Systems Engineering at MITRE

SERVICE-ORIENTED ARCHITECTURE (SOA) SERIES

SOA Characterization Framework

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MITRE

Executive Summary

Federal information technology (IT) leaders trying to realize the maximum value from their IT investments are frequently faced with a multitude of technical options on how to best serve their customers, including which tools and standards to use for service provider implementations. Decisions are often based on subjective measures of merit, rather than a structured framework for matching fundamental IT requirements to implementation characteristics. To address this challenge, MITRE has developed the Service-Oriented Architecture (SOA) Characterization Framework (SCF), which characterizes SOA service provider requirements in terms that can be mapped to SOA implementation technologies.

The SCF can help IT leaders to put aside the passionate opinions about the technologies available—which are voiced by various organizations, vendors, and influential individuals—and see the technologies in the perspective of the IT leaders' business constraints and objectives. The SCF puts the choices in context, matching requirements with customers' needs and characteristics, and thus helps IT leaders make effective, successful SOA implementation decisions.

The SCF characterizes service provider requirements across two key dimensions—requirements and organizational factors. The SCF Key Requirements Factors listed below determine the placement along the horizontal axis in Figure ES-1, Characterizing Services (seen on page iii). They are performance, security, reliability, and interface complexity. The SCF Key Organizational Factors determine the placement along the vertical axis of Figure ES-1. The factors are sophistication of IT staff, organization-specific costs and ability to fund adoption of technologies, requirements similarity, common vocabulary, number of stakeholders, number of disparate policies, and number of systems to integrate.

SCF Key Requirements Factors—Four SCF Key Requirements Factors drive implementation technology selections:

- **Performance:** From a business perspective, performance can be measured in terms of the responsiveness of the system to user input; numbers of transactions per unit of time and graphical user interface responsiveness are examples of performance metrics. In addition to the underlying network capability and the performance of the service, factors that affect business performance include the amount of data transmitted and the amount of pre- and post-processing required by the interconnect technology. System performance requirements may range from unconstrained to hard real-time.[1]
- **Security:** Security spans a variety of information assurance categories, including authentication, non-repudiation, and assurance that no unauthorized person or system can access or alter the information. Security requirements may range from simple transport-level protection[2] to content-based protection with fine-grained security controls.
- **Reliability:** Reliability refers to the level of guarantee that the technology can provide with respect to delivery of information. Reliability can range from "best effort" to a guaranteed level of service within a specific time period.
- **Interface complexity:** The flexibility and breadth of capabilities that an interface can provide are an important aspect of the technology selection. For example, an organization may need to provide a news feed that can be easily consumed across a wide number of organizations with a simple interface. Alternatively, an interface may be needed that can process complex, highly structured, transactional data across a small number of high-value customers. The complexity of a service interface can range from straightforward to highly complex.

SCF Key Organizational Factors—In addition to requirements factors, organizational factors have a significant effect on the appropriate selection of technologies and techniques. The organizational impact is driven by the diversity of stakeholders and their characteristics. Stakeholder characteristics affect whether or not there is similarity in the depth of IT staff capabilities, financial resources for adopting new technologies, requirements similarity, common vocabularies for exchanging data, common policies, and the number of unique systems to integrate. For example, homogeneous stakeholders can help to facilitate the choice of a technology by having consistent requirements, policies, resources, and technical staff capabilities. Alternatively, when there are many heterogeneous stakeholders, it can add complexity to the challenge of identifying a common technology standard that can support the diversity of their needs. The SCF Key Organizational Factors are:

- **Technological sophistication:** The technological sophistication of the organizations producing or consuming services can influence the complexity level of the technologies that can be employed. For example, when technologies will be accessed by numerous organizations with limited technical resources, simplicity can provide a significant advantage for ensuring successful adoption by the consuming organizations. In contrast, when a service is accessed by the IT staff from a small number of consumer organizations with deep technical capabilities, sophisticated technologies can be used.
- **Costs and resources for deploying technology:** Costs of adopting new technologies and an organization's financial resources can be a limiting factor in deploying capabilities across resource-constrained organizations. Costs may include legacy system and infrastructure modifications, hardware purchases, software licensing, training for technical staff, and operational changes.
- **Requirements similarity:** If consumers and producers are homogeneous with respect to their requirements, it may allow for a choice of technology that uniquely fits their needs. However, if the consumers and producers are heterogeneous with diverse requirements, a solution that can meet broad needs will be a better fit.
- **Common vocabulary:** Homogeneous consumers and producers can simplify the definition of the data semantics. Conversely, significant consumer and producer diversity tends to add challenges to standardizing the data semantics.
- **Stakeholders:** As the number of organizations consuming services increases, the number of distinct stakeholders will increase. More heterogeneous stakeholders can drive complexity in the selection of technologies, due to the challenges of meeting their diverse requirements.
- **Disparate policies:** As the number of heterogeneous organizations consuming services increases, there will be more distinct policies involved and thus a need for more flexibility in the underlying technology.
- **System integration:** The broader the heterogeneous consumer base, the higher the probability that more unique systems will need to leverage the service; therefore, the technology employed needs to address a wide range of system integration challenges when many organizations are utilizing services.

Figure ES-1, Characterizing Services, identifies four broad categories of SOA service implementations that drive detailed technology decisions. The four categories of the SCF are based on requirements and organizational factors and have the following characteristics:

- **Non-stringent requirements and homogeneous customer organizations:** Projects with non-stringent requirements involving one or a very small number of homogeneous organizations can usually be completed fairly quickly and at a low cost. Technologies used in the development are often the most expeditious technologies available to the development team. For example, business proof-of-concept projects are useful for quickly demonstrating or validating business ideas with minimal cost; they can be effective for concept development and mitigating business and operational risk.
- **Non-stringent requirements and heterogeneous customer organizations:** Projects with non-stringent requirements and many participating heterogeneous organizations may employ technologies that are lightweight and can be easily adopted by heterogeneous organizations. For example, a general-purpose news feed system can provide information in a consistent format across many organizations.
- **Stringent requirements and homogeneous customer organizations:** Projects with stringent

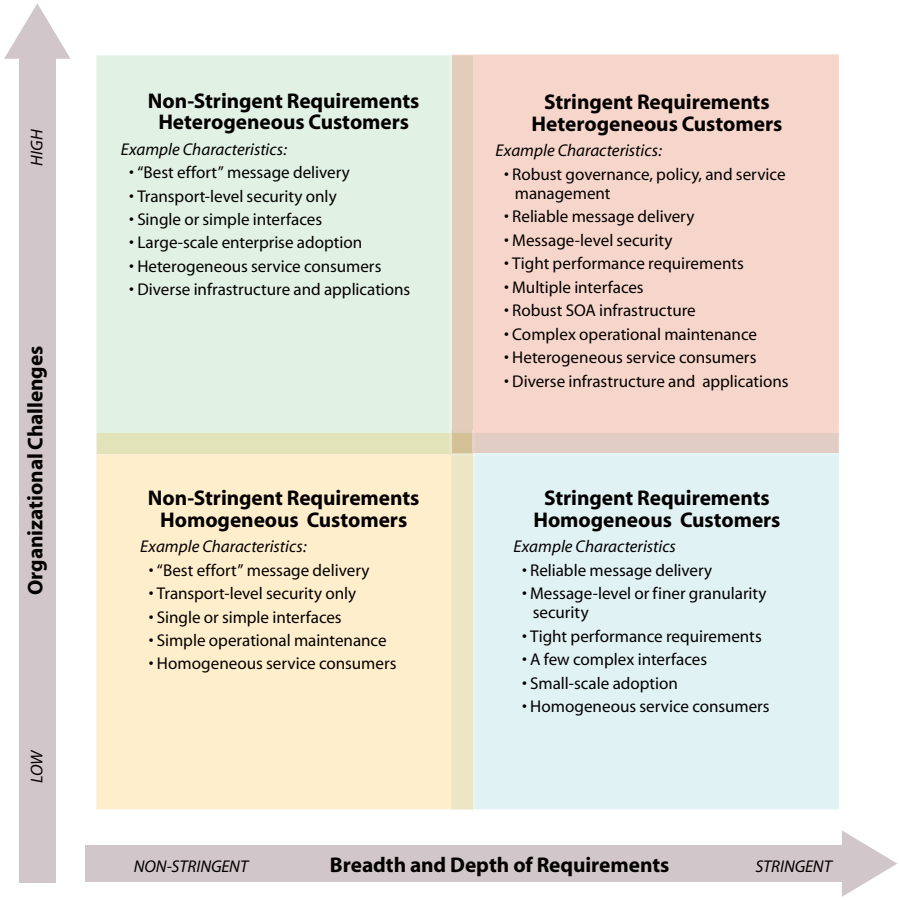

Figure ES-1. Characterizing Services

requirements and one or a minimal number of homogeneous organizations demand known performance, robust security, and reliability guarantees, including service availability, quality/pedigree of data, timely message delivery, and completion of transactions. While the requirements are stringent in this category, the small number of stakeholders allows the technologies to be optimized for the participating organizations. For example, a command and control system that provides rich functionality to a limited set of intra-organization consumers would fall into this category.

- **Stringent requirements and heterogeneous customer organizations:** Projects with stringent requirements and many participating heterogeneous organizations demand known performance, robust security, and reliability guarantees, including service availability, quality/pedigree of data, timely message delivery, and completion of transactions. These projects also demand rigorous specifications of interfaces and require the ability to expose interfaces that meet consumer needs. Technology considerations need to include the depth of requirements and the breadth of potentially diverse and disparate consumers and producers of services. For example, a highly sensitive Government financial system with capabilities for very large transactions, whose stakeholders include providers and consumers of services in many organizations, would fall into this category.

Intended framework usage—Many enterprises have a portfolio of services with a range of characteristics. This framework is a means to assess the individual service offerings or plan for new offerings, rather than to determine a single technology path for the entire enterprise. When determining a new offering, some of the enterprise or project characteristics needed for an SCF assessment may

not be known *a priori*. For example, a Federal leader may need to estimate the rate of adoption by new customers. While there is always uncertainty with estimates, using estimates and known factors with the framework will help the Federal IT leader determine technology selections and ensure that none of the driving variables are omitted.

The appropriate use of the framework is to compare the characteristics of the service offering to the organizational and requirements factors. When leveraging the framework and factors specific to the implementing organization, such as financial resources and technological sophistication, it is anticipated that this information will point the Federal leader to the appropriate SCF category. This information can then be compared against the case studies listed for validation of the choice.

For more information on SOA, see http://www.mitre.org/soa.

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THE BIG PICTURE: Federal IT leaders are faced with a multitude of technical options when evaluating how to best serve their customers. MITRE's SOA Characterization Framework helps them compare characteristics of service offerings to organizational and requirements factors. The framework enables decision makers to see the technologies in the context of business constraints and objectives and thus make effective SOA implementation decisions.

SOA Characterization Framework

Larry Pizette
Salim Semy

SOA—Characterization Framework Overview

Federal IT leaders are frequently faced with a multitude of technical options for how to best implement their IT systems to maximize the value of their investment. For example, Alex Cullen from Forrester Research writes, "As few firms can shell out the funds for a complete transformation all at once, Forrester recommends placing tactical SOA investments in a planning framework for evolving to a strategic SOA platform." He goes on to identify steps on how to move an organization to an effective SOA, including analyzing existing software infrastructure, prioritizing new SOA capabilities, and ensuring investments evolve in line with business value.[3] While many of these activities are focused on the business and not the underlying implementation technologies, eventually IT leaders will have to specify particular technology investments to realize their business goals. When making this determination, Federal IT leaders frequently are faced with making decisions on the basis of subjective inputs of merit rather than using a structured decision framework that matches key needs to capabilities.

Consistent with all fielded IT investments, service provider implementation technologies should be selected to meet operational and business needs. "As with most software and platform choices, there is no one correct answer," notes Cutter Consortium's Michael Rosen. "Each enterprise must evaluate platform choices against business requirements and then integrate a platform into a business-driven SOA approach."[4] There are multiple factors that drive platform technology decisions. This paper focuses on two key dimensions—requirements and organizational factors—that form the basis of the SOA Characterization Framework (SCF).

Within the context of this framework, most enterprises will have a portfolio of services with a range of characteristics. The framework is a means to assess the individual service offerings, rather than to necessarily determine a single technology path for the entire enterprise. "Many IT shops will have to simultaneously deal with multiple starting points and paths for their SOA platform evolution. Perhaps one division has a priority for external services while another division needs rich enterprise integration,"[5] states Forrester's Randy Heffner. It is clear that there could be multiple service technology profiles in a large enterprise.

Dimensions of the Problem Space

For the SCF, the key requirements factors that impact a technology selection are performance, security, reliability, and service interface complexity. In addition to addressing the key requirements factors, the Federal IT leader should explore key organizational factors in determining the technology selection. For example, when technologies will be accessed by numerous organizations with limited

technical resources, simplicity can provide a significant advantage for ensuring successful adoption by the consuming organizations. In contrast, when a service is accessed by the IT staff from a small number of consumer organizations with deep technical capabilities, sophisticated technologies can be used. In these instances, the technologies will likely be integrated by the IT staff, and their use will be transparent to the end users.

Breadth and depth of requirements—Four areas of requirements have been identified as impacting the choice of technologies for the SCF. These are described below and then graphically depicted in Figure 1.

- **Performance:** Performance requirements across any distributed system, including an SOA implementation, are a fundamental factor impacting the technologies employed. From a business perspective, performance can be described in many ways (e.g., number of transactions per unit of time, response time for users). The performance, as perceived by the business, can be impacted by many factors, including the network and the type of information being exchanged. For example, American Standard Code for Information Interchange (ASCII) text information can be easily transmitted via SOAP;[6] however, binary data, such as video and pictures, need to be encoded and decoded when used with the same technology. As a result, transmission of video and pictures via SOAP requires more overhead. This processing need has implications on the performance of the service. Performance is essential, as noted by ZapThink's Jason Bloomberg: "enterprises simply cannot afford to trade away performance to achieve agility. As a result, architects must plan for performance up front, as part of their SOA planning process, and leverage a variety of techniques and solutions to achieve performance and scalability as well as business agility as the traffic to their services continues to increase."[7] Performance requirements can range from unconstrained to hard real-time.
- **Security:** Security needs should be considered at the outset of a technology selection, based on the constraints of the business. Security spans a variety of information assurance categories, including authentication, non-repudiation, ability to audit, granularity of security controls, and assurance that no unauthorized person or system has accessed or altered the information. For example, a "general information" news feed may have different security needs than a multimillion-dollar financial transaction or defense intelligence information system. Security requirements can range from simple transport-level security (e.g., HyperText Transfer Protocol/Secure [HTTP/S]) to an advanced level of security requiring content-based security[8] and associated policies.
- **Reliability:** Reliability refers to the level of guarantee that a technology can provide with respect to delivery of information. It is an essential factor for determining the technology to be employed. For information that is non-essential or can easily be requested again if it is not received, a "best effort" mechanism may be appropriate. Conversely, certain types of service offerings need to provide guaranteed delivery; this requires a different set of technologies, with cost and performance implications. The situation may be exacerbated if the guaranteed delivery of information needs to occur within a specific time period. For example, the aforementioned general news information could be transmitted on a best-effort basis, whereas the large financial transaction would need to be communicated with highly reliable mechanisms.
- **Interface complexity:** The flexibility and breadth of capabilities that an interface can provide are an important aspect of the technology selection. Continuing with the above example, an organization may need to provide a news feed that can be easily consumed across a wide number of organizations with a simple interface. Alternatively, an interface may be needed that can process complex, highly structured transactional data across a small number of high-value customers. Adding the ability to embed security assertions and the ability to accommodate multiple variations in data format while providing options for transactional integrity are features that can add to the complexity of the interface. Interface complexity ranges from simple—such as Really Simple Syndication (RSS) or HTTP/S—to complex—such as SOAP with transactional integrity, guaranteed delivery, and fine-grained security. Binary data such as video or custom interfaces can add to the complexity.

Organizational factors—Organizational factors can have a significant effect on the appropriate selection of technologies and techniques to interconnect

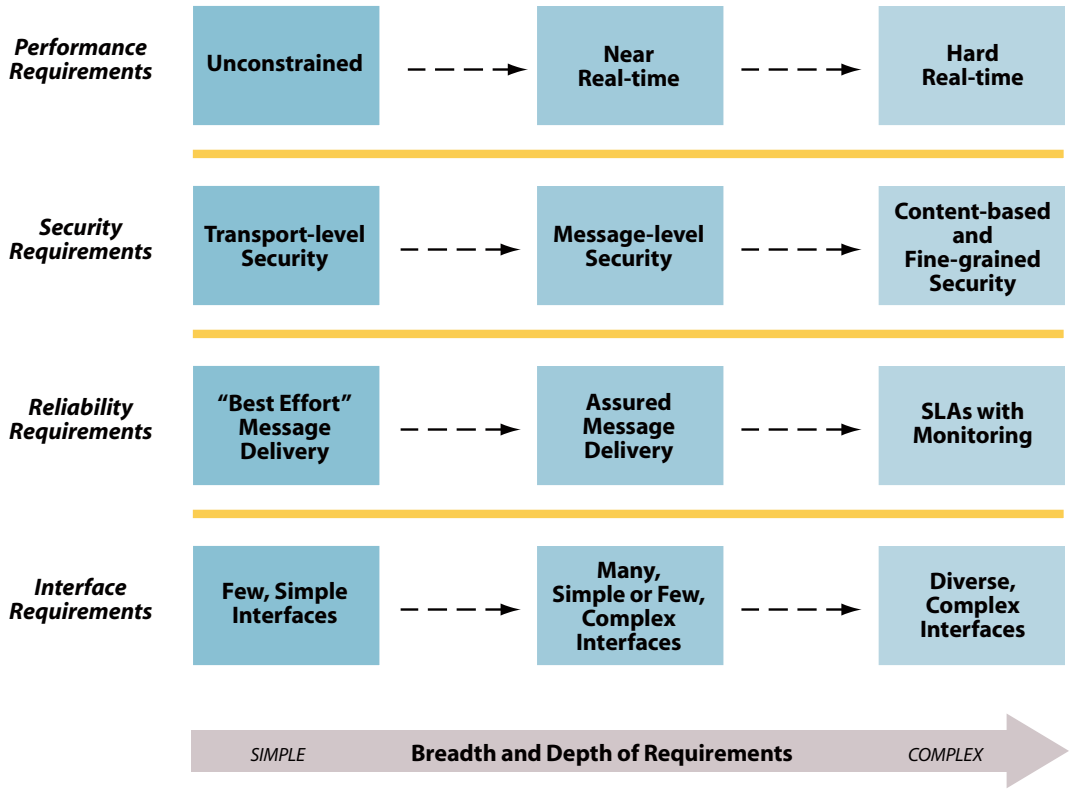

Figure 1. Requirements Factors

services. Heterogeneous or homogeneous stakeholders and their characteristics determine whether or not there is similarity in the depth of IT staff capabilities, financial resources for adopting new technologies, requirements similarity, common vocabularies for exchanging data, common policies, and the number of unique systems to integrate. The following seven organizational factors are shown in Figure 2.

- **Technological sophistication:** The technological sophistication of the organizations that are producing or consuming services can dictate the complexity level of the technologies that can be employed. Organizations with highly skilled technical staff may be able to leverage the capabilities of complex technologies, whereas organizations without skilled staff may require simpler technologies.
- **Costs and resources for deploying technology:** Costs of adopting new technologies and financial resources can be a limiting factor in deploying capabilities across resource-constrained organizations. Costs may include legacy system modifications, hardware purchases, software licensing, training for technical staff, and operational changes.
- **Requirements similarity:** If consumers and producers are homogeneous with respect to their requirements, it may allow for a choice of technology that uniquely fits their needs. However, if the consumers and producers are heterogeneous with diverse requirements, a solution that can meet broad needs may be a better fit.
- **Common vocabulary:** Homogeneous consumers and producers can simplify the definition of the data semantics. Conversely, significant consumer and producer diversity tends to add challenges with standardizing the data semantics.
- **Stakeholders:** As the number of organizations increases, the number of distinct stakeholders will increase. More heterogeneous stakeholders can drive complexity in the selection of technologies, due to the challenges of meeting their diverse requirements.

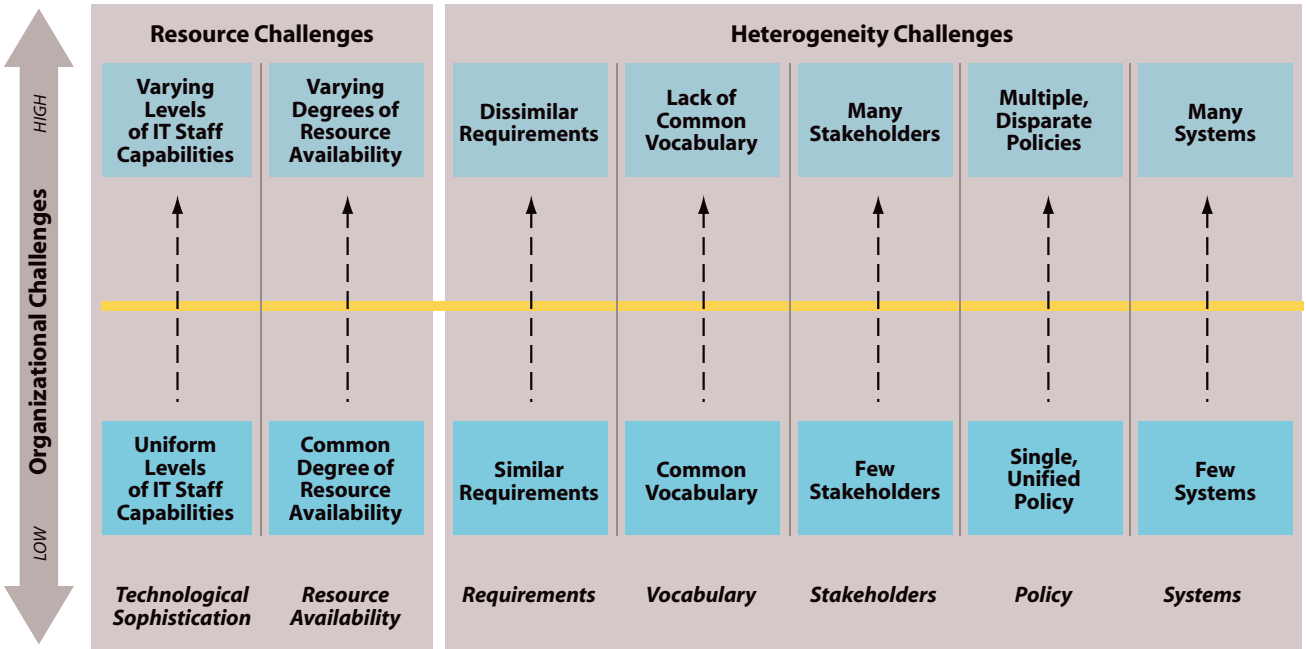

Figure 2. Stakeholder Organizational Factors

- **Disparate policies:** As the number of heterogeneous organizations consuming services increases, there will be more distinct policies involved and thus a need for more flexibility in the underlying technology.
- **System integration:** The broader the consumer base, the higher the probability that more systems will need to leverage the service; therefore, the technology employed needs to address a wide range of system integration challenges when many organizations are utilizing services.

Solutions for providing services to many heterogeneous customers may include accommodating their wide diversity of needs or may drive service providers toward a loose coupler concept, where small, well-understood nuggets of data with broad usage can be shared using widely deployed technologies (e.g., eXtensible Markup Language [XML]). Homogeneity of customers' levels of resources (i.e., IT staff capability and financial resources) may simplify the choice of appropriate technologies. When their available resources differ, however, the challenge is not always substantially greater. If some customers' IT staff have in-depth technological knowledge and/or significant financial resources compared with other customers, similarity in requirements across the customers may still dictate a common solution. When requirements are not similar, consensus solutions may become particularly difficult to identify when some customers with significant resources have more challenging needs than others but all are looking to work together in one enterprise.

SOA Characterization Framework Details

Employing the requirements factors across the horizontal axis and the organizational factors along the vertical axis in Figure 3, we have divided the characterization space into four quadrants that impact the selection of technologies. Although the boundaries among quadrants are inexact, this construct is still quite useful in thinking about technology choices.

Non-stringent requirements and homogeneous customer organizations—Projects with non-stringent requirements involving one or a very small number of homogeneous organizations can usually be completed quickly and at low cost. Technologies used in the development are often the most expeditious technologies available to the development team. For example, a business proof-of-concept project is useful for quickly demonstrating or validating business ideas with minimal cost.

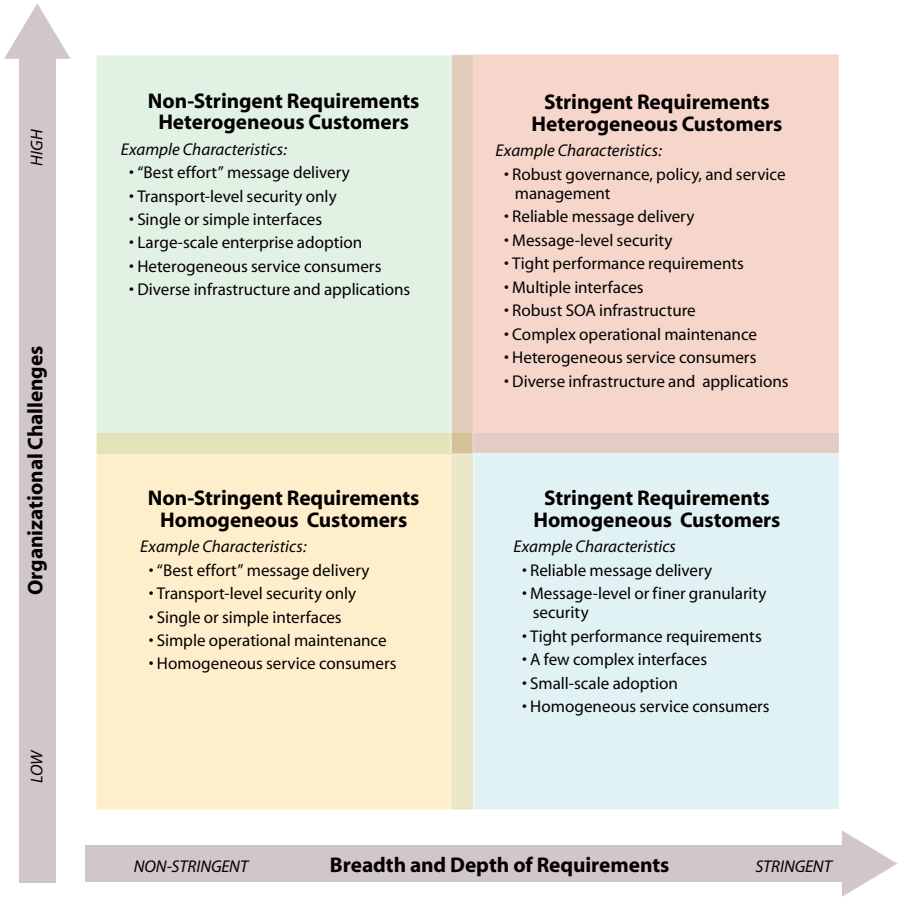

Figure 3. Characterizing Services

Proof-of-concept projects can help prove operational concepts and mitigate risks and generally have the characteristic of requiring less formal development practices, less rigorous tools, and limited numbers of users compared with a fully fielded capability.

- **Technology selection:** The technology selection should favor ease of use and ability to develop and deploy quickly.
- **Rigor vs. cost and schedule:** With a few homogeneous customers and non-stringent requirements, rigor could be reduced in favor of lower costs and a shorter development/deployment schedule.
- **Process:** Avoid heavyweight system and software engineering processes in favor of a lightweight approach. For example, the testing of services for a business proof-of-concept will not be as stringent or expansive as a production service.
- **Example technologies:** Consider Representational State Transfer (REST)[9] using HTTP/S.

Non-stringent requirements and heterogeneous customer organizations—For projects with non-stringent requirements and many participating heterogeneous organizations, technologies employed are frequently lightweight and can be easily adopted by heterogeneous organizations. For example, a general-purpose news feed can provide information in a consistent format across many organizations. Such lightweight capabilities usually do not require highly reliable messaging, and the flow of data may be unidirectional. This type of knowledge can be useful to an organization that disseminates information to widely disparate consumers.

- **Technology selection:** The technology selection should favor ease of adoption across widely disparate consumers using standards-based

technologies. It may be useful to keep the interfaces and technologies simple, given the potential for a significant number of diverse consumers to be using the service. This is especially important if the consumers are not technologically savvy or do not have deep IT resources. Small, easily exchanged data formats, known as loose couplers, may be useful for exchanging data. Two commonly used examples of data loose couplers are Universal Core[10] and Cursor on Target.[11]

- **Rigor vs. cost and schedule:** While the requirements for services in this category are non-stringent, consider using an increased level of rigor sufficient to adequately support external interfaces with many heterogeneous consumers.
- **Process:** Standard systems engineering processes normally employed by the provider organization should be sufficient for services in this category.
- **Example technologies:** Consider RSS that can be consumed by standard thin clients, such as an internet browser. Also, consider REST using HTTP/S.

Stringent requirements and homogeneous customer organizations—Projects with stringent requirements and one or a minimal number of homogeneous organizations demand known performance, robust security, and reliability guarantees, including service availability, quality/pedigree of data, timely message delivery, and completion of transactions. While the requirements are stringent in this category, the small number of stakeholders allows the technologies to be optimized for the participating organizations. For example, a command and control system that provides rich functionality to a limited set of intra-organization consumers would fall into this category. The small number of stakeholders allows implementation decisions to be optimized.

- **Technology selection:** The technology selection should favor industry standards that provide for a high level of capabilities in areas such as security, audit, and transactional integrity.
- **Rigor vs. cost and schedule:** Increased rigor in technologies employed should be favored over lower cost or time to develop and deploy the services.
- **Process:** Suggest leveraging comprehensive systems engineering (SE) processes to ensure service-level agreements (SLAs) can be met. Beyond standard SE best practices, the SE process for services in this category may include significant modeling and simulation and a wide range of testing under significant load and boundary conditions.
- **Example technologies:** Consider SOAP, Web Services Description Language (WSDL), Java Messaging Service,[12] and the REST approach using HTTP/S.

Stringent requirements and heterogeneous customer organizations—Projects with stringent requirements and many participating heterogeneous organizations demand known performance, robust security, and reliability guarantees, including service availability, quality/pedigree of data, timely message delivery, and completion of transactions. These projects also demand rigorous specifications of interfaces and require the ability to expose interfaces that meet heterogeneous consumer needs. Technology decisions need to consider both the depth of requirements and the breadth of potentially diverse and disparate consumers of services. This category could include a highly sensitive Government financial system with capabilities to handle very large transactions, or providers and consumers of services in many organizations.

- **Technology selection:** The technology selection should favor industry standards that provide a high level of capabilities in areas such as security, audit, and transactional integrity.
- **Rigor vs. cost and schedule:** Increased rigor in technologies employed should be favored over lower cost or time to develop and deploy the services.
- **Process:** Suggest leveraging comprehensive SE processes to ensure SLAs can be met. Beyond standard processes, the SE process for services in this category may include significant modeling and simulation and a wide range of testing under significant load and boundary conditions. Also, Federal IT leaders should consider enterprise governance policy requirements and the many heterogeneous users that may leverage the services. For example, service interface specifications may need to be put into a Federal repository and conform to repository standards. Data vocabularies may need to be defined and the data semantics may need to be coordinated with a broad community of interest (COI).[13]
- **Example technologies:** Consider SOAP, WSDL, Web Service Interoperability (WS-I) interface standards,[14] and Security Assertion Markup Language (SAML).[15]

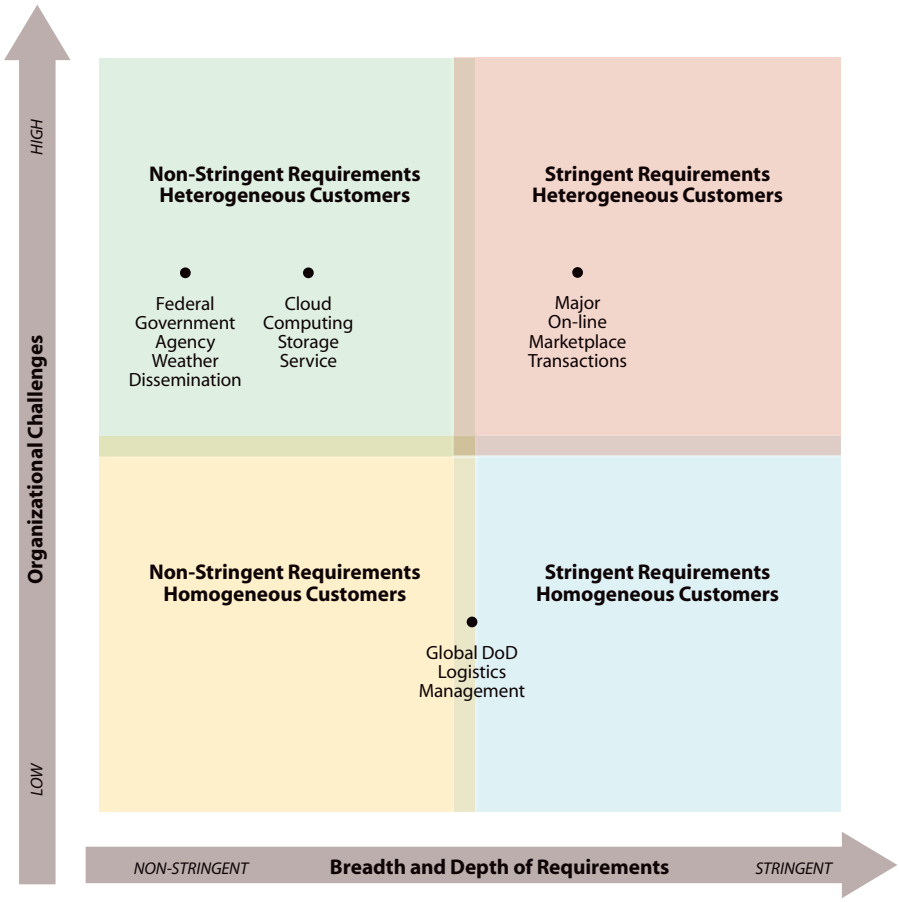

Figure 4. Characterization of Case Studies

Case Studies

These case studies provide Federal IT leaders with reference examples using the SOA Characterization Framework. The case studies demonstrate how to use the framework and validate the dimensions of the SCF by providing a mapping from problem space to solution technologies.

Case Study #1
Global DoD Logistics Management

Business overview: The global DoD logistics management service provides comprehensive insights into the global availability of U.S. military forces and provides senior decision makers with a process to quickly and accurately assess the impact and risk of proposed changes in force assignment. The global DoD logistics management service provides timely and accurate information along with a historical archive of data to authenticated and authorized users within a networked environment.

Problem space—requirements complexity:[16]

SIMPLE — Requirements Complexity — COMPLEX			
Interface	Few, simple interfaces	Many, simple, or few, complex interfaces	Diverse, complex interfaces
Performance	Unconstrained	Near real-time	Hard real-time
Security	Transport-level	Message-level	Content-based and fine-grained
Reliability	Best effort delivery	Assured delivery	SLAs with monitoring

The global DoD logistics management service makes its data available to a small set of combatant command organizations that share a common set of requirements. Security is largely based on transport-level security and usage of Government-only networks.

Communications reliability is considered to be best effort within a reasonable timeframe.

Problem space—organizational heterogeneity:

	Homogeneous	Heterogeneous
IT Staff Capabilities	Similar	Varying Levels
Availability of Resources	Similar	Varying Levels
Requirements	Similar Requirements	Dissimilar Requirements
Vocabulary	Common Vocabulary	Lack of Common Vocabulary
Stakeholders	Few	Many
Policies	Single, Unified	Multiple, Disparate
Systems to be Integrated	Few	Many

While use of the global DoD logistics management service spans multiple combatant command organizations, there is a consistent set of requirements across all consumers.

Solution space—service implementation: The global DoD logistics management service is an example of a capability that is useful across multiple organizations that are homogeneous in their use of the service. Furthermore, the data products, which have well-understood semantics, are made available using a consistent format defined by a COI.

The requirements for performance, security, and reliability are moderately but not highly stringent. The information needs to be accurate and protected; however, the response is not required within a specified amount of time, and security is at the transport level on a dedicated network.

The global DoD logistics management service was implemented using a SOAP-based solution to make data available through a well-defined interface to a known set of users. The SOAP interface can help provide rigorous capabilities and interface definition to the many users of this service. However, given the placement on the SCF, it would be reasonable to consider a simpler REST approach.

Case Study #2
Major, Online Marketplace Transaction Services

Business overview: A major online auction website provides an open trading platform for buyers and sellers to trade in an online marketplace through services. Sellers can list the items either as individual postings or establish an online store where multiple listings can be placed under a common seller. Buyers can browse listings within an online store or search for specific types of goods.

Transaction services are made available to buyers and sellers to interact with the online auction system. These services provide capabilities for the sale of items (e.g., buyers adding items to their shopping baskets), monitoring sales, adding listings to stores, or notifications to customers.

Problem space—requirements complexity:

	SIMPLE **Requirements Complexity**		*COMPLEX*
Interface	Few, simple interfaces	Many, simple, or few, complex interfaces	Diverse, complex interfaces
Performance	Unconstrained	Near real-time	Hard real-time
Security	Transport-level	Message-level	Content-based and fine-grained
Reliability	Best effort delivery	Assured delivery	SLAs with monitoring

Transactions associated with bids or sales are the core of the business and need to work within a tight set of requirements. The timely and guaranteed exchange of transaction data is essential to maintaining the function of the business (e.g., placing bids and selling items) and thus must be done in a timely and reliable manner. Furthermore, the transaction data may be sensitive (e.g., credit card information) and should be transmitted in a secure manner.

Problem space—organizational heterogeneity:

	Homogeneous	Heterogeneous
IT Staff Capabilities	Similar	Varying Levels
Availability of Resources	Similar	Varying Levels
Requirements	Similar Requirements	Dissimilar Requirements
Vocabulary	Common Vocabulary	Lack of Common Vocabulary
Stakeholders	Few	Many
Policies	Single, Unified	Multiple, Disparate
Systems to be Integrated	Few	Many

While users, buyers, and sellers work across a common set of policies as defined by the online marketplace firm, they span multiple organizations and represent different stakeholders. Common policies may mimic an intra-organizational environment, but given the multiple stakeholders, users may have varying requirements (from advertising individual items to a complete online store). Likewise, even when there are a common set of items for sale and consistent policies implemented by the firm, the way in which buyers search for items may vary.

Solution space—service implementation: Given the requirements of the transaction services and the characteristics of users, the firm has chosen an approach consisting of a formalized set of processes, policies, and message exchange since many users will use the service outside of the firm's organization. Policies such as practices for listing items and processes for completing sales are defined for sellers. In implementing their services, the firm has adopted a SOAP-based Web Service interface and an optional structured XML over HTTP/S interface, which uses the same schema for the data as the SOAP interface. These interfaces are more complex to use than a simple REST interface but provide an appropriate balance to maintain the integrity of the data.

Case Study #3
Large-Scale Commercial Cloud Computing

Business Overview: A large, commercial cloud computing vendor is offering a cloud-based data storage capability for the general public. With service-level agreements guaranteeing availability of at least 99.9 percent, users can store and retrieve their data in the cloud. The platform allows users to quickly scale storage needs up and down, as requirements change, and pay for storage and data transfer based on usage.

Problem space—requirements complexity:

SIMPLE **Requirements Complexity** *COMPLEX*			
Interface	Few, simple interfaces	Many, simple, or few, complex interfaces	Diverse, complex interfaces
Performance	Unconstrained	Near real-time	Hard real-time
Security	Transport-level	Message-level	Content-based and fine-grained
Reliability[17]	Best effort delivery	Assured delivery	SLAs with monitoring

The cloud capability is meant to provide an open environment in which heterogeneous and geographically dispersed users may leverage a storage capability in the cloud. Given the potentially diverse uses of storage, the services must be simple, easy to adopt, and provide enough security to keep the information safe.

Problem space—organizational heterogeneity:

	Homogeneous	Heterogeneous
IT Staff Capabilities	Similar	Varying Levels
Availability of Resources	Similar	Varying Levels
Requirements	Similar Requirements	Dissimilar Requirements
Vocabulary	Common Vocabulary	Lack of Common Vocabulary
Stakeholders	Few	Many
Policies	Single, Unified	Multiple, Disparate
Systems to be Integrated	Few	Many

The users of the cloud computing services can be diverse, given the general applicability of the platform and the multiple organizations and systems that leverage these capabilities. In addition, there also can be many heterogeneous systems interfacing with the cloud-based services.

Solution space—service implementation: Given the data layer capabilities offered by the platform, along with the diverse characteristics of the users, flexibility is more important than meeting custom requirements. In other words, the approach to develop the cloud storage offering is oriented toward providing an easily adoptable simple solution. The firm chose to make available both SOAP- and REST-based programmatic interfaces, which provide flexibility in the way a user interacts with the computing platform.

The choice to provide both interfaces exemplifies the flexibility that leaders can employ in their decisions. While this product's placement on the SCF grid as shown in Figure 4 would tend to suggest a REST approach, it is not an absolute. In this particular case, the firm wanted to make its offering available to a variety of users and determined that the benefit of accessibility was greater than the cost of supporting multiple interface types.

Case Study #4
Federal Government Agency Weather Service

Business Overview: A Federal agency provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, and adjacent waters. The agency's products populate a national information database that is accessed via services by Government agencies, the private and public sectors, and the global community.

Problem space: requirements complexity

SIMPLE — Requirements Complexity — COMPLEX			
Interface	Few, simple interfaces	Many, simple, or few, complex interfaces	Diverse, complex interfaces
Performance	Unconstrained	Near real-time	Hard real-time
Security[18]	Transport-level	Message-level	Content-based and fine-grained
Reliability	Best effort delivery	Assured delivery	SLAs with monitoring

The agency's weather service makes its weather data products available through a small set of interfaces that can be used easily across a large community. For the majority of users, the weather products are used only for informational purposes; thus, the performance and reliability of delivering the products is on the level of best effort. This allows the service to disseminate the products to a large group of users while not constraining the ease of use of the service. Furthermore, given the limited sensitivity of disseminating public weather products, security is minimal.

Problem space: organizational heterogeneity

	Homogeneous	Heterogeneous
IT Staff Capabilities	Similar	Varying Levels
Availability of Resources	Similar	Varying Levels
Requirements	Similar Requirements	Dissimilar Requirements
Vocabulary	Common Vocabulary	Lack of Common Vocabulary
Stakeholders	Few	Many
Policies	Single, Unified	Multiple, Disparate
Systems to be Integrated	Few	Many

Since there are many stakeholders, the use of the weather service data may vary. For example, the public sector may use the service purely for informational purposes, while a Government agency may use the data for informing specific analyses or to augment other data products. A Government agency may also have varying policies for employing and interpreting the information.

There will likely be multiple systems that will interface with the weather service to use its products. Therefore, it is important to maintain flexibility and simplicity in the service offering to support the heterogeneous use of the service.

Solution space—service implementation: The weather service is an example of a specialized set of capabilities provided to a large set of people. The requirements for performance, security, and reliability are not stringent. (For this example, it is assumed that the service is not the primary means for tornado warnings and similar emergency weather alerts.) The data products are a small set of products using a consistent format that are made available to many users.

The agency's weather service was implemented using an RSS-based solution to make data available in an easy and standard manner to many people. RSS is a good fit for this service because it is easy to use. Also, due to its standard format, RSS can be easily accessed through common desktop applications, generally without the help of IT staff.

While the weather service offering is in the same quadrant as the cloud storage case, which leverages a REST- and SOAP-based approach, there are different requirements affecting the choice of weather service technology. For example, the weather service needs to widely disseminate consistent information to all users in a standard format, based on selected location and day/time. In contrast, the cloud storage capability needs to reliably authenticate users and provide capabilities for customers to store, retrieve, and delete large amounts of data. This capability lends itself to a REST- or SOAP-based approach, whereas the weather service requirements fit well with the capabilities provided by an RSS approach.

Conclusion

As demonstrated by the case studies above, the SCF can help Federal IT leaders to determine the most advantageous SOA implementation technology selection on the basis of requirements and customers' organizational factors. While the SCF doesn't specify an absolute choice, it can help its users to view the selection of implementation technologies in the context of their business objectives and constraints. By using the SCF, Federal leaders can take advantage of the best technologies for their service offerings and make sound, effective SOA-based implementation choices.

References

[1] For traditional, hard real-time applications, the SOA technologies described in this paper may not be appropriate.

[2] In this context, content-based security is message-level security applied to specific data elements.

[3] June 27, 2008, "CIOs: Use an SOA Investment Road Map to Reach Strategic SOA, Avoid Duplication and Incompatibility with Justifiable Investment Increments," by Alex Cullen
http://www.forrester.com/Research/Document/0,7211,46232,00.html.

[4] Vol. 7, No. 7, "Implementing an SOA with Common Technologies," by Michael Rosen, Senior Consultant, Cutter Consortium.

[5] May 16, 2008, "How To Build Your SOA Platform, To Evolve an SOA Platform, Build From Tactical Needs Toward a Strategic Vision," by Randy Heffner with John R. Rymer and Kahini Ranade.

[6] Note that SOAP is no longer considered an acronym. For more information, see
http://www.w3.org/TR/2003/REC-soap12-part0-20030624/#L1153

[7] August 2008, "Performance Scaling SOA Implementations Now and into the Future," Jason Bloomberg.

[8] In this context, content-based security is message-level security applied to specific data elements.

[9] REST provides a set of architectural constraints that, when applied as a whole, emphasizes scalability of component interactions, generality of interfaces, independent deployment of components, and intermediary components to reduce interaction latency, enforce security, and encapsulate legacy systems.
http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm

[10] http://metadata.dod.mil/mdr/ns/ces/techguide/universal_core_uc.html

[11] http://cot.mitre.org/bin/view/CoT/

[12] http://java.sun.com/products/jms/

[13] The Department of Defense (DoD) Chief Information Officer (CIO) Information Management Directorate Net Centric defines a COI as "a term used to describe any 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."
https://acc.dau.mil/GetAttachment.aspx?id=18027&pname=file&aid=604&lang=en-US

[14] http://www.ws-i.org/

[15] http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=security

[16] The yellow boxes highlight the terms that apply to the particular case being discussed.

[17] Guarantees 99.9 percent availability through their standard offering; however, the interconnect technology does not provide assurance of message delivery.

[18] This service does not use transport-, message-, or content-based security.

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Distribution Unlimited
Case Number: 09-3233
Document Number: MTR090337

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