An Approach to the Analysis and Evaluation of an Enterprise Service Ecosystem

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Abstract. Currently, the implementation of service-oriented concepts is one of the main activities of many IT and business departments throughout enterprises of various industries. Service-orientation as a concept is no novelty for many enterprises - many software systems and components offering technical and business functionality do comply with service-oriented principles. Nevertheless, the analysis, evaluation, and integration of existing services are often neglected in process models describing the implementation of service-oriented concepts. This paper describes an approach to the analysis and evaluation of those existing services to become part of the enterprise service ecosystem, which we call service inventory. The service inventory is realized as a generic extension to existing systems development methodologies, which allows its integration into the already used service-oriented methodology. The service inventory approach is based on Service-oriented Architecture research, principles from systems analysis and design, as well as on auditing principles.

1 Introduction

A current trend in software and enterprise engineering is the Service-oriented Architecture (SOA) paradigm, which can be used to design and develop complex IT systems. The core concept of SOA is the "service", which can be understood as a self-describing encapsulation of domain-specific functionalities [1] [2]. Business processes and the applications supporting them can be built based on compositions of distributed and loosely coupled services.

Following the SOA trend many software vendors as well as IT service providers and consulting companies are jumping on the bandwagon, offering software, toolsets, and methodologies for the implementation of SOA in an enterprise and the system developments based on services. Especially in the area of middleware, supporting SOA (often referred to as the Enterprise Service Bus) and systems development methodologies for the implementation of SOA (the focus of this paper) there is a vast range of offers from almost all vendors. However, existing vendor specific systems development methodologies do not sufficiently consider the integration of an existing service ecosystem into the SOA, as they do not accept the fact that many principles and aspects of SOA are

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already in use. Furthermore, many software systems and components in use offer technical and business functionalities that already comply with service-oriented principles. Those existing service have to be found and integrated into the SOA.

In this paper, we describe an approach to the analysis and evaluation of an existing enterprise service ecosystem and its services, which we call “service inventory” according to the concept of the inventory process in financial accounting. Parts of the approach are the result of a research project in cooperation with an industry partner. The goal of this research was not to create “yet another” systems development methodology but to develop a generic enhancement of existing SOA systems development methodologies. Furthermore, the development of a tool for the analysis and evaluation of services (“auditing of services”) was also an objective. Intension behind the tool was to allow the creation of a service inventory by an experienced third party in a timely manner. Both the approach itself and the tool have to be customized with respect to data models and terminology in order to fulfill the needs of a particular enterprise.

The rest of this paper is structured as follows. In the next section, we will provide definitions important for the further understanding of the paper. The successive section introduces aspects of service-orientation, which are the foundation of the evaluation framework included in our service inventory approach. The service inventory approach is described in a separate section based on a generic process, which can be part of existing commercial systems development methodologies. The paper closes with a conclusion and an outlook on future work.

2 Basics and Definitions

2.1 Services and Business Processes

As already discussed in the introduction, we define services as self-contained encapsulations of domain-specific functionalities. The whole of services, which can be used by an enterprise, is referred to as “enterprise service ecosystem”, which includes both internal services and services obtained from external sources. The services can be composed to execution plans containing the functionality of the business process [3] [4] and subsequently be executed by a business process engine. The possibility of a mapping between business processes and services offering the needed functionalities are a precondition for our work. We will not further discuss this topic in this paper.

Every relationship between a service provider and a service requester, no matter if a service provider is internal or external, has to be documented in the form of a contract, a so-called Service Level Agreement (SLA), describing the most important aspects of the relationship. This contract can be explicit, i.e., described in a dedicated document, or implicit by simply using a given service. Especially in business critical processes the management and enforcement of SLAs is crucial [5]. SLAs can be part of the data, which is examined during the service inventory process.

2.2 Service Inventory

According to the common understanding of the term “inventory” in accounting as both “a detailed list of all the items in stock” and the “making (of) an itemized list ...” (fol-

lowing the definition of the term in WordNet), we also use the term “inventory” in this paper both for the process of taking stock as well as for the result of this process.

If applied to the concept of an enterprise service ecosystem, services (here: services provided by the enterprise in scope) also can be seen as intangible assets of an enterprise, which have to be valued. The stocktaking of existing services, their analysis, and evaluation is therefore called “service inventory”. Depending on the point in time and the frequency of a service inventory, we can distinguish between a periodic (i.e., annual or project initiated service inventory) and a perpetual service inventory (i.e., continuous tracking of services). We assign no monetary value to a service during the service inventory. Instead, the value of a service is measured based on its ability to be integrated in the SOA, which should be implemented by the enterprise. To be more precise, the measurement is founded on the assessment of several aspects of services, which are discussed in the next sections.

In addition to the definition of the service inventory process, a service inventory also describes the result of the taking stock process. Therefore, the service inventory also represents a listing of all services at a given point in time. It can be managed by a service repository. The description of services itself as well as the format of the listing of services is out of scope of this paper. We will focus on the service inventory as a process for the rest of the paper.

3 Service Aspects

This section about service aspects describes the foundation for the service inventory process. Based on the aspects given in Table 1, the ability of integration in a SOA is analyzed and evaluated. The service aspects were derived from different sources, i.e., the common principles of service-orientation presented by Erl [6], the rules for architectural design of enterprise IT by Voß et al. [7], the standardized specification of business components by Ackermann et al. [8], as well as from our experience in SOA projects.

Of further importance is the documentation of a service. It is the foundation for all the aspects mentioned above - without a sufficiently complete and comprehensible documentation the assessment of the services is not possible. To improve the usability of the service inventory process we created a criteria catalog, which represents the content and intension of the given service aspects. Every criterion is formulated as a question, which can be easily answered based on a given range of possible answers (mostly “yes”/“no”, where “no” signalizes a deviation from the targeted state).

4 Our Approach to the Analysis and Evaluation of Services

In this section, we describe the service inventory process. As a foundation for the service inventory process, we will also present a generic systems development process with respect to the implementation of SOA, in which the service inventory process can be integrated.

Table 1. Service aspects as the foundation for the service inventory.

Service aspect	Description
Reusability	Describes the ability of a service to be used without changes in different scenarios than the ones it was specified for. Only changes in the parameterization of the service are acceptable.
Granularity	Depicts the functional range as well as the complexity of a service. Services of coarse granularity offer functionalities of an entire business domain, e.g., the implementation of an entire business process, whereas services of fine granularity offer base functionalities useful in various scenarios.
Autonomy	Characterizes the independence of a service from other services as well as from other resources. Furthermore, autonomy also describes the uniqueness of a service with respect to its functionality, i.e., there are no two services in one enterprise service ecosystem with the same functionality.
Context independence	Describes the property of a service to operate without any context or state information. Every call/execution of the service provides the needed information to operate. There is no keeping of state information or session concept. Furthermore, a service has to offer compensating functionalities in order to be independent from external intervention in case of an exception.
Degree of coupling	Specifies an additional measurement for the independence of a service, aiming towards a preferably loose coupling of services, i.e., services can be exchanged on the fly without the consideration of any dependencies.
Information hiding	Neither information about technical details of the implementation nor information with business or security critical character should be visible to service requesters, especially if the service requesters are from outside the enterprise.
Discoverability	Characterizes the need to document a service and make it identifiable in order to be found. Additionally, discoverability is also crucial in order to avoid parallel developments of the same functionalities in different departments or the unnecessary purchase of services due to the lack of knowledge.

4.1 Prerequisites for the Approach

In order to apply the phases of the service inventory process to a given situation, we need a sufficiently complete set of data about the service in scope. In contrast to the inventory process known in accounting, we need a description of the subject we are looking at because of its intangible character.

Based on experience from projects in the finance and telecommunications sector, we observed that the following information about a service is usually available for an assessment:

- Non-formal description of the service functionality.
- Description of both service provider and service requester.
- Service Level Agreements describing the non-functional properties a service provider is willing to offer.

Furthermore, the following information is helpful, if available:

- Formal description of the service functionality, e.g., in form of a semantically enhanced interface description.
- Description of prospective service requesters and usage scenarios.
- Classification of the service based on a service model used by the enterprise.
- Documentation about the business processes, in which the services are/can be used.

It is not always possible to start the service inventory process with a complete set of the information described above. In case of missing or ambiguous information with respect to the service aspects, interviews or walkthroughs of the documentation in cooperation with members of staff should be used to gather the missing information.

4.2 A Generic Systems Development Approach for the Implementation of SOA

As we stated before, the service inventory process is not a standalone process. It has to be embedded in an existing systems development methodology for the implementation of SOA and respective process. Therefore, we will first present a generic systems development process in which the service inventory can be integrated. For this purpose, we analyzed different vendor specific systems development methodologies for the implementation of SOA, which we worked with before, i.e., methodologies, and processes of IBM, Software AG, and IDS Scheer. Based on the similarities of the models and the basic phases of the systems development processes discussed in Software Engineering and Systems Development literature (e.g., [9] and [10]), we derived a simple generic process for the implementation of SOA, taking full account of the given service ecosystem. Both the generic process and the service inventory process are modeled using the Business Process Modeling Notation (BPMN) [11], a standard for the description of business processes broadly used in the area of SOA, in order to simplify the integration with processes of different vendors or those already used by the enterprise.

The generic systems development process consists of five core phases, which all are sub-processes themselves (see Figure 1). For simplification, we do not model iterations of single phases or sub-processes as parts of the process in this paper, but they are possible and valid in our process. The analysis phase is depicted in-depth, as the service inventory process is part of it. The phases of the process are described in Table 2 in more detail.

4.3 Phases of the Service Inventory Process

As stated in the previous section, the service inventory process is part of the analysis phase in the generic systems development process for the implementation of SOA. We can distinguish four phases of the service inventory process, which are depicted in Figure 2. An in-depth description of the single phases is subject of Table 3. The result of the service inventory process can be directly used for the design of a SOA-based system, as it describes services, which can be reused. The four phases are intentionally kept generic in order to allow the adaptation to the current project context. Unfortunately, there are also no generally accepted recommendations for service aspects, e.g., for the granularity of a service, which could be used as a guide for the process.

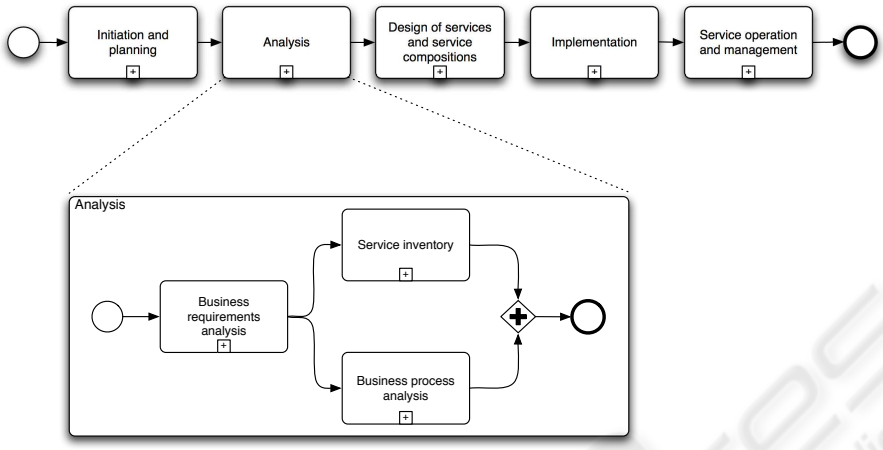

Fig. 1. Generic systems development process for the implementation of SOA.

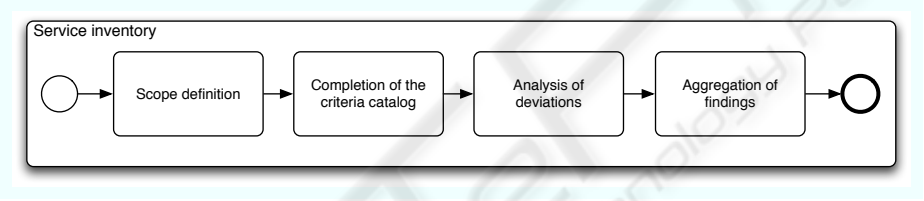

Fig. 2. Overview of the service inventory process.

Nevertheless, the service inventory process is not only an academic concept. In cooperation with a German IT consulting firm we developed an Excel based criteria catalog containing 28 questions, which can be mapped to the seven service aspects. We further integrated the service model of the firm, which classifies services into four categories. As a further enhancement of the generic process and criteria catalog, we created examples for the evaluation of the criteria to allow a quick access to the approach. Finally, we estimated the time needed for the completion of every single criterion in order to bundle the criteria into three preconfigured tests of different duration. Currently, the approach is used in first SOA projects.

4.4 Service Inventory Process by Means of an Example

In this section, we want to give an example of the service inventory process. In the first phase of our example, the objective of the service inventory is set to a check of service reusability. Due to this fact, the criteria of the catalog are the most important, i.e., receive the highest weights, which are related to the service aspect of reusability. A single critical deviation of a criterion related to reusability leads to an “orange” rating of the service, classifying it as only usable with restrictions. More than one critical deviation will lead to a “red” rating and therefore to the exclusion of the service from the

Table 2. Phases of the generic systems development process for the implementation of SOA.

Phase	Description
Initiation and planning	In this initial phase, problems with respect to the business and its processes are identified. The identification as well as the following sketching of a solution based on SOA is done on a high level, which is not sufficient for an implementation. If in this phase the decision is made to start a SOA-based project, further scoping and resource planning has to be carried out, e.g., staffing, budgeting, or the planning of milestones.
Analysis	Subsequent to the initiation and planning phase, the business needs and processing requirements as well as the as-is situation of both the business processes and the underlying enterprise architecture have to be examined in detail during the analysis phase. In this phase, a service inventory has to be performed to get an overview of services already in use, which could be integrated into the solution.
Design of services and service compositions	Based on the results of the analysis, we now can design services and compositions of services in order to implement the needed business processes. During this phase, not only new services have to be designed. Moreover, the focus of a service-oriented approach is on the reuse of existing services. Both the existing and new services are combined in the form of service compositions, i.e., parts lists forming blueprints of the business processes to be implemented.
Implementation	The blueprints and designs of business processes, service compositions, and services from the last phase are implemented in this phase. The implementation is realized on different levels of abstraction. Services are implemented for example using traditional programming languages and Web Service technology. Furthermore, service compositions also have to be implemented in a format, which is machine-readable and -interpretable. For this purpose, higher level composition languages are used, e.g., the Business Process Execution Language (BPEL) in the Web Service domain [12]. Service implementations and execution plans of business processes based on services, which can be processed by business process engines, are the outcome of this phase.
Service operation and management	As the last phase of the generic systems development process for the implementation of SOA, we describe the service operation and management phase. This phase contains aspects of both a systems development process and a service lifecycle model. In this phase, the set of services implementing business functionalities is executed. The monitoring and measurement of the execution often results in a need for improvement and optimization of the developed system, so that additional iterations of the systems development process have to be performed.

SOA. In the next phase, the adapted criteria catalog is completed based on a review of the given documentation. The following questions are examples of criteria with respect to the reusability of a service:

– *Does the documentation provide information about the data types and formats used to invoke the service?*

Table 3. Phases of the service inventory process.

Phase	Description
Scope definition	In this initial phase, the aims and objectives of the service inventory have to be defined depending on the current situation of the enterprise. Therefore, the scope of the service inventory has to be set, e.g., what services have to be assessed and what amount of time is available for the service inventory. Furthermore, the properties of a service, which are needed to fulfill the goals of the targeted project, have to be specified in terms of the seven service aspects. In addition, the aspects have to be weighted among each other with respect to their relevance for the project and deviations from the targeted state have to be defined. Finally, it has to be specified how many deviations of what severity lead to negative rating of the service for the project ("definition of materiality").
Completion of the criteria catalog	Based on the scope of the service inventory, in this phase the questions in the criteria catalog have to be completed during a review of the documentation, an interview, or a walkthrough. The criteria catalog is completed per single service.
Analysis of deviations	In this phase, the deviations detected in the previous phase have to be analyzed with respect to their severity. The deviations are classified into the three types "minimal", "moderate", and "critical", based on the definitions provided in the initial phase.
Aggregation of findings	In the final phase of the service inventory process, the results of the previous phases have to be aggregated for every single service. The result of this phase is a statement about the usefulness of the service for the project and its ability to be integrated in the SOA. There are three possible outcomes of the service inventory process for every single service in scope, which are classified into "green" ("service is useable without restriction"), "orange" ("service is useable, but with restrictions"), and "red" ("service is not useable" or "not a service").

– *Does the description of the service provide mapping information of the service functionality to the classification framework used by the enterprise?*

Subsequent to the completion of the criteria catalog, the deviations detected in the previous step have to be analyzed in detail during the third phase. In our example, the nonexistence of the documentation of both data types and format for the service invocation is classified as critical. Finally, the singular ratings of the service have to be aggregated. One single critical rating results in an overall classification of the service as "usable, but with restrictions" ("orange"), because of the lack of adequate documentation for data types and formats is easily remediable.

The service inventory process is documented in a dedicated format, containing information about the assessed services, the scope of the service inventory, the auditor performing the service inventory, the findings as well as the time needed for the service inventory. Based on the documented amount of time needed for both the service inventory process and single criteria, the service inventory process can be customized in order to fit the needs with respect to the time restrictions of the project.

5 Conclusion and Outlook

In this paper, we presented an approach to the analysis and evaluation of an enterprise service ecosystem, which is called service inventory. The service inventory is not a new systems development methodology but an enhancement of existing approaches with a strong emphasis on the current situation of an enterprise planning to implement a SOA. Our approach details the phases of vendor specific processes coping with the analysis and integration of existing services. All of the vendor specific processes address existing services, but they do not address how to analyze and evaluate them with respect to their potential use for the SOA implementation project. Based on the generic character of our approach it is highly adaptable to the needs of an individual enterprise.

In the future, we have to specify and formalize the phases of both the generic process and the service inventory process in more detail, whereas the differentiation of the phases in both processes will not be changed. Additionally, the service aspects, which are the foundation of the service inventory process, will be improved further with respect to recommendations for the individual service aspects. For this, we are currently preparing a multi-participant case study to evaluate best practices for service granularity in different industries. Of further importance is also the specification of services itself. We will evaluate existing specification frameworks for the description of services in order to integrate such a framework into our approach. Additionally, we plan to integrate our criteria catalog as well as the process into a web-based application in order to support the service inventory process.

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