Integration of IT Service Management into Enterprise Architecture

Christian Braun and Robert Winter
University of St. Gallen
Institute of Information Management
Müller-Friedberg-Strasse 8, 9000 St. Gallen, Switzerland
+41 71 224 29 35
{Christian.Braun ¦ Robert.Winter}@unisg.ch

ABSTRACT
Enterprise architecture supports organizational engineering in many ways. Service orientation is regarded as dominant operations model for service providers – within and beyond IT. As a consequence, it is important to integrate service management and service orientation into enterprise architecture. This paper proposes an enterprise architecture extension that achieves such an integration. IT service management is defined according to ITIL. Based on the integration of service management into enterprise architecture, the integration of Service Oriented Architecture is discussed as a further extension. The research is based on the Business Engineering approach and the guidelines of Method Engineering.

Categories and Subject Descriptors
D.2.11 [Software Architectures]: Domain-specific architectures

General Terms
Architecture, Design, Documentation, Modeling.

Keywords
Organizational Engineering, Enterprise Architecture, Framework, IT Service Management, Service Oriented Architecture, Conceptual Modeling, Metamodeling

1. Introduction
Organizational engineering aims at researching concepts, methods and technology in order to understand, model, develop and analyze all important aspects of changing businesses [26]. Using the Hevner et al. taxonomy of artifacts [11], organizational engineering design research can focus on terminologies / ontologies ("constructs"), on development and evolution methodology ("methods"), on reference models ("instantiations"), or on models that represent those features that are important for the development and evolution of businesses. This article focuses on models. Models are important for organizational engineering because they represent the dependencies between artifacts and representation layers, thereby guiding the development / evolution process and assuring certain aspects of design quality (e.g. consistency).

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1.1 Enterprise Architecture
Real-life organizations, however, are characterized by a huge number and a broad variety of artifacts. In order to reduce complexity and structure the development / evolution process, "architecture" layers have been introduced. According to ANSI/IEEE Std 1471-2000, architecture is defined as the "fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" [14]. Enterprise architecture (EA) therefore is understood as (1) the fundamental organization of an organization, either as a whole, or together with partners, suppliers and / or customers ("extended enterprise"), or in part (e.g. a division, a department, etc.) as well as (2) the principles governing its design and evolution [20].

In [7], dependency analysis, coverage analysis, interface analysis, heterogeneity analysis, complexity analysis, compliance analysis, cost and benefit analysis have been described as ways how EA can support IT/business alignment, business continuity planning, security management, technology risk management, project portfolio planning, business process redesign, quality and compliance management, post merger integration, the introduction of commercial of-the-shelf software, sourcing decisions, IT service and IT operations management as well as IT consolidation. By (1) representing essential artifacts of an enterprise and their dependencies consistently, and thereby (2) serving as a foundation for many different analyses in various application scenarios, EA is of utmost importance for organizational engineering.

1.2 IT Service Management
Customer orientation is one of the most important strategic orientations in the context of strategic IT management in today's enterprises [13]. Enterprises need to manage the delivery of services that support users in conducting their activities in the context of business processes. They have to achieve a common understanding between the customer/user and provider through managing service level expectations and service level delivery, and delivering and supporting desired results [23].

External IT providers as well as internal IT departments are no longer sheer technology providers. Instead, most of them act increasingly as service providers for IT users. These IT users, respectively customers, demand functionality with a defined quality that supports their activities within business processes and improves their productivity [1].

In order to specify IT provider / IT customer coordination, IT services need to be defined. Service and quality characteristics for such IT services are negotiated between service providers and customers and specified by means of a service level agreement (SLA) [12]. Thereby, it makes no difference whether the user receives the service from an internal IT department or from an external service provider. This transformation from a technology oriented IT shop towards a customer oriented service provider that engineers its IT processes in a systematic, methodical manner can only be done in terms of a service oriented IT management [13]. A plethora of service oriented IT management concepts have been developed in the past. The IT Infrastructure Library (ITIL) is the de-facto-standard for IT service provider and it is probably the most extensive concept for IT Service Management (ITSM) [19]. ITIL can be defined as a generic reference model that supports planning, monitoring and controlling of IT services [13]. Its most important components are "Service Delivery", "Application Management", "Service Support" and "ICT Infrastructure Management" [19]. Concepts for the provision of IT services can be found in "Service Support" and "Service Delivery", especially within the process definition for service level management (SLM).

1.3 Research Question

When EA is regarded as a pivotal concept for organizational engineering, and when ITSM is regarded as the dominant operations model for IT, ITSM must be sufficiently integrated into EA. This paper proposes an EA extension that achieves such an integration. We will define ITSM key elements according to ITIL [19]. Based on the integration of service management into EA, the integration of Service Oriented Architecture (SOA) will be discussed as a further extension.

The research is based on the Business Engineering (BE) approach [18] and the guidelines of Method Engineering (ME) [6]. It incorporates the three BE design layers "Business Strategy", "Organization" and "Information System". According to the design research reference process (e.g. [11]), this paper documents the construction of an artifact (the extended EA metamodel).

2. Essential Layers and Artifacts of Enterprise Architecture

The complex structure of an enterprise can be modeled from many different views and for many different purposes [29]. A layered architecture framework is useful in order to reduce complexity and represent different aspects in different models as long as overall consistency is preserved by appropriately modeling the frameworks' metamodel [4]. According to a literature analyses conducted by WINTER and FISCHER, an EA framework should comprise five essential architecture layers [30]: business architecture, process architecture, application architecture, software architecture and technology architecture.

According to the hierarchical, multi-level systems theory approach, results of the modeling process (models) on each architecture layer reduce the degrees of freedom of the subsequent layers [17]. On each layer, models differ in the degree of aggregation, specialization and abstraction as well as in their purpose. Different views often reflect interests and expertise of different stakeholders (e.g. managers, software engineers) [15]. For each of these groups, only a certain portion of enterprise architecture is relevant. In a multi-layer architecture, views can be layer-specific or cross-layer [30]. Examples for layer-specific views in EA are the structural view (organizational units, responsibilities) and the process view (business processes, performance indicators) on the organization layer. Examples for cross-layer views are security architecture and information architecture.

Based on the concepts of multi-layer representation, aggregation hierarchy and cross-layer view, EA can be defined as the view that represents all aggregate artifacts and their relationships across all layers [30]. This is due to the fact that only the most aggregate artifact representations and their relationships can be 'fundamental', and that all more decomposed artifact representations have to be covered by specialized architectures.

The definition of all aggregate artifacts of an enterprise and their relationships across all views and layers by means of a framework and an underlying formal or at least (semi-)formal metamodel guarantees consistency [4]. To support ITSM, an EA framework has to comprise appropriate service concepts. In the following section, we will therefore identify key elements of ITSM and SOA. These elements will be related to other EA key elements.

3. A Metamodel for IT Services

Management of the IT assets of an enterprise (or subunit) is central to ITIL [19]. Thus, according to LANKHORST, a well-developed and documented EA is a very valuable basis for ITSM [15]. EA provides an overview of the IT infrastructure, software components and applications, the support of business processes and customer processes, as well as the dependencies between these key components. Nearly all of the core operational processes identified by ITIL will benefit from this [15]. To be able to guarantee efficient and effective operational processes, the key elements of ITSM (e.g. IT services, SLAs, service providers, service processes, etc.) and their dependencies should be documented in an EA framework. Furthermore, the relations to other key elements within the EA (e.g. software components, infrastructure elements, organizational units, business processes) should be identified in order to enable cross-layer analyses of change impacts.

An appropriate metamodel for an IT service EA view is illustrated in **Fehler! Verweisquelle konnte nicht gefunden werden.**. We use UML notation to specify the metamodel. The IT service view will be integrated with other EA views in the following sections.

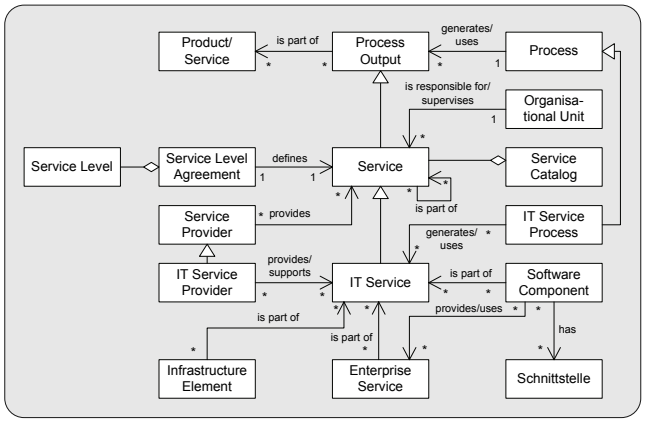

Figure 1. Metamodel for IT services

An *IT service* can be defined as a bundle of services that is provided by an IT system or the IT department (respectively an ex-

ternal IT service provider) to support business processes [19]. The characteristics of IT services can vary significantly. They can comprise functionality of single software components as well as bundles of software components, infrastructure elements and additional services. Additional services are usually information services, consulting services, training services, problem solving services or modification services. They are provided by operational processes (*IT service processes*) within the IT department or the external service provider [10]. Thus, an IT service process can be seen as part of an IT service and an IT service comprises services provided by information systems as well as services provided by humans. The service provider's IT services are documented in a *service catalog,* along with information about their costs [1]. According to the ownership of business processes and applications, every IT service is assigned to a responsible organizational unit that supervises the adherence to service levels defined in a service level agreement. A *service level agreement* (SLA) is a contract between the service provider and the customer that documents the stipulated service levels for a certain IT service [8]. A *service level* can be defined as a certain quality feature of an IT service (e.g. operational availability and response time). After agreeing on service level agreements, the IT service provider is committed to provide the defined services with the stipulated quality to the customer [1]. In addition to SLAs, ITIL differentiates between other contracts, like *operational level agreement* (OLA) and *underpinning contract*, depending on the partners involved [19].

As already mentioned before, IT services are generated by IT service processes. An IT service can be regarded consequently as output of one or probably more processes. The process output is provided to processes of internal or external customers. If the process output is provided to a process of an external customer or partner, then it is part of the services/products that the company or business unit provides on the market.

4. Integration of IT Services into Enterprise Architecture

The IT service view can be basically assigned to the application and software architecture, since software components, respectively their functionality, are an essential part of IT services.

IT services should be defined based on the requirements of the business and are related to many other key elements on different EA layers and in different EA views. Thus, the IT service view should be defined as a cross-layer view comprising elements from all architecture layers.

The IT service view can be basically related to the following six key elements which are assigned to different EA layers and EA views (see Figure 2):

(1) IT services are output of IT service processes and support business processes which are traditionally modeled in a process map or in a more detailed activity model (e.g. UML Activity Diagram or BPMN).

(2) IT services comprise functionality of software components which are provided via defined interfaces with additional services and which are usually documented in a component model (e.g. UML component model). The functionality of a software component can also be defined as service according to the SOA concept, if they are encapsulated and if their standardized interfaces are published in a service registry (see next section) [27].

(3) IT services can comprise infrastructure elements, like servers, workstations or routers. These are commonly documented in an infrastructure model that illustrates infrastructure and network components, as well as their connections.

(4) Every IT service is assigned to a certain organizational unit that is responsible for the provisioning of this service or for the supervision of the service levels stipulated with the service provider. Organizational units and their positions are for example documented in organization charts.

(5) IT services comprise IT service processes that can support customer activities in the context of a customer process. Customer activities can be specified by means of a customer process model that represents the succession of the elementary customer activities and how they are supported by certain service activities, respectively certain business processes.

(6) The IT service view also relates to elements of the business architecture. As already mentioned before, IT services can be part of the services/products a company or business unit provides on the market. These are usually specified by means of product models.

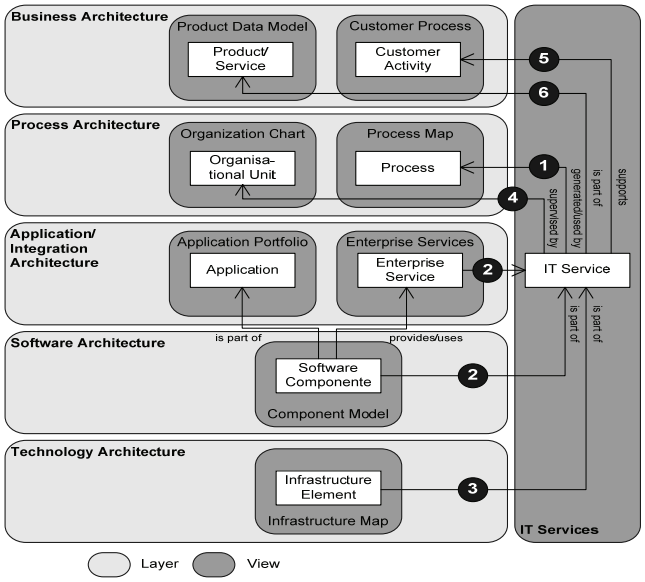

Figure 2. IT services and their relationships to other EA components / EA views

In conjunction with service oriented IT management and the cooperation between IT service provider and users by means of IT services, the SOA concept is increasingly discussed among practitioners as well as in the scientific community [2], [3], [8], [16], [23], [24], [25]. There is a perception for the strong relationship and synergy between IT service management and SOA. As already mentioned before, functionality of software components is an essential part of an IT service and can also be defined as service(s) according to the SOA concept. SOA is a way to deliver and reuse functionality more flexibly in both IT and business. Thus, the implementation of SOA strongly affects the design of IT services. Conversely, ITIL processes can be used to change or release any service defined according to SOA. ITIL processes are therefore an important enabler for the management of SOA. A

model for service oriented IT management has to comprise the basic SOA concepts and their relationship to IT services.

The following section describes fundamental SOA concepts and discusses their integration into EA.

5. Service Oriented Architecture

In general, service orientation implies a vision of a world in which resources are clearly partitioned and consistently represented in terms of loosely coupled services [23]. Following this vision, the different architecture layers of an enterprise and their elements should be decomposed in terms of services. Doing that in a consistent and consequent way will deliver loosely coupled functionality clusters that can be outsourced, insourced or bundled in so-called shared services centers [5], [23].

It is generally assumed that adopting the service orientation paradigm by an enterprise or organization and implementing it in an appropriate way, will enhance not only flexibility (adaptability to known, mostly evolutionary changes), but also agility (adaptability to unknown, even revolutionary changes) [24].

But until now, there is no common understanding of the SOA concept. It was originally invented in software engineering. The W3C defines SOA for example as "a form of distributed systems architecture. [It consists of] a set of components which can be invoked, and whose interface descriptions can be published and discovered" [27], [28]. Thus, they can be used more flexibly, and reused more easily. The underlying implementation is independent from the interface and can be modified at any time without affecting users or other software components. Besides, it is irrelevant whether services are provided by internal software components or by software components from external providers.

If the concept of service orientation is as beneficial for an organization as assumed, it should not only be viewed from a technical perspective, but also from a business oriented perspective. As a consequence, we define SOA as a cross-layer, distributed integration architecture that encapsulates parts of the application architecture as enterprise services and connects the process, application and software architecture layer of the EA framework. An *enterprise service* is defined as an abstract software element or interface that provides robust, reusable software functionality to other software components by means of common standards on a business oriented level of granularity [28].

Accordingly, the SOA concept is integrated into the EA framework as a horizontal view of the application architecture. This view encapsulates functionality from different applications in the sense of business so that it can be flexibly used and assembled to support business processes. The transition between the business and application architecture can thereby be designed more flexible and less complex.

Since enabling business processes cannot be a monolithic effort with overly rigid goals, such as to encapsulate the functionalities across all applications by means of services, or completing all transformations by a specified date [8], the concept of applications will coexist with the concept of services. A business process can hence be supported by one or more applications or by one or more enterprise services. Figure 3 illustrates the representation of SOA key elements and their relationships (see also Figure 2).

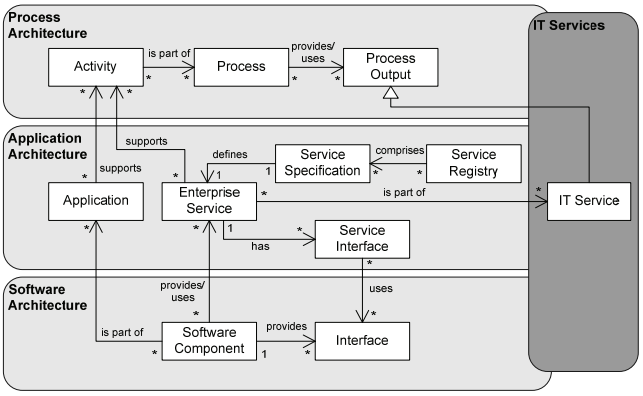

Figure 3. Enterprise service metamodel

Service specification comprises all information about the service that service users need - without having to know any implementation details of such service [25]. All available services and their specifications are stored in a *service registry*. The service specification is implemented by means of a *service interface* [28].

Enterprise services can be part of IT services, if they are provided together with other service components, like infrastructure elements or additional services, like training or customizing services (see also **Fehler! Verweisquelle konnte nicht gefunden werden.**). Loosely coupled, reusable and composable enterprise services can be managed and supported by service support and service delivery processes according to the ITIL guidelines. On the other side, IT services can be implemented and delivered in a more service oriented manner.

6. Resume and Outlook

Based on the importance of EA for organizational engineering and the increasing importance of service orientation in IT management as well as in organizational design, this paper aimed at integrating ITSM and SOA into EA. We proposed metamodel extensions that integrate service oriented concepts and relate them to other EA key elements.

According to the design research approach, the utility, quality, and efficacy of a design artifact (the metamodel extensions) must be rigorously demonstrated via well-executed evaluation methods [11]. FETTKE and LOOS propose a framework for a multiperspective evaluation of reference models [9]. They argue that reference models have to be systematically evaluated from different perspectives in order to validate their design process. This principle can also be applied to metamodels.

Therefore, our next steps will be to implement the proposed services metamodel in an EA management software prototype that we already developed in the past [4]. Thus, we will be able to evaluate the applicability of these service concepts in practice by means of case studies (empirical perspective). Furthermore, our metamodel will be compared with other metamodels (IS theory-based perspective) and evaluated according to predefined requirements (descriptive perspective).

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