Towards Service Engineering: Service Orientation and Business-IT Alignment

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Abstract

The rapid movement towards service orientation, on both the business and technology fronts, offers unprecedented opportunities for business-IT alignment. As we will argue, to achieve true agility in its service provisioning to meet rapidly changing requirements, an organization needs a multi-dimensional business-IT alignment strategy—alignment via architecture, via governance and via communication—integrated with a Service Oriented Architecture (SOA) paradigm to develop their service-based system. To help engineer such a service-based system with this integrated approach, we have developed a 3-layer, multi-disciplinary BITAM-SOA Service Engineering Schematic. The schematic also serves as a process model for service design and management. This schematic is rooted in the Resource-Based View theory perspective: business value can be created by IT-enhanced capabilities that can dynamically integrate resources. The strategic, managerial and practical implications of this schematic on service oriented implementations are exemplified and discussed.

1. Introduction

"*There is no such thing as a service industry. There are only industries whose service components are greater or less than those of other industries. Everybody is in service." ([30], p.41.*).

Service orientation is at the center of both business evolution and the e-business revolution. While traditionally service co-production was anchored in human-human interactions, IT is playing a transformative role in how services are conceived, developed, and delivered [37]. Service concepts are being embraced on two fronts.

First, on the business front, the focus of companies today is on providing superior services to customers. Service industries now account for 55% of economic activity in the U.S. [48]. Similar statistics can be found for other developed countries [32]. In addition, service activities are being incorporated more and more into manufacturing companies. It has been calculated that between 30% and 70% of added value in a typical manufacturing company can be attributed to the service component [32]. There has been a paradigm shift from "product/goods orientation" to "service orientation" in the business world [49]. According to the recent Service-Dominant Logic of Marketing [49] view, all economies are service economies. Today we live and work in the newly labeled Service Economy [37].

Second, on the technological front, Service oriented architecture (SOA), as an architectural style which promises interoperability, flexibility, cost-effectiveness and innovation power, is being enthusiastically pursued by organizations. The SOA movement is sustained by a rapidly evolving set of industry standards. Their broad acceptance is almost guaranteed by the global standardization organizations such as W3C, UNCEFACT, UDDI, OMG and OASIS. 70% of Fortune 500 companies have already implemented some form of SOA. IDC expects spending on SOA-related software to reach nearly $15 billion by 2009 [37].

The concept of service-orientation is not new to the Computer Science community, in that there are services available via the internet, service registries, a set of standard interfaces for service requests or provisioning, and it promotes a focus on component reuse and sharing. Nonetheless, service composition is a powerful concept for businesses: composite services may be recursively combined to produce even more services, offering new functionality and satisfying the diverse requirements of potential service consumers. Interoperability and the separation of internal and external behavior of services provides new dimensions of flexibility for businesses: flexibility to replace or substitute services in cases of failure, flexibility to upgrade or change services without affecting an enterprise's operation, and the flexibility to easily change suppliers of services. This has a positive effect on cost effectiveness and innovation [28]. With a SOA in place, organizations can leverage existing systems in a dynamic environment, abstracting the essence of applications into services that can be reassembled quickly into new business solutions. This is congruent with the Resource-based View (RBV) theory, rooted in the strategic management literature, that firms can create value by combining heterogeneous resources that are economically valuable, difficult to imitate or imperfectly mobile across firms [3][4][33]. Although the individual components that go into the IT infrastructure are commodity-like, integrating these components to develop a coherent infrastructure tailored to a firm's strategic context is a competitive advantage.

However, to achieve this competitive advantage, challenges remain regarding *how* to "orchestrate" the lower level IT infrastructure services to deliver the desired business-level customer services or to effect service innovation that increases firm performance in a fast changing regulatory and competitive environment. Simply put it, the issue is how to align IT with business. A *service* in a business sense is defined as a provider-client interaction that creates and captures value [21]. Within IT, a service is defined as a self-contained, distributed component with a published interface that supports interoperability, is discoverable, and is dynamically bound [15]. The wide disparity of definitions is fundamentally a problem for business-IT alignment—the two communities see services as very different things. Although "services" in the computing sense differ from service concepts in the business sense, service orientation embraced by both the business and IT communities presents an unprecedented new opportunity for alignment. Using coarse-grain services as a binding force, SOA allows for a *potentially* truer alignment with business goals. The assertion is that users/customers are the *service owners*: they don't necessarily understand the technology but they know what services they want. SOA enthusiasts claim that SOA can specify the "touch" points to the underlying technological components and allow the components to be assembled quickly and easily. As such, SOA holds promise to ease the chronic business-IT alignment problem. Interestingly and almost circularly, its successful implementation requires careful business-IT alignment and an integrated view of enterprise resources. Without these, service orchestration will be extremely difficult, as it is difficult to discover and use finely segmented and distributed components. SOA alone cannot achieve the desired organizational agility and must rely on alignment methods on both technical and social dimensions.

Based on the RBV theory of competitive advantage, this paper proposes an *engineering* approach to service design and development, drawing on the SOA paradigm and integrating research on business-IT alignment from three approaches in distinct academic disciplines—alignment via architecture, via governance and via communication. In the next section, the three approaches and an integrated alignment framework will be introduced and the potential impacts of SOA on business-IT alignment approaches will be discussed. In Section 3, the engineering approach to service design and management is argued and a BITAM-SOA Service Engineering Schematic is presented. A service design process based on the Schematic is illustrated with examples. Section 4 discusses the strategic, managerial and practical implications of the Schematic. Section 5 provides a conclusion with remarks on future research.

2. Business-IT alignment and SOA

Business-IT alignment—aligning information system capabilities with business goals—has been a top concern for Chief Information Officers (CIOs) for the past two decades [46]. The seminal alignment work, the Strategic Alignment Model (SAM), was introduced in 1993 [19]. The SAM first established a conceptual framework stressing strategic fit and functional integration between elements in the business and IT domains in an organization. Many approaches to alignment have been spawned in distinct research areas, but these approaches are not well linked with each other. These are: alignment via architecture, alignment via governance, and alignment via communications. These three approaches are integrated in the BITAM-SOA Framework depicted in Figure 1.

1) Alignment via Architecture: This approach utilizes architecture analysis and design techniques to assure proper alignment. The scope for analysis could be as broad as an enterprise. Enterprise Architecture is the principle structural mechanism for enterprise design from the IT perspective. Enterprise architecture [28][29] [52][53] provides a way to enable cross-functional, cross-discipline collaboration essential to articulating and implementing strategic business requirements. A coherent description of enterprise architecture provides insight, enables communication among stakeholders and guides complicated change processes. The BITAM [6], extending the ATAM [2] and CBAM [9] software architecture analysis methods, is a recent alignment method that uses a twelve-step process for managing, detecting and correcting misalignment at the architecture level. The method is an integration of two hitherto distinct analysis areas—business analysis and architecture analysis—for aligning elements in three layers of a business system: Business Model, Business Architecture, and IT Architecture [6]. It includes cost-benefit analysis, architectural decision templates, and other success measures.

2) Alignment via Governance: This approach has two major threads: IT service management (ITSM) [22] and Business Performance Management [9]. First, ITSM focuses on ensuring the linkage of business and IT plans, on defining, maintaining and validating the IT value proposition, and on aligning IT operations with enterprise operations. Additional governance areas include value delivery, resource management, risk management (including regulatory compliance), and performance measurement. There are major approaches embraced by industry: an IT governance framework (COBIT [11]) and a set of IT service management best practices (ITIL [22]). Emphasizing regulatory compliance and IT audit, COBIT allows managers to bridge the gap between control requirements, technical issues and business risks. ITIL outlines an extensive set of management procedures that are intended to support businesses in achieving both quality and value, in a financial sense, in IT operations. ITIL originated from managing IT functions in an organization as "services." Performance measurement tracks and monitors strategy implementation, project completion, resource usage, process performance and service delivery using, for example, balanced scorecards that translate strategy into action to achieve goals measurable beyond conventional accounting [24][25].

3) Alignment via Communication: This approach addresses the "social dimension" [36] of alignment, which is defined as "the state in which business and IT executives/personnel within an organizational unit understand and are committed to the business and IT mission, objectives and plans." Efforts are made to narrow "culture gaps" between business and IT people, which has been a major cause for system development failure. Research focuses on ways of marketing IT to business people, connecting IT planning with business strategic planning, and speaking a "common language" so that shared knowledge [31] about the IT and business domain can be built, and organizational learning or architectural competence can be achieved.

SOA initiatives impact on all three business-IT alignment approaches and can tie together the three approaches to create a holistic business-IT alignment strategy that enables business service innovation, as we will show.

First, impact on **Architecture**: Service-orientation emphasizes the importance of an enterprise perspective—hence enterprise architecture—for business and IT to align properly. An SOA is about creating, discovering, and using (remote) capabilities. SOA makes alignment easier because the large-grained capabilities are more comparable to the grains of business processes. (Classes, a programming-level concept, are typically too small to facilitate this.) The agility gained by a SOA's loose coupling serves as a basis for achieving architectural adaptability for realignment.

Second, impact on **Governance**: SOA facilitates aligning existing IT infrastructure and systems to achieve end-to-end enterprise connectivity by removing redundancies and streamlining IT processes. Flexible value configuration and service recomposition supports both stakeholder and financial perspectives and the interoperability that a SOA promotes simplifies IT service operations. In a SOA environment, a change to a vendor-supplied application programming interface means that an upgrade needs to be applied in one place only. Providing a central location for offering and discovering services makes their management easier and more consistent [5]. Developers can be persuaded, encouraged or forced to use repository-based services if they ever want their applications to see the light of day. As a result, SOA can facilitate compliance with, for instance, the Sarbanes-Oxley law and industry-specific regulations.

Third, impact on **Communication**: Service orientation brings the customer perspective closer to the IT resource perspective. Using "service" as a binding concept, SOA can facilitate communications between users, customers and technical personnel for requirements specification and analysis.

Recent research has shown that SOA, from a technical point of view, provides flexible, cost-effective solutions through interoperability, reusability and composability between loosely coupled services [16][27][27][43]. From a business point of view, SOA is an architectural strategy that will help achieve enterprise resource integration and organizational agility. The following section describes a Service Engineering approach based on the SOA paradigm, incorporating alignment principles and methods in all three approaches (communication, architecture, and governance) that have previously only been addressed *separately*.

3. The BITAM-SOA Service Engineering Schematic

A Service Engineering Schematic based on the BITAM-SOA framework [8] is depicted in Figure 1. As shown, the three alignment approaches are titled in the schematic. The Left Column (the 3-layer BITAM architecture) represents the *architectural alignment* of the three layers; the Middle Column shows the service oriented enterprise architecture that corresponds to the three layers of the BITAM model in the Left Column. The business process portfolios and applications portfolios are in the Business Architecture layer. The Right Column represents the *governance* approach integrating Business Performance Management (BPM) and IT Service Management (ITSM). Each of these approaches has a social dimension, which is captured under the *communication* approach. The modules (in boxes, to be detailed later) for service engineering are then added to link architectural and governance approaches which include both technical and social dimensions.

The BITAM-SOA Service Engineering Schematic offers a *multi-disciplinary* approach to service engineering. The goals of the schematic are threefold. First, to outline a set of *modules* (where a module denotes a set of processes, models, methods and techniques for a defined task that may span departmental or organizational boundaries) and the ways in which these modules interact for service design, development and management. Second, to offer a space of inquiry for integrating existing methods in distinct fields for service engineering. Third, to serve as an architectural blueprint for developing a service system as well as a model for new service development or service modification.

The decomposition of a service system and its tasks is the first step in moving away from a craft and towards an *engineering discipline.* While we acknowledge that the human "touch" aspect [7] of service co-production is most valuable and most difficult to be "engineered," our ultimate research goal is to move toward the integration of dispersed yet interrelated processes or automatic linking of design parameters and performance measurement in different modules of different layers in the Schematic: Business Models (strategic level), Business Architectures (operational level), and IT Architectures (infrastructure level). These modules are the "meta services" of a service system.

3.1 Features of the Schematic

There are six salient features of the schematic. First, the Schematic is focused on the **value proposition to the customers**. This focus drives strategic alignment and service innovation for value co-creation and building customer relationships. Based on the RBV, as opposed to a value chain perspective, value can be configured via the activities and resources in the lower layers of both technical and social dimensions [45]. As *service* is seen as the application of resources for the benefit of another entity [49], to serve effectively and efficiently necessitates

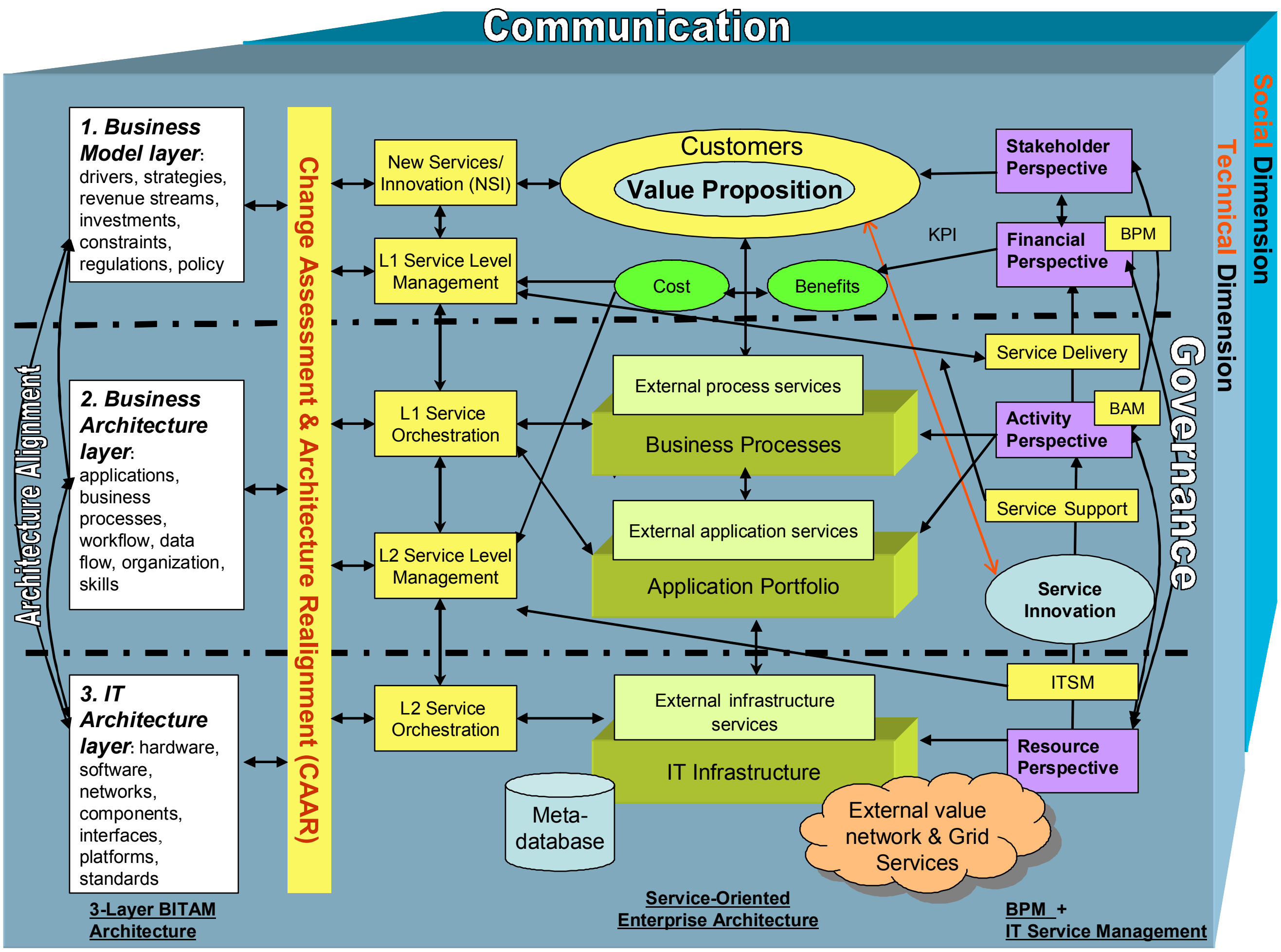

Figure 1. BITAM-SOA Service Engineering Schematic

cross-functional and inter-organizational and value network integration.

Second, the process is devised using a **layered approach** within the BITAM 3-layer architecture model [4] (Layer 1: Business Model layer, Layer 2: Business Architecture layer, Layer 3: IT Infrastructure Architecture layer). The layers indicate the traditional separation of concerns (strategic, operational and infrastructure) in different disciplines and domains and stipulate the areas for abstraction and encapsulation. For instance, changes in a database server in Layer 3 should not affect applications (e.g., Customer Relationship Management applications) in Layer 2 and the services (e.g., automatic prescription refill) provided to customers in Layer 1. This layered approach also helps manage design complexity. Most importantly, the mapping (represented by the dash lines in Figure 1) between layers in the Schematic is the key focus of Business-IT alignment.

Third, the service design process is anchored in a **service-oriented enterprise architecture** (depicted in the Middle Column) situated in a complex socio-technical system. The enterprise view provides an integration foundation for services to be orchestrated: created, discovered, composed, decoupled, shared and recomposed. The services, from larger granularity to smaller, are in hierarchical order in the three layers: business services in Layer 1, applications and process services in Layer 2 and IT infrastructure services in Layer 3. Note that further decomposition of services in each layer is commonly practiced [13]. Business services are conceived from a customer-focused requirements or business vision perspective to provide a value proposition in response to changes in the Business Model. Processes, workflows and application (Layer 2) services are then orchestrated to deliver business services. The processes and application services are aggregated from shared services (of smaller granularity) in Layer 3. Interfaces for services are well-defined in each layer so that these services can be called without requiring the service requestor to know the complexity of subordinate services that it, in turn, calls.

Fourth, a **metadata approach** is suggested for managing the enterprise application portfolio and business processes as well as its underlying services. All meta information in the three alignment approaches are integrated into the metadatabase. The metadatabase is designed to integrate the following:

1. With SOA, all services are registered so that they can be shared and so that new services can be added quickly. Service registries or Enterprise Service Bus, meta-data that describes service requesters and providers, mediations and operations on the information that flows between requestors and providers and the discovery, routing, and matchmaking [42], are managed in the metadatabase.
2. Policies and constraints (risk, resource, legal compliance) as well as directories of external value networks or public infrastructure services are included in the metadatabase.
3. Configuration Management Database (CMDB) that shows all hardware, software, and data components, typically utilized in ITSM can be subsumed by the metadatabase.
4. Service level management (SLM) [22] modules that embody company policies and are linked to key performance indicators (KPIs) from governance modules are also in the metadatabase. There are two levels of service level management: Layer 1 SLM module specifies the level of quality and performance metrics for business services while Layer 2 SLM module specifies those for IT services. Both levels of service level specifications and agreements should also be stored in the metadatabase for ensuring compliance and integrated management.

Fifth, IT governance and business performance management (BPM) measures are integrated for service design. The ITSM modules monitor the actual performance of the Layer 3 services provided. Governance methods oversee linkages of elements among all three layers for strategic alignment, resource management, risk management and performance measurement. Four BPM perspectives (adapted from [24][26]) are integrated into architecture decisions and service monitoring: stakeholder (including customer), financial (including revenue growth), activity (including internal processes [24]), and resources. The activity perspective includes both internal processes and other business processes in Layer 2. As depicted, from the governance standpoint, IT services (in the IT Architecture layer) are seen as resources for business activities and must be aligned with financial perspectives in the Business Model layer. Furthermore, the financial perspective must support value propositions to customers and stakeholders that will deliver revenue growth. The activity perspective (processes, applications, workflows, events) focuses on service support and delivery of the value proposition to the stakeholders. This perspective involves the design of processes, applications, and workflows in the Business Architecture layer. Business activities are monitored by the business activities monitoring (BAM) module[14].

Sixth, the **social dimension** is explicitly captured in this framework. The growth and learning perspective from the balanced scorecards of [24] is in this dimension where employees need systems, applications and skills to grow and learn. In the social dimension, *people* are an integral part of the enterprise and are formally modeled in enterprise architecture or workflows. Organizational competence in designing software architecture or enterprise architecture (e.g., architecture competence) is the social dimension that must be addressed in the architecture design. A service-oriented strategy implementation requires explicit consideration of the costs and management required in the social dimension. This involves a culture change: Management must foster a mind-set that encourages enterprise thinking so that appropriate motivation can be devised for rewarding customer-orientation and enterprise-wide cooperation. Specifically for SOA implementation, management must encourage shared infrastructure and common IT procurement policies, and an across-the-board willingness to give up best-of-breed systems that could be incompatible.

The schematic also serves as a *process model* for service design, development and management. Reflecting the agile nature of SOA for organizational design, service development is not a linear process and the modules discussed below are not in sequential order. Each module is a specialized field of research, including technical and managerial disciplines, and it is thus impossible to discuss each in detail. The schematic fosters insights into how the modules can work together to respond to changes and achieve architectural agility in service design and value delivery. As depicted in Figure 1, the service development process can be invoked by changes or events from all 3 layers. Top-down changes originate in the business environment and bottom up changes originate in the Business Architecture or IT Architecture Layer. Technological changes in the IT architecture level may propel new business strategies and adjustment, which can also spur service innovation as described in Section 3.3.

3.2 Modules of the Schematic

In this section we will describe the modules in the schematic in detail, describing their use, their inputs and outputs, and their interconnections.

The **Change Assessment & Architecture Realignment (CAAR)** module is used to assess the scope of impact by change event, primarily by means of architecture analysis. In response to this analysis related modules are activated, either sequentially or simultaneously to respond to changes. Architecture describes the structures of a system and the relationships among its components. IT architecture defines the operational infrastructure (e.g., servers, network connections, etc.) on which business services will be deployed, which will in turn meet business requirements. The Business Architecture includes workflows, business processes and applications. Change events may alter the state of system deployment and alignment among the layers and thus catalyze a need for realignment. Architecture tradeoff analysis is conducted to ensure that the levels of service quality are maintained according to governance standards, performance metrics and checklists [6]. Architecture strategies are evaluated based on cost-benefit analyses of business drivers [9] which ties with BPM measures that include financial perspectives. As such, this module interacts with Service Level Management modules and Service Orchestration modules to determine what components and services need to be bought, built, or reused, focusing on their externally visible properties. This process relies on 1) clear abstractions of layers to encapsulate the changes impacting on each other; and 2) well-understood mappings to propagate intended changes among the layers. The subsequent impact on both the social dimension and technical dimensions then needs to be assessed.

New Services/Innovation (NSI) module: A change event can cause new service developments [34] or service improvements that will provide value innovation. Service development in the SOA paradigm, as explained before, differs in its ability to develop new services via the flexible addition, composition or configuration of existing shared services. New service development may still follow the traditional stages of concept development, prototype development, prototype testing and launch [34]. The fast speed of service composition and orchestration is an advantage resulting from the SOA paradigm. This module will first analyze the components needed for the business services, matching customer characteristics and transaction goals [7]. The required qualities of the business services will become input to the L-1 (Layer-1) Service Level Management module.

L1 Service Level Management (L1 SLM) module: This module is responsible for Layer 1 service definition, specification and managing service level agreements. Service level agreements (SLAs) set norms for the delivery of services, including performance, quality, and compensation [47]. A service can be specified, measured and controlled in service-level agreements and can be comparison-priced in the marketplace. The architecture analysis function in the CAAR module will provide input as to the constraints of achievable service levels. Detailed economic cost-benefit analysis will determine the cost-effectiveness of a service offering. Depending on the type of organization, L-1 Service Level Management may involve collaboration with customers to collaboratively define metrics and a set of contingency plans and compensations.

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L1 Service Orchestration (L1 SO) module: This module will decompose and map the required Layer 1 business services onto course-grained services of workflows, processes and applications (elements of the Business Architecture layer) and compose existing services of coarse-grained, high-level building blocks with business logic for implementing new business services or modified services. Note that not every business subprocess, activity, or task is an “exposed” service and thus the orchestration process may not be straightforward [13]. Additional services for Layer 1 service orchestration are typically developed and managed in-house due to their strategic value, but can sometimes be purchased from a third party and managed in-house, or "leased" from an external vendor and consumed as “Software as a Service” [40] that is externally developed, maintained, and managed.

L2 Service Level Management (L2 SLM) module: This module defines and specifies IT Infrastructure service objects and manages SLAs between IT infrastructures (e.g., data, network, etc.) and Layer 2 course-grained process, workflow and application services. This module is monitored by the ITSM module.

L2 Service Orchestration (L2 SO) module: This module decomposes Layer 2 (process, workflow, applications) services and orchestrates lower fine-grained IT infrastructure services (e.g., data services, communication services, utility services, capability services, etc.) to support Layer 2 services. The services can be further subdivided into even finer grains to enable reuse. Services in Layer 3 are often more generic and can be reused by many different processes in Layer 2. Therefore, these types of services are more commonly purchased or leased than Layer 2 services.

IT Service Management (ITSM) module: The maintenance and operation of IT infrastructure is critical to service delivery. This module contributes to IT service quality by quality management and process control of IT service delivery and support. ITSM module controls the L2 SLM, provides financial management for IT services, capacity management, continuity management and availability management for service delivery. This module specifies procedures for service desk, incident management, problem management, configuration management, change management and release management. The activities of the ITSM module should be directly aligned with those in the Service Delivery and Service Support modules in Layer 2, which focus on business service operation management.

Service Delivery and Service Support modules: These modules execute the service as designed and ensure that a delivered business service meets customers’ expectations and requirements [17] and maintains the Layer 1 SLA. The service support function handles accidents and problems occurring during service delivery. This module will also define the parameters for measuring service quality. It involves system built-in functions for monitoring service activities and KPIs to achieve agreed service level and desired business goals. The results of Layer 2 Service Orchestration will be monitored and modified when necessary by invoking the CAAR module. Depending on the extent of human components in the service, this module may involve human resource management for optimizing personnel performance via training and knowledge management.

3.3 Examples

We will now briefly discuss three very simple examples showing how different modules are activated in response to different change events—some that are top-down, from New Services/Innovation and some that are bottom-up, from changes in the IT infrastructure and the Application Portfolio. Note that, in practice, the development process would go through several iterations to finalize the final service design.

Example 1: Top-down New Service Development: 1-day guaranteed electronic prescription (re)filling.

1. CAAR module: determines that the value proposition of the prescription refill services is convenience, time value, and assurance. The feasibility of such an offering and its architectural impact are assessed. A steering committee may be involved to decide on the final offering. Activate the NSI module.
2. NSI module: performs and the initial design of the new business service and a cost-benefit analysis. The design involves the service process as well as service objects. The initial process is designed to include the following steps: 1) customer web interaction, 2) online verification: customer eligibility, doctor authorization, check insurance coverage, check drug inventory, 3) payment, 4) drug assembly, 5) drug delivery. Activate the CAAR module for architectural analysis of the design. Activate the L1 SLM module.
3. L1 SLM module: devise a L1 SLA, e.g. prescriptions delivered within 24 hours (through an exclusive agreement with FedEx, delivered from an available warehouses). If the agreement is not met, the customer can pick up the prescription from the nearest drugstore and will be compensated $100.
4. L1 SO module: Further decompose the service processes. Payment process includes subprocesses: payment method selection, payment verification, etc. Two scenarios:
   4.1 Discover an existing reusable service—payment via Paypal—in the existing application portfolio. This change propagates to Layer 3: the PayPal

service is simply extended to cover re-filling prescriptions (from its existing use in filling prescriptions) by instantiating PayPal in a new context and by creating some additional web pages to handle the new logic.

4.2 Specify Paypal as a *new* service to be created, purchased, leased or contracted and registered as a new application in the application portfolio. This change provides input to the CAAR module for architectural modification. Activate the ITSM module.

5. ITSM module: register Paypal as a configuration item object. Activate the L2 SLM module.
6. L2 SLM module: Devise a new L2 SLA: PayPal must be contacted and responded to within 60 minutes; payment must be processed within 24 hours.
7. L2 SO module: existing APIs for the other (reused) services are used. Call the CAAR module for a second iteration.
8. CAAR module: An architectural analysis of the anticipated volume of web access indicates the need to purchase substantial additional server capacity. Tradeoff analysis of performance vs. availability due to cost constraints in CAAR will the activate NSI module to possibly re-evaluate the service design. For instance, the service may be initially offered to a smaller segment of customers.

Example 2: Service Innovation: Drug supply chain prediction. This is an example of a new innovative service offered by a drug-store chain. Using a disease-frequency reporting web-service offered by the CDC, a drug-store chain can predict where spikes in demand for specific drugs will arise and proactively ship additional inventory to those locations *before* demand has spiked. A similar process to that described in Example 1 is invoked. Some key points are:

1. Value proposition: adequate, timely supply of a time-critical drug.
2. L1 SLM module: devise a L1 SLA, e.g. drugs arrive at drug stores 24 hours before the demand spike
3. L1 SO module: Further decompose the service processes. A new business process is created for doing just-in-time demand forecasting (in contrast to the historically based demand planning that is current practice within the organization). New applications are required for the just-in-time forecasting process.
4. L2 SO module: Reuse the IT infrastructure services: ASP interface, database access and communications.

Example 3: Bottom-Up Cost-effective New Service Offering: Mobile VoIP. In this example we look at a new service that is driven from the bottom up. A company has an existing core competency—VoIP—that is used in a new way to create new business value—offering VoIP over a cell phone, saving customers who already have cell-phone IP plans the cost of having a voice plan.

1. L2 SO module: Company has an existing expertise in VoIP and in the IT infrastructure to run a commercial VoIP service and its ancillary applications. Activate the CAAR module.
2. CAAR module: based on this capability, a new service is proposed: to provide customers with VoIP on cell phones, using the cell phone's IP capabilities. The value proposition to customers: integration, convenience, low cost, mobility. This capability engenders a new set of business models, supported by new business processes. These must be aligned to ensure that both the stakeholder and financial perspectives are satisfied. The CAAR performs the cost-benefit analysis based on the new business model and activates the NSI module.
3. NSI module: performs the design from the L2 SO, to the L2 SLM, L1 SO and then the L1 SLM. For example, for calls to be natural, the latency on the network must be low and the throughput must guarantee at least 7 Kbps. For calls to be logged correctly, the master call database must be updated at the start and end of each call. Capacity planning is thus required, invoking the CAAR module. Such a service must be available 24x7 invoking a call to the ITSM module.

4. Implications

Effective service engineering is premised on tight business-IT alignment and integrated management of enterprise applications and resources. While service-orientation is critical in enabling the communication, application integration and business-IT alignment for fast service composition to respond to rapidly changing customer requirements and business needs in near real-time, the implementation of an SOA requires additional management capabilities, alignment or organizational maturity [31]. Companies without an enterprise integration foundation may have to rethink their strategies [38].

The schematic explicitly identifies the multidimensional (technical and social) complexity of SOA implementation and the continuous governance, communication, change assessment and architectural realignment required for achieving organizational agility promised by SOA for service management. With service orientation, innovation can come from the creative use of IT resources to support customer strategies. As such, it encourages a CIO to play the important role of the business innovation *leader*, instead just being a resource steward.

In addition, the move to globalization and cheaper or even free IT infrastructure makes the capability to orchestrate services to tailor to an organization's strategic context more critical than ever. Captured in the schematic is the next-generation service infrastructure called the Service Grid [18]. This will give large and small organizations access to IT resources that are currently out of reach. Grid Service developments strengthen the impact of service orientation on business architectures, as they extend the application of Web service technology to the domain of utility computing and ASP. This future trend makes "leasing" and outsourcing lower grained service development an even more cost-effective strategy for companies adopting SOA, particularly for smaller, startup companies. With the commoditization of IT resources, the integrated management and dynamic/creative composition of these resources becomes a critically needed capability for better value propositions and service provisioning to customers.

5. Conclusions and Future Work

Integrating the SOA paradigm and Business-IT alignment approaches enables strategic agile [51] service provisioning and management. In the past, Business-IT alignment was primarily a matter of repair—fixing poor alignment. The BITAM-SOA Service Engineering Schematic serves as a model for how to do *alignment by construction*. It also serves as a blueprint for service system development and focuses management's attention on value delivery and service innovation via flexible and fast service orchestration. This is the major contribution of the Schematic—it serves as a guide for value provision via business-IT alignment, top-down or bottom up.

Traditionally, IT has played a supporting role, as an "enabler" of business activities. IT infrastructures and applications support a business process, which in term realizes a business service. With service-orientation, IT plays a *strategic* role in business transformation as it allows a bottom-up strategy for service innovation, where business services are a mechanism for instantiating and commercially exploiting lower-level services. This RBV of competitive advantages will be further enhanced by future technological advancements and is a critical capability for business to compete in the service economy.

It is therefore a strategic imperative that companies carefully plan and cultivate business-IT alignment capabilities to reap the benefits promised by SOA. The schematic presented in this article helps companies understand the necessary mechanisms and dissect the processes for engineering an SOA-based agile service system cost-effectively, integrating different perspectives and distinct approaches to alignment.

In addition, this article contributes in the conceptual design of the modules and specifies links among modules (e.g., processes) of a service-based system using the BITAM-SOA framework. Future research is needed to flesh out the details of the Service Engineering Schematic presented here. To name a few, this schematic calls for future research on: 1) the harmonization between the technical and social dimensions of the service-based system; 2) practical service-oriented system analysis and design methodology and enterprise modeling techniques as well as standards, going beyond object-oriented methods;, 3) architectural analysis and design methods integrating business architecture modeling and alignment methods; 4) architectural flexibility based on real options [35] and service-orientation; 5) integration of service management and IT service management, and 6) integration of development tools and newly developed applications from each module in the schematic. Empirical studies of SOA adoption are also needed to refine methods and advance service engineering and management. We are empirically validating the Schematic and associated methods presented here in three different sectors: DoD, financial services and logistics services.

6. References

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