the user. For these reasons I feel that putting the cost and schedule numbers into the report was premature.

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