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# **“Enabling the Mission”**

**A Practical Guide to**

# **Federal Service Oriented Architecture**

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Version 1.1

June 30, 2008



Architecture and Infrastructure Committee,  
Federal Chief Information Officers Council



**The Federal CIO Council Architecture and Infrastructure Committee  
Services Subcommittee & Governance Subcommittee**

**In collaboration with the**



**The American Council for Technology / Industry Advisory Council's  
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**Presents:**

***A Practical Guide to Federal Service Oriented Architecture***  
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## Intended Audience

This document is intended for chief architects, chief information officers (CIOs), program executives, and other individuals in federal agencies who are responsible for leveraging information technology (IT) assets to assist in achieving maximum mission performance in pursuit of agency business objectives. The purpose of this document is to aid in understanding service oriented architecture (SOA) in its three major dimensions (enterprise, architecture, and infrastructure) and how these new service oriented best practices can be used to extend Enterprise Architecture, not replace it. This Guide provides specific guidance for adopting and exploiting this new paradigm for transforming business through agile, reusable, software development in conjunction with effective use of its supporting technology infrastructure.

Based on the information in this document, chief architects and CIOs can become leaders capable of developing and effectively explaining the SOA business case for business stakeholders to inform and guide them in understanding and supporting the investment philosophy they are being asked to champion. Leaders should be able to develop plans for implementing and exploiting a successful roadmap for SOA adoption, and leverage and shape ongoing development, modernization, and enhancement (DME) activities within their agency. In addition, individuals should be able to leverage, support, and use cross-boundary initiatives working with their peers in other agencies, in local, state, and tribal governments, as well as private sector partners.

Some of the guidance in this document is best described as a call to action for the Federal CIO community because it identifies specific areas where additional work or new cross-Government initiatives may be needed to further develop voluntary consensus standards or best practices. In keeping with a basic theme of this document -- that agencies and other stakeholders will come together via federated governance to act based on their common requirements and needs -- we expect this call to action and practical guidance to be the basis of informed decision-making, allowing Federal enterprise participants to have viable knowledge to support effective execution of investment strategies. As agencies evolve and mature their Service Orientation competencies and augment their EAs, the CIO Council will evaluate and facilitate SOA-enhanced EA based on the shared assessment of the requirements and needs.

## Executive Summary

The world is changing at an accelerating rate and the federal government needs to keep pace. Broad-based change is always difficult, but the federal government is plagued by a variety of inhibitors to change, including enterprise versus mission organizational orientation; bureaucratic culture; program aligned funding processes; budgetary cycles and processes that do not facilitate agility or reuse; and a very large and diverse embedded technology base. Service Oriented Architecture (SOA) promises to help agencies rapidly reconfigure their business and more easily position IT resources to serve it. Improved business agility – through the sharing and reuse of infrastructure, services, information, and solutions - is a key component of any Federal Enterprise Architecture whose need will become increasingly critical in the future.

These benefits have been promised in past waves of IT innovation. This time, they are enabled by the concurrent maturation of Internet-based IT standards and best practices and the adoption of those interoperable standards as a common fabric by stakeholders – Citizens, Government, Industry. This document is focused on packaging and presenting those techniques, standards and practices in a manner which fits within the norms and processes of the Federal IT community; allowing for consistent and evolutionary adoption and use, and eventually shared realization of its benefits.

SOA encompasses multiple dimensions which must work in concert for it to be successful. Adopting service-based technologies alone will not enable agencies to achieve the benefits associated with SOA. For the purposes of this document, we accept the definition of a service as defined by OASIS as:

**“The means by which the needs of a consumer are brought together with the capabilities of a provider.”**

Appropriately, this definition is fairly broad and includes more than technical services. As the name suggests, SOA involves architecture. This Practical Guide employs an industry standard definition of SOA (OASIS):

**“Service Oriented Architecture is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains.”**

The conventional concept of SOA does not include Event Driven Architecture (EDA), which is an essential component to a fully functional SOA environment. However, for the purposes of this document, the definition of SOA includes all of the functionality normally associated with EDA.

As described in this Guide, SOA has organizational, governance, business process, structural, and technical dimensions that must be managed and synchronized. This Practical Guide has been written to support Federal chief architects and CIOs in their efforts to adopt SOA best practices to further their organization’s mission, meet increasingly demanding compliance requirements, introduce more agility into their architecture, and optimize their IT architectures.

### ***Rationale for SOA***

The net results of broad-based adoption and advancement of SOA capability throughout the federal government will enable:

**Improved government responsiveness:** By employing services to establish a flexible architecture centered on business and technology capabilities, the impact of change can be isolated and business processes can be more easily and rapidly modified to meet business and mission performance requirements.

**Simplified delivery of enhanced government services:** SOA and the “service” business model enable collaboration by simplifying access to services and streamlined value chains across organizational boundaries.

**More efficient government:** SOA facilitates mutually leveraged public and private sector investment; reuse of capability; elimination of undesirable redundancies; and a more focused model for on-going IT recapitalization.

**Information sharing:** SOA provides an effective and efficient approach to implementing reusable data exchanges - taking logical interoperability coming from multiple data modeling activities and rapidly evolving it into physical interoperability.

**Transparency, security, and resilience:** SOA is predicated on a shared, standards-based infrastructure. This will enable consolidation, simplification, and optimization of IT Infrastructure, which in turn will enable greater transparency and audit-ability, as well as improved continuity of operations.

The primary risk of SOA is when its application is not effectively governed with purposeful intent -- in other words, the business agility SOA promises cannot be achieved through ad-hoc application of SOA technologies. Business agility must be purposefully designed into each organization's Enterprise Architecture, IT Governance, and IT Policy framework and implemented incrementally with each step tied to delivered business value. Agency CIO's and government-wide policy must ensure that this formalized, structured approach is incorporated into agency SOA implementations and evaluated through Assessment Frameworks.

### ***Vision: Improving Services from Federal Agencies***

This practical guide is organized around three perspectives of service orientation that together enable the effective adoption of SOA into a federal organization. For each of these perspectives, we characterize the objectives of a mature SOA capability. These are the objectives that each federal organization adopting SOA should strive to achieve in order to achieve its maximum benefits.

**Service Oriented Enterprise (SOE)** consists of the organizational and managerial practices needed to enable and govern SOA. SOE establishes trust and includes the incentive model that drives mutually profitable collaboration among service providers and consumers.

**Service Oriented Architecture (SOA)** is the body of standard design and engineering processes, tools, and best practices that leverage the modularity and composability of services to support business objectives. SOA deepens and extends the Enterprise Architecture and defines the implementation of the architecture in terms of its technical approach.

**Service Oriented Infrastructure (SOI)** is a collection of functioning capability, including technology, standards, and collaborative processes that enable safe (i.e., secure and private) and efficient collaboration through the development and deployment of shared operational IT services. SOI decreases the risk of security and privacy breaches by implementing standardized infrastructure components and services.

### **Keys to Federal SOA Implementation**

There are critical strategies and tactics that have been demonstrated to be effective at facilitating SOA adoption. In general, the intention is to de-couple the business objectives from the complexity of the IT infrastructure by developing a target service-based business model. Then, a services architecture needs to be developed with the specific objective of aligning program and project based DME (development, modernization, enhancement) funding to incrementally re-capitalize IT assets against the most critical business drivers, as well as encourage planned or immediate reuse of emerging or existing services rather than making duplicative investments. Early on, the challenge has been to balance the incremental demands on program and project teams – delivering for their immediate customers as well as the requirements of the broader enterprise. Later on, the objective is to balance the inter-twined dependencies - requirements, service levels, and funding models to name a few - in a way that results in increased organizational agility and improved mission performance. Both require strong leadership and effective governance.

<b>Keys to Implementing the Service Oriented Enterprise</b>
<b>Ensure IT planning and acquisition processes capture service reuse and funding requirements and target architecture technology constraints.</b> Build alignment into the SDLC so it is automatic.
<b>Identify enterprise requirements and organize around target services, standards, and information sharing that support key mission performance objectives; then fund accordingly.</b>
<b>Develop incrementally.</b> Employ an incremental “lifecycle recapitalization” approach and modify the SDLC to support a twin-track development process with separation between service provisioners and solution assemblers.
<b>Federate governance, engineering, and procurement.</b> Leverage existing agency and cross-agency governance processes to support the Federal E-Government initiatives, LOB initiatives, and other initiatives such as NIEM to enhance SOA implementations.

<b>Keys to Implementing the Service Oriented Architecture</b>
<b>Identify critical business objectives.</b> Perform business process analysis and reengineering and sustain accurate service-based business models for business automation requirements.
<b>Identify and define the target service architecture.</b> Establish a layered service architecture that directly supports the business performance objectives. Introduce “service” as a first order concept in your enterprise architecture. Integrate existing and emerging cross Government and cross agency services, ideally driven out of agency segment architecture activities.
<b>Enable and empower autonomous compliance and alignment.</b> Define and publicize the enterprise service portfolio plan and phased transition strategy. Note that this works best where you have the most detailed roadmaps, thus start with the core mission or business activities, or cross cutting services where you have developed segment architectures.
<b>Adopt model-driven architecture and pattern based design.</b> Establish model-based reference architectures and reference implementations. Start by bridging from segment to specific solution architectures.

<b>Keys to Implementing the Service Oriented Infrastructure</b>
<b>Establish a service oriented infrastructure that addresses security/privacy, scalability, and interoperability.</b> In particular, leverage secure virtualization approaches to clearly separate the shared security, transport, storage, and compute capabilities from individual services and solutions.
<b>Study critical transactions to develop a trust and semantic model.</b> Invest to develop standard government security services; test and certify adaptively and continuously. In particular, look to align with and adopt existing and emerging cross Government solutions, and improve them as needed via established governance models. Isolated agency-based solutions, no matter how good, run the risk of impeding downstream cross Government interoperability.
<b>Introduce run time service monitoring tools.</b> This includes monitoring and management across all relevant targeted attributes – security, privacy, reliability, serviceability, and availability. This is another area where it is important to align with and adopt existing and emerging cross Government approaches to ensure that creation of artificial boundaries for sharing, reuse, and interoperability are avoided.
<b>Establish performance-based service levels and service level management processes and cost and performance accounting processes to facilitate the effective sharing of services.</b> Look to express these service level agreements in shared, Government-wide structured IT policy frameworks.

### ***Roadmap for Federal SOA Implementation***

The purpose of a roadmap is to establish direction, identify the contributing factors (or work areas), and determine the specific steps to undertake within each of these areas. The first step in any roadmap is to perform an assessment – an evaluation of how SOA can be an enabler to help an organization to achieve its goals or implement its strategies. The assessment should examine organizational strengths, weaknesses, and actuators in context with the opportunities associated with SOA.

**Apply a relatively generic SOA Maturity Model** that outlines the stages of maturity through which organizations go to implement and operate a Service Oriented Architecture.

**Conduct a sound Maturity Assessment** to determine the organization’s level of maturity in relation to each SOA contributing factor. Consider governance, service orientation, technology environment, management commitment and perspective, technical skills, and capabilities.

**Evaluate existing agency governance processes** and agency participation in Government wide and other external governance processes, in light of the results of the Maturity Assessment and determine adjustments that are necessary to encourage and support Service Orientation.

**Begin or advance SOA implementation** to identify priority areas based on the SOA maturity assessment and balance achievements in each of the work areas.

**Define an incremental, sequenced approach to agency implementation** to deliver frequent, small, but visible successes and to capture and exploit best practices.

Implementing the recommendations contained in this Practical Guide will initiate a “journey” within the Federal government towards greater effectiveness and efficiency for both IT and the business/mission. The result of this journey will be an enhanced degree of responsiveness to the citizens and an improved ability to respond quickly to new requirements and situations.

## Contributors

A collaborative partnership exists between the Federal Chief Information Officers Council (FCIOC) Architecture and Infrastructure Committee (AIC) Services and Governance Subcommittees and the Office of Management and Budget (OMB) Federal Enterprise Architecture Program Management Office (FEA-PMO). With the support of the American Council for Technology's Industry Advisory Council (ACT/IAC) work on the PGFSOA began around December 2006.

This document was produced by a team of dedicated individuals led by the Service Subcommittee and the Governance Subcommittee of the Architecture and Infrastructure Committee (AIC) of the Federal Chief Information Officer Council in conjunction with the American Council for Technology/Industry Advisory Council's Enterprise Architecture Shared Interest Group (EA SIG).

Over 50 volunteers representing government and industry contributed to the collaboration that produced the PGFSOA Version 1.0 Public Draft. An external review was conducted on this first release throughout March 2008 and elicited over 300 comments. Subsequent versions of the PGFSOA will be published periodically from a Wiki that allows the public to advance the guidance with the latest best practices. You are invited to help refine and improve the PGFSOA by participating through the Wiki, <http://smw.osera.gov/pgfsoa>.

The AIC is grateful for the collaboration of these many talented originators and review contributors.

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## Section 1: Introduction

The world is changing at an accelerating rate and the federal government needs to keep pace. Broad-based change is always difficult, but the federal government is plagued by a variety of inhibitors to change, including vertical vs. mission organizational orientation; bureaucratic culture; budgetary cycles and processes that do not facilitate agility or reuse; and a large and diverse current technology base. Service Oriented Architecture (SOA) promises to help agencies rapidly reconfigure their business and more easily position IT resources to serve it. Improved business agility – through sharing and reuse of infrastructure, services, information, and solutions - is a growing requirement in the federal government today and will be increasingly critical in the future.

The purpose of this document is to describe a target federal service oriented architecture vision and to provide guidance in the management and governance of enterprise-wide services. Many federal organizations are considering or planning for a broad based adoption of SOA. In order to effectively move to an SOA environment, an organization must conduct careful planning and assessments for a variety of organizational, architectural, and technological challenges.

With recent advances in federal enterprise architecture, federal chief architects and chief information officers have a deeper insight into their current IT architectures at all levels of government. In most organizations, this visibility has exposed many inefficiencies and undesirable redundancies, as well as disconnect between the promise and the reality of technology for improving business outcomes. In turn, this has led to a variety of consolidation initiatives and reengineering efforts at all levels of the federal government. The most widely publicized and recognizable are those government-wide initiatives compiled into the annually published Federal Transformation Framework (FTF) from the Office of Management and Budget (OMB) [OMB, 2006].

While the FTF is concerned with cross-agency initiatives which leverage reuse efficiencies and improved organizational performance, agencies themselves are faced with similar internal challenges. Recognizing this concern, as well as others, OMB published the Federal Enterprise Architecture (FEA) Practice Guidance [OMB, 2007b] that introduces Segment and Solution Architectures and their relationships with Enterprise Architecture (EA) through a notional framework (see Figure 1-3 of the FEA Practice Guidance document). The Solution Architecture is equivalent to an IT system that is reconciled to the Segment Architecture. The FEA Practice Guidance strongly indicates that Segment and Solution Architectures inherit their structure, policies and standards and re-usable and sharable solutions from the Enterprise Architecture. This is directly aligned with the direction of Service Oriented Architecture.

Just as industry has adopted SOA best practices, it stands to reason that federal organizations will turn to SOA best practices to optimize their IT and business architectures. SOA is not just a technology to be leveraged; it is a true paradigm shift and requires substantial organizational, cultural and management changes to be effective.

**This Practical Guide to Federal Service Oriented Architecture has been written to help federal chief architects and chief information officers in their efforts to adopt SOA best practices to further their organizations' mission outcomes, meet increasingly demanding compliance requirements, and optimize their IT architectures.** There are other drivers for federal government adoption of SOA. To fully appreciate the potential of SOA for furthering federal government agencies' missions, some understanding of SOA's origin and subsequent evolution is helpful.

### SOA Concepts

Like most technological advances, SOA leverages the technologies and standards that preceded

it. Chief among the technology events that led to SOA are the rise of the Internet and the emergence of effective distributed computing platforms, such as Java 2 Enterprise Edition (J2EE), Microsoft .NET, and XML. For a discussion of the evolution of technologies leading to SOA, see the Federal CIO Council publication, *Services and Components Based Architecture (SCBA)* [CIOC, 2006].

The term “Service Oriented Architecture” was widely adopted when the World Wide Web Consortium (W3C) established standards for integrating business systems over the Internet through the standardized use of web technologies and protocols. The standards developed were designed to enable heterogeneous distributed systems to interoperate through standard web-based conventions modeled to support distributed component architectures. Many standards have been adopted by standards bodies in support of SOA. Some of the early standards included Web Service Definition Language (WSDL) and Simple Object Access Protocol (SOAP). These Web Service standards enabled businesses to automate collaboration over web-based technologies in a standard way. This in turn has facilitated the movement toward a focus on services and their ability to transform the delivery of business capabilities.

As commercial organizations and IT product vendors embraced these web service standards, the meaning of SOA evolved. Vendors in the IT space, using creative marketing to differentiate their offerings, adopted different perspectives and terminology to promote their strategies and products. At the time of this publication, federal government CIOs and chief architects are inundated by differing perspectives and definitions of SOA.

Some of the technology disciplines and products currently accepted as falling under the SOA umbrella include: Business Process Management, Enterprise Service Buses (see for example [Chappell, 2004]), Repositories and Registries, Composite Applications, and Component-Based Architectures [Spratt, 1999]. One of the purposes of this document is to clarify the many related concepts and technologies that fall under the SOA umbrella.

It is also widely accepted that service-based principles can be applied more broadly, even outside the scope of IT, to business architectures in general. It is important then for federal executives to come together around a common definition for SOA. For the purposes of this Practical Guide, we will adopt the Organization for the Advancement of Structured Information Standards (OASIS) definition for SOA presented in Exhibit 1-1.

The OASIS definition does not relegate SOA to IT architectures, but allows the broader interpretation that SOA can be applied to business architectures as well. This is particularly useful in understanding why **SOA is the best available paradigm for achieving many federal Enterprise Architecture goals and objectives**. In this Guide, we accept the broader interpretation of SOA as a business transformation paradigm. In order to achieve this broader promise of SOA, the organizational, architectural, and technical dimensions must be managed carefully, synchronized across boundaries, and focused on key business outcomes.

This broader view of SOA establishes the importance of a common definition for service. Therefore, for purposes of this Practical Guide, we use the OASIS standard definition of service:

#### Exhibit 1-1: SOA Definition



"Let's start at the beginning. This is a football. These are the yard markers. I'm the coach. You are the players." -- Vince Lombardi

*"Service Oriented Architecture is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains."*

Ref: OASIS SOA Reference Model version 1.0 IOASIS.

***“The means by which the needs of a consumer are brought together with the capabilities of a provider.”***

For a moment, ignore technology and consider that the majority of the US gross domestic product (GDP) is based on a “service model.” A service model is an approach to doing business that allows a task to be defined so that it can be accomplished by others. The details of the service provided should be transparent to the consumer; hence, a consumer finds a provider, chooses among service options, requests the service, and the desired service is provided within the terms of some agreement. Consider how many services a business operates. A marketing method introduces customers to service offerings and a supply chain composes an arrangement among various interoperating service providers (inventory management, transportation, legal, fiscal, artisan, etc.) to deliver the offering.

**Exhibit 1-2: Government Service Unit**



It is useful to view government organizations from the service perspective. The “government service unit” depicted in Exhibit 1-2 could represent an organization at any level (i.e., department, agency, bureau, program, division) or could represent a collaboration initiative that includes multiple government organizations. For the purpose of this document, we define a Government Service Unit as:

***A useful organization of government resources (staff, facilities, automated systems, etc.) viewed in a service perspective.***

**Exhibit 1-3: Service Consumer and Service Provider**

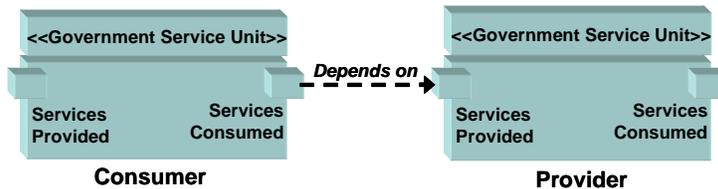


Exhibit 1-3 depicts two government service units in this consumer provider relationship. **The service model applies to the services the federal government offers to its constituencies.** The service

model is apparent within the Federal Enterprise Architecture (FEA) Business Reference Model and the Service Component Reference Model that the Office of Management and Budget (OMB) has established as the overarching framework for understanding the business of the US federal government [OMB, 2007a]. In particular, the relationship between the Business Reference Model and the Service Component Reference Model helps agencies begin to define their specific service model as a combination of business and technology services. The service model is the core vehicle to drive SOA adoption and implementation. This guide will navigate chief information officers and chief architects through the development and implementation of their “service model” by providing guidance for identifying, classifying, and organizing their services. This guide also prepares an organization’s IT leadership for transitioning to the service model.

The potential benefits that SOA can deliver to the federal government are far reaching and substantial, but they require significant change within federal government organizations and carry with them some inherent risks. The primary challenges for SOA arise when its application is not effectively governed with purposeful intent. The business agility that SOA promises is not

achieved through ad hoc application of SOA technologies. Rather, business agility must be purposefully designed into each organization's Enterprise Architecture, carefully governed and managed to ensure its incremental realization.

## SOA Challenges

The process of reconciling the Enterprise Architecture's IT services portfolio, both intra-agency and cross-agency, frequently results in conflict when two or more programs have an interest in a given service type. Conflict is, in part, due to a lack of an enterprise-wide SOA framework and may be grouped into at least four major challenge categories (politics aside):

1. Lack of an operational or target model for federal enterprise-wide SOA environment;
2. Lack of understanding and experience in implementing SOA at the agency/department-level;
3. Lack of procedures/guidance for consuming enterprise services in lieu of local services; and
4. Lack of operational services management; particularly for cross-agency services once implemented.

A key characteristic of SOA is modularity that facilitates/enables service reuse across processes and organizational boundaries. A service that is designated for reuse or as an enterprise service, such as authentication, must reside in an environment that is discoverable, reliable, maintainable, and can be monitored. An overarching architecture is needed to contain these services as they are developed and implemented. Further complicating this is the need to support service reuse at multiple levels – between programs, between bureaus, between departments, and so on. This challenge is addressed in Section 3.

The discipline of enterprise-wide SOA is immature in the federal government. For example, for any large federal organization, reuse of services across processes and between contractors is rare. While organizations may have a "repository" that is used (like a library) to check services in and out, it often fails to support a true SOA model. As a result, training and mentoring are needed to fully leverage the benefits of SOA within and across the enterprises.

The third challenge that creates conflict has two dimensions. The first dimension concerns the consequences of promoting a locally developed service up to an enterprise-wide or cross-agency level. Often, there are no procedures and/or compensation for the development of the service that is to be used by two or more entities. Related to this are the issues of quality of service (QoS) obligations of the original developer as consumption of the service increases (for example, as the service designed to support 100 transactions per second now needs to support 10,000 transactions per second) and the functional responsibility for the service (i.e., who is responsible for implementing changes to critical business rules of the service).

The second dimension concerns the reality "after the fact" that stand-alone SOA-based systems have been implemented and are in development. Should these systems be required to adopt the declared enterprise-wide services as an outcome of the organization's Enterprise Architecture, even though the services may not meet 100% of the requirements? This challenge is addressed in Sections 4 and 5.

The fourth challenge is associated with business management of services, including QoS standards and Service Level Agreements (SLAs). This challenge can be illustrated by analogy. Networks are closely monitored in "War Rooms" with banks of screens to monitor network performance. As the network experiences performance problems, engineers can quickly respond and in most cases resolve the issue before the problem cascades throughout the network. Returning to services, which are implemented within and across enterprises, the performance of each service and the interaction between services also needs to be monitored to ensure the

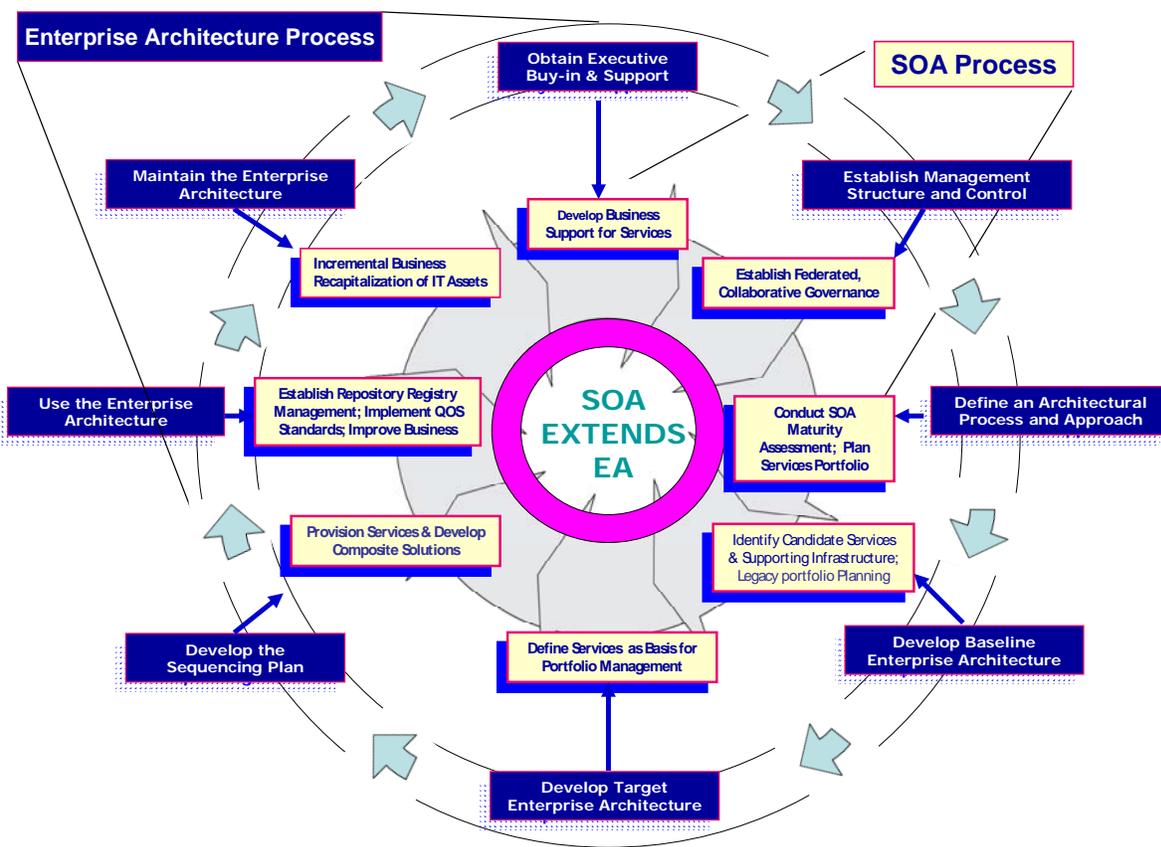
business output and outcomes are achieved.

## SOA and Enterprise Architecture

SOA does not replace EA. As depicted in Exhibit 1-4, Enterprise Architecture encompasses SOA. This diagram builds on the lifecycle diagram from the Practical Guide to Federal Enterprise Architecture [CIOC, 2001]. At each stage in the EA lifecycle, a set of activities is conducted to service-orient the EA. While the activities noted on the inner circle of the diagram are not intended to be exhaustive, they do indicate the types of activities organizations must undertake to implement SOA. These activities are discussed throughout this document with explanations and examples of how to accomplish the tasks.

The first stage of the EA lifecycle is “Obtain Executive Buy-In and Support.” For SOA, this aspect is extremely important. Adopting SOA should be considered a major change management initiative and requires executive support for transitioning an agency to a service-based organization. As we discuss in the document, this requires changes at three levels: enterprise (organizational management), architecture and infrastructure. If executive buy-in is not obtained, it will be nearly impossible to successfully adopt SOA.

Exhibit 1-4: SOA Best Practices Extend EA



In the second EA stage - “Establish Management Structure and Control”, the management structure and processes must be modified to enable a “Federated, Collaborative Governance” model. In order to achieve the benefits from SOA, services will be provided and consumed across organizational (internal and external) boundaries. As a result, the governance model

must be capable of guiding and adjudicating issues across organizations, thus requiring the need for a federated, collaborative governance model.

Under the third stage of EA - "Define an Architectural Process and Approach", the EA methodology is updated to incorporate services by conducting an SOA Maturity Assessment and developing a roadmap plan. In addition, the architectural artifacts are augmented with a Services Portfolio Plan which lays out the approach for identifying and grouping services within the EA.

The fourth stage of EA - "Develop Baseline Enterprise Architecture" is modified to begin to identify services in the current systems environment and to determine whether the current infrastructure platform is capable of supporting SOA. During this stage, the EA team begins to develop the Legacy Portfolio Plan which analyzes legacy applications for services/capabilities provided so that the best sources for services can be identified.

In the fifth stage - "Develop Target Enterprise Architecture", a major shift occurs. In this shift, services instead of applications are used as the unit for portfolio management. While conceptually simple, this shift has profound implications. Only by managing a portfolio of services, is the enterprise architect able to identify the opportunities for sharing and reuse, or alternatively, to identify redundancy of capabilities.

The sixth stage - "Develop the Sequencing Plan" is updated to incorporate the provisioning of services from internal development, outsourcing, or commercial sources, as well as the development of composite solutions, assembled from services. The sequencing or transition plan now indicates the sequence of developing or procuring of services so that they are available to be consumed in the applications as they are rolled out.

The next stage - "Use the Enterprise Architecture" is expanded to include managing the repository or registry of services so that they can be located, assessed and reused. In addition, Quality of Service (QoS) standards are implemented and maintained. The service oriented EA is used to improve the business and meet mission objectives.

Finally, during the "Maintain the EA" stage, the agility provided by the service oriented EA allows capabilities to be replaced with modern, more effective and efficient capabilities. In this way, the SOA is used to enable the incremental recapitalization of IT and business assets. Each of these enhancements to the EA is discussed in the following sections reinforcing the notion that SOA does not replace EA, it extends it.

## Organization of the Document

The sections of this document present a synthesis of best practices drawn from industry and government communities. Section 2 - The Rationale for Federal SOA, makes the case for adopting SOA. Section 3 - The Service Oriented Vision: the Target Architecture describes a target state or vision for a SOA enabled government. Section 4 - Keys to Federal SOA Implementation, presents some of the major factors that must be addressed and offers possible approaches and best practices that can be applied. The final section, Section 5 - A Roadmap for SOA Adoption, outlines a general SOA maturity model that can be used to assist agencies in organizing their implementation strategies and includes some activities that can be undertaken to advance SOA.

## Section 2: The Rationale for Federal SOA

As a result of significant increases in the need for government services that are effectively delivered, the growing threats to the country posed by terrorist organizations, requirements for increased information sharing and collaboration, and constrained agency budgets, agencies are under tremendous pressure to deliver higher levels of program performance through their information technology investments within tighter cost constraints. In particular, federal CIOs and chief architects who are responsible for a broad set of goals defined by the Federal Enterprise Architecture Program can realize the following spectrum of benefits for pursuing service orientation in their business, data sharing, and technology infrastructure transformations.

### Improve Government Responsiveness

SOA can enable agencies to better respond to the challenges they face. By employing services to isolate business functionality within architectures, the impact of changes can be mitigated, parallelism can be introduced to allow more change initiatives to proceed concurrently with shorter lifecycles, and IT investments can be better managed and measured to more effectively deliver mission/business value. Additional benefits include:

- Increasing the speed at which critical mission capabilities are added;
- Improving agencies' ability to rapidly respond to changing demands;
- Implementing more effective service and information discovery and reuse capabilities; and
- Offering new functionality for end users/citizens and produce better communication between citizenry and government.

#### Exhibit 2-1: Data Sharing and Standardization on the National Level

### Simplify Delivery of Enhanced Government Services

- Enable broader and more consistent access to data and information.
- Enhance the ability of agencies to more rapidly and effectively modernize their business processes and systems.
- Implement more effective models for the specification, procurement, and operating effectiveness of services.
- Manage shared value streams across government organizational boundaries to facilitate the delivery of common services to citizens.

N-DEx, the Law Enforcement National Data Exchange initiative, demonstrates the ability to share criminal justice data across local, tribal, regional, state, and federal lines. The initiative exhibits the SOA adoption benefits of cross agency information sharing and optimization from the use of standards such as the Global Justice XML Data Model and the National Information Exchange Model.

*[http://www.fbi.gov/hq/cjisd/ndex/ndex\\_home.htm](http://www.fbi.gov/hq/cjisd/ndex/ndex_home.htm), January 2008*

### Contribute to a More Efficient Government

- Find ways to collaboratively leverage public and private sector investments to innovate IT architecture and drive business and mission improvement.
- More effectively use the agency IT budget through the reuse of existing capabilities. More effective staff utilization through common training and modernization of skill sets.
- Foster consistency, discipline, and control through cross-domain governance of IT

Infrastructure development, and bridge the gap between business and IT stakeholders.

- Create cross-domain/cross-agency trust, data access, and semantic interoperability to enable an increased use of shared services.

## Promote Information Sharing

- Provide an effective, efficient and repeatable approach to implementing reusable data exchanges.
- Take logical interoperability coming from collaborative data modeling and architecture activities and turn it into physical, on-the-wire interoperability.

## Increased Transparency and Resilience

- Provide a shared, standards-based infrastructure.
- Enable consolidation, simplification, and optimization of IT Infrastructure for audit ability and continuity of operations, while maintaining appropriate levels of security.
- Support an effective integration approach to deal with the rationalization of the enterprise applications and diverse technology infrastructures.

To meet today's challenges, federal CIOs and chief architects must find new and more effective ways to develop, deploy and apply their IT assets. Implementation of SOA can provide federal CIOs and chief architects the environment and tools to more effectively deploy IT resources. There are many reasons federal organizations should embrace SOA today. Some of the reasons are technological and others are driven by recent changes in the federal IT environment, but the primary reason is that SOA has the potential to substantially improve the ability of federal organizations to execute their mission. The discussion below highlights the rationale for implementing SOA to achieve dramatic improvements in business outcomes.

### 2.1 Enhancing Mission Effectiveness

A variety of emergency situations in recent years has demonstrated the tragic consequences that can result from information overload or the inability or unwillingness of organizations to share information. Terrorist attacks, natural disasters, and large-scale and organized criminal incidents too often serve as case studies that reveal weaknesses in our nation's information sharing capabilities.

As a result, agencies are under tremendous pressure to collaborate across agencies, and levels of government, and share information to deliver higher levels of program performance. In addition to the program imperative to leverage existing process and technology capabilities, OMB is putting substantial pressure on agencies to reduce the costs of their IT portfolio and the redundancy in applications and infrastructure. With multiple competing demands for budget funds, it is critical that agencies make more effective use of IT dollars. Budget pressures are increasingly forcing agencies to improve their processes and technology to deliver higher value to their missions.

The ability to reuse capabilities and leverage infrastructure to support multiple application delivery initiatives is the most salient values of SOA and the one with the most potential for substantial gain. SOA can improve agency and overall federal mission performance by improving business agility and enhancing the ability to share capabilities effectively and securely. **The objective is better mission outcomes.**

CIOs and chief architects should validate the rationale that SOA helps achieve this objective by monitoring measures of effectiveness such as the following:

- Service level objectives (SLO) and associated service level agreements (SLA) built around

performance factors like latency, availability, response time and accuracy.

- Objectively quantified productivity metrics and associated mission level agreements (MLA) around performance factors like:
  - Decreasing time required to complete planning cycles
  - Decreasing inventory “at rest” in a supply chain
  - Increasing number of, quality of, and/or cost of “widgets” out the door.

## 2.2 Continuous Innovative IT Asset Re-capitalization

Two related and critical tasks of federal CIOs and IT architects are to operate and continuously evolve the organization’s IT assets. In government, this has traditionally meant sustaining a given type and level of capability over many years. The best practitioners of e-business utilize their resources more effectively by regularly refreshing their IT architecture. They use a combination of capital investment and operations and maintenance (O&M) funds to innovate, reconfigure and add new capabilities -- thus re-capitalizing the IT architecture to enhance enterprise capabilities. In traditional system-focused architecture, this technical refresh is an expensive big bang process where extensive and costly hardware and software upgrades are carefully designed and implemented across the enterprise over the course of multiple years.

SOA offers flexibility at several levels; ranging from a reduction in dependence on proprietary technologies, to a streamlining of the development process, to reusing both business and IT assets. Many commercial enterprises have adopted SOA as a means of breaking up inflexible IT infrastructures, which are usually characterized by monolithic customized applications. SOA enables an evolutionary, structured transition from monolithic applications to composite applications (i.e., applications that are composed from services) by allowing new capabilities to access legacy transactions that have been exposed as services. The composite applications exhibit greater agility and when requirements for the “exposed” service change, the service can be replaced by a newly developed or acquired service, also without major change to the underlying supporting infrastructure.

When a service oriented architecture is in place, incremental improvements to business and IT services (i.e., IT-enabled business process enhancements) can be deployed rapidly and as part of independent, parallel efforts across the enterprise. Trial enhancements can be evaluated and adopted or passed over in the course of months or weeks. This approach enables agile business process innovation by drastically reducing the time and cost it takes to experiment with and deploy better solutions. In addition, SOA enables the “pre-testing” of services and business processes which contributes to reduced implementation time.

Hence, from a business perspective, the overarching Federal Enterprise Architecture guidance to exploit SOA should result in an increase in the relative percentage of the IT budget that can be applied to improving critical business processes by reducing the cost and scope of the changes, as well as to decrease the cycle time to implement improvements.

Note that for a given enterprise requirement, it does not generally cost less to deploy the infrastructure to support SOA than it costs to deploy a system-focused infrastructure. However, once deployed, the service oriented architecture lends itself to more agile and adaptive updating, as well as reuse by multiple service components. This can drive down the long-term cost of the IT architecture; releasing funds for either higher priority mission/business needs or to enhance the IT asset base. This also allows a gradual migration to service orientation at a relatively low investment cost per year (recognizing that governance, culture, roles, portfolio, and other issues must also be addressed). It should be noted that during the migration process (which will most likely be years) it will be necessary to support the existing and the SOA environments. Additionally, it can take a long time to migrate COTS products to the SOA environment. In many cases it will be necessary to wait for the product owner to incorporate the necessary functionality. The organization must be prepared to fund both environments for a considerable length of time.

The rationale described above has been successfully applied by many commercial businesses, including Internet portals like Google, as well as “back end” applications of businesses in many domains (financial, health, manufacturing, logistics, etc.). Top down “model based” methods of architecting applications have contributed to this success [Juneja, 2007]. This model-based approach allows enterprises to analyze the business transactions that are critical to their desired business outcomes in a way that is separate from the IT infrastructure. Enterprises can then compose their required IT capability improvements from the best of breed off the shelf technology and/or identify critical technology gaps to address.

Any organization today that relies on software will find SOA capabilities and features embedded in the software products they use. For example, a purchase of the latest release of any commercial enterprise resource planning (ERP) product will include an enterprise service bus (ESB) designed to enable SOA. The leading integrated development environments (IDEs) include features that simplify and automate the design, development and publication of services. Java and XML are ubiquitous on the Internet and in shrink wrapped software. Whether or not an organization chooses to adopt SOA, the number of services in place will nonetheless increase each time an agency purchases or installs the latest version of a software product. The critical question is whether it will expand haphazardly, or expand in a planned manner as a key enabler of the enterprise strategy defined within the Enterprise Architecture. Some measures of effectiveness (MOE) to support this rationale are:

- Increase in the percentage of the IT budget available for expanded business capabilities.
- Decrease in the cycle time from the management approval to the implementation of an IT-enabled business process improvement.
- Increase the availability of reusable services deployed by one program or project and used by others.
- Increase in the ratio of funds spent on shared services to developing unique IT capabilities within individual programs or projects.

## **2.3 Cross-Domain/Agency Trust, Data Access, and Semantic Interoperability**

The ability to provide the right information and service, in the right context, securely, and at the right time is the overarching objective of any IT architecture. Achieving this objective requires increased collaboration across domains. Differences in perspective, priorities, semantics (i.e., the “language” of a particular domain) as well as concerns over security make collaboration across domains inherently difficult. Programming machines to collaborate in view of these issues is just as difficult.

SOA offers significant improvements in this collaborative model across both an agency’s IT architecture as well as between disparate architectures. SOA makes it feasible to implement reusable services for security, discovery, and business contexts that can be shared collaboratively within and across communities of interest. On the one hand, these collaborative services can allow information providers to deliver information from the authoritative source to all potential consumers of the information. On the other hand, proper security controls can permit or deny consumers access to data and services based on multi-level security and risk factors.

Federal CIOs and chief architects can apply this SOA rationale specifically to the enterprise concerns of their agency or to specific architectural segments to deliver IT capabilities that add collaborative value. Federal CIOs and IT architects should carefully devise and track measures of effectiveness, such as the following, to validate the collaborative value of SOA:

- The percentage of data and services discoverable in context.
- Presence of risk/reward models governing access to data and service.
- Volume of cross-domain data exchange.

- Percentage of exchanged data to total data accessed/managed (by type and volume-weighted).
- Number of unintended disclosures of sensitive information.
- Amount of downtime due to “denial of service” attacks.

## **2.4 Leveraging IT Investments across Federal Agencies and Sharing Best Practices**

Agencies are increasingly pressured to increase the effectiveness of their IT spending and to drive efficiencies in the use of their IT assets. In order to more effectively leverage IT assets, the federal government should take better advantage of the scope and cumulative nature of its IT expenditures to achieve commodity pricing and improved quality of service. Individual agencies, and in many cases, sub-components of Cabinet-level agencies procure software, hardware and IT support services separately.

The Office of Management and Budget (OMB), through the Federal Enterprise Architecture (FEA), the GSA SmartBuy Initiative and the Line of Business Initiatives, intends to identify and share the “best pricing” obtained across departments and in some cases across governments.

SOA can enable an agile, modular IT environment where business process delivery is separated from the technology, and where security and semantic models allow enhanced collaboration. It follows then that SOA can enhance cross-agency acquisition efficiency through the re-use of capabilities and best practices that are easily identified, shared and adopted in such an environment. Multiple agencies can pool their resources and spread the costs and risks to address common requirements.

Note that this secure, modular, interoperable, collaborative IT environment, i.e., federal service-oriented enterprise, does not yet exist. Therefore CIOs and IT architects may validate this “re-use” rationale for SOA by monitoring measures of effectiveness or maturity such as the following:

- Increase in the percentage of dollars leveraged across federal lines of business for common IT capabilities can help validate that reuse is occurring. One would expect to see this measure increase year over year.
- Increase in the number of processes, incentives, and resources for collaborative IT architecture that exist across the federal IT professional community.

## Section 3: Service Oriented Vision - The Target Architecture



"Begin with the end in mind"

-- Steven Covey's *"Seven Habits of Highly Effective People"*

This section presents a vision of the future when the benefits described in the previous section have been achieved. The vision presented here presumes that the IT-enabled business improvement required to embrace SOA has already been largely achieved throughout the Federal Government. As such, this Service Oriented Vision presents an idealistic future that has been extrapolated from an understanding of today's promising technologies, standards, and best practices and an assumption that they will mature and converge -- ultimately enabled by automated tool sets.

The service oriented vision described here sets the stage for the subsequent sections by describing the objectives, behaviors, and outcomes that federal architects should strive for. The Target Architecture we ultimately seek to achieve provides the necessary context for understanding the subsequent sections. The SOA Adoption Roadmap presented in Section 5 is a roadmap to achieve this vision. The Keys to Implementation presented in Section 4 identify critical success factors and challenges that organizations

need to address to realize this vision.

While "target architecture" notionally represents the end point in the evolution (that is, time independent), in reality the target will need to evolve to keep pace with the rampant technological innovation of our time. So take heed, this section of the document, this vision, will become stale over time. Chief architects and CIOs should keep abreast of both enterprise objectives and technology trends and then work together to periodically revise their organizations' target architectures. On the bright side, because SOA enables agility and innovation, as agencies mature their SOA capability, they will find they can more rapidly progress toward their target architecture.

### The Federal SOA Vision

The SOA vision is that federal agencies become more agile from a management, operational and acquisition perspective by employing a "service model" with continuously improved automation support. For example, an agency that has achieved the Target Architecture would exhibit the following characteristics:

- IT responds more rapidly to meet the demands of changing business and mission needs.
- Government organizations routinely organize into ad hoc partnerships to automate collaboration models.
- Government can more easily and effectively recapitalize IT components to leverage the latest commercial technology capabilities and reuse standard government and industry solutions and services.
- Government services are easier to access, deliver higher value, and extend across organizational boundaries.

As the Target Architecture is adopted throughout the federal government and these

characteristics are manifested within bureaus, agencies, and departments, we can expect to see streamlined lines of business, more robust and useful end-to-end services, and new government capabilities converge to deliver more effective mission fulfillment. But the vision extends far beyond an isolated federal government. These same characteristics will be leveraged to adopt industry domain standards and will engender more extensive collaboration with business, state and local government, and international partners.

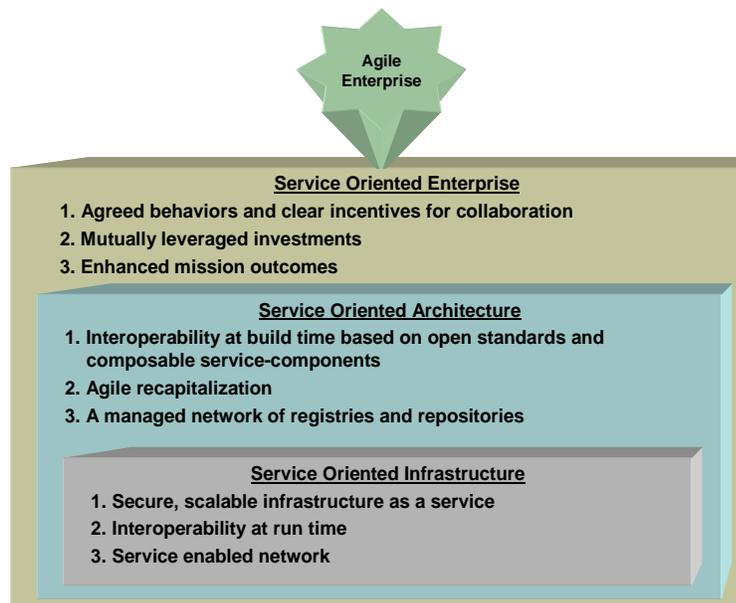
The next section provides a top-level overview of the Target Architecture.

## Overview of the Target Architecture

Because there are many interdependent aspects to the target agile enterprise, we will divide the discussion into three major parts (see Exhibit 3-1):

- **Service Oriented Enterprise (SOE):** The business, management, and operational processes, procedures, and policies that support a services model. In essence this is an organizational behavior model aligned with the service model and designed to facilitate and govern its effective maturation.
- **Service Oriented Architecture (SOA):** Enhanced architecture practices that leverage robust models to capture and facilitate service architecture engineering best practices. SOA is the application of the service model from EA through segment architectures to solution architectures.
- **Service Oriented Infrastructure (SOI):** The service-enabling environment, itself delivered as a collection of robust enterprise services that enable runtime connectivity and interoperability. SOI represents the operational environment that supports the service model.

**Exhibit 3-1: A Service Oriented Framework**



SOE enables the service model by facilitating shared acquisition models, incorporating architectural alternatives in the decision process, and enabling effective collaboration across boundaries. SOE also governs the SOA and SOI activities ensuring that justifiable business drivers support IT investments and deliver intended results. SOA is an architectural style that uses modularity to decouple technical complexity from the business drivers. The run time service-oriented environment that constitutes SOI supports the implementation, deployment, and manageability of delivered service oriented solutions. These three major parts are integrated and mutually supportive.

Because the Target Architecture is forward looking, it has been derived by envisioning today's emerging SOA related best practices and technologies in a more mature state; then imagining an organization that has fully embraced and adopted the service oriented model. This section presents the best practices and technologies that are projected to advance and enable the SOA

vision presented here. These best practices and technologies have been organized in a table (Exhibit 3-2) that includes a brief description of each, a statement of how it supports the vision, at least one reference for more information, and examples of specific related standards or initiatives.

**Exhibit 3-2: Target Architecture Best Practices and Technologies**

Best Practice or Technology	Description	Relevance to SOA Vision	Reference	Example Standards and Initiatives
Business Process Management (BPM)	An approach to improving business performance.	Enables agile business process orchestration and service choreography.	<a href="#">OMG BPMI</a>	BPMN, BPXML, BPEL
Model Driven Architecture (MDA)	OMG best practice for architecting solutions.	Enables complex IT architectures and solutions to be precisely represented in simplified forms. Many of today's integrated development environments products incorporate MDA capabilities.	<a href="#">OMG MDA</a>	UML, XMI
Composite Applications	Unified solutions assembled from heterogeneous systems under different custodianship (e.g., different software product vendors).	Enables collaboration and extended value chains.	<a href="#">Open Service Oriented Architecture</a>	BPEL4WS, WSCI
Enterprise Service Bus (ESB)	Leverages industry standards to provide a robust integration and operational infrastructure that supports the integration, operation, and management of heterogeneous, distributed computing systems.	Provides a service oriented infrastructure that enables SOA infrastructure.		Sonic, BEA, IBM, Oracle, SAP, TIBCO, and many other vendors offer an ESB
Semantic Interoperability Standards	Models, frameworks, and standards for cross Community of Interest semantic interoperability.	Enables shared semantics to the extent needed for cross boundary information sharing and services.	<a href="http://www.niem.gov">www.niem.gov</a>	XML Schemas, OWL, NIEM
Enterprise Architecture	Governance and IT planning and management framework.	SOE concepts exist at the enterprise and segment architecture levels; SOA. SOI concepts come into play at the segment and solution architecture levels.	<a href="http://www.egov.gov">www.egov.gov</a> <a href="http://www.cio.gov">www.cio.gov</a>	Federal Enterprise Architecture and related CIO Council guidance

The following subsections provide additional insight into the Target Architecture Vision by examining SOE, SOA, and SOI in more detail.

### 3.1 Service-Oriented Enterprise (SOE)

SOE is perhaps the most challenging of the major parts of the Target Architecture because it requires the greatest change to entrenched business practices. Enterprise architecture, as a discipline, is designed to achieve efficiencies and mission enablement by standardization, optimization and collaboration across organizational boundaries. Service orientation is an approach to architecture that is particularly well-suited to achieve these objectives. SOE, discussed in this section, builds upon the foundation laid in the 2006 Federal CIO Council report, “Services and Components Based Architecture” [CIOC, 2006]. In particular, Section 3 of that report addresses the strategic, policy and organizational changes required for success with SOA. This document takes the discussion a step further by defining what the target environment will look like when the change has taken place. The primary objectives for SOE are described below:

- **Enhance Mission Focus:** The envisioned SOE will reduce redundancy and allow greater resources to be directed to achieving intended mission outcomes. Government transformation initiatives will result in more agile, policy-enabled, service-oriented organizations.
- **Increase Agility:** The envisioned SOE has established a clear line of sight for impact of IT investments on business outcomes. This enables informed executive decisions to be made more rapidly and with more confidence. The business of managing change has been formalized and is continuously exercised and improved. Portfolio management addresses both service-components and enabling business solutions. More parallel change initiatives can be carried out simultaneously without increased risk. Architectural considerations are prominent in investment decisions. Performance-based contracting has been enabled by a well-defined SOA. Standard enterprise SLAs, security models, and capabilities are leveraged across lines of business.
- **Increase Collaboration and Interdependency:** The envisioned SOE has enabled program funding to be pooled to support effective enterprise services that can be shared at lower cost and delivered at higher quality. The agency has met its responsibility to share data and is actively participating in appropriate Communities of Interest (CoI). Improved federated governance models reward initiatives that share resources and disallow undesired redundant investments. Dependable service delivery and standard trust models enable organizations to inter-operate with confidence. Consensus policies are established to manage the service life-cycle.

#### Exhibit 3-3: Reducing Data Duplication

NIEM, the National Information Exchange Model, is a partnership of the U.S. Department of Justice and the Department of Homeland Security. It is designed to support enterprise-wide information exchange standards and processes that can enable cross-agency collaboration. The NIEM exchange development methodology results in a common semantic understanding among participating organizations and data formatted in a semantically consistent manner. Agencies are challenged with responding to increasing demands for their services and are spending valuable time manually rekeying data into multiple systems. For example, Orange County, Florida, has reported that eliminating redundant entry of arrest information saves an estimated \$5 million to \$7 million per year. NIEM provides a means to eliminate data entry redundancy—freeing resources to perform more valuable services for the public.

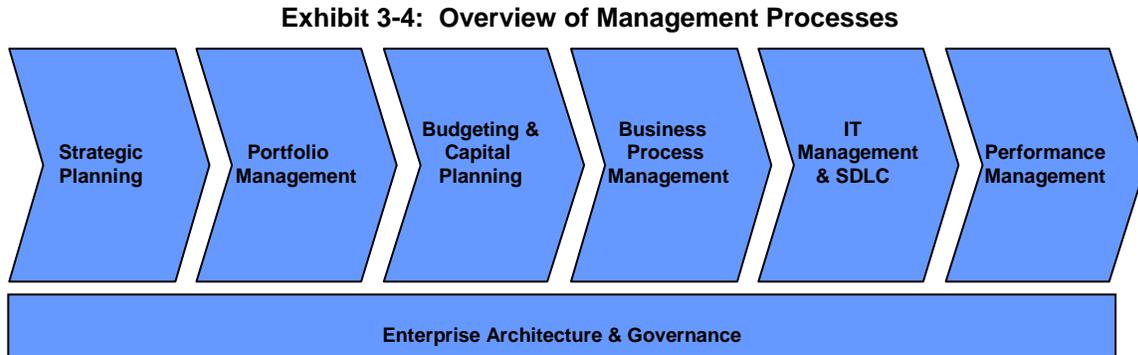
*Value of NIEM,*  
<http://www.niem.gov/topicIndex.php?topic=ValueOfNIEMPDE>, June 2007

**The National Information Exchange Model (NIEM) provides a glimpse of this future vision today. Driven by national security concerns in the wake of the terrorist activities of 2001, NIEM became a national priority, received requisite funding, and required the effective collaboration of many independent organizations. Today, NIEM serves as a leading example of a Service Oriented Enterprise. See Exhibit 3-3 for more information on NIEM.**

**To achieve these objectives federal government organizations need to behave differently. The desired organizational behavior is described below.**

### 3.1.1 Management, IT and Business are All Service Focused

Enterprise architecture has provided a broad-based movement throughout the federal government to bring strategic planning, portfolio management, budgeting and capital planning, business process management, and IT management together to achieve the vision of “architect, invest, implement”. Exhibit 3-4 below shows a notional value chain for how these processes fit together.



Given the rapid maturation of federal organizations EA capabilities it is not difficult to imagine a time when federal organization EAs produce well-represented target architectures that define the strategic direction for the organization in terms of service capabilities supported by transition plans for migrating to the target architecture.

As these service-based target architectures, and plans improve and visibility into these plans increases, opportunities for efficiencies and sharing will manifest more clearly. As a result, Federal agencies will exhibit the following characteristics:

- Software-as-a-service (SaaS) will become a well established federal business model. Many services will be hosted under software-as-a-service contracts with vendors or other agencies.
- Portfolio management will become more focused and agile. Portfolio assessment will focus more on performance outcomes, service levels, integration with other services, and support for planned transformation initiatives.
- Performance measurement (PRM) will be enabled because the service architecture and will provide a clear line of sight from business value chains through the business capabilities, technology capabilities, and operational capabilities that support them. This will simplify the development of more accurate business cases.

### 3.1.2 Sustaining SOE through Federated Governance

It should be apparent that the federal SOA environment is quite complex, dynamic, and large in scale, involving many actors (for example, business process stakeholders, IT consumers and producers, vendors, programs, bureaus, offices, agencies, communities of interest, other departments and multiple levels of government) residing at a variety of intra, inter, and extra organizational levels. They must all interface with a host of management processes (see Exhibit 3-4), while providing sustained business output and outcomes. SOA decreases the barriers to distributed and federated collaboration and the relative ease required to engineer links among disparate vertical service oriented domains, i.e., “federation”, enables less onerous approaches to governance.

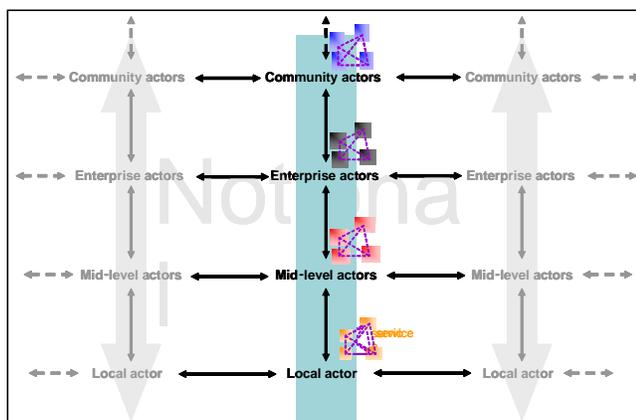
Because today’s government-wide policies increasingly require federal agencies to share services, it follows that a federated governance model is most appropriate to ensure that service consumer and provider needs are met across disparate organizational boundaries.

In the Introduction above, we identified several major challenges:

- Absent or ill-defined target federal SOA environment that is consistent with enterprise architecture activities;
- Lack of guidance to promote, demote, and retire services through multiple tiers of actors;
- Inadequate enterprise-wide and cross-enterprise management and monitoring of web services;
- A governance mechanism that facilitates the interaction and commitment of actors; and
- Funding processes that inhibit cross-domain, cross government collaboration.

These broad challenges reveal an underlying theme - interaction and essential, if not mandatory, participation of vested actors within and across multiple levels for common enterprise services as notionally illustrated in a SOA-centric view in Exhibit 3-5. Adding additional complexity is the relationship of business units and process “owners” such as the Communities of Interest (COI) with regards to direction and oversight of a particular service. As such, traditional IT governance archetypes tend to focus on one organization (there are of course exceptions) or while supporting complex organizations are themselves rudimentary. In any case, the relationships at each level for enterprise-services illustrated in Exhibit 3-5, will rapidly extend beyond the direct authority boundaries of the concerned organizations. In effect, the interactions at each layer are similar to a commercial alliance and taken altogether resemble a networked hierarchy or federation.

**Exhibit 3-5: Service Collaboration Relationships**



As we envision our target SOE, we expect to see standardized and proven bilateral and multi-

lateral governance models become available. These will mature to include:

- Standardized contract language to assist agencies to procure business and IT capabilities;
- Standardized service level metrics and agreements;
- Effective funding models to support shared services and shared infrastructure;
- Procedures for holding service providers accountable for SLA terms; and
- Portfolio Management models that focus on collaboration around common business and IT services.

Additional information on federated governance can be found in *Section 4 - Keys to Implementation*.

### **3.1.3 Model Based Acquisition Processes**

Model based acquisition processes will leverage modeling standards and best practices to provide more accurate descriptions of organizational requirements in solicitations. In conjunction with service based target architectures, organizations will be able to substantially reduce the effort required to define their requirements and, because the requirements will be more precise and understandable, perhaps even testable, they will mitigate downstream risks of selecting vendors and contractors that do not sufficiently meet their needs. Model-based acquisition processes will also remove much of the guesswork for vendors and contractors, because the government's needs will be more clearly understood. Model based acquisition processes directly support the business agility and agile recapitalization benefits of SOA, and as a result, will yield improved mission performance.

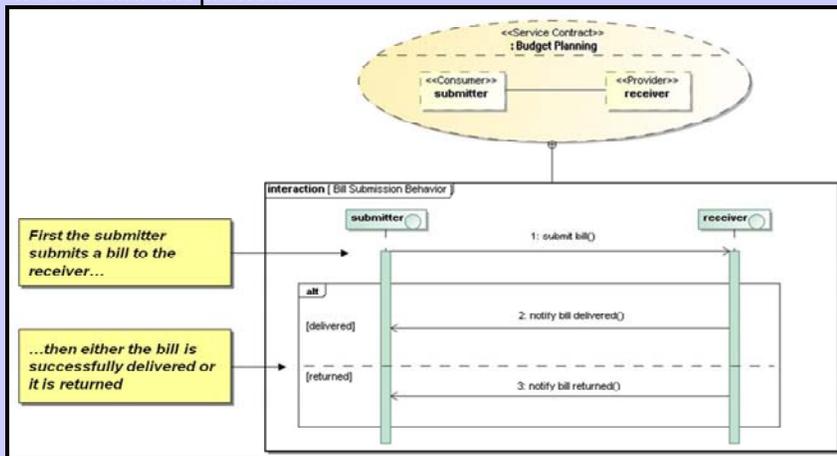
Model based acquisition processes leverage precise models developed in accordance with open modeling standards (e.g., UML, BPMN, and IDEF). Precise models reduce ambiguity, provide a more structured way to convey information, and lay the foundation for standardized patterns to evolve and be exploited. For a graphical depiction, see Exhibit 3-6: Modeling Service Orientations Example.

**Exhibit 3-6: Modeling Service Orientations Example**

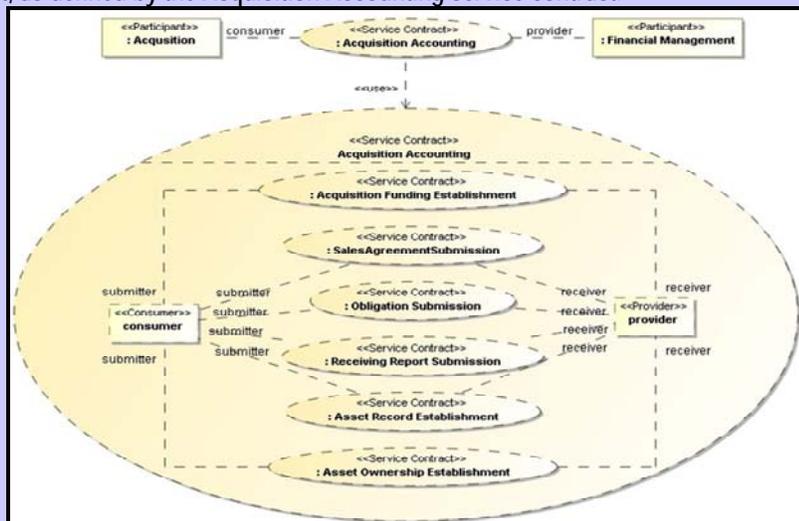
Organizations can use service orientation models to specify service behavior and provide a standardized method to communicate functionality. The service contract element can be used to demonstrate and visualize rules for how the service consumers and providers interact. Below is an example of a consumed Budget Planning service and a provided Acquisition Accounting service using UML.



Within each service contract, the behavior, message flow, and information exchange package can be defined. Below is an example of the Budget Planning contract definition of the interaction between the consumer and provider.



Service modeling can also be used to illustrate composite service contracts and how services can be bundled. Below is an example of a bundle of services provided by a Financial Management participant, as defined by the Acquisition Accounting service contract.



*E-Gov Institute / EA 2007 / PGFSOA / Tutorial Presentation, George Thomas, 2007*

### 3.2 Service Oriented Architecture (SOA)

The Service Oriented Architecture (SOA) is at the center of the Service Oriented Framework presented in Exhibit 3-1. The Service Oriented Infrastructure (SOI) is required to enable its operation and the Service Oriented Enterprise (SOE) is required to manage and govern it. The SOA is also the area in which federal chief architects and federal CIOs have the greatest ability to control the Target Architecture.

The three primary objectives for SOA are described below:

1. **Provide line of sight traceability from mission to implementation.** The envisioned SOA is driven by accurate, vetted business models. The business models are supported by a layered service architecture designed to automate and support the modeled business. Traceability is provided by tracking service dependencies.
2. **Deliver agile, executable architectures.** The layered service architecture is policy driven. Business policy is governed by the business; IT policy is governed by OCIO. The service portfolio is managed to increase and enable effective business and technology capability reuse. Architecture policy facilitates introduction of new technology capabilities, the use of 3rd party services, and the publication of services for external consumption. Recapitalization can and should occur for individual service components.
3. **Ensure semantic interoperability.** Semantic interoperability is achieved by employing standard schema (or ontologies). These standard schemas are developed through data modeling methodologies to ensure that the data are complete and consistent. Schemas are published to the collaborating community by an authoritative source (e.g., government authority, standards body, or COI). Modifications to the schema must also be vetted through the governance processes established by the authoritative source. Self service, on-demand interoperability test environments are available for the collaborators. Automated test scenarios must be passed to deploy to operational environments.

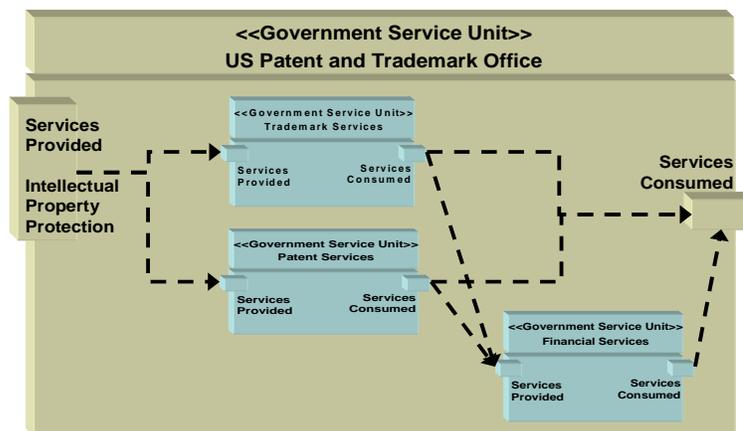
To achieve these objectives, federal government organizations will need to embrace SOA and change the processes they employ to manage and develop systems. The desired behavior is described in subsequent subsections, but before further discussion ensues, we should establish a reference framework.

### An SOA Reference Framework

According to the Organization for the Advancement of Structured Information Standards (OASIS) Reference Model for Service Oriented Architecture, "Service Oriented Architecture (SOA) is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. In SOA, services are the mechanism by which needs and capabilities are brought together."

Let's examine an example enterprise from the service

Exhibit 3-7: Sample Component Model for USPTO



perspective. Exhibit 3-7 shows a sample model of the US Patent and Trademark Office (USPTO). The exhibit shows that USPTO delivers Intellectual Property Protection services by delegating to either Trademark Services or Patent Services. Furthermore, it can be seen that both the patent and trademark service units consume financial services. While this example is an oversimplification, it highlights some useful characteristics of the service model. In this perspective, the USPTO responsibilities are clear. It delivers Intellectual Property Protection services by providing an effective environment for the three depicted government service units to collaborate. It also demonstrates the recursive nature of the service model. The service model applies at many different levels of granularity, from the largest federal government departments down to individual subsystems.

If we look inside a service oriented government service unit, we'd expect to see a service oriented architecture. By definition, that is an organized collection of distributed capabilities marshalled to effectively deliver higher order services.

**Exhibit 3-8: A SOA Reference Framework**

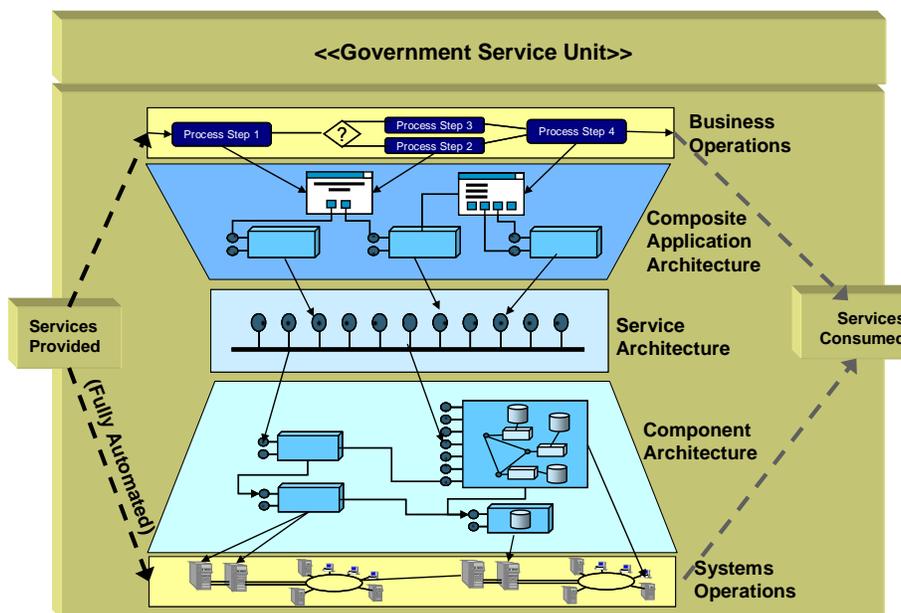


Exhibit 3-8 presents a straightforward reference framework for a service oriented architecture. The top layer, Business Operations, and the bottom layer, Systems Operations are the only two operating aspects of the business. The other layers reflect a service oriented approach to organizing (architecting and designing) capabilities to support the business. The Composite Application Architecture assembles and orchestrates services to fulfill business operations while the service architecture presents useful services for assembly. The component architecture employs resources to deliver the business services.

### 3.2.1 Federal SDLC and EA are Integrated and Support SOA

Federal System Development Life Cycles (SDLCs) will be expanded to support both the solution development life cycle and the service life cycle. This will enable the agile recapitalization model by supporting solution delivery and service provisioning teams to work concurrently and more independently than conventional systems project teams. The Target SOA and supporting transition plans, as defined within the EA, will guide integration activities throughout the SDLC. Teams will stay synchronized by aligning to configuration management controlled service specifications. Project release plans will demonstrate how individual teams are executing the

transition plans to converge on the target architecture. As projects progress through the SDLC, architecturally significant changes will be reflected in impacted EA work products.

With these changes in place, and once the operational service inventory grows, solution project teams will be able to rapidly deliver composite applications that better meet business needs, simplify business procedures, and enhance mission effectiveness because much of the technical complexity will now be the responsibility of the service provisioning teams. Solution delivery teams will be focused on providing intuitive user interfaces, stable business process orchestrations, and service choreographies; all developed in adherence to approved business semantic models.

Service provisioning teams will be responsible for delivering the services called for by the target architecture. They will provide the necessary services by incorporating legacy system capabilities, introducing 3rd party products and services, and through custom development where necessary. Furthermore, the service provisioning teams will ensure the consistency of data in disparate data stores and provide data aggregation services to the solution delivery teams.

### 3.2.2 SOA and Interoperability Will be Well Established

Communities of Interest (COIs) and Communities of Practice (CoPs) will use data modeling methodologies to develop standard semantic models (schema or ontologies) and approved choreographies. These semantic models will be established and changed only through a strong governance process. Each collaborator will have developed compliant services that map their business concepts to the community standards and fulfill their responsibilities in the collaboration. (See sidebar). These communities will comply with applicable Federal Reference Architectures (FRA). Proven reference implementations will be available for FRAs.

The Federal SOA Community of Practice (CoP) is an open community demonstrating the business value and technical feasibility of SOA. The CoP has begun a full life-cycle, multi-party SOA solution that demonstrates interoperability and involves multiple technologies collaborating via common standards. The solution engages two lines of business in separate organizations, and the SOA contracts between the lines of business allow for real time and high fidelity tracking of project costs across these organizational boundaries. In addition, other providers of either lines of business could be substituted - providing flexibility for multiple government hosted and commercially hosted line of business providers.

*<http://colab.cim3.net>, 2007*

### 3.2.3 Standard Federal Government Services Will Emerge

As collaboration spreads through the federal government, best of breed common infrastructure services will emerge. Adoption of some common services across the federal government will start with infrastructure services (e.g., authentication, auditing) but quickly expand to business utility services (e.g., federal employee lookup, simple approval process, calendar services, scheduling).

In particular, the security services required to enable basic collaboration and information sharing are already in demand. Fully compliant security best practices will be formalized and integrated into management processes, governance, and the SDLC, so that a formal definition of security requirements based on enterprise policy is specified in accordance with a standard federal model. Service registration discovery and delivery protocols that include requirements for Single-Sign-On (SSO) authentication, authorization, audit, confidentiality and integrity will be integrated into a standard federal government security service that can be delivered over a network.

Today, the IT Infrastructure Line of Business (ITI LoB) serves as the umbrella, a cross-agency initiative driving agencies toward a unified federal SOI.

### 3.2.4 Model Driven Architecture Will Be Embraced

As SOA, Business Process Management (BPM), and model driven architecture (MDA) converge, federal EA best practices will evolve to exploit them. MDA provides a set of guidelines for structuring specifications as standard models. Transformation techniques are then employed to enable automated generation of systems and services compliant with specified reference architectures.

As the convergence of MDA and BPM continues, it will enable the development of platform-independent models (PIM) expressed in domain specific languages to create executable business process models. BPM capabilities already provide the capability to design, simulate and test business services in business context before they are deployed.

## 3.3 Service-Oriented Infrastructure

The natural result of a Service Oriented Enterprise applying Service Oriented Architecture to enable its objectives is a functioning collection of services resting on a service-based platform. The platform is the Service Oriented Infrastructure (SOI) which provides more than just the communications environment that enables service-based integration. It also provides the capability to register, locate, and deploy services as well as monitor and manage the service architecture.

The objectives for the envisioned SOI are described below:

- 1. Provide a secure, reliable, resilient infrastructure.** The envisioned SOI provides a reliable, flexible, policy driven platform to enable the target SOA. SOI services are centrally managed and used consistently in support of cross domain integration. A standards-based security/trust and semantic model enables trusted delivery of valuable information between organizations. Resilience capabilities are designed into the infrastructure (e.g., COOP, IOI, COG).
- 2. Operate to Quality of Service (QoS) needs.** The envisioned SOI will provide one or more inter-operating environments that support the full range of enterprise QoS needs within a reasonable budget.
- 3. Automate service development, deployment, and operations management.** Service lifecycle runtime tools and platforms are mature and established in federal agencies.

To achieve these objectives, federal organizations will need to change their current development and operations practices. The desired behavior is described below.

### 3.3.1 Service Management is Coordinated Throughout the Federal Government

Service registries (and/or repositories) will be organized and coordinated so that service consumers can identify and locate candidate reusable services. Service registry/repository management will have to mature as an important aspect of the configuration management and operations disciplines. Processes will be developed to allow useful services to be promoted so that they are available across a broader scope. Either central management or sophisticated protocols will be established to enable the varied collaborative environments to be coordinated. The registries will provide sufficient information for consumers to determine whether a service will fulfill their requirements.

Adaptive embedded testing and certification will enable agencies to deploy and consume service based capability with confidence and federated registries will enable registered services

to be identified across the entire federal government.

### **3.3.2 Increased Collaboration with 3<sup>rd</sup> Parties**

Federal IT infrastructure will comply with SOA standards to enable federal government business partners and collaborators to interact with agencies in real time. As service best practices are adopted, the government will be able to extend their value chains to their partners including State, Local and International governments, business partners, associations, and citizens themselves. One example of this currently under development is the Nationwide Health Information Network, which defines a set of common services to be used by both public and private sector organizations to exchange electronic health record data with trusted partners.

The envisioned SOIs will be inter-operable, efficient, secure, robust, modular, composable platforms for service execution. When broadly adopted and mature the envisioned SOI will support the following:

- Standard, composable middleware adapters (e.g., JBI, SCA and their successors) as the primary means of automated integration across organizations;
- Infrastructure services and adapters to dynamically enforce policy for security, interoperability, and quality of service;
- A set of fully compliant security-based services will intrinsically support solutions. For example the SOI will provide solution architectures with standard services that provide: single sign-on, access control, identity management, and consolidated user profiles; and
- Scalable Federal IT infrastructure.

### **3.3.3 Toolsets to Manage the SOI**

The envisioned SOI will be supported with robust development, deployment, and operations management tools including:

- Service Registries and/or repositories to manage the service lifecycle and service meta data;
- Service management tools to monitor SLA compliance and security breaches and anomalies;
- Message translation accelerators (e.g., for XML);
- Application, service, and business monitoring tools;
- Modeling tools;
- Testing tools;
- Activity logs that log each invocation of a service; and
- Tools to implement policy enforcement.

## Section 4: Keys to Federal SOA Implementation

As previously discussed, the primary objectives of a federal SOA are to:

- Improve Federal agility – the ability of agencies and the federal government as a whole to rapidly respond to new and unforeseen circumstances as a consistent and inter-operable enterprise;
- Simplify the delivery of government services; and
- Improve the efficiency of government.

This section highlights some keys to implementing SOA within a federal government organization. Each key highlights an area that warrants consideration by a chief architect. The chief architect should assess each of the “Keys to Implementation” presented to determine its applicability to their organization. For those that are applicable, the architect should ensure that their agency’s SOA strategy effectively addresses the identified issues.

We recommend that an agency develop a service oriented architecture by first determining its business objectives. Once these are determined, the agency should map them to enable business and technological components to be organized in a layered service architecture keeping in mind the following principles:

- Define mission critical business objectives and design the business processes to achieve those objectives. From there, determine what services best support those processes;
- Establish these services as a primary aspect of your enterprise target architecture; and
- Leverage change management best practices and proactive governance techniques to reorganize IT delivery around these services.

The full benefits of SOA will be realized when the organization is positioned to incrementally replace its IT assets in line with its most critical business objectives. In effect, the organization, through its SOA, creates the agility necessary to rapidly re-focus its IT investments as business objectives change.

The keys to implementation presented here are organized along the same perspectives defined in the Target Architecture section: SOE, SOA, and SOI.

### 4.1 Keys to Implementing the Service-Oriented Enterprise

Establishing the service-oriented enterprise is perhaps the most difficult aspect of SOA because it challenges many of the conventional business practices employed today. This section highlights key enterprise changes necessary to enable the benefits from SOA.

#### 4.1.1 Treat SOA Adoption as an Organizational Change Initiative

The experience of the past few decades has shown that organizational change is difficult. For it to succeed, several critical factors must be in place:

- There must be a compelling reason to adopt the change. That reason must be effectively articulated within the organization;
- The executive leadership of the organization must be solidly behind the change initiative;

- It must be treated seriously – create a program to oversee and manage its rollout - stakeholder objections must be addressed, etc.;
- For a cross-cutting initiative such as SOA, often a central coordinating group, or center of excellence (COE) is required; and
- Adequate resources to support the initiative must be allocated to sustain the change.

#### 4.1.2 Obtain Executive Support

Significant change initiatives require strong support from executive leadership. This typically only happens when there is a compelling need to make the change and the senior management of the organization understands the need and drives the change.

Many federal agencies are already at this point. Executive management understands the need for greater responsiveness – as delivered through increased agility – and is frustrated by the reliance on outdated, rigid software applications. SOA offers the opportunity to incrementally reengineer the agency to achieve the desired flexibility.

Change initiatives succeed when organizational passions are re-channeled to achieve well articulated goals consistent with those passions. Our advice is to downplay the SOA hype and buzzwords, and concentrate on the targeted business outcomes. Therefore, the task for senior management is to carefully define and articulate the goals and establish associated progress metrics that the rest of the organization can rally around.

More importantly, senior management must sustain this level of support for the duration necessary to support the change. The chief architect is responsible for demonstrating how to apply architectural best practices to achieve the desired business outcomes. Having a service oriented Target Architecture enables the chief architect to define and articulate individual business solutions that clearly address today's business challenges and business goals, while also incrementally enabling a strategic architectural vision.

##### **Critical Success Factors:**

- Understand today's business challenges.
- Conceive a service-oriented Target Architecture Vision for the enterprise.
- Effectively, but rapidly, model business objectives, processes, and information that support the Target Architecture.
- Architect and articulate solutions that solve today's business challenges, while at the same time advancing the Target Architecture vision. The use of a SOA Adoption Roadmap will allow informed investment decision-making so that funding to support an enterprise architecture enhanced by SOA is allocated according to a logical sequencing plan.

#### 4.1.3 Establish a Program Plan for SOA and Measure Results

Meaningful change requires a well thought out approach. Our recommendation is to treat SOA as a "program" – not in the sense of another stovepipe, but rather as a serious cross-organizational initiative – with a plan, a champion or manager, and defined results that can be measured. Specifically, the natural place for executive sponsorship is shared between the CIO and the mission or business owner associated with a specific high(est) priority initiative with

##### *Executive Support for Cultural Change*

Strong executive support from the National Resource Program Center Director, Team Lead and Enterprise Architecture group has promoted organizational and cultural changes that have successfully enabled the current SOA effort.

*Integrated Resource Management  
Applications (IRMA), National Park  
Service Case Study, 2007*

enterprise scope. The program manager or champion should be the chief architect or chief technology officer, depending on specifics of the individuals, the organization of the IT function, and the ongoing IT planning and architecture activities and functions that are to be leveraged. This last point is key; we are not recommending an additional freestanding planning and architecture activity, we are recommending leveraging existing activities – enhance and extend - and focusing them within the guidance of this document.

The establishment of a “program” entity does not reduce the power of collaboration at the individual organizational level that SOA facilitates, but it does help to provide strategic direction and focus to the SOA effort. We feel that the establishment of a program structure from the top, as described above, must be combined with the bottom-up efforts that are naturally occurring within the organization to insure an effective implementation. The focus of the program should be on enterprise and segment architecture, identifying and prioritizing services, and supporting governance activities that channel demand to reusable services.

The program should leverage and align existing activities such as enterprise architecture or technology test and evaluation laboratories. More importantly, the program should work with existing DME (development, modernization, enhancement) programs and projects for solution architecture and implementation activities.

A measurement strategy is an important component of any change management initiative, but is particularly important to the SOA implementation. We recommend that agencies use a goal-based measurement process that focuses on finding meaningful measures for monitoring the progress of SOA initiatives.

Generally, there are three tiers of performance analysis: project, program, and enterprise. The project objectives are to develop, integrate, and deploy useful services that solve real business problems. While developing these tiers, keep in mind the following guidance:

- Project performance outcomes are the inputs to program performance analysis.
- The program objectives are to enhance productivity and efficiency by evaluating, procuring, and managing services shared across projects.
- The program performance outcomes are the enterprise performance analysis inputs.
- The enterprise objectives are to enhance productivity and efficiency by evaluating, selecting, and controlling services shared across programs.

Agencies are constantly required to make IT investments to field new and better operational capabilities. Accordingly, they need meaningful metrics and benchmarks that allow them to monitor progress and make adjustments to ensure desired outcomes are achieved. A dashboard is a useful mechanism for presenting stakeholders a number of key indicators chosen to link SOA-enabled business and technology initiatives with business/mission performance targets.

#### **4.1.4 Establish an SOA Center of Excellence (COE) to Oversee Adoption**

For cross-organizational initiatives, a best practice is to establish a coordinating committee, or center of excellence (COE) of knowledgeable individuals from across the organization and augmented with experienced SOA practitioners. The purpose of the COE, which may be established within an agency’s existing EA program/governance structure (see Federated Governance discussion, below), is to set direction, draft policies, develop/adopt methods, and oversee the development/execution of the service portfolio plan. An additional purpose is to elicit participation and buy-in from the organizational and stakeholder components.

Across the Federal space, maturity with EA implies organizations have architecture review boards and subordinate architecture working groups. The recommendation is to use that framework where it exists and extend it explicitly to SOA and the related concepts in this

document. Further, agencies should be looking to participate in the AIC Services subcommittee, other like cross Federal organizations and entities, and external standards bodies to insure Government-wide alignment and adoption of external best practices.

#### **4.1.5 Appropriately Plan and Fund the Change Initiative**

In order to initiate and sustain any change initiative, sufficient on-going planning, funding and resource allocation must occur. Another challenge for an SOA-based implementation is funding the necessary infrastructure, which can represent a large expense that is not easily associated with a specific program. Organizations need to identify a means to align continuing enterprise infrastructure funding with the needs of the SOA implementation. Given the scope and importance of the targeted initiative, it is reasonable to build these incremental costs into its business case. The amount of funding necessary depends on the maturity of the organization, its strategy for implementing SOA and its overall objectives. In addition, while highlighting the full cost via an integrated business case, it is important to capture the benefits as outlined elsewhere in this document.

For more mature organizations, SOA reuse and agility result in cost savings. Organizations need to plan proactively to identify and harvest the savings – for reinvestment in additional SOA capabilities, to enable additional mission or business performance improvements, or to reallocate resources outside IT. A significant integration of SOA into an agency environment can take a long time. It may be years before the point of cost savings through reusable services can be reached. Once it is reached, savings can grow exponentially.

Our recommendation is to highlight the full scope of costs and benefits by leveraging the agency EA through segment architectures. This approach will highlight overall opportunities for reuse, information sharing, reduced duplication, and overall cost effectiveness as well as clearly delineate the full spectrum of investments required and how they interrelate. It will produce a full and proactive picture of the federated governance structures required, and how they relate to existing governance bodies and processes. Perhaps most importantly, by leveraging natural partitions evident via the architecture, the implementation challenges can be decomposed into a smaller number of lower risk steps that form a natural roadmap to the target outcomes.

#### **4.1.6 Build Community Processes and Collaborative Platforms**

Many of the benefits of SOA are derived from sharing – sharing information, sharing business processes, sharing reference architectures, and sharing services. As a result, a mechanism must be put into place to enable the collaboration that is necessary to establish standards for sharing. One potentially effective mechanism for collaboration in the federal government is the Community of Interest (COI) model where participants from a particular domain (horizontal or vertical) come together with sufficient resources to establish the basis for sharing. The typical issues dealt with include semantics, standards for exchange, platforms, etc. To be successful, a COI must have a governance mechanism, sufficient funding, and portfolio management oversight, and must provide a collaborative environment for authorized users. The COI should also have defined operating processes, including a process for resolving conflicts and arriving at collaborative decisions. This process may include agreements based on consensus, a majority vote of the members, or other procedures that are agreed to by the members.

#### **4.1.7 Establish Federated Governance**

Effective governance recognizes that it is not just about control, policing, and enforcement functions – it is also about providing essential services. Likewise, governance has jurisdictional boundaries, both within programs, at the enterprise level, and beyond. For this document, we adopt the following definition of (IT) governance: “Specifying the decision rights and accountability framework to encourage desirable behavior in the use of IT.” [Weill, 2004] Agencies must clearly establish governance charters, statements of scope, and areas of

responsibility for specific organizational elements within the governance structure. In Section 3, the need for SOA governance was established and specifically the need for federated SOA governance. What does a federated governance model look like and how is it different from a non-federated model?

Weill and Ross [Weill, 2004, p.61] define federated IT governance as "...coordinated decision making involving both the center [central authority] and the business units," suggesting a two tiered vertical model that shares power in some manner. However, this concise definition does not accurately convey the principles of federalism based on a multi-tiered environment (see Exhibit 3-5). Within the context of the federal government, federated governance deals with semi-autonomous, but interconnected, organizations (at multiple levels) coordinating their efforts through a centralized mechanism.

To be effective, the central authority should have the capabilities to effectively carry out the responsibilities delegated to it by the federation. This includes overseeing the establishment of standards and resolving conflicts, and providing the necessary resources, including funding and staff, to effectively operate. While the members of the federation retain their individual program authorities, they give up some control to the centralized authority to create the shared value that each seeks through the federation.

At this point, the discussion has focused on actor relationships or management of the SOA environment. What technical aspects of the SOA need to be governed in a federated environment? The provider/consumer model introduced in the beginning of this document provides insight. The provider's lifecycle involves service development consisting of these primary phases: requirements, design, implement, publish, manage/service, and retire. The consumer's lifecycle is concerned with the manage/service phase of the provider's lifecycle and includes: discovery, binding, using, and ending with disassociation. Within these two lifecycles, specific aspects of the SOA lifecycle would concern governance with respect to two or more actors and across multiple tiers. These include, but are not limited to:

- Service requirements to include performance metrics
- Service design specifically with respect to standards (i.e., interoperability)
- Service versioning
- Service funding
- Service stewardship
- Service elevation to enterprise-wide services
- Service compensation for elevated services
- Service monitoring and diagnosis
- Service registration
- Service publishing
- Service discovery
- Service consumption
- Service security (i.e., trust channel mechanisms).

Also of concern is the governance of federal SOA infrastructure (i.e., SOI) where enterprise-services, at any level, may reside. These may initially be hosted by an agency specific COE, but will evolve to a federated COE due to the joint requirements of the participants. These include, but are not limited to:

- Federated SOA funding

- Federated SOA requirements
- Federated SOA design
- Federated service repository
- Federated monitoring and diagnosis
- Federated SOA security
- Federated consumption.

Federated governance includes the agreed upon incentives and rules of behavior among peers that enable collaboration to occur across related domains. We offer the following suggestions for creating and leveraging federated governance:

- Turn enterprise business/operational service level objectives into measures of effectiveness and associated mission level agreements, business/mission level agreements, and/or service level agreements. Use these to provide incentives instead of “mandates” wherever possible. Rigorously enforce compliance with the agreements.
- Adopt commercial open standards and provide implementation guidance in the form of well documented reference implementations of those standards.
- Develop a funded forum for representatives of all stakeholders to weigh in on architecture, process, and requirement development and prioritization.
- Establish agreements (MOUs) to define and enable value-based interaction among the participants in the community. The US DoD Cross-domain Information Exchange Framework (CIEF) is an example that can be employed to define the terms of the agreements.
- Balance enterprise concerns with program level objectives.
- Establish overall service operational scope objectives within and across enterprises and gain executive support.
- Guarantee enterprise service levels to program adopters and indemnify risk associated with using services provided by others.
- Employ enterprise architecture tools and artifacts to identify significant information exchanges across domains of interest.

From a practical standpoint, it is recommended that existing governance structures be leveraged whenever possible. For example, one alternative might be to leverage the existing e-Gov and LOB initiative communities. In general, we only recommend establishing new governance organizations when there is currently no existing governing body to absorb the new responsibilities.

#### **4.1.8 Provide Communities of Interest (COI) with Sufficient Funding**

The most successful communities of interest are those with the delegated authority to accomplish change and the means by which to do so. In most cases, this means having access to sufficient funding to operate effectively. Having access to the necessary budget to implement the services, solutions, or other enablers can make all the difference.

Different communities will require different COI models; however it is likely that different COI models will evolve for different patterns of collaboration. For now, we recommend that agencies examine successful COI models (such as the National Information Exchange Model – NIEM – and the Gov Benefits E-Gov initiative) and that principal stakeholders be required to invest

commensurate with the expected value of their return.

The investments should be used to design, specify, and develop shared services, create service certification capabilities, or to accomplish the objectives of the COI. Coupled with enforceable Service Level Agreements (SLA) that incorporate objective service delivery metrics, this will establish the service value exchange that has been lacking in previous cross-agency collaborative efforts. To facilitate this, it is recommended that organizations develop an enforceable SLA model. (Note - not all stakeholders are equal. For constituencies whose participation is valuable or even vital but their return from participation is negligible, the barriers for entry must be made as low as possible.)

#### 4.1.9 Create a Services Development, Test, and Evaluation (DT&E) Laboratory

An SOA laboratory for collaborative DT&E, i.e., a federal community SOA space, is a combined design time, build time, and run time environment with the following characteristics:

- Community brokerage to reconcile requirements and expertise across organizations.
- A collaborative, distributed, service-oriented build time development environment.
- A secure, shared, service-oriented runtime test environment where prototype capability bundles can be adaptively verified and validated against common government requirements.
- A legal and intellectual property rights (IPR) regime to support open technology development (OTD).

##### *Open Testing through the GIGlite Lab*

The World Wide Consortium for the Grid Institute, chartered by the Office of Secretary of Defense, provides an open "GIGlite" on-line laboratory that supports collaborative SOA Development, Testing and Evaluation (DT&E) of commercial and government off the shelf (COTS/GOTS) products. The environment is enabling the Department of Defense's Netcentric initiatives and provides adaptive validation and verification, security certification, service orientation, and "pre-approval" for other software initiatives developed for government purchase.

*www.w2cog.org, 2007*

Use this community SOA space as the natural place to satisfy enterprise requirements. In other words, the physical SOA framework needn't be restricted to just providing transport capabilities. It can also address broad enterprise requirements like information assurance, interoperability, test and evaluation, and information value chain management as well. While testing service performance in a federated environment is challenging within the Federal government, the benefits of a common testing capability for services are substantial.

#### 4.1.10 Establish Service Funding and Charging Mechanisms

Effective funding and charging mechanisms that provide incentives for appropriate behavior among service providers and consumers are critical success factors for SOA in the longer term.

Funding mechanisms deal with the investment required to acquire or provision services. In general, there are four types of service funding mechanisms: project, reciprocal arrangements, consortium, and central/corporate. While most organizations begin with a 'project-based funding' of services, project level investment usually leads to every program developing or acquiring its own business and infrastructure services built to its own specifications; thus

obviating most of the potential benefit at the enterprise or inter-enterprise level of SOA. This is an immature approach to implementing SOA and can lead to "service anarchy."

Reciprocal arrangements between projects have the same issues, but allow for some sharing of services on a bilateral basis. The consortium funding model aligns well with the COI recommendations above and includes the following:

- The investment is shared across the stakeholders of the COI;
- The model is appropriate for the provisioning of "core business services" for specific domains; and
- The model requires a very clear and articulate value proposition for all players, the involvement of motivated individuals, and extreme patience and discipline.

The central or corporate funding model is most appropriate for infrastructure or "utility" level services in the layered services architecture. In this case, the central authority (such as the OCIO) funds the development of services on behalf of the entire organization or community.

Charging mechanisms are a potentially viable funding model, but have yet to be proven in the federal arena. Charging mechanisms are methods to recoup the costs for shared services across multiple user communities. The three basic charging mechanisms are: no charge, flat fee and usage charges. Although not charging is often an initial strategy, particularly for centrally-provided utility services, over the long term, not charging does not provide the proper incentive to provision and upgrade such services. In the short term, however, not charging may be a desirable approach because fees act as a tax or disincentive for projects to consume shared services – the opposite of the desired behavior. Flat fees are easier to administer, but usage charges are the most equitable method of covering the cost of provisioning and maintaining services. Alternatives within the usage charge approach include volume discounts and charging early users and new adopters on a different basis.

Creating enabling services at the enterprise level therefore implies the need for some explicit budgeting above the individual program level and/or clear incentives to programs to make it worth their while to federate. Our recommendation is to adopt the mechanisms most appropriate for the program or enterprise given its stage of SOA maturity. As organizations become more mature, a portfolio of sharable services makes the decision of program managers to consume services easier. Eventually, as more programs contribute to the service portfolio, the model becomes self-sustaining.

#### **4.1.11 Use a Service-Based SDLC with Incremental Development Practices**

The service-based solution model is characterized by two primary roles: provider and consumer. Because the lifecycles, skills, and responsibilities for these two roles are significantly different, SOA methodologies separate the solution development lifecycle (SDLC) into two tracks (known as "twin track" development): service provisioning and solution assembly. An important step for agencies to take is to revise their SDLC to incorporate twin track development and recognize the different life cycles for services and (composite) applications.

SOA implementations are by design, continuously improving environments that deliberately feed on the innovation of the various participants. Therefore, SOA implementations should not be designed with a single deliverable and a firm deadline. That is, SOA should not be fielded as a traditional major acquisition program via a long waterfall process. Rather, it should be fielded as the service-oriented capability via the lifecycle maintenance model, i.e., as a continuous and innovative technology refresh. Lifecycle maintenance of a modern computer network requires incremental innovation on a time scale consistent with Moore's law and aimed at specific operational issues and opportunities.

Agencies should define their services environment as a major resource that is already in place

and that requires continuous improvement. The task is to enhance business agility through incremental re-capitalization. Think of SOA lifecycle maintenance as an innovative and evolving technology refresh rather than as a major acquisition.

#### 4.1.12 Practice Service-Based Procurement

Service-based procurement is the logical successor to the concept of incremental development and a service-oriented SDLC. While the current acquisition environment (based on the Federal Acquisition Regulations (FAR)) does not explicitly describe a service-based approach to procuring IT assets, we believe that all of the necessary acquisition steps required can be undertaken within the FAR framework. For example, the FAR does encourage procuring managed services in general when it is in the government's best interest. As discussed above, agencies should adopt policies that encourage vendor competition around service models. Accordingly, contract incentives and penalties should revolve around SLAs that address both the frequency of software capability refresh and associated target business outcomes.

Service-based procurement has the following elements:

**Procurement strategy:** Services form the basic building blocks for solutions and should be procured separately from the integration of the services into solutions. From the service portfolio plan, which identifies all of the required services within a particular domain or segment, services with a common purpose should be bundled into defined solutions that can be described within procurement packages. Because the IT industry is in the midst of a natural progression of increasing commoditization, this should be factored into the procurement strategy. For commoditized capabilities, service procurement should be largely focused on Commercial-Off-The-Shelf (COTS) products or third party services. Agencies should only invest to develop a specialized capability when commercial solutions are unable to meet current government requirements.

**Requirements statement:** Agencies should develop specifications for services based on use cases, desired outcomes, performance criteria, etc. Where applicable, agencies should reuse specifications and performance outcomes from industry, other programs, and other agencies. Requirements should be factored to reflect service types that already exist in industry or government. Specifications should not be over-engineered. Agencies should use test driven approaches to specification – define the tests that the successful service must pass and require vendors to demonstrate that their services pass the tests. Let the potential service providers innovate and compete around your use cases. Requirements should also address critical service management criteria such as quality of service adjustment over time, managing granularity, SLA auditing and transaction control with events, warnings and alert notification capabilities, policy enforcement, advanced security and authentication management capabilities.

**Government Furnished Equipment (GFE):** License agreements for acquired services should be defined to allow appropriate consumption of services across the federal government or the transfer of the underlying software component to other agencies acting as service providers. In this manner, services can be made available to programs/contracts as government furnished equipment. Reference architectures and implementations for domains/segments should be made publicly available to industry and incorporated into RFPs. SOA, within the context of FEA, can help the federal government identify the intended scope of use for products and services.

**Integration services:** Contract with a service-oriented systems integrator to integrate the services into business processes and composite applications. The integrator must possess the necessary skills to work within the agency's technical environment, including any middleware products, such as an enterprise service bus (ESB).

**Certification of services:** Establish a capability to test and certify services procured against the specifications and requirements of your technical environment and desired business

outcomes. Write these objective certification requirements into your RFPs, contract SLAs, and task orders. This can be accomplished through the Services Development, Test and Evaluation Laboratory discussed above.

**Services source selection board:** Include operational customers and representatives from independent industry expert bodies in addition to the representatives from the COI. This representation should be agreed upon by the COI members.

**Wrap legacy application transactions:** Agencies should contract with operations and maintenance contractors when they have determined requirements for the service and the legacy application is best able to meet the requirement for the relevant timeframe.

**Services management:** Agencies should consider contracting to provide services management, including configuration management, over the growing portfolio of services. Service execution management should include a real time monitoring capability (e.g., dashboard) similar to those used by network operation centers.

**Advance institutional knowledge and capture best practices:** While the draw of SOA as a software paradigm is undeniable, each agency will travel this path at a different speed. Some agencies will embrace the approach and move quickly down the path – encountering challenges and overcoming obstacles earlier than others will. The spirit of SOA is sharing – not just sharing services: agencies should devote the effort to document their lessons learned, abstract from implementations to reference architectures, document discoveries and patterns, and capture best practices (or at least practices that have worked).

Best practices are a set of actions that solve a problem critical to business success most often found within organizations that excel against business and mission objectives. The capture of a “best practice” is traditionally coupled with measuring via benchmarking. Benchmarking gauges performance against leaders and seeks to find and describe practices that most heavily contribute. Christopher Alexander, who originated the notion of patterns in the field of building (i.e., brick and mortar) architecture described patterns as a recurring solution to a common problem in a given context and system of forces [Alexander 1979].

By advocating and supporting the collection and dissemination of best practices and patterns, federal executives, architects, and developers can reduce the uncertainty and risk in determining when, where, and how to apply SOA. The Federal CIO Council and GSA have already created a vehicle for sharing best practices, services, architectures, templates and many other artifacts that can be used to give organizations a “jump start” in SOA. The Core.gov website is a collaboration environment designed to facilitate sharing and communication. Agencies should look to leverage this resource and in the spirit of sharing should contribute to it as well.

## Recommendations for Service Oriented Enterprise

- Treat SOA as a change initiative. It must have strong executive buy-in, adequate resources, organizational visibility and sustained support.
- Create a program plan with goals and objectives, and objective performance measures for the SOA initiative.
- Establish a Center of Excellence (COE) to guide and manage the SOA initiative.
- Adequately fund the COE and the SOA initiative.
- Develop and sustain appropriate and viable Communities of Interest (COI) to help facilitate the development and use of shared standards, platforms and semantics.
- Establish formal funding mechanisms to support the creation and delivery of services, coupled with appropriate charging mechanisms that are tied to service usage.

- Establish a Federated Governance structure that includes a charter defining organizational structure and relationships, scope of responsibility, rules of behavior, conflict resolution processes and the authority and structure of the COE.
- Adopt a twin-track SDLC that facilitates the incremental, innovative refresh of the IT assets on an on-going basis.
- Create and use a services development, test and evaluation laboratory to meet enterprise requirements.
- Adopt procurement policies and processes that encourage vendor competition around service models.

## 4.2 Keys to Implementing a Service Oriented Architecture

Enterprise architecture has evolved as a discipline to take a view across programs and organizations – both horizontally and vertically, and is maturing rapidly in most federal government organizations. As a result, federal agencies have new insight into value chain inefficiencies and undesirable redundancies.

At the same time, the Federal Enterprise Architecture is enabling government-wide consolidation and improvements, catalogued each year in the Federal Transformation Framework. The result is a need to interoperate and share information on a broader scope at every level of the Federal Government.

To achieve the benefits of service orientation, they must be purposefully designed into the enterprise target architecture. Depending on the maturity of the organization the enterprise architecture may still be evolving, but architectures at the business unit or line of business level may be in place and more mature. Regardless, it is important to extract a working service portfolio from the target architecture(s) in order to link services effectively to business requirements. Ultimately, the most effective target service portfolio plan will be derived from enterprise business models that are developed based on real business activities. The service portfolio plan identifies the enduring collection of services required to support the automation of your business/mission and, through this automation, ultimately improve business outcomes.

Once established, this enterprise service portfolio plan becomes the lynch pin of your SOA. The target service portfolio plan will:

- Decouple business operations from the underlying current technology architecture.
- Provide a holistic vision that can serve as the common context for all proposed IT solutions.
- Enable restructuring of your IT portfolio to include both solutions and services.
- Enable improved procurement practices and governance of outsourced IT capabilities.
- Drive the restructuring of your legacy portfolio to reduce the cost and risk associated with strategic undertakings such as outsourcing.

### 4.2.1 Use EA and SOA to Align with Business Objectives

Service-oriented architecture enables organizations to establish their context within complex value chains. Federal agencies should take an enterprise view of the value they provide to their constituencies – across programs or sub-organizations within their agencies, between agencies and often different levels of government, and at times between governments internationally. The provider/consumer model intrinsic to SOA allows each organization to focus on providing the services their constituents require while enabling them to request, with new clarity, the services they want.

### **Critical Success Factors:**

- Business models are developed jointly by the business operators and IT, but are maintained by IT to insure that they are integrated within the overall enterprise architecture.
- Up-to-date and accurate business models are maintained in your EA. Depth increases with maturity by incorporating detail required for each business solution.
- Business models become the primary means for communicating changing business requirements.

### **4.2.2 Introduce Services as a First-Order Concept in your EA**

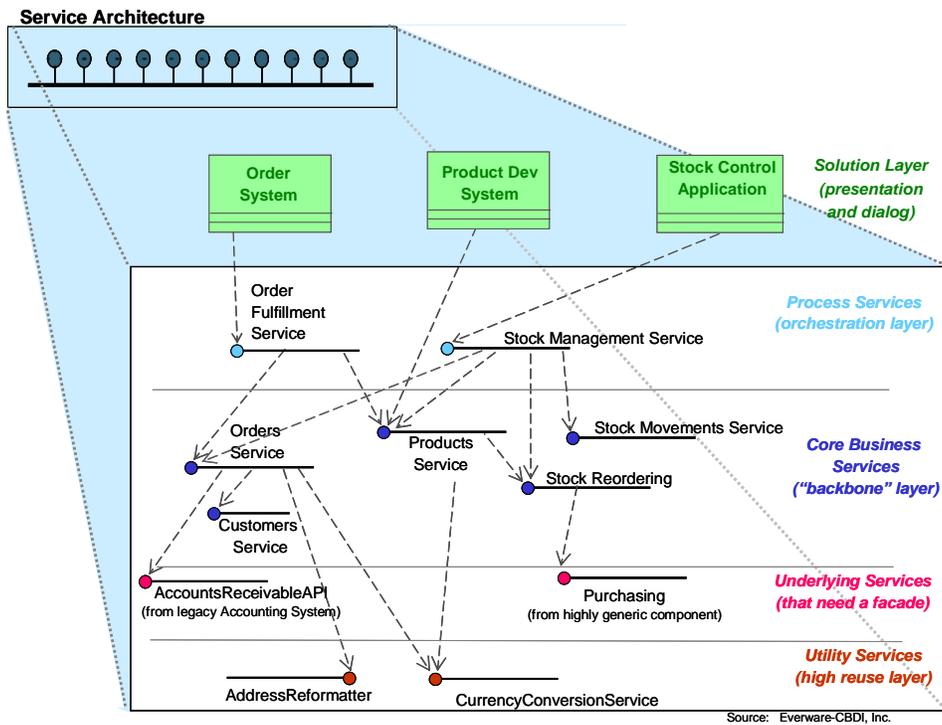
As described in the previous section (the Target), the EA Target Architecture for federal agencies should be based on service-oriented concepts and built out based upon business priorities. EA should drive the development of the portfolio of services; and, portfolio management should be based on services and solutions rather than on applications. By reorienting portfolio management to focus on the services and solutions, agencies can establish the enterprise foundation for service orientation.

An additional benefit from service based portfolio management is that the chief architect has a tool to rein in the multitude of disconnected SOA initiatives that have sprung up across many agencies. The service portfolio plan identifies the services needed to provide common capabilities across the agency and can be used to promote the collaboration that is necessary to implement enterprise services. The service portfolio plan also provides the basis for aligning these initiatives with the agency's EA.

### **4.2.3 Establish a Service-Based Target Architecture**

The target architecture should incorporate a layered services architecture like the one presented in Exhibit 4-1 below. Layered models are well understood among architects. A layered service model is used to define and constrain the dependencies between services and to identify the set of policies that apply to each service layer. The figure below shows that if we zoom in on the Service Architecture, we should see a layered service model that allows us to allocate services to specific layers, depending on their characteristics and intended use. The layered model shown below accommodates the following layers:

1. Underlying Layer used to bring in resource APIs and provide access to legacy systems.
2. Utility Layer for highly reused services (this may include enterprise services provided by a parent service unit).
3. Core Business Services to transform and access business information.
4. Process Services to orchestrate an assembly of lower order services.
5. Solution Layer that includes composite applications.

**Exhibit 4-1: Services Organized into Layers**

#### 4.2.4 Adopt Model-Based Architecture and Pattern-Based Design

A best practice in the architecture discipline is to establish or adopt reference architectures and reference implementations that can be used by project implementation teams to jump start their efforts. Commonly used architecture patterns are a form of the reference architecture and reference implementation.

- Pattern-based design incorporates both the concepts of reference architectures as well as model based approaches. Architecture patterns exist at the design, build and runtime levels of the architecture.
- Model-based architecture (also referred to as model driven architecture, or MDA, by the Object Management Group) is an approach to bridging the divide between business requirements and technical solutions. Similar to moving down the rows of the Zachman Framework (The Zachman Institute for Framework Advancement (ZIFA), <http://www.zifa.com>), it involves a progressively more detailed and specific set of models. These models range from the most abstract depiction of the business, to a functionally complete, but platform- independent model, to a platform-specific specification from which code can be generated.

The advantage of this approach is the linkage between the different levels and the automated mechanisms for moving from one level to the next. This provides traceability from the business requirements to the code and allows the impact of changes to be identified and managed. Combined with SOA which allows the impact of changes to be isolated to particular services, the model based approach holds great promise to enable flexibility in IT – the ability to quickly modify the code base necessary to implement new capabilities.

Agencies should begin to adopt model based approaches to application development and integrate them into their service based SDLC. As they mature this capability, they should

pursue pattern-based design techniques. However, the use of model based and pattern based design techniques should be closely linked to effective technical performance measures.

#### **4.2.5 Enable Automated Compliance and Alignment**

Many EA efforts in the federal government are focused on compliance. It is not uncommon for organizations to resort to after-the-fact efforts to demonstrate compliance with the EA so that program funds will be approved. Enforcing the many compliance requirements that EA programs demand is a growing challenge; the default approach is to rely on teams of experts charged with sifting through inconsistent and often incorrect development lifecycle documentation of hundreds of projects.

By adopting the SOA paradigm and the recommendations in this Guide, agencies should be able to use the EA to mitigate or even largely eliminate the compliance burden today's EA programs place on projects. Since the move to SOA is an evolutionary sequence of steps, each program step will either take the agency closer to the target architecture or away from it. By placing more emphasis on architecting the solution and by employing model-driven architecture best practices in conjunction with the service portfolio planning technique discussed above, project teams can be provided with technologically compliant reference architectures that have service reuse requirements embedded in them. In this way, the EA becomes a benefit to programs rather than a burden.

By using the portfolio approach described above, "core business services" can be developed for specific domains or verticals and "enterprise services" can be developed for common horizontal services. The Segment Architecture approach advocated by OMB is focused on this exact outcome of building out the EA incrementally in vertical and horizontal directions [OMB, 2007]. Developing services based on the service portfolio plan will ensure that the development efforts are automatically aligned with the EA and consistent with the principle of "architect, invest, implement" defined by OMB." As a result, programs will be consumers and potentially providers of multiple services across the enterprise.

#### **4.2.6 Leverage Legacy Assets to Enable Evolutionary Progress**

One of the main advantages of adopting SOA as a modernization approach is the fact that it is an incremental or evolutionary approach, rather than a wholesale replacement approach. In the more mature states, an advantage of SOA is the ability to rapidly innovate, that is to experiment with and then adopt new business processes, much faster and more cheaply than with traditional IT systems. The challenge is how to reach that mature state in government agencies where legacy systems are prevalent and tightly coupled with business processes, data, and rules that support critical business and mission capabilities.

Based on a services portfolio plan and with a clear understanding of your phased approach to achieving targeted incremental releases of capabilities, legacy assets must be assessed and factored into the analysis for service provisioning in each phase of the plan. In the early phases, there may be no choice: legacy transactions must be wrapped to expose the services. Over time, the four modernization alternatives—replace, consolidate, extend, and re-platform, should be considered for each legacy application. As an initial step, sharing can be achieved by wrapping legacy transactions with service interfaces, where practical. Then, examine service requirements over time to determine whether the wrapped transactions are able to meet future needs. Note that wrapped transactions are still subject to the rigidities of the underlying legacy application. Most applications have an inherent work flow definition; capture that first, then capture as many embedded business rules as possible.

Many legacy systems do not have clear architectural delineation among data, business logic, and user interface. You may need to re-factor portions of applications to expose them as services. Business rules (logic) are typically embedded in the code and are not externalized to

a separate component such as a business rules engine. Many use older generation database technologies such as hierarchical, networked, or file-based, where there is a lot of data redundancy, and little inherent documentation. Some legacy systems are too old and/or complex to be fully understood and therefore when the services are developed on top of such systems, rigidity, slow performance or maintenance problems may result.

Legacy assets are key components of the existing enterprise architecture that can demonstrably add value to the enterprise's strategic objectives. Consider the following advice.

- Reuse existing and still relevant business rules. Use an analysis tool to better understand legacy systems and harvest these rules. Consider the several approaches to decoupling data from business logic and user interface in legacy systems:
- For a large or complex application, use discovery tools that facilitate identification of business rules, business processes, and flows. Use tools to perform re-factoring of legacy code to decouple and minimize the risk of developing "rogue" services.
- Use, if necessary, the alternative of custom adapters that interface with the legacy code. Use ESB adapters to access legacy code.
- As a last resort, consider using standards such as Database Access Integration Services (DAIS) to access data in a database directly as a service [EPRI, 2001].

Top down and bottom up approaches should be used when producing services from legacy systems. Combine both approaches, balancing what the business needs with what the current IT organization is able to support. In the top-down approach, business processes and their flows drive what services are required that can be satisfied by legacy systems and how these services should be orchestrated. Allow business users or their counterparts in IT to drive this approach because of their familiarity with particular business domains. In the bottom-up approach, available services are identified by mining legacy applications and then determining what business processes are feasible to orchestrate. IT personnel should drive this approach.

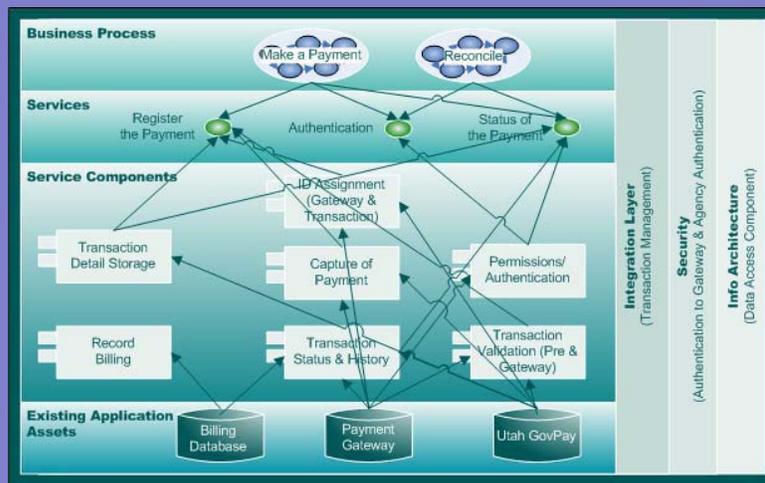
As services proliferate, ensure the utilization of adequate governance criteria in order to maximize the reuse of developed services without compromising security and efficiency. Applying and implementing governance from the beginning will pay rich dividends as the SOA efforts and consequently the service assets grow.

## Recommendations for Service Oriented Architecture

- Develop, in collaboration with business units and IT, business models that help to align the EA with business objectives.
- Develop an EA Target Architecture that is service based and focused on business priorities.
- Based on the service-based Target Architecture, develop investment portfolios that are founded on services and solutions focused on fulfilling key business objectives.
- Establish or adopt reference architectures and reference implementations that can be used by project implementation teams to jump start their SOA efforts.
- Use the EA artifacts and the database of information developed during the EA process to mitigate the compliance burden placed on projects.
- Assess all legacy assets in terms of their relationship to Target Architecture objectives, and factor this analysis into decisions for how to provision each service.

*Leveraging Legacy Systems*

The State of Utah's use of the GovPay payment processing solution on State agency web sites provides an example of the application of Utah's SOA reference models and the leveraging of legacy systems. The Utah GovPay Web Processing Service (WPS) provides a secure method to pass customer transaction information and has two main functions: registering transactions and querying transactions. In the registration process, the agency's Web application sends the transaction data to WPS and WPS returns a registration ID. The agency's Web application then forwards the user to Utah GovPay with the registration ID. After a completed payment transaction, the agency's Web application can use the registration ID to query WPS to find out if the transaction was approved. The figure illustrates the use of the components of the application and the use of service components that ultimately tie back to existing legacy operational systems and data.



*State of Utah SOA Reference Architecture*

## 4.3 Keys to Implementing the Service Oriented Infrastructure

The keys to implementing the Service Oriented Infrastructure focus on some of the most complex and demanding architectural concerns. Without the infrastructure that enables service-oriented architectures, the rest of these concerns are moot. It is critical to the growth of your SOA to understand the key infrastructure needs early in order to support the growth in services.

### 4.3.1 Focus on Enterprise Security, Scalability, and Interoperability

The flexibility of SOA comes with some costs in terms of complexity and the need to manage a greater number of moving parts. The issues are notionally similar to traditional environments. As a result, organizations need to pro-actively address the issues of security, scalability and interoperability in the design and implementation of their Service Oriented Infrastructure.

**Security:** Due to the number of environments, domains, and platforms that potentially will be crossed in executing a business process based on SOA, a federated approach to security must be adopted. While work is on-going to produce government-wide security architectures and standards, defined communities of interest should perform pragmatic risk/reward analysis to define level of service requirements for common security issues. The fundamental security areas to address include the following:

- Authentication and identity management across domains and environments
- Authorization and confidentiality (access control)
- Integrity (no inappropriate modifications are made)
- Availability (reliable service, no denial of service)
- Non-repudiation (positive identification and cannot deny providing or receiving services)
- Audit and monitoring
- Security administration and policy management

Industry standards are under development and are rapidly improving, including WS-Security and Liberty Alliance specifications. However, while the standards available today are necessary, they are not yet sufficient for the most stringent government use cases.

**Scalability:** With traditional applications, the number of users is typically known beforehand and the performance of the systems can be tuned to that user base. On the other hand, in an SOA environment, the number of users or consumers of the service is (almost intentionally) unknown. Loose coupling implies that the service is not aware of the number or types of ways in which it will be accessed. However, in reality, to be able to meet the terms of an SLA, the service provider must have some indication of the level of demand and develop mechanisms to scale up to accommodate spikes in demand. SOA Governance should provide this by having consumers register to consume a service from a provider. This allows providers to understand who its potential consumers are (and consumers to understand the SLA that the provider is offering) and to develop demand expectations prior to provisioning the service.

#### *The Importance of Security Models*

Within the Department of Defense (DoD) Enterprise, Service Security is considered to be a capability comprised of services and functional components. Service security should provide protection mechanisms to the Service Oriented Architecture by supporting authentication and authorization processes for exposed GIG Web Services. In a Net-Centric environment, DoD's focus on perimeter-based security models is augmented with an application or service-level view of security. With both models in mind, the emphasis is placed not on physical ownership and control but on network identities, trust, and authorized access to resources by both users and other principals. To help secure Net-Centric interactions among enterprise service consumers and providers, the Service Security Services themselves are defined as Web Services that are standards-based,

Some operating environments (such as Java Enterprise Edition - JEE) have mechanisms built in to provide scalability; however, this must still be anticipated and provided for. Thus, as a best practice, service providers should have SLAs in place with potential users and use this information to design scalability into the service offering as appropriate.

**Interoperability:** The concept of interoperability in an SOA enabled routable network is fundamentally different than in a traditional point to point information exchange architecture. In the latter, the job is to guarantee that one known system can synchronize with another. In the former, the job is to allow a virtually infinite number of unknown nodes supported by an unlimited number of known and unknown services to interoperate.

Both traditionally and with SOA, use of standards across domains is a necessary, but not sufficient approach. Engineers also need pragmatic reference implementations. Reference implementations are examples of standard components bundled effectively to solve a critical problem. SOA engineers need these interoperable reference implementations for both semantic interoperability and run time infrastructure.

There are two fundamentally different approaches to achieve semantic interoperability among disparate organizations, systems, domains, etc. The first approach is pre-instantiation – negotiating semantic consistency and then implementing it through common definitions (e.g., metadata schema). Achieving this commonality has proven extremely difficult. However, it has been approached by a few very focused COIs (e.g., the NIEM process between DOJ, DHS, and others) and has proven to be well worth the effort. Many efforts to negotiate semantic standards have fallen under their own weight, often as a result of participants resisting compromises for common definitions.

The second approach to semantic interoperability is post- instantiation – using adaptors and translators to reconcile different data sources for common processing. Indeed, most middleware, including EAI (enterprise application integration), EII (enterprise information integration), and ESB (enterprise service bus) technologies contain capabilities to enable this. However the drawback is that in cases where the need for rigor is high, adapters are not capable of translating or aggregating disparate data sources.

An emerging development in the second approach is the use of semantic technologies and ontologies to establish precise relationships among data that can be used with inference engines to uncover additional relationships and enable interoperability across domains. While these technologies are at an early stage, they appear to hold significant promise for the future. The increasing “openness”, granularity, and modularity in the service implementation infrastructure (e.g., Java Business Integration (JBI), or Service Component Architecture (SCA)) allows considerable cross enterprise interoperability at reasonable cost and time scales.

**Service Management:** Service management becomes increasingly important as the number of services and collaborating organizations increases. Agencies should incorporate run time and build time service management functionality to define, monitor, enforce, and adjust the service level agreements (SLAs) between service providers and their consumers. The service management details (quality of service) should be rolled up to populate management dashboards for use at operational, tactical, and strategic levels in a manner similar to how network operation centers monitor network performance.

### 4.3.2 Establish Discovery and Trust Mechanisms

The SOI is responsible for enabling the operation and management of the service-oriented architecture, as well as providing the tools and environments to support the development, acquisition, and integration of services and service-based solutions.

## Discovery - Registries/Repositories

No SOA is complete without governance and visibility. Reuse of services, and for that matter, all assets is not possible without the ability to discover these assets as and when required. Registries and repositories are the safe houses where all assets can be located and managed. Providers use this capability to advertise their services and assets for others to use. Owners utilize the capabilities of the Registry/Repository to manage their assets through the various lifecycle stages from development through operations into retirement. Consumers use them to locate and identify assets that may meet their requirements.

The current level of maturity in the industry regarding Service Discovery does not allow for run-time discovery and consumption. The current most effective discovery mechanisms use Registries/Repositories at build time to discover pre-existing services that can be consumed within a composite application. Upon evaluation and selection, the service is then designated using UDDI registries as the accepted service at run time.

In evaluating a discovered service, additional criteria such as reliability, efficiency, dependency, adherence to and/or violations of policies, etc provide valuable information to aid in determining the suitability of a service. Registry/Repository provides the capability to store this type of metadata related to the assets (including services) and the relationships among them; thus forming the cornerstone for SOA Governance.

## Trust – Enterprise Security/Privacy and Level of Service

Discovery of valuable information or services across verticals is useless without a trust model that enables the discoverer to consume it with confidence; part of this relates to the need for enterprise security and privacy. There are various commercial security and privacy services on the market, but none has been shown to scale across a large federated enterprise. Further, none is certified and accredited for the most robust government applications. In fact, US Government policy insists that government network security services be developed and managed by the government.

Any IT architecture must guarantee a level of service. Therefore, any SOA instantiation requires an ability to monitor and optimize quality of service with respect to discovery, security/privacy, and other vital functionality.

### 4.3.3 Establish an Adaptive and Collaborative Testing and Certification Environment

SOA allows an adaptive and collaborative approach to information processing. Hence, the SOA assessment method, i.e., validation and verification (V&V), test and evaluation (T&E), and/or certification and accreditation (C&A), should itself be an adaptive and collaborative process. This adaptive approach is as fundamentally different from traditional T&E methods as SOA is fundamentally different from previous computing paradigms. Making the transformation will require similar attention.

An “SOA assessment” is a useful engineering service embedded throughout the software development and deployment process, based on measurable and testable parameters that can accomplish the following:

- Reduce policy documents, and operational requirements to measurable and testable attributes coded in machine readable formats.
- Bundle candidate information processing capabilities into reference implementations.
- Assess both the adequacy of the service-oriented infrastructure and the value-add to business objectives.
- Weigh risk and reward to scale the rigor of assessment as appropriate.

- Assist developers of large complex systems to deploy their capability continuously and incrementally.
- Rapidly assess information processing capability prior to its operational deployment. Follow up with operational V&V.
- Reduce the barrier to entry for IT vendors and developers who don't generally deal with the U.S. Government.

SOA certification should be addressed in three broad categories:

- Software performance and vulnerability,
- Network performance and vulnerability, and
- Demonstrated value added to enterprise objectives.

Effective testing and certification to guarantee SLA terms and conditions is required to establish and sustain trust in shared services. Publishing services to a controlled test environment goes one step further by empowering government partners, business partners, IT vendors, and system integrators to enable compatibility and add value.

An investment is required to develop the assessment tools and processes necessary to achieve these outcomes or outsource "testing as a service."

## Recommendations for Service Oriented Infrastructure

- Adopt a Federated approach to security and privacy for defined Communities of Interest (COI) that identifies common security and privacy solutions based on a risk/reward approach.
- Determine the most effective approach to achieve semantic interoperability, either through processes like NIEM or through semantic technologies.
- Incorporate run time and build time service management functionality to define, monitor, enforce, and adjust Service Level Agreements (SLA).
- Utilize a Registry/Repository to discover needed services during application build and to insure that key criteria such as reliability, efficiency, dependency, and adherence to and/or violations of policies are fulfilled.
- Adopt a trust model that addresses both security and privacy and also quality of service.
- Establish a collaborative test/evaluation and certification/accreditation process for services.
- Evaluate emerging technology against relevant test cases. Using better technology can lead to working smarter rather than just working harder. For example, *Internet Business Logic* is a kind of Wiki for applications written as business rules in open vocabulary, executable English. **As befits a Wiki, shared use is free. It also works as an advanced SOA endpoint on the Web. See [www.reengineeringllc.com](http://www.reengineeringllc.com).**

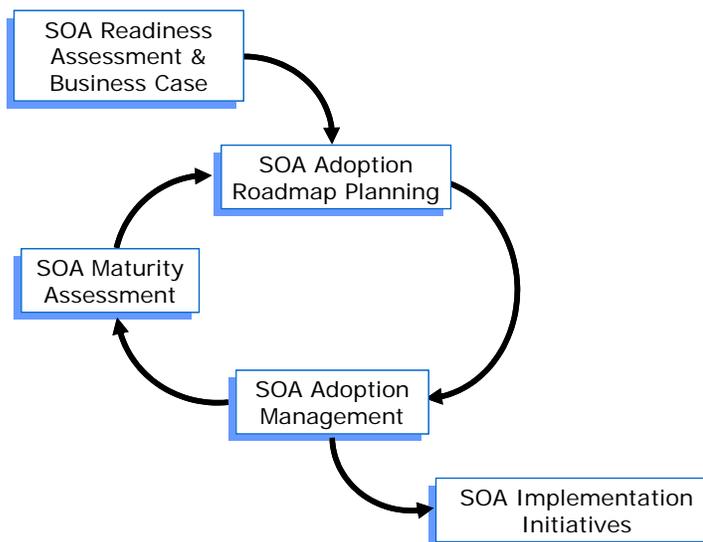
## Summarizing the Keys to Implementation

This section presented many best practices and challenges that are applicable to most organizations journeys towards a mature SOA. The next section presents a roadmap approach that organizes these keys into a logical sequence that can be balanced with your organization's business objectives.

## Section 5: A Roadmap for SOA Adoption

**Exhibit 5-1: SOA Adoption Process Overview**

Exhibit 5-1 depicts a high level view of the basic SOA Adoption process discussed in this section. The Practical Guide for SOA presents a series of logical steps that agencies should take, starting with an SOA Readiness Assessment which can help the agency to determine the level of support that exists within the agency. This assessment will help provide the degree of value the agency believes will follow from implementing SOA. We recommend that the agency develop a sound Business Case for SOA that will identify the value proposition, approach, and costs and benefits of pursuing SOA. Depending on the maturity stage the agency finds itself



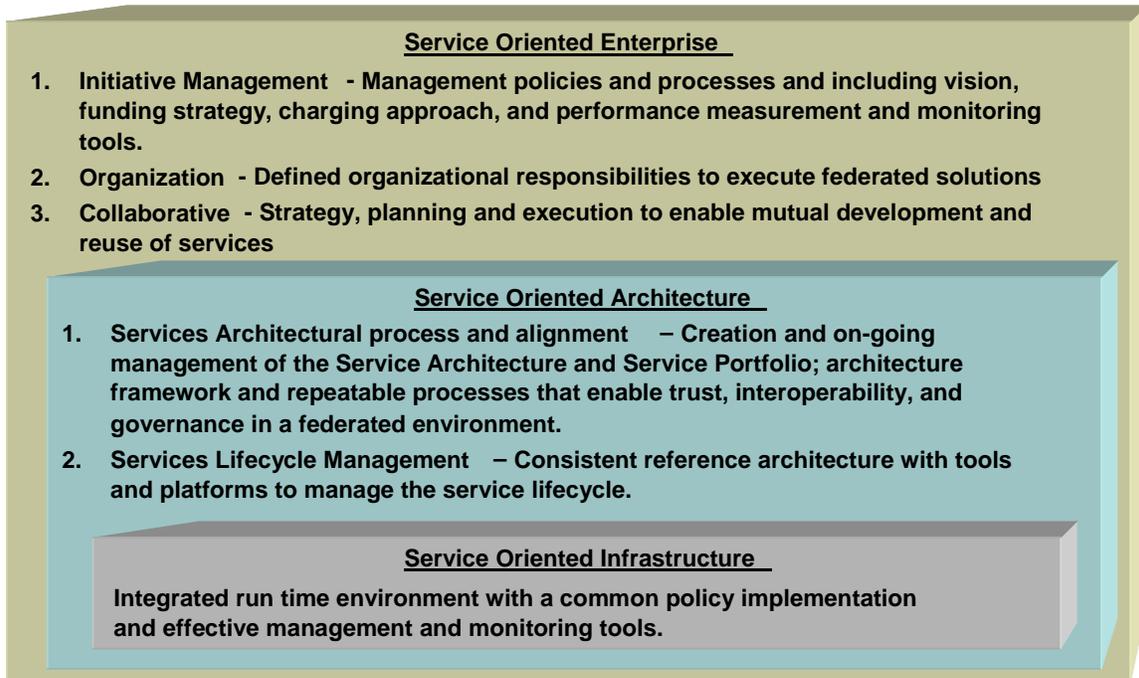
in following an SOA Maturity Assessment, the agency should then develop a more detailed SOA Adoption Roadmap Plan, followed by execution of management processes identified in the Roadmap Plan. This will spawn (multiple) initiatives to implement specific capabilities necessary for effective adoption. Periodically (e.g., annually), the adoption program should be reassessed from a SOA maturity perspective and modifications should be made to the Roadmap Plan based on the advancing maturity of the organization.

An agency that plans to implement SOA should develop a SOA roadmap (i.e., a structured SOA implementation plan for managed adoption based on best practices) that is synchronized with its enterprise strategic goals and objectives. Industry literature indicates that a SOA roadmap can enable an organization's enterprise architecture to implement business strategic plans through the design of new systems, as well as the transformation of legacy systems.

The SOA roadmap provides a strategy that:

- Considers an enterprise's rationale for SOA;
- Establishes goals and objectives associated with an enterprise's target architecture; and
- Applies best practices to SOA implementation.

### Exhibit 5-2: Roadmap Objectives Aligned with Service Framework



The SOA roadmap articulates the changes and growth in capabilities over time - expressed as a capability maturity model. It documents the enterprise's specific approach to reaching the next desired level of maturity and provides a conceptual plan that is used as a basis for developing detailed project plans and allocating responsibility to accomplish each of the activities.

The SOA roadmap, depicted in Exhibit 5-2, allows an agency to leverage industry and government experience and to tailor the approach to the specific needs of the agency. It helps extend and adapt existing governance, application development lifecycle, and support processes to the service-oriented approach, and more closely aligns them with desired outcomes.

### Roadmap Critical Success Factors

The following key factors, distilled from the previous chapters, help an SOA rollout succeed:

- Well defined and accepted principles to prioritize when and where to apply SOA.
- Engineering processes that leverage service orientation, i.e., reuse, modularity and composability.
- Enhanced lines of communication across project teams.
- Realtime feedback loop from run-time business activity to design-time planning activity.
- Current year discretionary funds available for business process innovation.
- Measures of effectiveness that specify return on investment through enhanced modularity and composability.
- Steps to establish and support SOA governance policies, procedures and mechanisms.
- Clear and continuing support from IT and business leadership.

## Roadmap Focus Areas

In the least, an SOA Roadmap should address the following key areas:

- **Identification and Description of Common Services:**
  - Activities to increase maturity of service identification, definition, development, implementation, and operation, e.g., Business Process Management and Business Activity Monitoring.
  - Activities to develop and manage the organization's services portfolio.
  - Coordination of service identification and management activities and responsibilities among COIs.
  - Activities that support the services lifecycle.
- **Fiscally Enable Community Of Interest (COI) Governance Bodies to:**
  - Manage and monitor the development, integration, testing, deployment and retirement of services.
  - Harvest EA best practices, use cases, architectural patterns and principles, as well as extensions or modifications to existing lifecycle and support processes.
  - Establish and enable key services management roles and responsibilities.
  - Develop and implement communication and training plans.
  - Review and extend existing project support processes for cross-organization, cross-agency services development, and operation.
- **Services Infrastructure, Integration Platform and Tooling:**
  - Establish and sustain SOA development, test, integration and runtime environments.
  - Identify and implement tools to monitor and enforce governance policies and service level agreements.
  - Establish and cultivate a services-oriented infrastructure environment.
  - Establish repositories/registries that will capture system artifacts, including policies to help enforce governance and manage assets throughout the lifecycle.
  - Identify and implement key SOA management components that integrate with the infrastructure environment.

## 5.1 SOA Maturity Model

A SOA maturity model identifies phases that characterize the scope of SOA adoption and experience. There are a number of SOA Maturity Models available (for example, Everware-CBDi, IBM, Oracle, and BEA). This guide does not endorse any particular SOA maturity model, but does draw attention to the fact that there is widespread agreement surrounding the usefulness of leveraging a maturity model. Rather, we suggest that agencies review all of the models available, and select the elements which meet their needs.

SOA maturity models generally have four to five linked stages of maturity moving from very little understanding of, or activity associated with SOA adoption, to a business model thoroughly organized around services. This guide offers a generic maturity model to assist agencies in determining where they are on this continuum. Our generic model represents a composite of publicly available information from the four cited commercial models which has five stages that build on one another: Early Learning, Application, Adoption, Optimization, and Federation.

Within each maturity stage, the state of the agency’s SOA adoption is expressed in terms of the six key dimensions listed above. Based on an assessment of the agency against this basic information, or a similar SOA maturity model, the agency should be able to identify where it lies along the maturity continuum as well as prioritize how to move to successively higher stages of maturity. This information is important for developing the agency’s specific SOA Roadmap.

### SOA Maturity Stages

	<b>Early Learning</b>
<b>Initiative Management</b>	Funding is primarily directed to individual projects.
<b>Organization</b>	Either individual application architects or the Chief Architect sponsors SOA.
<b>Collaboration</b>	Application projects are generally focused on their own deliverables; limited cross-project collaboration.
<b>Architectural Process and Alignment</b>	Architecture is fragmented and exploratory. Architecture frameworks are ad hoc; no mature enterprise approach.
<b>Services Lifecycle Management</b>	Services are mostly not identified. If services are identified, they are not managed in a cross-project, enterprise manner.
<b>Services Infrastructure</b>	Limited services infrastructure; primarily supports individual Proofs-of-Concept; possible project Enterprise Services Bus.

	<b>Application</b>
<b>Initiative Management</b>	Services are identified and managed as an IT architecture concept.
<b>Organization</b>	SOA is generally a project level responsibility and is found consistently

	in most appropriate projects.
<b>Collaboration</b>	Service delivery and usage governance, process and practices are incorporated into projects and projects collaborate to share services. Management recognizes the need for a collaborative DT&E process.
<b>Architectural Process and Alignment</b>	Project architectures are service oriented; no enterprise level service orientation within the enterprise architecture. There are consistent project level architectures; no overall enterprise level SOA reference architecture.
<b>Services Lifecycle Management</b>	Services are available for individual projects to use and leverage.
<b>Services Infrastructure</b>	There is an Enterprise Service Bus Proof of Concept; some projects beginning to use common services and sharable services.

	<b>Adoption</b>
<b>Initiative Management</b>	Funding processes specifically support the development, implementation and use of shared services; governance processes are in place to manage services effectively.
<b>Organization</b>	There is a single organizational entity responsible for integration and processes in place to facilitate integration.
<b>Collaboration</b>	Project processes and governance are built around identifying and incorporating shared assets. Some projects are beginning to perform collaborative DT&E.
<b>Architectural Processes and Alignment</b>	SOA is employed as a component of EA. There are standards in place for rich service specification and use. There is an enterprise level SOA reference architecture and implementation processes in place; they are governed at the enterprise level.
<b>Services Lifecycle Management</b>	There is an enterprise level services repository that provides consistent lifecycle governance of run-time service assets.
<b>Services Infrastructure</b>	There is an enterprise level ESB that is mandatory for project use; common enterprise services are available, well governed, and can be found and used.

	<b>Optimization</b>
<b>Initiative Management</b>	Services are managed effectively as enterprise business assets. Governance processes for managing services are mature, applied consistently across the organization.

<b>Organization</b>	Services are owned by business units but managed as enterprise business assets.
<b>Collaboration</b>	There are processes in place for service quality management that are understood and used by individual projects. Collaborative DT&E occurs regularly across internal projects.
<b>Architectural Process and Alignment</b>	Internal agency EA goals and objectives are realized.  The agency has an enterprise services portfolio plan and uses it to identify, develop, and use service assets as a fundamental way of doing business. There are agreed-to and managed business processes and business architectures for business collaboration. Services are managed within a service-oriented enterprise architecture as shared federated assets.
<b>Services Lifecycle Management</b>	The enterprise registry and repository provides design and runtime service asset lifecycle governance and asset dependency analysis.
<b>Services Infrastructure</b>	There exists a common framework and tools for enterprise management of services, and security services facilitate inter and intra business collaboration.

	<b>Federation</b>
<b>Initiative Management</b>	Services facilitate inter and intra business collaboration.
<b>Organization</b>	Services are defined and managed within an inter-business, collaborative basis.
<b>Collaboration</b>	Collaborating parties within the SOA relationship operate and act as service provider and consumer. Collaborative DT&E occurs seamlessly and virtually across multiple agencies.
<b>Architectural Process and Alignment</b>	EA goals and objectives are realized across multiple agencies. There are agreed business processes and data architectures for integration and business collaboration. A complete, agreed SOA reference architecture exists and is used to manage key collaboration points.
<b>Services Lifecycle Management</b>	Ecosystem registries provide governance structures and processes over collaborative business processes.
<b>Services Infrastructure</b>	Services are managed as enterprise sharable but federated assets. Structures, tools and processes are in place at the infrastructure level to facilitate this.

*Everware-CBDI SOA Maturity Stages (CBDI Journal 2005, December Best Practices Report)*

## 5.2 Establishing a Core SOA Team

It is crucial to establish a focused team of specialists that have both a commitment to the change process that an SOA vision requires and also the technical skills required to sustain the process. Those general skills should include leadership, engineering, and business acumen

with specific expertise in things like change management, security, agile methods, modeling and simulation, and business process analysis. This team has been variously called a “Tiger Team,” an SOA Center of Excellence (COE), or SOA Program Management Office (PMO). Any of these approaches will work if the team has top management support, the ability to interact effectively with program managers, project managers and developers within the agency, as well as adequate resources.

The Core SOA Team introduces new integration technologies, selects standards and develops reference models for services, identifies service domain owners, and creates the agency SOA governance model. The most effective approach is to employ pilots and proofs of concepts that quickly and clearly demonstrate value to the entire organization.

### 5.3 SOA Roadmap Model

Using the SOA Maturity Model phases described above, an agency can begin to build a customized Roadmap based on the stage when they start the adoption process, what changes need to be accomplished at each stage in the process, and what level of maturity the agency decides is appropriate for its strategic objectives. Every agency does not need to reach the highest level of maturity to fulfill its business goals.

The table below, Exhibit 5-3, provides a general example of an SOA Roadmap that can help agencies develop customized roadmaps.

**Exhibit 5-3: An Example SOA Implementation Roadmap Based on Maturity Phase**

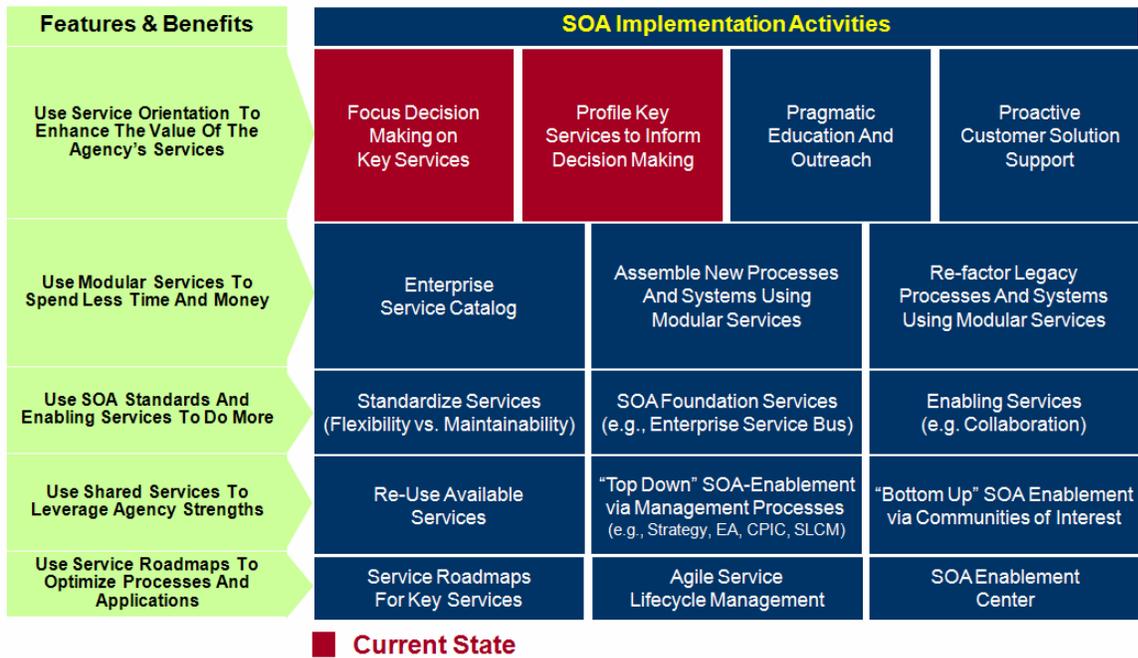
Timeline	Phase 1	Phase 2	Phase 3	Phase 4
<b>Maturity Phase</b>	<i>Early Learning</i>	<i>Application</i>	<i>Adoption</i>	<i>Optimization/Federation</i>
Scope of SOA Adoption	Project-Centric, Opportunistic	Strategic, Business Segment Wide	Enterprise Wide	Business Transformation
Suggested Timeframe	0 - 6 Months	6 – 12 Months	12 – 18 Months	18 months – Indefinite
Key SOA Implementation Processes	<ul style="list-style-type: none"> <li>- Secure executive support for SOA pilot.</li> <li>- Create rudimentary collaborative DT&amp;E environment</li> <li>- Establish a core SOA Team</li> <li>- Establish incentives for collaborative SOA governance</li> <li>- Lay out scope, objectives and governance for SOA pilot. Re:                             <ul style="list-style-type: none"> <li>• Business</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Document tangible performance improvements based on SOA pilot.</li> <li>- Extend collaborative DT&amp;E environment to active and critical candidate projects.</li> <li>- Extend common services discovery scope to include:                             <ul style="list-style-type: none"> <li>• Individual project analysis,</li> <li>• Critical</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Extend service level metrics to encompass all projects using enterprise services.</li> <li>- Utilize full scope of SOA design patterns across all candidate projects.</li> <li>- Services funding and pricing models are in use for all enterprise services and tied to SLAs.</li> <li>- Full portfolio of services is developed and</li> </ul>	<ul style="list-style-type: none"> <li>- Identify mechanisms and processes to consolidate and optimize services.</li> <li>- Continuously evaluate alternative approaches to allow adaptation and evolution.</li> <li>- As the industry matures, evaluate and adopt/adapt alternative approaches,</li> <li>- Federated services discovery, run-time policy governance and performance monitoring are in place and drive service delivery.</li> <li>- Service level performance is provided</li> </ul>

Timeline	Phase 1	Phase 2	Phase 3	Phase 4
	<p>Engagement</p> <ul style="list-style-type: none"> <li>• SOA Design Patterns.</li> <li>• Basic integration platform &amp; middleware.</li> <li>• SOA Standards.</li> <li>• Service level metrics.</li> <li>• Business improvement goals.</li> </ul>	<p>support of business domain requests, and legacy systems analysis.</p> <ul style="list-style-type: none"> <li>- Execute analysis to fulfill business and IT strategies for initial portfolio assessment</li> <li>- Develop and implement services funding and pricing models for a few services.</li> <li>- Extend scope and depth services available to project developers including security, data sharing, and run-time integration services.</li> <li>- Core SOA team propose candidate enterprise services.</li> <li>- Core SOA team identifies touch-points and approach to align IT strategies</li> <li>- Identify key commodity services that support multiple lines of business.</li> <li>- Identify customized services that support core business areas.</li> <li>- Project engagement process documented and</li> </ul>	<p>used to identify key SOA initiatives.</p> <ul style="list-style-type: none"> <li>- Engage in enterprise-wide analysis to accelerate SOA benefits.</li> <li>- Service level metrics in place for all projects tied to performance and business agility.</li> <li>- SOA executive dashboard providing real-time performance results of service level metrics.</li> <li>- SOA enables top-down EA analysis</li> <li>- Identify cross lines of business and cross agency integration opportunities</li> <li>- Create SLAs between mutual services providers and mutual lines of business for shared services.</li> <li>- Establish run-time SOA governance across lines of business</li> <li>- Identify common services through process for bottom-up discovery.</li> <li>- Strategic planning with business partners.</li> <li>- Implement run time discovery processes.</li> </ul>	<p>real-time to program managers who use it to perform business process innovation</p> <ul style="list-style-type: none"> <li>- Standards based business systems are composed rapidly to react to business performance requirements.</li> <li>- Development and operating environment are fully service oriented.</li> <li>- Cross domain collaborative incentives are clear and collaborative process for mutual investment and engineering are seamless</li> <li>- Collaborative DT&amp;E environment is, continuous, seamless, virtual, and ad hoc.</li> </ul>

Timeline	Phase 1	Phase 2	Phase 3	Phase 4
		provided to projects at onset of engagement. <ul style="list-style-type: none"> <li>- Define strategic planning services identification process</li> <li>- Extend service level metrics</li> <li>- Implement pilot service performance dashboard</li> </ul>		

**Exhibit 5-4: Example of SOA Implementation Plan Currently in Use at Federal Agency**

Agency Example: SOA Implementation Activities Plan



(Source: 2007-12-13 EPA SOA Implementation Plan Update Slideshow)

## Section 6: Glossary

Term	Source	Definition
Adapter	Enterprise SOA	An intermediary service that bridges incompatible data formats between services and its clients. An adapter often also acts as a façade or technology gateway.
Authentication	IBM, Understanding SOA Security	The process of proving that the consumer legitimately has their claimed identity by evaluating additional information (authentication credentials) that is bound to this identity and can only be provided by a consumer with that identity.
Authorization	OASIS	The process of determining, by evaluating applicable access control information, whether a subject is allowed to have the specified types of access to a particular resource. Usually, authorization is in the context of authentication.
Best Practice	Benchmarking, The Search for Industry Best Practices that Lead to Superior Performance	Best practices are a set of actions that solve a problem critical to business success most often found within organizations that excel against business and mission objectives. The capture of a “best practice” is traditionally coupled with measuring via benchmarking. Benchmarking gauges performance against leaders and seeks to find and describe practices that most heavily contribute. This reference is adapted from a classic text on benchmarking.
Business Process Management	Gartner	Provides governance of a business's process environment to improve agility and operational performance.
Capability	OASIS	A real-world effect that a service provider is able to provide to a service consumer.
Component	SCBA 2006	Independently deployable unit of software that exposes its functionality through a set of services accessed via well-defined interfaces. A component is based on a component standard, is described by a specification, and has an implementation. Components can be assembled to create applications or larger-grained components.
Composite Application	OASIS	Applications that contain multiple services used in combination.
Consumption Service	OASIS	The process of interfacing with and utilizing the functionality of, and or providing functionality to, another Service Component.
Coupling	SCBA	Coupling is a measure of the level of interdependency between two components. “Loose Coupling” (low interdependence) is good, as it maximizes system flexibility. “Tight coupling” (high interdependence) is bad as it restricts system flexibility.
Community of Interest (COI)	Department of Defense (DoD) Guidance for COIs	A collaborative group of users who must exchange information in pursuit of their shared goals, interests, missions, or business processes and who therefore must have shared vocabulary for the information they exchange.
Design Pattern	-	See “Pattern.”

Term	Source	Definition
Development, Test, and Evaluation (DT&E)	Department of Defense Test And Evaluation Master Plan (May 2002)	Testing and evaluation conducted to evaluate design approaches, validate analytical models, quantify contract technical performance and manufacturing quality, measure progress in system engineering design and development, minimize design risks, predict integrated system operational performance in the intended environment, and identify system problems to allow for early and timely resolution or correction.
Discovery	W3	The act of locating a service (specification) that meets certain functional criteria. It involves matching a set of functional and other criteria with a set of resource descriptions.
Enterprise Service Bus (ESB)	Bitpipe.com	An enterprise integration architecture that allows incremental integration driven by business requirements, not technology limitations.
Enterprise Architecture	CAF Glossary	(A) means— (i) a strategic information asset base, which defines the mission, (ii) the information necessary to perform the mission, (iii) the technologies necessary to perform the mission, and (iv) the transitional processes for implementing new technologies in response to changing mission needs; and (B) includes—(i) a baseline architecture, (ii) a target architecture, and (iii) a sequencing plan.
Federal Enterprise Architecture	www.egov.gov , FEA PMO Action Plan	<p>The Federal Enterprise Architecture is an Office of Management and Budget initiative to comply with the Clinger-Cohen Act and provide a common methodology for information technology acquisition in the U. S. Federal Government. It is designed to ease sharing of information and resources across federal agencies, reduce costs, and improve citizen services.</p> <p>The FEA consists of a set of interrelated reference models designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across agencies. These include the Performance Reference Model, the Business Reference Model, the Service Component Reference Model, the Data Reference Model, and the Technical Reference Model.</p>
Framework	CAF Glossary	A logical structure for classifying and organizing complex information.
Government Service Unit	-	A useful organization of government resources (staff, facilities, automated systems, etc.) viewed in a service perspective.
Granularity	SCBA 2006	The size of the service or component under consideration. The term generally refers to the level of detail or abstraction of the service.
Harvesting	SCBA 2006	(1) The process of evaluating and organizations businesses processes and IT assets in an effort to discover Service Components. (2) The process of repacking of useful business functionality as a Service Component.
Identity	IBM, Understanding SOA Security	A user or a consumer typically represented with a unique value or identifier.
Identity Token	IBM, Understanding SOA Security	A unique representation of the identity and attributes of the consumer in a standardized format.

<b>Term</b>	<b>Source</b>	<b>Definition</b>
Integrated Development Environment (IDE)	TechTarget	A programming environment that has been packaged as an application program, typically consisting of a code editor, a compiler, a debugger, and a graphical user interface (GUI) builder. The IDE may be a standalone application or may be included as part of one or more existing and compatible applications.
Interface, Component or Service	SCBA 2006	Mechanism by which a component describes what it does and provides access to its services. This is important because it represents the “contract” between the supplier of services and the consumer of the services.
Loose Coupling	Service Oriented Architecture: Concepts, Technology, and Design	A condition wherein a service acquires knowledge of another service while remaining independent of that service. Achieved through the use of service contracts that allow services to interact within predefined parameters. Service contracts are what enable loose coupling between services, as the contract is the only piece of information required for services to interact.
Model Driven Architecture	IBM Service Oriented Architecture Compass	A software design methodology proposed and sponsored by OMG. Defines levels or abstract, platform independent models that can be used to generate more concrete models using an appropriate specification language.
Open Technology Development (OTD)	Department of Defense OTD Roadmap Plan (April 2006)	A practice for development and implementation of current and next-generation software. Enabled by the Internet and related technologies which enable distributed groups of programmers to collaboratively develop and manage code libraries in a decentralized fashion. The key elements of this approach are: 1. Open Standards and Interfaces 2. Open Source Software and Designs 3. Collaborative and Distributed Online Tools 4. Technological Agility
Pattern	Gartner	A pattern is a design idea that can be reused and leveraged across the enterprise. They are blueprints that identify components at a design or logical level (for example, a data server or an application server), and show the roles, interactions, and relationships of components at that level.
Process Model	OASIS	The characterization of the temporal relationships between and temporal properties of actions and events associated with interacting with the service.
Provisioning	Services Provisioning Markup Language Specification	The automation of all the steps required to manage (setup, amend, and revoke) user or system access entitlements or data relative to electronically published services.
Registry	SCBA 2006	A database providing information describing and categorizing objects, but which does not contain the objects themselves. Registries usually provide information as to how to access the objects they describe.
Repository	SCBA 2006	A storage mechanism; typically a storage and retrieval mechanism for components and service information.
Reuse	SCBA 2006	Any use of a pre-existing software artifact (component, specification, etc.) in a context different from that in which it was created.

<b>Term</b>	<b>Source</b>	<b>Definition</b>
Security Architecture	OASIS	A plan and set of principles for an administrative domain and its security domains that describe the security services that a system is required to provide to meet the needs of its users, the system elements required to implement the services, and the performance levels required in the elements to deal with the threat environment.
Security Service	OASIS	A processing or communication service that is provided by a system to give a specific kind of protection to resources, where said resources may reside with said system or reside with other systems, for example, an authentication service or a PKI-based document attribution and authentication service.
Semantic Data Model	IBM	Defines the standard business data objects for a given enterprise (such as customer, agreement, and so on). These objects effectively create an ontology of the enterprise data by defining common concepts and their content, which describe the functioning of the enterprise. Using this data model for defining the business services interfaces leads to the creation of interoperable semantic service interface definitions--a semantic SOA.
Service	OASIS	The means by which the needs of a consumer are brought together with the capabilities of a provider.
Service Component	SCBA 2006	A self-contained business process or service with predetermined and well-defined functionality that may be exposed through a well defined and documented business or technology interface. Well-designed Service Components are "loosely coupled" and collaborate primarily by exchanging messages.
Service Contract	Enterprise SOA	Describes a service in a technology independent way. It specifies the functionality, purpose, usage, and constraints of the service.
Service Interface	OASIS	The means by which the underlying capabilities of a service are accessed.
Service Level Agreement (SLA)	SCBA 2006	A contract or memorandum of agreement between a service provider and a customer that specifies, usually in measurable terms, what services the service provider will furnish. Information technology departments in major enterprises have adopted the idea of writing a service level agreement so that services for their customers (users in other departments within the enterprise) can be measured, justified, and perhaps compared with those of external (sourcing) service providers.
Service Level Management	Gartner	The ongoing process of using service-level agreements (SLAs) to maintain high quality in the provision of services — and to ensure that service-level objectives (SLOs) and performance meet the changing needs of the recipient's business — through continuous improvement of service activities, functions, and processes.
Service Level Objective	Gartner	A goal defined in a service-level agreement (SLA). SLOs are the objectives that must be achieved — for each service activity, function and process — to provide the best opportunity for service recipient success.

<b>Term</b>	<b>Source</b>	<b>Definition</b>
Service Oriented Architecture (SOA)	OASIS	Service Oriented Architecture is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations.
Service Oriented Enterprise (SOE)	IDG	A business-driven architectural framework that defines and exposes an organization's core business processes to the external market through the use of standardized open technology in the form of services.
Service Oriented Infrastructure (SOI)	IDG	A service-driven infrastructure that provides a common and shared set of technologies that enable business processes to be added and changed readily.
Service Provider	OASIS	An entity (person or organization) that offers the use of capabilities by means of a service.
SOA Governance	BPTrends	An instance of IT governance with some refinement in IT processes and controls as required by particular enterprise needs across all phases of the enterprise SOA initiatives such as SOA Strategy, SOA Plan and Define, service-oriented analysis and design, SOA implementation, SOA testing, SOA deployment, etc.
SOA Management	BPTrends	Includes IT processes, services, and software/tools for managing and monitoring SOA composite applications and supporting infrastructure based on enterprise governance practices that are in accordance with business goals.
SOAP	CAF Glossary	Simple Object Access Protocol - A World Wide Web Consortium (W3C) specification that facilitates the interoperability between a broad mixture of programs and platforms.
SOA Roadmap	For the purposes of this guide.	A structured SOA implementation plan for managed adoption based on best practices.
Solution Assembly	SCBA 2006	Process of implementing a solution by assembling the necessary services into a complete solution. This process often involves additional "glue" code to integrate the assembled components.
Test Harness	SCBA 2006	Software that automates the software testing process to test software services or components as thoroughly as possible before using them on a real application.
UDDI	CAF Glossary	Universal Description, Discovery and Integration is a an online directory that gives businesses and organizations a uniform way to describe their services, discover other companies' services and understand the methods required to conduct business with a specific company.
Unified Modeling Language (UML)	IBM Service Oriented Architecture Compass	An accepted OMG standard visual language for specifying, constructing, and documenting the artifacts of systems.
Use Case	Jacobson92	A use case is a narrative document that describes the sequence of events of an actor (an external agent) using a system to complete a process.

<b>Term</b>	<b>Source</b>	<b>Definition</b>
Web Service	SCBA 2006	Specific method of implementing a service, using the Internet (XML, TCP/IP) as the transport mechanism and conforming to a specific set of standards (WSDL, SOAP, etc). Can be internally provided or can be offered externally.
Wrapping	SCBA 2006	Isolating the code to create an independently deployable unit of software and creating an interface around legacy code that exposes functionality as services via interfaces that conform to a component specification.
Web Services Description Language (WSDL)	CAF Glossary	Web Services Description Language is a specification that is published to a UDDI directory. WSDL provides interface/implementation details of available web services and UDDI Registrants. It leverages XML to describe data types, details, interface, location, and protocols.
XML	CAF Glossary	Extensible Markup Language is a non-proprietary subset of SGML (Standard Generalized Markup Language). It is focused on data structure and uses tags to specify the content of the data elements in a document.

## Section 7: References

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