

The Service Oriented Architecture Method for Federated Enterprise Architectures

By Thomas Mowbray, Grant Chanachote, Bruce Fenchel, and Mark Odell

Abstract

The Services Oriented Architecture (SOA) Method for Federated Enterprise Architectures (EA) comprises an integrated set of techniques for enterprise analysis, contextual visualization, decision support, and portfolio management. The method utilizes state-of-the-art SOA concepts and artifacts to produce federated community architecture designs supporting mission and business transformations. The resulting architectures are not exclusive to the SOA paradigm and can be engineered and implemented using a variety of techniques such as functional decomposition, component oriented, SOA, or COTS-centric methods. The SOA EA method produces and applies advanced artifacts and tools including Enterprise Component Maps (ECM), heat maps, business intelligence dashboards, and EA line-of-sight models for decision support and portfolio management. The authors tailored the method from a precursor SOA method that was heavily exercised in practice. Tailoring extended and applied the EA metamodel to support decisions such as IT consolidation, information sharing, programmatics, and portfolio management. The method integrates with federated system lifecycles in consideration of downstream uses of the artifacts produced. Intended for application to community-level architectures, the method is lightweight, extensible, agile, and can produce actionable architectures. We also present some sample artifacts from a security EA case study.

Keywords

enterprise architecture, reengineering, components, services, federation, SOA, portfolio management

INTRODUCTION AND RELEVANT WORK

Architecture is the leading edge of design, capturing the most critical decisions for a mission or business solution, as a set of constraints for engineers to elaborate. The Federated SOA EA Method can produce architectures that link concepts from business analysis, SOA, and systems architecture into a lifecycle value chain that produces actionable plans for acquisition and implementation.

The Federated SOA EA Method combines best practices from the fields of SOA, EA, software architecture, and security management to produce actionable architectures. (Sherwood, 2005) The method is performed at the inception of system lifecycles, and produces actionable

target architectures for elaboration into requirements, designs, acquisitions, configurations, and deployments.

Figure 1 portrays a generic system lifecycle from initial business strategy through deployment and operations. Shown are commercial best practices that the authors have applied throughout their careers defining mission and business architectures, such as the District of Columbia Citywide EA (Mowbray, 2005). The top half represents Phase 1 activities from early business analysis through the delivery of actionable plans for acquiring a business solution. The bottom half of Figure 1 represents downstream activities such as requirements analysis, acquisition, gap analysis, design, configuration, test, deployment, and operations.

Phase 1 results should consider and support all those downstream activities. In practice, Phase

1 occurs prior to the inception phases of methods such as IBM Unified Process.

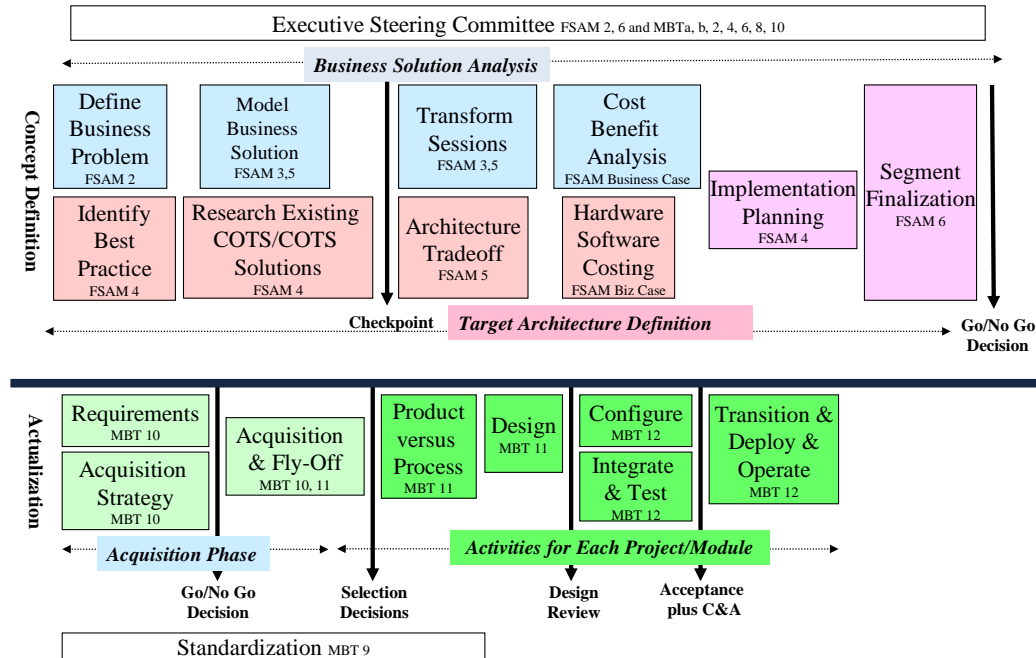


Figure 1. End-to-End EA Lifecycle Value Chain

The purpose of information technology (IT) is to automate mission/business processes to realize enterprise strategies. Ideally, Phase 1 produces to-be mission/business processes, a business case, a target solution architecture, an implementation plan, and most importantly, strong executive and functional agreement on the need for these changes. To-be mission/business processes define how the enterprise practices will change. The business case defines the qualitative and quantitative benefits as outcomes of transformation. The target solution architecture defines the goal state of the implementation. The implementation plan defines the activities for organizational change and realization of the target architecture.

All of these elements are essential for an actionable transformation plan. As an example, consider the two disciplines required to produce these results: business consulting skills and solutions architecture skills. While the Phase 1 team should be primarily business consulting-driven; a lack of architecture skills leads to a superficial target architecture that never properly defines what should be built, resulting in invalid estimates and an unrealistic plan (Brown, 1998). Conversely, a Phase 1 team dominated by IT and architecture skills, usually avoids

mission/business change and cost-benefits analysis, potentially automating a bad business process and delivering no measurable benefits.

Both aspects are necessary to make the Federated SOA EA method produce successful architectures, solutions that get built and deliver benefits. The focus of the method is the Phase 1 target solution architecture. Target architectures should be mission/business-driven, and we include in the method, essential business analysis activities which drive the architecture.

Figure 1 also shows correspondence to 2 other EA methods, the Federal Segment Architecture Method (FSAM) and the Department of Interior's Methodology for Business Transformation (MBT). (CIO Council, 2009). FSAM is a Phase 1 segment architecture method; whereas, MBT applies to the full lifecycle. We believe that FSAM is a method adapted from MBT for use across multiple agencies. The Federated SOA EA method could be used with FSAM, supporting FSAM Steps 4 and 5. The key differences between the methods are the artifact templates, SOA concepts, business intelligence (BI), TOGAF-like analysis, reliance on EA/BI tools, and our emphasis on lightweight agility of the method and it's artifacts. (TOG, 2009) The

Federated SOA EA method is intended to be applied at the family of systems level across entire communities of EAs for decision-support, federated segment elaboration, and portfolio management.

METAMODEL CONCEPTS AND EAMT SCENARIO

We can explain the Federated SOA EA's metamodel by way of example. Metamodels define the universe of discourse for EAs, clearly defining concepts which can be instantiated in architecture models, such as components, services, and interfaces. (Bernard, 2005) Metamodels also define relationships between concepts for trace-ability, line-of-sight, visualization, and queries. The DODAF Common Architecture Data Model (CADM) is a useful metamodel, but lacks many of the essential concepts from our financial, programmatic, and portfolio management domains. In this scenario, we also transform reference models into architecture models and vice versa. A clear understanding of what this means is essential for applying the method (see Figure 2).

Portfolio management decision support is an example of how the Federated SOA EA Method is applied in practice. The following scenario runs on the EA Management Toolkit (EAMT), including IBM/Telelogic System Architect (SA), Enterprise Elements (EE), and Oracle Business Intelligence (OBI). SA visualizes concepts and relationships; EE can manage extract-transform-load, metamodels, and the repository; and OBI visualizes queries, reports, dashboards, and heat maps. Storing EA data relationally outside EA tools is essential for integration between tools such as portfolio management, to automatically instantiate relationships, to execute advanced multi-join queries, and to support business intelligence analysis.

The scenario starts with the Enterprise Component Map (ECM) which visualizes the entire enterprise on 1 sheet (see Figure 3). The elements on the ECM are Enterprise Components (EC) that represent logical business units in the to-be, consolidated enterprise. Each EC corresponds to an existing or proposed Business Reference Model (BRM) sub-function. (OMB, 2007) The ECM is organized in terms of competency columns such

as human resources, finance, security, mission-specifics; and stratified into levels including Planning/Strategy, Management, and Execution. Subject Matter Experts (SME) who are knowledgeable about the relevant mission/business competencies (ECM columns) are essential decision-makers during this phase; EAMT is teeing up decision-support artifacts to the SMEs from its up-to-date EA repository. We visualize a number of heat maps in the scenario for decision support. A heat map takes perhaps a 3 or 5 point scale (e.g. low-medium-high or <\$1M, 1-5, 5-10, 10-50, >\$50M) and visualizes it as colors, positions, or sizes on a dashboard graphic. For example, we could visualize the total investments in each Enterprise Component. We could show the total number of sustainment investments, which is analogous to the number of systems. How many systems are out of compliance with security or standards mandates? Or how many projects are at risk? We have identified over a dozen heatmap dimensions which may be useful for decision-makers.

Utilizing the ECM as if it were a reference model (taxonomy), we map each enterprise investment to an EC using BRM mappings, then heat map the grouped investments in aggregate. The SMEs pick one or more ECs to further analyze for potential consolidation, integration, or cost avoidance. Using the Federated SOA EA Method, the selected ECs are decomposed into Enterprise Services (ES). The ESs are laid out on a dashboard and the investments are mapped to them, using the Service Reference Model (SRM) mapping or equivalent. (OMB, 2007) The architecture model instances, ESs, are utilized as if they were taxons to categorize investments. Heat maps are applied, and the SMEs pick one or more ESs for in-depth analysis.

The decomposition process is recursive, and the categories can be divided into smaller scopes until it is fair to say that the grouped investments are overlapping. For example, suppose the ESs were correspondence tracking systems, work order systems, and call center systems. Why would any enterprise need many dozens of investments in any of these ES taxons, unless the investments were highly duplicative? According to Gartner Group, more than half of most enterprises' systems are unnecessary; in effect, if portfolios are managed very efficiently,

as much as half the existing investments can be avoided.

To end this scenario, the investments within each ES are compared side by side, perhaps by attribute values or heat maps. When is the decommissioning date of the systems? How many users? How many transactions? What are the other benefits or consequences of each investment or system? For example, suppose one system has only 20 users, another system is non-compliant with policy, a third will be decommissioned this year, and a fourth has 10,000 users and 10 more years lifecycle. We could migrate the users from systems 1, 2, and 3 to system 4, and save the investment costs.

SOA EA CONCEPTS

The Federated SOA EA Method traverses and instantiates metamodel concepts to provide clear linkage from the mission or business to automated services. Generation of these concepts requires multiple traversals from reference model spaces to architecture spaces, and vice versa.

In the previous section, we introduced the ECM, EC, and ES concepts. Enterprise Services (ES) comprise both human activities and automation.

The automated activities are called Technical Services (TS). Enterprise Services communicate by exchanging Commodities of Business (COB). TSs communicate through Technical Interfaces (TI).

Instances of these key metamodel concepts are identified, defined, and decomposed (or elaborated) in the Federated SOA EA Method. The formal definitions of these metamodel concepts are modified from previous unpublished work and tailored to the needs of federated community architectures and portfolio management (see Acknowledgements).

The method extends the use of common EA concepts in novel ways that requires greater clarity. (OMB, 2007) For example, an EA Framework is an defined set of concepts and (optionally) artifact templates that guide the specification of architectures. The most detailed level of an EA framework is its metamodel. The Federal Enterprise Architecture (FEA) is not a framework in this sense; instead FEA comprises *reference* models, which are taxonomies. (OMB, 2007) EA frameworks, such as DODAF and RM-ODP, define concepts, constraints and guidelines for *architecture* models. (Putman, 2001).

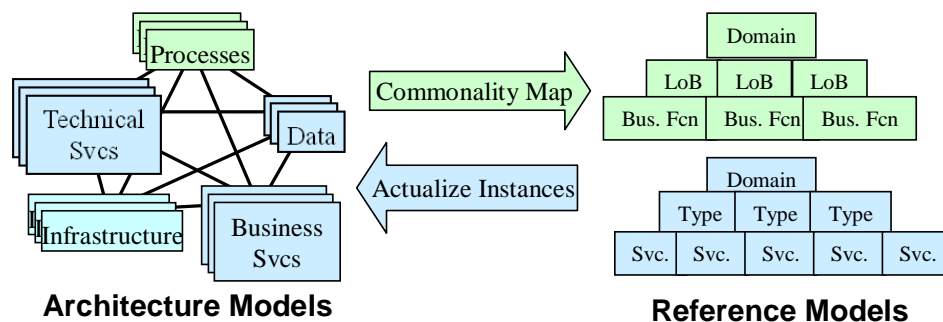


Figure 2. Transformation between Architecture Model and Reference Model Spaces

Figure 2 explains how architecture models and reference models interact. Architecture models comprise instances of metamodel classes. Architecture models represent things like business activities, business information, web services, and networks. Reference models are taxonomies (categorical containers) used to characterize and group similar architecture instances and investments. In the Federated SOA EA Method, we frequently transform

architecture models to reference models and vice versa. (See the next section.) We map from architecture to reference spaces to find commonality and overlap. We actualize reference models as a starting point for architectures. We can repurpose an architecture model, as if it were a taxonomy to find commonality at different scopes.

METHOD SUMMARY

The Federated SOA EA Method produces architectures using state-of-the-art artifacts from SOA, EA tools, and business intelligence (BI) tools. The method is documented as courseware with 3 dozen templates and sample artifacts linked from the visuals. Some of the key principles and goals of the method include:

- Actionable Architecture Results
- Support Fact-Based Decisions (make decision contexts visible)
- Minimal Artifacts – No Make Work

- All Artifacts have Downstream Utility
- Agile Essential Core Attributes and Extensible Method
- Vendor and Product Neutral
- Paradigm Neutral – Not OO, Not “Structured” (accommodates all paradigms)

Figure 3 below is a sketch of how the method works. The Enterprise Component Map (ECM), a map of the entire enterprise, is examined by SMEs with collateral artifacts such as portfolio reports. An area of the ECM is selected for further analysis. A summarized ECM is created and heat mapped using BI tools.

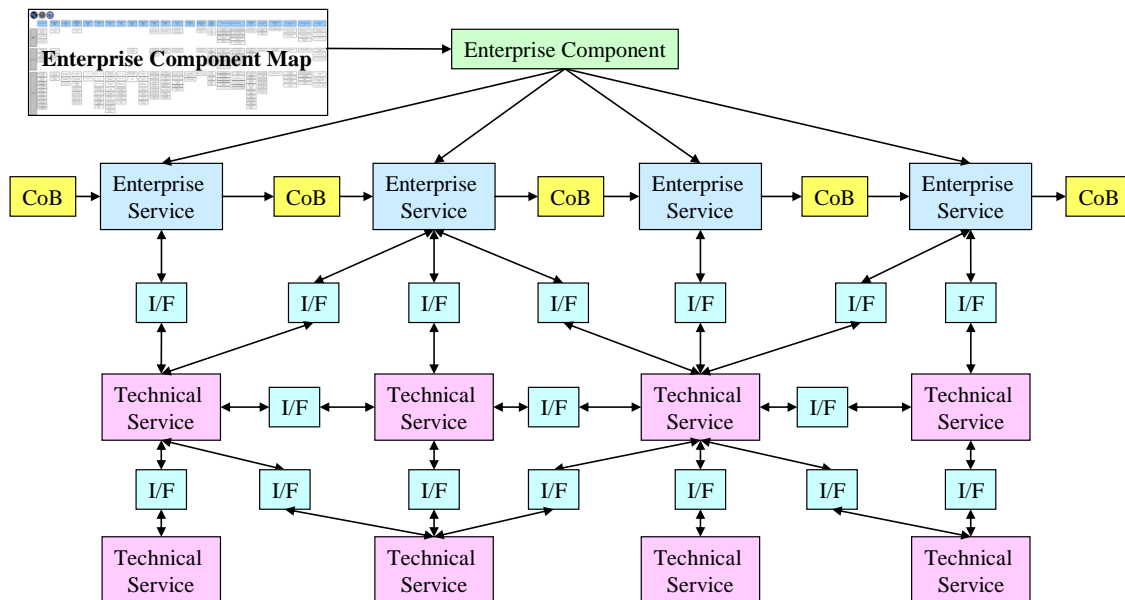


Figure 3. Federated SOA EA Decomposition into Architecture Entities

One or more Enterprise Components (EC) are selected for decomposition. Both the mission/business services and the information flows of the EC are identified in the EC template (Figure 4). The Enterprise Services (ES) decomposition can use the FEA SRM as a

starting point (realizing Service Components as service instances). Each ES is then defined in the ES template, which identifies business functions and business objects (exchangeable information). Potential for automation is identified at this level too.

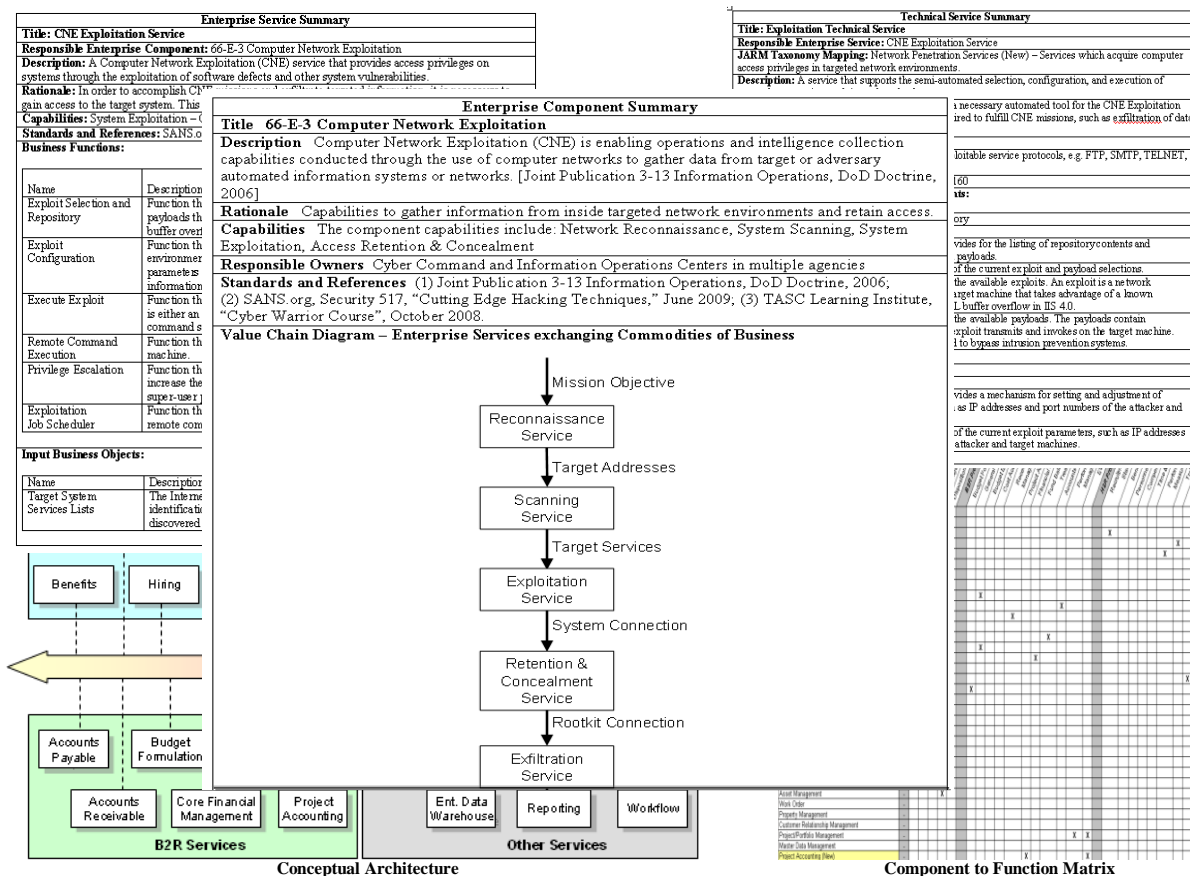


Figure 4. Federated SOA EA Decomposition into Architecture Entities

A survey is conducted to identify Technical Service (TS) categories within the EC scope. Each TS represents an automated service such as an ERP module, a software application, or a web service. The survey identifies best in class commercial off-the-shelf modules, reusable government modules, and installed applications and services. A special-purpose taxonomy is formed from this survey and related taxonomies. The implementations are set aside. The taxonomy is then used in a TOGAF-style matrix for mapping TSs to business functions from the ES template. As a result, we are transforming the TS taxonomy back into architecture space. The matrix identifies which TS will support which business functions. The TS template includes further functional and data decomposition.

A conceptual architecture sketch is created, including horizontal services, such as enterprise service bus, master data management, directories, warehouses, reporting tools, and security. The TS survey and the EA repository

are used to identify and analyze candidates for reuse. A number of alternatives are presented to stakeholders for system transformation. Based on reuse decisions, an architecture footprint is visualized in EAMT with interfaces between new, reused, and feeder systems (systems outside the EC scope). These Technical Interfaces (TI) are defined using the TI template. The target architecture is then integrated into actionable plans from Phase I.

SECURITY EA CASE STUDY

We have performed a number of EA analyses using the Federated SOA EA Method artifacts and techniques in diverse domains such as portfolio management, mission architectures, and business transformation. To create an interesting SOA EA case study that we can share widely, we chose the domain of IT security, in particular Computer Network Operations (CNO).

CNO is a capability within Information Operations (IO). We had not previously elaborated CNO on an ECM, so we performed modeling using IO concepts found in DOD doctrine. (DOD, 2006). We modeled a summarized ECM for IO. This defined a new ECM competency (column) with ECs at the strategy/planning, management, and execution levels. We used the ECM to select an EC for decomposition: Computer Network Exploitation (CNE). See Figure 4 for example artifacts.

CNE architectures are commonplace in the wild on the Internet, for example (Stone-Gross, 2009). Finding nothing in the FEA SRM about this domain, we used industry best practices to decompose the EC into ESs. (TLI, 2008; Skoudis, 2009) The resulting services (Reconnaissance, Scanning, Exploitation, Retention & Concealment, and Exfiltration) interchange Commodities of Business (COB) in our value chain diagram. (Figure 4) The EC template defines the ESs, COBs, and includes point and systemic performance metrics.

The CNE Exploitation Service was elaborated, documenting its business functions and business objects. We indicated on the ES template which business functions should be supported by automation. The input and output business objects were also identified, and a detailed service use case was elaborated based upon hands-on scenarios. (TLI, 2008; Skoudis, 2009)

This being a fairly narrow domain, we used sample artifacts from a business transformation architecture for the TS survey and the TS to business function matrix (see Figure 4).

The business functions were decomposed into Technical Components using the TS template. Technical Components are the lowest level of decomposition in Phase 1; each corresponds to a primitive object on a detailed target architecture model (i.e. poster). The business objects are decomposed into major attributes. Attributes can be marked in the TS template for master data management (data integrity through controlled vocabularies).

Finally, the Technical Interface (TI) template was completed to identify the interchanges between TSs. The time it takes to perform the method varies depending upon the complexity of the components and the ready availability of SME

and source information. An approximate functional allocation of the time needed to complete each artifact is: ECM 15%, EC 30%, ES 30%, TS 15%, TI 10%. Based on previous case studies using similar techniques for HR/procurement, law enforcement, CRM, health information sharing, and document management architectures, a good enterprise architect working with a business consulting team should be able to complete significant target architectures within 6 to 10 weeks, including hardware/software cost estimation.

CONCLUSIONS AND FUTURE WORK

The Federated SOA EA Method is a lightweight method suitable for community-level architectures that makes decision contexts visible for purposes such as information sharing, consolidation, cost avoidance, and portfolio management.

In future work we plan to extend the method for further exploitation and integration of EA, BI, budgeting, and portfolio tools. We are planning the consolidation of numerous agency and program-level EAs into community repositories, as some DOD agencies have done.

In the long term, we envision attaching semantic metadata to all appliances on government networks, for dynamically updated operational pictures of our EAs. In that environment, we could focus our EA modeling almost exclusively on human processes, and connect those to the up-to-date IT models to support strategic, operational, and tactical business decisions. Through virtualization and provisioning, the EA and IT lifecycle could become much more agile and responsive to business needs, closing the gap between business changes, development lead times, and deployment.

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