Guide to the (Evolving) Enterprise Architecture Body of Knowledge

Draft

6 February 2004

EABOK

A Project of The MITRE Corporation

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Not an official position of The MITRE Corporation

Draft Working Materials – There may be errors and inconsistencies in the materials herein

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Acknowledgement
Thanks to Frank Driscoll for championing the idea of a Guide to the EABOK and supporting the effort.

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Chapter 1

1. Introduction to the Guide[1]

Enterprise Architecture (EA) is a rapidly evolving but still immature discipline; however, there is considerable knowledge about the discipline available. Capturing and organizing that knowledge will help practitioners advance the discipline by both defining and bounding EA concepts and practices and help others by explaining and showing relationships among the elements of the discipline.

An EA describes how the elements of an organization fit together – the business processes, organizations responsible for them, Information Technology (IT) capabilities and infrastructure – today and in the future. The EA also describes how the elements transition to support the organization's strategic plans. Federal agencies are required to develop an EA to facilitate capital planning and IT development sequencing. In addition, the EA defines high level interoperability needs and specifies standards. It is a useful guide for technical developers.

Purpose of the Guide

The purpose of the Guide to the EA Body of Knowledge (EABOK) is to provide a characterization of and structure to the knowledge content of the EA discipline, promote a consistent view of EA, begin to bound the scope of the discipline, and place the EA discipline in the context of related disciplines. The guide provides topical access to the EABOK. It subdivides EA into knowledge areas and topics within each knowledge area, presents overviews of each topic, and gives references to sources of further information. The Guide to the EABOK is a guide, not the EA body of knowledge itself.

The reader may observe that some overviews are summaries of several specific methods or techniques. At the current level of maturity EA evolution, no definitive 'winner' of that particular area has yet emerged, but there are dominant contributors. Other overviews are more in-depth tutorials because suitable reference materials for the topic have not been developed. As the field matures and EA becomes more of an engineering discipline, a more even presentation of topic overviews will be provided.

Scope

The Guide to the EABOK addresses the purpose, creation, engineering, use, evaluation, and management of an EA and associated best practices, governance, legislation, and guidance. The guide also relates the EA to other disciplines. It does not address the implementation of the EA through the closely related discipline of Enterprise Engineering (EE) in this first edition.

[1] Revised January 28, 2004

Intended Audience

The guide is initially intended to serve MITRE in focusing corporate perspectives on EA to present consistent and cohesive guidance to our sponsors on the use and benefits of the discipline of EA. At a later date, the guide is intended to serve Government EA practitioners by providing an organized view of the EA discipline, identifying best practices, and pointing the reader to references with further information. The guide is also intended to serve the engineer and manager from other disciplines by providing an understanding of terms, overview of EA practices, and explanation of how EA fits with other disciplines. The guide is useful for teachers in defining course content and organizing EA presentations.

Organization of the Guide

There are many ways to decompose EA into a set of coherent knowledge areas, particularly for a new domain where all knowledge areas may not be recognized at this writing. This guide uses the following knowledge areas:

EA Charter and Context

Foundational practices and tools for EA development

Establishing and managing the EA program

Engineering the EA

Using the EA

Evaluating EA

Lessons learned and practical advice

Each of the knowledge areas is broken down into a set of topics. The topic breakdown does not assume a particular viewpoint, architecture approach, or philosophy. A write-up is presented for many of the topics in this first edition. References point the reader to further information on the topic at the end of the write-up. Some topics have references only at this writing.

The Knowledge Areas

Figure 1 shows the knowledge areas and topics associated with them. The following paragraphs discuss the topics within the knowledge areas.

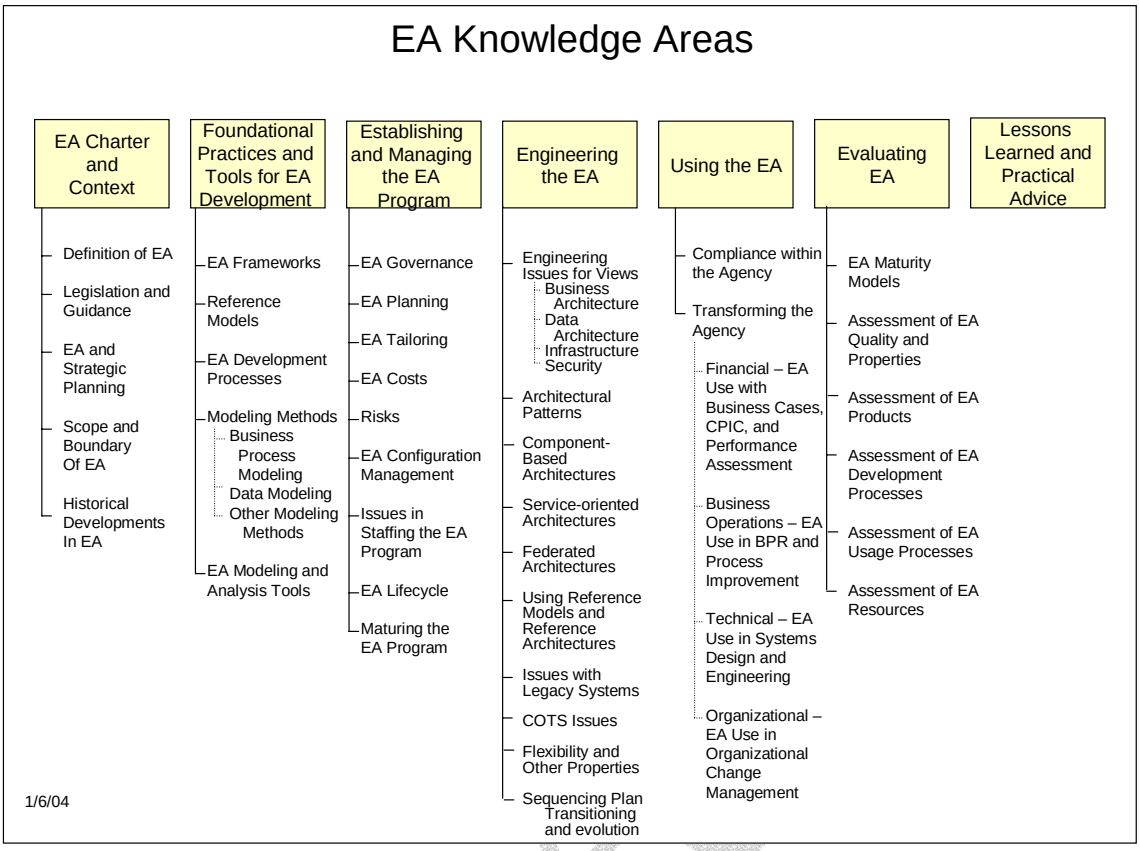

Figure 1. EA Knowledge Areas and their Associated Topics

EA Charter and Context

EA has been rapidly evolving since the early 1990s; the definition, scope, and guidance for EA have likewise evolved. This knowledge area covers the evolution of the definition of EA in Federal writings, legislation and guidance mandating agencies develop and use EAs, and how EA is intertwined with strategic planning. The knowledge area also covers the scope and bounds of EA with respect to other disciplines and some historical information on major developments leading to the current state of EA practice.

Foundational Practices and Tools for EA Development

An enterprise architect' repertoire includes a set of basic tools and practices that could apply at any agency or Service. Normally an agency does not use all of the practices and tools, but rather uses one of several options. The Foundational Practices and Tools knowledge area has five topics: EA frameworks, reference models and reference architectures, EA development processes, modeling methods, and EA modeling and analysis tools. An EA framework provides an organizational structure for the information to be covered in an EA. The topic write-up provides an overview of several widely known EA Frameworks. EA reference models and reference architectures provide a

standard or common categorization of the critical elements of the concept, process, or object being modeled and may serve as a point of departure for more detailed specification. They enable the comparison among various elements. The write-up provides an overview of the OMB Reference Models. Others will be added in a later edition. The topic write-up for EA development processes examines several sources of process information including the DOD Architecture Framework (DODAF), Steven Spewak's *Enterprise Architecture Planning*, the CIO Council's *A Practical Guide to tie Federal Enterprise Architecture,* and The Open Group's Architecture Development Method (ADM).

An EA normally includes models of the business processes, data, and infrastructure and a variety of modeling methods can be used to create them. Along with selecting modeling methods, the agency must select modeling and analysis tools. As commercial software packages, modeling software is being enhanced rapidly to support EA efforts. The topic presentation discusses issues in selecting EA tools and provides a list of selection criteria with references to recent comparison studies.

Establishing and Managing the EA Program

An EA Program, like other programs, needs policy, an organization structure, staff positions, approval boards, procedures, planning, funding, and other management attention. This knowledge area has nine topics directed at these and other subjects to make the EA Program a success. EA Governance addresses the policies, roles and responsibilities, processes, approval mechanisms, and other governance needed to establish and operate an EA Program. The topics also include planning; tailoring the EA project, processes, and products; costs and issues related to costs of establishing and maintaining the EA program; risks associates with the EA and possible mitigation strategies; and EA staffing issues. The EA and the enterprise capabilities its implementation changes must be placed under Configuration Management and EA lifecycle processes must be in place to keep the EA current and relevant. These two topics will be addressed in a future version of the guide. As an agency begins to establish an EA program, to conserve resources they want to separate those things that must be done first from those things that can be postponed for a time. The topic on maturing the EA Program provides advice based in government experience on how to simplify initial efforts and what to do later.

Engineering the EA

Developing a quality EA is not just a matter of using a framework and following a process. There are some engineering decisions to be made and tradeoffs to be considered. Which decisions are EA decisions and which decisions are systems engineering decisions is not always clear. How to incorporate security into the EA is increasingly important. The Engineering the EA knowledge area has ten topics that begin to address engineering issues in the EA. They include engineering issues in different views, including the business, data architecture, infrastructure, and security; architectural patterns; component-based architectures; service-oriented architectures; federated architectures;

using reference models and reference architectures; issues with legacy systems; COTS issues; flexibility and other properties need to incorporating new technology; and the sequencing plan, sometimes called the transition plan (Futures).

Using the EA

The EA is both a tool for executives, managers, and technical developers. Managers and executives use the EA to ensure investments and systems are linked to the mission and agency strategy. Executives and managers also use the EA for planning and sequencing acquisitions and making sure investments are effective and non redundant. Engineers use the EA to examine redundancy, consistency, integration, interoperability, and standardization issues and to look for 'good design'. The EA provides management visibility and control over investments while providing a shared vision of the future direction across the agency. This knowledge area has two topics, one with four sub-topics: Compliance within the Agency or Service and Transforming the Agency EA with sub-topics addressing financial practices using the EA with business cases and Capital Planning and Investment Control (CPIC), EA use in business process transformation, EA use for technical transformation through systems design and engineering, and EA organizational use in transformation of the Agency or Service (Future).

Evaluating EA

There has been considerable EA work and many products produced, and the quality and usefulness of that work needs to be evaluated. This knowledge area has six topics: EA maturity models, EA quality and properties, assessment of EA products (Future), assessment of the EA development processes (Future), assessment of EA usage processes (Future), and assessment of EA resources, staff, and capabilities (Future).

Lessons Learned and Practical Advice

This knowledge area condenses some of the EA experience and 'mis-experience' into succinct lessons learned. As this knowledge area grows, it will be subdivided into topics such as making transformation more efficient, on the selection of modeling tools, managing the team and subcontractor, or designs to avoid.

Appendices

Appendix A provides a glossary of EA-related terms.

References

Guide to the Software Engineering Body of Knowledge Trial Version SWEBOK, James W. Moore, editor, IEEE Computer Society, May 2001.

Guide to the Program Management Body of Knowledge (PMBOK), Project Management Institute,
http://www.pmi.org/prod/groups/public/documents/info/pp_pmbok2000welcome.asp

Configuration Management Body of Knowledge - http://www.cmcrossroads.com/cgi-bin/cmwiki/bin/view.cgi/CM/CMBoK

Chapter 2

2. EA Charter and Context

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2.1 Evolution of the Definition of Enterprise Architecture[2]

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The definition of Enterprise Architecture (EA) has evolved over several years. The E-Government Act of 2002 (Public Law (PL) 107-347) states that *Enterprise Architecture*

"(A) means -

(i) a strategic information asset base, which defines the mission;
(ii) the information necessary to perform the mission;
(iii) the technologies necessary to perform the mission; and
(iv) the transitional processes for implementing new technologies in response to changing needs; and

(B) includes -

(i) a baseline architecture;
(ii) a target architecture; and
(iii) a sequencing plan".

[2] Revised January 19, 2004

This definition draws on terms used elsewhere in Federal EA writings. The following paragraphs trace the evolution of the definition of EA and show the source and meaning given to the terms in those sources.

Webster's Dictionary associates the word architecture with the concepts of 'the science, art, or profession of designing and constructing…., a style of construction, … any framework, system, etc., and the design and interaction of components …'.

In April 1995, Garlan and Perry cited a definition of software architecture developed in group discussion at the Software Engineering Institute (SEI) as

> *The structure of the components of a program/system, their interrelationships, and principles and guidelines governing their design and evolution over time.*

IEEE built on this definition in its *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems* (STD 1471-2000). The emphasis on components, relationships, principles, and guidelines has continued to characterize architecture work.

The 1996 Clinger Cohen Act (CCA) (PL 104-106) requires agencies to have an Information Technology Architecture which, "with respect to an executive agency, means an integrated framework[3] for evolving or maintaining information technology and acquiring new information technology to achieve the agency's strategic goals and information resources management goals" (CCA Section 5125). The CCA Information Technology Architecture concept was expanded to an EA which includes the description of the business processes in OMB A-130 guidance.

The 1999 *Federal Enterprise Architecture Framework* (FEAF) describes the FEAF itself, an architecture framework, as an organizing mechanism for managing the development and maintenance of architecture descriptions. It provides a structure for organizing Federal resources and describing and managing the Federal Enterprise Architecture[4] activities. The FEAF introduces the term *strategic information asset base*; it describes the Federal Enterprise Architecture as a 'strategic information asset base that defines the business, information necessary to operate the business, technologies necessary to support the business operations, and transitional processes for implementing new technologies in response to the changing needs of the business' (FEAF p 2).

The November 2000 version of OMB Circular A-130: *Management of Federal Information Resources* describes an Enterprise Architecture as the explicit description and documentation of the current and desired relationships among business and

[3] The choice of the word 'framework' reflected one aspect of the dictionary definition of architecture, but overlayed the term within the EA field, confusing it with the concept of an architecture framework such as that already published by Zachman as an organizing structure for architecture information rather than the architecture itself.

[4] The FEAF reference to a Federal Enterprise Architecture should not be confused with the OMB Reference Model reference to a Federal Enterprise Architecture. See the description of the FEAF under Frameworks and the OMB Reference Model sections for a fuller explanation.

management processes and information technology. It describes the current and target architectures, and includes the rules, standards, and systems lifecycle information to optimize and maintain the environment which the agency wishes to create and maintain by managing its Information Technology (IT) portfolio. The EA must also provide a strategy that will enable the agency to support its current state and also act as the roadmap for transition to its target environment. The *transition processes* will include agency capital planning and investment control processes, agency EA planning processes, and agency systems lifecycle methodologies. The EA will define principles and goals and set direction on such issues as the promotion of interoperability, open systems, public access, compliance with the Government Paperwork Elimination Act (GPEA) (PL 105-277), end user satisfaction, and IT security. In the creation of an EA, agencies must identify and document business processes, information flow and relationships, applications, data descriptions and relationships, and technology infrastructure and include a technical reference model and standards profile.

The 2001 *A Practical Guide to the Federal Enterprise Architecture* (Practical Guide) built on the definitions in the FEAF and OMB A-130 to define an EA as "a strategic information asset base, which defines the mission, the information necessary to perform the mission and the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs. An enterprise architecture includes a baseline architecture, target architecture, and a sequencing plan (p 5)". At the same time, the Practical Guide defines an architecture as "the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time (p 5)".

The Practical Guide describes a *baseline architecture* as the set of products that portray the existing enterprise, the current business practices, and the technical infrastructure. It is commonly referred to as the 'As-Is' or current architecture. The *target architecture* is the set of products that portray the future or end-state enterprise, generally captured in the organization's strategic thinking and plans. It is commonly referred to as the 'To-Be' architecture. The *architecture products* are the graphics, models, and/or narrative that depict the enterprise environment and design. The *Sequencing Plan* is a document that defines the strategy for changing the enterprise from the current baseline to the target architecture. It schedules multiple, concurrent, interdependent activities, and incremental builds that will evolve the enterprise.

The EA is distinct from an EA framework, though the two are sometimes confused. A framework is a logical structure for classifying and organizing complex information.[5] An *enterprise architecture framework* provides an organizing structure for the information contained in and describing an EA. The framework does not contain the EA itself. Many organizations can use the same EA framework, but each EA with its content is organization-specific.

Today, there is general agreement that, at a minimum, the EA includes models of business practices or processes, data, computing systems for mission-related and business

[5] From the Practical Guide to the Federal Enterprise Architecture

support, networks and other technology infrastructure, for both the baseline, or current, and target architectures; several source also include the organization structure. The EA includes a standards profile, security considerations, and a sequencing plan, sometimes called a transition plan; is linked to agency strategic plans; and is a major basis for investment decisions. Figure 1 shows the elements on an EA.

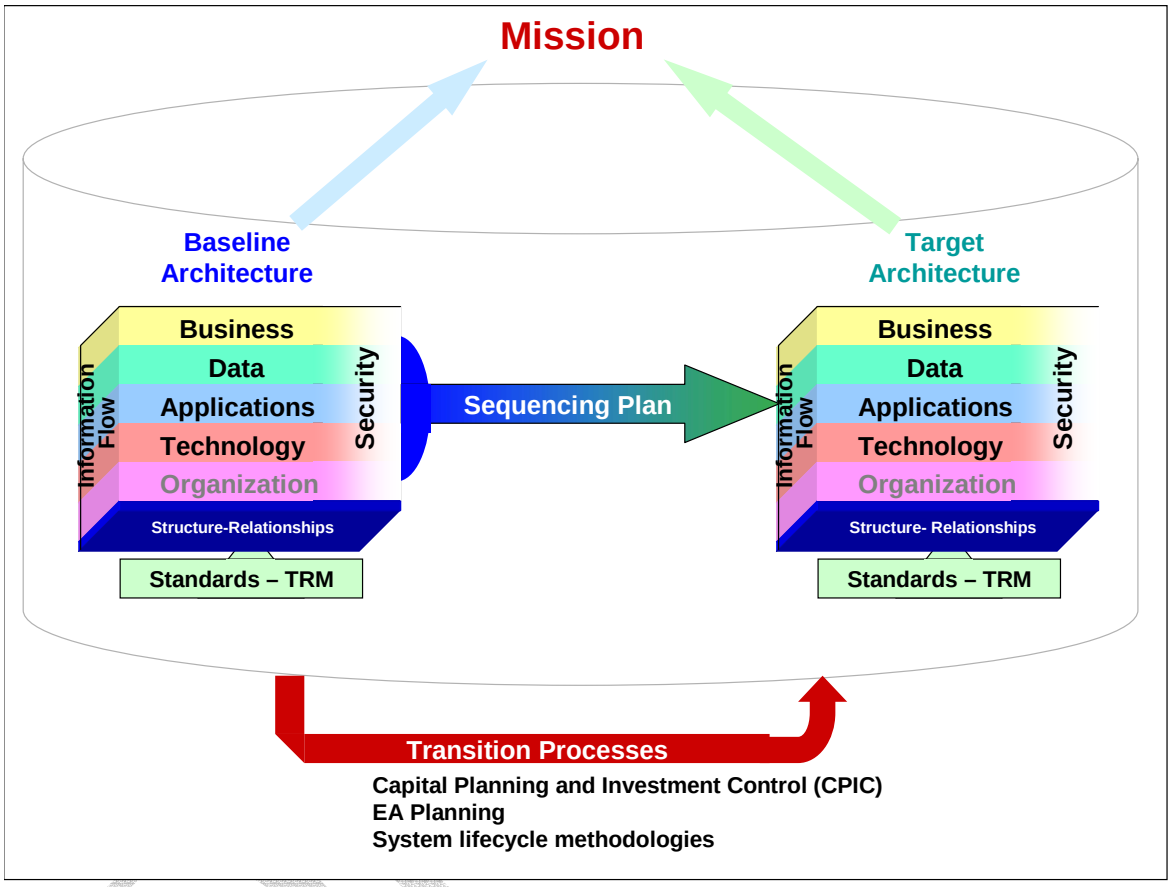

Figure 1. Elements of an Enterprise Architecture

The agency achieves its target architecture by:

- Managing its investment portfolio to invest in projects that implement the agency strategy in accordance with the sequencing plan,
- Enforcing the EA through its Configuration Management (CM) boards,
- Managing the delivery of capabilities identified in the EA through its Systems/Software Development Life Cycle (SDLC) and Capital Planning and Investment Control (CPIC) processes, and
- Evaluating the result of its delivered capabilities through its CPIC processes.

The agency continually updates its EA through its EA planning processes.

Editorial Comment

Architects and planners should keep in mind the descriptive communication, planning, engineering, and management value of the EA when defining it for their intentions.

One might try to make a distinction between an EA as a description and an EA as an information asset base. A description calls for something to be pictured with words. As an architecture, an EA is usually pictured with models and words describing the models. These models are best captured electronically with searchable, analyzable data available from them, but the word descriptions should not be lost. As an information asset base, one might be tempted to think of the EA as only a (relational) database and omit the descriptive and graphical aspects of the architecture. To serve EA users well, the EA must be viewed as a strategic information asset base with models, text descriptions, and relationships available in both electronic and human readable form.

References

Clinger Cohen Act of 1996 (PL 104-106) - Legislation can be found by law number on http://thomas.loc.gov/

E-Government Act of 2002 (PL 107-347) - Legislation can be found by law number on http://thomas.loc.gov/

OMB Circular A-130: Management of Federal Information Resources, November 30, 2000. http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html

Federal Enterprise Architecture Framework (FEAF) Version 1.1, Chief Information Officers Council, September 1999. http://www.cio.gov/documents/fedarch1.pdf

A Practical Guide to Federal Enterprise Architecture, Version 1.0, Chief Information Officers Council, February 2001. http://www.cio.gov/documents/bpeaguide.pdf

IEEE Recommended Practice for Architectural Description of Software-Intensive Systems, IEEE Standard 1471-2000. http://ieeexplore.ieee.org .

Webster's New World Dictionary of American English, Third College Edition, Victoria Neufeldt editor, New York: Simon and Schuster, Inc., 1988.

Garlin and Perry, Guest Editorial, *IEEE Transactions on Software Engineering* Vol 21 No 4 (April).

2.2 EA Legislation and Guidance[6]

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The Federal government has been passing legislation and providing guidance to agencies and Services to improve management and financial accountability for over a decade. Using an Enterprise Architecture (EA) to identify needs, plan investments, establish transition strategies, and guide development is a mechanism to improve management and financial accountability. The following sections outline how direction on EA has evolved through legislation, Office of Management and Budget (OMB) direction, and Chief Information Officers (CIO) Council guidance. The material covers only items at the Federal level, not DoD, Service, or Agency-specific direction.

2.2.1 The Evolution of EA-Related Legislation

Developing and using an EA is directed at improving the management, planning, investment, and technology capabilities of an enterprise. To improve the management and planning of government agencies, the Government Performance and Results Act (**GPRA**) of 1993 requires each agency to develop and submit to OMB a five year strategic plan stating the mission, goals, and objectives for its major functions and operations and a description of how they will be achieved. The detailed requirements for the strategic plan are addressed in OMB Circular A-11. The strategic plan is essential to developing a target enterprise architecture; it provides the vision and goals for major agency functions and operations which the target architecture must support. The GPRA required performance plan identifies performance indicators to measure outputs, service levels, and outcomes which the architecture must support.

The planning emphasis continued in the Paperwork Reduction Act **(PRA)** of 1995 (Public Law (PL) 104-13, May 22, 1995, 44 United States Code (USC) 3501 et seq.). It requires an Information Resources Management (IRM) strategic plan that describes how IRM activities help accomplish the agency mission and links to the strategic plan required by GPRA. The PRA also began the emphasis on integrated decision making by requiring integration of Information Technology (IT) management operations and decisions with organizational planning, budget, financial management, Human Resources (HR), and program decisions. It introduced the Select, Control, Evaluate terminology that eventually matured into the Capital Planning and Investment Control Process (CPIC) later described in OMB Circular A-130. The PRA also called for reducing the burden on the public.

[6] Revised January 25, 2004

the Clinger-Cohen Act (**CCA**) of 1996 (PL 104-106) (part of which is called the Information Technology Management Reform Act (ITMRA)), mandates an Information Technology Architecture integrated framework[7] for evolving or maintaining existing information technology and acquiring new information technology to achieve the agency's strategic and information resources management goals. The Chief Information Officer (CIO) is responsible for its development, maintenance, and facilitation. The CCA also calls for a capital planning process, process benchmarking, process revision (i.e., Business Process Reengineering (BPR)) before investing in Information Technology (IT), modular contracting, and adequate security practices.

At the same time the Federal government was improving its management processes and investment practices, it was also defining characteristics of the interactions it wanted available for citizens and the operation of its technology systems. The 1998 Government Paperwork Elimination Act (**GPEA)** (PL 105-277, October 21, 1998) (Title 17, section 1701 FF (1710)) requires Federal agencies to provide individuals or entities that deal with the agencies the option to submit information or transact with the agency electronically, and to maintain records electronically, when practicable. The Act encourages Federal government use of a range of electronic signature alternatives.

The **E-Government Act of 2002** (PL 107-347, Dec 17, 2002) continues the emphasis on electronic interaction with the government. It calls for maintaining and promoting an integrated Internet-based system for providing the Public access to government information and services, provides funding for digital signature certification, and addresses information security, privacy, and disclosure issues. It requires each agency to have a publicly accessible web site with prescribed content. It also establishes the OMB Office of Electronic Government to oversee the implementation of electronic government, oversee the development of enterprise architectures within and across agencies (Section 3602 (14)), and lead the activities of the CIO Council. It establishes the Interagency Committee on Government Information to submit recommendations for standards to enable the organization and categorization of government information in ways to be electronically searchable and interoperable across agencies. It requires a continuity of operations plan (COOP) and an inventory of major information systems and their system and network interfaces. The E-Government Act of 2002 also contains a definition of EA as a strategic information asset base with a baseline architecture, target architecture, and sequencing plan. This definition is similar to the definition in the Practical Guide to the Federal Enterprise Architecture.

Other legislation that requires capabilities in Federal agencies includes:

- Freedom of Information Act (**FOIA**) (5 United States Code (USC) 552) calls for public access to agency records to the greatest extent possible unless protected or exempted.

[7] See the comments on the definition of EA for a clarification of the term framework in the context of EA.

- Computer Security Act of 1987 (40 USC 1441) (PL 100-235) requires Federal agencies to identify and afford security protections commensurate with risk and harm.

- Government Information Security Reform Act (**GISRA**) (PL 106-398) requires efforts to secure electronic information and systems, including the integrity, confidentiality, authenticity, availability, and non repudiation of information and information systems and to assess their security management practices.

- Federal Information Security Management Act of 2002 (**FISMA**) - Future

- Cyber Security Act of 2002 - Future

2.2.2 United States Code Sections Relevant to EA

After legislation is passed, it is added to sections of the United States Code. Some of the sections relevant to EA include Title 40 Chapter 25 on Information Technology Management which describes policies, responsibilities, and other aspects of IT management. It codifies many elements for the PRA and CCA.

CIO responsibilities are described in Title 44 Sec. 3506 and Title 40 Sec 1425.
Title 40 Sec 1425 (b) (2) codifies the CIO responsibility for developing, maintaining, and facilitating a sound and integrated enterprise architecture.

2.2.3 Refining EA Guidance through OMB Circulars

2.2.3.1 Required EA Content - OMB A-130

The CCA and other legislation and guidance were expanded upon in Office of Management and Budget (OMB) Circular A-130: Management of Federal Information Resources (November 2000). A-130 describes the required content of an Enterprise Architecture which must be submitted to OMB. The EA is the explicit description and documentation of the current and desired relationships among business and management processes and information technology. In the EA, agencies must identify and document business processes, information flow and relationships, applications, data descriptions and relationships, and technology infrastructure, among other things. The EA must provide a strategy that will enable the agency to support its current state and transition to its target state.

OMB A-130 also describes the select, control, and evaluate components of a Capital Planning and Investment Control (CPIC) process, how agencies will ensure security in information systems, and how agencies will acquire information systems. See Chapter 6 for more information on CPIC. *NOTE – OMB A-130 is being revised at this writing.*

2.2.3.2 Relating Business Cases to EA in Budget Submissions - OMB Circular A-11

OMB Circular A-11: Preparation, Submission and Execution of the Budget (Revised 05/27/2003) requires agency Capital Asset Plans (Exhibit 300 business cases) to be mapped against the OMB reference models (See Chapter 3 for a description of the OMB Reference Models.). In 2002, the Exhibit 300 had to be related to only the Business Reference Model (BRM). Mappings to other models are now required since more reference models have been published. The reader should check the latest A-11 guidance for details.

2.2.3.3 OMB A-76 Performance of Commercial Activities

OMB A-76: Performance of Commercial Activities should be addressed in the scope and content of governance and performance sections of an EA to reflect the basic differences between internally operated systems and outsourced managed services.

2.2.4 EA Guidance from the CIO Council

2.2.4.1 An EA Framework - The Federal Enterprise Architecture Framework

In September 1999, the Federal CIO Council published the *Federal Enterprise Architecture Framework* (FEAF) Version 1.1 to "promote shared development for common Federal processes, interoperability, and sharing of information among the agencies of the Federal Government and other Governmental agencies." It "consists of various approaches, models, and definitions for communicating the overall organization and relationship of architecture components required for maintaining a Federal Enterprise Architecture."

2.2.4.2 EA Development Process and Governance – A Practical Guide to Federal Enterprise Architecture

The Federal CIO Council sponsored the publication of *A Practical Guide to Federal Enterprise Architecture* in February 2001 to provide 'a step-by-step guide to assist agencies in defining, maintaining, and implementing EAs by providing a disciplined and rigorous approach to EA lifecycle management. It describes major EA program management areas, beginning with suggested organizational structure and management controls, a process for development of baseline and target architectures, and development of a sequencing plan. The guide also describes EA maintenance and implementation, as well as oversight and control.[8]' More detail on the Practical Guide processes are presented in the section on EA development processes in Chapter 3.

2.2.4.3 EA and CPIC - Architecture Alignment and Assessment Guide

[8] From the Preface to *A Practical Guide to Federal Enterprise Architecture*

The *Architecture Assessment and Alignment Guide* (AAAG) was published by the CIO Council in October 2000 to provide agencies an overview of the integration of enterprise architecture with the CPIC process. The CPIC process ensures an agency follows its EA once it is approved. The AAAG identifies touchpoints between the EA and CPIC and describes a U.S. Customs Service prototype to demonstrate and document the need for an integrated architecture and investment process. The AAAG also provides an example 2 X 2 matrix that relates organizational goals with project requirements.

References

Legislation can be found by law number on http://thomas.loc.gov/

The United States Code (USC) can be searched at http://uscode.house.gov/usc.htm or located through http://www.access.gpo.gov/congress/cong013.html. It is also available at the Government Printing Office.

OMB Circular A-11: Preparation, Submission and Execution of the Budget (Revised May 27, 2003) http://www.whitehouse.gov/omb/circulars/a11/02toc.html

OMB Circular A-76: Performance of Commercial Activities, May 29, 2003 http://www.whitehouse.gov/omb/circulars/a076/a76_rev2003.pdf

OMB Circular A-130: Management of Federal Information Resources, November 30, 2000 http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html

Federal Enterprise Architecture Framework (FEAF) Version 1.1, Chief Information Officers Council, September 1999. http://www.cio.gov/documents/fedarch1.pdf

Architecture Alignment and Assessment Guide, Chief Information Officers Council, October 2000. http://www.cio.gov/documents/arch_align_assess_oct_2000.pdf

A Practical Guide to the Federal Enterprise Architecture, Version 1.0, Chief Information Officers Council, February 2001. http://www.cio.gov/documents/bpeaguide.pdf

2.3 The Enterprise Architecture Is a Strategic Management Tool

MITRE Internal Draft

2.4 Boundaries of EA and Relationship to Other Disciplines

MITRE Internal Draft

2.5 Historical Developments in EA[9]

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Enterprise Architecture (EA) contributions have come from many sources through commercial, Federal, state, and local government efforts. The contributions provided guidance that motivated the need for EA, structures to organize EA information, and processes to develop an EA. They shaped the description and improved the utility of the EA. Today, EA efforts are moving toward compliance issues, evaluation, and use of the EA. Figure 1 shows some major contributions to the field.

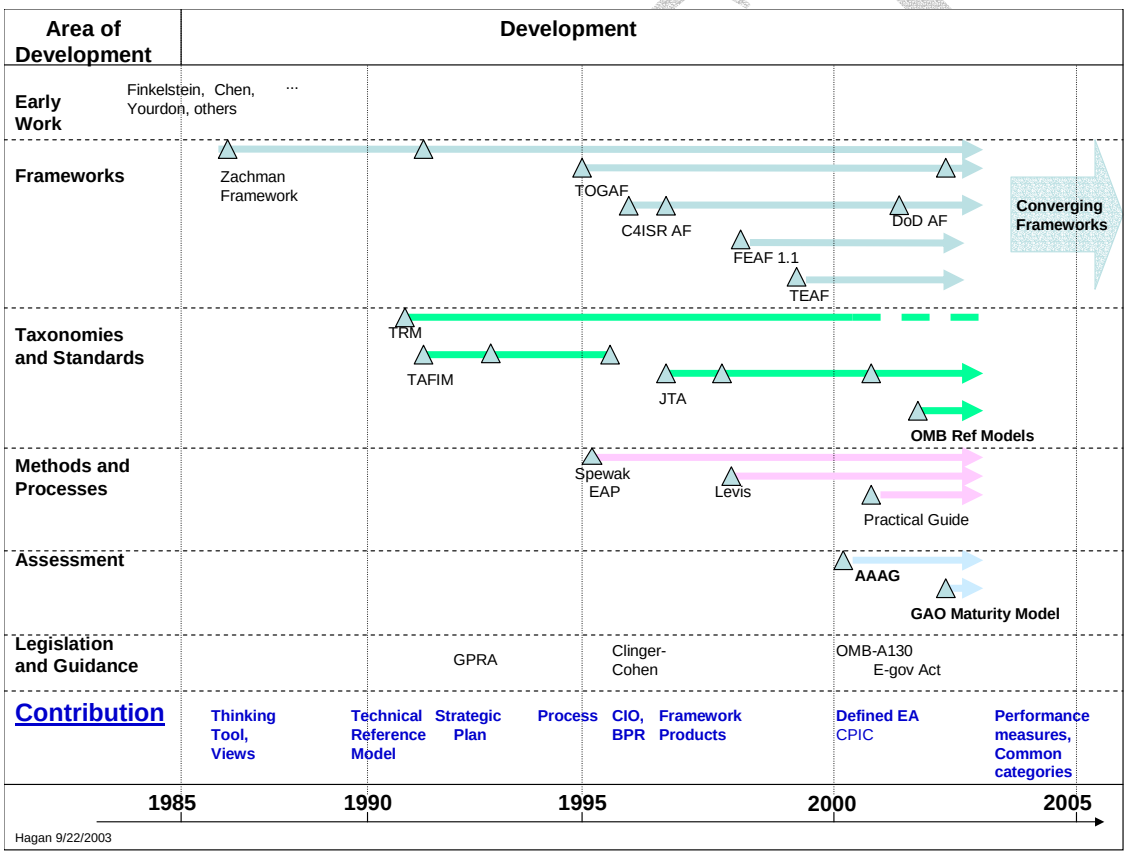

Figure 1. Major Developments in the History of EA

Clive Finkelstine's development of Information Engineering in 1976 was designed to address the growing problem of data redundancy. Data modeling techniques and system analysis and design methods expanded in the 1970s and 1980s with Peter Chen's Enterprise Relationship (E-R) diagrams, Yourdon's structured analysis and design, and

[9] Revised January 25, 2004

others. Finkelstein states that business driven information engineering had evolved into Enterprise Engineering by 1986[10].

Zachman first published his EA Framework as an Information Systems Architecture Framework in 1987 and republished a revision of it as an Enterprise Architecture (EA) framework in 1992. The Zachman EA framework provides structure for EA information and serves as a thinking tool on what to consider and how to organize EA information. Steven Spewak published his *Enterprise Architecture Planning* text in 1995 (possibly 1993 in informal versions). The text describes a process, information to collect, and other advice to develop an EA based on the Zachman Framework.

In the early 1990s, DOD was addressing interoperability issues that emerged in the 1991 Gulf War. The Technical Architecture Framework for Information Management (TAFIM), begun in 1992, was an effort to provide guidance for the evolution of the DoD technical infrastructure. It did not provide a specific system architecture, but rather provided the services, standards, design concepts, components, and configurations that could be used to guide the development of technical architectures that meet mission specific requirements. The TAFIM is now superceded by other documents including the Joint Technical Architecture (JTA).

The Open Group, an international vendor and technology-neutral consortium, developed The Open Group Architectural Framework (TOGAF) Version 1 in 1995 based on the TAFIM. The TOGAF supports building business, applications, data, and technology architectures, has an architecture development Method (ADM), a Technical Reference Model that provides a taxonomy of generic platform services, and a Standards Information Base (SIB) - a database of open industry standards.

The DoD developed the *Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconniassance (C4ISR) Architecture Framework* (first published in 1996) to provide direction to contractors and agencies on how to document system architectures to allow comparability and promote interoperability across systems, projects, and Services. It has been revised several times and is now called the *DOD Architecture Framework* (DODAF). It is often adapted for EA descriptions. Alexander Levis of George Mason University developed a process to produce architecture descriptions according to the C4ISR framework. Several Services now have their own processes.

DoD recognized the need for information to flow quickly and seamlessly among DoD sensors, processing and command centers, shooters, and support activities and the need for standards across the supporting systems. The DoD developed the *Joint Technical Architecture* (JTA) in 1997 to provide the minimum set of standards that, when implemented, facilitates the flow of information in support of the warfighter.

In the 1990s, Congress passed several pieces of legislation aimed at improving government management and performance. The Government Performance and Results

[10] Finkelstein, *Building Corporate Portals with XML*, p 34

Act (GPRA) required agencies to develop five year strategic plans and report on their performance annually. The Clinger Cohen Act (CCA) required the position of a Chief Information Officer (CIO) and gave the CIO responsibility for an Information Technology Architecture for the agency. The CCA also called for a capital planning process, benchmarking, and revision of a process before investing in IT.

As agencies began to create their Information Technology Architectures, the need for guidance was recognized. The CIO Council sponsored the development of the *Federal Enterprise Architecture Framework* (FEAF) (1999) to provide a framework based on the Zachman Framework and *A Practical Guide to the Federal Enterprise Architecture* (2001) to provide advice on setting up an EA program and a process for developing and maintaining the EA.

OMB published OMB Circular A-130: Management of Federal Information Resources in November of 2000 amplifying CCA guidance. It defined the required content of an EA, described elements of a Capital Planning and Investment Control (CPIC) process required by the CCA, and discussed how agencies will ensure the security in information systems.

Several agencies developed their own EA frameworks between 1998 and 2001, notably the Department of the Treasury. The *Treasury EA Framework* (TEAF) combined concepts from the Zachman-oriented FEAF and the C4ISR Architecture Framework, including many C4ISR-like products for architecture description.

GAO developed an EA Maturity Model to gauge the progress agencies were making with their EA processes in 2002.

Despite all these EA efforts, in 2002 the Government still did not have a government-wide EA on which to build its E-Gov initiatives. Therefore, OMB began to build the Federal Enterprise Architecture through five OMB Reference Models: the Business Reference Model (BRM), Performance Reference Model (PRM), Service Component Reference Model (SRM), Data Reference Model (DRM), and Technical Reference Model (TRM). These models facilitate identification of related business functions, services, and standards across the Federal government. Equally importantly, the models are aimed at developing common performance measures.

EA as a discipline is in its early years with the emphasis beginning to move from frameworks, modeling methods, and tools to compliance and performance issues. The future is likely to emphasize EA best practices, EA assessment, and effective use of the EA to improve government management.

References

Finkelstein, Clive, and Aiken, Peter, *Building Corporate Portals with XML*, New York: McGraw-Hill, 2000.

Zachman, J.A., "A Framework for Information Systems Architecture", IBM Systems Journal Vol 26, No 3, 1987.

Zachman, J.A., and Sowa, J.F., "Extending and Formalizing the Framework for Information Systems Architecture", IBM Systems Journal, Vol 31, No 3, 1992

Spewak, Steven H., *Enterprise Architecture Planning*, New York: John Wiley and Sons (Copyright approximately 1993)

Levis, A., and L. Wagenhals, C4ISR Architectures I: Developing a Process for C4ISR Architecture Design, **To be published**, Systems Engineering, Vol. 3, No. 4, Fall 2000.

Office of Management and Budget, Circular No. A-130, Management of Federal Information Resources, November 30, 2002.

Joint Technical Architecture (JTA) http://www-jta.itsi.disa.mil/

DoD Architecture Framework Version 1.0 (Draft) http://aitc.aitcnet.org/dodfw

Federal Enterprise Architecture Framework (FEAF) Version 1.1, CIO Council, September 1999.

Treasury Enterprise Architecture Framework (TEAF) Version 1, Department of the Treasury Chief Information Officer Council, July 2000.

Technical Architecture Framework for Information Management (TAFIM) http://www-library.itsi.disa.mil/tafim/tafim3.0/pages/word.htm
http://www2.umassd.edu/swarchresearch/tafim/v4.pdf

The Open Group Architecture Framework (TOGAF):
http://www.opengroup.org/architecture/

A Practical Guide to the Federal Enterprise Architecture, Version 1.0, Chief Information Officers Council, February 2001. http://www.cio.gov/documents/bpeaguide.pdf

The FEA Program Management Office published the OMB Reference Models. Official versions of the Reference Model descriptions can be found on the FEAPMO Web site.
http://www.feapmo.gov

A Framework for Assessing and Improving Enterprise Architecture Management (Version 1.1) GAO-03-584G, United States General Accounting Office, April 2003.
http://www.gao.gov/ - *Contains a description of the GAO Five Stage EA Maturity Framework. NOTE – A Version 2 has been published.*

Chapter 3

3. Foundational Practices and Tools for EA Development

Developing an EA requires several key decisions in the planning process. The organization and documentation of the information to collect must be determined. The processes to use to collect, present, and market the EA must be established. The modeling methods and tools must be selected. The reference models to be related to must be determined. A team must be established. The architect draws on EA frameworks, processes, and tools that are available to all EA practitioners and tailors them to his organization's needs. Before EA project planning or management is well under way, the architect and planners should be generally familiar with the choices available and what they can contribute. The following sections provide an overview of the major EA frameworks, reference models and reference architectures, processes to develop the EA, modeling choices, and modeling tools.

Table of Contents

3.1 Enterprise Architecture Frameworks[11]

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3.1.1 What is an Enterprise Architecture Framework?

An *enterprise architecture framework*

- Identifies the types of information needed to portray an Enterprise Architecture (EA),
- Organizes the types of information into a logical structure, and
- Describes the relationships among the information types.

Often the information is categorized into architecture models and viewpoints.

This categorization of EA information facilitates thinking about the architecture and how the information fits together. The EA framework can also identify the product types, sometimes called models, needed to describe the EA and show how to portray linkages between different types of EA information such as mission needs, business processes, data, and IT capabilities. This helps structure and mange the development of the EA. Using predetermined EA product descriptions speeds the architecture development process. Using the same framework and product types across different but related EAs increases the comparability of the EAs and facilitates communications among the architects, planners, and developers working with the different EAs. The EA Framework is not the EA itself, but rather tells how to organize and describe the EA.

Based on the required information content of an EA (See Chapter 2 on definition of EA), an EA framework should, at a minimum, organize information types and describe the relationships between business processes, data, IT mission systems, and IT infrastructure used to perform the enterprise mission and planned to achieve the future strategy of the enterprise. The framework should also address standards, security, relating the EA to the corporate strategy and objectives, and the sequencing plan/transition strategy to move from the baseline architecture to the target architecture. Since an EA has many different users, the EA framework may also address what types of information are appropriate for different user viewpoints. Some frameworks also address repository needs or provide guidance on processes, governance, or Configuration Management. Most frameworks do not prescribe a modeling methodology, analytical methods, or tools.

The November 2000 version of OMB Circular A-130 required the use of an EA framework to develop an agency EA. With the advent of the OMB reference models, there is a trend in some circles to eliminate or minimize the importance of frameworks.

[11] Revised January 31, 2004

Two frameworks, the Federal Enterprise Architecture Framework (FEAF) and the Treasury Enterprise Architecture Framework (TEAF) are not actively supported at this time. Nevertheless, the following discussion includes these frameworks because of their contribution to the EA field. The following sections contain a brief overview of major frameworks. Table 1 provides a comparison of characteristics of several frameworks. The references point the reader to further information.

3.1.2 The Zachman EA Framework – Foundational Ideas

Foundational thinking for many EA frameworks came from John Zachman's framework for information systems architecture first published in 1987 when Zachman was working at IBM. Zachman has evolved it over time into an EA framework. His EA Framework is organized as a 'schema'[12] of six columns and five rows. The columns are based on the six interrogatives what, how, where, who, when, and why leading to column titles of data, function, network, people, time, and motivation. The five rows represent the views of users of the EA - the planner, owner, designer, builder, and subcontractor. (See Figure 1.) Zachman sees each cell as independent single variables – normalized in relational database thinking; data should be treated independently of function and independent of network location to allow clarity of thinking and flexibility. Zachman uses the term primitive as opposed to composite to describe the independent single variables. A composite might combine information from several cells such as data and business function or network location. Within a cell, information might be at a high level or, as Zachman would say, at 'an excruciating level of detail', e.g., 10 high-level processes summarizing corporate functions at the owner level, or 200 processes detailing corporate functions in the owner level.

[12] Zachman prefers the term schema instead of matrix

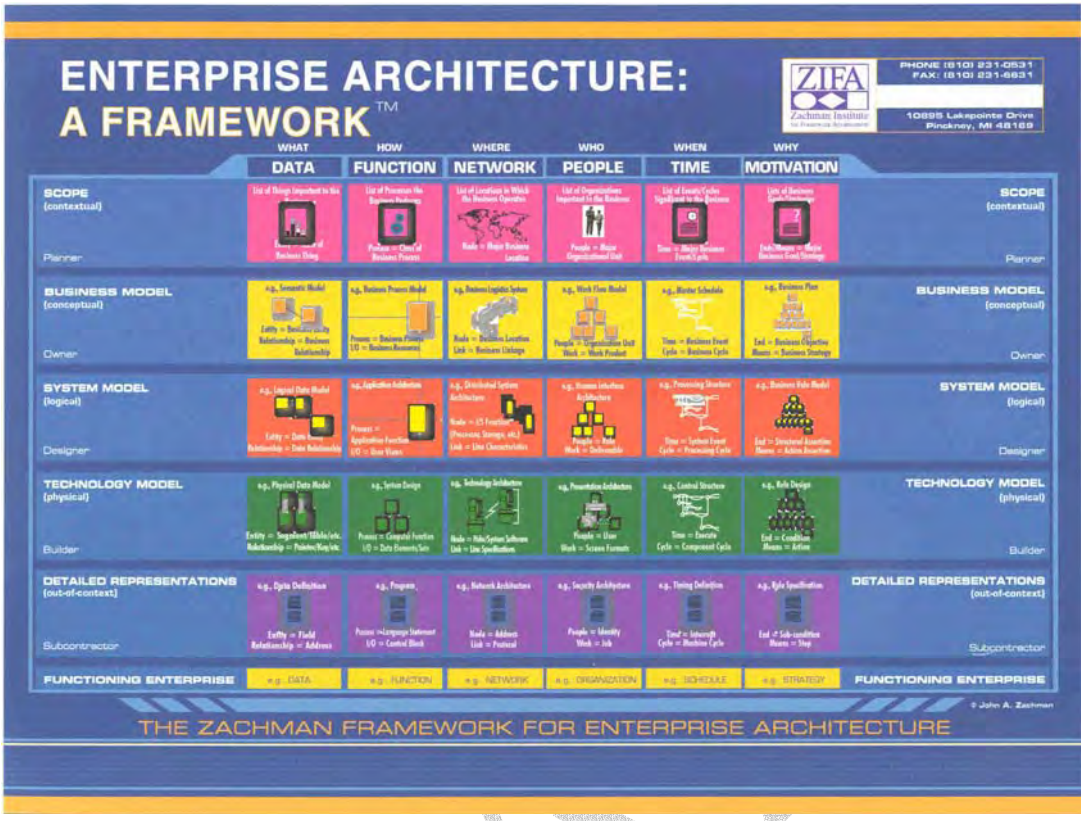

Figure 1. The Zachman EA Framework[13]

While Zachman states that each cell has different models and constraints, no product specifications are provided, only 'for example' descriptions of what is in each cell. The framework also provides no direction on security (Zachman has published a note on security, but it does not contain substantive detail.) There is no discussion of standards, principles, transition strategy, or repositories. The motivation column could be construed to incorporate agency strategic vision and plans. Some columns of the framework are not as well developed as others, for example, time and motivation. The framework is methodology and tool independent.

Zachman has expanded on his original thinking and recognizes that each cell has relationships to other cells in the same row as shown in Figure 2. Data could be used in a function, transmitted between locations, or produced by a particular organization. That information could be presented in a matrix.

Today Zachman sees his framework as a thinking tool. It helps the architect and manager isolate issues and sort out what needs to be addressed. The Zachman EA Framework has contributed to the organization of several later frameworks and much architectural thinking.

[13] The Zachman EA Framework diagram is available at http://www.zifa.com

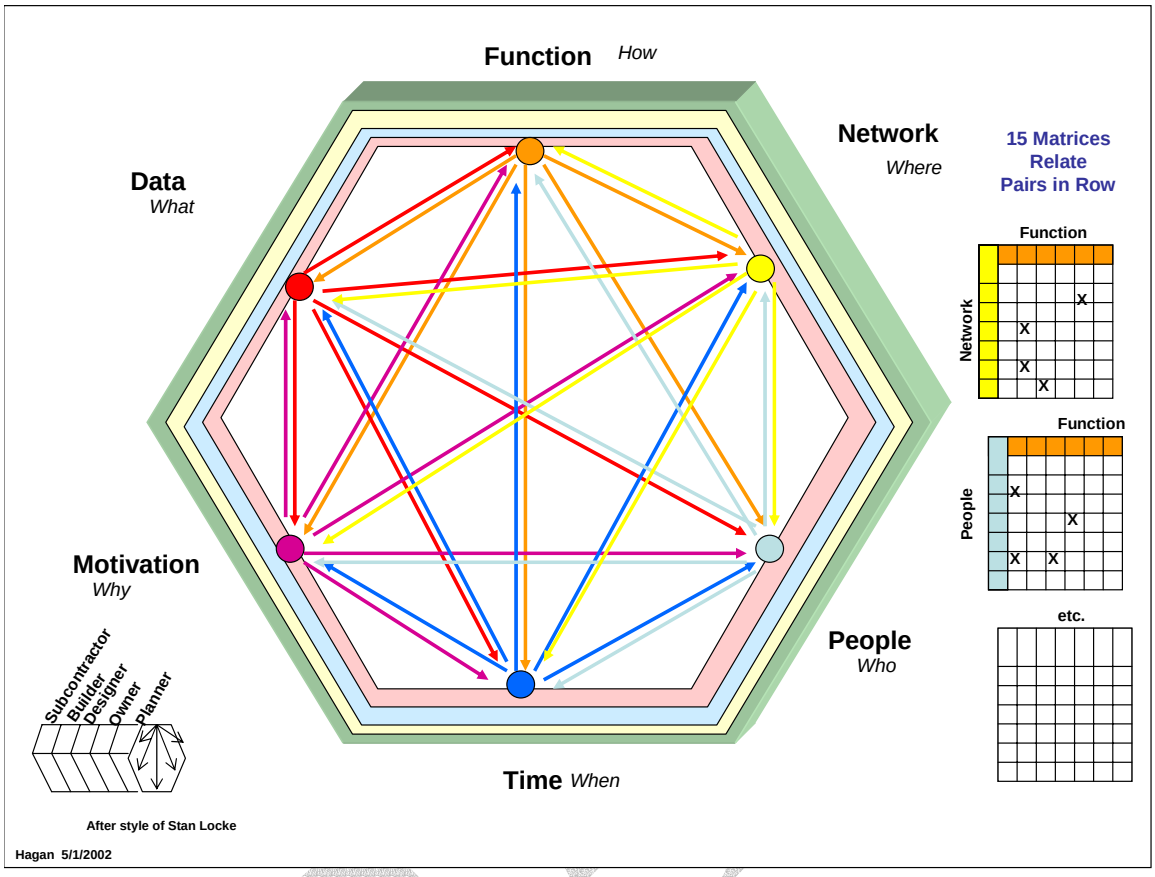

Figure 2. Zachman Identifies Relationships Across Cells in the Same Row

3.1.3 Overview of Major Federally-Sponsored Frameworks

3.1.3.1 Federal Enterprise Architecture Framework (FEAF)

The 1999 Federal CIO Council-sponsored Federal Enterprise Architecture Framework (FEAF) defined eight framework components: architecture drivers, strategic direction, current architecture, target architecture, transitional processes, architectural segments, architectural models, and standards (See Figure 3). The strategic direction guides the development of the agency target architecture and includes the agency vision, principles, and goals and objectives. The architectural models define the business, data, applications, and technology architectures. The models are strongly based on the Zachman EA Framework and Zachman provided a brief (one paragraph) description of what should be in the models for the FEAF publication.

While the FEAF identifies standards and transitional processes as part of the EA, it does not identify how the standards should be organized or presented and provides no guidance on the transitional processes or transition strategy. The FEAF acknowledges the

need for a repository, but does not provide any detail. The FEAF does not provide guidance on security.

As originally conceived, the FEAF was to be a framework for the development of the Federal Enterprise Architecture, not an agency EA. The FEAF architectural segment concept was an attempt to divide the Federal Government into cross-cutting business areas such as common administrative systems, international trade, or criminal justice. While grants and international trade pilots were developed, the concept did not move forward; it depended largely on volunteers. Segments are a different approach to dividing up the Federal government work than the OMB reference model approach, but there are similarities.

The FEAF was a major step forward in defining the elements of an EA. It recognized the link to strategic plans and goals and the need for transition. It referred to the Spewak text titled *Enterprise Architecture Planning* (EAP) for processes to develop the EA. Its weakness is the lack of specific product direction to help an agency to move forward with concepts that were new at the time the FEAF was published and to produce comparable EA products across agencies. Nevertheless, the FEAF was widely adopted by civilian agencies for development of agency EAs. Many concepts from the FEAF became part of November 2000 OMB A-130 EA direction, but the FEAF itself is presented as guidance only, not mandatory. A revision to the FEAF was initiated in 2002 to include many of the products in the DoD Architecture Framework (DODAF) thus adding actionable substance and direction, but the revision was not completed.

Federal Enterprise Architecture Framework Components

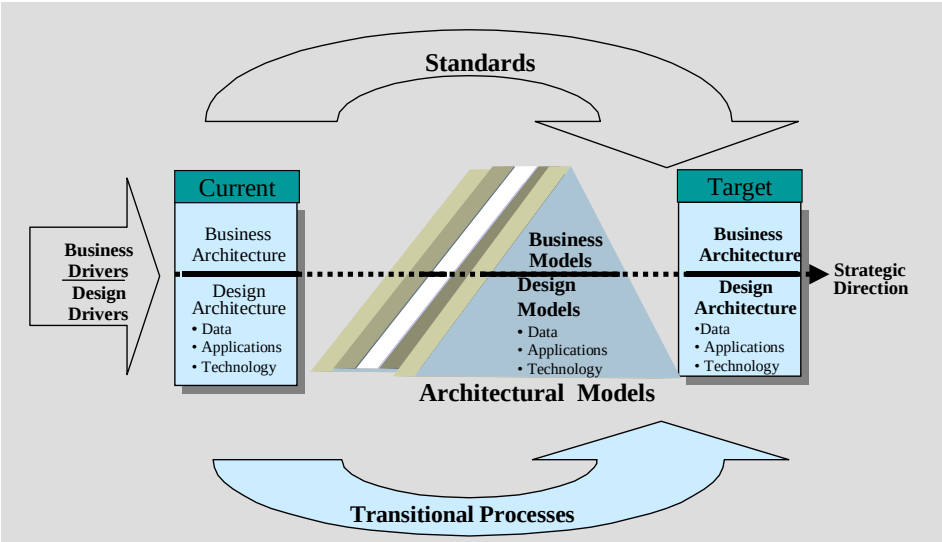

Figure 3. The Eight Components of the FEAF

3.1.3.2. DoD Architecture Framework (DODAF)

The DODAF was originally developed as the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconniassance (C4ISR) Architecture Framework (AF), first published in June 1996 for use in the C4ISR community. Now its use is mandated across all of DoD; it is also used by other civilian and international organizations, making it a very widely used framework. The development of the C4ISR AF was originally motivated by the need for complete and comparable architectural descriptions for very complex systems of systems which must be interoperable. Today, the DODAF is used for enterprise, system, and system-of-systems architectures.

The DODAF 'defines a common approach for DoD architecture description development, presentation, and integration. The framework is intended to ensure that architecture descriptions can be compared and related across organizational boundaries, including Joint and multinational boundaries.' (DODAF Version 1, Vol 1 ES-1)

The DODAF is organized around three architectural views. The Operational View (OV) is a description of the tasks and activities, operational elements, and information exchanges required to accomplish DoD missions. The Systems View (SV) is a description, including graphics, of systems and interconnections providing for, or supporting, DoD functions. For a domain, the SV shows how multiple systems link and

interoperate and may describe the internal construction and operation of particular systems within the architecture. The Technical Standards View (TV) is the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements whose purpose is to ensure that a conformant system satisfies a specified set of requirements. The TV captures the standards to be used in the architecture (See Figure 4.). The DODAF also has a fourth designation called All Views (AV) that has products such as the Overview and Summary and the Information Dictionary that apply to the other three views - the entire architecture.

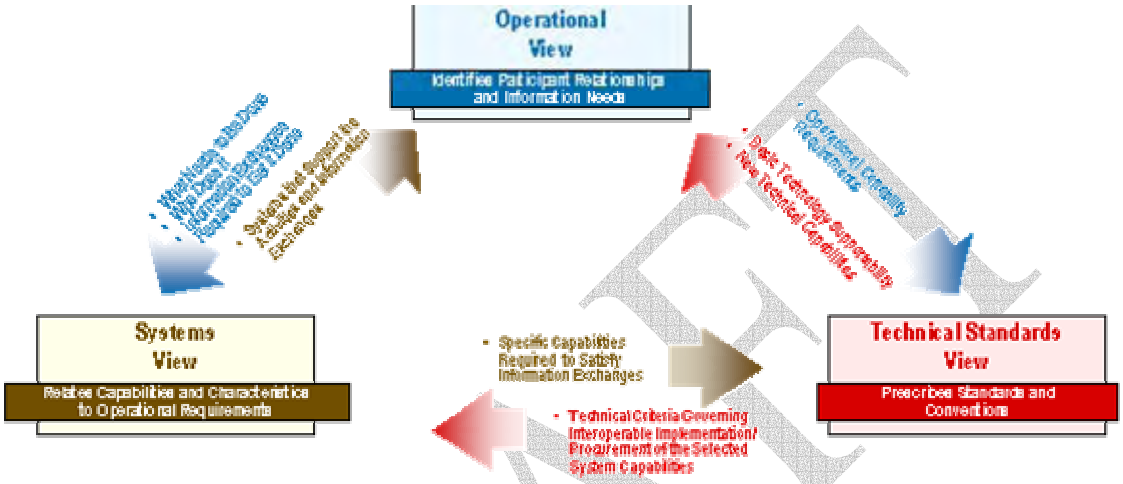

Figure 4. DODAF Operational, Systems, and Technical Views

The DODAF's major feature is the description of a set of integrated architectural products associated with each view. The product descriptions provide detailed direction on the content of each product (required and recommended attributes or content) and simple product examples. Figure 5 shows a high level view of the nature of eight commonly desired products. Table 1 provides a complete list of the 26 products. DoDAF practitioners commonly refer to the products by number such as OV-5 for the Activity Model or SV-1 for the System Interface Description. The architect must select the product types required for his situation. It would be abnormal to develop all 26 products for a single project. The DODAF products are integrated – they work together to present the architecture description. The DODAF Version 1.0 Volume 1 Section 4.3 provides a description of the relationships among the products.

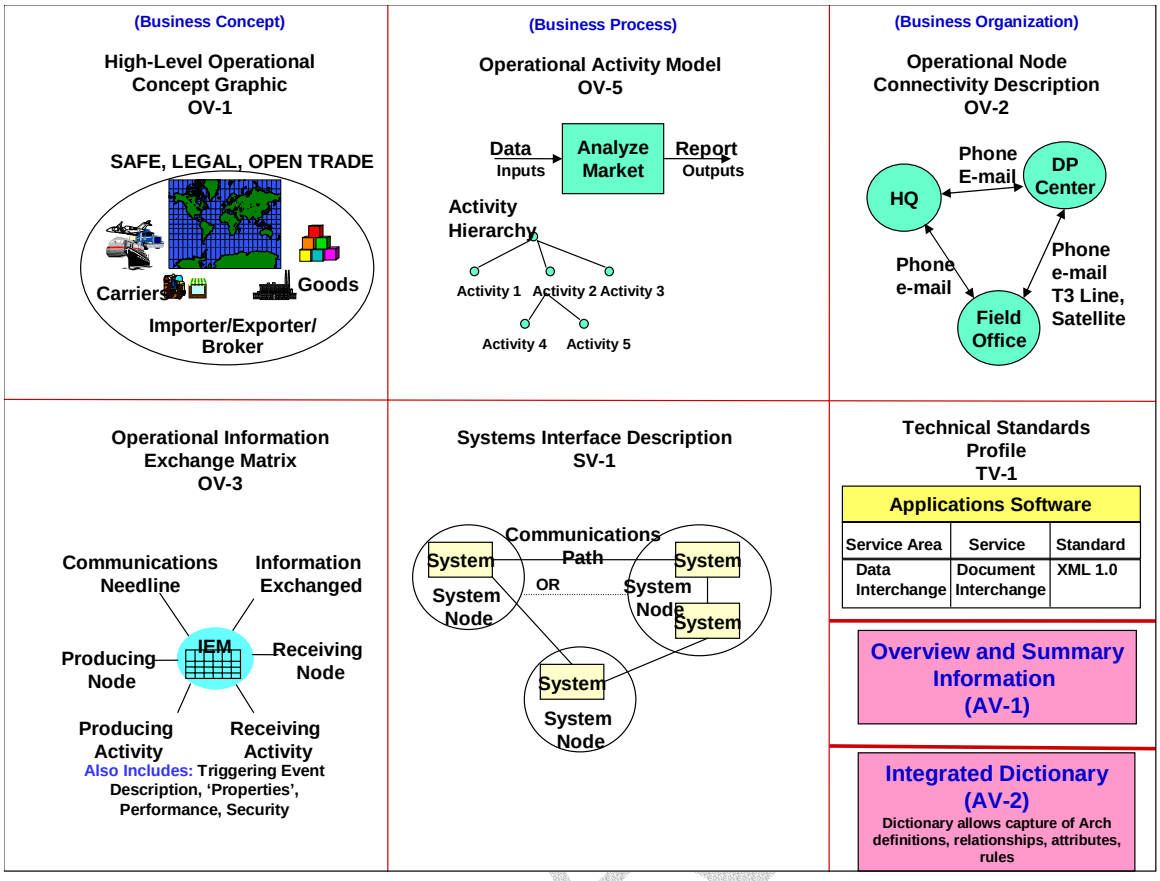

Figure 5. Eight Commonly Used DODAF Products

Table 1. DODAF Architecture Products

Applicable View	Framework Product	Framework Product Name	General Description
All Views	AV-1	Overview and Summary Information	Scope, purpose, intended users, environment depicted, analytical findings
All Views	AV-2	Integrated Dictionary	Data repository with definitions of all terms used in all products
	OV-1	High-Level Operational Concept Graphic	High-level graphical/ textual description of operational concept
	OV-2	Operational Node Connectivity Description	Operational nodes, operational activities performed at each node, connectivity and information exchange needlines between nodes
	OV-3	Operational Information Exchange Matrix	Information exchanged between nodes and the relevant attributes of that exchange
	OV-4	Organizational Relationships Chart	Organizational, role, or other relationships among organizations
	OV-5	Operational Activity Model	Operational Activities, relationships among activities, inputs and outputs. Overlays can show cost, performing nodes, or other pertinent information
	OV-6a	Operational Rules Model	One of the three products used to describe operational activity sequence and timing - identifies business rules that constrain operation

Applicable View	Framework Product	Framework Product Name	General Description
Operational	OV-6b	Operational State Transition Description	One of three products used to describe operational activity sequence and timing - identifies business process responses to events
Operational	OV-6c	Operational Event-Trace Description	One of three products used to describe operational activity sequence and timing - traces actions in a scenario or sequence of events and specifies timing of events
Operational	OV-7	Logical Data Model	Documentation of the data requirements and structural business process rules of the Operational View.
Systems	SV-1	Systems Interface Description	Identification of systems and system components and their interconnections, within and between nodes
Systems	SV-2	Systems Communications Description	Systems nodes and their related communications lay-downs
Systems	SV-3	Systems-Systems Matrix	Relationships among systems in a given architecture; can be designed to show relationships of interest, e.g., system-type interfaces, planned vs. existing interfaces, etc.
Systems	SV-4	Systems Functionality Description	Functions performed by systems and the information flow among system functions
Systems	SV-5	Operational Activity to Systems Function Traceability Matrix	Mapping of systems back to operational capabilities or of system functions back to operational activities
Systems	SV-6	Systems Data Exchange Matrix	Provides details of systems data being exchanged between systems
Systems	SV-7	Systems Performance Parameters Matrix	Performance characteristics of each system(s) hardware and software elements, for the appropriate timeframe(s)
Systems	SV-8	Systems Evolution Description	Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation
Systems	SV-9	Systems Technology Forecast	Emerging technologies and software/hardware products that are expected to be available in a given set of timeframes, and that will affect future development of the architecture
Systems	SV-10a	Systems Rules Model	One of three products used to describe systems activity sequence and timing—Constraints that are imposed on systems functionality due to some aspect of systems design or implementation
Systems	SV-10b	Systems State Transition Description	One of three products used to describe systems activity sequence and timing—Responses of a system to events
Systems	SV-10c	Systems Event-Trace Description	One of three products used to describe systems activity sequence and timing -- System-specific refinements of critical sequences of events and the timing of these events
Systems	SV-11	Physical Schema	Physical implementation of the information of the Logical Data Model, e.g., message formats, file structures, physical schema
Technical	TV-1	Technical Standards Profile	Extraction of standards that apply to the given architecture
Technical	TV-2	Technical Standards Forecast	Description of emerging standards that are expected to apply to the given architecture, within an appropriate set of timeframes

The DODAF is published in three volumes. Volume I: Definitions and Guidelines explains the value of architectures, provides an overview of the framework, describes how the views and products relate to each other, relates products to their use, provides principles for describing architectures, presents a six step process for building the EA (See EABOK section on process), and discusses the C4ISR Core Architecture Data Model (CADM) and repository issues. Volume II contains the product descriptions

including the attributes required and recommended for each product. Volume III is called the Deskbook. It provides architecture guidance on the development and use of the EA, use of UML techniques, incorporating security into the architecture, use of the EA in Capital Planning and Investment Control (CPIC), and tools. It does not address the transition plan extensively.

As a framework that has been revised twice over an extended period of time, the DODAF contains considerable supplemental and explanatory material relating to the Program Objectives Memorandum (POM) process, OMB reference models, UML, architecture repositories, and other topics.

Editor's Comment:
Many novice EA practitioners comment that they find the DODAF too complex for a starting point to build an enterprise architecture. Others practitioners find the DODAF a good source of product description information to get them started. Guidance is needed to know which products to begin with depending on the needs of the situation, how the products fit together, and what level of detail to include.

3.1.3.3 Treasury Enterprise Architecture Framework (TEAF)

The TEAF builds on the Zachman EA Framework, the FEAF, and the C4ISR (now the DODAF) frameworks. It was published in July 2000 as guidance to the Department of the Treasury and its bureaus. It includes not only an EA framework to organize and structure EA information with a prescribed set of products, but also recognizes the need for strategic direction to determine what the target EA must support, requires a transition strategy to show how the EA will evolve to support future capabilities, and provides principles to define the characteristics of the target EA. The TEAF relates the EA to the enterprise life cycle, identifies issues associated with basic EA activities, discusses the need for Configuration Management and a repository, and provides guidance on architecture management roles and responsibilities.

Figure 6 shows how the TEAF is divided into three parts - direction, description, and accomplishment - and the products for each part. The EA Description part is a matrix somewhat like Zachman's. Its columns are four architectural views – Functional, Information, Organizational, and Infrastructure. Its rows are four perspectives – Planner, Owner, Designer, and Builder. Figures 7 and 8 provide definitions of these terms. The TEAF does not see views as mutually exclusive. The TEAF prescribes products for each matrix cell. Many of the products are based on DODAF products. The TEAF addresses security in the Information Assurance Policy and the Information Assurance Trust Model. The Technical Reference Model and Standards Profile products in the Infrastructure View organize and define the standards to be used in the agency.

The TEAF benefited from the earlier work of the Zachman, FEAF, and C4ISR (DODAF) frameworks by recognizing the end-to-end nature (strategic planning, investment, development, transition) of an EA and providing product specifications, many of which

had already been tested in the field. It attempts to expand and improve the guidance to the architect. Today the TEAF is not actively supported.

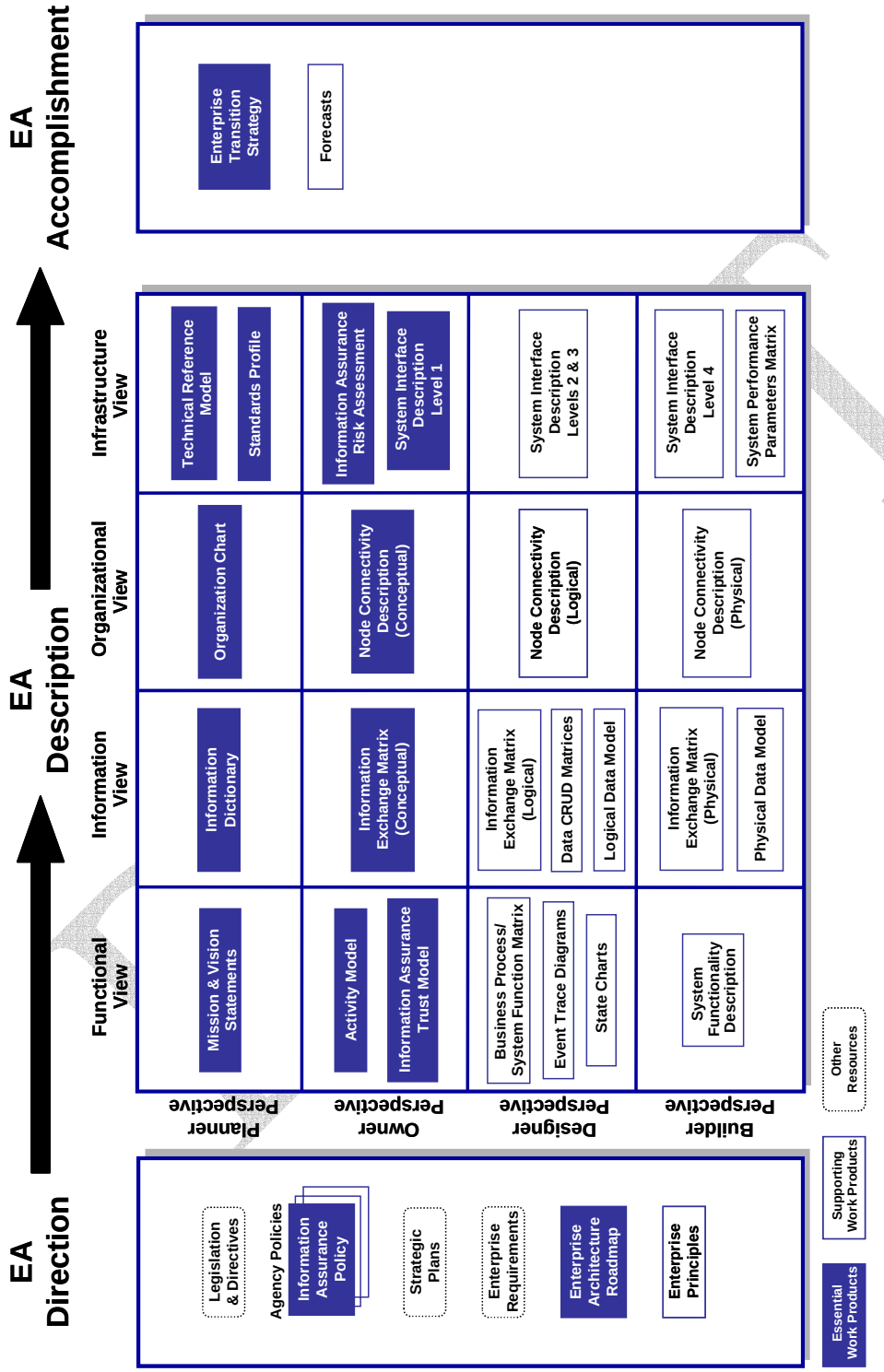

Figure 6. The TEAF Work Products for EA Direction, Description, and Accomplishment

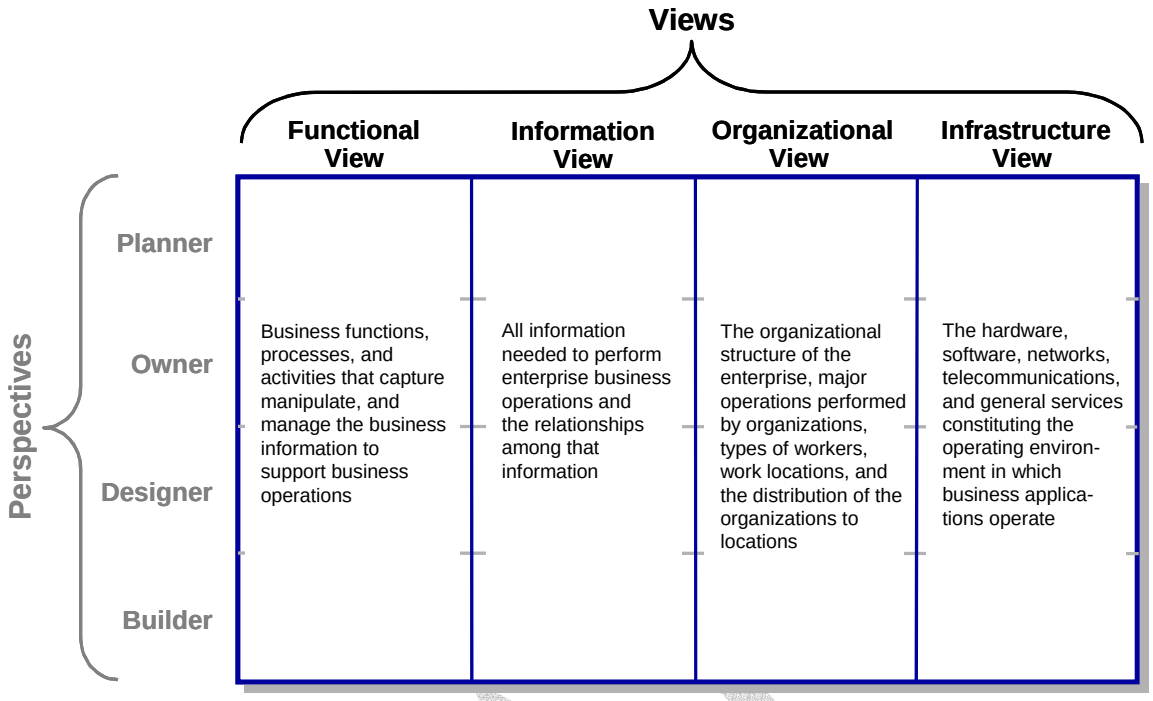

Figure 7. TEAF Core Views

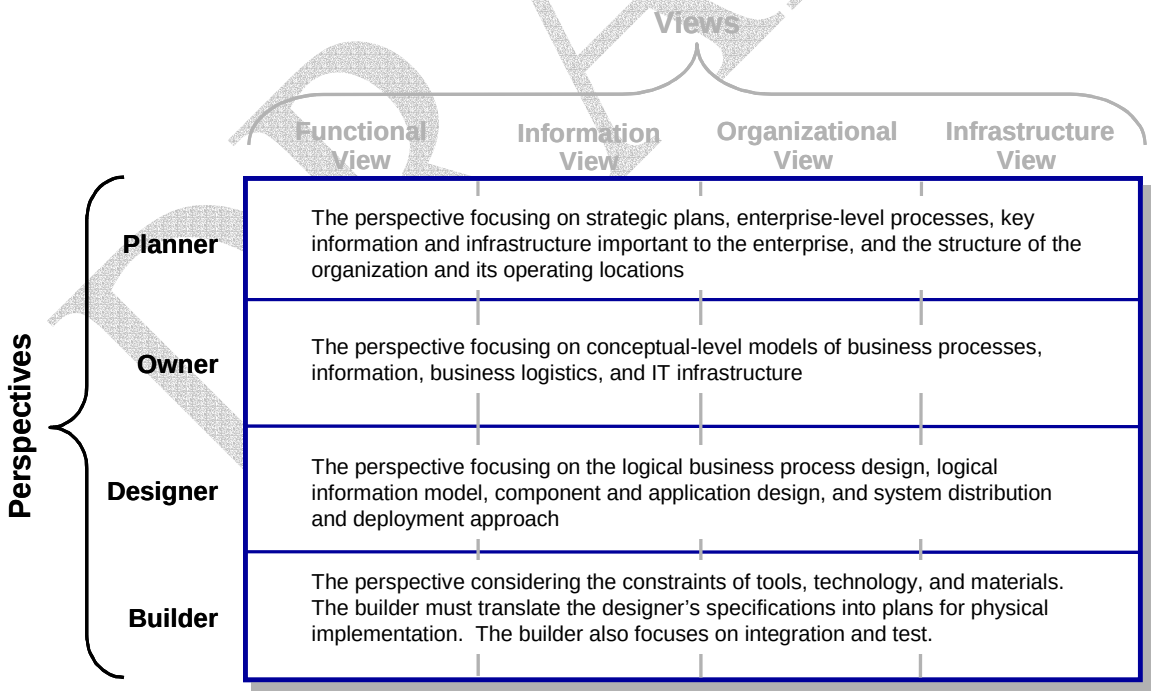

Figure 8. TEAF Core Perspectives

3.1.4 State and Industry-Sponsored Frameworks

3.1.4.1 National Association of State Chief Information Officers (NASCIO)

The state-sponsored National Association of State Chief Information Officers (NASCIO) Enterprise Architecture Development Tool-Kit V 2.0 approach has business, technology, and governance frameworks. Its governance framework contains descriptions of EA related positions, e.g., chief architect, organizational roles and structures, processes for governance (documentation, review, compliance, communication, framework vitality, and blueprint vitality). The extensive detail of the technology architecture is planned for a later version of the tool kit. There are many EA examples from state governments (e.g., Kentucky) developed using the NASCIO tool-kit available on the web.

3.1.4.2 The Open Group Architectural Framework (TOGAF)

TOGAF 8: Enterprise Edition provides an Architecture Development Method (ADM) as part of a framework for developing an enterprise architecture. The TOGAF was developed by consensus among members of The Open Group. Its method can be used with other frameworks or based on the information recommended in the TOGAF. The TOGAF was originally based on the Technical Architecture Framework for Information Management (TAFIM) and includes a Technical Reference Model organizing service categories, standards information, a discussion of boundaryless information flow and Integrated Information Infrastructure Reference Model (III-RM) concepts, discussions on developing various architecture views such as business, security, and software, governance information, and templates to help readers get started.

As described on the TOGAF web site

> 'There are four main parts to the TOGAF document.
>
> PART I: Introduction … provides a high-level introduction to some of the key concepts behind enterprise architecture and in particular the TOGAF approach.
>
> PART II: Architecture Development Method is the core of TOGAF. It describes the TOGAF Architecture Development Method - a step-by-step approach to developing an enterprise architecture.
>
> PART III: Enterprise Continuum describes the TOGAF Enterprise Continuum, a virtual repository of architecture assets, which includes the TOGAF Foundation Architecture, and the Integrated Information Infrastructure Reference Model.
>
> PART IV: Resources comprises the TOGAF Resource Base - a set of tools and techniques available for use in applying TOGAF and the TOGAF ADM.'

3.1.4.3 Reference Model for Open Distributed Processing (RM-ODP) - FUTURE

This section will describe the RM-ODP framework if warranted. ISO standard ISO/IEC 10746-1: Reference Model – Open Distributed Processing (RM-ODP)

3.1.5 Comparing Frameworks

Table 2 below compares aspects of four frameworks. Each framework has made its contribution to improving EA efforts in a still immature field. As the definition of what is in an EA has begun to stabilize, the information types addressed and organized by EA frameworks and supporting topics discussed has begun to move toward a common norm. Because the architectures each attempt to model similar information, the frameworks are comparable or relatable to varying degrees. They each have their own emphasis and maturity. As each revision of a framework is published, greater comparability on the fundamental content of an EA might be expected while coverage of more sophisticated topics and issues will appear such as those in the DODAF Deskbook and TOGAF.

An architect may be required to use a particular framework by agency policy. The agency architect should select an existing framework - preferably one developed by a Federal sponsor/organization for use by Federal organizations - appropriate for his agency to save the cost of developing one. The architect should then incorporate best practices from other frameworks to improve the agency EA effort. Several major frameworks are supported in EA tools.

Table 2. Comparison of Architecture Frameworks

Item	FEAF (V 1.1)	DODAF (V1.0)	TEAF	TOGAF V8
Sponsor	Federal CIO Council	DoD	Dept. Treasury	The Open Group
Basic organizational approach and views	Matrix Based on Zachman: Data, Applications, Technology Columns	Operational, Systems, Technical Linked Views	Zachman-like Matrix: Functional, Informational, Organizational, Infrastructure Columns	Uses views – Identifies several, but uses Business, Data, Applications and Technology as main categories
Detailed, Integrated product type specifications for EA description?	No – Very brief general description of product content for data, applications, technology models	Yes for products within each view: Operational, Systems, and Technical Views	Yes - Some based on DODAF products, also planning and transition products	No – Can use with other frameworks that do this or develop types of information described in TOGAF
Discuss EA relationship to strategic vision and agency goals?	Discussion	Discussion and some addressal in products; not a separate product	Yes, as a specific product (“Roadmap”)	Recognizes Business Strategy as input to principles and Architecture Vision phase
Provide architecture principles ?	Provided for FEA characteristics	Discusses principles for DESCRIBING architecture	Lists principles for Dept of Treasury - Bureau responsibility	Yes
Product for specifying standards?	No	TV-1 - Standards profile	Standards Profile - Bureau responsibility	Provides TRM, standards information
Discuss security considerations in EA?	No	Yes – in Deskbook and in selected products	Treats as cross cutting view - Information Assurance Trust Model	Discusses Security view
Discuss transition strategy issues and define transition plan product?	Discussion, but no specific product	Yes, somewhat	Yes, as a specific Product	Has Migration Planning phase to prioritize projects considering dependencies, costs,

Item	FEAF (V 1.1)	DODAF (V1.0)	TEAF	TOGAF V8
				and benefits
Discuss EA Repository Issues?	Mentions need for one	Yes	Assigns agency the responsibility	
Provide guidance on EA development process?	Minimal- refers to EAP text, generally outside scope – see Practical Guide	High level 6 step process	Some – develop EA strategy, EA roles and responsibilities, CM, investment management	Yes – Architecture Development Method (ADM) forms 'core' of framework
Maturity/Status	Version 1.1 Sept 1999 – 2002 revision not completed – Currently on hold	Two major revisions	Version 1 2000 – Currently on hold	Version 8.1 Had several revisions
Tool Support		Popkin System Architect Plug in		
Systems/Organizations Using Framework		Global Information Grid (GIG); CCIC2S		
Comments				

References

Goicoechea, Ambrose, What is the Best EA Framework for your Customer? Criteria for EA Framework Selection and/or Tailoring, MITRE Corporation, October 2003. *Provides an overview of several frameworks, relates them to a methodology and criteria, discusses tailoring, and presents lessons learned.*

Zachman, J.A., A Framework for Information Systems Architecture, IBM Systems Journal Vol 26, No 3, 1987.

Zachman, J.A., and Sowa, J.F., Extending and Formalizing the Framework for Information Systems Architecture, IBM Systems Journal, Vol 31, No 3, 1992.

John Zachman Web Site: http://www.zifa.com/ - Has a bibliography of Zachman's publications

Zachman Framework Tutorial:
http://www.va.gov/oirm/architecture/EA/theory/tutorial.ppt

Office of Management and Budget, Circular No. A-130, Management of Federal Information Resources, November 30, 2002.

Federal Enterprise Architecture Framework (FEAF) Version 1.1, Federal CIO Council, September 1999.

DoD Architecture Framework Version 1.0 (Draft) aitc.aitcnet.org/dodfw

Treasury Enterprise Architecture Framework (TEAF) Version 1, Department of the Treasury Chief Information Officer Council, July 2000.

Enterprise Architecture Development Tool-Kit, V 2.2, National Association of State Chief Information Officers (NASCIO), July 2002. (provides guidance on roles and governance) https://www.nascio.org/hotIssues/EA/

The Open Group Architecture Framework (TOGAF) Version 8 Enterprise Edition: http://www.opengroup.org/architecture/

Reference Model – Open Distributed Processing (RM-ODP) 1996, ISO standard ISO/IEC 10746-1 http://www.dstc.edu.au/Research/Projects/ODP/ref_model.html

FEAF Example Products: See the W900 Web Site **(TBD)**

TEAF Example Products: See the W900 Web Site **(TBD)**

DODAF Example Products: See the W900 Web Site **(TBD)**

NASCIO Example Products: Examine the web sites for various state governments such as Kentucky.

3.2 Reference Models and Reference Architectures[14]

3.2.1 OMB Reference Models: The Federal Enterprise Architecture (FEA)[15]

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3.2.1.1 Overview

The Office of Management and Budget (OMB) Federal Enterprise Architecture (FEA) Program Management Office (FEA-PMO) describes the FEA as a business and performance-based framework for cross agency, government-wide improvement. The purpose of the FEA is to identify opportunities to simplify processes, re-use Federal IT investments, and unify work across the agencies and within the lines of business of the Federal Government, i.e., the focus is on performance, comparability, and reuse. The outcome of the effort will be a more citizen-centered, customer-focused government that maximizes technology investments to better achieve mission outcomes.[16] The OMB views the Federal Enterprise Architecture not as a model, but as a program built into the annual budget process to repeatedly and consistently improve all aspects of government service delivery. [17] Because of the newness of the OMB Reference Models, this section provides an in-depth explanation of the models. For the complete details, the reader should examine the references.

The FEA is composed of five interrelated reference models as portrayed by OMB in Figure 1. The models are designed to facilitate cross-agency analysis and opportunities for collaboration.

[14] Revised January 31, 2004
[15] Much of the factual material in this document has been taken directly from the OMB references cited for the BRM, PRM, SRM, and TRM.
[16] The Service Component Reference Model (SRM) Version 1.0 Page 33.
[17] The Business Reference Model Version 2.0 Page 1.

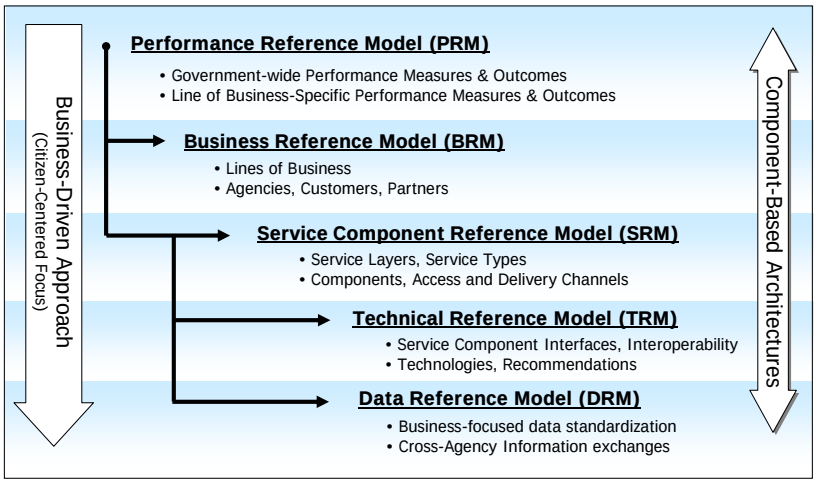

Figure 1. Five Reference Models Compose the FEA[18]

The four models (BRM, PRM, SRM, and TRM) published at this writing each use a hierarchical structure to develop and refine classification categories for their respective domains. The BRM hierarchy identifies Business Areas, Lines of Business (LOB) and sub-functions. Example of sub-functions are Legal Investigation, Worker Safety, and Goods Acquisition. The PRM defines Measurement Areas such as Customer Results, Measurement Categories such as Timeliness, and Indicators such as percent of calls answered within 15 seconds. The SRM classifies service components with respect to how they support business or performance objectives. The SRM identifies seven service domains like Customer Services or Business Management Services, then defines service types and associated components for each. A component is a self contained business process or service with predetermined functionality such as Call Center Management, Case/Issue Management, or Data Recovery. The lower levels of the TRM hierarchy define standards and specifications.

These classification categories allow OMB and agencies to separate business functions, relate performance measures and service components to those functions, and relate standards and specifications to the service components needed to support the business functions. OMB is interested in uniquely separating business functions to identify redundant efforts and potential cross agency investments. The President's Management Agenda calls for the development of a common set of performance measures across the government. The PRM supports that goal by identifying categories of measures for which

[18] Taken from OMB Reference Models materials

agencies will collaboratively define specific indicators associated with business functions identified in the BRM.

The Agency Chief Architect and other planners can identify efforts from other agencies through the BRM, SRM, and TRM to determine if another agency has already developed a capability for a needed business function that the agency could potentially reuse as portrayed in Figure 2.

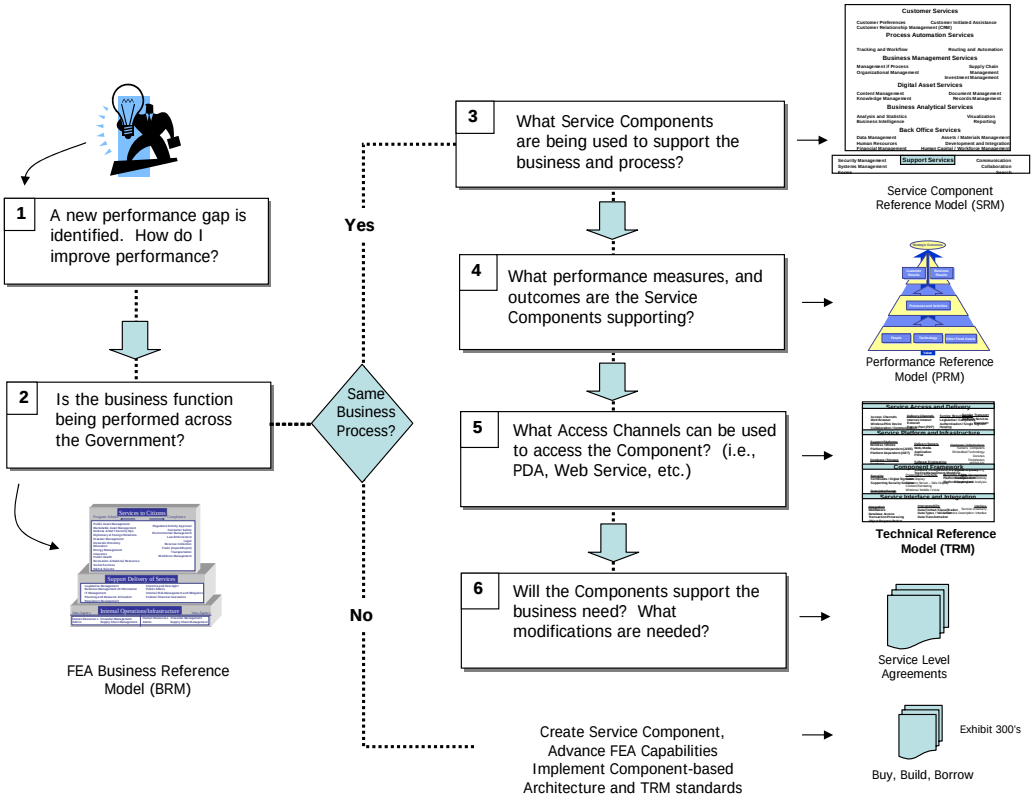

Figure 2. Using the Reference Models in EA Planning[19]

The Chief Architect can use the SRM and TRM to speed component-based architecture solutions by identifying Service Components associated with a business function through the SRM, then identify the e-business pattern associated with the agency needs and finally locating products that can provide the capability for that pattern through the TRM. (See the reference on e-business patterns for more on patterns.) Figure 3 shows the high-level relationships between the five models.

[19] Taken from OMB Reference Models materials

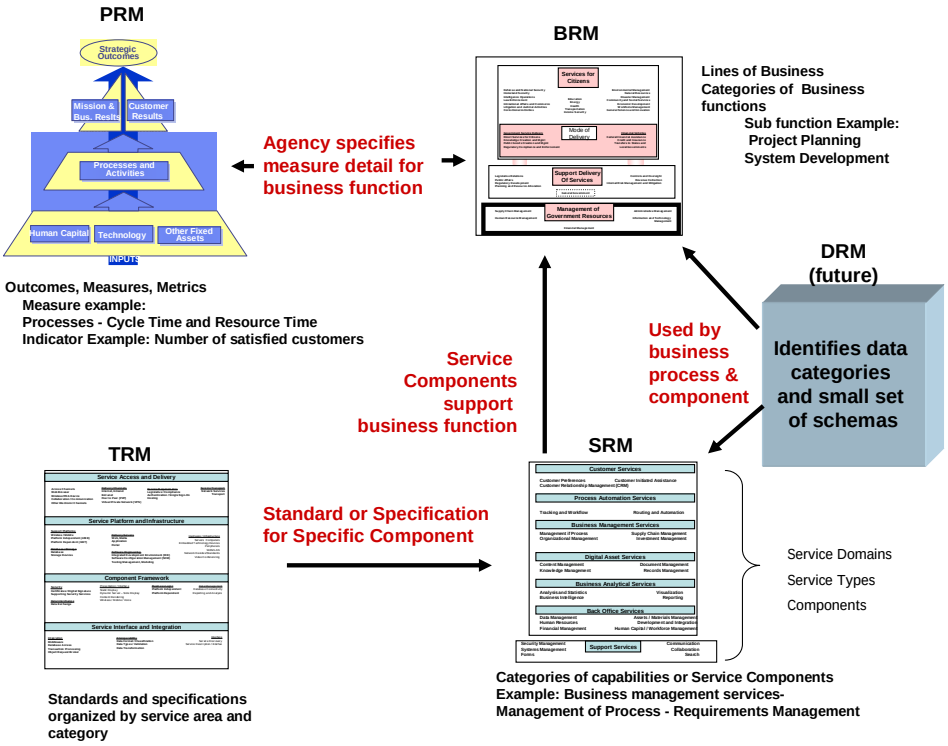

Figure 3. Relationships Among the OMB Reference Models

OMB will use the FEA to analyze investments in information technology to identify

- What agencies share common business functions, processes, and activities
- What budget requests support duplicative business functions and information systems
- Where the government is investing money on redundant capabilities, including work under the human capital strategy
- How IT investment is supporting the achievement of performance goals.

OMB will enforce the use of the FEA by requiring agencies to link or relate their proposed initiatives to the reference models in their 300 submissions required by OMB Circular A-11. Agencies must explain alignment with the BRM in submissions for FY 2005 funding. They must identify

- All Lines of Business and Sub-Functions from the FEA Business Reference Model that IT investment supports II.A.1.E.
- What types of data will be used in the project II.A.2.A.
- Relationship to the Service Component Reference Model Section of the FEA. Include a discussion of the components included in the major IT investment. II.A.3.A.
- Relationship to the Technical Reference Model Section of the FEA. Identify each Service Area, Service Category, Service Standard, and Service Specification that

collectively describes the technology supporting the major IT investment. II.A.3.C.

The reader should consult the latest version of OMB A-11 for the current guidance.

3.2.1.2. Model Overview Descriptions

3.2.1.2.1 Business Reference Model (BRM)

The BRM provides a functional as opposed to organizational (i.e., by Department) way of looking at government operations that allows identification and comparison of functions across agencies. The BRM three tier hierarchy has business areas, lines of business (LOB) within the business areas, and sub-functions for the lines of business. Figure 4 shows the Service Areas and Lines of Business (LOBs).

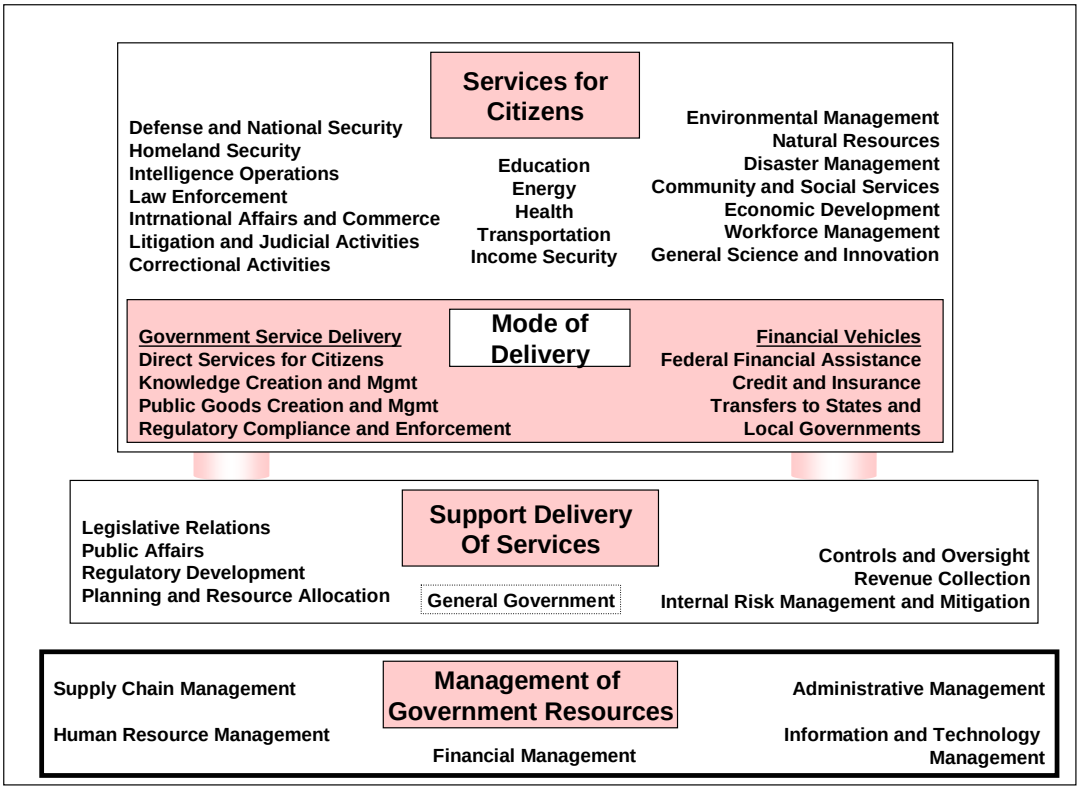

Figure 4. BRM Version 2.0 Business Areas and Lines of Business

The four Business Areas are Services for Citizens, Mode of Delivery, Support Delivery of Services, and Management of Government Resources. A Mode of Delivery like 'Credit and Insurance' is a way to deliver a service like 'Economic Development' to the citizen. Each Line of Business has associated sub-functions. For example, Workforce Management has the sub-functions Training and Employment, Labor Rights Management, and Worker Safety. Figure 5 shows sub-functions associated with the Services for Citizens LOBs from Version 2.0. The OMB Reference Model writeup

provides diagrams of all business areas and their LOBs, and associated sub-functions and a few lines of description of each sub-function.

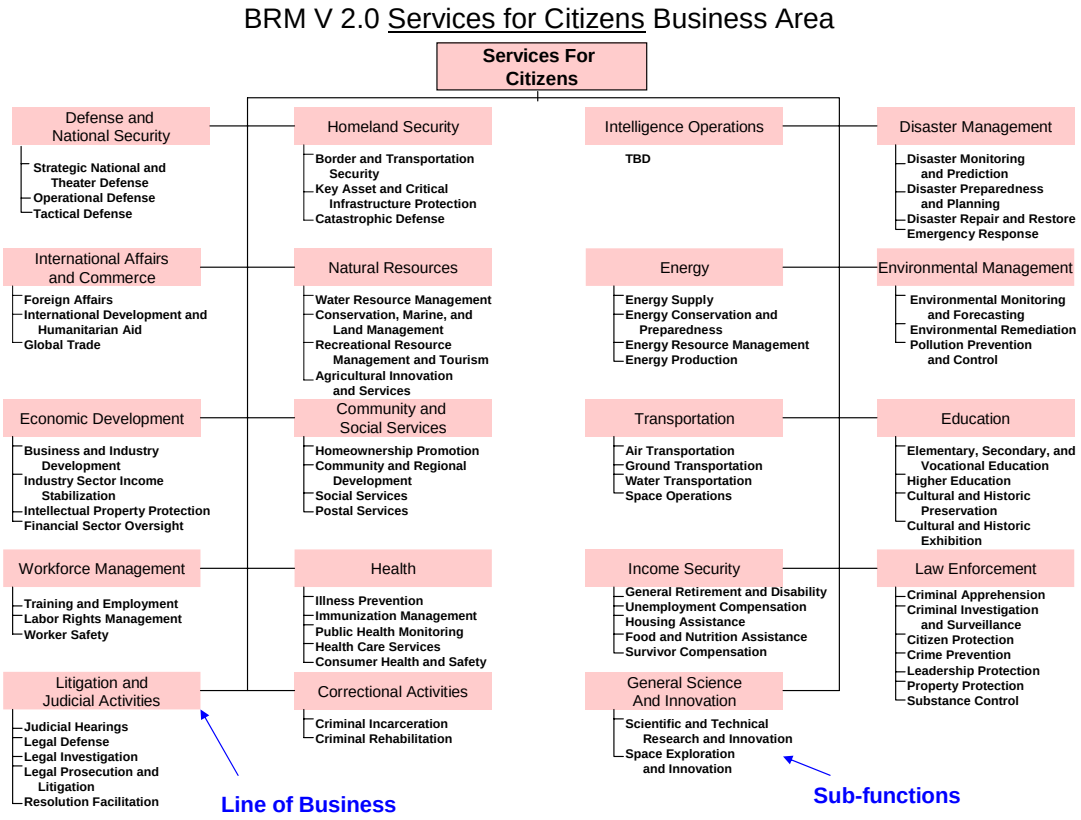

Figure 5. Example Sub-Functions for Services For Citizens – BRM Version 2.0

In Version 1.0 of the BRM, the statement was made that the BRM had been normalized – lines of business and sub-functions did not overlap, a good feature for a mechanism designed to distinguish and separate for identifying overlap and redundancy. Figure 6 illustrates the BRM acting as a sorting mechanism for new initiatives.

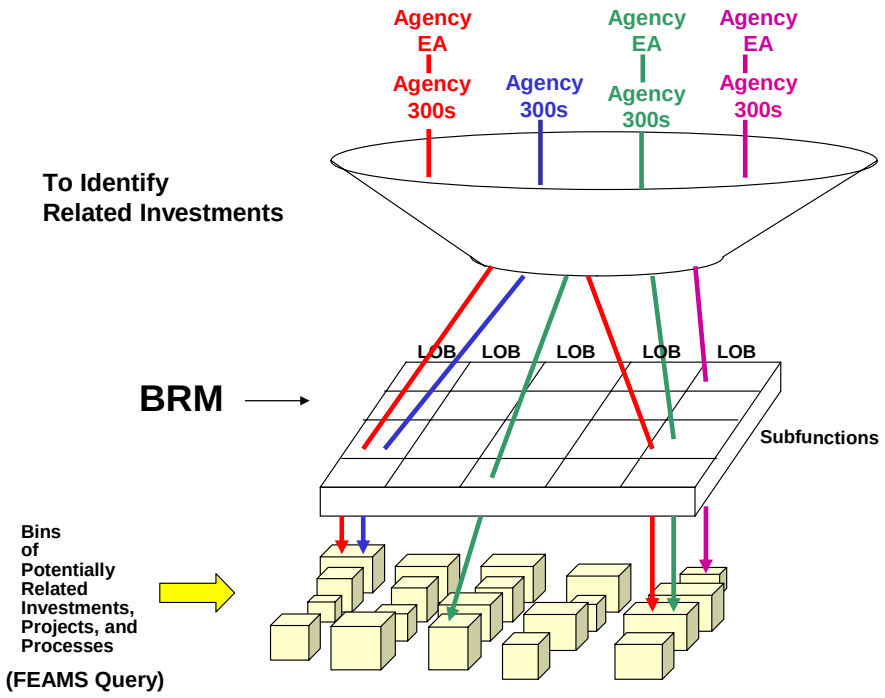

Figure 6. The BRM as a Sorting Mechanism to Identify Related Investments

The categories within the BRM have been reviewed for alignment with budget function classifications, the President's Budget Performance Integration Initiative and the PRM, and cross agency efforts to improve Federal financial management and financial management systems.

The **???reference** on the BRM provides high level guidance on Federal agency use of the BRM within Federal agencies Capital Planning and Investment Control (CPIC) processes and the annual budget process.

3.2.1.2.2 Performance Reference Model (PRM)

The draft PRM[20] is a standardized framework to measure the performance of major IT initiatives and their contribution to program performance. It has three main purposes:

- Help produce enhanced IT performance information to improve strategic and daily decision-making
- Improve the alignment - and better articulate the contribution of - IT to business outputs and outcomes, thereby creating a clear 'line of sight' to desired results

[20] The PRM is available only in draft form (July 2003) at this writing.

- Identify performance improvement opportunities that span traditional organizational structures and boundaries.

The PRM is structured by:

- Four Measurement Areas for FY 2005 such as Mission and Business Results
- Measurement Categories that describe the attribute or characteristic to be measured such as support delivery of services
- Generic Measurement Indicators that agencies can tailor or 'operationalize' for their environment, such as percentage of satisfied customers for a particular service.

Figure 7 shows the Measurement Areas and Measurement Categories.

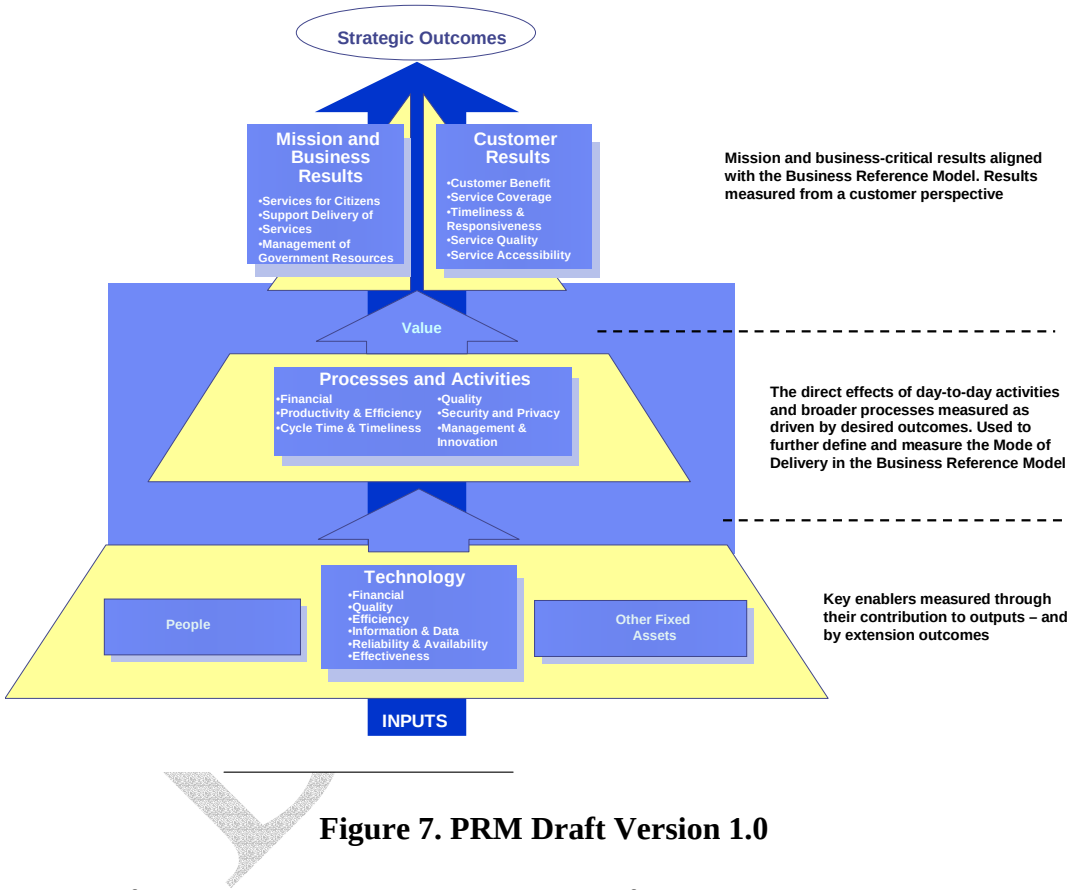

Figure 7. PRM Draft Version 1.0

The PRM reference document provides examples of indicators associated with each Measurement Category. On this first draft, the indicators are generally high level counts and percentages such as number of satisfied customers or average time to fill unfilled positions.

Agencies use PRM Version 1.0 to improve performance as they see fit, and as required in OMB Circular A-11 when submitting FY 2005 Exhibit 300s for DME IT Initiatives. Agencies can use the indicators in their GPRA Annual Performance Plans and Annual Performance Reports. If agencies performing the same sub-function use the same

performance indicators or measures to assess their outputs and outcomes, the Government has a way to compare how effectively and efficiently agencies are performing similar functions. This is consistent with the President's Management Agenda Budget and Performance Integration item.

3.2.1.2.3 Service Component Reference Model (SRM)

The SRM is a business driven, functional framework that classifies service components with respect to how they support business and/or performance objectives. A component is "a self contained business process or service with predetermined functionality that may be exposed through a business or technology service."[21] The SRM defines five levels of component granularity, four of which are included in the SRM. Federated Component, Business Component System, Business Component, and Distributed Component are included; Language Class (e.g., COBAL) is not included. The conceptual hierarchy of these components is shown in Figure 9. The effective identification, assembly, and usage of components allow for aggregate services to be shared across agencies and governments. The services provide the functionality and execution of business processes which in turn sustain the BRM sub-functions.

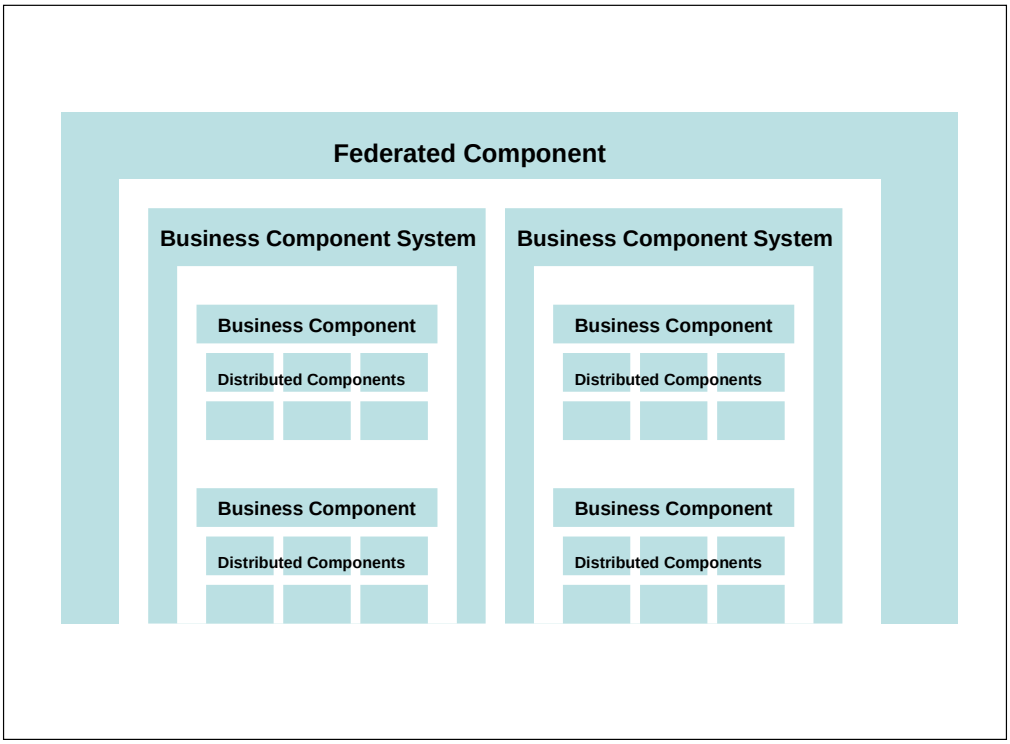

Figure 9. Conceptual Hierarchy of Components showing Granularity

Some of the reasons the SRM was created are to:

[21] SRM Version 1.0 Page 3.

1) provide a framework that identifies service components and their relationships to the technology architecture of agencies,
2) classify, categorize, and recommend components for the reuse of business services and capabilities, and
3) align and leverage existing federal guidance and application/architecture recommendations.

The SRM is intended for use in discovering government-wide business and application Service Components in IT investments and assets. The SRM is business-driven and classifies Service components with respect to how they support business and/or performance objectives.

The SRM's three level hierarchical structure to support categorization consists of Service Domains, Service Types, and Components. Figure 10 shows the SRM structure listing the domain services and their supporting service types. The service domains are differentiated by the business-oriented capability they represent.

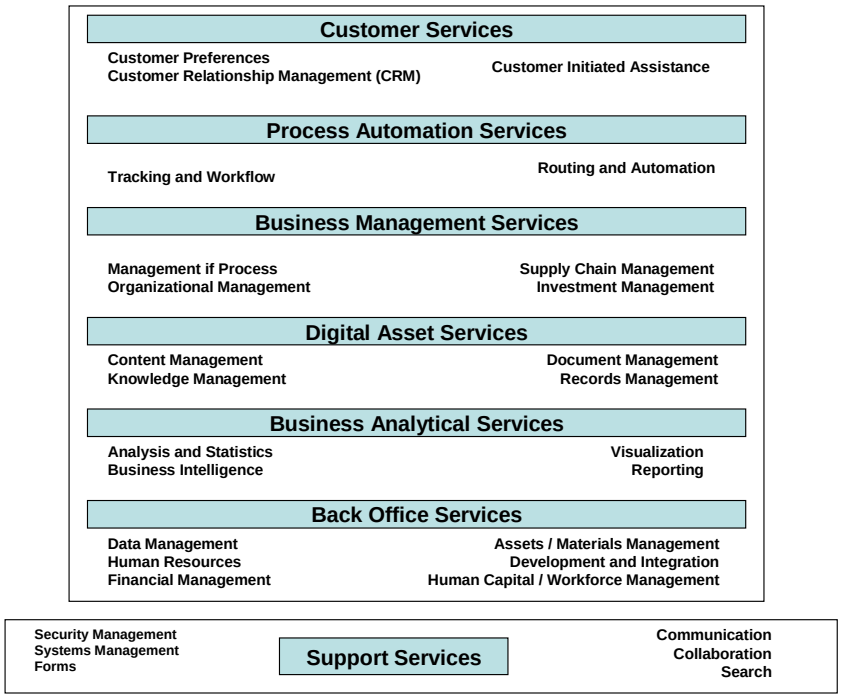

Figure 10. SRM Structure with 7 Service Domains and 29 Associated Service Types

OMB provides a description of each service domain, service type, and component. The following table shows examples of each. See the OMB SRM document for the complete description.

Table 1. Example SRM Service Domain, Service Type, and Component

SRM Element	Example	Example Description
Service Domain	Customer Service Domain	Defines the set of capabilities that are directly related to an internal or external customer, the business' interaction with the customer, and the customer driven activities or functions. The Customer Services domain represents those capabilities and services that are at the front end of a business, and interface at varying levels with the customer.
Service Type	Customer Relationship Management	Defines the set of capabilities that are used to plan, schedule, and control the activities between the customer and the enterprise both before and after a product or service is offered
Component	Call Center Management	Defines the set of capabilities that handle telephone sales/and/or service to the end customer

An intended use of the SRM by agencies is for an agency planning its IT capital investments, the agency can access the FEA through the Federal Enterprise Architecture Management System (FEAMS), identify other agencies addressing similar business functions or service needs, and locating components (and performance measures) that may be available to fill the agency need. To achieve this kind of searching supported by categorization, an agency's technology, business processes, and applications architectures must be aligned with the FEA SRM, TRM, and BRM.

3.2.1.2.4 Technical Reference Model (TRM)

The TRM is a component-driven, technical framework used to identify the standards, specifications, and technologies that support and enable the delivery of service components and capabilities. It supports reuse of technology and component services through standardization. The reasons the TRM was created are to

1) create a government-wide reference model that unifies agency TRMs and existing e-Gov guidance,
2) focus technology standards, specifications, and recommendations on those that embrace the internet and related approaches,
3) create a foundation that focuses heavily on the secure delivery and construction of Service Components and their interfaces, and
4) identify the layers of a component based architecture, the supporting technologies, and recommendations for each.

The TRM is built on a four level categorization scheme; Service Area, Service Category, Standard, and Specification as defined in Table 2.

Table 2. TRM Categorization Levels

Level	Description	Example
Service Area	A technical tier that supports the secure construction,	Service Access

	exchange, and delivery of business or service components. Each service area groups the requirements of component-based architectures within the Federal Governement into *functional* areas.	and Delivery
Service Category	Sub-tier of the Service Area to classify lower levels of technologies, standards, and specifications in respect to the business or technology function they serve	Access Channel
Standard	Hardware, software, or specifications that are widely used and accepted (de facto) or are sanctioned by a standards organization (de jure).	Web Browser
Specification	A formal layout/blueprint/design of an application development model for developing distributed component-based architectures.	Internet Explorer

Figure 11 shows the four service areas, their service categories (underlined), and their standards. The OMB TRM writeup contains a description of each of these and associated specifications.

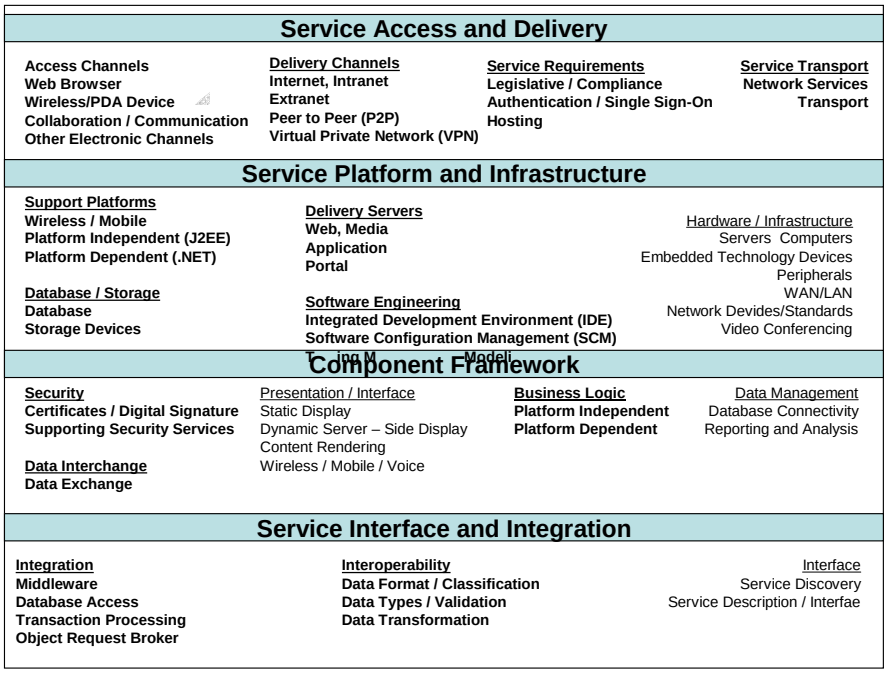

Figure 11. TRM Version 1.0 Service Areas, Service Categories, and Standards

OMB views the TRM as providing "the foundation for identifying target technical architectures and should be reflected where applicable in baseline architectures. Migration strategies should be developed to outline the approach to achieving the target

architecture consisting of component-based architectures. Upon 'publishing' this collection of information, and coupling with the SRM, agencies are offered the ability to discover workable capability and technology configurations."[22]

3.2.1.2.5 Data Reference Model (DRM)

The Data Reference Model has not been published at this writing and is not covered at this time.

3.2.1.3 FEAMS

The Federal Enterprise Architecture Management System is OMB's software tool and repository in which agencies capture their FEA-related information and submit it to OMB. OMB then can combine all agencies' information and query the information to look for cross agency initiatives, redundancy, and performance comparisons. FEAMS is driven by a relational database. Figure 12 is a screenshot from FEAMS showing how one can see the line of business and agencies supporting that LOB related to an initiative.

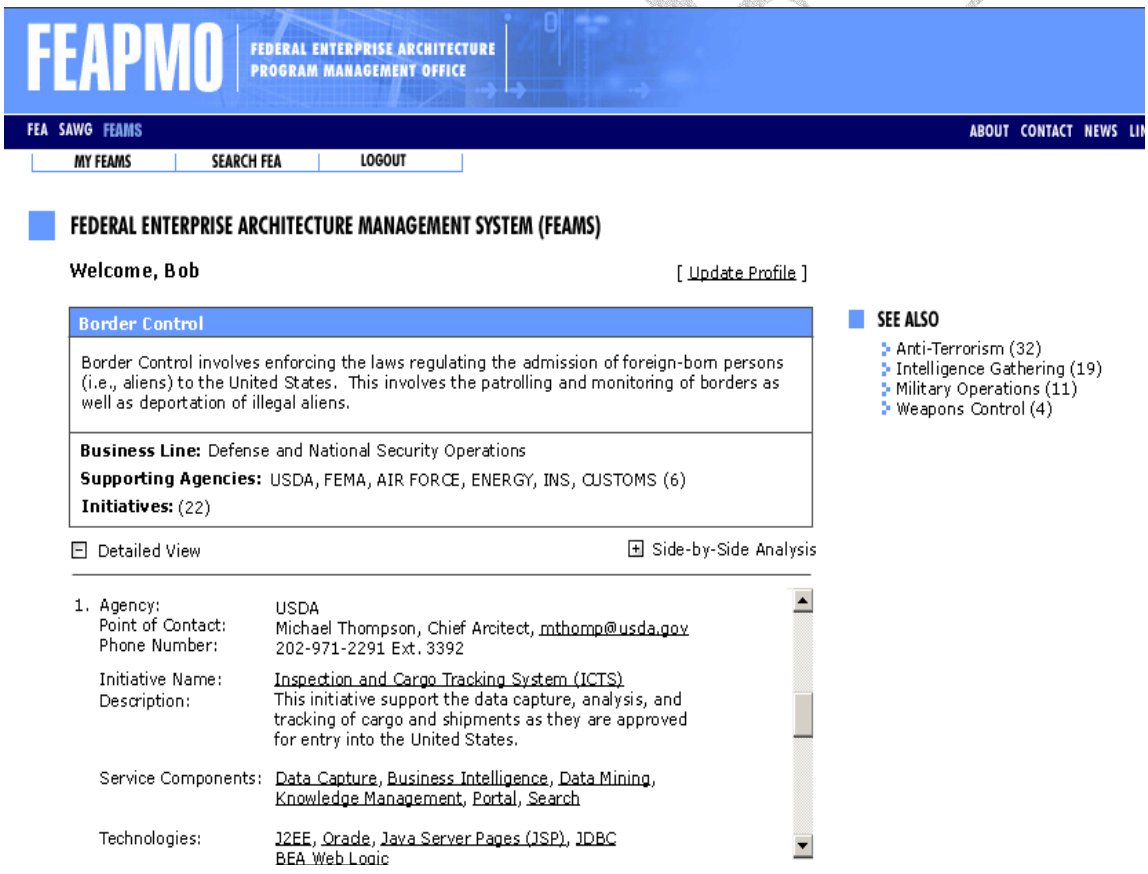

Figure 12. Sample Screen from FEAMS

[22] TRM Version 1 Page 46

References

The FEA Program Management Office (PMO) published the OMB Reference Models. Official version of the Reference Model descriptions can be found on the FEAPMO Web site. http://www.feapmo.gov

The Business Reference Model Version 2.0, FEA-PMO, June 2003.
The Business Reference Model Version 1.0, FEA-PMO, July 2002.
Performance Reference Model Development, FEA-PMO, October 29, 2002
The Performance Reference Model Version 1.0, FEA-PMO, DRAFT, July 2003
The Service Component Reference Model (SRM) Version 1.0, FEA-PMO, June 2003.
The Technical Reference Model Version 1.0, FEA-PMO, June 2003.

Patterns for e-business, A Strategy for Reuse, Jonathan Adams, Srinivas Koushik, Guru Vasudeva, and George Galambos, Double Oak, TX:IBM Press, 2001

How FEA Reference Models Impact Agency-Wide Strategies, Diane A. Reeves, OMB, Scott Bernard, Syracuse University, August 20, 2003 presented at e-gov Enterprise Architecture 2003, September 10, 2003. http://www.e-gov.com/events/2003/ea/downloads/

3.2.2 Net-Centric Operations and Warfare (NCOW) Reference Model (NCOW RM) - Future

This section will discuss DoD's NCOW RM.

3.2.3 The Global Information Grid (GIG) – Future

This section will discuss the GIG.

References

Habitats: Organizing the Global Information Grid, Assad Moini, Software Productivity Consortium, http://www.software.org/pub/darpa/habitats/overview.pdf

3.3 Processes for Developing the EA[23]

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3.3.1 Introduction

There have been several publications on how to gather the information for an Enterprise Architecture (EA), each with different scopes and detail. The scopes vary with such things as whether they address getting executive support, maintenance of the EA, and using the EA. They all address the process of building EA products. At least three of them are based on a particular architecture framework. The concepts and tasks within all of them are generally applicable and the planner can gain insight from examining each of them. None of them are complete because they do not deal with all topics, such as planning, selecting tools, or estimating cost.

The following sections provide overviews of the DoD Architecture Framework (DODAF) six step process which is a high-level, simple introduction, Enterprise Architecture Planning (EAP) which was developed by Steven Spewak and based on the Zachman EA Framework, the process presented in the Practical Guide to the Federal Enterprise Architecture which is based on the Federal Enterprise Architecture Framework (FEAF), and The Open Group Architecture Framework (TOGAF) Architecture Development Method (ADM) . The sections also identify other sources of information. A Work Breakdown Structure (WBS) for EA development can be found in the DODAF Deskbook.

3.3.2 DODAF Six Step Process

The DODAF has a high-level, generic six step process for building an EA shown in Figure 1 and described in Volume Three (Deskbook), Section 2.4, of the DODAF. The description has detail on developing the DODAF operational, systems, and technical views and a suggested build sequence for DODAF products. The DODAF Deskbook Section 2.5 contains Department of the Navy CIO process guidance that includes a work breakdown structure for developing DODAF architecture products and identifies a web site that contains the full navy Architecture Development Process Model (ADPM).

[23] Revised January 19, 2004

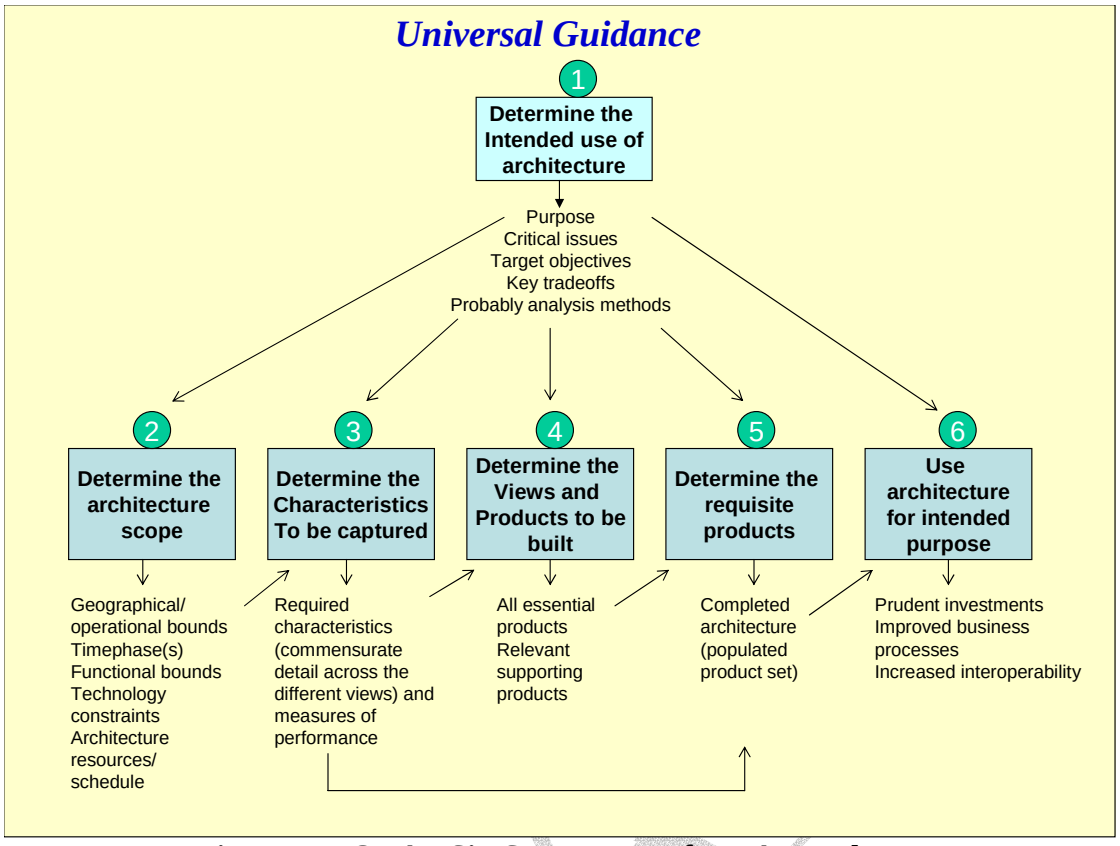


Figure 1. DODAF Six-Step Process for EA Development

3.3.3 MetaGroup Process Model

The MetaGroup developed a process model that has a broader focus including the need for the business vision, the cycle of applying and revising the architecture, and assessing the EA program. A modified version of it is shown in Figure 2.

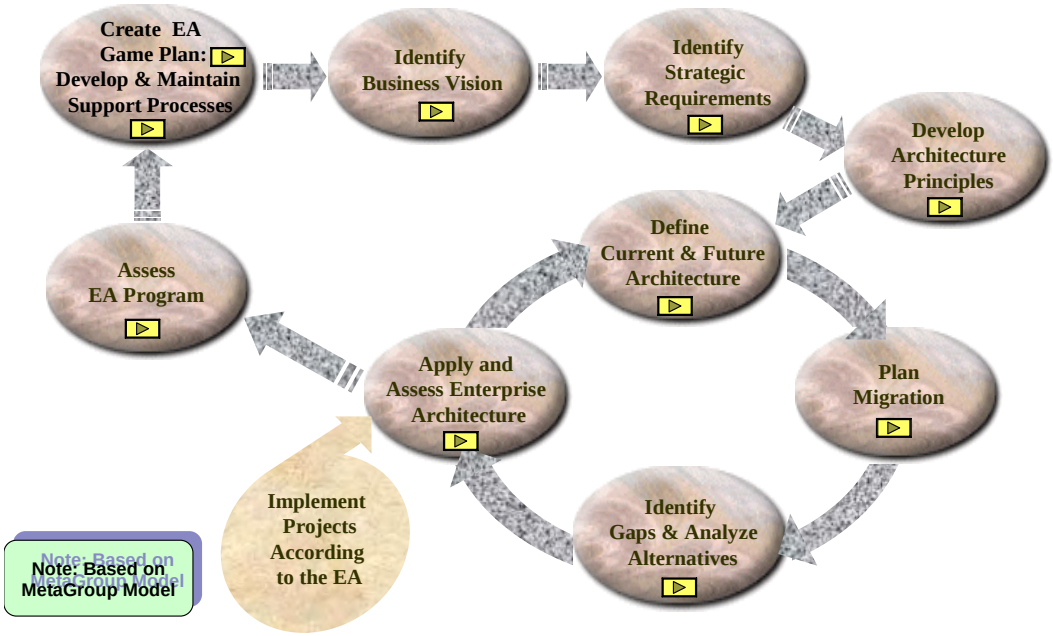
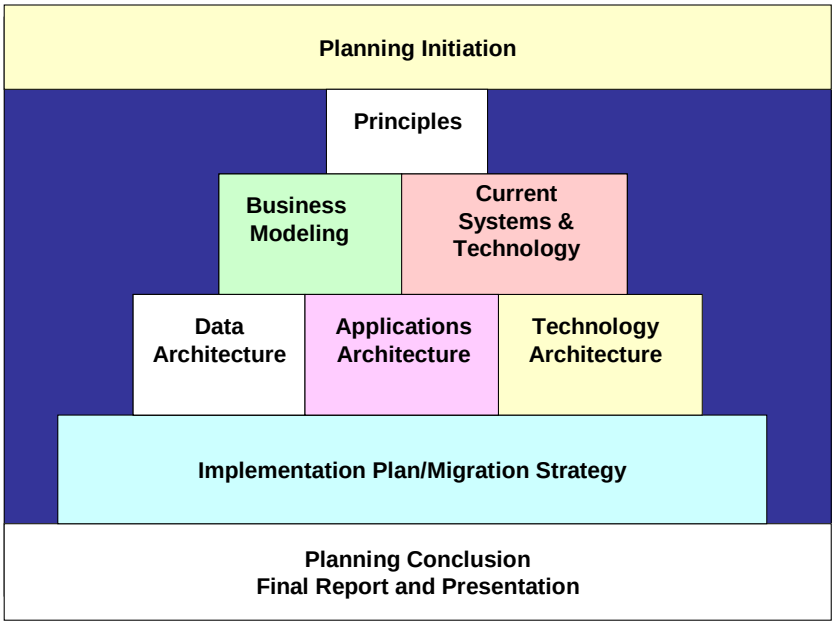


Figure 2. Activities in the EA Program based on MetaGroup Model

3.3.4 Spewak's Enterprise Architecture Planning

The 1993/1995 Steven Spewak book *Enterprise Architecture Planning* provides advice, process, and suggested product content for defining an enterprise architecture. It is based on the Zachman EA Framework, though the concepts are generally applicable. Spewak defines EAP as the process of defining architectures for the use of information in support of the business and the plan for implementing those architectures. The 'wedding cake' diagram shown in Figure 3 shows the components or phases of the EAP methodology. Figure 4 shows the detail stages in each of the high level phases and main products[24].

[24] The careful reader may note the Preliminary Business Model and Enterprise Survey steps in the detail diagram which are combined into the Business Modeling Phase in the wedding cake diagram. The Transition to Implementation phase also does not appear in the wedding cake diagram.



Based on 1993/1995 Enterprise Architecture Planning text and later Spewak materials

Figure 3. Spewak's Enterprise Architecture Planning Phases

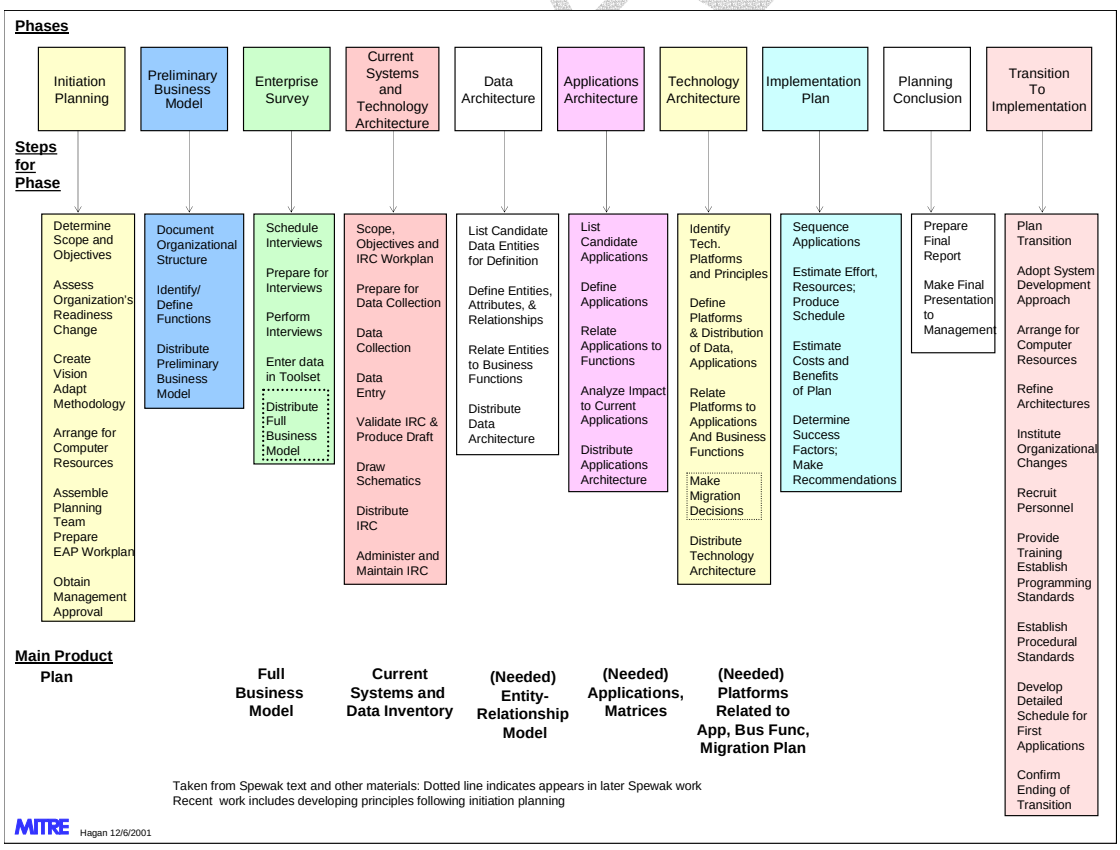


Figure 4. EAP Process Steps for Each Phase

Spewak's EAP was foundational work at the time it was written. It champions the 80/20 rule - showing results quickly rather than getting the last detail correct. The text contains many checklists, ideas for planning, example products, and practical advice. Spewak does not favor a fixed set of EA products, but rather would determine the specifics of EA products on a case by case basis[25]. He emphasizes the use of matrices to relate elements of the EA, e.g., systems to business functions.

3.3.5 Practical Guide Process

A Practical Guide to the Federal Enterprise Architecture provides a process for developing an EA as shown in Figure 5. The process steps overlap with those in the Spewak EAP processes. The Practical Guide adds governance, more on tools, establishing a Program Mangement Office (PMO), transitioning, and marketing the EA. The practitioner can combine Practical Guide and EAP process ideas.

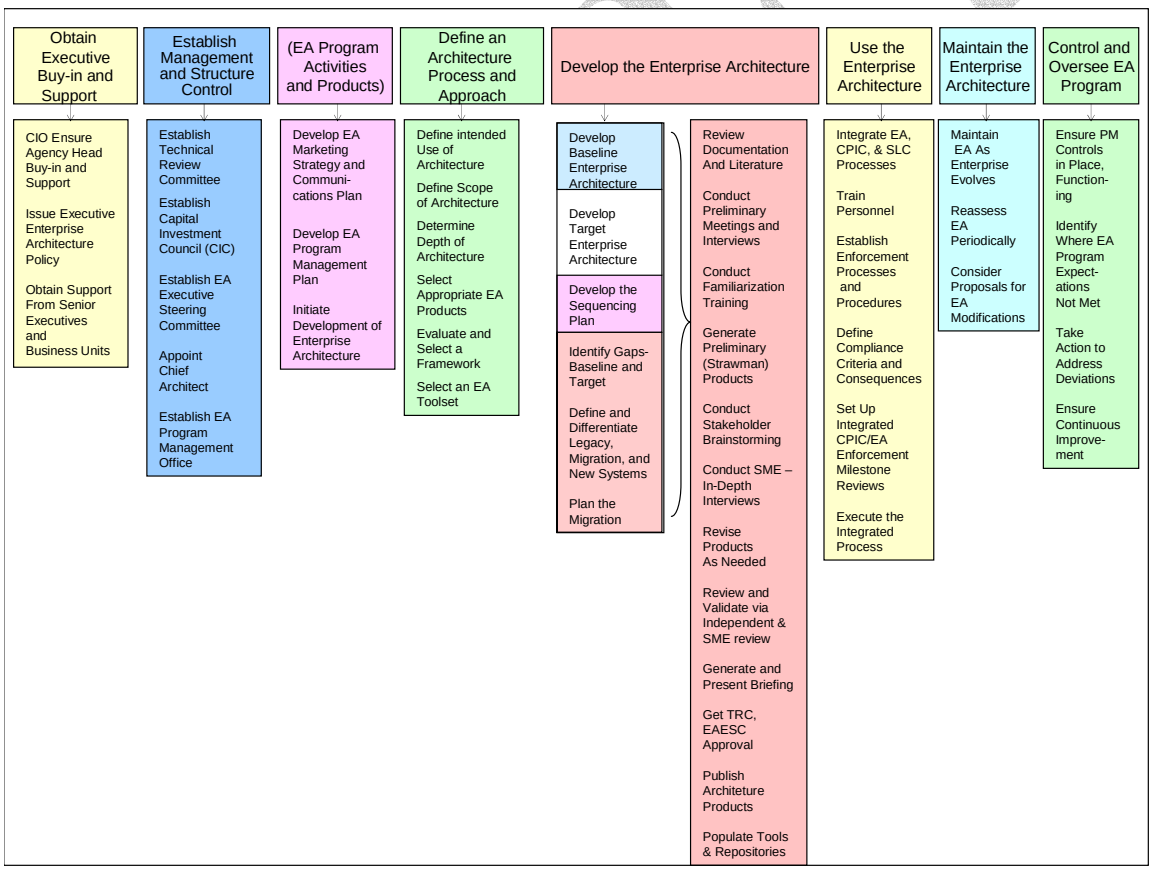


Figure 5. Process Steps from the Practical Guide

[25] Based on statement by Spewak at FEAF revision Committee meeting.

3.3.6 TOGAF Architecture Development Method (ADM)

The Open Group Architecture Framework (TOGAF) Architecture Development Method (ADM) describes a method to develop an EA.[26] Figure 6 shows the phases in the ADM architecture development cycle. The TOGAF includes a description of each phase including its objective, key steps in the phase, inputs and outputs. The TOGAF also contains materials on a technical architecture framework and standards, principles, its relationship to other frameworks, and other topics.

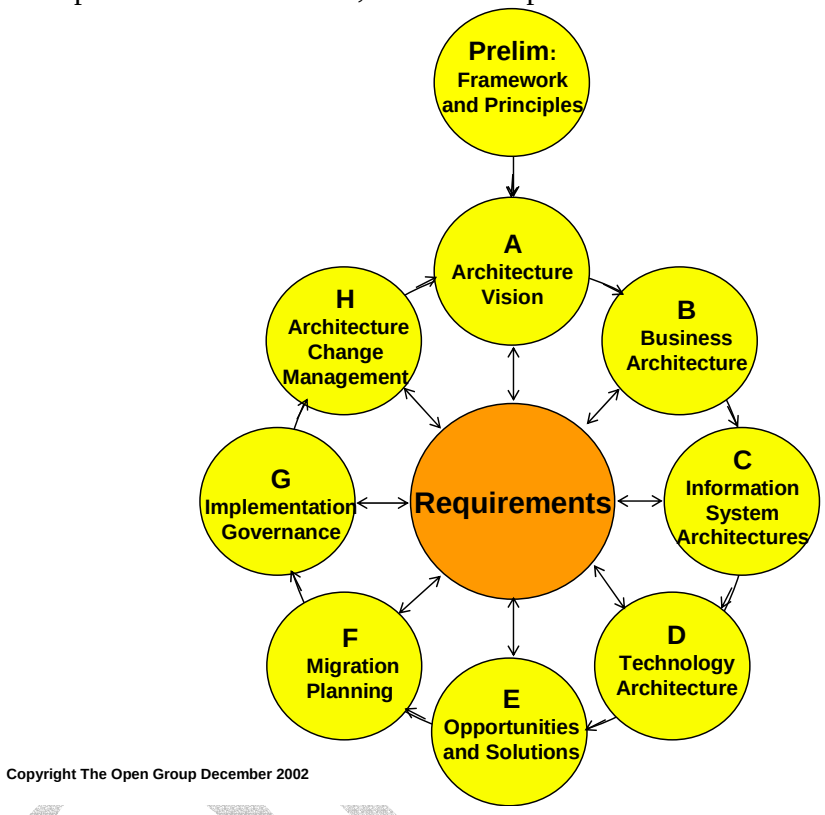


Figure 6. TOGAF ADM Architecture Development Cycle

3.3.7 Levis Process for Developing Products for the C4ISR (DODAF) Framework

Alexander H. Levis has developed a seven step process for developing architectures according to the the C4ISR Framework, predecessor to the DODAF. His process is taught in classes at George Mason University.

[26] Source: The Open Group Architecture Framework (TOGAF) Version 8.

Step	Products Produced
Step 0: Problem Definition and Collection of Domain Information	
Step 1: Operational Concept and Requirements	**High Level Concept (OV-1)**
Step 2: Functions and Organizations	
Step 3: Information and Operational Elements, System Nodes	**Command Relationships Chart (OV-4)**
Step 4: Needlines, System Elements, and Functions	**Operational Information Exchange Matrix (OV-3)** **System State Transition Description (SV 10b)**
Step 5: Activity Model, Logical Data Model, and Task Allocation	**Activity Model (OV-5)** **Operational Activity to System Function Traceability Mtx (SV-5)** **System Evolution Description (SV-8)** **Logical Data Model (OV-7)**
Step 6: Operational Rules, Interfaces, System Performance	**OV 6a, OV3, OV 6b, SV 11, SV 2, SV 3, SV 1, SV 4, SV 6, SV 7**

Figure 7. Steps in the Levis Process for Developing Architectures according to the C4ISR Framework

3.3.8 Other EA Development Processes

The Department of the Navy, Air Force, and other organizations each have their own processes for developing EAs. The Navy Architecture Development Process Model (ADPM) is described briefly in the DODAF Deskbook Segment 2, Section 2.4. It includes a work breakdown structure and lessons learned. The ADPM is available on the DONCIO website HTTP://WWW.DONCIO.NAVY.MIL. Follow the links to the Architecture and Standards area.

References

DoD Architecture Framework (DODAF) Deskbook Version 1 DRAFT aitc.aitcnet.org/dodfw

Spewak, Steven H., *Enterprise Architecture Planning*, New York: John Wiley and Sons (Copyright approximately 1993, 1995).

Spewak, Steven company Enterprise Architects, Inc. web site http://www.eap.com

Chief Information Officer Council, *A Practical Guide to the Federal Enterprise Architecture*, Version 1.0, February 2001.

Bienvenu, M., I. Shin, and A. Levis, C4ISR Architectures III: An Object-Oriented Approach for Architecture Design, Systems Engineering, Vol. 3, No. 4, Fall 2000.

The Open Group Architecture Framework (TOGAF) Version 8 Enterprise Edition. http://www.opengroup.org/architecture/

Levis, A., and L. Wagenhals, C4ISR Architectures I: Developing a Process for C4ISR Architecture Design, **To be published**, Systems Engineering, Vol. 3, No. 4, Fall 2000.

Wagenhals, L., I. Shin, D. Kim, & A. Levis, C4ISR Architectures II: A Structured Analysis Approach for Architecture Design, Fall 2000**, to be published**, Systems Engineering, Vol. 3, No. 4.

Navy ADPM process description http://www.doncio.navy.mil

3.4 Modeling Methods[27]

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Table of Contents

3.4.1 Introduction

Economy demands that all elements of an enterprise fit together and work well with minimal investment while taking advantage of reuse and eliminating unnecessary redundant efforts. Elements of an enterprise include the business processes, organizations responsible for them, information and systems data they need to inter-operate, information technology (IT) capabilities, systems, infrastructure, and specific technical standards that facilitate their inter-operation. An enterprise architecture (EA) describes these elements, their structures, and inter-relationships to facilitate capital planning and IT development sequencing.

EA models allow understanding and visualization of enterprise elements and their relationships, and facilitate analysis. The modeling done for Enterprise Architecture includes many aspects of the enterprise such as business processes, resources (people as

[27] Revised October 2003

well as IT and other equipment), systems, infrastructure, and so on. By way of comparison, software design models are used in software and systems analysis. Similarly, EA models addresses enterprise elements at different levels of detail and have a broader scope. Figure 1 shows some of the differences in elements modeled and modeling techniques used in software, system, and enterprise models.

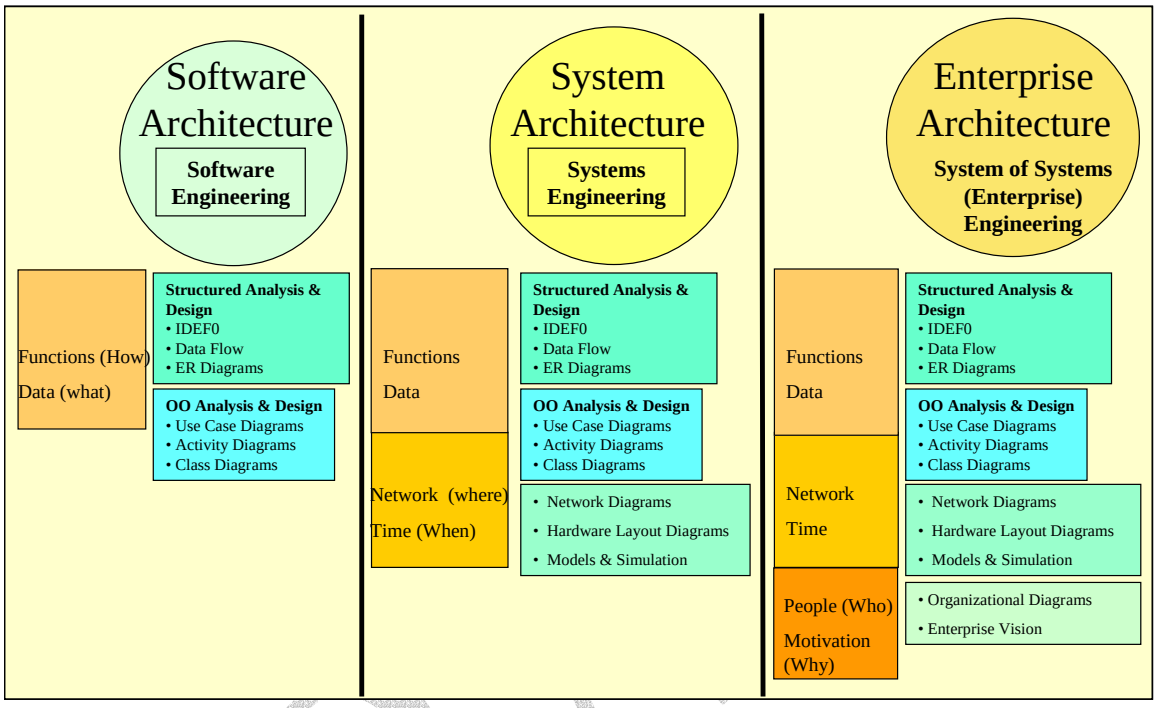


Figure 1. Differences in Elements Modeled and Modeling Approaches

The following sections identify some modeling issues and techniques for modeling the business and data of an enterprise.

3.4.2 The Business Process Model

The sophistication of the enterprise architecture business model has ranged from the simple activity hierarchy chart to extensive business process, software, and information flow modeling notations (e.g., BPMN [BPMI, 2002], IDEF0 [FIPS 183 1993], and UML [OMG, 2002]). The practitioner must determine the reason(s) for modeling the processes, the elements related to processes wanted, the organization strategy for the processes, the process modeling technique, and the level of detail needed to begin the modeling process.

3.4.2.1 Purpose of the Business Process Model

There are many reasons to create a business model, for example:

1. Get a first round general picture of how the enterprise operates
2. Identify the current authority and accountability for the process
3. Show the relationship other elements like IT, data, etc.
4. Provide a communications tool
5. Provide a basis for cost modeling

6. Provide a basis for simulation
7. Provide a basis for performance assessments
8. Provide a basis for process reengineering
9. Define new methods or processes
10. Provide a basis for systems development
11. Show the future or expected manner of operation
12. Show alignment with other business processes in other organizations

The reasons for developing a business process model affect the information to be shown, the level of detail needed, the type of model, process breakdown or categories, and the relationships shown to other aspects of an enterprise such as its data, organizations, and information systems. For example, the categories of business processes used for cost analysis may be more closely related to budget line items whereas business processes for IT design may be more closely related to decomposition for communications or system boundary separation. No matter what reason for developing the business model is chosen, as a resource describing the business, the model will in all likelihood be adapted for other purposes as well.

Models also typically have viewpoints. A *viewpoint* is an abstraction that yields a specification of the whole enterprise related to a particular set of concerns (adapted from [RM-ODP 1996]. Business models could be presented as the executive sees the company, the service provider, the customer, IT needs, accounting, etc. The viewpoint affects what information is modeled, what detail is captured, and sometimes the style of presentation. The Zachman EA Framework represents the views of five users of the EA - the planner, owner, designer, builder, and subcontractor in each of the five rows, each with different associated models and different information in the models. Other possible viewpoints might be that of the Citizen or that of a particular Government Agency.

3.4.2.2. Business Process Model Content

It may seem obvious that the business model is going to model the business activities, but some models model capabilities, some high level functions, some processes, some activities. The following list suggests the variety than can be included depending on the intended uses of the model.

- Activities
- Capabilities
- High-level Functions
- Processes
- Resources
- People
- Organizations
- Locations
- Data used or generated (inputs and outputs)
- It Systems
- Equipment
- Costs
- Roles
- Time required
- Relative timing
- Sequencing
- Dependencies
- Coordination requirements
- Collaboration
- Constraints
- Controls
- Parallelism possible
- Decision points
- Business rules
- Automated or manual activities
- Transaction vs. processes distinction

3.4.2.3 Process Modeling Techniques

This section discusses various popular techniques for business process modeling and does not include a discussion of other modeling techniques (such as modeling the dynamic behavior of a software system). Styles of modeling business processes have come out of the business process reengineering, cost modeling, and system/software engineering arenas. Table 1 shows some methods and the type of information they portray. The following sections discuss some of the techniques and point the reader to fuller discussions of them. The discussion will address only styles of diagrams (methodologies) to show what the style has to offer to allow the reader to determine whether he may want to explore it further.

Table 1. Information portrayed by Modeling Techniques

Category	Examples	Reference	Information Depicted
User requirements and business tasks	BPMN UML Use Case Diagrams	[BPMI, 2002] [OMG, 2001]	Business process flow The use cases represent functionality of a system or a classifier, like a subsystem or a class, as manifested to external actors with the system or the classifier.
Task Dependency	PERT Chart Gannt Chart Flow Chart Decision Point Diagram UML Activity Diagram	 [OMG, 2001]	Activity breakdown Required sequences Schedule (for Gantt charts) Components, decisions (for Flow Charts) Complex Decisions (for Decision Point Diagram)
Information Flow	BPMN Data Flow Diagram (DFDs) IDEF0 Diagram UML Sequence Diagram	BPMI, 2002 [DeMarco 1979], [GANE 1977], [Yourdon 1989] [FIPS 183 1993] [OMG, 2001]	Information Flow Activity breakdown Activity inputs, outputs Mechanisms, controls (for IDEF0)
Work Flow	IDEF3 Model BPMN	[IDEF3, 1995] [BPMI, 2002]	Activity breakdown, Role assignments Modeling of complex business processes with consideration for implementation, architecture, and technology in environments such as Web Services.
Dynamic Behavior Event-Trace Diagram	UML Sequence Diagram	[OMG, 2001]	Sequence and timing of operations, events, and information flow
Dynamic Behavior State Transition Diagram	Petri-Nets, Harel Statecharts UML State Transition Diagrams	[Kristensen, 1998] [HAREL 1987a,b] [OMG, 2001]	the states which the system may be in and the transitions between these states

3.4.2.3.1 A Simple Function Hierarchy Chart

The function hierarchy chart, sometimes called a node tree diagram, lists the high level functions of the business in a hierarchical decomposition (See Figure 2). It usually goes to three or four levels of detail. The diagram is usually presented in one of two forms. One uses a columnar arrangement of the activities as shown below. The other has a more inverted tree branches-like appearance. The choice of which style to use is the modeler's and will depend on the number of boxes – breadth and depth of the hierarchy - to be presented and the customary practice of the modeling group. The chart provides no detail on, for example, IT systems used, locations, or organizations. The chart does confront the issues of what are the business functions, and how to organize and separate functions. Depending on the skill of the modeler, they may give some sense of process flow or business organization structure. Hierarchical function charts provide a quick context reference with no distraction by other information. They can be useful even if a more sophisticated model is available.

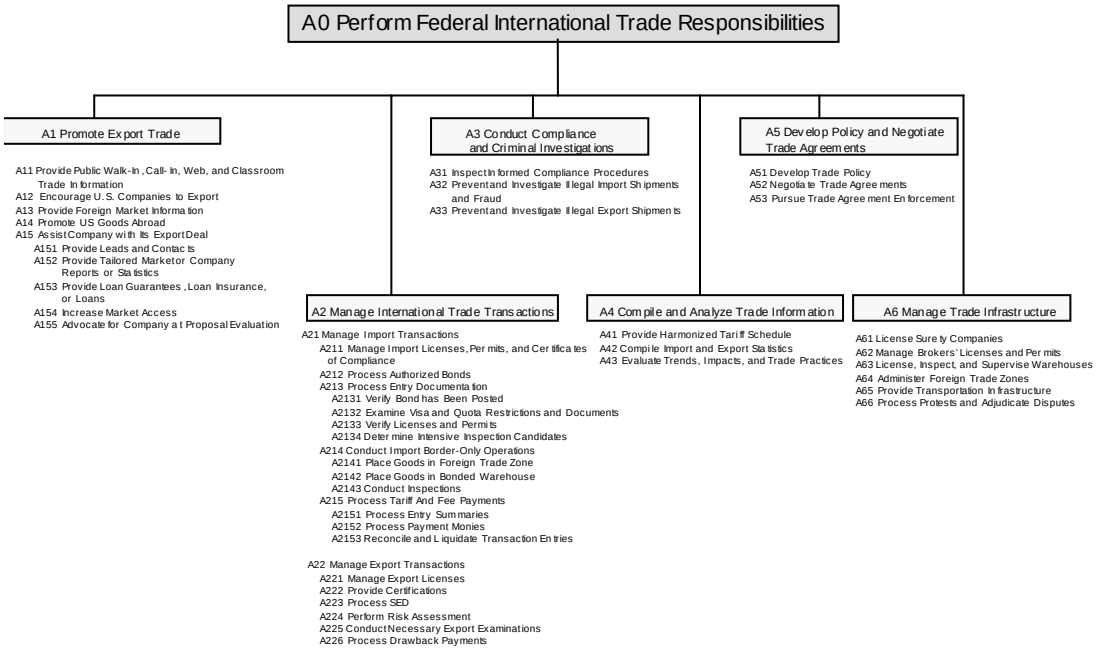


Figure 2 Example of a Hierarchy Function Chart

3.4.2.3.2 Business Process Management Notation

Editor's Comment: This topic will be addressed more thoroughly in a future edition.
Business Process Management Notation (BPMN) is a standard notation for business process modeling that is the result of the Business Process Management Initiative. The initiative (BPMI.org) is a non-profit corporation whose mission is to promote and develop the use of Business Process Management (BPM) through the establishment of standards for process design, deployment, execution, maintenance, and optimization. BPMI.org develops open specifications, assists IT vendors for marketing their

implementations, and supports businesses for using Business Process Management technologies.

BPMN will provide businesses with the capability of defining and understanding their internal and external business procedures through a Business Process Diagram, which will give organizations the ability to communicate these procedures in a standard manner. BPMN will also be supported with an internal model that will enable the generation of executable BPML.

BPMN provides a standardized notation for defining internal and external business processes and a formal mechanism to generate an executable business process (such as the Business Process Modeling Language [BPML]) from the Business Level notation. BPML is a meta-language for the modeling of business processes, just as XML is a meta-language for the modeling of business data. BPML provides an abstracted execution model for collaborative & transactional business processes based on the concept of a transactional finite-state machine.

In much the same way XML documents are usually described in a specific XML Schema layered on top of the eXtensible Markup Language, BPML processes can be described in a specific business process modeling language layered on top of the extensible BPML XML Schema. BPML represents business processes as the interleaving of control flow, data flow, and event flow, while adding orthogonal design capabilities for business rules, security roles, and transaction contexts.

BPMI.org also defines open specifications, such as the Business Process Query Language (BPQL), that will enable the standards-based management of e-Business processes with forthcoming Business Process Management Systems (BPMS), in much the same way SQL enabled the standards-based management of business data with off-the-shelf Database Management Systems (DBMSs).
The first draft of BPML was made available to the public on March 8, 2001.

3.4.2.3.3 UML Diagrams

The Unified Modeling Language (UML) is a modeling language devoid of a methodology or a modeling process. The UML is maintained as a standard by the Object Management Group [OMG, 2002] which is composed of a broad consortium of major companies. The UML contributes several styles of diagrams that are useful for modeling business processes. A diagram is a view into a model, presented from the aspect of a particular stakeholder. It provides a partial representation of the system (or enterprise), and it is semantically consistent with other views. A diagram is a graphical representation of a set of elements, most often rendered as a connected graph of vertices (things) and arcs (relationships). UML diagrams include:

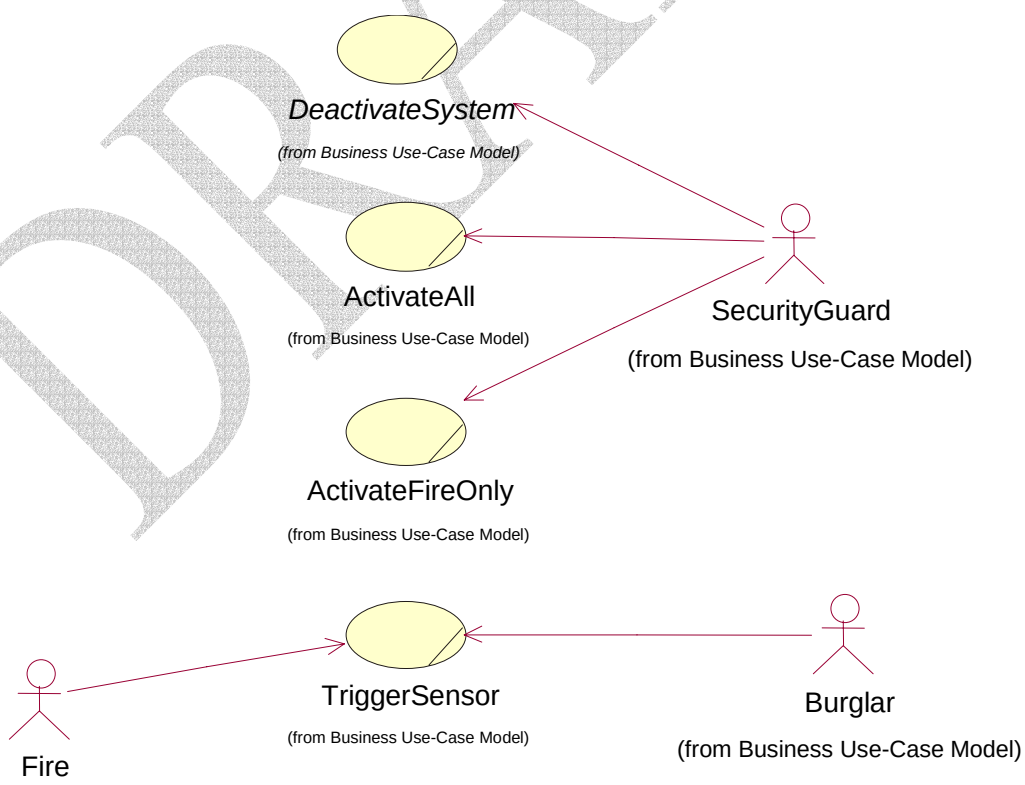
- Class diagram
- Object diagram
- Behavior diagrams:
    - Use Case Diagram

  - Statechart diagram
  - Activity diagram
  - Interaction diagrams:
    - Sequence diagram
    - Collaboration diagram
- Implementation diagrams:
  - Component diagram
  - Deployment diagram

The underlying UML integrates these different perspectives so that a consistent and integrated system can be analyzed and built.

The use case describes the behavior of a system or other semantic entity, like an enterprise, without revealing the entities internal structure. More formally a Use Case is "A specification of sequences of actions including variant sequences and error sequences, that a system, subsystem or class can perform by interacting with outside actors." Use case diagrams show actors and use cases together with their relationships Use cases are sometimes expressed as narratives. Figure 3 shows an example of a Use Case Diagram.

Figure 3. Example Use Case Diagram



Use Case Interaction Diagrams consist of sequence diagrams or collaboration diagrams (equivalent). They show:

- Roles (classes) or their instantiated objects
- Association roles Or links (in case of instantiated diagrams)
- Messages and message flow

Sequence diagrams describe the time-ordered sequence of messages sent between instances. The sequence diagram is also called an event trace or event flow diagram in some methodologies. Sequence diagrams show the sequence of events that occurs between sending and receiving participants – objects, usually for a scenario describing a business process or transaction. Event trace diagrams are good for capturing the sequence of actions. Figure 4 shows an example of a sequence diagram.

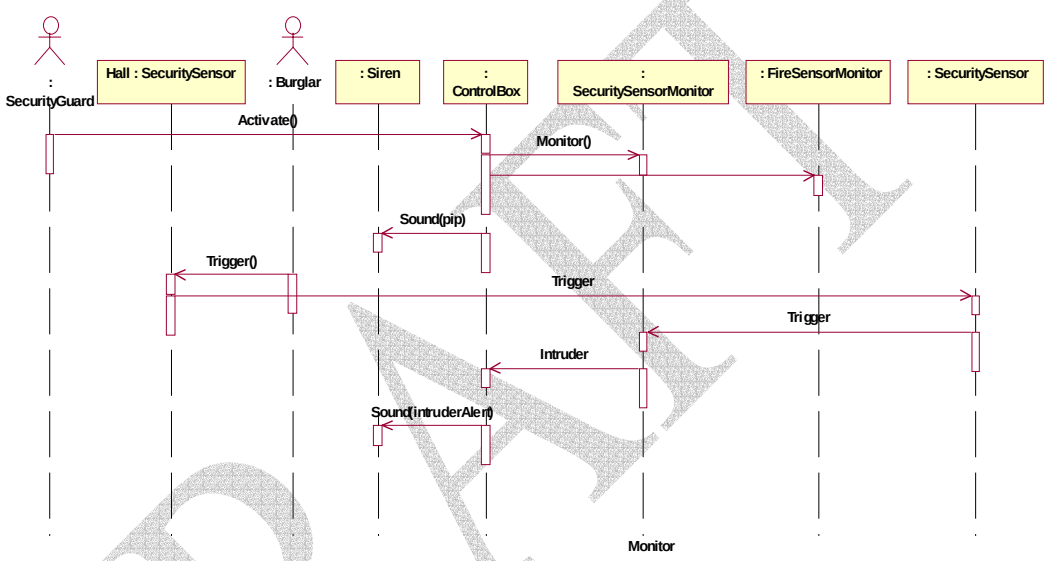


Figure 4. Example of a Sequence Diagram

Activity diagrams model a process as a collection of activities and transitions between those activities, i.e., they model the dynamic behavior of the business processes.

- Typically attached to (to capture the behavior of):
  - Use cases
  - Classes
  - Interfaces
  - Components (a collection of classes that realize a use case or use cases)
  - Nodes (a collection of components/software and other components/hardware)
  - Operations (within classes and objects)

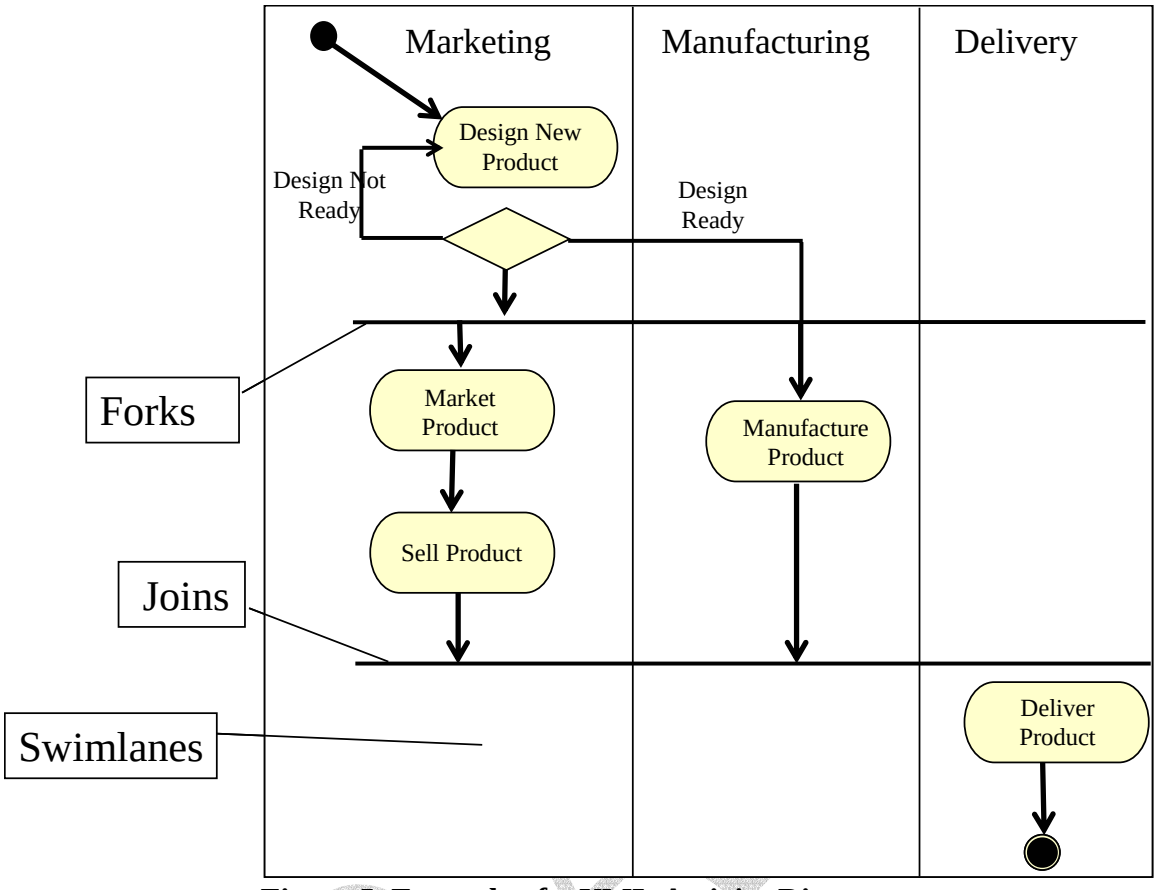


Figure 5. Example of a UML Activity Diagram

The DoDAF provides suggestions on using UML with the DODAF products. The examples are useful to consider using UML with any framework's business process models.

3.4.2.3.4 IDEF0 Diagrams

'IDEF function modeling is designed to represent the decisions, actions, and activities of an existing or prospective organization or system. IDEF0 graphics and accompanying text are presented in an organized and systematic way to gain understanding, support analysis, provide logic for potential changes, specify requirements, and support system-level design and integration activities. (from IDEF 0 standard document)' IDEF0 is used heavily in military and industrial environments. The references cite the standard for IDEF0 Modeling. IDEF0 has a top level context diagram, decomposition diagrams, and facing page text that describes the diagrams.

The Context Diagram establishes the bounds for the model and depicts the major Inputs, Controls, Outputs, and Mechanisms (ICOMS) used to perform the activity as shown in Figure 6. The diagram consists of a single box and its related ICOMS. It sets the general context and scope of what is being modeled and displays the purpose and viewpoint of the model. This diagram is labeled A-0 (A minus 0).

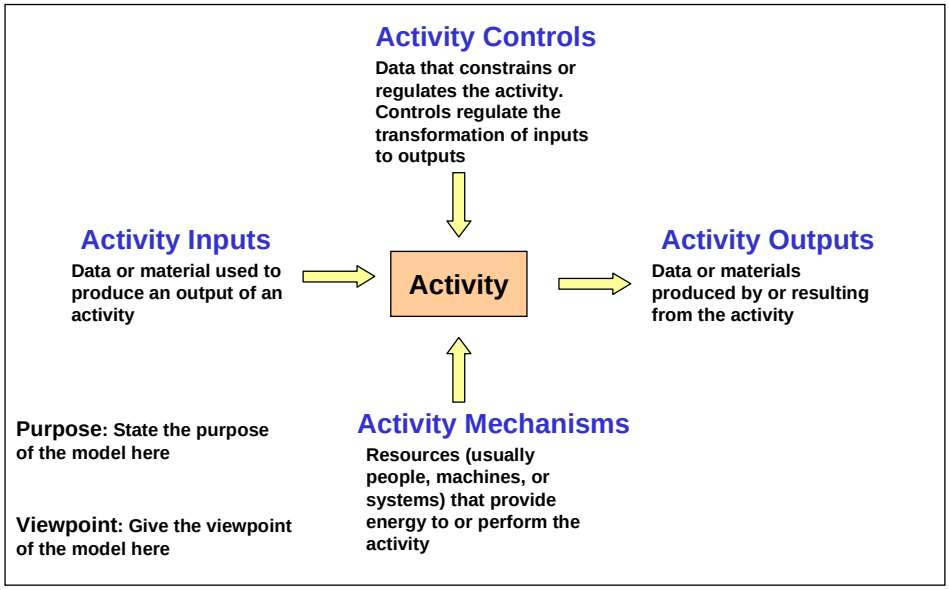


Figure 6. IDEF0 Context Diagram Style

The Decomposition Diagram describes the components of an activity and their relationships to one another (See Figure 7). The diagrams also show the flow of ICOMs among activities. A decomposition diagram shows only one level of decomposition below its parent on each page. The first decomposition diagram of a model is labeled A0. The subsequent second level decomposition diagrams are labeled with the number of the box within A0 that they refine, e.g., A1 or A3. Third level decomposition labels could be, for example, A11 for a box that refines A1 or A32 for a box that refines A3. There is no significance to the size of boxes. Some are larger to accommodate spacing ICOMs neatly. By tradition the boxes are arranged upper left to lower right within a page. The order of boxes on the page does not imply a sequence of operations. Figure 8 shows an example of an Activity Decomposition Diagram.

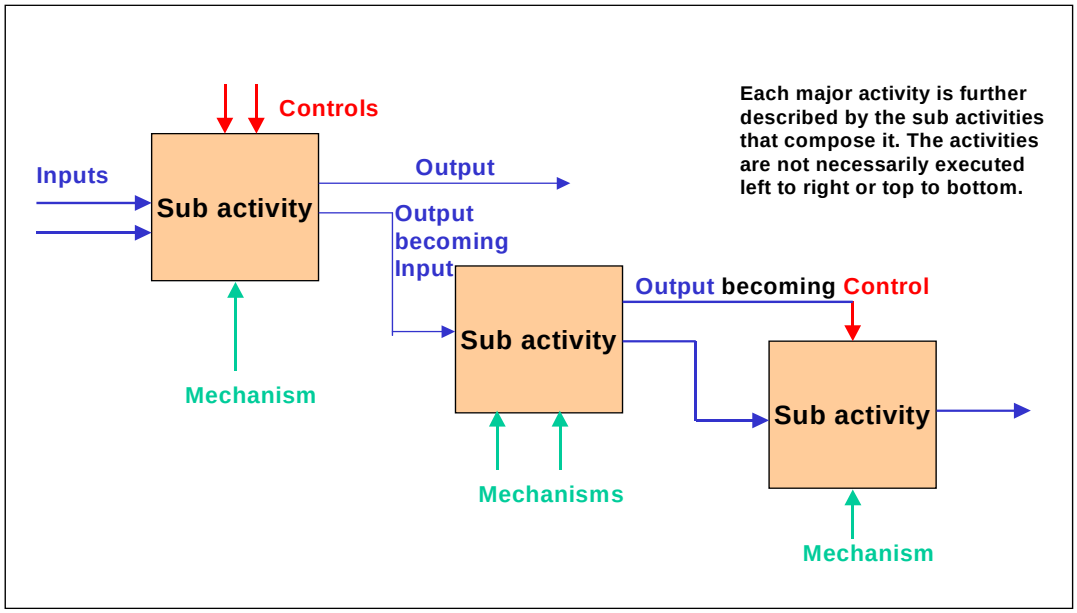


Figure 7. IDEF0 Decomposition Diagram Style

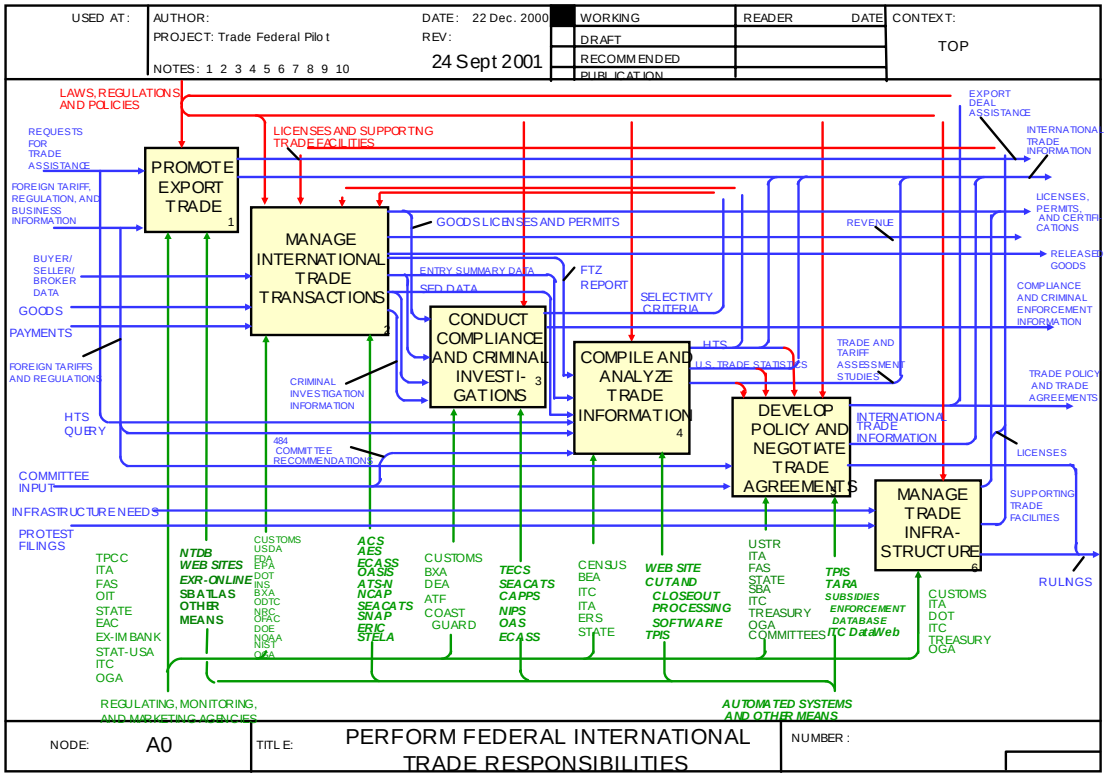


Figure 8. Example of IDEF0 Activity Decomposition Diagram

While each diagram should, by and large, stand on its own, IDEF0 adds facing page text for the diagram to provide a place to explain ambiguities or additional details not evident in the diagram. The A-0 facing page text emphasizes the purpose and viewpoint of the model and the high-level ICOMs. The A0 facing page text description emphasizes the interaction among the high-level activities performed. Lower level decomposition diagram facing page text emphasizes the interactions between the activities and how the activities support each other. The text can address input, output, control, or mechanism issues, who is involved in performing the activity, anomalies, what could change a process, who approves the outputs, or other aspects of interest.

3.4.2.4 Organizing the Business Processes - Value Chain (Management) Analysis

Michael Porter introduced the concept of Value Chains in his 1985 book *Competitive Advantage* as the basic tool providing a systematic way of examining all the activities a firm performs and how they interact to analyze the sources of competitive advantage. The value chain disaggregates a firm into its strategically relevant activities to understand the behavior of costs and the existing and potential sources of differentiation. Differentiation refers to a firm differentiating itself, services, or products in its target markets from its competitors.

A Value Chain is a system of interdependent activities. “Every firm’s value chain is composed of nine generic categories of activities which are linked together in

characteristic ways. There are five generic primary activities as shown in Figure 9. Which category is vital depends on the industry the firm is engaged in. There are four generic support activities and three categories within each type: Direct, Indirect, and Quality Assurance.

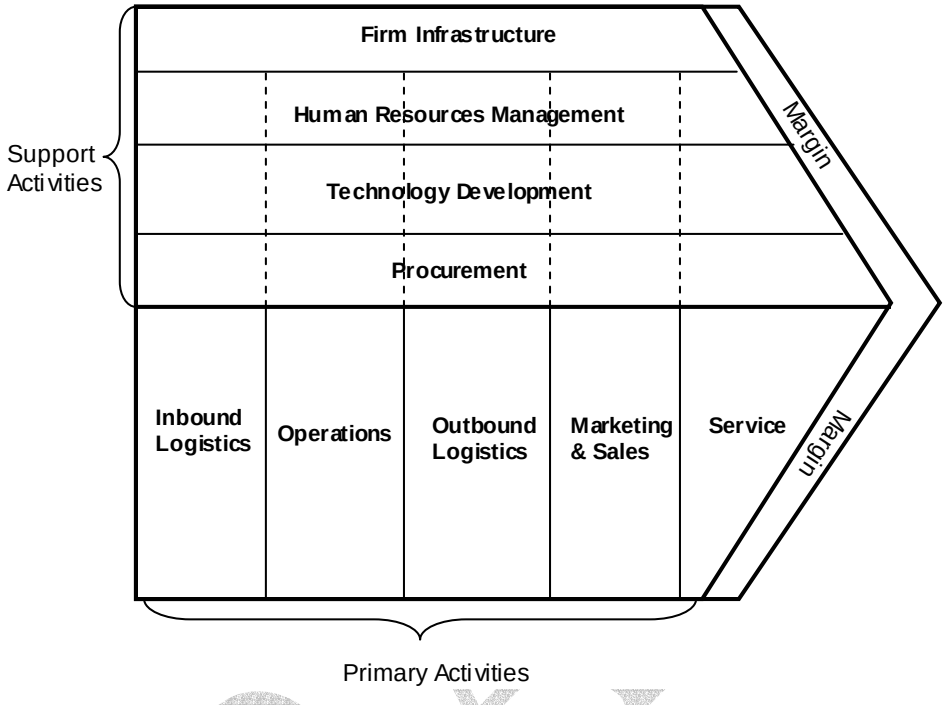


Figure 9. Porter's Generic Value Chain

Each firm constructs its own value chain for the particular activities it performs. The value chain provides a systematic way to divide a firm into its discrete activities, and thus can be used to examine how the activities of a firm are and could be grouped – how to group organizational units. The need for coordination and integration is indicated in linkages between value activities. Value activities are the physically and technologically distinct activities a firm performs. Every value activity uses purchased inputs, human resources, and some form of technology to perform its function. Each activity also creates and uses information, and may create financial assets and liabilities.

Identification of value activities requires the isolation of activities that are technologically and strategically distinct. The ordering of activities should broadly follow the process flow. Some activities are done in parallel. "The appropriate degree of disaggregation depends on the economics of the activities and the purposes for which the value chain is being analyzed." Some basic principles are to isolate and separate those activities that have 1) different economies, 2) have high potential impact of differentiation, or 3) represent a significant or growing proportion of cost. Assigning activities to the appropriate category may require judgment. Place them based on the best representation of their contribution to competitive advantage. Activities are related by linkages within the value chain.

Further explanations of value chain analysis can be found in references by Porter.

Using the concept of a value chain provides an organizing strategy for other modeling approaches.

3.4.2.5 General Advice - Future

This material may belong in Chapter 5.

Selecting a technique
What detail to include
Level of Detail – *Determine whether this goes in planning, here, or engineering*
Some general rules of thumb.
Sometimes see guidance that says 150-300 processes.
Sometimes see 3-4 levels of detail.
If the top layer contained 5 processes, the second layer provided 5 processes of each of those, and the third layer provided 5 processes for each of those, one would have 125 processes. Also see one estimate that says 8-12 per parent breakdown, 4 levels which would yield around 1500 processes.
Where to Place Emphasis
Some general guidelines are to:

1) Develop those areas where you plan to make investments. Develop them to sufficient level of detail that you can see the new projects you intend to develop.
2) Develop areas where you are experiencing difficulties such as performance problems or coordination problems.
3) Develop nontrivial areas where there is high turnover and constant training needs.
4) Develop areas where you will have significant interaction with other organizations and the interface needs to be well defined.

Shortcoming of the hierarchy
What makes the model useful
What makes the model useless
Relating the business process model to IT
Distinguish transaction modeling, process modeling, product production processes

3.4.2.6 Related Disciplines - Future

Editor's Note: This material may belong elsewhere, possibly in the section on using the EA.

3.4.2.6.1 Business Process Reengineering (BPR)

Discuss how Pareto charts, fishbone charts, etc. relate to the diagrams and models producted for an EA, how they are different, how the EA supports BPR– show samples

Discuss relationship with Six Sigma (but a process, not a business modeling technique per see
Goals-Means (Multi-Level Flow Modeling (MFM) – Check if value – Lind, M. The Use of Flow Models for Automated Plant Diagnosis, Human Detection and Diagnosis of System Failures, J Rasmussen & W.B. Rouse eds, London: Plenum Press, 1981, pp 411-432.

3.4.2.6.2 Activity Based Costing – Future

Explain how EA Models can support ABC, different needs of the two models

References

General Modeling

[DeMarco 1979] DeMarco, Tom, Structured Analysis and Systems Specification, Prentice-Hall, Englewood Cliffs, New Jersey, 1979.
[GANE 1977] Gane, , and T. Sarson, "Structured Systems Analysis: Tools and Techniques", McDonnell Douglas Information, June 1977
Gou, Hongmei, Huang, Biqing, Liu, Wenhuang, Ren, Shouju, and Li, Yu, Petri-Net-Based Business Process Modeling for Virtual Enterprises, IEEE 2000. Shows extensions for process modeling.
[HAREL 1987a] Harel, D., Statecharts: A visual Formalism for complex systems, The Science of Computer Programming, 1987, 8, pp. 231-274.
[HAREL 1987b] Harel, D., A. Pnueli, J.P. Schmidt, and R. Sherman, On The Formal Semantics of Statecharts, Proceedings, Second IEEE Symposium, Logic Computer Science, Dorset House, New York, 1987, pp. 54-64.
[IEEE Std 1471-2000]IEEE Recommended Practice for Architectural Description of Software-Intensive Systems, The Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY, 2000.
[IEEE, 1990] Institute of Electrical and Electronics Engineers, Inc., IEEE Standard Glossary of Software Engineering Terminology, IEEE STD 610.12-1990, Piscataway, NJ, 1990.
[IEEE, 1995] Institute of Electrical and Electronics Engineers, Inc., Guide to POSIX Open Systems Environment, IEEE STD 1003.0 (ISO/IEC Technical Requirement 14252-1995), Piscataway, NJ, 1995.
[Kristensen, 1998] Lars M. Kristensen, S_ren Christensen, Kurt Jensen, "The Practitioner's Guide To Coloured Petri Nets," Springer-Verlag, 1998
[Jacobson et al., 1992] Jacobson, I; M. Christianson; P. Jonsson; G. Overgaard, Object-Oriented Software Engineering – A Use-Case Driven Approach, Addison-Wesley, 1992.
[Jacobson et al., 1995] Jacobson, I., M. Ericsson, A. Jacobson, The Object Advantage: Business Process Reeingineering with Object technology, Addison-Wesley Publishing Company, Wokingham, England, 1995.
Workflow Management Coalition http://www.wfmc.org

Yokley, Charles, Process Improvement in Enterprise Architecutre (briefing), MITRE Corporation, June 20, 2002.
[Yourdon 1989] Yourdon, Edward., Modern Structured Analysis, ISBN 0-13-598624-9, Prentice-Hall, Englewood Cliffs, New Jersey, 1989.
[Shlaer and Mellor, 1988] Shlaer, S., S. Mellor, J. Stephen, Object-Oriented Systems Analysis: Modeling the World in Data; Yourdon Press, Englewood Cliffs, NJ, April 1988.

BPMI

[BPMI, 2002] Business Process Modeling Notation, *Working Draft (0.9)*, November 13, 2002. http://www.bpmi.org/
[BPMI-Arkin 2002] Assaf Arkin, "Business Process Modeling Language," November 13, 2002

UML

[OMG, 2001] Object Management Group, UML 2001, Unified Modeling Language Specification, Version 1.4, Framingham, Mass., September 2001, Internet: http://www.omg.org,
[OMG, 2003] Object Management Group, *Unified Modeling Language Specification*, Version 1.5, Framingham, Massachusetts, March 2003, Available: Internet: http://www.omg.org/docs/formal/03-03-01.pdf

IDEF

Institute of Electrical and Electronic Engineers, Inc., IEEE Standard for Functional Modeling Language – Syntax and Semantics for IDEF0, IEEE Std 1320.1-1998, 1998.
[FIPS 183 1993] Integration Definition for Function Modeling (IDEF0), Federal Information Processing Standards (FIPS) Publication 183, 21 December 1993.
[FIPS 184 1993] Integration Definition for Data Modeling (IDEF1X), Federal Information Processing Standards (FIPS) Publication 184 21 December 1993.
[IDEF3, 1995] "Information Integration For Concurrent Engineering (IICE) IDEF3 Process Description Capture Method Report," KBSI-IICE-90-STR-01-0592-02, Knowledge Based Systems, Incorporated, 1995

Value Chain

Porter, Michael E., *Competitive Advantage Creating and Sustaining Superior Performance*, New York: The Free Press, 1985, 1998.
Developing a Results Driven Enterprise Architecture, Kimberly McCabe, Advanced Performance and Consulting Group (APCG), Value Chain information Slides 7-9 presented at Sept 11, 2003, eGov Enterprise Architecture Conference, http://www.e-gov.com/events/2003/ea/downloads/

BPR

Dr. Michael Hammer http://www.Hammerandco.com
Six Sigma reference – Panda, DFSS reference - _____

ABC

"Activity-Based Costing, Accounting for Operational Readiness," A concept paper from *The LearningSource*, at the OSD Comptroller iCenter, 2002. From: http://www.dod.mil/comptroller/icenter/learn/abcosting.htm

Daniels, Introduction to Process Modeling and Activity Decomposition, MITRE Institute Class.
Daniels, Activity Flows, MITRE Institute Class.
Fox, Introduction to Data Modeling, MITRE Institute Class.
Fox – Data Modeling Special Topics, MITRE Institute Class.

3.4.3 The Data Model – Future

Describe modeling methods for data and information applicable to the EA.

3.4.4 Other Modeling Methods – Future

Describe other modeling approaches or methods applicable to EA.

NOTES
(Consider the terminology change from business process model A 130 to business practices (Egov 2002 legislation)

Add discussion on what should be in model depending on need, modeling technique Recognize to include this list have a complex model, not primitive approach. Value of tools, database, separation of elements. Recognize dependencies, what can separate and redesign.
Look for T. H. Davenport work

3.5 Architecture Modeling Tools[28]

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The purpose of this section is to provide criteria for evaluating architecture modeling tools and architecture data repository tools that effectively support Enterprise Architecture description needs for any enterprise. The assessment criteria should be customized (and relevant weights assigned) based on the enterprise's intended use of the architecture. Tools are also to be evaluated with respect to an integrated approach for dealing with architecture data elements and architecture design and modeling efforts.

The scope of the evaluation criteria is modeling tools for producing architecture products and repository tools that store data and their metadata. Figure 1 illustrates this scope. Tools for various purposes and uses are illustrated against the system development processes. The scope of this report is limited to the architecture modeling and repository tools shown in the box labeled "Architecture Tools" and does not include other tools (such as acquisition tools or decision support tools).

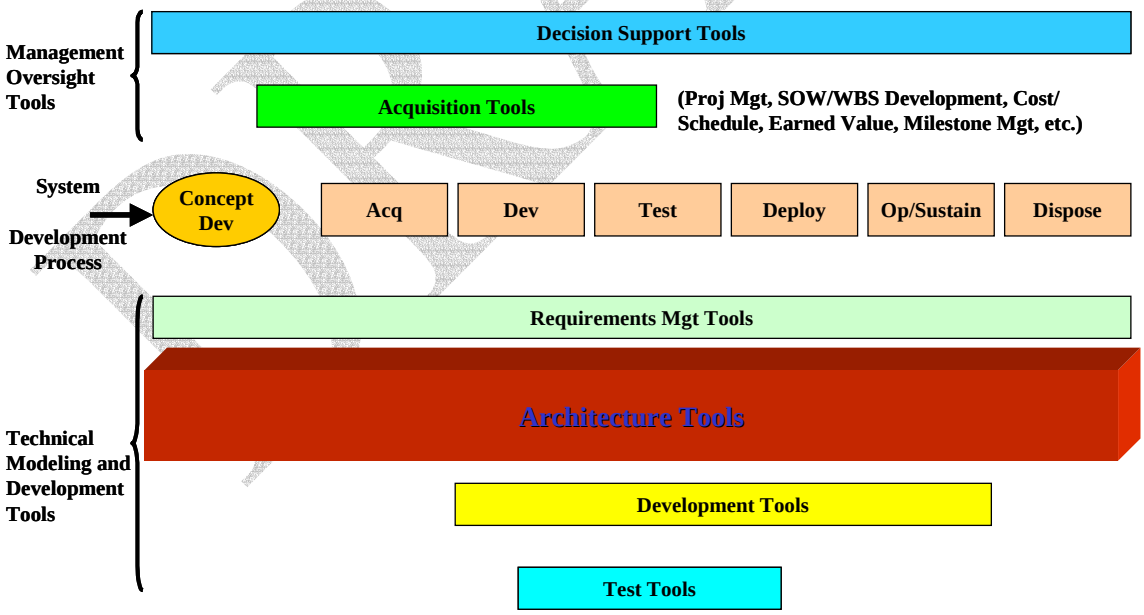

Figure 1. Scope of Architecture Tools with Respect to Other Tools

[28] Revised October 2003

3.5.1 Types of Architecture Tools and Users

An architecture modeling and repository tool set may be used by architects and by managers to:

- Serve as a centralized repository to effect communication
- Organize, integrate, and roll up architecture information across organizations
- Identify Information Technology (IT) systems and standards, and associate them with architecture information
- Include capabilities for configuration and change management
- Facilitate identifying, organizing, and disseminating
    - The mission or vision
    - The operational processes
- Facilitate integrating architecture development within an organization
- Facilitate collaboration, information sharing, and information reuse
- Provide decision makers with better, more consistent information and tools
- Facilitate linking important program milestones and resource decisions to architecture activities

Architecture modeling and repository tools may be grouped into several sets depending on their use in the organization. Figure 2 illustrates these sets, ranging from repository (relational or object-oriented [OO]) tools or database management systems (DBMSs) and development tools that form the foundation for constructing, storing, and manipulating architecture data, and ending with the web viewer tools and report generation tools that present the finished enterprise architecture (EA) models and architecture data to the architecture users who do not need to be expert architects or expert tools users to access and utilize the architecture data to aid them in making decisions.

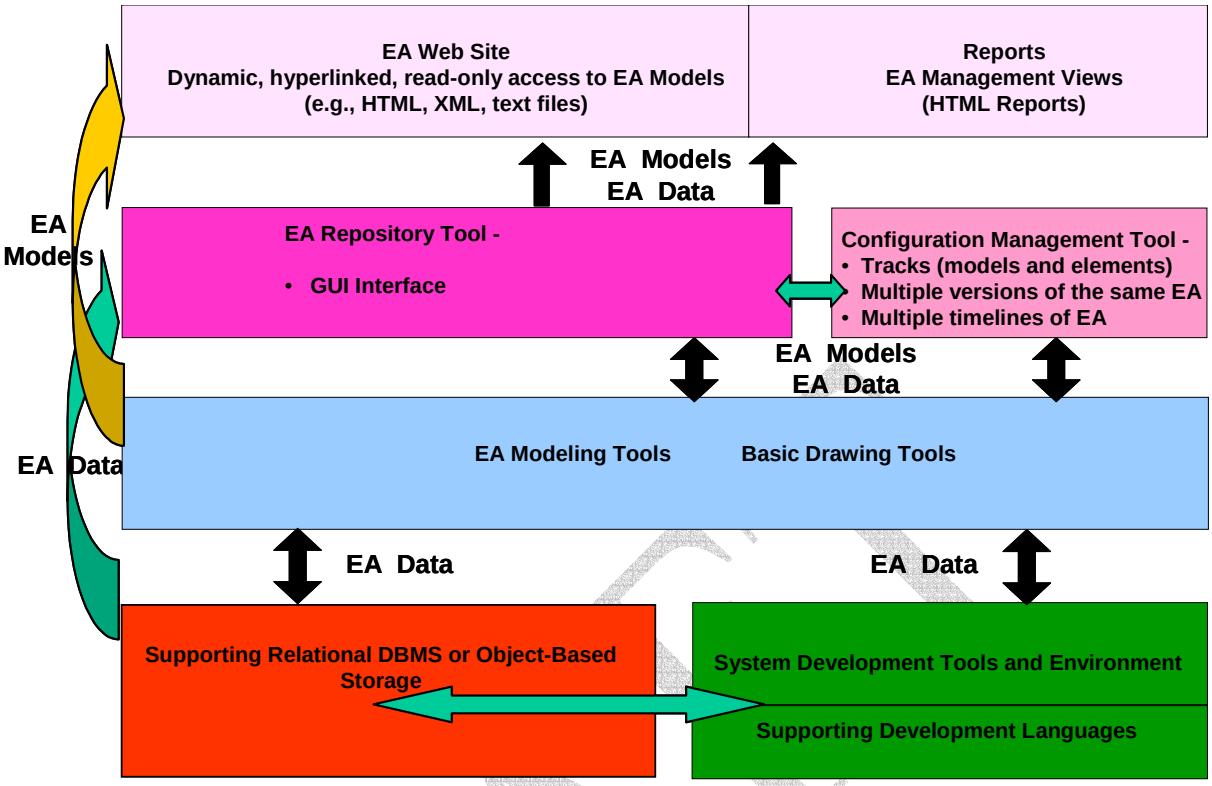

Figure 2. Architecture Modeling and Repository Tool Suite

A variety of users may need to use architecture tools to access architecture information. The following are categories of users:

- Architecture Designers and Developers: Require direct support through modeling, modeling standards, and customization capabilities
- Architects: Need to maintain, update, and oversee the architectural data elements, and work products across the organization
- Planners, Stakeholders, and Management: Need to run analysis, obtain guidance, and evaluate baseline and current models
- Browsers: Need specific views and perspectives of the architecture via technologies such as the HTML

Several user characteristics influence the choice of architecture modeling tools. Users:

- May be in several locations
- Have a variety of IT platforms
- Require numerous mechanisms to access the information
- Can view relatively static information on Web pages
- Have interactive access to components and relationships

Tools for modeling EAs are rapidly changing. Any evaluation that recommends one tool over another would be outdated with each vendor's next release. The reader can consult

latest industry publications on tool evaluations (see References). The following sections provide criteria for evaluating architecture modeling tools and architecture repository tools based on six different evaluation categories coupled with an assessment approach to help the reader select the best tool for his or her environment.

3.5.2 Tool Assessment Criteria

To aid tool users in evaluating and deciding on a tool or tool set for their organization, the following sets of criteria have been developed based on industry best practices and current research on architecture modeling and repository tools.

3.5.2.1 Framework Products Modeling Support – Criteria

The first set of evaluation criteria consists of criteria for evaluating architecture modeling tools or tools whose purpose is to create architecture models or products. Architecture modeling tools should meet the following criteria:

- Ability to roll up and describe an organization's architecture as a high-level summary for use in planning, budgeting, decision analysis, etc.
- Ability to link cost and budgeting information to architecture elements
- Ability to describe the architecture of complex systems for use in system development
- Ability to build an architecture, as described by the Framework of use
- Ability to organize architecture products into views that are subsets of the organization information architecture
- Ability to support views of time-based architecture (i.e., current, current+n months/quarter/years, target)
- Ability to customize and enforce robust traversal relationships between architecture products and architecture data elements
- Ability to perform consistency and completeness checks among the various architecture products
- Ability to choose modeling notation and methodology
- The scope of the products encompasses architecture information description for the whole organization
- The products illustrate the essential information flows and process flows
- Tool offers a variety of industry accepted modeling standards (e.g., Unified Modeling Language [UML], Business Process Modeling Notation [BPMN], etc.)
- Ability to customize data dictionary capability with attributes and relationships, as required by the architecture products
- Ability to support simulation

3.5.2.2 EA Repository Tools – Criteria

The second set of evaluation criteria consists of criteria for evaluating architecture repository tools or tools whose purpose is to create, store, and provide access to architecture data for use in architecture models or products. EA repository tools should meet the following criteria:

- Ability to maintain architecture data in a repository/database using a non-proprietary, commercial (COTS) DBMS based on relational technology, persistent object storage, or using XML
- Ability for user customization and manipulation of the data schema or the persistent object attributes
- Ability to generate custom reports
- Ability to create, update, delete, and retrieve data from repository (knowledge) base using a graphical user interface (GUI)
- Ability to use simple queries to generate high-level, summary reports for management from the architecture data that facilitate acquisition, requirements generation/management, or budgeting decisions
- Ability to populate data repository by importing architecture data elements and data from external data sources

3.5.2.3 Customization Support – Criteria

The third set of evaluation criteria consists of criteria for evaluating the ability of the tool suite to allow customization in support of varying user needs and user environments. A tool suite should support the following:

- Ability to provide formal graphical modeling symbols
- Ability to create custom symbols
- Ability to import third-party graphical symbols
- Ability to add custom icons to the tool's set of modeling symbols
- Ability to customize diagrams
- Ability to create report templates
- Provide an easily extendable internal structure (e.g., ability to add user defined properties)
- A capability to collect and publish various architecture products (diagrams, tables, and requirements) in standard document templates
- Ability to support queries and custom reports within specific architectures and across groups of architectures

3.5.2.4 Interoperability – Criteria

The fourth set of evaluation criteria consists of criteria for evaluating the ability of the tool suite to interoperate with other tools. A tool suite should support the following:

- Ability to integrate with other tools

- Two-way interfaces for architecture models to multiple tools including notation and semantics
- Interface with office automation and productivity tools
- Import/export database information (entities, attributes, and relationships) from other existing DBMSs, or object-based storage using open standards and techniques (e.g., Open Data Base Connectivity [ODBC])
- Ability to support multiple data exchange formats
- Enable data sharing (import/export) with other tools via standard formats (e.g., Comma Separated Values [CSV] file formats, XML, ISO AP233)
- Ability to support defined, published import/export interface (e.g., XMI)
- Provide open standard Application Program Interface (API)

3.5.2.5 General Purpose Characteristics – Criteria

The fifth set of evaluation criteria covered consists of general purpose criteria that apply to any of the tools in the tool suite. A tool suite should support the following:

- Configuration Management of model data
- Ability to create, maintain, and compare different versions
- Ability to group versions by architecture and by product within the architecture
- Ability to support other Configuration Management (CM) functions such as change management and status accounting
- Ability to track ownership of data entered
- Ability to enforce/customize various security standards
- Ability to support a multi-user environment
- Ability to support collaboration among project team members
- Ability to provide read-only Intranet access or ability to generate HTML
- Ability to support direct HTML publishing and/or offer a free viewer
- Ability to support a Web interface (with access to the models or data repository from geographically distributed locations)
- Scalability (to thousands of architectural elements and relationships, and multiple versions of the architecture)
- Adaptability (to new standards, techniques, etc.)
- Support various IT platforms (e.g., Windows, Unix, or both)
- Cost of ownership (initial and ongoing maintenance costs, training costs)
- Usability, refers to the quality of a user's experience when interacting with the EA tool
- Short learning curve, reasonably easy to use
- Ease of use of GUI (e.g., MS Explorer-like interface)

- Ease of use of query capability (e.g., is knowledge of a query language needed?)
- Spell check capability
- Adaptable/customizable user interface

3.5.2.6 Vendor Assessment – Criteria

The sixth set of evaluation criteria is general purpose criteria that apply to tool vendors. Figure 2 highlights the set of tools covered by these criteria. The criteria are listed below.

- Training: The vendor provides training or training material to help users learn how to use the tool. Kinds of training offered should include:
  - Classroom
  - Computer-based training/tutorial
  - Customized training
- Quick training time (3–5 days)
- Technical support
- Online help
- User manuals and support documentation
- Help-desk response time - quality of vendor support
- Maintenance agreement upgrades
- Vendor Stability: The vendor is a recognized, stable tool vendor
- Customer categories and experience (e.g., Military, Federal, private industry, etc.)
- Target market
- Number of installed licenses
- Number of years in business
- Product development history ("roots")
- Tool Release Schedule
- Vendor's future plans for the package

3.5.3 Assessment Approach

The following approach can be used for assessments:

Weights are assigned to evaluation criteria. For example, each criterion can be assigned a weight on a scale from 4 to 1. The weights reflect the users' needs:

4 = must have (i.e., tool must satisfy criterion)

3 = important to have

2 = desirable to have

1 = nice to have

For each criterion, scores are assigned to each tool based on testing results. For example, scores can be based on a 3-point scale:

1 (if tool meets criterion)

0 (if tool does not meet it)

0.5 (if tool only partially meets criterion)

Measurements are calculated for each criterion per each tool based on the criterion weight multiplied by the tool score for that criterion.

Totals for each tool are computed by summing up the total measurements for the tool.

The total obtained for each tool can be compared to totals of other tools, and a final decision can be made based on the totals obtained.

3.5.4 Issues with Choosing a Tool

The following issues exist when dealing with choosing and adopting an architecture and repository tool or tool suite.

- Currently, no one tool(s) meets all criteria. Therefore, users need to choose a tool(s) that currently exists and satisfies immediate needs, and has the potential to meet the criteria in the future.

  Mitigation: Choose a tool(s) that provides the most open interface to industry-standard data formats and to other industry-standard tools.

- Initial investment costs (i.e., cost, training, learning curve) are incurred when introducing new tools and processes.

  Mitigation: Weigh long-term cost-benefit analysis against potential cost overruns if automated tools and new processes are not introduced.

- Several groups are responsible for related architectures but are using non-interoperable architecture tools. This results in disjoint architectures that can be readily compared, or integrated.

  Mitigation: Groups should not be forced to use one "standard" tool. Groups should:

  - Use tools compliant with industry-standard data formats
  - Use tools that follow a common data model
  - Use integrated repository to:
    - -- Bring together architectures and EA data information
    - -- Enable chief architect to make sound investment decisions

3.5.5 Issues with Organizational Use of Automated Tools

Many types of issues are associated with organizational use of architecture modeling tools and repositories including:

- Programmatic issues
  - How to roll up architecture information - authority
- Architecture issues
  - Limited time and resources to define criteria and assessment approach and choose and customize too
  - Resolution of data naming conflicts
- Policy compliance issues
  - While policy requires use of a common data model, there is no enforcement mechanism.
  - A common data taxonomy is needed for interoperability but currently is not supported by policy.

3.5.6 Recommended Solution

A recommended approach is to follow a common data model and to use tools that allow the direct import and export of architecture data between the chosen tools and the data repository. Figure 3 illustrates this recommended approach.

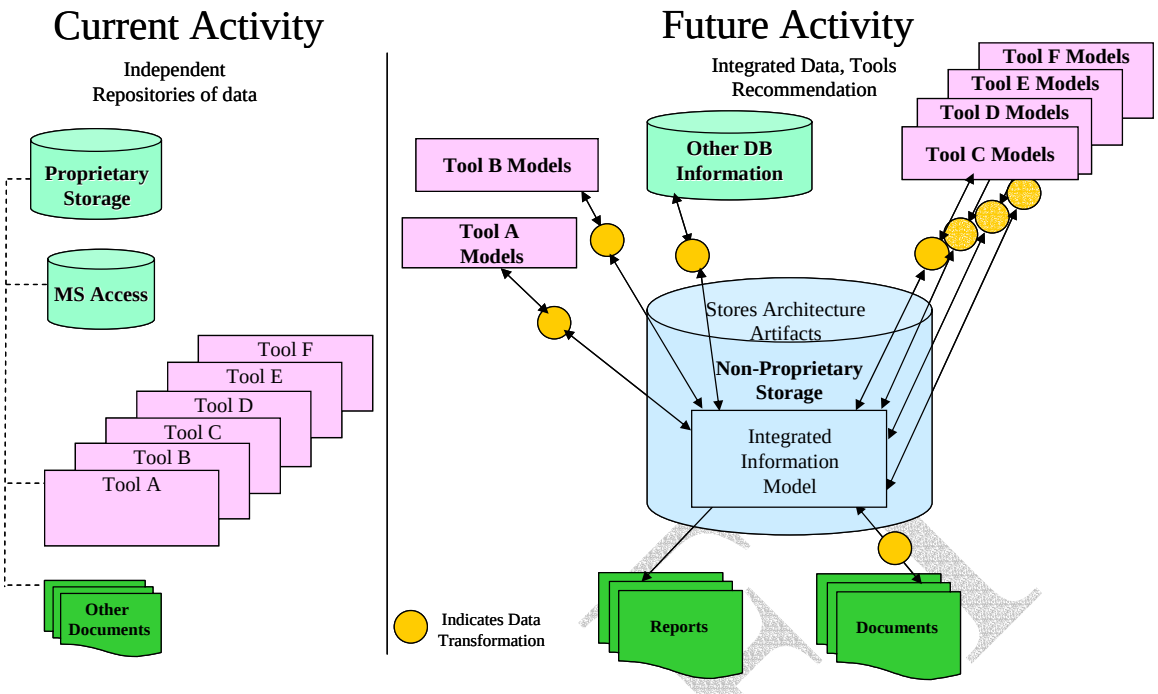

Figure 3. Approaches to utilizing tools in supporting architecture development

References

Dandashi, Dr. Fatma, MITRE, *Architecture Modeling and Repository Tools: Assessment Criteria and Approach*, Briefing sponsored for the Federal CIO Council, October 5, 2002.

Gartner Group, "What Is the Right Scope for a Tool Suite?" COM-13-5238, M. Blechar, Research Note, May 2001

Gartner Group, "IT Metadata Repository Magic Quadrant Update 2002," M. Blechar, Research Note , October 2001

International Council on Systems Engineering (INCOSE) System Architecture, Tools Survey, Available: http://www.incose.org/tools/tooltaxs.html, September 2001.

Comparison of Business Process Modeling Tools, Working Note WN 02W0000049, Pawlowski, T, Payne, D, Hawkins, A, MITRE Corporation, September 2002.
Discusses Bonapart, Extend, and Re-Think

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Chapter 4

4. Establishing and Managing the EA Program

Table of Contents

4.1 EA Policy, Roles, and Responsibilities Supporting Governance

MITRE Internal Draft

4.2 Planning

MITRE Internal Draft

4.3 Tailoring EA Planning, Processes, Products, and Practices to Agency Needs[29]

Editor's Note:
The scope of this section needs to be thought about. Should considerations on tailoring planning to agency needs be put in with the planning sections? Should considerations about tailoring practices and processes be elsewhere? Possibly. But they are decisions which are part of managing the program and agency specific, not generic. This section is a beginning.

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4.3.1 Determining the Information Needed for the Enterprise Architecture

An enterprise architecture (EA), as an information resource, provides input to critical decisions that determine the evolution of the enterprise. These decisions are embedded in key management and technical decision processes that, together, determine how the enterprise will change (Figure 1). They include:

- Strategic planning
- Mission analysis/process
- Portfolio management and the Information Technology (IT) investment decision
- The emerging systems acquisition life cycle, and
- Data management

One approach to developing an EA is to analyze these processes to precisely define the decisions required and the information required to make those decisions. That information will become the content and structure of the enterprise architecture.

[29] Revised January 25, 2004

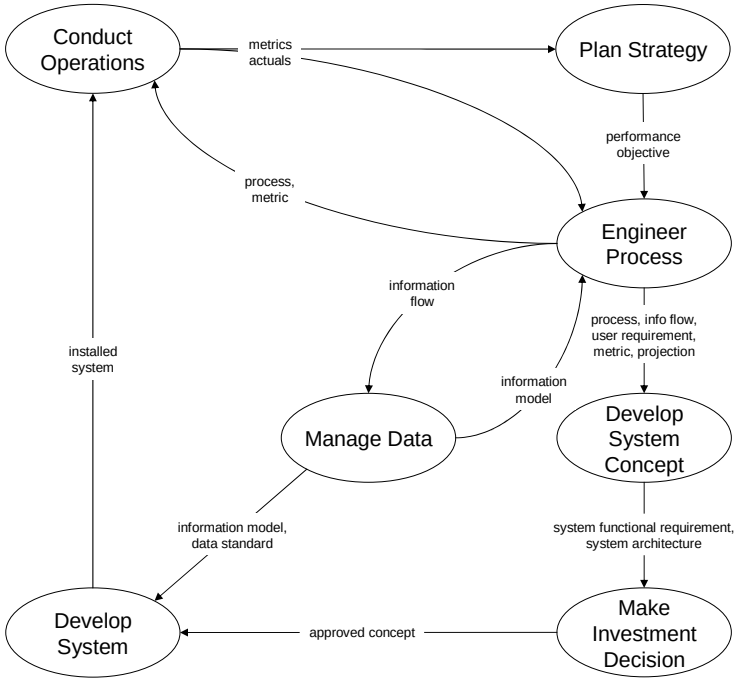

Figure 1. Key Management and Technical Decision Processes

The actual definition and tailoring of the architecture requires six simple steps:

1. Analyze/model the EA goals to determine the intended uses of the architecture and the processes associated with those uses. Determine the decisions that must be made using the information in the EA.
2. Analyze the decisions to identify the information required to make those decisions; analyze any non-decision uses to identify the information required;
3. Re-engineer the decision processes to capture, validate, and consume that information as an integrated architecture, building other improvements as appropriate into the new logical process and ensuring that the enterprise's architecture objectives are fulfilled;
4. Update the decision support information as needed to accommodate process improvements;
5. Model that information as a single, integrated meta-model defining architecture content (the architecture's semantic model);
6. Map the information meta-model into a standard architecture model set – generally taken from an architecture framework – and tailor the model definitions as needed to capture the necessary information.

Editor's Note: Need to relate the above process to the EA development processes described in Chapter 3.

4.3.2 Tailoring EA Products for Specific Circumstances

As part of building in the agency EA objectives into EA processes and product models, the architect may discover agency circumstances or characteristics that impact the information required in the EA. Figure 2 identifies a set of architectural models to support a specific enterprise architecture goal given particular issues that an organization may face in building and applying the EA. The following sections discuss each issue.

AGENCY ISSUE / EA GOAL	Multiple, autonomous communities	Incremental architecture	Unarchitected systems	Uncertain priorities	Uncertain requirements	Controversy
Inform strategic planning	Semantic model			Process model w/ metrics, values (as-is)		
Improve mission processes	Semantic model	High-level process models; foundation semantic model		Process model w/ metrics, values (as-is)	Process model w/ user functional requirements	Decision point model w/ metrics
Tailor IT to mission needs	Semantic model; process model w/ information flows		Transitional process model; system function map	Process model w/ metrics, projections (to-be)	Process model w/ user functional requirements	Fully allocated process model w/ information flows
Prioritize development projects			Transitional system function map	Process model w/ metrics, projections (to-be)		Process model w/ metrics, projections (to-be)
Ensure viable system concept	Semantic model; to-be process model w/ information flows;		Transitional system function map		Process model w/ user functional requirements	Fully allocated process model w/ information flows
Interoperability	Semantic model; process model w/ data sampling, information flows		Transitional system interfaces, transactions			

Figure 2. Architecture Products to Support EA Goals For Given Agency Issues

4.3.2.1 Multiple, Autonomous Communities

For purposes of architecture, there is no such thing as "plain English." Work teams that operate in relative isolation develop separate vocabularies, often with very subtle semantic differences; external contractor or consulting personnel can aggravate the problem. Misinterpretation and misunderstanding can interfere with consensus among teams on any complex issue, including the appropriate IT support for mission and objectives. However, establishing a shared vocabulary among architecture stakeholders can begin with a semantic model, which includes concept relationships that place otherwise unavoidably ambiguous text definitions in context. A process model, cross-referenced to the semantic model through information flow definitions, can further help if it identifies where and how information is generated or captured, and where that information impacts specific decisions. To ensure data interoperability, a process model

may need sufficient detail to define just how processes generate, capture, or sample information, precisely defining its semantics. In most cases, this information suffices to define concepts for the most naïve participants.

4.3.2.2 Incremental Architecture

In many cases, organizations are simply too big and too complex to halt all IT projects and other change initiatives while the organization builds and validates a complete enterprise architecture. However, permitting projects to go forward before completing the whole architecture raises the possibility that early projects will build new systems with assumptions inconsistent with later work. These risks can be mitigated by an integrated product team (IPT) working with high-level, early process models to identify information shared across functional increments. An early, "foundation" version of the semantic model that focuses on core business objects can help identify other shared information missed by the process models.

4.3.2.3 Un-architected Systems

For the first iteration, many enterprise architectures face the challenge of projects already underway that cannot, for a variety of reasons, be halted. Legacy systems and technical infrastructure pose the same problem. The architecture must somehow integrate new concepts and projects with these un-architected systems. However, a transitional view of the enterprise, beginning with a map of the allocation of functions to systems, shows how each step in a transition deviates from the to-be architecture baseline. This information allows the architect to check coverage and overlap of system functions and estimate the viability of any step in the transition process. Also, note that technically viable system concepts may imply organizationally infeasible mission processes; attempting to validate a transitional process model gives the architect an opportunity to catch such problems. Finally, the detailed system-to-system interfaces can identify system-level data dependencies that may impact scheduling priorities at both project and implementation phase levels; this information should be input to approval and scheduling decisions under Portfolio Management to ensure interoperability at each transition.

4.3.2.4 Uncertain Priorities

Resolving strategic planning and process improvement priorities requires knowledge of actual performance against goals. For strategic planning, the goals in questions are the concrete performance goals associated with annual performance planning under OMB Circular A-11; in process improvement, the goals refer to success criteria and planned performance metrics at the process level. In either case, actual measurements or other results may be recorded during execution of a specific mission process. Systematically resolving uncertainty in priorities, therefore, implies that individual process models incorporate concrete success criteria and performance metrics, that these metrics can be traced to annual performance goals, and that the organization capture actual values against the metrics. In addition, developing and prioritizing new systems concepts requires some idea of how they will impact these goals and metrics; therefore, to-be process models may require projections of expected metrics outcomes.

4.3.2.5 Uncertain Requirements

While many process owners have clear concepts for new systems or process improvements, many do not, and may only vaguely understand the opportunities in technology. To leverage technology and tailor IT support to mission needs, the organization needs a method for generating – not simply recording – functional requirements explicitly from mission processes (such as Decision Point Analysis (DPA)). The halting criterion for decomposition is consensus among participants that a particular set of functional requirements, defined from the users' point of view, suffices for a particular process. The analysis produces separate user functional requirements for that process. Such an approach helps to ensure that IT actually serves to improve operational processes, that functional requirements are traceable through process back to mission, and that systems so defined conform to the perceived needs of the users and are therefore more likely to succeed in real terms.

4.3.2.6 Controversy

Many initiatives fail because of unresolved conflict stemming from real or perceived disagreement, or simple competition. Conflicts thrive in the abstract; participants cannot directly compare their expectations and can hide, avoid, or simply miss critical issues. In addition, apparent consensus may collapse unless participants record and publish the details of an agreement. Many conflict resolution and consensus building techniques therefore focus on concrete detail to help resolve issues and keep them resolved.
To improve mission processes, for example, a decision point model would identify who makes what decisions and who owns what processes on which metrics are captured. The process of developing these models would provide a forum for establishing consensus on and balancing levels of authority and accountability within new work processes. Additionally, to define functional requirements, process decomposition would continue all the way to a "fully allocated" process model, in which the lowest-level activities are either candidate automated functions or completely manual. A process model detailed down to the point where analysts could reasonably project metrics outcomes would provide a concrete foundation for developing consensus on investment decisions. Finally, a fully allocated process model allows analysts to place a system concept into context, to ensure that it forms part of a viable operational solution.

4.4 EA Costs

Editor's Comment: Newer materials are under development.

With permission based on work by

How do You Cost an Enterprise Architecture?

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The United States General Accounting Office (GAO) surveyed more than 116 federal agencies to collect the costs to complete and maintain an EA. The cost data, summarized in the February 2002 report *Enterprise Architecture Use across the Federal Government Can Be Improved,* shows a significant spread of monies that agencies have committed to EAs. Fourteen agencies provided actual costs as shown in Table 1. Estimated costs to complete and maintain an EA were submitted by an additional 32 agencies and are listed in Table 2.

Table 1: Agencies' Reported Actual Costs to Complete EA and Annual Costs to Maintain EA

Agency	Actual cost to complete EA ($000s)	Actual cost to maintain EA ($000s)
Patent and Trademark Office	None reported	30
International Trade Administration	70	10
Defense Legal Services Agency	120	30
Federal Railroad Administration	194	0
Farm Service Agency	200	None reported
Bureau of Prisons	276	0
Census Bureau	285	170
Defense Contract Audit Agency	358	0
Office of Personnel Management	400	65
Small Business Administration	1,100	200
Veterans Health Administration	2,100	1,000
Department of Energy	3,600	800
Customs Service	6,000	1,500
Internal Revenue Service	18,200	None reported

Source: Agency survey responses.

Source: *Enterprise Architecture Use across the Federal Government Can Be Improved*

Table 2: Agencies' Reported Estimated Costs to Complete EA

Agency	Estimated cost to complete EA ($000s)	Agency	Estimated cost to complete EA ($000s)
Economic Development Administration	100	Immigration and Naturalization Service	1,600
Smithsonian Institution	225	Department of the Interior	2,280
Peace Corps	250	Federal Bureau of Investigation	2,500
Ballistic Missile Defense Organization	300	National Highway Traffic Safety Administration	2,500
Coast Guard	300	Drug Enforcement Administration	2,800
Railroad Retirement Board	400	Department of the Treasury	3,000
Bureau of Alcohol, Tobacco, and Firearms	500	Department of Transportation	3,000
Administration for Children and Families	750	Department of the State	4,280
Federal Law Enforcement Training Center	750	Department Threat Reduction Agency	6,731
General Services Administration	898	Department of Labor	7,000
U.S. Mint	900	Forest Service	12,500
Bureau of Reclamation	1,000	Department of the Navy	15,000
Social Security Administration	1,100	Federal Motor Carrier Safety Administration	15,000
Defense Logistics Agency	1,200	Natural Resources Conservation Service	15,000
Bureau of Indian Affairs	1,500	National Imagery and Mapping Agency	20,000
Securities and Exchange Commission	1,500	Nuclear Regulatory Commission	25,300

Source: Agency survey responses.

Source: *Enterprise Architecture Use across the Federal Government Can Be Improved*

As shown, costs to build an EA vary. Thus the resources, in terms of staffing, that each agency commits to build the EA will vary. Determining the appropriate staffing level depends on many factors, including:

- Size and complexity of agency
- Objective of the architecture
- Specificity of recommendations to be made
- Extent of agency transformation
- Timeframe to be examined
- Number of communities involved
- Type of information required
- Fidelity of information required
- Volatility of information collected
- Risk willing to accept

Additionally, the cost analyst must consider the boundary of the estimate. In other words, the analyst must set ground rules that outline which costs are to be included and which costs extend beyond the scope of the analysis. Framework selection and product selection, including the level of detail projected for the products, will greatly influence EA costs.

As noted, the EA must be tailored to the specific needs and objectives of each agency. Thus there is no set of activities to build an EA that is appropriate across all agencies. However, a "generic" activity structure is being designed to provide insight into generic cost elements, activities, and cost content. This structure is intended to serve as a point of departure for discussion between cost analysts and architects in scoping an EA program as well as estimating its costs.

A general equation for the cost of an enterprise architecture is:

EA Lifecycle Cost = EA Initiation/Definition Cost
+ EA Development Cost
+ EA Implementation Cost
+ EA Maintenance Cost

There are a number of costing challenges for an enterprise-wide capability, but EAs are important from a cost perspective because EAs should provide a more cost-effective use of limited resources (dollars, people, and equipment) through economies of scale that offer ways of sharing services, elimination of duplicative, incompatible, or non critical capabilities, identification of new business initiatives or innovative IT solutions through gap analysis, and information for the Selection, Control, and Evaluation of IT decisions.

References

"How do You Cost an Enterprise Architecture?", Dello Russo, Francis M., Garvey, Paul R., and Woodward, Beverly S. MITRE Institute Training Program, January 27, 2003.

Enterprise Architecture Use across the Federal Government Can Be Improved, GAO-02-6, General Accounting Office, February 2002, http://www.gao.gov . *Contains lists of costs and estimated costs from agencies to develop and maintain EAs. Also contains a description of the GAO Five Stage EA Maturity Framework and survey results from agencies identifying where they are on the maturity framework.*

Federal Pilot Architecture Project Analysis and Lessons Learned, Paula Hagan, Ann Reedy, P. Kathie Sowell, MITRE Corporation, September 28, 2001. *Documents the use of seven staff months over a period of five months including about 3.5 staff months from the primary analyst; 2.7 staff months from other analysts providing interview, modeling expertise, sounding board, and review support; and 0.8 staff months of management time to produce a small EA of 50 some business functions from 17 interviews.*

4.5 Risks[30]

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There are many risks in establishing and executing an Enterprise Architecture (EA) Program. There are cultural risks from internal resistance, risks of inconsistent or incomplete plans, business processes, or technical implementations, risks from delays in implementation or funding changes. The following table identifies some risks and associated mitigation strategies for them. These risks should be addressed in the agency EA strategy and implementation approach.

Table 1: Enterprise Architecture Major Risks Summary

RISK	MITIGATORS
Insufficient models, information: Models are insufficient to support key decisions in strategic planning, functional/operational area analysis, portfolio management, technology refreshment, and the systems life cycle process.	Tailor the architecture structure and level of modeling detail to specific decision points in management processes.
Poor Quality Information: Quality of architecture information reduced by poor or obsolete documentation, resistance.	Consistency checking through a central architecture repository that assists with identification of gaps and overlaps. Top management attention, support. Carrot: participative planning and decision-making, focus on aids to process success; may consider non-monetary rewards structure. Stick: danger of loss of IT support, processes imposed from above with audits to enforce compliance.
Non-Viable Transition State: Risk of non-viable transition state as agency implements initiatives, program phases in moving from current to program architecture baseline.	Explicit identification of program/phase dependencies, both technical and operational in setting master program schedule, ability to extract “transition” architectures from repository to facilitate validation.
Inconsistencies from Incremental Development: Incremental development that locks in inconsistencies with unarchitected functional areas.	Architecture Integrated Project Team (IPT) working from enterprise models to identify specific areas of consistency risk; resolve through “spot” modeling.

[30] Reviewed January 25, 2004

RISK	MITIGATORS
Wrong Increment Prioritization: Prioritization of increments for architecture development is inappropriate robbing the architecture of immediate impact and delaying Return On Investment (ROI).	Prioritize list of functional areas based on defined criteria, including potential for impact, critical path considerations, and functional priorities.
Wrong Process Improvement Priorities: Inappropriate process improvement priorities may dilute architecture impact and lead to inappropriate investment decisions.	Dynamic process simulation to estimate sensitivity of strategic performance goals to specific processes, generate reliable process performance projections.
Architecture not Mainstream: Risk of isolating architecture from rest of organization, leading to “shelfware” architecture.	Institutionalize the architecture by designating owners of models required to develop and maintain through tailored management decision processes. Architecture team stays small; will function as consultants, facilitators, and reviewers only.
Resistance from Loss of Autonomy: Resistance to implied loss of autonomy due to visibility of processes and IT solutions (especially as applied to the field activities), and centralized IT funding decisions. Resistance to cultural, business, or system change.	Top management attention, support. Carrot: participative planning and decision-making, focus on aids to process success; may consider non-monetary rewards structure. Stick: danger of loss of IT support, processes imposed from above with audits to enforce compliance.
Loss of Momentum, Currency: Long architecture development lead time leading to architecture obsolescence; especially due to loss of focus in initial current baseline and getting bogged down in recreating system documentation.	Initial current baselining limited to available documentation plus minimum analysis for enterprise-level models to establish scope, vocabulary. Other current models developed only as needed to ground specific analyses. Incremental “core-out” architecture beginning with key mission/investment area; not waiting on unarchitected functional areas to define initiatives, systems.

4.9 Maturing Agency EA Efforts

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The United States General Accounting Office (GAO) has developed a five stage maturity model for enterprise architecture that shows maturing policy development, functioning staff and oversight bodies, maturing current and target architecture products, and metrics to measure the benefit of enterprise architecture (EA). The following discusses some initial capabilities and those that might be developed as the agency efforts mature. An agency can use these materials and others to gather ideas on how to mature its EA efforts.

Editor's note: This section needs to be coordinated and possibly consolidate with parts of the Section on Governance.

4.9.1 Vision, Values, and Leadership

Before beginning an EA effort to develop a baseline and target architecture, the agency needs a strategic plan that contains a vision of where the agency wants to go in the future. This strategic plan guides the development of the target architecture and the transition plan. As part of the strategic planning effort, the agency needs to assess its core values and driving force to allow later development of principles to guide architectural decisions. Some agencies may value fast and easy customer interface while others may value highly accurate and current data more. Some agencies may be, for example, production capability driven; others may be customer service driven.

Ea leadership must be clearly identified. EA leadership is essential to provide direction and to oversee the use of the EA. Leadership also publicizes the benefits of EA and promotes cooperation.

4.9.2 Areas of Responsibility and Establishing Cooperation

Both large and small agencies must set up roles and responsibilities for the EA. The Practical Guide to the Federal Enterprise Architecture, the NASCIO Toolkit, and other references provides guidance on roles and responsibilities. These roles have to be defined considering the agency size and staff.

The EA team building the initial version of an agency's EA should be a balance of business and Information Technology (IT) representatives. When one group has control over one section of the EA, such as the business processes, and a different group has control over another section, such as all IT systems, or administrative systems only, the groups must work out a collaborative arrangement to ensure consistency and cohesiveness. Affinity groups can be established to focus efforts on a particular area of

the architecture. The affinity group may address a particular business process, best practices, or standards to provide advice and guidance on development of that area of the architecture. Examples of affinity group areas might be desktop standards or emergency response.

4.9.3 Purpose and Scope

One of the first tasks in developing an EA is to determine its purpose, or intended use, and scope. These will change as the EA matures. In broad terms, the EA provides a basis for investment decisions and guidance for process improvement and IT development. The intended use will determine the information detail to be captured. For example, if the EA is to be used to assess the cost of processes, then capturing a process at a level of detail where its cost can be determined and possibly capturing the cost itself are appropriate. If the EA is to be used as a baseline for new initiatives in three particular areas, current and target models should be developed for those three areas. If the funding to support the EA effort is limited, the scope could be restricted to key mission areas, developing back office functions in a later revision (unless investments are planned in back office functions in the near future). However, the scope should be large enough to cover the business process, data, applications, and technology of a significant portion of the enterprise. (Risks from not having a fully defined EA are discussed elsewhere).

4.9.4 Simplifications for the Initial EA Products

Maturing the EA, incorporating its use into Capital Planning and Investment Control (CPIC), and achieving the target architecture are multi-year endeavors. The initial EA might model only the agency's core mission functions and areas where major investment is anticipated in the near future; other high level or incomplete areas can be detailed as the EA matures. The initial technology infrastructure models may contain only the identification of network needs without the detail of path connections and capacity. The first data model may be conceptual with only high-level subject areas described. The standards profile might use an industry or government standard technical reference model to show the organization of service areas. Getting an initial target EA is critical for investment planning and business case development.

The first transition plan may have the dependencies known for major projects, but not all projects. The sequencing/transition plan should reflect realistic schedules for incorporation of those capabilities. Using examples drawn from other agencies will speed the process. The initial EA effort should not shortchange the development of the integrated dictionary that defines all the terms in the EA and their relationships – the business processes, data and data flows, systems, standards EA products, etc. This dictionary becomes a repository that will be used repeatedly and promotes consistency. The simplifications or adjustments to the EA products described in the selected framework can be documented in a tailoring plan.

4.9.5 Initial and Maturing Processes

The Practical Guide, the Enterprise Architecture Planning (EAP) text, and other references provide guidance on processes to build the EA. The following discussion provides some tips on what might be critical initially, and what might be developed as the EA matures.

4.9.5.1 Ability to Manage and Maintain

Initial Requirements

- An EA approval authority, normally the executive steering committee.
- The ability to place the EA under Configuration Management with version control and defined procedures for change
- The ability to capture the EA with tools suitable for analysis.
  NOTE: Some agencies have more funds available for tools than others and so may be able to begin their EA efforts with more sophisticated tools. EA products can be developed with Office Automation (OA) tools if necessary, but they require more manual checking for consistency and completeness.
- A repository of terms and definitions developed as products are constructed, incorporating Federal Enterprise Architecture (FEA) terms and definitions and agency terms and definitions

Maturing Capabilities

- A process for regular maintenance of the EA, incorporating recommended changes from ongoing projects, new projects, new business drivers, and new strategic goals
- EA capture with tools set that supports all analysis tasks

4.9.5.2 Ability to Communicate

Initial Capabilities

- Ability to communicate the essence of the EA to executives
- Ability to show EA benefits and gain proactive participation from stakeholders
- Ability to communicate the use of the EA to project managers, technical staff, and investment planners

Maturing Capabilities

- Have regular planned distribution of EA information
- Obtain regular feedback from stakeholders

4.9.5.3 Ability to Enforce

Initial Requirements

- A policy and procedure that requires a new initiative or project to show it is part of the target architecture, is represented in the sequencing plan, and is being implemented in the proper sequence, i.e., all of the capabilities upon which it will depend will be in place and are funded prior to the new project capabilities needing them for test or fielding, before the project can

be funded. The procedure should be linked to existing CPIC, Systems Development Life Cycle (SDLC), and acquisition processes. The SDLC process addition could be as simple as an additional step to require that the project is compliant with the EA.

- A policy and procedure that requires all projects to comply with the standards profile of the EA. This can be incorporated into the existing systems development and acquisitions lifecycles.

Maturing Capabilities

- Policy that requires the use of data, applications, and technology, consistent definitions, standard schemas, components, etc. from the EA and FEA repository.
- Full incorporation of use of EA into CPIC and SDLC processes. The agency systems lifecycle should require any proposed project to be compliant with the EA to be funded and to continue to demonstrate that compliance at each milestone review and post implementation assessment. Agency business cases should consider OMB Performance Reference Model PRM measures.

4.9.5.4 Ability to Analyze

Maturing Capabilities

- The EA can be used to answer significant management and technical questions such as those contained in the Uses of EA section of the FEAF.

Chapter 5

5. Engineering the EA

Table of Contents

5.1 Engineering Issues for EA Views

5.1.1 The Business Architecture View – FUTURE

This section will discuss issues in designing and modeling business processes that relate to the EA and developing the business view of the EA.

References

Desired Business Results (DBRs): A Case Study, Lizann Messerschmidt, TEM Presentation, July 17, 2003.

An Approach to Capabilities Based Analysis Using DOD Architecture Products, Dave Payne, TEM Presentation, July 17, 2003.

5.1.2 The Data Architecture View

Editor's Note:
This section should provide an overview of the types of decisions, choices available, and issues for enterprise level data architecture and management strategies/approaches plus any other topics appropriate for the data view of the enterprise and associated references. The following material is provided as a beginning. It points to MITRE materials that one agency contractor used to guide its decisions in making data strategy decisions at the enterprise level. Other topics to address in the future are the general framework and conclusions material from the material referenced, semantic mapping issues, and the difficulties of data standardization.

Reviewed January 25, 2004

Many government agencies are data driven. Some are transaction oriented. Some push data, information, and knowledge to their customers. Some government processes require sharing or communicating significant volumes of data electronically across agencies or with customers. The decisions on basic strategies to manage data in such situations are of such significance and widespread influence that they should be addressed at the enterprise level rather than at the system design level. The agency chief architect in collaboration with the Chief Information Officer (CIO) should assess data management decisions and determine those issues that should be addressed in the enterprise architecture (EA) and those that should be addressed at the systems design level. Both require engineering evaluations. The following material identifies some data management options and their strengths and weaknesses to inform such decisions. The reader is encouraged to examine the references to understand the complexity of data management and further considerations.

Extracted from

5.1.2.1 Data Access and Integration Architectures Overview

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The taxonomy in Figure 1 provides an overview of data management (DM) architecture approaches. These architectures are supported by mature, commercially available technologies.

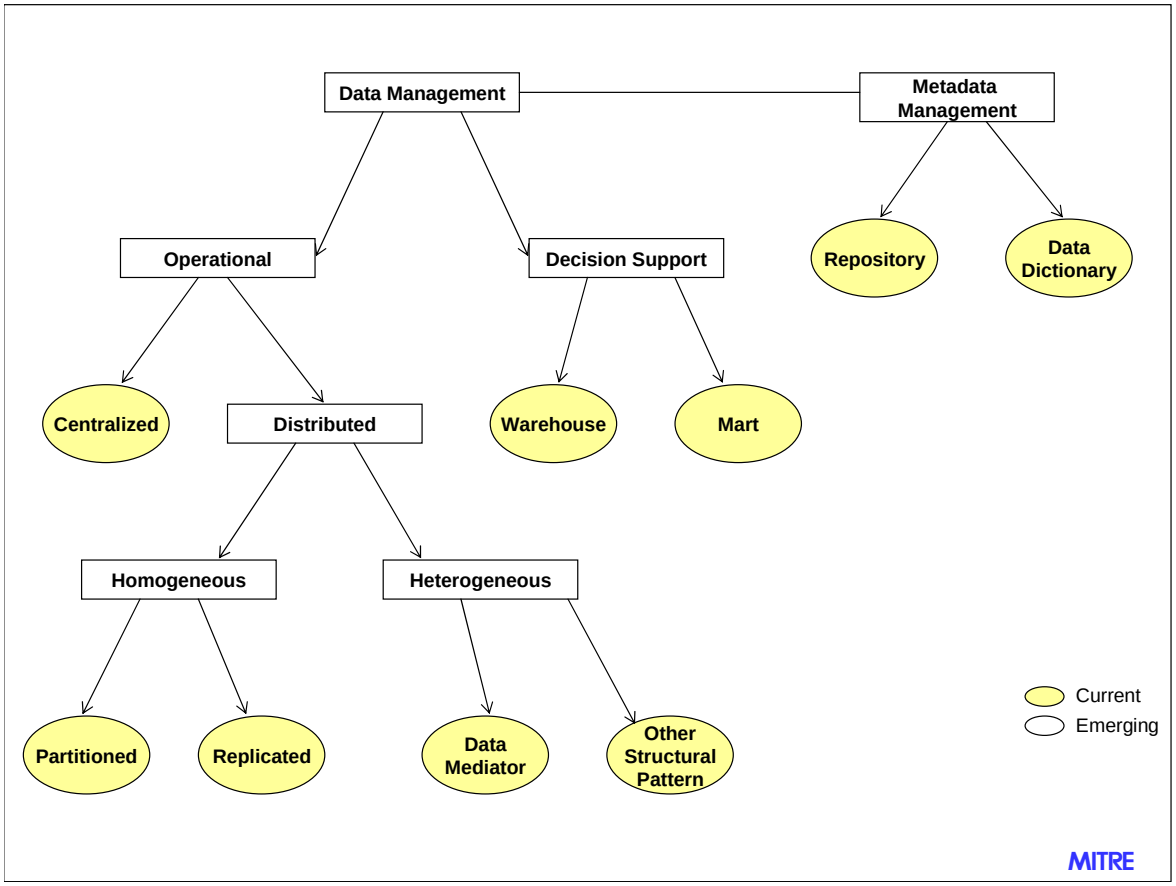


Figure 1. Data Management Architectures: Overview

Metadata applies to all DM architectures. Metadata includes a repository for managing metadata and the data itself, which for DM minimally includes a data dictionary.

Operational data stores support day-to-day business data and are transaction oriented. Approaches include:

- Centralized database having single database management system (DBMS), language, location, operating system (OS), and platform.
- Distributed homogeneous database having single DBMS but data is distributed. Additionally there is support for partitioned data (horizontal fragmentation) and replication of data.
- Distributed heterogeneous databases involve multiple DBMSs/platforms, which are distributed and are accessed through a data mediator (which is a kind of database middleware).

- Decision support includes data warehouse and associated data marts. Note: A centralized operational database (DB) has many of the characteristics of a data warehouse but primarily supports operations vice decision support or data mining.
- Other structures like Bridge, Adaptor interface, Proxy, language interpreter, gateway, and mediator interface are proven architecture solutions that are used in industry applicable to a range of distributed data management interoperability problems and a wide variety of different circumstances [Gang-of-4, Design Patterns].

5.1.2.2 Strengths and Weaknesses

The following lists strengths and weaknesses of some approaches.

DDBMS Homogeneous- Partitioned

Strengths

- Global applications
- Continuous operations (high availability)
- No synchronization problems (currency control)
- Distributed updating with security and integrity managed
- Data location and OS transparency
- Scaleable with respect to adding horizontal fragments and sites
- Mature products supported by major DBMS vendors

Weaknesses

- Cannot manage database from different product (e.g. Oracle cannot manage a Sybase fragment)
- Performance penalties for users not close to needed fragment
- Limited local autonomy
- Schema growth limitations

Data Mediator Architecture

Weaknesses

- Performance (can be slow)
- No update capability in some data mediation systems
- Does not scale well, in terms of number of data sources capable of being added
- Commercial Off-the-Shelf (COTS) available, but still maturing
- Interoperability between two or more data mediators

Data Warehouse Architecture

Strengths

- Increases speed and flexibility of analysis
- Optimized for supporting ad hoc queries, including tools to help users formulate queries
- Provides a foundation for enterprise-wide data analysis and access
- Improves or re-invents business processes
- Gain a clear understanding of customer behavior

- Data stored for ease of reporting and understanding

Weaknesses

- High total cost of ownership (purchase, implement, scale, evolve, manage, maintain)
- Very large data sets require massive processing power
- Does not typically provide direct access to operational data

Messaging Architectures

General Strengths

Infrastructure for Application Integration

- Message queuing, message handling services support compose, submit
- Message routing, e.g., for distribution lists and guaranteed delivery

Flexible communications

- Added value for X.500 – Directory services support enter, store, and retrieve user addresses, security credentials, and routing information
- Variety of mechanisms, e.g., group messaging, broadcast messages, store and forward, etc.

General weaknesses (Implications for lack of workflow, business model integration)

Key weakness is that messaging approaches offer no way of representing transformations other than opaque codes. More difficult to program than familiar data-oriented APIs, e.g., SQL.4

- Variable message formats – preparation systems
- Proprietary protocols – translations and cost of change
- Large messages require bandwidth and reliability

5.1.2.3 Common Risk Areas

Access Control Policies

- Disparate policies limit data sharing… owners unwilling to share unless THEIR policies are enforced

Assured quality of service (Network)

- User frustration because of unstable or unavailable systems
- Expensive systems reengineering needed to correct deficiencies

Interoperability of systems/data

- Effort required to reach agreements and maintain translations
- System performance impacts due to adaptation for interoperability
- Site autonomy is limited to extent required by agreements
- Data misinterpreted when mapped to new context

5.1.2.4 General Approaches

Table 1 shows some DM approaches to consider for particular situations.

Table 1. General Approaches Supporting IT Architecture

If your motivation is	Consider these technologies	And mitigate these risks
Global application w/ distributed updates, scalable	DDBMS Message Broker	System administration Configuration management
Ad Hoc query of heterogeneous operational data	Data Mediator, XML	Performance, Scalability Interface management
Query of voluminous data for mining and forecasting	Data warehouse Data marts	Costs to model, populate, and reorganize warehouse
Integration of COTS packages or legacy applications	Message broker, OTM, ORB Distributed objects	System administration, CM Cost to adapt applications
Integration of added-value, reuse components to existing systems	Application frameworks	Unknown development costs New roles, and supporting methods and tools
Electronic commerce/ Electronic data interchange	Mediation Agents XML	Inter-domain management Standards incomplete
User assistance and information monitoring/ control	Mediation agents Messaging	High development costs Performance

References

Zeisler, E.D., Smith, M. Cassandra, and Hooper, Mike, Data Access and Integration Architectures Overview, MITRE Corporation, March 10, 2000.

5.1.3 Infrastructure – Future

5.1.4 Security

MITRE Internal Draft

5.2 Architectural Patterns – Future

This section will discuss the value and types and identification of patterns that can improve the design and implementation of the EA (and systems).

References

Patterns for e-business, A Strategy for Reuse, Jonathan Adams, Srinivas Koushik, Guru Vasudeva, and George Galambos, Double Oak, TX:IBM Press, 2001

5.3 Component-Based Architectures – Future

This section will describe what component-based architectures are, their value, and how to incorporate the approach into the EA. It may be combined with the Service-Oriented Architecture section.

References

Service-Oriented Architecture: A Primer, Michael S. Pallos, *EAI* Journal, 2001. http://www.eaijournal.com/PDF/SOAPallos.pdf

5.4 Federated Architectures – Future

This section will discuss the issues associated with related or overlapping EAs. The following paragraphs and picture begin the discussion of the ideas.

5.5 Using Reference Models and Reference Architectures – Future

This section will discuss how to relate the EA to and incorporate EA reference Models and Reference Architectures such as the OMB FEA Reference Models, the NCOW Reference Model, and the Global Information Grid (GIG).

5.6 Issues with Legacy Systems – Future

This section will discuss issues in retiring and in modernizing Legacy Systems and the planning needed for such actions.

References

Seacord, Rovert C., Plakosk, Daniel, and Lewis, Grace A., *Modernizing Legacy Systems: Software Technologies, Engineering Processes, and Business Practices*, Boston: Addison-Wesley, 2003.

Brodie, Michael and Michael Stonebraker: *Migrating Legacy Systems*: Gateways, Interfaces, and the Incremental Approach, Morgan Kaufman, April 1995 (Possibly out of print).

5.7 COTS Issues

Based on a presentation given at the Third Annual Conference on the Acquisition of Software-Intensive Systems, Arlington, VA., 29 January 2003,
"Enterprise Architecture and COTS-Intensive System Acquisition Strategies",
Diane Mularz (MITRE), James Smith (SEI), Duane Hybertson (MITRE). Contact: Diane Mularz, mularz@mitre.org.

5.7.1 Introduction

Business demands and available technical solutions are constantly and rapidly changing. An enterprise architecture (EA) serves to make informed choices about what technology to acquire and when, while Commercial Off-The-Shelf (COTS) holds the promise of being able to rapidly field the technology and align with the changing business demands.

While EA-based acquisition and COTS-based solutions hold promise as a way to operate in the midst of change, these two approaches have competing objectives.

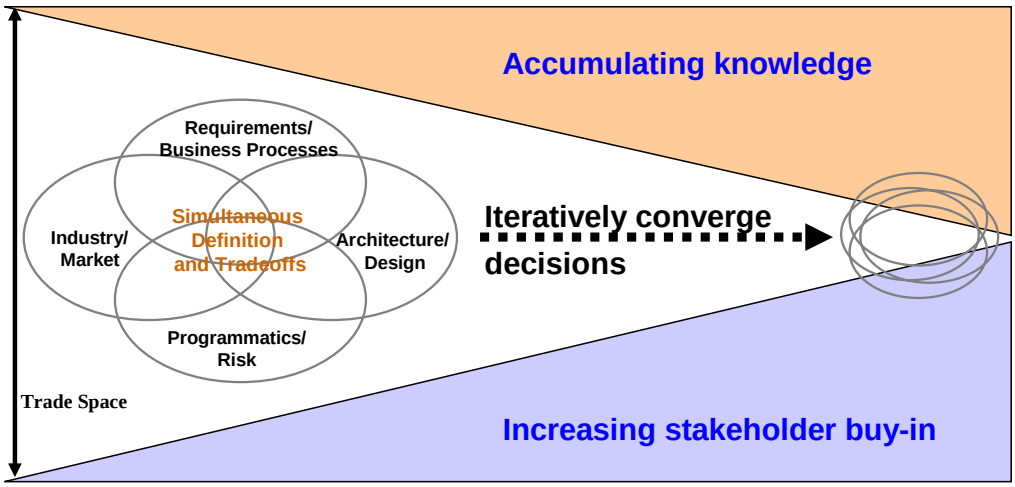
- The goal of EA-based acquisition is to ensure that Information Technology (IT) solutions align with *business needs*. Here the focus is on a single enterprise and its business demands and the architecture that can support the business needs.
- The goal of the COTS market place is to find reusable solutions that *span* enterprises. Here vendors focus on reusable products that can be applied to many problem domains with some tailoring possible for each enterprise.

A COTS-intensive *architecture* is constrained by how close the market can come to satisfying the needs. Therefore, there is a need for negotiation and compromise among the competing concerns: business needs, market offerings, and architecture. The Evolutionary Process for Integrating COTS-Based Systems (EPIC) is a COTS integration process model that recognizes the need for tradeoffs among these concerns, tempered by risk. The EPIC process calls for simultaneous refinement of problem and solution, and therefore successive narrowing of the trade space. EPIC also recognizes the need for rapid iteration to understand risks and for improving the understanding of what is possible (marketplace) vs. what is acceptable (enterprise stakeholders. This approach keeps requirements and architecture fluid, allowing for optimized use of available components.

Strategies for an EA-based acquisition of a COTS-intensive system are non-trivial to define. There is no right or wrong answer on how to structure the acquisition but without consideration given to the implications of a particular model, the ability to be successful at integrating COTS for the enterprise can be hampered. Acquisition strategists need to consider the ramifications of their strategy carefully and put in place mechanisms for dealing with issues that will arise under different execution allocation schemes because of the need to negotiate and iterate across multiple spheres of influence.

5.7.2 Evolutionary Process for Integrating COTS-Based Systems (EPIC)

The Software Engineering Institute (SEI) reports that attempts to exploit COTS or other preexisting components 'through traditional engineering approaches that involve defining requirements, formulating an architecture, and then searching for components that meet the specified requirements within the defined architecture have been disappointing.' SEI has developed EPIC, a process model for COTS integration. EPIC 'redefines acquisition, management, and engineering practices to more effectively leverage the COTS marketplace and other sources of pre-existing components. This is accomplished through concurrent discovery and negotiation among four diverse spheres of influence: user needs and business processes, applicable technology and components, target architecture, and programmatic constraints as depicted in Figure 1. EPIC codifies these practices in a structured flow of key activities and artifacts. This approach is a risk-based disciplined, spiral engineering approach which leverages the Rational Unified Process (RUP) ®. The approach is fully described in SEI-2002-TR-009 and SEI-2002-TR-005.



From 'Evolutionary Process for Integrating COTS-Based Systems (EPIC)' SEI, TR-2002-005, November 2002

Figure 1. EPIC Iteratively Converges Decisions Among Four Spheres of Influence

EPIC recognizes the need for tradeoffs among business needs, architecture, and the marketplace, tempered by risk. Tradeoffs among these four 'spheres of influence' lead to simultaneous refinement of problem and solution; and therefore successive narrowing of the trade space. EPIC uses a risk-based spiral that supports rapid iteration to understand risks and improve understanding of what is possible (marketplace) vs. what is acceptable

(enterprise stakeholders). This approach keeps requirements and architecture fluid, allowing for optimized use of available components.

5.7.3 Enterprise Architecture and COTS-Intensive System Acquisition Strategies

Choosing an acquisition strategy for an EA-based acquisition of a COTS-intensive system is a complex, multi-faceted problem. Not only must consideration be given to allocation of responsibilities for execution of the program but the selected allocation scheme must be considered in the context of a COTS integration process such as EPIC. In particular, there is a need to iterate and negotiate across the spheres of influence. Since it is highly unlikely that all responsibilities (spheres of influence) will be allocated to a single contractor, negotiations will span contract boundaries. It is not a question of which acquisition approach is the right one; it is a matter of understanding the issues for a chosen approach and developing a strategy to address them.

Three commonly-used strategies, based on different allocations of *execution responsibility*, are:

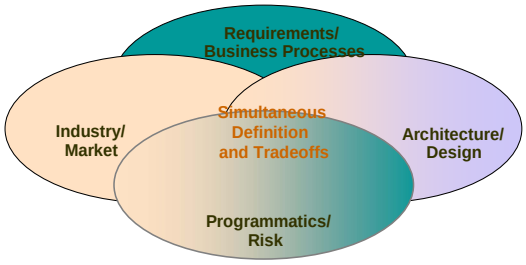
- Strategy #1: “Functional” allocation, with specific acquisition responsibilities assigned to discrete organizations (both Government and contractor)
- Strategy #2: “Project based” allocation, where responsibilities are assigned according to the scope of the effort (e.g., enterprise, project “*x*,” etc.)
- Strategy #3: “Site based” allocation, where responsibilities are assigned on the basis of geographic “spheres of influence”

Each strategy will be described based on the EPIC model for executing a COTS integration followed by a discussion of the issues associated with actually integrating COTS products given that allocation strategy. There is also a brief discussion of some of the trade-offs which need to be considered in the context of any program.

Tyranny of the dominant decomposition: In the field of software engineering one deals with complexity of a software system by using a separation of concerns. Many approaches have been devised to deal with complexity. For instance in an object-oriented approach the system is defined in terms of objects. This can cause distortions as to how the problem is modeled. This distortion has been labeled the 'tyranny of the dominant decomposition' because by focusing on one way to separate concerns the result is that only concerns that align with the dominant hierarchy can be separated. Likewise by fixing the allocation of execution responsibilities for purposes of an acquisition, one might say that we now have a parallel notion in acquisition. There is nothing wrong with fixing some aspect of the problem in order to deal with complexity but when it comes to a COTS-intensive system acquisition, the interplay of execution responsibilities and needed negotiation points becomes critical to examine simultaneously. What may seem clean from an organizationally-based allocation of responsibilities can lead to critical negotiation areas that cross contractual/government boundaries for a COTS-intensive system. By explicitly acknowledging such issues up front, the acquisition strategy can be refined to improve the likelihood of success.

5.7.3.1 Functional Allocation Along Architectural Lines

The Functional Allocation strategy aligns responsibilities roughly based on the C4ISR/DODAF framework architecture views, allocating the operational architecture/business process decisions to the enterprise architect and the system architecture to the system developer.



Enterprise Architect

Enterprise-level architectural/business process decisions (i.e., Scope and Enterprise levels of the Zachmann Framework, Levels I and II of the FEAF, or Operational Architecture views in the C4ISRAF)

System Developer

System architecture (i.e., below the enterprise-level as defined above)

Market/technology forecasting

System implementation/spiral management/product selection/modernization decisions

Sustainment

Maintenance of fielded systems

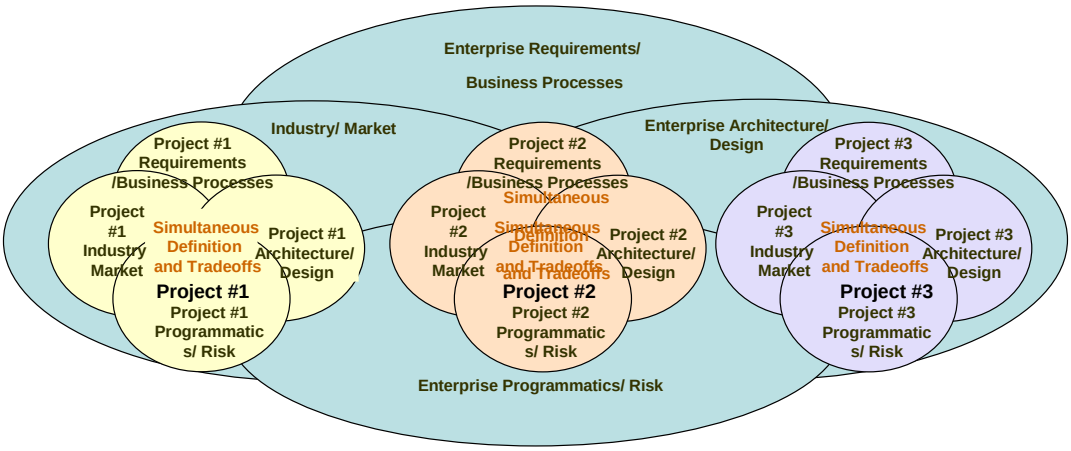
Figure 2. Functional Allocation Acquisition Strategy

Allocation of responsibilities along architecture view lines is clean from an architecture perspective but not from a COTS integration perspective. An acquisition strategy must consider these issues:

- **Responsibilities cross organizational boundaries**: The architecture responsibilities are split between the system developer and the sustainment group. There must be decisions made about migration of legacy which requires negotiation between the sustainment contractor and system developer.
- **Reconciling business processes and architecture**: In the EPIC model there are trades needed between requirements and architecture, thus there must be consideration given to how the two contractor organizations will operate and negotiate.
- **Continuously evolving systems**: At one stage in the implementation the system developer will have control of the architecture but the sustainment contractor will maintain it and make changes as needed to support operations. This could lead to a need to migrate to a new version of a COTS package or to consider other options.

5.7.3.2 Project-Based Allocation

A second possible strategy is to allocate responsibilities for all trade areas to a contractor on a project-by-project basis. Here the enterprise architect has global responsibility for governance at the enterprise level while each project developer is allocated local responsibilities with a requirement to demonstrate compliance with the enterprise architecture.



Enterprise architect

Governs overall enterprise architecture and its realignment based on project demands/outcomes

Decides on projects to be developed, order of acquisition/development, and their degree of parallelism

Project Developers

Each developer (Government entity, or contractor) is allocated requirements and business processes. Contractor has responsibility for project-specific requirements, business processes, architecture, market survey, standards, …with additional requirement to demonstrate that project is EA compliant

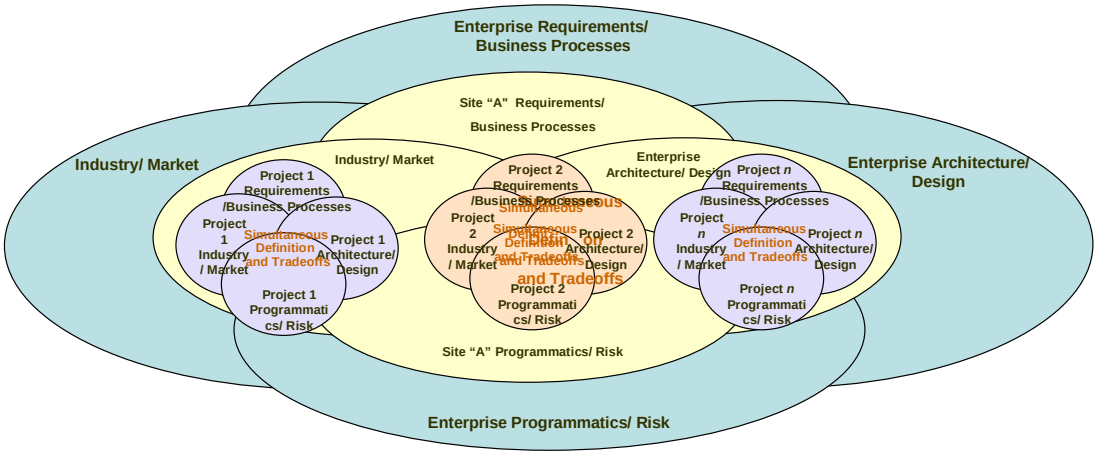
Figure 3. Project-Based Allocation

A project-based allocation makes the allocation of responsibilities self-contained at the project level but project-specific decisions must be reconciled within the greater context of the enterprise. A project-based strategy must consider:

- **Reconciling project clashes** - Trades will be done locally but may have global impact. Clashes between component selections, business process models, etc. must be identified and resolved, especially if there are project-spanning implications. For instance, a business process may cross project boundaries. Different decisions on COTS products or modification of requirements to accommodate a COTS product in a project may cause compliance problems at the enterprise level.
- **Maintaining EA compliance** - If multiple projects are being executed simultaneously it will be difficult to maintain compliance since there will be the potential for competing concepts and decisions. This strategy may require more elaborate integration testing to ensure EA compliance and perhaps some incremental reviews across projects to minimize impact at the end of a project.

5.7.3.3 Site-Based Allocation Strategy

In a site-based allocation strategy, there is an overall enterprise architect with a site integrator responsible for integrating multiple projects associated with a site and project developers responsible for individual systems.



Enterprise architect

Governs overall enterprise architecture and its realignment based on project demands/outcomes

Allocates site responsibilities to site integrators

Site integrator

Each site integrator is allocated requirements and business processes. Responsibility for site-specific requirements, business processes, architecture, market survey, standards, etc., with oversight of site projects to ensure EA compliance

Project developers

Responsible for development and sustainment of systems under site integrator direction

Figure 4. Site-Based Allocation

A site-based allocation allows for flexibility in how sites acquire and integrate systems but the impacts on the enterprise must be considered. There are similar issues as in the project-based allocation with another layer of allocation to deal with between the project and the enterprise.

5.7.3.4 Conclusion

Strategies for an EA-based acquisition of a COTS-intensive system are non-trivial to define. There is no right or wrong answer on how to structure the acquisition but without consideration given to the implications of a particular model, the ability to be successful at integrating COTS for the enterprise can be hampered. Acquisition strategists need to

consider the ramifications of their strategy carefully and put in place mechanisms for dealing with issues that will arise under different execution allocation schemes because of the need to negotiate and iterate across multiple spheres of influence.

References

Evolutionary Process for Integrating COTS-Based Systems (EPIC): An Overview, CMU/SEI-2002-TR-009, Albert, Cecilia, in collaboration with Col. David Bentley, Thomas Bono, Edwin Morris, and Deborah Pruitt, 64 pages, July 2002. http://www.sei.cmu.edu/publications/

Evolutionary Process for Integrating COTS-Based Systems (EPIC): Building, Fielding, and Supporting Commercial-off-the-Shelf (COTS) Based Solutions, CMU/SEI-2002-TR-005, Cecilia Albert, Lisa Brownsword in collaboration with: Colonel David Bentley (USAF),Thomas Bono (MITRE),Edwin Morris (Software Engineering Institute), Deborah Pruitt (MITRE), 275 pages, November 2002. http://www.sei.cmu.edu/publications/

Enterprise Architecture and COTS-Intensive System Acquisition Strategies, briefing, Mularz, Diane, Jim Smith, and Duane Hybertson, January 2003. http://www.sei.cmu.edu/products/events/acquisition/2003-presentations/mularz.pdf

COTS Architecture Analysis Method, Kieth Balliruo, Software Productivity Consortium, SPC-2002002-CMC, January 2002. *An approach to analyze and resolve architectural decisions for COTS-intensive systems. The system architect uses CAAM to help expose hidden architectural constraints between COTS products, legacy applications, and infrastructure*. http://www.software.org/pub/darpa/darpa.html#CAAM

5.8 Achieving Flexibility to Incorporate New Technology - Future

EA design requires a long term view. Being able to incorporate new technologies and new capabilities without having to redesign the entire EA requires flexibility in the EA and enterprise. This section will discuss issues related to putting some of the ‘ility properties, e.g., flexibility and scalability in the EA and incorporating new technologies.

5.9 Sequencing Plan – Future

The Sequencing Plan, sometimes called the Transition Plan, is a major product of the EA program. It identifies dependencies and recommends sequencing for new investments and retirement of legacy systems. It guides Capital Planning and Investment Control (CPIC). This section will discuss issues in developing the Sequencing Plan.

Chapter 6

6. Using the Enterprise Architecture

6.1 Compliance within the Service or Agency – Future

This section will address requirements and processes inside a Service or Agency through which Service or Agency systems development and other investments should comply with the Service or Agency EA.

References

Enterprise Architecture Compliance and Certification, John Anderson, Briefing at MITRE TIE, May 28, 2003.

6.2 EA Use in Transformation - Future

6.2.1 Financial

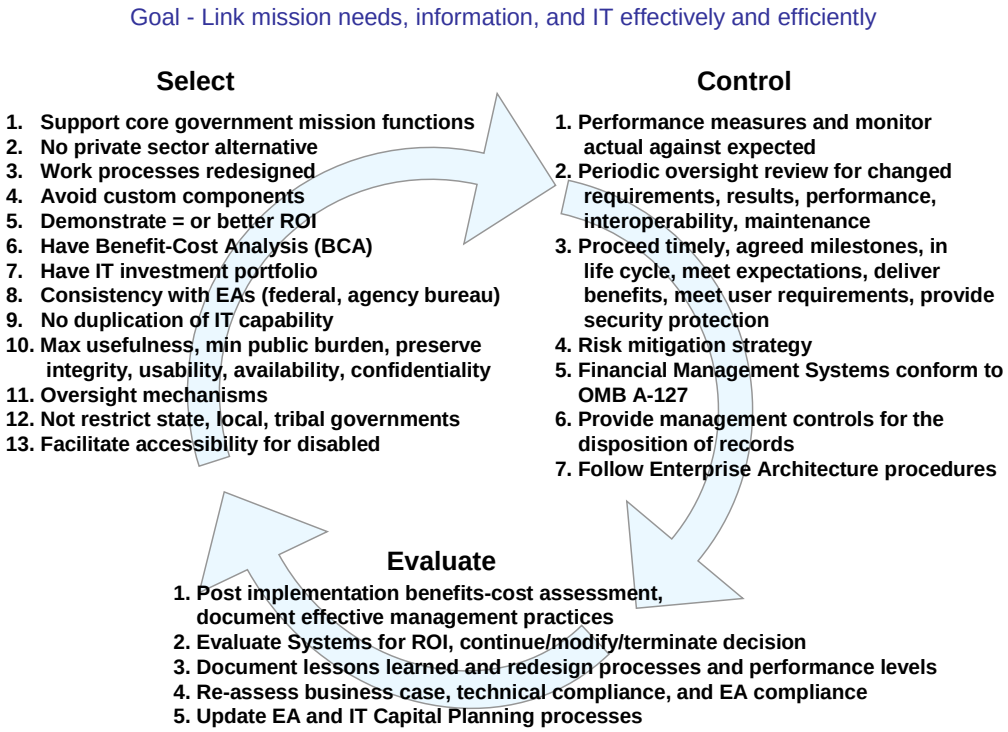


Figure 1. OMB A-130 Requirements for Capital Planning and Investment Control Process

References

OMB A-11

OMB A-130

A Summary of First Practices and Lessons Learned, CIO Council, March 2002

Reflecting EA in OMB Exhibit 300 and 53 Reports, Darren Ash, Dept. of Transportation, Sept 10, 2003 presented at e-gov Enterprise Architecture 2003, September 10, 2003. http://www.e-gov.com/events/2003/ea/downloads/

Integration of EA, Security, and Capital Planning Processes, Michael Tiemann, AT&T Government Solutions Sept 10, 2003 Slides 7, 18, 32, 40 presented at e-gov Enterprise Architecture 2003, September 10, 2003. http://www.e-gov.com/events/2003/ea/downloads/

Coast Guard EA Program, Richard Tucker, MITRE TEM Presentation, Feb 17, 2003. (John Anderson's transfer folder – EA IDM TEM folder)

EA and CPIC at U.S. Customs Service, William J. Bunting, Raymond Beamer, MITRE TEM presentation, Feb. 17, 2003. (John Anderson's transfer folder – EA IDM TEM folder)

Department of Homeland Security CPIC and EA Alignment, Jennifer Charfield, MITRE TEM presentation, Feb. 17, 2003. (John Anderson's transfer folder – EA IDM TEM folder)

DOD (c) IT Investment Approval Process, Tom Arnsperger, MITRE TEM presentation, March 3, 2003. FOR INTERNAL USE ONLY (John Anderson's transfer folder – EA IDM TEM folder)

Add references to agency CPICs like HHS.

Smart Practices in Capital Planning, Federal CIO Council, October 2000

6.2.2 Business Operations – EA Use in BPR and Process Improvement – Future

This section will discuss how the models and analysis done for the EA contribute to BPR and process improvement.

6.2.3 Technical – EA Use in Systems Design and Engineering – FUTURE

This section will discuss how the EA facilitiates system design and engineering and how system design and engineering projects should be incorporating information in the EA into their efforts.

6.2.4 Organizational – EA Use in Organizational Change Management

This section will discuss how the EA is used in change management and other organizational topics.

Chapter 7

7. Evaluating EA

7.1 EA Maturity Models[31]

Editor's Comment: This section describes only the GAO maturity model Version 1. GAO has published a later version.
If other major models arise, they will be addressed here.

The United States General Accounting Office (GAO) has developed an Enterprise Architecture Management Maturity Framework (EAMMF) that outlines steps toward achieving a stable and mature process for managing the development, maintenance, and implementation of Enterprise Architecture (EA). The framework has five hierarchical stages of management maturity and four attributes that are critical to success. For each of the five stages, core elements are defined for each attribute as shown in Table 1.

Table 1. Summary of GAO's EAMMF Maturity Stages, Critical Success Attributes, and Core Elements

	Stage 1: Creating EA awareness	Stage 2: Building the EA management foundation	Stage 3: Developing EA products	Stage 4: Completing EA products	Stage 5: Leveraging the EA to manage change
Attribute 1: Demonstrates commitment		Adequate resources exist. Committee or group representing the enterprise is responsible for directing, overseeing, or approving EA.	Written and approved organization policy exists for EA development.	Written and approved organization policy exists for EA maintenance	Written and approved organization policy exists for IT investment compliance with EA
Attribute 2: Provides capability to meet commitment		Program office responsible for EA development and maintenance exists. Chief architect exists. EA is being developed using a framework, methodology, and automated tools.	EA products are under configuration management	EA products and management processes undergo independent verification and validation.	Process exists to formally manage EA change. EA is integral component of IT investment managementprocess.
Attribute 3: Demonstrates satisfaction of commitment		EA plans call for describing both the "as-is" and the "to-be" environments of the enterprise, as well as a sequencing plan for transitioning from the "as-is" and the "to-be" environments in terms of business, performance, information/data, application/service, and technology.	EA products describe or will describe both the "as-is" and the "to-be" environments of the enterprise, as well as a sequencing plan for transitioning from the "as-is" to the "to-be". Both the "as-is" and the "to-be" environments are described or will be	EA products describe both the "as-is" and the "to-be" environments of the enterprise, as well as a sequencing plan for transitioning from the "as-is" to the "to-be". Both the "as-is" and the "to-be" environments are described in terms of business, performance, information/data, application/service, and	EA products are periodically updated. IT investments comply with EA. Organization head has approved current version of EA.

[31] Based on October 2003 Information. Revised January 25, 2004.

		EA plans call for business, performance, information/data, application/service, and technology descriptions to address security.	described in terms of business, performance, information/data, application/service, and technology. Business, performance, information/data, application/service, and technology descriptions address or will address security.	technology. Business, performance, information/data, application/service, and technology descriptions address security. Organization CIO has approved current version of EA. Committee or group representing the enterprise or the investment review board has approved current version of EA.	
Attribute 4: Verifies satisfaction of commitment		EA plans call for developing metrics for measuring EA progress, quality, compliance, and return on investment.	Progress against EA plans is measured and reported.	Quality of EA products is measured and reported.	Return on EA investment is measured and reported. Compliance with EA is measured and reported.
Matuation ->					

GAO sees the EAMMF being used 1) to provide a set of benchmarks against which to determine where the enterprise stands in its progress toward the ultimate goal: having architecture management capabilities that effectively facilitate institutional change (maturity stage 5), and 2) as a high-level basis for developing specific architecture management improvement plans, as well as for measuring, reporting, and overseeing progress in implementing these plans. The references provide a detailed description of the model.

References

A Framework for Assessing and Improving Enterprise Architecture Management (Version 1.1) GAO-03-584G, United States General Accounting Office, April 2003. http://www.gao.gov/ - *Contains a description of the GAO Five Stage EA Maturity Framework*

Enterprise Architecture Use across the Federal Government Can Be Improved GAO-02-6, United States General Accounting Office, February 2002. http://www.gao.gov/

Contains an early description of the GAO Five Stage EA Maturity Framework and survey results from agencies identifying where they are on the maturity framework.

GAO's Enterprise Architecture Management Maturity Framework (Version 1.1), Randy Hite, GAO, Sept 12, 2003, briefing presented at eGov Enterprise Architecture Conference, http://www.e-gov.com/events/2003/ea/downloads/

7.2 Seven High-Level EA Evaluation Criteria[32]

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As the EA and its associated processes mature, an agency and others will assess EA efforts. The assessments may examine the EA description represented in EA products, the processes used to produce and manage the EA, and other processes such as capital planning and investment management or systems development that use the EA. This discussion focuses primarily on the EA content and use.

An EA portrays the end state an organization wishes to achieve so must have the right target. That target must be well-engineered for the business to function properly and efficiently. The EA must be well-described to capture all the relevant information consistently and completely and to communicate among users of the EA. The EA must be well-captured to be modifiable and available for analysis. An EA must be useful for investment decisions, guiding development efforts, and managing the enterprise.

High-Level EA Evaluation Criteria	
EA Creation	EA Use - Transformation
Right Target	Invest Well
Well-Engineered	Manage Well
Well-Described	Guide Development
Well-Captured	

These seven high-level criteria focus on what an enterprise needs to address to have a quality, useful EA.

The EA is a management and a technology tool. It has many facets and uses that are overlapping and intertwined. Therefore, its evaluation criteria are overlapping and intertwined. By focusing on the following seven areas, the evaluator can remember the forest amid the detail of the trees.

1. (*Right Target*) Are the vision and strategic goals of the enterprise supported (the focus of) in the target EA?

> An EA guides the evolution of the entire enterprise. The target architecture description portrays how the enterprise is to function, its capabilities, and its

[32] Written September 2003.

infrastructure. That portrayal should accurately reflect the business vision. The business vision should incorporate agency strategic objectives as well as government values such as easy, electronic public access to data, privacy protection, or providing quick responses in an emergency.

2. (*Well-Engineered*) Is the target EA engineered to provide the desired qualities in the business, data, applications, and technology architectures?

Some desired qualities include the flexibility to change in response to new drivers, data sharing, security protection, privacy, interoperability, upgradability, operational effectiveness, and use of a component-based approach with the incorporation of shared solutions such as e-gov initiatives, common Federal components, or state, local, or international interfaces. Note that the qualities described here may overlap with achieving the target vision which is tied to strategic goals, but these qualities are designed or engineered into the EA.

3. (*Well-Described*) Do the EA descriptive products contain the necessary information presented in a useful, readable manner consistent with the chosen framework?

The Federal Enterprise Architecture Framework (FEAF) provides direction on product organization and content to help achieve an integrated, consistent EA description that can be compared across agencies. Completeness, consistency, traceability, and readability are important aspects of those products. The EA should portray not only within-agency information, but also incorporate cross-agency, cross-departmental, state, local, and outsourcing relationships. These relationships could involve data exchange, data sharing, business process, solution sharing, or service provision. They affect the EA detail needed, investments, and the solutions required to achieve the target architecture. The EA should also use terminology consistent with legislation, directives, industry standards, and other guidance. It is beneficial if the agency EA, as part of the total Federal Enterprise Architecture, is comparable to other Federal EA descriptions and linked to the Business Reference Model (BRM).

4. (*Well-Captured*) Is the EA captured in such a way that it is available easily, maintainable, can have different elements extracted for selected audiences, and can be analyzed?

The EA should be available electronically, possibly on a web site, and captured with tools such that it can be easily managed and updated. Portions for executive, engineering, contracting, or other audiences should be extractable while conforming to security, privacy, and release concerns. Analysis on the EA to examine performance, dependencies, investment planning, and other issues should be facilitated by the capture tool.

5. (*Invest Well*) Do the current EA and its transition plan contain enough detail to identify and sequence the efforts and investments needed to achieve the target architecture?

To guide investment decisions, the EA must indicate where changes are needed and the dependencies and sequencing among the changes. Much of this is addressed in the transition strategy which is addressed under the Manage-Well criterion. The EA provides the information to guide decisions and begin examining consequences of alternative choices; executives, through the Capital Planning and Investment Control (CPIC) Process, use that information to reach investment decisions.

6. (*Guide Implementation*) Does the EA provide guidance for developers to know what environment they must fit into and the standards they must follow?

The EA, through its standards profile and description of the environment and context into which a new capability must operate, should provide the builder with the necessary 'build to' information.

7. (*Manage Well*) Does the EA provide information necessary to manage change, support cost and value assessments, assess the impact of potential changes, and identify risks?

The EA transition strategy includes a plan to achieve the target architecture. Through its direction, dependency, sequencing, risk, and priority information the transition strategy provides Management the information needed for sound technical and resource planning, risk management, and assessment of 'what-ifs.' The EA should also support metrics to assess costs and value.

Editor's Note: *This material will be replaced by EA Property and Quality Assessment in a future edition.*

7.3 Assessment of EA Products - Future

This section will address criteria and techniques or processes to evaluate EA products, i.e., the description including models of the enterprise architecture that is developed and used by the Service or Agency. The evaluation includes how well the products serve their intended use.

7.4 Assessment of EA Development Processes - Future

This section will address criteria and techniques or processes to evaluate the quality of the processes used to develop and manage the EA. It is concerned with the quality of the of those processes and ways to improve EA Program management and execution. The boundary between the management of the EA Program and *use* of the EA needs to be established.

7.5 Assessment of EA Usage Processes – Future

This section will address criteria and techniques to evaluate the use of the EA in strategic planning, financial investment, technical engineering, and organizational transformation processes.

7.6 Assessment of EA Resources – Future

Chapter 8

8. Lessons Learned and Practical Experience

Editors Comment: A strategy for presenting and organizing this material needs to be developed. Users don't necessarily like long lists of things. The material also needs to be worked back into the sections where they are applicable, a possible organizing strategy.

MITRE Internal Draft

References

Overall Presentations on EA

E-Gov EA 2003 Pest Practices in Implementing Federal Enterprise Architectures, Patrick Bolton, Headstrong and FEAF Institute, Sept 11, 2003, eGov Enterprise Architecture Conference, http://www.e-gov.com/events/2003/ea/downloads/

Designing an EA for Business Value and Relevance, Patrick Bolton, Headstrong and FEAF Institute, Sept 11, 2003, eGov Enterprise Architecture Conference, http://www.e-gov.com/events/2003/ea/downloads/

Lessons Learned

Lessons Learned in Developing an Enterprise Architecture Program for the USDA Forest Service, John King, USDA Forest Service, , Sept 11, 2003, eGov Enterprise Architecture Conference, http://www.e-gov.com/events/2003/ea/downloads/

"Governing Enterprise Architecture: Lessons Learned from Implementing Federal Government EAs," by Patrick Bolton, in The Cutter IT Journal, Volume 16, No. 7, July 2003. A free copy of the article may be obtained by downloading the report "EA Governance: From Platitude to Progress" at the following URL: http://www.cutter.com/architecture/eaemail.html. (Registration is required.)

Lessons Learned, Notions, Tips, and Tricks, Based on Years of Enterprise Architecture Experience, Michael Tiemann, DOE (now AT&T) Briefing.

Enterprise Architecture – What Works, What Doesn't, George Brundage, Scott Bernard, Col. Bill Nelson, Lewis Sanford, Briefing Slides, Oct 8, 2002.

Architecture ROI : Exercise 'Victory Scrimmage' Lessons Learned, John Manley, MITRE TEM presentation, (Winter –Spring 2003- No date cited) (John Anderson's transfer folder – EA IDM TEM folder)

Seven Architecture Management Best Practices," by Greta A. James of the Gartner Group (http://www.gartner.com), 31 December 2002; 4 pages, $95.

General Web Sites

OMB FEA PMO http://www.feapmo.gov/resources/

Federal CIO Council http://www.cio.gov

NASCIO http://www.nascio.gov

ArchitecturePlus http://www.itpolicy.gsa.gov

The Open Group (TOGAF) http://www.opengroup.org

National Defense University http://knet.ndu.edu

Egov conference http://www.e-gov.com/events/2003/ea/downloads/

Government EA Conference http://www.dci.com/eac

Federal EA Certification Institute http://www.feacinstitute.org

EA Community http://www.eacommunity.com

EABOK Glossary[33]

Activity

Architecture - the science, art, or profession of designing and constructing…., a style of construction, any framework, system, etc., and the design and interaction of components. Source: Webster's Dictionary

Architecture products - the graphics, models, and/or narrative that depict the enterprise environment and design. (Source: Practical Guide)

As-Is Architecture – See baseline architecture

Baseline architecture - the set of products that portray the existing enterprise, the current business practices, and the technical infrastructure. It is commonly referred to as the 'As-Is' architecture. Source:

(Business) Function

Capability (Get DoD definition)

Capital Planning and Investment Control (CPIC) is the same as capital programming and is a decision-making process fro ensuring the information technology (IT) investments integrate strategic planning, budgeting, procurement, and the management of IT in support of agency missions and business needs. The term comes from the Clinger-Cohen Act of 1996 and is generally used in relationship to IT management issues. Source: OMB A-11 Section 300 (300-3).

Capital Programming means an integrated process within an agency for planning, budgeting, procurement, and management of the agency's portfolio of capital assets to achieve agency strategic goals and objectives with the lowest life-cycle cost and least risk. Source OMB A-11 Section 300.

CIMOSA defines a model based enterprise engineering method which categorizes manufacturing operations into Generic and Specific (Partial and Particular) functions. These can then be combined to create a model which can be used for process simulation and analysis. The same model can be used on line in the manufacturing enterprise for scheduling, dispatching, monitoring, and providing process information. http://www.pera.net/Arc_cimosa.html

Current Architecture – See baseline architecture

[33] January, 2004

Engineering – the science concerned with putting scientific knowledge to practical uses, divided into different branches, divided into different branches, as civil, electrical, mechanical, and chemical engineering. The planning, designing, construction, or management of machinery, roads, bridges, buildings, etc. The act of maneuvering or managing. (Webster's Dictionary)

Enterprise – An organization supporting a defined business scope and mission. An enterprise is comprised of interdependent resources (people, organizations, and technology) who must coordinate their functions and share information in support of a common mission (or set of related missions). Source: Practical Guide

Enterprise Architecture -

"(A) means -

(i) a strategic information asset base, which defines the mission;
(ii) the information necessary to perform the mission;
(iii) the technologies necessary to perform the mission; and
(iv) the transitional processes for implementing new technologies in response to changing needs; and

(C) Includes -

(i) a baseline architecture;
(ii) a target architecture; and
(iii) a sequencing plan".

Source: 2002 E-Government Act of 2002 (Public Law (PL) 107-347)

Enterprise Architecture Engineering (EAE) TBD.

Enterprise architecture framework - provides an organizing structure for the information contained in and describing an EA. The framework does not contain the EA itself. Many organizations can use the same EA framework, but each EA with its content is organization-specific.

An *enterprise architecture framework*

- Identifies the types of information needed to portray an Enterprise Architecture (EA),
- Organizes the types of information into a logical structure, and
- Describes the relationships among the information types.

Often the information is categorized into architecture models and viewpoints.

- An organizing mechanism for managing the development and maintenance of architecture descriptions (Source: FEAF V 1.1)

Enterprise Engineering – that body of knowledge, principles, and practices having to do with the analysis, design, implementation and operation of an enterprise. The enterprise engineer addresses a fundamental question: 'how to design and improve all elements associated with the total enterprise through the use of engineering and analysis methods and tools to more effectively achieve its goals and objectives. Source: The Enterprise

Engineering Discipline, Donald H Liles, Mary E. Johnson, Laura Meed, University of Texas. http://arri.uts.edu/enteng/ent_eng.htm

Event Trace – an ordered list of events between different objects assigned to columns in a table (Rumbaugh p173)

Framework – a structure, usually rigid serving to hold the parts of something together or to support something constructed or sketched over or around it. The basic structure, arrangement, or system. (Webster's Dictionary)

Governance - The governance structure of an enterprise is concerned with the leadership, organizational structures, and processes that:

- Set strategic enterprise goals
- Provide direction and strategy on achieving those goals
- Secure resources and allocate those resources to activities
- Establish measures for activities and results directed at achieving the goals
- Manage risks in the process of achieving the goals and operating the business
- Measure performance to ensure business value is being achieved

Source: *Board Briefing on IT Governance*, It Governance Institute, Information Systems Audit and Control Foundation, ISBN 1-893209-27-X, Rolling Meadows IL 60008, 2001.

Process – a repeatable unit of work with recognizable starting and stopping points, using personnel, materials, tools, and information to create products and/or new information

Process Model

Sequencing Plan - a document that defines the strategy for changing the enterprise from the current baseline to the target architecture. It schedules multiple, concurrent, interdependent activities, and incremental builds that will evolve the enterprise. (Source: Practical Guide)

Service-Oriented Architecture – In Service Oriented Architectures, services, data, and workflow processes are enabled, through object-oriented languages, XML protocols, and standards, to be shared across the distributed, inter-connected set of users. A user discovers the set of shared service components and data that are appropriate for the user's application process through directory services. These services are dynamically invoked and assembled at run time, and intended to operate on data made available within 'shared spaces.' Service oriented architectures may take advantage of network-associated storage (NAS) or storage-area-networks (SANs) to distribute, stage, and manage information content and services. Publish and subscribe protocols to move data into 'shared spaces' enable the decoupling of information producers and consumers. Service-oriented architectures use n-tiered server architectures to meet the needs of distributed, interconnected users in the most efficient manner. Service-Oriented architectures are component-based (i.e., object-oriented) and machine independent. Source: NCOW Reference Model

Software Architecture – The structure of the components of a program/system, their interrelationships, and principles and guidelines governing their design and evolution over time. Source: IEEE Transactions on Software Engineering Vol 21 No 4 April 1995 guest editorial by Garlan and Perry

Target architecture - the set of products that portray the future or end-state enterprise, generally captured in the organization's strategic thinking and plans. It is commonly referred to as the 'To-Be' architecture. (Source: Practical Guide)

To-Be Architecture – See target architecture

Transition processes will include agency capital planning and investment control processes, agency EA planning processes, and agency systems lifecycle methodologies. Source: OMB A-130, Nov 2000.

Transition Strategy Source OMB A-130 – term sometimes used interchangeably with sequencing plan. However the concept is broader and more inclusive. (WORK THIS OUT)

Use Case – a narrative document that describes the sequence of events of an actor (an external agent) using a system to complete a process (Jacobson 92 p 49 of Larman – get from UML SPEC)

Value Chain - disaggregates a firm into its strategically relevant activities to understand the behavior of costs and the existing and potential sources of differentiation *(from other companies/products)* (Source – *Competitive Advantage* by Michael Porter)

Workflow – describes the automation of internal business operations, tasks, and transactions that simplify and streamline current business processes (source – http://www.WFMC.org web site)