2008

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Towards a Generic Governance Model for Service-oriented Architectures

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ABSTRACT

Over the past years, Service-oriented Architecture (SOA) Systems have been recognized more and more as a serious alternative to common monolithic systems for Enterprise Architectures (EA). An SOA provides a flexible means of effectively mapping business processes to IT processes. However, large IT systems require consistent leadership – IT Governance. For SOAs, governance faces new challenges. A number of different approaches for SOA Governance Frameworks exist, which differ extensively in scope and capability, as most of them are product-driven and developed by software companies. In this paper, we outline and compare existing SOA Governance approaches and present our approach - a Generic Governance Model for SOA.

Keywords

SOA, Governance, SOA Governance, Governance policies

INTRODUCTION

In recent years, the globalization and deregulation of markets have forced enterprises to react quickly to changing environments and to adapt their business processes continuously. IT architectures within organizations are often heterogeneous and developed towards a high complexity that is hardly manageable. A large amount of legacy systems, middleware platforms, programming languages, operating systems, and communication channels is the prevailing characteristics of these architectures (Hammer and Champy 2003). According to Becker, Kugeler and Rosemann, only companies with the high flexibility to adapt to new market conditions would survive in the long-term (Becker et al. 2003). In order to achieve flexible business processes, architectural support is required for integrating internal legacy systems, as well the services of business partners. The Service-oriented Architecture (SOA) paradigm is often recommended as it enables agile business processes (Papazoglou 2003).

The SOA paradigm ensures agile implementations of business structures that are able to adjust flexibly to changing environments. However, SOA also poses new challenges. As common EA, being mostly structured heterogeneously, require high level management, i.e. IT Governance, so does SOA. Services as the smallest units of SOA systems provide the means necessary to enable an EA to adjust flexibly to changing business processes, on the one hand. On the other, they implicitly contribute towards system complexity. Along with the large number of new software artefacts, new challenges emerge, e.g., in the areas of enterprise organization, roles and responsibilities, service lifecycles, standards, finance, etc. In order to provide homogenization of these issues, the governance approach for SOA addresses the new challenges by providing a holistic management framework, basically based on enforcement of governance policies. The central challenge in order to be effective is to guarantee compliance to legal, technical and internal regulations.
A number of different SOA Governance approaches which address these issues have been proposed. In this paper, we propose a generic model for SOA Governance integrating all previously considered related aspects. In the first part of this paper we study the existing approaches to SOA Governance. The second part describes our SOA Governance Model in detail. The paper concludes with an outlook, as well as, plans for future work.

EXISTING APPROACHES

SOA Governance topics strongly relate to IT Governance. Usually, SOA Governance is described as the "little brother" of IT Governance. Often, extensions of existing IT Governance approaches are proposed which allow for the specific requirements of SOA in particular (Woolf, 2006). The main task of SOA Governance is to define and introduce company-wide policies for the adoption and operation of an SOA, as well as to introduce mechanisms which control their enforcement (Keller, 2007; Fabini, 2007; Kalex, 2007; Windley, 2006; Manes, 2005; Schelp and Stutz, 2007).
For IT Governance, numerous frameworks have been specified, e.g., CObIT, ITIL, ValIT, ISO 20000, ISO 17799 etc. Basically, each of them focuses on a different aspect of a company's IT. While the IT Infrastructure Library (ITIL), e.g., mainly deals with IT process definition (OCG, 2007), the ISO 17799 standard targets security management (ISO) primarily. A comparison shows that they do not exclude but rather complement each other. CObIT (Control Objectives for Information and related Technologies) by the IT Governance Institute (ITGI) is a governance and control framework, which is more closely aligned with the business objectives of the organization than with operational issues (ITGI, 2007). Most other frameworks class into CObIT. It has become a de facto standard for IT control globally, furthermore its implementation and application has gained increasing interest among companies. CObIT (version 4.1) has served as a basis for many of the proposed SOA Governance approaches.
Basically, approaches for SOA Governance are specialized on particular regulation needs emerging from an SOA, such as additional organizational units, accountabilities for service development and operation, cross-company cooperation projects, etc. The focus of IT Governance approaches is more generic than the one of SOA Governance.

Numerous models for SOA Governance have been proposed so far. All of them emphasize on different aspects, e.g., service lifecycle management (BEA Systems, 2006) or organizational change (Bieberstein, Bose, Walker and Lynch, 2005). The following paragraphs give an overview of a variety of approaches to SOA Governance Frameworks. Table 1 shows a comparison of the approaches mentioned and points out which characteristic elements of SOA Governance are included in each approach, respectively.

Brauer and Kline (2005) at HP consider SOA Governance within the context of business service lifecycles. They define two key infrastructure solutions that support SOA Governance: the business service registry and business service management.

Bieberstein et al. propose an SOA Governance Model. They identify six Governance processes and three steps for launching the SOA Governance Model. The SOA strategy and SOA objectives should be defined in such a way that both the business and IT units have a clear understanding of them. According to them, policies defined by Governance positions, form the basis for any decision. Their model is made complete by a set of best practices (Bieberstein, Bose, Fiammante, Jones and Shah, 2006). In a further publication, Bieberstein et al. describe an approach for guiding an SOA successfully, with an emphasis on the transformation of organizational structures and behavioural practices. They have proposed the Human Services Bus (HSB) as a new organizational institution, which streamlines cross-department processes, thereby exploiting the SOA approach optimally (Bieberstein et al., 2005).

The SOA Governance approach at WebMethods consists of two parts: *Architecture Governance* and *Service Lifecycle Governance*. The latter is divided into design-time, run-time and change-time Governance. Architecture Governance deals with issues such as corporate technology standards, the definition of an SOA topology and the determination of an SOA platform strategy. Service Lifecycle Governance focuses on the regulation of design, etc. of services through its respective policies and enforcement mechanisms (WebMethods, 2006).

The approach by Software AG (2005) identifies *maturity and governance levels*. Besides this six-level-maturity model, they also define an SOA service lifecycle, which incorporates services, related artefacts and roles. They provide a five-step SOA adaptation plan, as well as a set of best practices.

The BEA Systems approach (2006) emphasizes the importance of the service lifecycle for governance. Central policy definition and enforcement, which regulates the design, building, provisioning and operation of services, affect the whole SOA system particular in terms of quality insurance, monitoring, and SLA management. Primary goals are the reduction of development costs and faster "time-to-service".

The SOA Governance approach of SAP AG consists of a framework of guidelines and an organizational governance institution, the Process Integration Content (PIC) Council. The framework consists of three parts: modelling and implementation guidelines, a special review process performed by the PIC council (guidelines enforcement), and the continuous execution of manual and automated service tests (SAP AG, 2007). The PIC Council guarantees the quality of process integration content by reviewing interfaces for semantic correctness, ensuring standard conformity, encouraging reuse, establishing enterprise-wide consolidation and improving the integration guidelines (Wagner and Krebs, 2004).

The SOA Governance approach proposed at Oracle consists of nine 'key areas of interest', that are combined with a structured set of best practices. It is completed by an SOA adaptation model which defines a cycle of six steps that supports continuous improvement of the SOA (Afshar, 2007).

Authors at IBM have defined SOA Governance as an extension of IT Governance that focuses on the service lifecycle and composite applications. The IBM SOA Governance model comprises a service lifecycle and an SOA Governance lifecycle, both consist of four phases (Brown, Moore and Tegan, 2006; Holley, Palistrant and Graham, 2006; Woolf, 2006).

Legend ○ – integrated ● – integrated and specified in detail × – not integrated	Organizational changes	SOA Maturity Model	Specific Roles/ Accountabilities	Best practices	Metrics model	Impact on behavior	SOA Lifecycle	SOA Roadmap	Policy Catalog	Service Lifecycle
Brauer/Kline	×	○	×	×	×	×	×	●	●	●
Bieberstein	●	×	●	●	○	●	×	●	○	×
WebMethods	○	○	×	○	×	×	●	×	●	○
Software AG	●	●	●	●	×	×	×	●	●	●
BEA Systems	×	×	×	×	×	×	●	×	○	●
SAP AG	●	×	×	×	○	×	×	×	●	○
Oracle	●	○	●	●	○	○	●	×	●	○
IBM	○	×	○	●	○	×	●	×	×	●
Marks/Bell	●	×	●	●	●	●	●	○	●	○
Schelp/Stutz	●	×	●	×	×	×	○	×	○	×
Weill/Ross	●	×	●	×	●	●	×	×	○	×

Table 1. Comparison of SOA Governance approaches

The SOA Governance Framework introduced by Marks and Bell (2006) identifies organization, processes, policies, metrics and behaviour as the major elements of SOA Governance. SOA Governance, according to them, consists of three basic steps. The setup of an overarching governance model which determines fundamental principles like high-level organization, services ownership and funding issues, is the initial step. Second, basic service-related policies concerning, e.g. designing, building and operation are created. The third step consists of the implementation and integration of the actual SOA Governance.

According to Schelp and Stutz (2007), a SOA Governance Model is composed of a set of management activities combined with organizational structures based on governance principles. Its activities are devided into three groups: implementation, management and control of an SOA. The components of the organizational structure are SOA strategy, SOA organizational structure and SOA operational structure..

Weill and Ross (2004) have identified six interacting components for the effective design of IT Governance. Their main focus lies in the use of IT metrics and accountabilities to influence behaviour. The goal is to create target-oriented incentives in order to evoke specific desirable behaviour.

These proposals show the diversity in approaches to SOA Governance. However, they show congruencies. All authors agree that SOA Governance is a fundamental requirement for trouble-free adaptation, as well as, for the successful operation of an SOA.

A Working Definition

For consistence in modelling, a precise definition of SOA Governance is required. There are several definitions of SOA Governance that diverge in their focus. Fabini (2007) states "SOA Governance is a management structure including creational and administrative elements.". According to Keller (2007), "SOA Governance is about creating conditions that

allow an SOA to grow in a company.". "SOA Governance is a set of solutions, policies and practices which enable companies to implement and manage an enterprise SOA." (Brauer et al., 2005). The definition for IT Governance by Weill/Ross (2004) "IT Governance: specifying the decision rights and accountability framework to encourage desirable behaviour in the use of IT" emphasizes the thoughtful assignment of responsibilities and roles in an EA (or SOA) in order to stimulate desirable behaviour. Bloomberg (2004) defines SOA Governance as the application of IT Governance to an SOA system: "it is how IT Governance should operate within an organization that has adopted SOA as their primary approach to EA.". Based on these approaches, we have elaborated a definition for the term "SOA Governance" as follows:

> *"SOA Governance is a management model,that provides the ability to guarantee sufficient adaptability and integrity of an SOA system as well as to check services concerning capability, security and strategic business alignment. Its overall goal is SOA Compliance, i.e. compliance of legal, technical and intra-company regulations, respectively. In particular, it ensures the reliable long-term operation of an SOA. "*

A governance approach focuses on the smooth adoption and successful operation of an SOA as the EA in a company. It provides guidelines and mechanisms to ensure the integrity of an SOA and its adaptability to business and administration processes. Governance tools support the monitoring and control of services concerning security issues and their alignment to business processes. All of these procedures are supported by a best practice catalog which serves as repository of implementation recommendations that are continuously supplemented. Beside supporting the achievement of IT goals and the realization of business-IT alignment, a further goal of SOA Governance is to achieve adherence of the regulations and standards in an SOA system, such as the Sarbanes Oxley Act, ISO norms or internal regulations, for example.

A GENERIC SOA GOVERNANCE MODEL

Based on this understanding of SOA Governance we have designed a generic SOA Governance model. We aim to provide a simply structured process control tool that provides the essential means in order to deal with the growing complexity of SOA systems – to optimally support SOA Governance. It is the first model to define a general approach considering and integrating all elements of prior approaches to SOA Governance.

Basically, our SOA Governance approach consists of two parts: the SOA Governance Control Cycle and the SOA Governance Operational Model. The control cycle represents the overall steering process which controls the operation of the entire SOA system. The operational model describes the activities and competencies, as well as coherences and relations of these components, thereby targeting the achievement of SOA goals. Both parts closely interact with each other.

The SOA Governance Control Cycle

On a top level, an SOA is navigated according to stages in the SOA Governance Control Cycle which reflect the lifecycle of an SOA system (cf. Figure 1). It covers governance activities in particular, as well as basic SOA policy topics such as, funding, organizational changes, and choice of technology. Its main goal is to provide a consistent holistic control process for the SOA.
The cycle consists of four phases, starting with the *planning* phase, subsequently followed by *design*, *realization* and *operation*. In the last phase, new challenges that need to be addressed may be uncovered, which are then dealt with in the planning phase of the cycle's next iteration.

The *planning* phase covers the general SOA requirements. It includes all processes and activities which deal with fundamental decisions and specifications, i.e. the SOA strategy and governance processes, e.g., policy and metrics creation procedures. The responsibilities, roles and competences, as well as organizational governance structures are defined. Furthermore, services ownership and funding models are established. The initial governance framework is set up.
The *design* phase deals with the general specification of an SOA system. Decisions made in the first phase are reviewed, concretized, and the fundaments for a successful implementation and operation are laid. SOA policies and metrics are defined, based on business and technical requirements, for example the technology infrastructure is set up and basic decisions concerning human resources, SOA roles and responsibilities are made.
The *realization* phase comprises of all the activities and processes concerned with the implementation of SOA Governance. Governance mechanisms are installed and processes are activated, i.e. metrics and policy enforcement mechanisms. With this phase, the actual governance process begins.
During the *operation* phase, SOA Governance processes are evaluated. The results of the governance policies executed are continuously analyzed for their effectiveness. Hence, potential weaknesses or flaws in the governance processes themselves are identified. This ensures the system's compliance to the policies defined. If policies became ineffective, they are redefined, changed or abolished. This phase provides the actual *governance*. If changes be necessary, a new iteration of the control cycle is initiated.

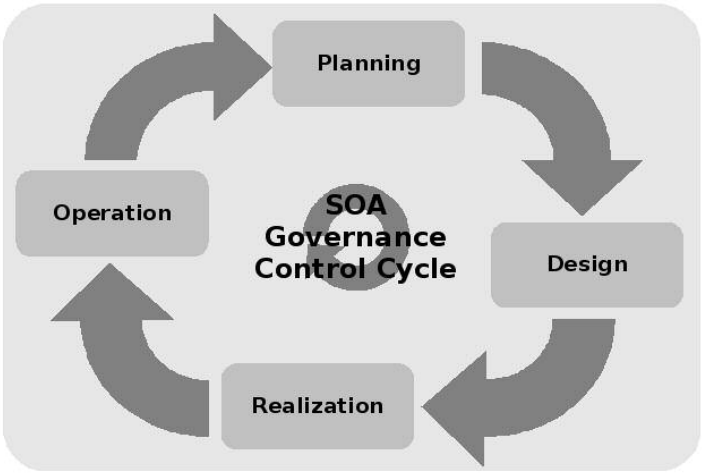

Figure 1. SOA Governance Control Cycle

The SOA Governance Operational Model

The SOA Governance Operational Model consists of six main elements and targets the achievement of predefined *SOA goals*. All Governance mechanisms and methods aim to realize these goals that are aligned with the company goals. The *policy catalog* provides the main means to achieve these goals, consisting of policies and guidelines for all aspects of the SOA system. All policies are defined based on structured best practices and enforced by the *organizational governance entities*. They also define and apply according *metrics* that assess the adaptation of policies. The *SOA Maturity Measurement* component assesses the readiness and maturity of the *SOA Processes*, providing feedback to the organizational entities. In the following, each of the mentioned elements is outlined in detail. Figure 2 shows the coherences.

SOA Goals

The overall SOA goals to be accomplished are aligned with and derived from a company's overall goals (Schelp and Stutz, 2007). One central goal is *SOA Compliance*, i.e. a general adherence to various kinds of regulations. Legal, technical, internal regulations are targeted, e.g. Sarbanes Oxley Act or compliance with company security concepts. A further, SOA-inherent goal is the alignment of a company's SOA strategy to its business strategy (*Business IT-Alignment*).

SOA Processes

The sum of all SOA processes forms the actual SOA system that is governed by the SOA Governance model. Being IT processes, all of them are subject to Governance policies (cf. Figure 2). Characteristics such as standards, implemented business processes, as well as ownership issues or interface specifications are targeted here.

Organizational Governance Entities

SOA Governance requires a correspondent on the organizational level that is often called "SOA Center of Excellence" (SCE). It is in charge of defining and enforcing guidelines and policies valid throughout the company. Ideally, members of the SCE come from every section and department in the company, i.e. representatives of the upper management, lines of business as well as from the IT department, e.g., software developers (Kalex, 2007; Keller, 2007). A crucial requirement for effective work is the full support of the company's upper management.

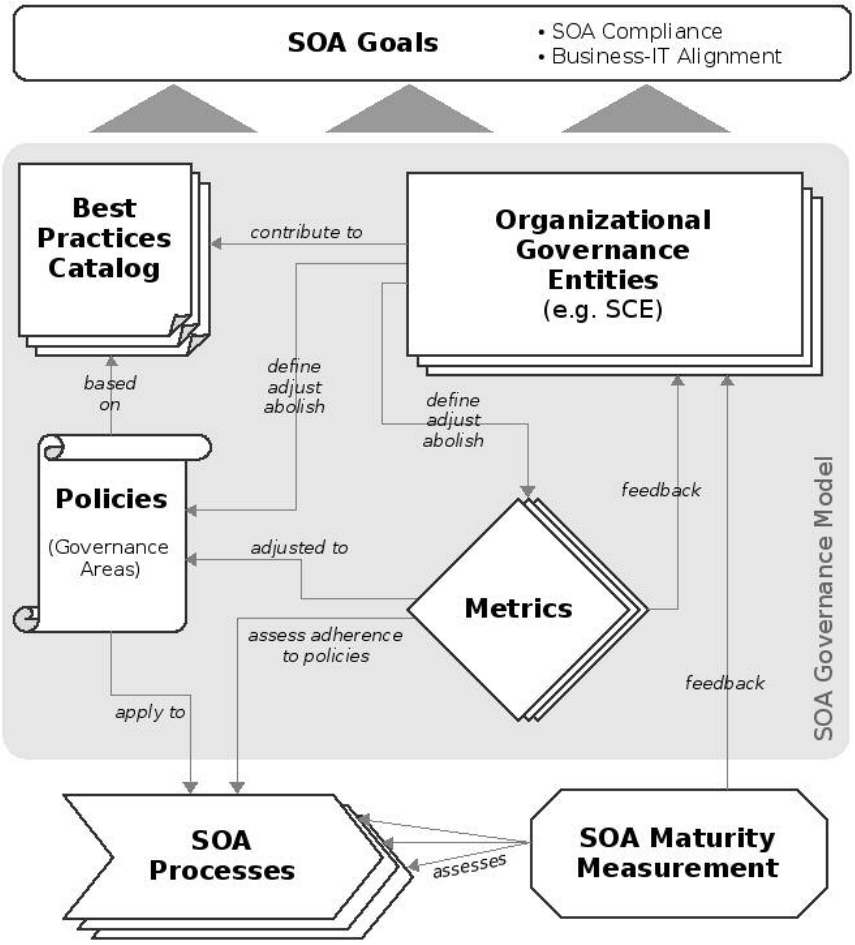

Figure 2. SOA Governance Operational Model

The SCE is in most cases a new organizational institution. Depending on the organizational composition of a company, numerous instances can exist, connected either hierarchically or in a coordinating manner (Keller, 2007; Fabini, 2007). The main task of these institutions is the definition, adjustment, and abolishment of governance policies, as well as their enforcement. For defining and designing new policies, a *best practices catalog* is consulted in order to benefit from previous experience.
Policies are created at all stages of the control cycle and all SOA maturity levels. Successfully deployed and applied policies are stored in the best practices catalog.

The SCE receives feedback concerning the realization and development of the enterprise SOA via the *SOA Maturity Measurement* component and the results from the metrics application. Thus the feedback cycle which emerges between the SCE, metrics system, SOA Maturity Measurement component and SOA processes assures the adherence of the policies and enables monitoring of policy effectiveness (cf. phase 4 of the SOA Governance Control Cycle, *operation*).

Metrics

The creation of a metrics system is a central issue. It is common to align metrics with specific goals and to assess the achievement of these goals. Goals are usually arranged in several nesting levels. Low level goals are defined by the governance policies, such as the implementation of interfaces or the adherence to a standard. These are part of higher level goals like “conformity of service design” or “general standards conformance” respectively. Metrics refer to the activities or processes that are regulated by the SCE in order to contribute to the achievement of a SOA goal. They are dynamic, i.e. subject to change, when policies change. The result measured provides feedback to the SCE regarding the degree of adherence to the given policy.
There are a number of metric types: business, process, performance, service level agreement (SLA), and SOA conformance

metrics (Marks and Bell, 2006). Each of these corresponds to a specific type of policies. CObIT provides a set of common metrics (ITGI, 2007).

Best Practices Catalog

All policies defined for SOA Governance are based on best practices, i.e. prior experience with an SOA system or that provided by commonly available recommendations. The best practices catalog contributes massively to the model's ability to constantly improve an SOA. The experience is stored in form of policies and ratings, and is always consulted when new policies are implemented or changed. In the case of abolishment, the respective recordings are added as negative best practices.
The best practices catalog represents a fundamental component of the governance model. It provides valuable information concerning regulation mechanisms, is able to store external experiences and records the success as well as failures in an SOA system.

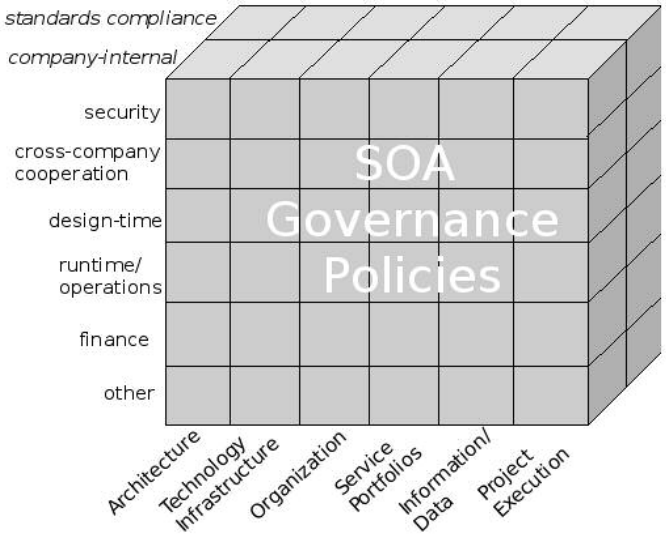

Figure 3. SOA Policies Cube

Policies

As stated above, the successful operation of an SOA is a complex challenge. One of the core elements of our governance model is a catalog of structured governance policies. The enforcement of these policies supports the achievement of SOA goals. It comprises all policies valid for an SOA system, for all control stages and maturity levels. The catalog is divided into several governance areas. It is the task of the SCE to define, adjust, and abolish policies.
In our model, we have identified 12 major governance areas that need to be regulated by SOA policies. The policy categories of previous SOA Governance models all class into this structure. The six main aspects are outlined in the lower part: architecture, technology, organization, portfolios, information and project execution. We have distinguished six cross sectional areas: security, cross-company cooperation, design-time, operation, finance and others. Furthermore, there are two major areas on the Z-axis: the *standards compliance* and *company-internal* layers (cf. Figure 3). In the following paragraphs, each area is described briefly.

Based on the work by Afshar (2007) and Marks and Bell (2006), we have defined six primary areas. *Architecture* includes reference architectures, architectural assessment mechanisms, application guidelines as well as architectural blueprints. The area *Technology Infrastructure* comprises aspects concerning the strategic SOA platform and governance platform, the migration of legacy systems as well as design and implementation of infrastructure services. *Organization* covers all aspects dealing with human resources and organizational structures. Incentives for employees, the definition of roles and responsibilities, and the installing of SOA trainings are also part of these considerations, in addition to the definition of service and process owners. The governance area *Portfolios* deals with SOA project portfolios, service portfolios and legacy portfolios for the strategic planning of an SOA and support for project management. *Information/Data* determines the rules for data ownership, data service architecture, data formats and standards, formalization of the description of data

requirements in SLAs as well as data quality. All project related issues are covered in the area *project execution*: project selection, competence alignment, as well as the formalization of the lifecycle control of business processes and policies.

The secondary, cross-sectional areas comprise the following. All primary areas specify *security*-related policies. These comprise data and communication security, systems security, as well as secure authentication and authorization mechanisms. The *cross-company cooperation* area comprises legal, technical and organizational issues for SOA-based cooperation between companies, e.g., operating an application which consists of services from several enterprises. In particular, it considers service ownership and operational issues. Many policies target the *design-time* of the system. This comprises all the regulations which concern the design of SOA software artefacts. The area *runtime* comprises all the operational aspects, such as capacity planning, operational models for cross-department deployment and enforcement of SLAs, for example. *Finance* covers the financial issues, such as the funding of business and technical services, hardware and software infrastructure, as well as accounting models: usage feeds, end-to-end funding, funding models, etc. All remaining aspects are summarized in *others*.
Each of these resulting 36 areas can be divided into two parts. The *company-internal* aspects comprise all the general policies concerning a company's SOA system. The *standards compliance* covers all aspects of adherence to accepted standards. This targets the software design and operation, but also project execution (e.g., ISO/DIN norms) or SOA organization.

SOA Maturity Measurement

An often mentioned element of SOA Governance is SOA Maturity Measurement. A number of SOA Maturity Models (SMM) were proposed (Sprott, 2005; Pieterse, 2006; Sonic, 2006; Johannsen, 2007; Mittal, 2007; Shah, 2007), some governance approaches also integrate them (cf. Table 1). Most of them are based on the Capability Maturity Model Integration (CMMI) by the SEI (2007). An SMM assesses an EA system in terms of its SOA conformance. It defines several maturity levels, where each level defines goals and metrics which determine and verify the current maturity level of an SOA implementation.
In our model, SOA maturity measurement is one of the six core components. Its main task is to provide feedback to the SCM, which it derives from the overall assessment of an SOA. This component represents the general approach for SOA maturity. This comprises in particular service inventory, the adaptation and the operation of an SOA in a company (Ashar, 2006; Repp, Schulte, Eckert, Berbner and Steinmetz, 2007).

CONCLUSION AND FUTURE WORK

In this paper we have presented an approach for a generalized SOA Governance model. We have identified six main components which form a mechanism for the optimal support of governance activities for an SOA system in a company.
The central issue of a governance approach for SOA is a superior control cycle. Some approaches consider this, however, they neglect other important elements of SOA Governance, and the effect of their interaction. Our model combines these proposals. It integrates an SOA Control Cycle (SCC), as well as the common concept of SOA Maturity Models. In previous studies of SOA Governance, these concepts were seldom combined. All existing approaches define best practices, metrics and policies, although often not explicitly. Most of the existing concepts, interaction schemes, and approaches to SOA Governance frameworks fit into our generalized SOA Governance model.
One of the new key opportunities an SOA provides is the ability to cooperate with other companies more easily on a technical level. The policy framework of our governance model is among the first ones to propose a governance area which addresses this issue.

With this SOA Governance model, we provide a fundamental generic approach to SOA Governance. We achieved a general perspective on this topic that efficiently supports future considerations and design of similar approaches. Our future work will focus on refining and extending this model. We aim to compare and evaluate it against comparable approaches.

ACKNOWLEDGEMENTS

This work is supported in part by the E-Finance Lab e.V., Frankfurt am Main, Germany (http://www.efinancelab.com).

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