Enterprise Business, Computing, and Information Services in a Multi-Agency Environment: A Case Study in Enterprise Architect-Engineering

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***Abstract*—The modernization of computing, communication, and information services is a high-risk venture in any environment. It has proven even more difficult to fully align these services with the high-performance operational objectives of enterprises. Enterprises are expected to have information environments that fully integrate business processes and systems to deliver optimal products and services, and high-quality business outcomes for both internal and external stakeholders. Many of the challenges faced by modern society – international trade, health care, national security – require even more complex multi-agency responses involving public and private networked institutions cooperating on a global scale. The effective integration of their information systems with modernized business processes is an absolute requirement and a major engineering and governance challenge.**

This paper describes a Case Study developed in a research program sponsored by The MITRE Corporation (MITRE) that applies Enterprise Architecture and Engineering tools and methods to monitor and manage international trade in an environment of heightened security risk. The approach uses web service and semantic technology as "Enterprise Middleware" to integrate Enterprise Architectures with Geographic Information System (GIS)-based business performance modeling and planning tools in an Integrated Enterprise Engineering Workbench (IEEW). Full alignment of enterprise information services with business processes is achieved by applying governance principles of Activity-Based Management (ABM) and Enterprise Resource Planning (ERP).

***Keywords*—Information Systems, Management, Architecture, Modernization, Managed Service, Multi-agency, Performance Analysis**

Manuscript received July 8, 2005. This work was supported by the MITRE Sponsored Research (MSR) Program

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I. Introduction

GOVERNMENT and commercial operations increasingly require the integration of a complex mix of business activities, and services from multiple public and private organizations, to perform missions (and deliver services) of high national importance. When these operations are to be modernized to reach higher levels of performance through new business processes supported by advanced technology and information systems, they present unique engineering and governance challenges that demand increasingly powerful analytical capabilities.

Programs to modernize computing, communication, and information services are high-risk ventures with very low success rates. It has proven especially difficult to align these services fully with new business processes that are often deployed at the same time. The enterprise transformation that is required involves all elements of an enterprise – management, organizations, technology, and information. Further complicating these efforts are the rapid pace of technology advancement and the emergent behavior it facilitates within and external to the enterprise. Increasingly, the required performance of enterprise information systems is fully known only in retrospect. Hence the enterprise architect needs to plan for uncertainly and build in agility. While organizations are "groping and coping" with these challenges, the increased demand for multi-agency services is raising risks to an even higher level.

A number of management and engineering tools and methods have been developed and employed for specific aspects of enterprise planning and analysis. This paper describes the results of a Research program sponsored by The MITRE Corporation (MITRE) that surveyed this range of tools and methods, and then selected a set to comprise an Integrated Enterprise Engineering Workbench (IEEW) with the scope needed to address the very complex multi-agency operational environment. The IEEW implements a web based enterprise planning and management approach that allows decision makers to visually plan for operations performance. With this integrated planning tool set, and web enabled

capability, one can readily drill down to the lower level details of principal elements of the IEEW, including:

- Enterprise Architectures – describing tangible, and some intangible, aspects of an enterprise using a variety of common frameworks
- Business Process simulation models – for dynamic representation and measurement of business operations and supporting services and resources required to perform the enterprise mission and/or deliver services to the citizen
- Geographical Information System (GIS) – to portray the spatial, environmental, and demographic dimensions of the operations
- A common repository to assure consistent information content across the tool set, and to integrate tools and methods using web services and semantic technologies

Multi-agency operations vary in their complexity and are increasingly "networked" at stakeholder, organizational, business process, and information services levels (the "Net-Centric Enterprise"). Their missions range from planned operations performed on a continuous or repetitive basis (veterans' health care, cargo and passenger clearance in international trade) to those performed on an intermittent, reactive or proactive basis in response to an emergency (joint military missions, disaster recovery). Continuous or repetitive tasks allow for constant organizational improvements; under these circumstances, the IEEW may be applied at regular planning intervals to manage and measure such progress, and when major investments are planned related to business processes and/or information services. For intermittent tasks, a gaming approach may be used in conjunction with applicable elements of the IEEW, particularly in cases where the situation may vary, requiring ad hoc responses, and organizations must interact in new ways.

The IEEW was developed and is applied to the Case Study from the perspective of governance of multi-agency operations. "Governance," in its largest sense, deals with all management aspects of an enterprise, including stakeholder relations and the public good [1].

"A good corporate governance regime helps to assure that corporations use their capital efficiently. Good corporate governance helps, too, to ensure that corporations take into account the interests of a wide range of constituencies, as well as the communities within which they operate, and that their boards are accountable…."

These corporate governance principles apply equally to the government sector, to both individual and multi-agency "enterprises." The working definition of governance applied in the Case Study focuses on the important mission-oriented aspects of managing operational activities and modernization programs with significant technological content in a way that meets management's obligations to stakeholders—in short, the efficient use of capital, both human and financial. This working definition is drawn from the Information Systems Audit and Control Foundation [2]:

"The set of responsibilities and practices exercised by the board and executive management with the goal of providing strategic direction, ensuring that objectives are achieved, ascertaining that risks are managed appropriately, and verifying that the enterprise's resources are used responsibly."

A sound governance structure is essential in the multi-agency environment where responsibilities, authorities, and accountability for both technical and operations management are widely distributed and must be coordinated for effective performance. This situation can involve varying degrees of centralization of governance authority ranging from an overall operations manager (or coordinator) to the other extreme of a distributed collaborative management team. The IEEW applies across this spectrum and encompasses mission descriptions as well as all the assets and resources needed to perform the mission. As such, the IEEW represents a major planning and analysis asset for governance in complex operational situations.

The definitions for governance establish specific requirements for the IEEW to fully describe mission activities and their performance objectives along with the management structures, human resources, tangible assets and information services required to perform an enterprise mission.

The objective of the IEEW is to support a complex governance environment for very close coupling of strategic planning, and technical and operational management, by integrating the basic planning and management tool set within a performance dashboard. It provides the ability to continually identify potential operational capabilities associated with technology modernization, strategic plans, and performance plans.

II. The Integrated Enterprise Engineering Workbench (IEEW)

The Integrated Enterprise Engineering Workbench provides a suite of Commercial-Off-The-Shelf (COTS) and MITRE-developed planning and analysis tools for the governance of enterprise transformation. Because the multi-agency environment generally involves a spectrum of such commercial products, the emphasis in the IEEW is on utilizing common standards and protocols, including semantic principles, so that the tools, whether COTS or custom, can share information working off a common planning repository.

Integration of these tools is accomplished through a consistent definition of planning content covering business and mission operations as well as the supporting information services and their technical features. The use of Activity-Based Management [3] principles in describing the mission and business operations of the enterprise are key to defining supporting information services to improve the operational performance of the enterprise. Activity-Based Management methods, coupled with integrated planning, management, and execution systems such as Enterprise Resource Planning (ERP), play an important role in enterprise management and governance supported by the Workbench design.

For the purposes of this case study, Mission Activities are defined as: A combination of people, technology, raw materials, methods and environments producing a given product or service. Activities defined in Enterprise Architectures can provide a common definition for organizational roles and responsibilities, performance monitoring, financial reporting and operations management.

Coupling mission performance with business and information services and systems is based on a full definition of the business, computing, communications, and information services (e.g. workflow management, account management, Enterprise Resource Planning, image processing, analytical processes, data management, secure messaging), that are required to support the mission and business activities.

The core elements of the IEEW are illustrated in Figure 1 and include the following elements applied in sequence:

1. Operations Plans and Scenarios

The initial plan and operations scenario for the multi-agency mission provides the focus and content for the simulation and architecting steps to follow. The plans and scenarios will be updated and improved as a result of the analyses performed using other elements of the IEEW, particularly the performance analysis capabilities.

2. Performance Simulation Models – Mission Activities and Information Services

Process models are employed to simulate the performance of business operations using the precise business activities represented in the Operations-Centric Architecture. Information services are modeled using computing and communications system tools such as capacity planning, network simulation, and data management.

Linkages between information services and business process performance are defined through Operating Level Agreement (OLA) and Service Level Agreement (SLA) specifications that serve as requirements statements for selecting systems and components or managed commercial services. Information services are modeled using capacity planning tools for distributed computing along with network design tools for communications and other conventional information systems design and simulation methods.

3. Operations-Centric Architecture to integrate essential features of Enterprise Architectures for participating organizations.

The Operations-Centric Architecture (Figure 2) integrates the applicable elements of the Enterprise Architectures of individual agencies at all enterprise levels defined in various architecture frameworks [4,5]. The more recent OMB-FEA Reference Models [6] provide descriptive elements encompassing all aspects of an enterprise—Performance, Business, Services and Components, Data and Information, and Technology (infrastructure). The Operations-Centric Architecture uses these same categories, and Case Study results are discussed for each.

Integration of the individual Enterprise Architectures into the Operations-Centric Architecture is driven by the linked activities carried out and the information services employed by multiple agencies to perform the mission.

4. Geographical Information System (GIS)

Multi-Agency operations are generally performed on a widely distributed, sometimes global, scale. Accordingly, the geographic aspects of operations, service delivery, and resource location are of great importance. The use of the GIS provides for the portrayal of all architectural assets and enterprise resources for the multi-agency operation, and supports their intelligent allocation.

5. Performance Dashboard

The Performance Dashboard portrays all geographic and organizational aspects of the Multi-Agency operations. It presents the performance results of simulations to identify strengths and weaknesses in technical and governance capabilities, as well as gaps and/or overlapping organizational responsibilities and information services.

6. Readiness Model

This is a structured method [7] for defining and evaluating the readiness of agencies participating in multi-agency operations to interact at the level required for performance. Five levels are defined, ranging from the least stringent requirement that agencies merely be aware of each others' activities in an operational region or with respect to a citizen service, to the most extreme case where joint management and a central point of operational control is required.

7. Web Services Repository and Environment– "Enterprise Middleware"

It is important that consistent definitions be used to share appropriate information on a timely basis among all elements of the IEEW. This is accomplished using a common repository for planning information, along with Web Services technology which enables aggregation and re-branding of heterogeneous services across the enterprise. Web Services provides a single common framework for business services and mission partners.

Other standards applied in the IEEW include the Business Process Executable Language for Web Services (BPEL4WS) and Semantic Web Services using the Resource Definition Framework (RDF) and Web Ontology Language (OWL). Semantic technologies are important to application integration solutions because they provide a shared and common understanding of data, and achieve knowledge sharing by formalizing the application semantics between multiple organizations and agencies. The use of the BPEL offers additional capabilities for the IEEW to integrate processes and businesses based on a standard format, metadata, and a common set of notations [8].

Application of a consistent set of mission/business activity and information service definitions across the set of tools in

the IEEW, and in a form that can be embedded in ERP and other management systems, positions the IEEW as major analytical asset for supporting enterprise governance. Specific functions of enterprise governance that are supported are noted in Figure 1.

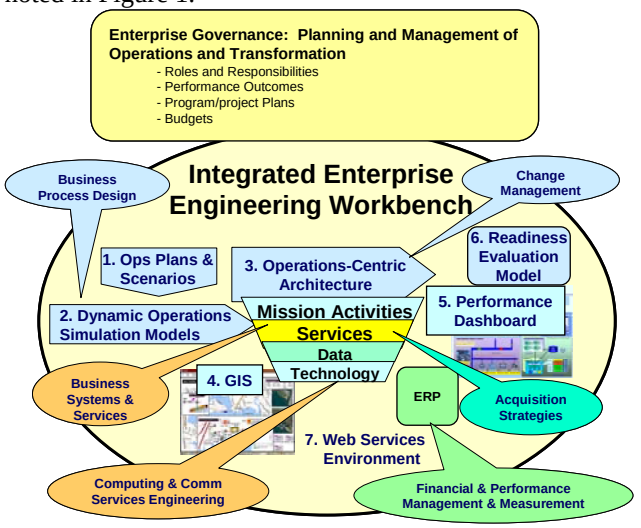

Fig. 1. Elements 1 through 7 of the Integrated Enterprise Engineering Workbench (IEEW), related to functions of enterprise governance.

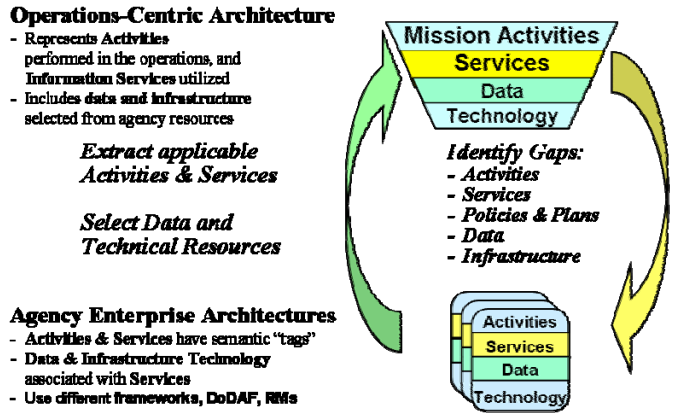

Fig. 2. Operations-Centric Architecture, the central element of the IEEW. All mission activities, resources, and assets are described. Explicit relationships are established here with the architectures of the agencies, bureaus, and/or commercial entities that support the mission activities as described in the Case Study.

III. Architect-Engineering Case Study: Multi-Agency Planning In International Commerce

End-to End Mission Activities in International Commerce promote economic growth and security.

This Case Study describes the major elements of a demonstration exercise using representative public data sources on the processes involved in international commerce. The description is intentionally at a generic level so as to apply to any geographic region engaged in secure global commerce. The Case Study exercise serves to develop and apply the IEEW Architect-Engineering approach to international commerce—a sector of major economic importance that poses serious security concerns. Specific activities (and related information services) defined include:

- Cargo import and export processing (account maintenance, data mining, and inspection services)
- Passenger security processing at departure and arrival (image processing, data mining, and decision support services)
- Apprehension and identification of individuals (biometric, data mining, and communication services)
- Financial flows in international commerce (workflow, data mining, and decision support services)

Each activity is the responsibility of an individual public agency or private entity, and must be coordinated with effective information sharing (within security and privacy constraints) to meet the overall mission objective of furthering economic growth while protecting nations from the illegal entry of people and goods. The IEEW elements provide a complete description of the mission activities performed by the participants in the multi-agency mission. Figure 3 illustrates the end-to-end activities involved in cargo and passenger flow between continents mapped onto a GIS.

The primary objective of the Case Study is a Proof of Concept for the planning and analysis capabilities of the IEEW to support the governance of complex multi-agency mission operations and modernization planning. General results of the more detailed activity and process modeling conducted for selected business processes are described below.

- Enterprise Architectures constructed at the single-agency level focus primarily on the technical infrastructure, and there are gaps in the mission and business activity descriptions. The Operations-Centric Architecture described here uses the activities simulated in the process models and identifies specific activities to be added at a consistent level of detail across participating agencies.
- Critical organizational interactions are identified, along with overlaps in roles and responsibilities among participating agencies conducting a specific activity. These can be resolved in the Operations-Centric organizational view.
- Duplicative information services employed to perform similar activities across agencies are identified. The performance simulation models allow a comparative analysis of duplicative services as the basis for selecting a "service provider" for that activity, and enable measurement of the improvement resulting from the introduction of technology.