United States Government Accountability Office

GAO

Executive Guide

August 2010

# ORGANIZATIONAL TRANSFORMATION

# A Framework for Assessing and Improving Enterprise Architecture Management (Version 2.0)


GAO-10-846G

August 2010

# ORGANIZATIONAL TRANSFORMATION

## A Framework for Assessing and Improving Enterprise Architecture Management (Version 2.0)

GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-10-846G, an executive guide

### Why GAO Did This Study

Effective use of an enterprise architecture (EA) is a hallmark of successful organizations and an essential means to achieving a desired end: having operations and technology environments that maximize institutional mission performance and outcomes. Among other things, this includes realizing cost savings through consolidation and reuse of shared services and elimination of antiquated and redundant mission operations, enhancing information sharing through data standardization and system integration, and optimizing service delivery through streamlining and normalization of business processes and mission operations. Not using an EA can result in organizational operations and supporting technology infrastructures and systems that are duplicative, poorly integrated, unnecessarily costly to maintain and interface, and unable to respond quickly to shifting environmental factors.

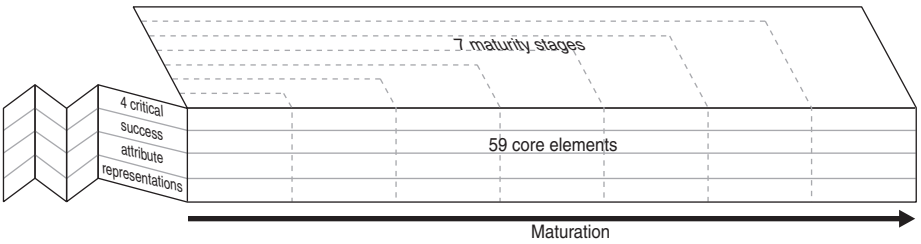
To assist organizations in successfully developing, maintaining, and using an EA, GAO is issuing this major update to its Enterprise Architecture Management Maturity Framework. Its purpose is to provide a flexible benchmark against which to plan for and measure EA program maturity. To develop the update, GAO solicited comments from 27 federal departments and agencies, as well as representatives from the private sector, state governments, and academia, and it leveraged its prior experience in applying the framework.

View GAO-10-846G or key components.
For more information, contact Randolph C. Hite at (202) 512-3439 or hiter@gao.gov.

### What GAO Found

The framework consists of three interrelated components: (1) seven hierarchical stages of management maturity; (2) four representations of management attributes that are critical to the success of any program or organizational endeavor; and (3) 59 elements, or building blocks, of EA management that are at the core of an EA program. (See the figure below for a conceptual view of the framework's components.)

**Conceptual Depiction of the EAMMF's Interrelated Components**




Source: GAO.

Each of the seven maturity stages reflects those EA management conditions that an enterprise should meet to logically build on the capability established at the preceding stage. As such, the stages provide a road map for systematically maturing or evolving an organization's capacity to manage an EA. The stages are: Stage 0: Creating EA Awareness; Stage 1: Establishing EA Institutional Commitment and Direction; Stage 2: Creating the Management Foundation for EA Development and Use; Stage 3: Developing Initial EA Versions; Stage 4: Completing and Using an Initial EA Version for Targeted Results; Stage 5: Expanding and Evolving the EA and Its Use for Institutional Transformation; Stage 6: Continuously Improving the EA and Its Use to Achieve Corporate Optimization.

The four critical success attribute representations provide different and complementary ways to view and thus understand the 59 core elements. The four are referred to as the (1) EA Management Action Representation, (2) EA Functional Area Representation, (3) Office of Management and Budget Capability Area Representation, and (4) EA Enabler Representation. Each provides a unique perspective on the focus and nature of the framework's core elements.

The 59 core elements are collectively the EA practices, structures, activities, and conditions that, when properly employed based on the unique facts and circumstances of each organization and the stated purpose of its EA program, can permit that organization to progress to increasingly higher states of EA management maturity and thereby maximize its chances of realizing an EA's institutional value.

# Contents



## Tables



## Figures

**Abbreviations**

| | |
|---|---|
| CIO | chief information officer |
| CMMI | Capability Maturity Model® Integration |
| CXO | chief "X" officer |
| DOD | Department of Defense |
| DODAF | Department of Defense Architecture Framework |
| EA | enterprise architecture |
| EAMMF | Enterprise Architecture Management Maturity Framework |
| ECIMT | Executive Council for Information Management and Technology |
| FEAF | Federal Enterprise Architecture Framework |
| FEAPMO | Federal Enterprise Architecture Program Management Office |
| IT | information technology |
| ITIM | Information Technology Investment Management |
| NIST | National Institute of Standards and Technology |
| OMB | Office of Management and Budget |
| OPM | Office of Personnel Management |

GAO
Accountability * Integrity * Reliability

**United States Government Accountability Office**
**Washington, DC 20548**

# Preface

Effective use of a well-defined enterprise architecture (EA) is a hallmark of successful organizations and a basic tenet of organizational transformation and systems modernization. Since the early 1990s, GAO has promoted federal department and agency EA adoption as an essential means to achieving a desired end: having operational and technology environments that maximize institutional mission performance and outcomes.[1] Among other things, this includes realizing cost savings through consolidation and reuse of shared services and elimination of antiquated and redundant mission operations, enhancing information sharing through data standardization and system integration, and optimizing service delivery through streamlining and normalization of business processes and mission operations. The alternative, as GAO has reported, is department and agency operations and supporting information technology (IT) infrastructures and systems that are duplicative, poorly integrated, unnecessarily costly to maintain and interface, and unable to respond quickly to shifting environmental factors.[2]

Managed properly, an EA can help simplify, streamline, and clarify the interdependencies and relationships among an organization's diverse mission and mission-support operations and information needs, including its associated IT environment. When employed in concert with other institutional management disciplines, such as strategic planning, portfolio-based capital planning and investment control, and human capital management, an EA can greatly increase the chances of configuring an organization to promote agility and responsiveness, optimize mission performance and strategic outcomes, and address new federal initiatives like promoting open and participatory government and leveraging cloud computing.

[1]See, for example, GAO, *Strategic Information Planning: Framework for Designing and Developing System Architectures*, GAO/IMTEC-92-51 (Washington, D.C.: June 1992).

[2]See, for example, GAO, *Homeland Security: Efforts Under Way to Develop Enterprise Architecture, but Much Work Remains*, GAO-04-777 (Washington, D.C.: Aug. 6, 2004); *DOD Business Systems Modernization: Limited Progress in Development of Business Enterprise Architecture and Oversight of Information Technology Investments*, GAO-04-731R (Washington, D.C.: May 17, 2004); *Information Technology: Architecture Needed to Guide NASA's Financial Management Modernization*, GAO-04-43 (Washington, D.C.: Nov. 21, 2003); *DOD Business Systems Modernization: Important Progress Made to Develop Business Enterprise Architecture, but Much Work Remains*, GAO-03-1018 (Washington, D.C.: Sept. 19, 2003); and *Information Technology: DLA Should Strengthen Business Systems Modernization Architecture and Investment Activities*, GAO-01-631 (Washington, D.C.: June 29, 2001).

To assist federal departments and agencies in their efforts to develop, maintain, and use an EA, we issued the first version of this framework (version 1.0) in 2002, followed by a minor update (version 1.1) in 2003.[3] We offer here the first major revision to the framework (version 2.0). This update is based on our extensive use of version 1.1 in performing two governmentwide and numerous department- and agency-specific EA evaluations, as well as our solicitation of comments from departments and agencies and other stakeholders on the usability, completeness, and sufficiency of the framework as a tool to define and measure an organization's EA management maturity. The update also incorporates comments received from GAO's Executive Council on Information Management and Technology (ECIMT) on version 1.1 and a draft of version 2.0.[4]

In summary, version 2.0 builds on the prior version by introducing considerably more scope and content to accommodate the evolving and complex nature of EA as one of many enterprise management disciplines and the practical realities surrounding actual EA development and use. As such, this version of the framework provides a more current and pragmatic construct for viewing EA development and use. In this regard, it provides a flexible benchmark against which to plan for and measure EA program management maturity that permits thoughtful and reasonable discretion to be applied in using it. Restated, the framework is not intended to be a rigidly applied "one size fits all" checklist, but rather a flexible frame of reference that should be applied in a manner that makes sense for each organization's unique facts and circumstances. Moreover, the framework is not intended to be viewed as the sole benchmarking tool for informing and understanding an organization's journey toward EA maturity.

[3]GAO, *Information Technology: Enterprise Architecture Use across the Federal Government Can Be Improved*, GAO-02-6 (Washington, D.C.: Feb. 19, 2002); *Information Technology: A Framework for Assessing and Improving Enterprise Architecture Management* (version 1.1), GAO-03-584G (Washington, D.C.: April 2003).

[4]GAO's Executive Council on Information Management and Technology is composed of senior-level officials from the public sector, private sector, and academia. Members include former chief information officers for government agencies, professors of information technology, presidents of private businesses, information technology consultants, and representatives of the National Association of State Chief Information Officers.

Questions and comments about this framework should be directed to me at (202) 512-3439 or at hiter@gao.gov. Key contributors to this framework were Nabajyoti Barkakati, Nancy Glover, Michael Holland, Neelaxi Lakhmani (Assistant Director), Anh Le, Emily Longcore, Constantine Papanastasiou, and Jennifer Stavros-Turner.

Randolph C. Hite
Director, Information Technology Architecture and Systems Issues

# Section 1: Introduction

An EA provides a clear and comprehensive picture of the structure and substance of any purposeful activity, whether it is an organization (e.g., a federal department or agency) or a functional or mission area that cuts across organizational boundaries (e.g., terrorism information sharing or homeland security). Accordingly, an EA is an essential tool for effectively and efficiently engineering business or mission processes and for implementing and evolving supporting systems.

The concept of using an architecture to describe an enterprise first emerged in the mid-1980s, and over the years various frameworks for defining the content of EAs have been published.[5] Our research in the early 1990s identified the use of architectures as critical to an organization's success in effectively applying IT to meet mission goals. Since then, we have worked with the Congress, the Office of Management and Budget (OMB), and the federal Chief Information Officers (CIO) Council to recognize the importance of architectures and assist federal departments and agencies in developing, maintaining, and using them. In our reviews of agency IT management practices and major systems modernization programs, we continue to identify the lack of a well-defined architecture as a major management challenge, and we have made numerous recommendations addressing this important area.[6]

## EA: A Brief Description

An EA can be viewed as a blueprint for organizational transformation and IT modernization. Generally speaking, it consists of "snapshots" of the enterprise's current, or "as-is," operational and technological environment

[5]A framework can be viewed as a logical structure for classifying and organizing complex information.

[6]See, for example, GAO, *Information Technology: HUD Needs to Strengthen Its Capacity to Manage and Modernize Its Environment*, GAO-09-675 (Washington, D.C.: July 31, 2009); *DOD Business Systems Modernization: Military Departments Need to Strengthen Management of Enterprise Architecture Programs*, GAO-08-519 (Washington, D.C., May 12, 2008); *Federal Aviation Administration: Stronger Architecture Program Needed to Guide Systems Modernization Efforts*, GAO-05-266 (Washington, D.C.: Apr. 29, 2005); GAO-04-777; GAO-04-731R; *Information Technology: Architecture Needed to Guide NASA's Financial Management Modernization*, GAO-04-43 (Washington, D.C.: Nov. 21, 2003); *Information Technology: Leadership Remains Key to Agencies Making Progress on Enterprise Architecture Efforts*, GAO-04-40 (Washington, D.C.: Nov. 17, 2003); GAO-03-1018; GAO-03-877R; *Information Technology: DLA Should Strengthen Business Systems Modernization Architecture and Investment Activities*, GAO-01-631 (Washington, D.C.: June 29, 2001); and *Information Technology: INS Needs to Better Manage the Development of Its Enterprise Architecture*, GAO/AIMD-00-212 (Washington, D.C.: Aug. 1, 2000).

and its target, or "to-be," environment, and contains a capital investment road map for transitioning from the current to the target environment. These snapshots consist of "views," which are basically one or more architecture products that provide conceptual, logical, or physical representations of the enterprise. Further, these views or representations are not static, but rather will evolve and change over time, making the EA a "living document."

The genesis of EA as an organizational management discipline can be traced to the mid-1980s. At that time, John Zachman, widely recognized as a leader in the EA field, identified the need to use a logical construction blueprint (i.e., an architecture) for defining and controlling the integration of systems and their components.[7] Accordingly, Zachman developed a structure, or "framework," for defining and capturing an architecture. In his work, Zachman drew parallels to the field of classical architecture and later to the aircraft manufacturing industry, in which different work products (e.g., architect plans, contractor plans, shop plans, and bills of lading) represent different views of the planned building or aircraft. Similarly, Zachman's framework identified the kinds of work products needed for people to understand and thus build a given system or entity. This framework provides for six windows from which to view the enterprise, which Zachman terms "perspectives" on how a given entity operates: those of (1) the strategic planner, (2) the system user, (3) the system designer, (4) the system developer, (5) the subcontractor, and (6) the system itself. Zachman also proposed six abstractions, or models, associated with each of these perspectives: These models cover (1) how the entity operates, (2) what the entity uses to operate, (3) where the entity operates, (4) who operates the entity, (5) when entity operations occur, and (6) why the entity operates. Zachman's framework provides a taxonomy for identifying and describing an entity's existing and planned component parts and the parts' relationships before one begins the costly and time-consuming efforts associated with developing or transforming the entity.

Since the development of Zachman's EA framework, various approaches have emerged to develop and implement EAs. For example, the EA product development methodology outlined by Steven Spewak in 1992 calls for the development of "as-is" architecture models before the

[7]J. A. Zachman, "A Framework for Information Systems Architecture," *IBM Systems Journal* 26, no. 3 (1987).

development of detailed "to-be" models, followed by the development of a plan for transitioning from the "as-is" to the "to-be" environment.[8]

## Overview of Federal EA Guidance and Legislation

Architecture guidance within the federal government can be traced to a National Institute of Standards and Technology (NIST) publication in 1989.[9] Subsequently, we issued a guide[10] and published our research on successful public- and private-sector organizations' IT management practices, which identified the use of architectures as a factor critical to these organizations' success.[11] Since that time, other federal entities have issued frameworks for defining the content of EAs, including the federal CIO Council,[12] the Department of the Treasury,[13] and the Department of Defense (DOD).[14]

- In September 1999, the federal CIO Council published the Federal Enterprise Architecture Framework (FEAF), which provided federal agencies with a common construct for their architectures and thereby facilitated the coordination of common business processes, technology insertion, information flows, and system investments among federal agencies. The FEAF, which has been essentially replaced by the Federal Enterprise Architecture Program Management Office (FEAPMO) reference models discussed below, defined a collection of interrelated models for describing multi-organizational functional segments of the federal government. Similar to the Zachman framework, the FEAF's models covered business functions, data necessary to conduct the business

[8]Steven H. Spewak with Steven C. Hill, *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology* (Princeton, N.J.: John Wiley and Sons, 1992).

[9]National Institute of Standards and Technology, *Information Management Directions: The Integration Challenge*, Special Publication 500-167 (Gaithersburg, MD: September 1989).

[10]GAO/IMTEC-92-51.

[11]GAO, *Executive Guide: Improving Mission Performance through Strategic Information Management and Technology*, GAO/AIMD-94-115 (Washington, D.C.: May 1994).

[12]Federal Enterprise Architecture Framework, Version 1.1 (September 1999).

[13]Treasury Enterprise Architecture Framework, Version 1.0 (July 3, 2000).

[14]DOD, Department of Defense Architecture Framework, Version 2.0, Volumes I-III (May 2009).

functions, applications to manage the data, and technology to support the applications.

- In July 2000, the Department of the Treasury published the Treasury EA Framework, which provides (1) guidance to Treasury bureaus concerning the development and evolution of an architecture; (2) a unifying concept, common principles, technologies, and standards for information systems; and (3) a template for the development of the EA. According to the department, it is to be used to guide the development and redesign of bureau business processes. It consists of four architectural views (functional, information, organizational, and infrastructure) and a set of notional products to portray these views from four core perspectives (planner, owner, designer, and builder).

- In August 2003, DOD released version 1.0 of its DOD Architecture Framework (DODAF), which defines the type and content of the architectural artifacts, as well as the relationships among the artifacts.[15] DODAF version 2.0, released in May 2009, builds on the prior versions and specifies a set of eight "viewpoints"—all, capability, data and information, operational, project, services, standards, and systems—each of which includes various architecture models that apply to DOD-, component-, and program-level system architectures.

In 2002, OMB established the FEAPMO to develop a federal EA according to a collection of five "reference models":

- The Business Reference Model is intended to describe the business operations of the federal government independent of the agencies that perform them.

- The Performance Reference Model is to provide a common set of general performance outputs and measures for agencies to use to achieve business goals and objectives.

- The Data and Information Reference Model is to describe, at an aggregate level, the type of data and information that support program and business line operations, and the relationships among these types.

[15]DODAF was based on DOD's Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance framework, developed by DOD in response to the Clinger-Cohen Act of 1996.

- The Service Component Reference Model is to identify and classify IT service (i.e., application) components that support federal agencies and promote the reuse of components across agencies.

- The Technical Reference Model is to describe how technology is supporting the delivery of service components, including relevant standards for implementing the technology.

Together, the reference models are intended to facilitate governmentwide improvement through cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration, interoperability, and integration within and across government agencies.

In addition to these frameworks governing the structure and content of EAs, OMB, in collaboration with us, developed guidance on the development and implementation of EAs.[16] Further, the federal CIO Council collaborated with us in developing EA guidance focused on assessing an IT investment's compliance with an EA,[17] as well as guidance that addressed the end-to-end steps associated with developing, maintaining, and implementing an EA program.[18] These steps include how to get started and organized, what kind of management controls are needed, what factors to consider in formulating an EA development approach, how to go about defining the current and target architecture and the plan for sequencing from the current to the target, how to ensure that the architecture is implemented and enforced, and how to systematically refresh and maintain the architecture to ensure its currency and relevance.

The emergence of federal architecture guidance and frameworks over the last 15 years is largely owing to the Congress's passage of the Clinger-Cohen Act in 1996. This act, among other things, requires the CIOs for major federal departments and agencies to develop, maintain, and facilitate architectures as a means of integrating business processes and

[16]OMB, *Information Technology Architectures*, Memorandum M-97-16 (June 18, 1997), rescinded with the update of OMB Circular A-130 (Nov. 30, 2000).

[17]Chief Information Officers Council, *Architecture Alignment and Assessment Guide* (October 2000).

[18]Chief Information Officers Council, *A Practical Guide to Federal Enterprise Architecture*, Version 1.0 (February 2001).

agency goals with IT.[19] The E-Government Act of 2002 established the OMB Office of Electronic Government and assigned it, among other things, responsibilities for overseeing the development of EAs within and across federal agencies.[20]

## OMB's EA Assessment Framework

In April 2004, OMB issued the first version of its EA Assessment Framework, and since then has issued multiple updates.[21] According to the latest version of this framework (version 3.1), its purpose is to provide the measurement areas and criteria for federal agencies to use in realizing EA-driven performance improvements and outcomes (e.g., improving mission performance; saving money and avoiding costs; enhancing the quality of agency investment portfolios; improving the quality, availability and sharing of data and information; and increasing the transparency of government operations). To accomplish this, the framework uses key performance indicators to assess EA maturity or effectiveness relative to three capability areas—completion, use, and results (see table 1 for a description of these three capability areas).

**Table 1: OMB EA Assessment Framework Capability Areas**

| Capability area | Summary |
|---|---|
| Completion | Measures agency completion of the current and target EA in terms of performance, business, data, services, and technology as well as the completion of the agency's enterprise transition plan. |
| Use | Measures agency demonstration of EA awareness and establishment of the necessary management practices, processes, and policies needed for EA development, maintenance, and oversight. Also measures agency EA use in strategic planning, information resources management, IT management, and capital planning and investment control processes. |
| Results | Measures actual results attributed to the EA, and therefore the effectiveness and value of its EA activities. |

Source: OMB.

[19]40 U.S.C. § 11315.

[20]44 U.S.C § 3602(f)(14). The E-Government Act also provided a more detailed definition of the concept and elements of enterprise architecture. See 44 U.S.C. § 3601(4).

[21]OMB, *Improving Agency Performance Using Information and Information Technology* (*Enterprise Architecture Assessment Framework v3.1*) (June 2009).

Each capability area contains a set of key performance indicators and associated outcomes, as well as criteria for gauging progress in meeting the outcomes. For example, the Completion capability area is composed of four key performance indicators: Target EA and Enterprise Transition Plan, Architectural Prioritization, Scope of Completion, and Internet Protocol Version 6. Each key performance indicator is scored on a 1-5 scale. For example, according to the criteria for the Target EA and Enterprise Transition Plan key performance indicator, an agency at level 1 has a target EA that is a consolidated representation of all agency segments and has submitted its segment architectures to OMB, but the agency has yet to begin reusing IT investments. At level 5, all of the agency's segment architectures are in progress or complete, reuse and/or information sharing among subunits of the agency and/or other agencies is demonstrated, and EA segments demonstrate a "line-of-sight" to agency performance goals.

## Overview of EA Structural Approaches

Several approaches to structuring an EA exist and can be applied to the extent that they are relevant and appropriate for a given enterprise. In general, these approaches provide for decomposing an enterprise into its logical parts and architecting each of the parts in relation to enterprisewide needs and the inherent relationships and dependencies that exist among the parts. As such, the approaches are fundamentally aligned and consistent with a number of basic EA principles, such as incremental rather than monolithic architecture development and implementation, optimization of the whole rather than optimization of the component parts, and maximization of shared data and services across the component parts rather than duplication. Moreover, these approaches are not mutually exclusive, and in fact can all be applied to some degree for a given enterprise, depending on the characteristics and circumstances of that enterprise. The approaches, which are briefly described below, are federated, segmented, service-oriented, and extended architectures.

### Federated

Under a federated approach, the architecture consists of a family of coherent but distinct member architectures that conform to an overarching corporate or parent architecture. This approach recognizes that each federation member has unique goals and needs as well as common roles and responsibilities with the members above and below it. As such, member architectures (e.g., component, subordinate, or subsidiary architectures) are substantially autonomous, but they also inherit certain rules, policies, procedures, and services from the parent architectures. A federated architecture enables component organization

autonomy while ensuring corporate or enterprisewide linkages and alignment where appropriate.

### Segmented

A segmented approach to EA development and use, like a federated approach, employs a "divide and conquer" methodology in which architecture segments are identified, prioritized, developed, and implemented. In general, segments can be viewed as logical aspects, or "slivers," of the enterprise that can be architected and pursued as separate initiatives under the overall corporate architecture. As such, the segments serve as a bridge between the corporate frame of reference captured in the EA and individual programs within portfolios of system investments. OMB has issued guidance related to segment architectures.[22] As part of its guidance, agencies are to group segments into three categories: core mission areas (e.g., air transportation), business services (e.g., financial management), and enterprise services (e.g., records management).

### Service-Oriented

A service-oriented approach to EA is intended to identify and promote the shared use of common business capabilities across the enterprise. Under this approach, functions and applications are defined and designed as discrete and reusable capabilities or services that may be under the control of different organizational entities. As such, the capabilities or services need to be, among other things, (1) self-contained, meaning that they do not depend on any other functions or applications to execute a discrete unit of work; (2) published and exposed as self-describing business capabilities that can be accessed and used; and (3) subscribed to via well-defined and standardized interfaces. This approach is intended to reduce redundancy and increase integration, as well as provide the flexibility needed to support a quicker response to changing and evolving business requirements and emerging conditions.

[22]See, for example, OMB, *Improving Agency Performance Using Information and Information Technology (Enterprise Architecture Assessment Framework v3.1)* (June 2009); Federal Segment Architecture Working Group and OMB, *Federal Segment Architecture Methodology, Version 1.0* (December 2008); and OMB, *Federal Enterprise Architecture Practice Guidance* (November 2007).

**Extended**

An extended approach to EA looks beyond the enterprise's organizational boundaries and involves linking the EA to the architectures of its external partners in order to inform and leverage the information, applications, and services provided by these external partners. This approach recognizes that certain organizations, particularly government agencies, share mission goals and/or operational environments and thus can improve their mission performance by working together to share information or services.

## Overview of Related Management Guidance

In addition to being consistent with key federal EA guidance, version 2.0 of the EA Management Maturity Framework is consistent with other GAO and federal guidance associated with other key management activities, such as strategic planning, human capital management, IT investment management, and information security management. Principles reflected in the guidance associated with these four management activities are described below and, along with guidance related to other institutional management activities, have been incorporated into the framework.

### Strategic Planning

Effective strategic planning supports organizational transformation by defining outcome-related strategic goals, how those goals are to be achieved, and risk factors that could significantly affect their achievement.[23] Accordingly, among other things, a strategic plan should

- define performance goals and measures and cascade those goals and measures to lower organizational levels,
- assign accountability for achieving results,
- provide a comprehensive view of performance, and
- link resource needs to performance.

[23]See, for example, the Government Performance and Results Act, P.L. 103-62, section 3, and GAO, *Defense Business Transformation: Status of Department of Defense Efforts to Develop a Management Approach to Guide Business Transformation*, GAO-09-272R (Washington, D.C., January 2009).

As described in this framework, EA activities should be directed toward achieving the goals and objectives described in an organization's strategic plan.

## Strategic Human Capital Management

A strategic approach to human capital management includes viewing people as assets whose value to an organization can be enhanced by investing in them. Such an approach enables organizations to effectively use their people and determine how well they integrate human capital considerations into daily decision making and planning for mission results. It also helps organizations remain aware of and be prepared for current and future needs as an organization, ensuring that they have the knowledge, skills, and abilities needed to pursue their missions. This framework is consistent with GAO and Office of Personnel Management (OPM) human capital guidance that includes such key practices as identifying gaps between human capital needs and existing resources and developing and implementing plans to address these needs.[24]

## IT Investment Management

IT investment management is a process for linking IT investment decisions to an organization's strategic objectives and business plans. It focuses on selecting, controlling, and evaluating investments in a manner that minimizes risks while maximizing the return of investment.[25] More specifically,

- During investment selection, the organization (1) identifies and analyzes each project's risks and returns before committing significant funds to any project and (2) selects those IT projects that will best support its mission needs.
- During investment control, the organization ensures that projects are meeting mission needs at the expected levels of cost, schedule, and risk. If the project is not meeting expectations or if problems arise, steps are quickly taken to address the deficiencies.

[24]See, for example, GAO, *A Model of Strategic Human Capital Management* (Exposure Draft), GAO-02-373SP (Washington, D.C.: March 2002); *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39 (Washington, D.C.: Dec. 11, 2003); and OPM, *Human Capital Assessment and Accountability Framework*, http://apps.opm.gov/HumanCapital/tool/index.cfm (accessed June 9, 2010).

[25]See, for example, GAO, *Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity*, GAO-04-394G (Washington, D.C.: March 2004); GAO/AIMD-10.1.13; and *Executive Guide: Improving Mission Performance Through Strategic Information Management and Technology*, GAO/AIMD-94-115.

- During investment evaluation, actual versus expected results are compared once a project has been fully implemented. This is done to (1) assess the project's impact on mission performance, (2) identify any changes or modifications to the project that may be needed, and (3) revise the investment management process based on lessons learned.

GAO's IT Investment Management (ITIM) framework embodies each of these phases in the key practices and activities associated with its five levels of investment management maturity.[26] These practices and activities recognize the need for evaluating investment compliance with the EA, and thus our ITIM and EA maturity frameworks are explicitly aligned.

### Information Security Management

Managing the security of an organization's information assets is a complex, multifaceted undertaking that requires the involvement of the entire organization. Accordingly, NIST issued guidance[27] that provides an approach to understanding and addressing organization-wide exposure to information security risks by, among other things, defining and prioritizing parent and subordinate organization core missions and business processes and defining the types of information needed to execute these missions and processes, including the associated internal and external information flows. As such, NIST describes its approach as being "tightly coupled" with an organization's EA and its security component.

## Section 2: Overview of EA Management Maturity Framework Version 2.0

The ability to effectively manage any activity, including developing, maintaining, and using an EA, depends upon having meaningful measures of that activity in relation to some benchmark or standard. Such measurement permits progress toward the desired end to be assessed and gauged so that corrective actions to address unacceptable deviations can occur.

In February 2002 and April 2003, we issued versions 1.0 and 1.1 of our EA Management Maturity Framework (EAMMF).[28] This update of the framework (version 2.0) is based on our extensive use of version 1.1 in performing governmentwide and agency-specific EA evaluations, as well as our solicitation of comments from federal departments and agencies

[26]GAO-04-394G.

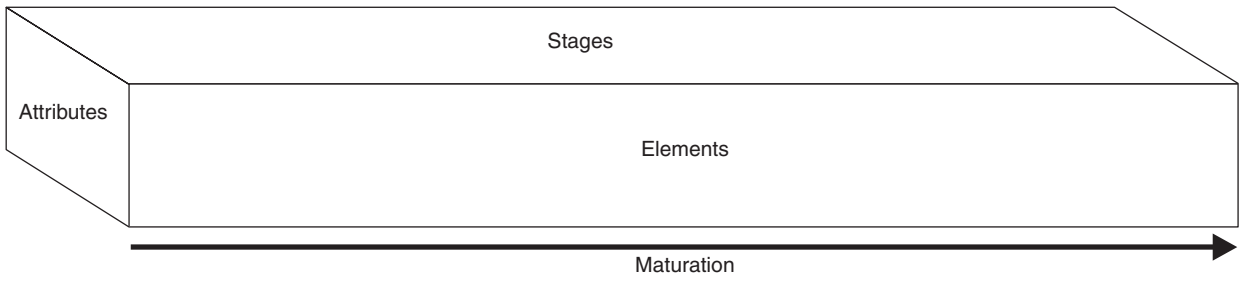
[27]NIST, *Guide for Applying the Risk Management Framework to Federal Information Systems: A Security Life Cycle Approach*; Special Publication 800-37, Revision 1; February 2010.

[28]GAO-02-6 and GAO-03-584G.

and other stakeholders on the usability, completeness, and sufficiency of the framework as a tool to define and measure an organization's EA management maturity. The update also incorporates comments received from GAO's ECIMT on version 1.1 and a draft of version 2.0.

This latest version of the framework builds on the prior version by retaining and expanding on the EAMMF's three interrelated components. These three basic components are (1) hierarchical stages of management maturity, (2) management attributes that are critical to the success of any program or organizational endeavor, and (3) elements of EA management that form the core of a successful and mature program. (See fig. 1 for a simplified three-dimensional view of the EAMMF components.)

**Figure 1: Simplified Three-Dimensional View of EAMMF**




Source: GAO.

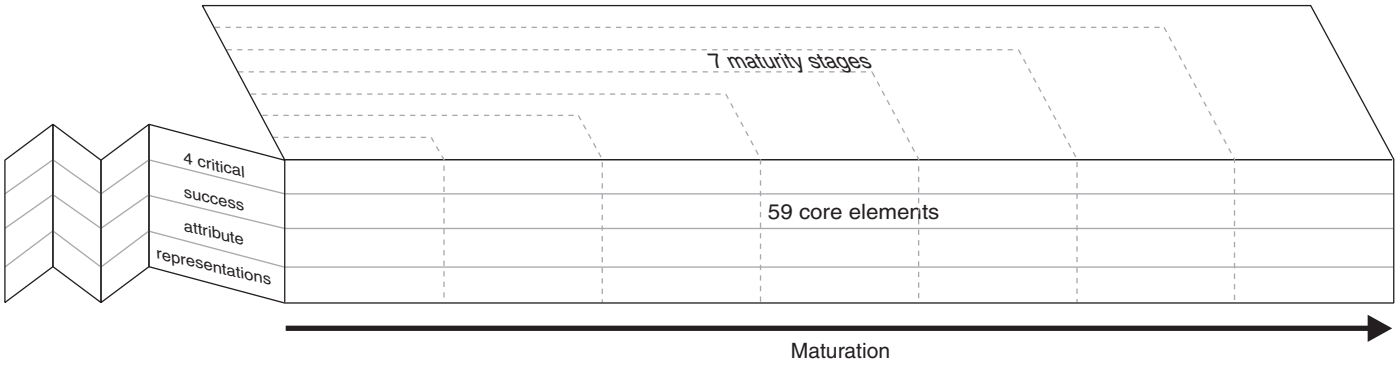
More specifically, version 2.0 consists of seven maturity stages, as compared with the five stages in version 1.1. In short, each stage reflects those EA management conditions that an enterprise should meet to logically build on the EA management capability established at the preceding stage, and to position it for introducing the EA management capability applicable to the next stage. As such, the stages provide a road map for systematically maturing or evolving an organization's capacity to manage an EA.

Further, version 2.0 includes four different ways to represent the attributes that are critical to the success of any program or organizational endeavor, and it allocates the core elements of EA management to each of these four representations of critical success attributes. For purposes of the framework, we refer to the four representations as the EA Management Action, EA Functional Area, OMB Capability Area, and EA Enabler representations. Each provides a unique perspective on the focus and

nature of the framework's core elements. In version 1.1 of the framework, only one of the four representations (EA Management Action) was used.

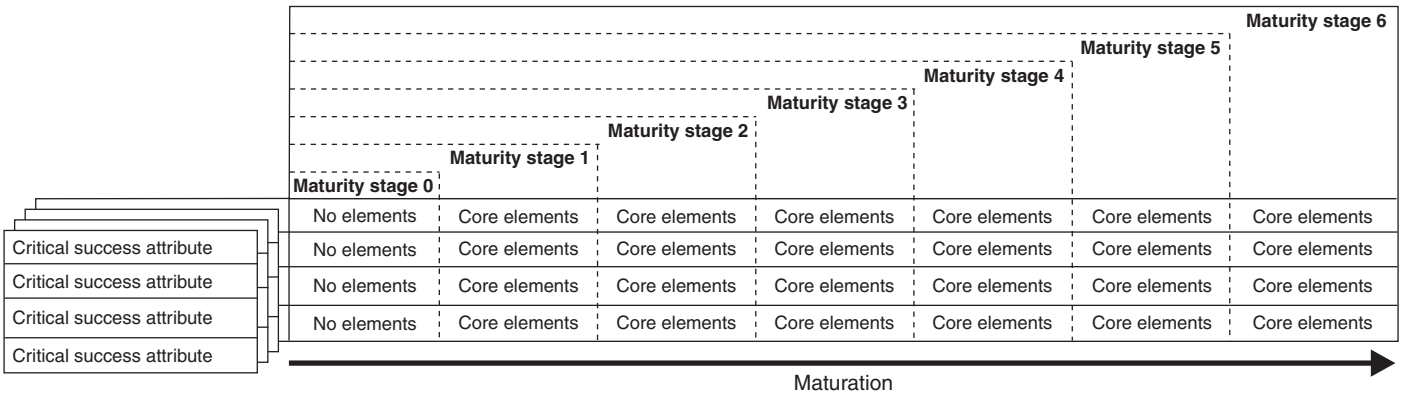
Finally, version 2.0 consists of 59 key framework elements of EA management, referred to as core elements, as compared with 31 that were in version 1.1. (See app. II for a detailed description of each of the 59 core elements.) Of the 59 core elements, 33 are new, 19 are modifications of the elements described in version 1.1, and 7 are the same as the elements described in version 1.1. Simply stated, a core element is an EA practice or condition that should be performed or met. Like the maturity stages and the critical success attributes in each of the four representations, the core elements share relationships and dependencies. Building on figure 1, figure 2 adds the core elements, maturity stages, and the four representations of the critical success attributes, and provides a transition to the EAMMF matrix presented in figure 3.

**Figure 2: Conceptual Depiction of the EAMMF's Interrelated Components**




Source: GAO.

**Figure 3: Generic EAMMF Matrix**

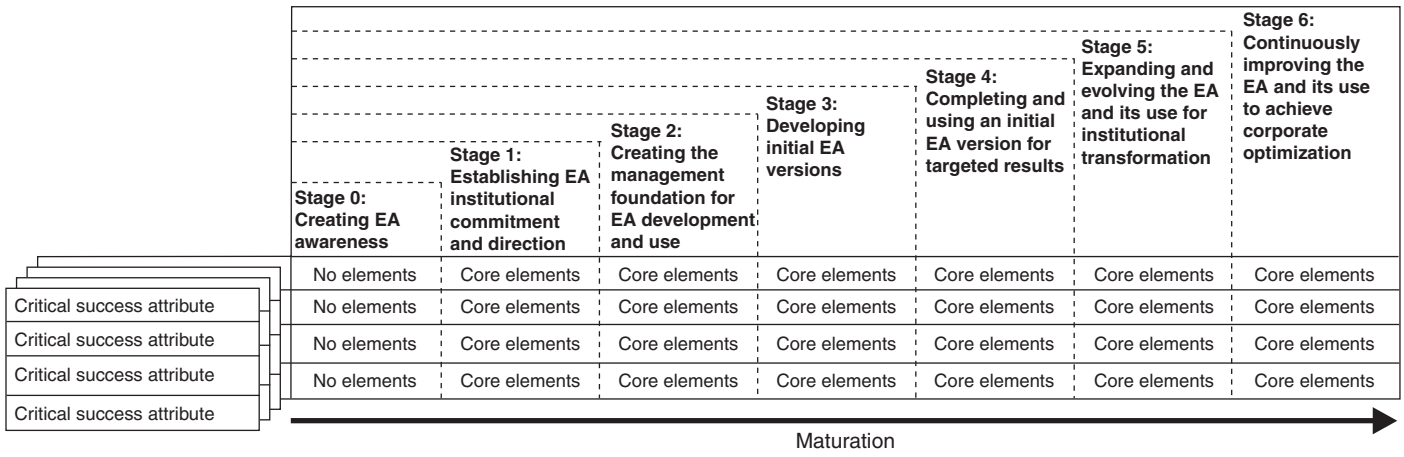



Source: GAO.

## Maturity Stages

Version 2.0 is made up of seven stages of EA management maturity, each of which includes all the core elements that are resident in previous stages. To the generic EAMMF structure of figure 3, figure 4 adds the specific names of the seven stages. Each of the stages is described in detail below.

**Figure 4: EAMMF Overview with Seven Stages of Maturity Identified**




Source: GAO.

### Stage 0: Creating EA Awareness

At this stage, either an organization does not have plans to develop and use an EA or it has plans that do not demonstrate an awareness of the management discipline needed to successfully develop, maintain, and use an EA. While Stage 0 organizations may have initiated some EA activity, their efforts are largely ad hoc and unstructured and lack the institutional leadership necessary for successful EA development, maintenance, and use as defined in Stage 1. Therefore, Stage 0 has no associated core elements.

### Stage 1: Establishing EA Institutional Commitment and Direction

At this stage, an organization puts in place the foundational pillars for treating its EA program as an institutional imperative and for overcoming traditional barriers to its success. In particular, the organization grounds EA development and compliance in policy and recognizes it as a corporate asset by vesting ownership of the architecture with top executives (i.e., lines of business owners and chief "X" officers (CXO)[29] as members of a chartered architecture executive committee who are provided with the knowledge and understanding of the architecture concepts and governance principles needed to lead and direct the EA effort. Through the EA executive committee (hereafter referred to as the executive committee), leadership is provided in the form of approved EA goals and objectives and key aspects of the architecture's construct, such as the framework(s) to be used and the approach for establishing the hierarchy and structure of organization components (e.g., federation members, segments, etc.). Leadership is also provided at this stage through the executive committee members' proactive outreach to their respective parts of the organization to facilitate a shift toward a more holistic and less parochial and change-resistant culture.

Also during this stage, the central figure in managing the program, the chief architect, is appointed and empowered, and the integral and relative role of the EA vis-à-vis other corporate governance disciplines is recognized in corporate policy. In addition, the construct for measuring program performance and holding the executive committee, chief

[29]CXO, or chief "X" officer, is a generic term for job titles where "X" represents a specific specialized position that serves the entire organization, such as the chief information officer, chief financial officer, chief human capital officer, chief procurement officer, chief performance officer, chief technology officer, chief information security officer, or chief management officer.

architect, and subordinate architects accountable for results is established. Organizations that achieve this maturity stage have demonstrated EA leadership through an institutional commitment to developing and using the EA and a strategic basis for directing its development, maintenance, and use.

### Stage 2: Creating the Management Foundation for EA Development and Use

This stage builds on the strategic leadership foundation established in Stage 1 by creating the managerial means to the ends—an initial version of the EA (Stages 3 and 4) and an evolving and continuously improving EA (Stages 5 and 6) that can be used to help guide and direct investments and achieve the architecture's stated purpose. More specifically, at this stage the organization establishes operational EA program offices, including a corporate program office that is headed by the chief architect, who reports to the executive committee. Also at this stage, the executive committee continues to exercise leadership by ensuring that the chief architect and subordinate architects have the funding and human capital needed to "stand up" their respective program offices and have acquired the requisite architecture tools (development and maintenance methodologies, modeling tools, and repository).

Leveraging these resources, the corporate program office develops the core plans and processes needed to manage and execute the EA program, such as a human capital plan, a work breakdown structure and schedule defining the timing and sequencing of key work steps and events (integrated master schedule), a quality assurance plan, a configuration management plan, and a risk management plan. Among other things, these plans build on the executive committee's EA strategy by, for example, identifying federation or extended enterprise members and defining and prioritizing segments. At the same time, the corporate and subordinate architecture program offices work with owners of related institutional management disciplines (e.g., strategic planning, human capital management, capital planning and investment control, and system life cycle management) to explicitly integrate EA management processes into each discipline's policy and guidance documents. Also during this stage, progress in establishing corporate and subordinate program office EA management capacity and readiness is measured and reported to the executive committee. Organizations that achieve this stage have largely

established the program management capability needed to develop initial versions of an EA.[30]

### Stage 3: Developing Initial EA Versions

At this stage, an organization is focused on strengthening the ability of its program office(s) to develop initial versions of the EA while also actually developing one or more of these versions. Among other things, steps are taken to engage stakeholders in the process and implement human capital plans, to include hiring and training staff and acquiring contractor expertise. During this stage, these resources are combined with earlier acquired tools (e.g., framework(s), methodologies, modeling tools, repositories) to execute EA management plans and schedules aimed at delivering an initial corporate version of the architecture that includes current "as-is" and target "to-be" views of the performance, business, data, services, technology, and security architectures, as well as an initial version of a plan for transitioning from the "as-is" to the "to-be" views.

Also during this stage, one or more segment architectures or federation member architectures are being developed using available tools and defined plans and schedules, and progress in developing initial architecture versions is measured by the chief architect and reported to the executive committee. The organization also begins to lay the foundation for using its EA as a corporate decision-making tool by establishing investment compliance and subordinate architecture alignment methodologies that are criteria-based and that are supported by evaluation tools that treat areas of noncompliance and misalignment as risks to be proactively mitigated. Additionally, EA development risks are being proactively identified and addressed. Although an organization at this maturity stage does not yet have a version of an EA that is ready for implementation, it is well on its way to defining an EA of sufficient scope and content that can be used to guide and constrain investments in a way that can produce targeted results.[31]

### Stage 4: Completing and Using an Initial EA Version for Targeted Results

At this stage, an organization has developed a version of its corporate EA that has been approved by the executive committee, to include "as-is" and

[30]Stage 2 includes all Stage 1 core elements.

[31]Stage 3 includes all elements in Stages 1 and 2.

"to-be" views of the performance, business, data, services, technology, and security architectures, as well as an initial version of a plan for transitioning from the "as-is" to the "to-be" views. In addition, one or more segment and/or federation member architectures have been developed, according to established priorities, and approved. Moreover, the approved corporate and subordinate architectures are being used to guide and constrain capital investment selection and control decisions and system life cycle definition and design decisions. Also during this stage, a range of factors are measured and reported to the executive committee, such as EA product quality, investment compliance, subordinate architecture alignment, and results and outcomes. Organizations that achieve this stage of maturity have a foundational set of corporate and subordinate EA products that provide a meaningful basis for informing selected investments and building greater EA scope, content, use, and results.[32]

**Stage 5: Expanding and Evolving the EA and Its Use for Institutional Transformation**

At this stage, the EA's scope is extended to the entire organization, and it is supported by a full complement of segment and federation member architectures, all of which include "as-is" and "to-be" views of the performance, business, data, services, technology, and security architectures, as well as well-defined plans for transitioning from the "as-is" to the "to-be" views. Moreover, this suite of architecture products is governed by a common EA framework, methodology, and repository, thus permitting the products to be appropriately integrated. Also at this stage, the architecture products are continuously maintained, and major updates of the corporate EA are approved by the head of the organization, while subordinate architecture product updates are approved by their corresponding organization heads or segment owners. In addition, architecture product quality (i.e., completeness, consistency, usability, and utility) as well as EA management process integrity are assessed by an independent agent, and the results are reported to the chief architect and the executive committee. An organization that achieves this level of maturity has established a full suite of architecture products that can be employed as a featured decision-support tool when considering and planning large-scale organizational restructuring or transformation initiatives.[33]

[32]Stage 4 includes all elements in Stages 1 through 3.

[33]Stage 5 includes all elements in Stages 1 through 4.

**Stage 6: Continuously Improving the EA and Its Use to Achieve Corporate Optimization**

At this stage, an organization is focused on continuously improving the quality of its suite of EA products and the people, processes, and tools used to govern their development, maintenance, and use. By achieving this stage of maturity, the organization has established a truly enterprisewide blueprint to inform both "board room" strategic planning and decision making and "on-the-ground" implementation of these changes through a range of capital investment and maintenance projects and other corporate initiatives.[34]

## Critical Success Attributes and Core Elements

Version 2.0 also consists of four sets of characteristics or attributes that are critical to the successful performance of program and organizational management. Each of the sets provides a unique way to represent (i.e., group and view) the framework's 59 core elements, which are the basic building blocks of the framework and are described in appendix II. Accordingly, the four are referred to as representations. They are the (1) EA Management Action Representation, (2) EA Functional Area Representation, (3) OMB Capability Area Representation, and the (4) EA Enabler Representation.

**EA Management Action Representation of Core Elements**

This representation reflects four characteristics or attributes that are recognized in other models as critical to successfully performing any management function, initiative, or program. Restated, these attributes collectively form the basis by which an organization can institutionally manage a given function, initiative, or program, like EA. Both version 1.0 and 1.1 of the framework were centered on this representation. (See table 2 for a presentation of the version 2.0 core elements using this representation.) The four attributes are as follows:

- *Demonstrates commitment:* Efforts and activities to show organizationwide commitment to perform the function, initiative, or program by, for example, establishing policies, providing resources, and involving organizational leaders.

[34]Stage 6 includes all elements in Stages 1 through 5.

- *Provides capability to meet commitment:* Efforts and activities to put in place the capability (people, processes, and tools) needed to execute the function, initiative, or program.

- *Demonstrates satisfaction of commitment:* Products, results, and outcomes that demonstrate that the function, initiative, or program is being performed.

- *Verifies satisfaction of commitment:* Efforts and activities to verify, via quantitative and qualitative measurement, that the function, initiative, or program has been satisfactorily performed.

**Table 2: EA Management Action Representation of the Critical Success Attributes and the Core Elements**

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 1: Demonstrates commitment** | | (1) Written and approved organization policy exists for EA development, maintenance, and use.<br>(2) Executive committee representing the enterprise exists and is responsible and accountable for EA.<br>(3) Executive committee is taking proactive steps to address EA cultural barriers. | (9) EA budgetary needs are justified and funded. | (19) Organization business owner and CXO representatives are actively engaged in architecture development. | (33) Executive committee has approved the initial version of corporate EA.<br>(34) Key stakeholders have approved the current version of subordinate architectures.<br>(35) EA is integral to the execution of other institutional management disciplines. | (44) Organization head has approved current version of the corporate EA.<br>(45) Organization component heads or segment owners have approved current version of their respective subordinate architectures. | (53) EA is used by executive leadership to inform organization strategic planning and policy formulation. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 2: Provides capability to meet commitment** | | (4) Executive committee members are trained in EA principles and concepts.<br>(5) Chief architect exists.<br>(7) EA framework(s) is adopted. | (10) EA program office(s) exists.<br>(11) Key program office leadership positions are filled.<br>(12) Program office human capital plans exist.<br>(13) EA development and maintenance methodology exists.<br>(14) Automated EA tools exist. | (20) EA human capital plans are being implemented.<br>(21) Program office contractor support needs are being met.<br>(22) Program office staff are trained in EA framework, methodology, and tools.<br>(23) Methodologies and tools exist to determine investment compliance with corporate and subordinate architectures.<br>(24) Methodologies and tools exist to determine subordinate architecture alignment with the corporate EA.<br>(25) EA-related risks are proactively identified, reported, and mitigated. | (36) Program office human capital needs are met. | (46) Integrated repository tools and common EA framework and methodology are used across the enterprise.<br>(47) Corporate and subordinate architecture program offices operate as a single virtual office that shares resources enterprisewide. | (54) EA human capital capabilities are continuously improved.<br>(55) EA methodologies and tools are continuously improved.<br>(56) EA management processes are continuously improved and reflect the results of external assessments. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 3: Demonstrates satisfaction of commitment** | | (6) EA purpose is clearly stated. | (15) EA program management plan exists and reflects relationships with other management disciplines.<br>(16) Work breakdown structure and schedule to develop EA exist.<br>(17) EA segments, federation members, and/or extended members have been identified and prioritized. | (26) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan are being developed.<br>(27) Initial version of corporate EA describing the enterprise in terms of performance, business, data, services, technology, and security is being developed.<br>(28) One or more segment and/or federation member architectures is being developed.<br>(29) Architecture products are being developed according to the EA content framework.<br>(30) Architecture products are being developed according to a defined EA methodology.<br>(31) Architecture products are being developed using EA tools. | (37) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan exist.<br>(38) Initial version of corporate EA captures performance, business, data, services, technology, and security views.<br>(39) One or more segment and/or federation member architectures exists and is being implemented. | (48) Corporate EA and sequencing plan are enterprisewide in scope.<br>(49) Corporate EA and sequencing plan are aligned with subordinate architectures.<br>(50) All segment and/or federated architectures exist and are horizontally and vertically integrated.<br>(51) Corporate and subordinate architectures are extended to align with external partner architectures. | (57) EA products are continuously improved and updated. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 4: Verifies satisfaction of commitment** | | (8) EA performance and accountability framework is established. | (18) Program office readiness is measured and reported. | (32) Architecture development progress is measured and reported. | (40) EA product quality is measured and reported.<br>(41) EA results and outcomes are measured and reported.<br>(42) Investment compliance with corporate and subordinate architectures is measured and reported.<br>(43) Subordinate architecture alignment with the corporate EA is measured and reported. | (52) EA products and management processes are subject to independent assessment. | (58) EA quality and results measurement methods are continuously improved.<br>(59) EA continuous improvement efforts reflect the results of external assessments. |

Source: GAO.

### EA Functional Area Representation of Core Elements

This representation reflects four major groups of core elements that can be viewed as the functions associated with developing and implementing a well-defined EA. We first discussed how the substance of the core elements could be viewed according to these functional areas or groupings in our August 2006 report on the state of EA maturity across the federal government.[35] At that time, we derived the functional areas based on the inherent purpose, focus, and substance of the core elements. Thus, this representation of critical success attributes, in contrast to the other three representations, is not grounded in existing management models, frameworks, and principles. (See table 3 for a presentation of the version 2.0 core elements using this representation.) The four groupings are as follows:

- *Governance:* The group of core elements that provides the means by which the EA program is managed.
- *Content:* The group of core elements that defines the actual substance and makeup of all of the EA artifacts as well as how these artifacts are derived, captured, maintained, and made accessible.
- *Use:* The group of core elements that provides for the actual implementation of the EA and treats it as an authoritative frame of reference for informed transformation, modernization, and investment decision making.
- *Measurement:* The group of core elements that verifies the quality of EA products and management processes and ensures that EA outcomes and results are achieved.

[35]GAO, *Enterprise Architecture: Leadership Remains Key to Establishing and Leveraging Architectures for Organizational Transformation*, GAO-06-831 (Washington, D.C.: Aug. 14, 2006).

**Table 3: EA Functional Area Representation of the Critical Success Attributes and the Core Elements**

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 1: Governance** | | (1) Written and approved organization policy exists for EA development, maintenance, and use.<br>(2) Executive committee representing the enterprise exists and is responsible and accountable for EA.<br>(3) Executive committee is taking proactive steps to address EA cultural barriers.<br>(4) Executive committee members are trained in EA principles and concepts.<br>(5) Chief architect exists. | (9) EA budgetary needs are justified and funded.<br>(10) EA program office(s) exists.<br>(11) Key program office leadership positions are filled.<br>(12) Program office human capital plans exist.<br>(15) EA program management plan exists and reflects relationships with other management disciplines.<br>(16) Work breakdown structure and schedule to develop EA exist. | (19) Organization business owner and CXO representatives are actively engaged in architecture development.<br>(20) EA human capital plans are being implemented.<br>(21) Program office contractor support needs are being met.<br>(22) Program office staff are trained in EA framework, methodology, and tools.<br>(25) EA-related risks are proactively identified, reported, and mitigated. | (33) Executive committee has approved the initial version of corporate EA.<br>(34) Key stakeholders have approved the current version of subordinate architectures.<br>(36) Program office human capital needs are met. | (44) Organization head has approved current version of the corporate EA.<br>(45) Organization component heads or segment owners have approved current version of their respective subordinate architectures.<br>(47) Corporate and subordinate architecture program offices operate as a single virtual office that shares resources enterprisewide. | (54) EA human capital capabilities are continuously improved. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 2: Content** | | (6) EA purpose is clearly stated.<br>(7) EA framework(s) is adopted. | (13) EA development and maintenance methodology exists.<br>(14) Automated EA tools exist.<br>(17) EA segments, federation members, and/or extended members have been identified and prioritized. | (24) Methodologies and tools exist to determine subordinate architecture alignment with the corporate EA.<br>(26) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan are being developed.<br>(27) Initial version of corporate EA describing the enterprise in terms of performance, business, data, services, technology, and security is being developed.<br>(28) One or more segment and/or federation member architectures is being developed.<br>(29) Architecture products are being developed according to the EA content framework.<br>(30) Architecture products are being developed according to a defined EA methodology.<br>(31) Architecture products are being developed using EA tools. | (37) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan exist.<br>(38) Initial version of corporate EA captures performance, business, data, services, technology, and security views.<br>(39) One or more segment and/or federation member architectures exists and is being implemented. | (46) Integrated repository tools and common EA framework and methodology are used across the enterprise.<br>(48) Corporate EA and sequencing plan are enterprisewide in scope.<br>(49) Corporate EA and sequencing plan are aligned with subordinate architectures.<br>(50) All segment and/or federated architectures exist and are horizontally and vertically integrated.<br>(51) Corporate and subordinate architectures are extended to align with external partner architectures. | (55) EA methodologies and tools are continuously improved.<br>(56) EA management processes are continuously improved and reflect the results of external assessments.<br>(57) EA products are continuously improved and updated. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 3: Use** | | | | (23) Methodologies and tools exist to determine investment compliance with corporate and subordinate architectures. | (35) EA is integral to the execution of other institutional management disciplines. | | (53) EA is used by executive leadership to inform organization strategic planning and policy formulation. |
| **Attribute 4: Measurement** | | (8) EA performance and accountability framework is established. | (18) Program office readiness is measured and reported. | (32) Architecture development progress is measured and reported. | (40) EA product quality is measured and reported.<br>(41) EA results and outcomes are measured and reported.<br>(42) Investment compliance with corporate and subordinate architectures is measured and reported.<br>(43) Subordinate architecture alignment with the corporate EA is measured and reported. | (52) EA products and management processes are subject to independent assessment. | (58) EA quality and results measurement methods are continuously improved.<br>(59) EA continuous improvement efforts reflect the results of external assessments. |

Source: GAO.

### OMB Capability Area Representation of Core Elements

This representation reflects the three capability areas that are provided for in OMB's EA Assessment Framework. As such, this representation demonstrates how the GAO and OMB EA frameworks, albeit different, are fundamentally aligned and substantially consistent. (See table 4 for a presentation of the version 2.0 core elements using this representation.) The three capability areas and OMB's definition of each are as follows:

- *Completion:* The extent to which an agency has developed an integrated, organizationwide architecture, in terms of business, performance, data, services, technology, and security, as well as a comprehensive enterprise transition plan.

- *Use:* The extent to which the agency has established key management practices, processes, and policies needed for developing, maintaining, and overseeing its architecture, and for demonstrating both the importance of architecture awareness and the value of employing architecture practices; it also assesses the extent of the agency's use of its architecture to inform strategic planning, program performance improvement planning, information resources management, IT management, and capital planning and investment control processes.

- *Results:* The extent to which the agency is measuring the effectiveness and value of its architecture activities by assigning performance measurements to its architecture and related processes, and reporting on actual results to demonstrate architecture success.

**Table 4: OMB Capability Area Representation of the Critical Success Attributes and the Core Elements**

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 1: Completion** | | | (17) EA segments, federation members, and/or extended members have been identified and prioritized. | (26) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan are being developed.<br>(27) Initial version of corporate EA describing the enterprise in terms of performance, business, data, services, technology, and security is being developed.<br>(28) One or more segment and/or federation member architectures is being developed.<br>(29) Architecture products are being developed according to the EA content framework.<br>(30) Architecture products are being developed according to a defined EA methodology.<br>(31) Architecture products are being developed using EA tools. | (37) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan exist.<br>(38) Initial version of corporate EA captures performance, business, data, services, technology, and security views.<br>(39) One or more segment and/or federation member architectures exists and is being implemented. | (48) Corporate EA and sequencing plan are enterprisewide in scope.<br>(49) Corporate EA and sequencing plan are aligned with subordinate architectures.<br>(50) All segment and/or federated architectures exist and are horizontally and vertically integrated.<br>(51) Corporate and subordinate architectures are extended to align with external partner architectures. | (57) EA products are continuously improved and updated. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 2: Use** | | (1) Written and approved organization policy exists for EA development, maintenance, and use.<br>(2) Executive committee representing the enterprise exists and is responsible and accountable for EA.<br>(3) Executive committee is taking proactive steps to address EA cultural barriers.<br>(4) Executive committee members are trained in EA principles and concepts.<br>(5) Chief architect exists.<br>(6) EA purpose is clearly stated.<br>(7) EA framework(s) is adopted. | (9) EA budgetary needs are justified and funded.<br>(10) EA program office(s) exists.<br>(11) Key program office leadership positions are filled.<br>(12) Program office human capital plans exist.<br>(13) EA development and maintenance methodology exists.<br>(14) Automated EA tools exist.<br>(15) EA program management plan exists and reflects relationships with other management disciplines.<br>(16) Work breakdown structure and schedule to develop EA exist. | (19) Organization business owner and CXO representatives are actively engaged in architecture development.<br>(20) EA human capital plans are being implemented.<br>(21) Program office contractor support needs are being met.<br>(22) Program office staff are trained in EA framework, methodology, and tools.<br>(23) Methodologies and tools exist to determine investment compliance with corporate and subordinate architectures.<br>(24) Methodologies and tools exist to determine subordinate architecture alignment with the corporate EA.<br>(25) EA-related risks are proactively identified, reported, and mitigated. | (33) Executive committee has approved the initial version of corporate EA.<br>(34) Key stakeholders have approved the current version of subordinate architectures.<br>(35) EA is integral to the execution of other institutional management disciplines.<br>(36) Program office human capital needs are met. | (44) Organization head has approved current version of the corporate EA.<br>(45) Organization component heads or segment owners have approved current version of their respective subordinate architectures.<br>(46) Integrated repository tools and common EA framework and methodology are used across the enterprise.<br>(47) Corporate and subordinate architecture program offices operate as a single virtual office that shares resources enterprisewide. | (53) EA is used by executive leadership to inform organization strategic planning and policy formulation.<br>(54) EA human capital capabilities are continuously improved.<br>(55) EA methodologies and tools are continuously improved.<br>(56) EA management processes are continuously improved and reflect the results of external assessments. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 3: Results** | | (8) EA performance and accountability framework is established. | (18) Program office readiness is measured and reported. | (32) Architecture development progress is measured and reported. | (40) EA product quality is measured and reported.<br>(41) EA results and outcomes are measured and reported.<br>(42) Investment compliance with corporate and subordinate architectures is measured and reported.<br>(43) Subordinate architecture alignment with the corporate EA is measured and reported. | (52) EA products and management processes are subject to independent assessment. | (58) EA quality and results measurement methods are continuously improved.<br>(59) EA continuous improvement efforts reflect the results of external assessments. |

Source: GAO.

### EA Enabler Representation of Core Elements

This representation reflects four critical enablers (i.e., resources) within any organization that can be leveraged to effect change, produce outcomes, and accomplish desired goals and objectives. This representation is integral to other models and frameworks and has been used extensively by GAO in its analysis of a range of programs, such as our nation's elections system.[36] (See table 5 for a presentation of the version 2.0 core elements using this representation.) The four organizational dimensions are as follows:

- *Leadership:* Efforts and activities to assign senior executives responsibility and accountability for a given function, initiative, or program, including these executives' coordinated actions to guide, direct, oversee, and otherwise demonstrate their collective and individual ownership of the function, initiative, or program.
- *People:* Efforts and activities to ensure that the function, initiative, or program has sufficient human capital, including individuals with the necessary knowledge, skills, and abilities.
- *Processes:* Plans, policies, and procedures that govern how people are to execute the given function, initiative, or program. This organizational dimension also includes outputs of these plans, policies, and procedures, such as EA content.
- *Tools:* Frameworks, methodologies, and repository and analytical tools used to assist people in executing processes.

[36]See, for example, GAO, *Elections: The Nation's Evolving Election System as Reflected in the November 2004 General Election*, GAO-06-450 (Washington, D.C., June 6, 2006).

**Table 5: EA Enabler Representation of the Critical Success Attributes and the Core Elements**

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 1: Leadership** | | (1) Written and approved organization policy exists for EA development, maintenance, and use.<br>(2) Executive committee representing the enterprise exists and is responsible and accountable for EA.<br>(3) Executive committee is taking proactive steps to address EA cultural barriers.<br>(4) Executive committee members are trained in EA principles and concepts. | (9) EA budgetary needs are justified and funded. | (19) Organization business owner and CXO representatives are actively engaged in architecture development. | (33) Executive committee has approved the initial version of corporate EA.<br>(34) Key stakeholders have approved the current version of subordinate architectures. | (44) Organization head has approved current version of the corporate EA.<br>(45) Organization component heads or segment owners have approved current version of their respective subordinate architectures. | (53) EA is used by executive leadership to inform organization strategic planning and policy formulation. |
| **Attribute 2: People** | | (5) Chief architect exists. | (10) EA program office(s) exists.<br>(11) Key program office leadership positions are filled.<br>(12) Program office human capital plans exist. | (20) EA human capital plans are being implemented.<br>(21) Program office contractor support needs are being met.<br>(22) Program office staff are trained in EA framework, methodology, and tools. | (36) Program office human capital needs are met. | (47) Corporate and subordinate architecture program offices operate as a single virtual office that shares resources enterprisewide. | (54) EA human capital capabilities are continuously improved. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 3: Processes** | | (6) EA purpose is clearly stated.<br>(8) EA performance and accountability framework is established. | (15) EA program management plan exists and reflects relationships with other management disciplines.<br>(16) Work breakdown structure and schedule to develop EA exist.<br>(17) EA segments, federation members, and/or extended members have been identified and prioritized.<br>(18) Program office readiness is measured and reported. | (25) EA-related risks are proactively identified, reported, and mitigated.<br>(26) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan are being developed.<br>(27) Initial version of corporate EA describing the enterprise in terms of performance, business, data, services, technology, and security is being developed.<br>(28) One or more segment and/or federation member architectures is being developed.<br>(32) Architecture development progress is measured and reported. | (35) EA is integral to the execution of other institutional management disciplines.<br>(37) Initial versions of corporate "as-is" and "to-be" EA and sequencing plan exist.<br>(38) Initial version of corporate EA captures performance, business, data, services, technology, and security views.<br>(39) One or more segment and/or federation member architectures exists and is being implemented.<br>(40) EA product quality is measured and reported.<br>(41) EA results and outcomes are measured and reported.<br>(42) Investment compliance with corporate and subordinate architectures is measured and reported.<br>(43) Subordinate architecture alignment with the corporate EA is measured and reported. | (48) Corporate EA and sequencing plan are enterprisewide in scope.<br>(49) Corporate EA and sequencing plan are aligned with subordinate architectures.<br>(50) All segment and/or federated architectures exist and are horizontally and vertically integrated.<br>(51) Corporate and subordinate architectures are extended to align with external partner architectures.<br>(52) EA products and management processes are subject to independent assessment. | (56) EA management processes are continuously improved and reflect the results of external assessments.<br>(57) EA products are continuously improved and updated.<br>(58) EA quality and results measurement methods are continuously improved.<br>(59) EA continuous improvement efforts reflect the results of external assessments. |

| | Stage 0: Creating EA awareness | Stage 1: Establishing EA institutional commitment and direction | Stage 2: Creating the management foundation for EA development and use | Stage 3: Developing initial EA versions | Stage 4: Completing and using an initial EA version for targeted results | Stage 5: Expanding and evolving the EA and its use for institutional transformation | Stage 6: Continuously improving the EA and its use to achieve corporate optimization |
|---|---|---|---|---|---|---|---|
| **Attribute 4: Tools** | | (7) EA framework(s) is adopted. | (13) EA development and maintenance methodology exists.<br>(14) Automated EA tools exist. | (23) Methodologies and tools exist to determine investment compliance with corporate and subordinate architectures.<br>(24) Methodologies and tools exist to determine subordinate architecture alignment with the corporate EA.<br>(29) Architecture products are being developed according to the EA content framework.<br>(30) Architecture products are being developed according to a defined EA methodology.<br>(31) Architecture products are being developed using EA tools. | | (46) Integrated repository tools and common EA framework and methodology are used across the enterprise. | (55) EA methodologies and tools are continuously improved. |

Source: GAO.

## Section 3: Uses of EAMMF Version 2.0

The EAMMF is intended to serve a wide range of stakeholders. For federal agencies, primary internal stakeholders are agency senior executives, including the agency head, business owners, and CXOs. Primary external stakeholders are those with agency oversight responsibilities, such as parent departments, OMB, and congressional committees, as well as independent audit and evaluation organizations, such as inspectors general.

As a model defining ascending levels of EA management maturity, the framework can be used by these stakeholders in two principal ways. First, it can provide a standard yet flexible benchmark against which to determine where the enterprise stands in its progress toward the ultimate goal: having a continuously improving EA program that can serve as a featured decision support tool when considering and planning large-scale organizational restructuring or transformation initiatives (maturity Stages 5 and 6). Second, it can provide a basis for developing architecture management improvement plans, as well as for measuring, reporting, and overseeing progress in implementing these plans. In either capacity, the EAMMF should not be viewed as either a rigidly applied checklist or as the only relevant benchmark for assessing and planning an EA program. Instead, it is intended to be applied flexibly with discretion in light of each organization's unique facts and circumstances, and it is intended to complement and augment other frameworks, such as OMB's EA Assessment Framework.

### Tool for Assessing EA Management Maturity

By describing the elements of an effective EA management program according to both a hierarchy of phases and accepted attributes of program and organizational success, the EAMMF provides a simplified and structured way to answer a very complex question—Where does an organization stand in its walk toward its EA destination? In so doing, it allows for the answer to be presented in terms of EA management strengths and weaknesses at both a single point in time and over a period of time, and for groups of enterprises to be assessed, represented, and compared. Further, it enables users to identify and understand these strengths and weaknesses in a range of contexts, such as in relation to other agencies in the same department, or other agencies of a similar size or that share a common mission (e.g., homeland security).

In addition, the framework allows for this answer to be viewed in the context of hierarchical stages of progression. In doing so, however, it is not intended to prescribe rigid criteria governing what is needed to view a given program as having advanced to a given maturity stage. Rather, it

allows the user to apply his or her own set of criteria, or to use multiple sets of criteria. In this regard, our reports have represented the application of the framework in three different ways: (1) requiring all core elements at a given stage to be met in order to achieve that stage of maturity; (2) requiring all core elements at a given stage to be at least partially met to achieve that stage of maturity; and (3) not using the maturity stages, and instead describing what portion of the core elements was met or partially met across all stages or within one or more critical success attributes. Thus, the value of the EAMMF goes beyond merely "grading" a given enterprise and extends to identifying the full range of specific EA program strengths and weaknesses (i.e., which core elements are satisfied and which are not). This knowledge allows a given enterprise to build on its collective strengths in addressing its recognized weaknesses.

Additionally, the EAMMF allows its users to assess and understand any enterprise, regardless of whether the enterprise is a cross-organization function (e.g., border security), an entire organization (e.g., a federal department), or a component organization (e.g., a branch, bureau, or agency). That is, the EAMMF is enterprise independent. The key consideration is to clearly understand and define the unit of assessment (i.e., the enterprise). Equally important is to understand and define the scope and depth of the assessment. This is because the purpose of the assessment and the needs of the framework's users can vary. As a result, not every EAMMF core element may be equally applicable to every enterprise, not every assessment has to consider every element, and not every assessment has to consider every element in the same level of detail. For example, a large and complex organization that is developing corporate, federated member, and segment architecture components, such as DOD or the Department of Homeland Security, might apply this entire framework, whereas a small organization developing a corporate architecture supplemented by several small segment architectures might apply a subset of the core elements. Moreover, the extent to which the framework is applied to subordinate architectures could also vary depending on the type of subordinate architecture (e.g., federated member or segment); the size, scope, and complexity of the subordinate organization; and needs of the framework user. Accordingly, the EAMMF does not presume a one-size-fits-all application methodology or approach, and instead allows the framework users to decide how it will be applied and how the results will be interpreted, represented, and used.

## EA Management Improvement Planning

The EAMMF's seven stages of maturity provide a road map for incremental improvement. In using this road map for planning, it is important to recognize that certain core elements are inherently dependent on others, requiring an ordered approach, whereas others do not share such direct relationships, and thus the timing of their implementation is more flexible. It is also important to recognize that not every element will be applicable to every enterprise.

Generally speaking, the core elements in the lower maturity stages provide the foundation for those at higher maturity stages. In fact, some lower-stage core elements serve as prerequisites for higher stage core elements. For example, EA plans established in Stage 2 serve as a prerequisite for measuring progress against those plans in Stage 3. However, certain higher-stage core elements can be addressed even though lower-stage core elements have not been completely addressed. For example, an organization may have satisfied the Stage 5 core element of subjecting EA products and management processes to an independent assessment without satisfying lower-level core elements. Our use of the EAMMF has shown that it is not unusual for federal departments and agencies to have satisfied some core elements at multiple stages, even though they may not have satisfied all core elements at any one particular stage.

Additionally, in using the EAMMF for improvement planning, it is important to remember that the framework describes what needs to be done, and not the details surrounding how it needs to be done. Thus, when the EAMMF is used for management improvement, the framework remains just that: a framework within which to plan specific EA management steps, activities, processes, authorities, etc., and to subsequently measure, report, and oversee progress on each. To develop an EA management improvement plan that is "implementable," an enterprise would need to augment the EAMMF with other guidance and frameworks that address, for example, the appropriate scope of work of an independent assessment agent or the attributes of an effective process for assessing a given investment's architectural compliance. In particular, implementing the EAMMF core elements related to architecture content need to be based on an EA content framework and associated methodology for developing architecture products and artifacts.

# Appendix I: Approach to Developing EAMMF Version 2.0

This update of the Enterprise Architecture Management Maturity Framework (EAMMF) is based on our extensive experience in using version 1.1 in performing two governmentwide and numerous department- and agency-specific enterprise architecture (EA) evaluations and our research of the evolving EA discipline. In addition, it is based on our solicitation of the comments and views of EA practitioners and related experts within all levels of government, academia, and the private sector. More specifically, we solicited comments and suggestions on version 1.1 from the 27 federal departments and agencies that participated in our 2006 governmentwide review of the state of the government's use of EA,[1] and we obtained comments and suggestions on version 1.1 and a draft of version 2.0 from members of GAO's Executive Council on Information Management and Technology (ECIMT).[2] Collectively, we obtained about 175 comments and suggestions that we have incorporated, as appropriate, in version 2.0. These comments and suggestions generally fall into six categories, as shown in table 6.

**Table 6: Categories of Comments and Suggestions Provided for Update of EAMMF Version 1.1**

| Category of comment or suggestion |
|---|
| Align with other frameworks (e.g., Information Technology Investment Management [ITIM] framework) |
| Align with other EA frameworks |
| Incorporate federation, service orientation, and segmentation concepts |
| Add, modify, or delete stages, attributes, or core elements |
| Clarify expectations and add examples of deliverables |
| Revise criteria for satisfying a given stage |

Source: GAO.

Many of these comments and suggestions reflect new developments in the field of EA since we released version 1.1 of our EAMMF. For example, since 2003, many departments and agencies have adopted federated, segmented, and service-oriented approaches to developing their EAs, and

[1]GAO-06-831.

[2]As described previously in this report, GAO's ECIMT is composed of senior-level officials from the public sector, private sector, and academia. Members include former chief information officers (CIO) for government agencies, professors of information technology (IT), presidents of private businesses, IT consultants, and representatives of the National Association of State CIOs.

both the Office of Management and Budget (OMB) and the Federal CIO Council have issued guidance on these approaches.[3]

Using these various inputs, we followed an evolutionary and agile approach to simultaneously redefining the framework's stages, core elements, and critical success attributes. In doing so, we developed a series of versions of the framework and analyzed each in the series for internal consistency and satisfaction of the comments and suggestions that we received, the experience that we gained from using the framework, and the research that we conducted around EA management. We then developed drafts of version 2.0 that we shared with GAO ECIMT members for comment, which we have incorporated as appropriate.

[3]See, for example, OMB, *Federal Enterprise Architecture Practice Guidance* (November 2007); Federal Segment Architecture Working Group and OMB, *Federal Segment Architecture Methodology* (December 2008); and Federal Chief Information Officers Council, *A Practical Guide to Federal Service Oriented Architecture* (June 2008).

# Appendix II: Framework Elements

The framework's core elements are the basic building blocks of the EAMMF. Each of the core elements is briefly described here, along with references to related guidance and frameworks.

## Core Elements

**Core Element 1: Written and approved organization policy exists for EA development, maintenance, and use.**

An organization should have a documented policy, approved by the organization head, to institutionalize the architecture's importance, role, and relationship to other corporate management disciplines. Among other things, the policy should define the EA as consisting of the current ("as-is") and target ("to-be") architecture, as well as the transition plan for migrating from the current to the target architecture, and it should provide for EA development, maintenance, and use. The policy should also identify the major players associated with EA development, maintenance, and use, including the chief architect, program office(s), executive committee, investment review board(s), and CIO. It should provide for developing a performance and accountability framework that identifies each player's roles, responsibilities, and relationships and describes the results and outcomes for which each player is responsible and accountable. The policy should also acknowledge the interdependencies and relationships among the EA program and other related institutional management disciplines, such as strategic planning, human capital management, information security management, privacy, records management, and capital planning and investment control.

Selected references

- *CIO Council Practical Guide*, section 3.1.2: "Issue an Executive Enterprise Architecture Policy."
- *GAO EAMMF*, version 1.1: "Written and approved organization policy exists for EA development"; "Written and approved organization policy exists for EA maintenance"; and "Written and approved organization policy exists for IT investment compliance with EA."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 2: Executive committee representing the enterprise exists and is responsible and accountable for EA.**

An organization should assign responsibility and accountability for directing, overseeing, and approving the architecture not to just one individual, but to a formally chartered executive committee with active representation from across the enterprise. Establishing enterprisewide responsibility and accountability is important for demonstrating the organization's institutional commitment to EA and for obtaining buy-in from across the organization. Accordingly, this committee should be composed of executive-level representatives from each line of business, and these representatives should have the authority to commit resources and enforce decisions within their respective organizational units. If the EA extends beyond traditional organizational boundaries (e.g., across multiple departments or agencies), this executive committee should also include executive representation from other related organizations.

This committee, which is typically chartered by the head of the organization (e.g., the department or agency head), should be responsible for establishing the EA's purpose, goals, strategy, and performance and accountability framework, and for ensuring that EA plans, management processes, products, and results are achieved. To augment the executive committee, subordinate committees may also exist for federation, segment, and extended enterprise members. Such subcommittees should also define their respective roles, responsibility, authority, accountability, and relationship to other executive bodies.

Selected references

- *CIO Council Practical Guide*, section 3.2.3: "Establish an EA Executive Steering Committee."
- *GAO EAMMF*, version 1.1: "Committee or group representing the enterprise is responsible for directing, overseeing, and approving EA."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 3: Executive committee is taking proactive steps to address EA cultural barriers.**

Parochialism and cultural resistance to change are significant barriers to organizations having a mature EA. Accordingly, we have previously reported on the need for sustained executive leadership to overcome these and other barriers.[1] Among other things, this can include proactive steps by the executive committee and its members to promote and reward EA-related collaboration across organizational boundaries, commit component organization resources to EA activities, and encourage the disclosure and adoption of EA shared services. Similarly, subordinate committees and their members should also take proactive steps to address cultural barriers.

Selected reference

- *CIO Council Practical Guide*, section 3.2.3: "Establish an EA Executive Steering Committee."

**Core Element 4: Executive committee members are trained in EA principles and concepts.**

Executive committee members need to understand basic EA principles, structures, and concepts in order to effectively execute the committee's roles and responsibilities. Therefore, each committee member should complete sufficient training to provide the member with a basic understanding of the fundamentals of EA management, development, maintenance, and use. If applicable, such training should also provide committee members with a basic understanding of the organization's approach to identifying and developing subordinate architectures. If training is acquired commercially, steps should be taken to ensure that the training is appropriately tailored to the needs of organizational executives. Similarly, subordinate committee members should also receive targeted EA-related training.

Selected references

- *CIO Council Practical Guide*, section 3.2.3: "Establish an EA Executive Steering Committee."

[1]GAO-06-831, GAO-04-40, and GAO-02-6.

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

- *Capability Maturity Model® Integration (CMMI) for Development*, version 1.2:[2] "Organizational training process area."

- *GAO ITIM Framework*, version 1.1: "Instituting the Investment Board."

**Core Element 5: Chief architect exists.**

A successful EA program should be led by an individual who is well versed and knowledgeable about all aspects of architecture development, maintenance, and use and who can serve as the interface between the organization's business and IT communities. Accordingly, an organization should have a chief architect who leads the corporate EA program office and who is responsible for EA development and maintenance and accountable to the executive committee. The chief architect is typically an organization executive whose background and qualifications span both the business and technology sides of the organization. Because the chief architect also typically serves as the EA program manager, this person should be knowledgeable about program management as well as capital planning and investment control, systems engineering, and organization and data modeling. The chief architect (in collaboration with the CIO, executive committee, and the organization head) is instrumental in obtaining organizational buy-in for the EA (including support from the business units) and in securing resources to support architecture management functions, such as risk management, configuration management, and quality assurance. As such, the chief architect acts as the corporate spokesperson and advocate for EA adoption. When federation and segmentation approaches are used, lead architects should also be designated for these component efforts and, like the chief architect, these lead architects should similarly be knowledgeable about and skilled in EA promotion, development, and use.

Selected references

- *CIO Council Practical Guide*, section 3.2.4: "Appoint Chief Architect."

[2]Carnegie Mellon Software Engineering Institute, *Capability Maturity Model® Integration (CMMI) for Development*, version 1.2, CMU/SEI-2006-TR-008 (Pittsburgh, Pa.: August 2006).

- *GAO EAMMF*, version 1.1: "Chief architect exists."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- *Federal Segment Architecture Methodology*, step 1: "Determine participants."

**Core Element 6: EA purpose is clearly stated.**

The purpose of the organization's EA drives virtually all aspects of how the EA program will be planned and executed, including the EA framework, methodology, plans, products, and tools. The purpose of an EA can range from consolidating the organization's IT infrastructure, to normalizing and integrating its data and promoting information sharing, to reengineering core business/mission functions and processes, to modernizing applications and sharing services, to modernizing the entire IT environment, and to transforming how the organization operates. Regardless of the purpose, which will in turn drive the expected value to be realized from the EA's implementation (e.g., reduced operating costs, enhanced ability to quickly and less expensively change to meet shifting external environment and new business demands/opportunities, improved alignment between operations and strategic goals and operations, etc.), it needs to be clearly defined by the executive committee and be communicated to and understood by all stakeholders and corporate and subordinate architecture staff. In addition, the purpose needs to be aligned with and supportive of the organization's overall strategic plan's goals, objectives, and outcomes, and it needs to be used to help establish the purpose of each subordinate architecture.

Selected references

- *CIO Council Practical Guide*, section 4.1: "Define the Intended Use of the Architecture."
- *GAO EAMMF*, version 1.1: "Written and approved organization policy exists for EA development."
- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan"; section 6.3.4: "Measuring EA Program Value."

- *Federal Segment Architecture Methodology*, activity 1.2: "Develop the purpose statement for the segment."

**Core Element 7: EA framework(s) is adopted.**

To effectively and efficiently develop an EA, an organization should use an architecture framework, which can be viewed as an EA content taxonomy, to define the specification of the suite of EA products and artifacts to be developed, used, and maintained, and the relationships among them. As such, the framework is instrumental in promoting consistent and collaborative representations of architectural information across the organization.

Our prior work has shown that organizations have experienced various levels of satisfaction in using a range of frameworks.[3] Consequently, organizations need to carefully evaluate framework options to ensure that they effectively support achievement of the EA's stated purpose.

Selected references

- *CIO Council Practical Guide*, section 4.5: "Evaluate and Select a Framework."
- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 8: EA performance and accountability framework is established.**

Successfully managing any program, including an EA program, depends in part on establishing clear commitments and putting in place the means by which to determine progress against these commitments and hold responsible parties accountable for the results. Because the EA is a corporate asset, and its development and use are corporate endeavors

[3]See GAO-06-831. The frameworks most frequently cited by departments and agencies in this report were the Federal Enterprise Architecture Program Management Office Reference Models, the Federal Enterprise Architecture Framework, and the Zachman Framework.

involving a host of organizational players, a corporate approach for measuring EA progress, management capacity, quality, use, and results should be established that extends to all levels of the organization involved in the EA. In particular, it should recognize the critical roles and responsibilities of key stakeholders, including the executive committee, the CIO, the chief architect, investment review board(s), and all subordinate committees and architects, and it should provide the metrics and means for ensuring that these roles and responsibilities are fulfilled and any deviations from expectations are documented and disclosed.

Selected reference

- *CIO Council Practical Guide*, section 8.2: "Identify Where EA Program Expectations Are Not Being Met"; section 8.3: "Take Appropriate Actions to Address Deviations"; section 8.4: "Ensure Continuous Improvement."

**Core Element 9: EA budgetary needs are justified and funded.**

An organization should have sufficient resources to establish and execute its EA program. Accordingly, program plans and activities should be appropriately justified and adequately funded. Among other things, funding requests should be based on reliable program cost estimates and justified based on expected EA program benefits, such as improvements to organization efficiency, better product and/or service delivery, and reduced investment and/or operating costs. In so doing, the organization should recognize that its EA is an investment in its future, and thus the EA should be viewed as a capital asset whose cost is not solely a current period expense. By funding EA as a capital investment, an organization's leadership demonstrates its long-term commitment to having and using an EA to inform investment decision making and optimize mission-facing and mission-supporting operations.

Selected references

- *CIO Council Practical Guide*, section 3.1.1: "Ensure Agency Head Buy-in and Support"; section 3.1.3: "Obtain Support from Senior Executives and Business Units."
- *GAO EAMMF*, version 1.1: "Adequate resources exist."
- GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP, March 2009.

**Core Element 10: EA program office(s) exists.**

EA development and maintenance should be managed as a formal program. Accordingly, a corporate EA program management office should be chartered. While the program office is typically within the Office of the CIO, another organizational option is to place it under the purview of the organization's chief operating officer or chief management officer, and to align it closely with the organization's strategic planning or continuous process improvement functions. Regardless, the program office should be responsible to the EA executive committee for ensuring that those core elements that are within its span of authority and control, as discussed throughout this framework, are met. Among other things, this includes EA program planning and performance monitoring, EA development and maintenance using supporting tools, and EA quality assurance, configuration management, and risk management. The corporate program office can be augmented by subordinate architecture program offices or core teams responsible for their respective subordinate architecture programs, processes, and products.

Selected references

- *CIO Council Practical Guide*, section 3.2.5: "Establish an Enterprise Architecture Program Management Office."
- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- *Federal Segment Architecture Methodology*, activity 1.3: "Solicit core team members."

**Core Element 11: Key program office leadership positions are filled.**

The chief architect designated in Stage 1 typically serves as the EA program office manager, and should be supported by a range of program office leadership positions (see table 7).

**Table 7: Examples of EA Program Management Office Leadership Positions**

| Position | Description |
|---|---|
| Product-specific architects | Develop architecture products such as business process models, data models, and technical reference models |
| Risk manager | Identifies, monitors, controls, and mitigates EA program risks in light of internal and external environmental factors (e.g., external business constraints and technical constraints) |
| Configuration manager | Establishes and maintains the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits |
| Quality assurance manager | Defines, monitors, and enforces EA product quality standards, such as standards for completeness, usability, consistency, and accuracy |

Source: GAO.

In filling these positions, the chief architect should leverage the program office's human capital management capabilities discussed in the next core element. Consistent with the corporate EA program office, subordinate architecture program offices or core teams should be led by their respective lead architects, all of whom should also ensure that their key leadership positions are filled.

Selected references

- *CIO Council Practical Guide*, section 3.2.5.1: "Appoint Key Personnel"; section 3.2.5.2. "Establish Enterprise Architecture Core Team."
- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- GAO, *A Model of Strategic Human Capital Management*, GAO-02-373SP, March 2002; *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.
- *Federal Segment Architecture Methodology*, activity 1.3: "Solicit core team members."

**Core Element 12: Program office human capital plans exist.**

Having sufficient human capital to successfully develop and maintain the corporate EA is the responsibility of the chief architect, and it begins with identifying human capital needs and developing a plan for acquiring, developing, and retaining qualified staff with the requisite knowledge, skills, and abilities. The process of identifying program office human capital needs and developing a plan to address them should be governed by human capital management best practices, as defined in relevant guidance, such as GAO's *Model of Strategic Human Capital Management* and the Office of Personnel Management's (OPM) *Human Capital Assessment Accountability Framework*. This guidance can be applied to individual programs such as an EA program. In short, it provides for assessing existing human capital capabilities, defining needed capabilities, and performing a gap analysis to identify the positions that need to be filled and their required qualifications. The EA human capital plan is the vehicle for addressing identified gaps by, for example, training existing staff, hiring new staff, and using contract staff, and should also address staff retention, development, and recognition and reward. For organizations that have adopted, for example, a federated architecture approach, human capital planning for each subordinate architecture should also be performed. While the formality of these planning efforts will vary depending on the size, scope, and complexity of the respective architecture efforts, it is important that this planning reflect the basic tenets of effective human capital management provided in GAO and OPM guidance.

Selected references

- *CIO Council Practical Guide*, section 3.2.5.1: "Appoint Key Personnel"; section 3.2.5.2. "Establish Enterprise Architecture Core Team."
- *CMMI for Development*, version 1.2: "Establish an Organizational Training Capability."
- GAO, *A Model of Strategic Human Capital Management*, GAO-02-373SP, March 2002; *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.
- OPM, *Human Capital Assessment and Accountability Framework.*

**Core Element 13: EA development and maintenance methodology exists.**

An EA methodology defines the steps to be followed to generate and sustain the desired set of architecture artifacts, as identified in the EA framework(s). As such, the methodology or methodologies that corporate and subordinate program offices select and employ should address how the architecture products provided for in the selected EA content framework will be developed and maintained to ensure that they are, among other things, consistent, complete, aligned, integrated, and usable. Because of its pivotal role, the methodology should be documented, understood, and consistently applied, and should provide the standards, tasks, tools, techniques, and measures to be followed in developing and maintaining the architecture products.

One example of an architecture methodology is the Federal Segment Architecture Methodology. According to OMB and the CIO Council, this methodology provides steps for developing a core mission area segment architecture and includes guidance for tailoring the approach to develop business service and enterprise service segment adaptations.

Selected references

- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 14: Automated EA tools exist.**

Information about how the enterprise operates is captured and maintained in a variety of sources, such as the business vision statement, business strategy, performance and accountability plans and reports, policies, procedures, and guidance. Assimilating this information to support organizational transformation by creating a holistic view of the current and future state of the enterprise can be a challenging endeavor. Automated tools support this endeavor by assisting in the process of extracting, assimilating, relating, and presenting this organizational information. Automated EA tools can be used to graphically and textually capture information described by the framework, such as information or activity models, and can assist in developing, communicating, storing, structuring, relating, accessing, and maintaining the architecture products

described in the EA framework and methodology (e.g., business process models and data models).

Our prior work has shown that federal agencies have experienced various levels of satisfaction in using a variety of EA tools.[4] As a result, organizations should carefully consider their options when selecting EA modeling and/or repository tools. Table 8 lists a number of factors to consider in selecting tools.

**Table 8: Factors to Consider in Selecting EA Modeling and Repository Tools**

| Factors |
|---|
| Ability to import existing models |
| Ability to tailor EA information to stakeholder needs |
| Analytical needs and capabilities |
| Available platforms |
| Configuration management support |
| Cost and licensing |
| Degree of customization required |
| EA program maturity |
| Framework support |
| Integrated and consolidated repository |
| Interoperability with other tools/repositories |
| Model size and complexity |
| Modeling methods and techniques support |
| Quality assurance support |
| Risk management and issue tracking support |
| Traceability to requirements and other enterprise engineering artifacts |
| Training schedule, cost, and length |
| Vendor support |

Source: CIO Council.

[4]See GAO-06-831. The most frequently cited tools were System Architect, Visio, and Metis.

Selected references

- *CIO Council Practical Guide*, section 4.6: "Select an EA Toolset."
- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 15: EA program management plan exists and reflects relationships with other management disciplines.**

An EA program management plan should describe the means by which the corporate EA program will be managed. As such, this plan defines the range of management structures, controls, disciplines, roles, and accountability mechanisms discussed throughout the EAMMF. Moreover, the plan should describe, at least notionally, the major EA releases or increments to be developed, and in doing so, should be aligned with the EA frameworks and methodologies to be employed. In addition, the plan should be approved by the chief architect and the executive committee, and it should address how EA program management will be performed in concert with other institutional management disciplines, such as organizational strategic planning, strategic human capital management, performance management, information security management, and capital planning and investment control. While the program management plan can be self-contained, it can also be supported by subordinate plans that more specifically address key EA management areas, such as an organization communication plan, a human capital management plan, a configuration management plan, a risk management plan, and a quality assurance plan.

Selected references

- *CIO Council Practical Guide*, section 3.3.2: "Develop an EA Program Management Plan."
- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists"; "EA products are under configuration management"; "Progress against EA plans is measured and reported"; "Process exists to formally manage EA change."

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

- *Federal Segment Architecture Methodology*, activity task 1.4.2: "Create project plan for segment architecture development."

**Core Element 16: Work breakdown structure and schedule to develop EA exist.**

Each program management plan should be supplemented by a work breakdown structure that decomposes the specific tasks, activities, and events needed to execute the program, as well as a reliable schedule that defines the timing, sequencing, and duration of the tasks, activities, and events. Among other things, the selected EA framework and methodologies as well as the program management plan should help to inform the work breakdown structure and schedule.

Because the EA program is a major organizational undertaking, both in terms of significance and of resources, the work breakdown structure and schedule should be derived in accordance with best practices, as provided in GAO's *Cost Estimating and Assessment Guide*.[5] According to this guidance, the work breakdown structure is to provide a clear picture of what needs to be accomplished to develop a program and provide a basis for identifying resources and tasks for developing a cost estimate. In addition, the success of any program depends in part on having a reliable schedule that defines, among other things, when work activities will occur, how long they will take, and how they are related to one another. As such, the schedule not only provides a road map for the systematic execution of a program, but also provides the means by which to gauge progress, identify and address potential problems, and promote accountability.

Selected references

- *CIO Council Practical Guide*, section 3.3.2: "Develop an EA Program Management Plan."

- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists."

[5]GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

- *Federal Segment Architecture Methodology*, activity task 1.4.2: "Create project plan for segment architecture development."

- GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP, March 2009.

**Core Element 17: EA segments, federation members, and/or extended members have been identified and prioritized.**

Organizations that adopt segmented or federated architecture approaches should identify and prioritize their subordinate or member architecture components. The initial identification and prioritization of components should be performed by the corporate EA program office and approved by the executive committee. Factors that should be considered in identifying, prioritizing, and approving segments and federation members include strategic improvement opportunities, needs and performance gaps, organizational structures and boundaries, relevant legislation and executive orders, and key component organizational and program dependencies. Consistent with the EA communication plan, organizations should ensure that these priorities are communicated throughout the organization.

Selected reference

- *OMB Federal Enterprise Architecture Practice Guidance*, "Initiating Segment Architecture."

**Core Element 18: Program office readiness is measured and reported.**

The capacity of the corporate and subordinate EA program offices to manage their respective EA programs will largely be determined by the organization's satisfaction of the Stage 2 core elements. Thus, it is important to measure and understand the extent to which the framework's people, processes, and tools enablers have been put in place and to share this readiness information with the executive committee, chief architect, and subordinate architects.

**Core Element 19: Organization business owner and CXO representatives are actively engaged in architecture development.**

Because the scope of the EA is organizationwide, its stakeholders include all business owners and chief "X" officers (CXO).[6] While many of these senior executives will be engaged in the EA program as members of the executive committee, it is equally important that their representatives, as subject matter experts, be actively engaged with EA program staff in developing the corporate and subordinate architecture products, particularly those products that capture information that is best known and understood by the subject matter experts. As such, these representatives should be assigned to the appropriate corporate and subordinate program offices and should work with the architecture staff in developing EA products. For an organization whose EA scope extends to other external organizations, the chief architect should work with his or her counterpart in these other organizations to ensure interorganizational EA alignment.

Selected references

- *CIO Council Practical Guide*, section 3.1.3: "Obtain Support from Senior Executives and Business Units"; section 3.3.1: "Develop an EA Marketing Strategy and Communications Plan."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- *Federal Segment Architecture Methodology*, activity 1.3: "Solicit core team members"; task 2.1.3: "Identify stakeholders"; task 2.2.2: "Determine stakeholders' needs."

**Core Element 20: EA human capital plans are being implemented.**

Corporate and subordinate EA program offices should be staffed with employees with the knowledge, skills, and abilities needed to manage the EA program, including the means by which to oversee and manage contractors that are tasked with delivering EA product content or

[6]CXO, or chief "X" officer, is a generic term for job titles where "X" represents a specific specialized position that serves the entire organization, such as the CIO, chief financial officer, chief human capital officer, chief procurement officer, chief performance officer, chief technology officer, chief information security officer, or chief management officer.

supporting EA management functions. To accomplish this, the program office(s) should have begun to implement the human capital plans developed in Stage 2, to include hiring and training staff in a manner consistent with the approved plan.

Selected references

- *CIO Council Practical Guide*, section 3.2.5: "Establish an Enterprise Architecture Program Management Office."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- GAO, *A Model of Strategic Human Capital Management*, GAO-02-373SP, March 2002; *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.

**Core Element 21: Program office contractor support needs are being met.**

Contractor support is an integral component of program office human capital capacity. For example, all federal departments and agencies included in our 2006 EA management survey reported developing their EAs using contractor support, which accounted for the majority of the agencies' EA development costs.[7] Accordingly, the corporate and subordinate program offices need to ensure that the human capital plan's provisions for contractor support are implemented so that the appropriate degrees of contractor expertise, skills, and competencies are acquired and assimilated into the program office.

As we have previously reported, agencies should use performance-based contracting to the maximum extent practicable when acquiring EA contract support.[8] Further, agencies should follow relevant acquisition management guidance pertaining to contractor tracking and oversight, to include, among other things,

[7]GAO-06-831.

[8]GAO, *Information Technology: FBI Is Taking Steps to Develop an Enterprise Architecture, but Much Remains to Be Accomplished*, GAO-05-363 (Washington, D.C.: Sept. 9, 2005).

- establishing a written policy for contract tracking and oversight,
- designating responsibility for contract tracking and oversight activities,
- establishing a group that is responsible for managing contract tracking and oversight activities, and
- using approved contractor planning documents as a basis for tracking and overseeing the contractor.

Selected references

- *CIO Council Practical Guide*, section 3.2.5: "Establish an Enterprise Architecture Program Management Office."
- GAO, *A Model of Strategic Human Capital Management*, GAO-02-373SP, March 2002; *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.
- *Federal Acquisition Regulation*, section 37.102(a) and part 46, "Quality Assurance."

**Core Element 22: Program office staff are trained in EA framework, methodology, and tools.**

Corporate and subordinate program office staff, including support contractor staff, should understand the framework, methodology, and automated tools that are to be used to develop and maintain the EA products. Consequently, consistent with the program's human capital management plan, steps should be taken to define and deliver training to meet these needs. Such training, whether provided by program office staff, a contractor, or both, should be customized to the program's selected EA framework, methodology, and tools, and should include a means for ensuring that sufficient staff understanding has been achieved. Further, the training should be tailored to specific staff roles and responsibilities.

Selected references

- *CIO Council Practical Guide*, section 6.1.1: "Train Personnel."
- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists."

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 23: Methodologies and tools exist to determine investment compliance with corporate and subordinate architectures.**

An organization's investments should be aligned with and comply with the applicable components (e.g., business, information/data, technical) of the current version of the corporate and subordinate architectures and should not be selected and approved under the organization's capital planning and investment control (i.e., investment management) approach unless such compliance is documented by the investment sponsor, substantiated by the architecture assessment team, and approved by the investment review board(s). Accordingly, organizations should document and consistently apply a methodology and supporting tools for assessing investments' architectural compliance. Among other things, the methodology should focus on the relevant architecture artifacts in the current versions of both the corporate and subordinate EAs, as applicable. Further, architectural compliance should be integrated with and reflected in the investment management and system life cycle management processes. As we have previously reported, investment compliance with the EA is not a onetime event, but rather is a key decision consideration at each major investment milestone, and the EA artifacts that apply will vary as the investment proceeds through its life cycle. In addition, the methodology and tool should not treat alignment as a binary—yes or no—determination, but rather should treat areas of noncompliance and misalignment as individual areas of risk, which collectively form a composite architecture compliance risk that should be disclosed to investment decision makers and proactively managed. The methodology should allow exceptions to architecture compliance only on the basis of compelling analytical justification and should state that such exceptions are captured in documented EA waivers that are in turn used to update the EA.

Selected references

- *CIO Council Practical Guide*, section 6.1: "Integrate the EA with Capital Planning and Investment Control and System Lifecycle Processes"; section 6.1.2: "Establish Enforcement Processes and Procedures."

- *GAO EAMMF*, version 1.1: "IT investments comply with EA."

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

- *GAO ITIM Framework*, version 1.1: "Selecting an Investment"; "Defining the Portfolio Criteria"; "Creating the Portfolio."

**Core Element 24: Methodologies and tools exist to determine subordinate architecture alignment with the corporate EA.**

An organization's subordinate architectures should be aligned with the corresponding components (e.g., business, information/data, technical) of the current version of its corporate EA. Such alignment will help in identifying the linkages between the subordinate architectures and the corporate EA, provide for sharing common applications and systems across the organization, and promote interoperability and data sharing among related programs. Accordingly, organizations should document and consistently apply a methodology and supporting tools to assess subordinate architecture alignment with the corporate EA. As is the case with investment compliance with the EA, the methodology and tools should recognize that alignment among architectures is a continuous risk-based determination that needs to be mitigated and disclosed to, among others, the executive committee.

Selected reference

- GAO, *Business Systems Modernization: Strategy for Evolving DOD's Business Enterprise Architecture Offers a Conceptual Approach, but Execution Details Are Needed*, GAO-07-451, April 2007.

**Core Element 25: EA-related risks are proactively identified, reported, and mitigated.**

Like any program that involves the development and maintenance of an enterprise asset, an EA program is intended to deliver specific capabilities and expected mission benefits for an estimated cost according to a defined schedule. Accordingly, an EA program will face a myriad of risks that might affect the accomplishment of these commitments and thus should

be proactively managed. These risks should be formally managed in accordance with relevant risk management guidance.[9]

To the extent that any of the core elements in this framework are not being satisfied, a risk to the program will exist, although the severity of the risk may vary depending on the specific core element. For example, an organization that has developed an EA compliance methodology and associated tools, but lacks important information, data, or technology content in its EA, risks developing systems that are not defined and designed in a manner that promotes interoperability.

Selected references

- *CMMI for Development*, version 1.2: "Risk Management Process Area."
- *Federal Segment Architecture Methodology*, task 2.2.3: "Identify segment risks and impacts."
- *GAO EAMMF*, version 1.1: "Program office responsible for EA development and maintenance exists."

**Core Element 26: Initial versions of corporate "as-is" and "to-be" EA and sequencing plan are being developed.**

As we have previously reported, EA development typically occurs in an incremental fashion, whereby an initial version is developed as the foundation upon which to evolve and build increasingly more comprehensive, detailed, and complete versions.[10] To create this initial version, the corporate EA program office should leverage the range of people, process, and tool enablers discussed in the Stage 2 and 3 core elements (e.g., human capital frameworks, methodologies, modeling tools, repositories), and it should do so in accordance with the management plans, budgets, and schedules also discussed as part of these Stage 2 and 3

[9]See, for example, Department of Defense, *Risk Management Guide for DOD Acquisition*, 6th Edition, version 1.0, http://www.acq.osd.mil/sse/ed/docs/2006-RM-Guide-4Aug06-final-version.pdf (accessed March 13, 2008); and Carnegie Mellon Software Engineering Institute, *CMMI for Acquisition*, version 1.2, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

[10]See, for example, GAO, *DOD Business Systems Modernization: Recent Slowdown in Institutionalizing Key Management Controls Needs to Be Addressed*, GAO-09-586 (Washington, D.C.: May 18, 2009).

core elements. Further, it is imperative that the initial version of the corporate EA be enterprisewide in scope, and that it describe both the current ("as-is") environment and the future ("to-be") environment, as well as a plan for moving from the current to the target environment. (See later core elements for further details on the content of these descriptions and this plan.)

Selected references

- *CIO Council Practical Guide*, section 5.2: "Generate Products and Populate EA Repository"; section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture"; section 5.3: "Develop the Sequencing Plan"; section 5.3.1: "Identify Gaps; Section 5.3.2: Define and Differentiate Legacy, Migration, and New Systems"; section 5.3.3: "Planning the Migration."

- *GAO EAMMF*, version 1.1: "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." "

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan."

**Core Element 27: Initial version of corporate EA describing the enterprise in terms of performance, business, data, services, technology, and security is being developed.**

In Stage 3, development of the initial version of the corporate EA should begin in earnest and should include the full range of conceptual models that are provided for in the selected EA content framework(s). At a minimum, this content should address the following key aspects of the enterprise: corporate performance, operations, information/data, applications/services, technology, and security. As a general rule, the corporate EA need only contain that thin layer of corporate outcomes, policies, rules, standards, and protocols that all component parts or slices will be expected to adopt and reflect.

Selected references

- *CIO Council Practical Guide*, section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture."

- *GAO EAMMF*, version 1.1: "Both the "as-is" and the "to-be" environments are described or will be 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."

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan."

**Core Element 28: One or more segment and/or federation member architectures is being developed.**

As we have previously reported, successful EA development for large, complex federal agencies does not involve an "all-or-nothing," monolithic approach.[11] Rather, EA development typically follows a "divide and conquer" strategy in which the level of architectural detail needed to guide and constrain individual investments is created for distinct organizational components or functional slices of the enterprise (i.e., "children") and in a way that ensures that the distinct parts or slices are architecturally aligned with the organization's corporate (i.e., "parent") EA. In general, these children can be viewed as either enterprise segments or federated members.[12] In taking one or both of these approaches, the EA is developed incrementally through segmented and/or federated architectures that are consistent and aligned with an overall corporate EA and developed according to the priorities defined in Stage 2. In so doing, the level of architectural content that needs to be defined to sufficiently inform high-priority, near-term system investments can be established relatively quickly, thus allowing the benefits of the EA to be realized sooner rather than later.

Selected references

- *OMB Federal Enterprise Architecture Practice Guidance*, "Initiating Segment Architecture."

- *CIO Council*, "Federal Segment Architecture Methodology," Dec. 2008.

[11]GAO, *DOD Business Systems Modernization: Key Navy Programs' Compliance with DOD's Federated Business Enterprise Architecture Needs to Be Adequately Demonstrated*, GAO-08-972 (Washington, D.C.: Aug. 7, 2008).

[12]See discussion earlier in this framework.

**Core Element 29: Architecture products are being developed according to the EA content framework.**

To varying degrees, EA content frameworks identify the collection of architecture artifacts that are to be developed as well as the relationships and dependencies that exist among these artifacts. For example, a framework may include an artifact that describes information exchanges among operational activities, and the information being exchanged in this artifact may link to data elements described in a conceptual data model artifact. Accordingly, the initial version of the corporate and subordinate EAs developed during this stage should consist of the set of products that are provided for in the selected content framework(s) being used. By doing so, architecture content across the organization can be transparent to and understood by those responsible for using it, thereby increasing the chances that the products will meet key quality attributes (i.e., consistency, usability, etc.).

Selected references

- *CIO Council Practical Guide*, section 4.5: "Evaluate and Select a Framework."
- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 30: Architecture products are being developed according to a defined EA methodology.**

The purpose of the EA methodology is to provide architecture players and stakeholders with a shared understanding of the architecture development approach, including defined steps, tasks, standards, tools, techniques, and measures that are to be used to create the specified EA products. Through such an understanding, a repeatable and consistent process to product development can result. To accomplish this, the initial versions of the corporate and subordinate EAs being developed during this stage should be developed in accordance with the selected methodology or methodologies.

Selected references

- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 31: Architecture products are being developed using EA tools**

Developing the corporate and subordinate EA products specified in the selected content framework and executing the methodology for developing these products is a complex and resource-intensive undertaking. To assist in meeting this challenge, EA development tools should be effectively leveraged to help capture and relate defined corporate and subordinate architecture product content and to help ensure the content's completeness, accuracy, usability, and consistency. A range of automated modeling and repository tools, as discussed earlier, exists to perform these functions. Steps should be taken to ensure the full and necessary utilization of these tools.

Selected references

- *CIO Council Practical Guide*, section 4.6: "Select an EA Toolset."
- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 32: Architecture development progress is measured and reported.**

A key aspect of managing the range of activities under way during this stage is to track and disclose the progress being made in completing them. To accomplish this, execution and completion of corporate and subordinate architecture tasks defined in the EA program plan, work breakdown structure, and schedule, as well as their associated costs, should be measured relative to existing commitments, and this progress should be reported through the chief architect to the executive committee.

Through such progress measurement and reporting, deviations from expectations can be identified, corrective action to address the root cause of any deviations can be taken, and responsible persons can be held accountable for achieving approved commitments.

Selected references

- *CIO Council Practical Guide*, section 8.2: "Identify Where EA Program Expectations Are Not Being Met"; section 8.3: "Take Appropriate Actions to Address Deviations"; section 8.4: "Ensure Continuous Improvement."
- *GAO EAMMF*, version 1.1: "Progress against EA plans is measured and reported."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 33: Executive committee has approved the initial version of corporate EA.**

As we have previously reported, a corporate EA represents the thin layer of policies, capabilities, and standards that apply across an organization and need to be adopted by and reflected in all subordinate architectures. As the entity ultimately accountable for EA development and maintenance, the executive committee should review and approve the initial release of the corporate EA and all subsequent major releases. Such approval demonstrates institutional buy-in and commitment to the architecture, and thus facilitates organizationwide acceptance and use of the EA.

Selected references

- *CIO Council Practical Guide*, section 5.4: "Approve, Publish, and Disseminate the EA Products."
- *GAO EAMMF*, version 1.1: "Committee or group representing the enterprise or the investment review board has approved current version of EA."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 34: Key stakeholders have approved the current version of subordinate architectures.**

As the entities who will be ultimately accountable for implementing solutions associated with the subordinate architectures, each subordinate architecture's core team and key stakeholders, such as the affected business owners and/or executive sponsors, should review and approve the initial release of the subordinate architecture and all subsequent major releases. Such approval denotes buy-in of affected organizational entities, and thus facilitates acceptance and use of the subordinate architectures.

Selected references

- *CIO Council Practical Guide*, section 5.4: "Approve, Publish, and Disseminate the EA Products."
- *Federal Segment Architecture Methodology*, activity 5.4: "Brief core team and obtain approval."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 35: EA is integral to the execution of other institutional management disciplines.**

EA is one of several interrelated institutional management disciplines that collectively provide the means for an organization to be successful in meeting its mission goals and target outcomes. Among others, these disciplines include strategic planning, human capital management, capital planning and investment control, system development and acquisition management, enterprise risk management, and performance management. EA is a contributor to many of these disciplines. In particular, it provides the bridge between strategic planning and program implementation, it informs human capital strategic planning and capital planning and investment control decision making, and it provides a critical underpinning to institutional performance management. As a result, the EA should be an integral input into the execution of each of these management disciplines.

Selected references

- *CIO Council Practical Guide*, section 2.5: "The Enterprise Life Cycle"; section 6.1: "Integrate the EA with Capital Planning and Investment Control and Systems Life Cycle Processes."
- *GAO EAMMF*, version 1.1: "EA is integral component of IT investment management process."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- *GAO ITIM Framework*, version 1.1: "Providing Investment Oversight."

**Core Element 36: Program office human capital needs are met.**

Having filled its key leadership positions and developed and implemented its human capital plans, the corporate and subordinate EA program offices have now acquired, either through training, direct hiring, organizational transfer, or contracting, the people that they need to execute the organization's EA program plans and schedules. Collectively, these people should possess the knowledge, skills, and abilities required to execute the functions and associated roles and responsibilities that formed the basis for the capability gap analysis in the human capital strategic plan developed during Stage 2.

Selected references

- *CIO Council Practical Guide*, section 3.2.5: "Establish an Enterprise Architecture Program Management Office."
- *GAO EAMMF*, version 1.1: "Adequate resources exist."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."
- GAO, *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.

**Core Element 37: Initial versions of corporate "as-is" and "to-be" EA and sequencing plan exist.**

As noted earlier, EA development typically occurs on an incremental basis. Consequently, a commonly practiced approach to developing and using an EA is to produce progressively more content-rich EA versions. The initial version of the EA is perhaps the most difficult and important step in this progression because it is in developing this version that the range of EA development enablers (people, processes, and tools) are first utilized, and it is this initial version that forms the basis for both developing the subordinate architectures of the EA and initial implementation of modernization and transformation solutions. As a result, it is extremely important that this initial version either be enterprisewide in scope and contain sufficient detail surrounding the principles, goals, measures, policies, rules, standards, protocols, etc. that will apply across the enterprise, or that it clearly disclose what scope and details are missing and in which subsequent version this content is expected to be added. As such, the initial version should not be viewed as a finished product but rather it should be viewed as a foundation upon which to architecturally build and evolve while also guiding and directing targeted initial subordinate EAs and solution development. The initial version, as with most long-term plans, will evolve and change over time (mature) as more is learned about near-term investments and initiatives, and as priorities funding availability change.

An organization should complete the initial version of its corporate EA products according to defined plans and schedules and using acquired people, processes, and tools. These products should, at a minimum, include artifacts applicable to both the "as-is" and the "to-be" environments of the enterprise, as well an initial version of a sequencing plan that provides a high-level investment road map for migrating between the two environments. While this sequencing plan should also not be viewed as a finished product, it should nevertheless provide a solid basis upon which to build and should reflect, among other things, governmentwide and agency-specific priorities (e.g., open and transparent government), notional dependencies among investments, conceptual expectations about investment costs and benefits, and emerging and available technological opportunities (e.g., cloud computing).

Selected references

- *CIO Council Practical Guide*, section 5.2: "Generate Products and Populate EA Repository"; section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture"; section 5.3: "Develop the Sequencing Plan; section 5.3.1: Identify Gaps"; section 5.3.2: "Define and Differentiate Legacy, Migration, and New Systems"; section 5.3.3: "Planning the Migration."

- *GAO EAMMF*, version 1.1: "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.""

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan."

**Core Element 38: Initial version of corporate EA captures performance, business, data, services, technology, and security views.**[13]

While the initial version of the corporate EA is not expected to be fully defined at this juncture, it nevertheless should capture and disclose EA information within the context of models and associated narrative. While the specific models will vary depending on the EA content framework being used, these models should nevertheless provide one or more interrelated representations and varying levels of abstraction of the enterprise's business operations, performance measurement approach, information and data needs and definitions, application and service delivery vehicles, technology profiles and standards, and security characteristics. Among other things, these models or architectural artifacts will establish the authoritative frames of reference that are not only interrelated with one another, but also aligned with and consistent with the subordinate architectures.

Selected references

- *CIO Council Practical Guide*, section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture."

[13]These six views may be captured in any number of EA models or architectural artifacts depending on the EA content framework being used.

- *GAO EAMMF*, version 1.1: "Both the "as-is" and the "to-be" environments are described in terms of business, performance, information/data, application/service, and technology"; "Business, performance, information/data, application/service, and technology descriptions address security."

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan."

**Core Element 39: One or more segment and/or federation member architectures exists and is being implemented.**

As discussed in the preceding elements, an organization's corporate EA captures key information about the current and future state of the enterprise as a whole and should provide the basis for informing the enterprise's subordinate architectures and related solution implementations. These subordinate architectures, such as segment architectures or federated member architectures, should, in turn, capture architectural information that is relevant to that specific segment or organizational components, such as a business mission or function (e.g., financial management) or a subagency or bureau that is needed to guide and constrain investment solutions that apply to that specific mission area or organizational component. Accordingly, in Stage 4, the organization should have developed and begun implementing one or more segment and/or federation member architectures on a targeted and prioritized basis in order to begin achieving its modernization and transformation goals and outcomes.

Selected reference

- *OMB Federal Enterprise Architecture Practice Guidance*, "Initiating Segment Architecture."

**Core Element 40: EA product quality is measured and reported.**

Realizing an EA's value depends in large part on the quality of the products or artifacts that compose it. As a result, an organization should ensure that corporate and subordinate architecture content is measured against the quality standards (i.e., metrics) that should be defined in the EA development and maintenance methodology. Generally, these quality standards should address, at a minimum, product completeness, usability, consistency, and accuracy. Moreover, the results of EA product quality measurement activities should be disclosed to the appropriate officials to inform decision making and permit timely corrective action. For example,

these metrics should be shared with the executive committee when it is being asked to approve the initial version of the EA or a subsequent update.

Selected references

- *CIO Council Practical Guide*, section 3.2.5.1: "Appoint Key Personnel"; section 5.2.3: "Review, Validate, and Refine Models"; section 8.2: "Identify Where EA Program Expectations Are Not Being Met"; section 8.3: "Take Appropriate Actions to Address Deviations"; section 8.4: "Ensure Continuous Improvement."

- *GAO EAMMF*, version 1.1: "Quality of EA products is measured and reported."

**Core Element 41: EA results and outcomes are measured and reported.**

The EA is a strategic asset that represents an investment in the organization's future. Restated, an EA is a corporate investment that is to produce strategic mission value (results and outcomes). As a result, measuring the extent to which this expected value is actually being realized is important to identifying what, if any, EA program changes are warranted. Moreover, examples of positive results and outcomes can be used to economically justify expanded EA development and use.[14] As a result, corporate and subordinate EA results and outcomes should be periodically measured and reported to, among others, the executive committee. Examples of results and outcomes to be measured include costs avoided through eliminating duplicative investments or by reusing common services and applications and improved mission performance through reengineered business processes and modernized supporting systems.

Selected references

- *CIO Council Practical Guide*, section 8.2: "Identify Where EA Program Expectations Are Not Being Met"; section 8.3: "Take Appropriate Actions to Address Deviations"; section 8.4: "Ensure Continuous Improvement."

[14]See GAO-06-831 for examples of architecture-related benefits reported by departments and agencies.

- *GAO EAMMF*, version 1.1: "Return on EA investment is measured and reported."

- *OMB EA Assessment Framework*, version 3.1, section 6.3.1: "Mission Performance"; section 6.3.2: "Cost Savings and Cost Avoidance"; section 6.3.4: "Measuring EA Program Value."

**Core Element 42: Investment compliance with corporate and subordinate architectures is measured and reported.**

Realization of an EA's strategic value depends on its use. This use is achieved by, among other things, requiring that investments comply with EA products or that they receive an explicit waiver from such compliance. Given the importance of EA investment compliance, organizations should develop metrics for measuring the extent to which this occurs and periodically report these metrics to, among others, the executive committee and the organization's investment review board(s). Examples of such metrics for a given reporting period include the number of new and ongoing investments that have been assessed for architecture compliance, the results of these assessments, and the number of compliance waivers requested versus the number granted. By measuring and reporting investment compliance, an organization can be positioned to identify relevant trends and anomalies and take corrective action, if warranted.

Selected references

- *CIO Council Practical Guide*, section 6.1: "Integrate the EA with Capital Planning and Investment Control and System Lifecycle Processes"; section 6.2: "Execute the Integrated Process."

- *GAO EAMMF*, version 1.1: "IT investments comply with EA"; "Compliance with EA is measured and reported."

- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

- *GAO ITIM Framework*, version 1.1: "Selecting an Investment."

**Core Element 43: Subordinate architecture alignment with the corporate EA is measured and reported.**

Successful EA development typically follows an approach in which the level of architectural detail needed to guide and constrain individual investments is created for distinct parts of the organization (i.e., children) and in a way that ensures that the distinct organizational parts are architecturally aligned with the organization's corporate (i.e., parent) EA. These children can be viewed as the earlier discussed subordinate architectures, which include the enterprise segments or federation members. Consequently, subordinate architecture alignment with the corporate EA is key to ensuring that architecture benefits, such as improving interoperability and reducing overlaps and gaps, are achieved across the enterprise. To ensure that this is accomplished, subordinate (child) architecture alignment with the corporate (parent) EA should be periodically measured and reported to, among others, the executive committee and the organization's investment review boards. Examples of metrics that can be used for determining subordinate architecture alignment include the percentage of relevant entities (e.g., operational activities, mission or business functions, data elements) in a subordinate architecture that are aligned with strategic missions and goals described in the corporate EA and the status of efforts to develop those subordinate architectures that have been identified as high priority in the corporate EA. As a byproduct of implementing segmented or federated architectures and steps taken to ensure alignment, an organization may also identify areas at the subordinate level that are different from the corporate architecture and may require a waiver. Thus, situations may arise where those responsible for the corporate architecture need to be petitioned for changes to the content of the corporate EA.

Selected reference

- GAO, *Business Systems Modernization: Strategy for Evolving DOD's Business Enterprise Architecture Offers a Conceptual Approach, but Execution Details Are Needed*, GAO-07-451, April 2007.

**Core Element 44: Organization head has approved current version of the corporate EA.**

The current version of the corporate EA should ultimately be approved by the head of the organization. Among other things, this approval should be based on a recommendation from the executive committee that is grounded in evidence that EA quality measures have been met. Such approval recognizes and endorses the corporate architecture for what it is

intended to be—an institutional tool for managing both business and technological change and transformation.

Selected references

- *CIO Council Practical Guide*, section 5.4: "Approve, Publish, and Disseminate the EA Products."
- *GAO EAMMF*, version 1.1: "Organization head has approved current version of EA."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 45: Organization component heads or segment owners have approved current version of their respective subordinate architectures.**

For the same reasons that the corporate EA should be approved by the organization head, the latest version of each subordinate architecture should be approved by its corresponding organization head or segment owner. The evidentiary basis for such approvals should also be grounded in quality measures that are provided to the approving executive, along with a recommendation for approval by any designated subordinate architecture governance bodies and/or accountable officials (e.g., component organization CIO).

Selected references

- *CIO Council Practical Guide*, section 5.4: "Approve, Publish, and Disseminate the EA Products."
- *Federal Segment Architecture Methodology*, task 5.4.2: "Conduct review and obtain approval."

**Core Element 46: Integrated repository tools and common EA framework and methodology are used across the enterprise.**

To the extent that the family of corporate and subordinate architectures is developed, maintained, and managed using either a common set of repositories, frameworks, and tools or, at a minimum, a set that is integrated and compatible, then the utility and usefulness of the collective family of architectural products will be enhanced, and the efficiencies in

doing so will be increased. While early stages of this framework provide for the use of tools, frameworks, and methodologies by all organizational entities, their selection as part of these earlier stages was left to the discretion of their respective users. As an organization matures in its development and maintenance of an EA, it should adopt a more homogeneous approach to frameworks, tools, and methodologies.

Selected references

- *CIO Council Practical Guide*, section 4.6: "Select an EA Toolset."
- *GAO EAMMF*, version 1.1: "EA is being developed using a framework, methodology, and automated tool."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 47: Corporate and subordinate architecture program offices operate as a single virtual office that shares resources enterprisewide.**

Consistent with efforts described in the previous element to moving toward greater homogeneity in the tools, frameworks, and methodologies used to develop and maintain corporate and subordinate architectures, a maturing EA organization should also evolve to the point that its corporate EA and subordinate architecture program offices operate closely and seamlessly, and in a manner in which EA management resources are shared. While these program offices may be physically and organizationally separate and distinct and include a variety of reporting relationships, they should operate as a single virtual office. As such, these offices should follow common policies and procedures, and they should share limited resources, such as EA repository and analysis tools, contractor support, and people with critical EA knowledge, skills, abilities, and tools.

**Core Element 48: Corporate EA and sequencing plan are enterprisewide in scope.**

As discussed earlier, development of the corporate EA typically occurs incrementally. However, the ultimate goal is to have a version that fully reflects both the "as-is" and "to-be" environments of an organization on an enterprisewide basis. Thus, while initial versions of the corporate EA and sequencing plan need not yet extend to all parts of the parent enterprise or

organization, the scope of a fully mature EA should ultimately do so. Relatedly, a fully mature corporate sequencing plan should document how the entire organization or enterprise intends to achieve the proposed "to-be" operational and technological state. In large part, achieving this core element is a byproduct of having employed the EA people-, process-, and tool-related core elements discussed earlier in this framework.

Selected references

- *CIO Council Practical Guide*, section 5.2: "Generate Products and Populate EA Repository"; section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture"; section 5.3: "Develop the Sequencing Plan"; section 5.3.1: "Identify Gaps"; section 5.3.2: "Define and Differentiate Legacy, Migration, and New Systems"; section 5.3.3: "Planning the Migration."

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan"; section 6.1.3: "Scope of Completion."

**Core Element 49: Corporate EA and sequencing plan are aligned with subordinate architectures.**

A mature EA program should ensure that each federated member and segment architecture is aligned with the corporate EA and sequencing plan. Establishing such alignment is essential to achieving the goals of the EA program, including optimized and rationalized enterprise operations and supporting technology solutions that are appropriately integrated and compatible. In large part, achieving this core element is a byproduct of having met many of the previously discussed core elements related to, for example, adopting one or more EA approaches (e.g., federation, segmentation, etc.) and employing EA management rigor and discipline.

Selected references

- *CIO Council Practical Guide*, section 5.2: "Generate Products and Populate EA Repository"; section 5.2.1: "Essentials in Building the Baseline Architecture"; section 5.2.2: "Essentials in Building the Target Architecture"; section 5.3: "Develop the Sequencing Plan"; section 5.3.1: "Identify Gaps"; section 5.3.2: "Define and Differentiate Legacy, Migration, and New Systems"; section 5.3.3: "Planning the Migration."

- *OMB EA Assessment Framework*, version 3.1, section 6.1.1: "Target Enterprise Architecture and Enterprise Transition Plan"; section 6.1.3: "Scope of Completion."

**Core Element 50: All segment and/or federated architectures exist and are horizontally and vertically integrated.**

While development of subordinate architectures, as discussed earlier, typically occurs incrementally based on institutional needs and priorities, the ultimate goal remains to develop each of the subordinate architectures and to ensure that they collectively form a coherent "family of parent and child" architectures that are integrated both horizontally and vertically. In large part, achieving this core element is a byproduct of having met many of the previously discussed core elements related to, for example, adopting one or more EA approaches (e.g., federation, segmentation, etc.) and employing EA development, maintenance, and management rigor and discipline.

Selected reference

- GAO, *Business Systems Modernization: Strategy for Evolving DOD's Business Enterprise Architecture Offers a Conceptual Approach, but Execution Details Are Needed*, GAO-07-451, April 2007.

**Core Element 51: Corporate and subordinate architectures are extended to align with external partner architectures.**

For organizations that support or depend on external organizations to accomplish their respective missions, such as many federal agencies, it is important to be architecturally connected to and aligned with their mission partners through an extended EA. In the case of some federal agencies, like the Department of Homeland Security, the number of these external organizations can be extensive and can span all levels of government. Thus, defining, understanding, and rationalizing these relationships through the kind of rigorous and disciplined EA management practices discussed in this framework can increase these organizations' potential for optimizing interorganizational performance. Accordingly, it is important that the corporate and subordinate architectures be extended and aligned with those of key external mission partners. Such alignment can assist organizations in leveraging external systems and services and promote information sharing to the benefit of all stakeholder organizations.

**Core Element 52: EA products and management processes are subject to independent assessment.**

An organization should take steps to ensure the quality of its corporate and subordinate architectures. One such step is to provide for subjecting its EA products, and the processes used to develop these products, to some type of independent assessment. To be independent, the assessment should be performed by a party that is outside the EA program office and is not otherwise accountable for meeting EA program commitments, such as the organization's internal audit function or a contractor not responsible for any architecture development, maintenance, or management activities. This third party should be accountable to, and thus report directly to, the executive committee. Consequently, the results of any assessments should be reported to the executive committee either before or at the same time as they are shared with the applicable parent and/or subordinate EA program office.

Selected references

- *CIO Council Practical Guide*, section 3.2.5.1: "Appoint Key Personnel"; section 5.2.3: "Review, Validate, and Refine Models"; section 8.2: "Identify Where EA Program Expectations Are Not Being Met."

- *GAO EAMMF*, version 1.1: "EA products and management processes undergo independent verification and validation."

**Core Element 53: EA is used by executive leadership to inform organization strategic planning and policy formulation.**

As noted earlier, the EA provides the information needed to bridge the gap between an organization's strategic plans and the programs it implements. As such, the EA has traditionally been informed and constrained by these plans and the institutional policies that govern the plans' implementation. As an EA program fully matures, however, a bidirectional relationship should exist whereby the EA helps to inform the same strategic plans and institutional policies to which it is integral to implementing. In particular, the EA can identify the organizational business process-, performance-, information-, service-, technology-, and security-related strengths, weaknesses, and opportunity gaps that should be considered for inclusion in strategic plans and institutional policies. For example, emerging technologies that are reflected in the EA's "to-be" view can serve as the

catalyst for introducing new, or modifying existing, strategic goals and objectives, and/or the timelines for achieving them.[15]

Selected references

- *CIO Council Practical Guide*, section 2.5: "The Enterprise Life Cycle."
- *GAO ITIM Framework*, version 1.1: "Using IT to Drive Strategic Business Change."
- *OMB EA Assessment Framework*, version 3.1, section 6.2.5: "EA Governance, Program Management, Change Management, and Deployment."

**Core Element 54: EA human capital capabilities are continuously improved.**

An organization should periodically reevaluate its existing corporate and subordinate EA human capital capabilities relative to its future needs so that it continues to update its understanding of gaps that need to be filled. Using such a gap analysis, those responsible for the EA program can take proactive steps to fill any knowledge and skill gaps through training, hiring, and contracting. As an organization engages in such continuous improvement, care should be taken to do so in coordination with other EA-related program improvement efforts, and in a manner that reflects established continuous improvement guidance.[16]

Selected references

- *CIO Council Practical Guide*, section 3.2.5.1: "Appoint Key Personnel"; section 3.2.5.2: "Establish Enterprise Architecture Core Team"; section 6.1.1: "Train Personnel"; section 8.4: "Ensure Continuous Improvement."

[15]This "inverse" relationship between strategic plans and program implementations is similarly recognized at the highest maturity stage in GAO's *IT Investment Management Framework*. Specifically, Stage 5 of this framework emphasizes the importance of IT-driven strategic business change, whereby IT is used to strategically renovate and transform work processes and push the organization to explore new and better ways to execute its mission. See GAO-04-394G.

[16]See, for example, Carnegie Mellon Software Engineering Institute, *CMMI for Development*, Version 1.2, CMU/SEI-2006-TR-008 (Pittsburgh, Pa.: August 2006).

- GAO, *A Model of Strategic Human Capital Management*, GAO-02-373SP, March 2002; *Human Capital: Key Principles for Effective Strategic Workforce Planning*, GAO-04-39, December 2003.

- *CMMI for Development*, version 1.2: "Establish an Organizational Training Capability."

**Core Element 55: EA methodologies and tools are continuously improved.**

An organization should periodically reevaluate its corporate and subordinate EA methodologies and tools to ensure that they continue to support its needs. Among other things, this reevaluation should consider user satisfaction with the currently employed methodologies and tools (e.g., usability, supportability, etc.), the commercial availability of alternative products, and the costs associated with transitioning to alternative methods and tools, including licensing, training, and conversion costs. As an organization engages in these continuous improvement efforts, care should be taken to do so in coordination with other EA program improvement efforts and in a manner that reflects established continuous improvement guidance.[17]

Selected references

- *CIO Council Practical Guide*, section 8.2: "Identify Where EA Program Expectations Are Not Being Met"; section 8.3: "Take Appropriate Actions to Address Deviations"; section 8.4: "Ensure Continuous Improvement."

- *GAO ITIM Framework*, version 1.1: "Selecting an Investment."

- *CMMI for Development*, version 1.2: "Ensure Continuous Process Improvement."

**Core Element 56: EA management processes are continuously improved and reflect the results of external assessments.**

An organization should periodically reevaluate its corporate and subordinate EA management processes to ensure that they are effective. Among other things, the reevaluation should compare existing processes

[17]See, for example, Carnegie Mellon Software Engineering Institute, *CMMI for Development*, Version 1.2, CMU/SEI-2006-TR-008 (Pittsburgh, Pa.: August 2006).

with relevant benchmarks and guidance, such as this framework, and identify any gaps that need to be addressed. As an organization engages in this continuous improvement activity, care should be taken to do so in coordination with other EA program improvement efforts, and in a manner that reflects established continuous improvement guidance.[18]

Selected references

- *CIO Council Practical Guide*, section 8.4: "Ensure Continuous Improvement."
- *CMMI for Development*, version 1.2: "Ensure Continuous Process Improvement."
- *GAO EAMMF*, version 1.1: "EA products and management processes undergo independent verification and validation."

**Core Element 57: EA products are continuously improved and updated.**

An EA needs to be continuously maintained to reflect, among other things, shifts in legal requirements, emerging threats and opportunities, shifting priorities, emerging technologies, and governmentwide priorities. Such maintenance also involves introducing changes that are aimed at increasing the EA product quality (i.e., currency, consistency, understandability, usability, accuracy, and completeness). As individual changes are made that collectively represent a significant modification to the products, these changes should be packaged as part of a new version of the corporate and subordinate architecture products. Such continuous improvement to the content of the EA and its products should be formally controlled using a formal configuration management process, as discussed earlier.

Selected references

- *CIO Council Practical Guide*, section 7.1: "Maintain the Enterprise Architecture as the Enterprise Evolves"; section 7.1.1: "Reassess the Enterprise Architecture Periodically"; section 7.2: "Continue to Consider

[18]See, for example, Carnegie Mellon Software Engineering Institute, *CMMI for Development*, Version 1.2, CMU/SEI-2006-TR-008 (Pittsburgh, Pa.: August 2006).

Proposals for EA Modifications"; section 8.4: "Ensure Continuous Improvement."

- *GAO EAMMF*, version 1.1: "EA products are periodically updated."

**Core Element 58: EA quality and results measurement methods are continuously improved.**

An organization should periodically reevaluate its methods for assessing corporate and subordinate architecture quality and program results. If opportunities for improvement exist, actions should be identified and undertaken to exploit these opportunities. Among other things, this reevaluation should address the extent to which program measures and metrics are sufficiently measurable, meaningful, repeatable, consistent, and actionable and aligned with the EA program's strategic goals and the EA's intended purpose. When planning, implementing, tracking, and reporting on improvements to EA quality and results measurement methods, care should be taken to do so in coordination with other EA program continuous improvement efforts, and in a manner that reflects established continuous improvement guidance.[19]

Selected references

- *CIO Council Practical Guide*, section 8.4: "Ensure Continuous Improvement."
- *CMMI for Development*, version 1.2: "Ensure Continuous Process Improvement."

**Core Element 59: EA continuous improvement efforts reflect the results of external assessments.**

All efforts to continuously improve the EA program capabilities and products should leverage the results of external assessments performed by organizations external to the program, including assessments periodically performed by GAO, OMB, and others. Our work in following up with agencies to determine the status of recommendations that we have made to address EA limitations and weaknesses shows that, over time, agency

[19]See, for example, Carnegie Mellon Software Engineering Institute, *CMMI for Development*, Version 1.2, CMU/SEI-2006-TR-008 (Pittsburgh, Pa.: August 2006).

actions have increased the quality of EA products and management processes and resulted in measurable accomplishments.

Selected references

- *GAO EAMMF*, version 1.1.
- *OMB EA Assessment Framework*, version 3.1.

## GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

## Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's Web site (www.gao.gov). Each weekday afternoon, GAO posts on its Web site newly released reports, testimony, and correspondence. To have GAO e-mail you a list of newly posted products, go to www.gao.gov and select "E-mail Updates."

## Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's Web site, http://www.gao.gov/ordering.htm.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

## To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Web site: www.gao.gov/fraudnet/fraudnet.htm
E-mail: fraudnet@gao.gov
Automated answering system: (800) 424-5454 or (202) 512-7470

## Congressional Relations

Ralph Dawn, Managing Director, dawnr@gao.gov, (202) 512-4400
U.S. Government Accountability Office, 441 G Street NW, Room 7125
Washington, DC 20548

## Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548