Approaches of Service Identification: Selective Comparison of Existing Service Identification Methods

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A B S T R A C T

The increasing digitalization in all spheres of life has resulted in complex business processes and interactions for companies worldwide. For this reason, they see themselves forced to implement efficient information systems which enable a simple and flexible coordination of all business processes within a company. The concept of service-oriented architecture has evolved to tackle this challenge by designing an enterprise architecture that is capable of a rapid response to changing business needs within a company or its environment. One of the very first steps in this context is the identification of services, which is argued to be key for a successful design and implementation. Numerous researchers have come up with models for a structured service identification process. The purpose of this study is to identify the most coherent approach with regard to its degree of detailedness and practicability from a business perspective. A structured literature review of 116 approaches was conducted of which 20 were selected for a detailed analysis using a specific set of comparison criteria. Given the analysis scope of the study, SOPLE-DE – design in the context of service-oriented product line engineering – by Medeiros et al. (2010) was found to be most conclusive for the identification of services.

Keywords: service science, service-oriented architecture, service identification

I. Introduction

Since business processes and interactions become increasingly complex with rising demands and expectations, an efficient information system which coordinates all business processes within a company is highly important. Service-oriented architecture is a relatively new paradigm to tackle this challenge. It aims to design an enterprise architecture, which can quickly react to changing business needs within the company or its environment. Until today, there is no best practice for the introduction of an efficient service-oriented architecture. Most researchers agree that one essential task is the identification of services, which is one of the first tasks and the basis for the successful design and implementation of a service-oriented architecture. There are numerous approaches which attempt to establish an efficient service identification method. Noticing great differences between them, this paper pursues to compare some of the existing approaches with regard to their detailedness and practicability. The comparison is conducted using a specific set of criteria.
In the course of this study, the respective literature was first reviewed. Based on the literature review, section 2 examines the basic concepts and definitions relevant for service identification. In section 3, the methodology of approach selection and comparison is presented providing a table of the selected approaches with the respective comparison criteria as a result. The classification tables are split into tables comprising criteria which were taken from other comparative studies (SIM Comparison – Existing Criteria), and tables which attempt to analyze the approaches taking into consideration the concept of situational method engineering (SIM Comparison – Elements of SME). The Service Identification Method (SIM) by Medeiros et al. (2010), which was found to be the most explicit one considering the set of classification criteria, is explained in more detail in section 4 and lastly, conclusions are drawn in section 7.

II. Basic Concepts and Definitions

Service identification is widely understood as a building block of a service-oriented architecture. Therefore, it is crucial to understand the concept of service-oriented architecture and the meaning of service in this context before tackling on service identification approaches. In the following, the terms service, service-oriented architecture, and service identification shall be explained in a generic way pointing out the different definition frames.

A. Services

Erl (2008: 39) describes services in the context of service-oriented architecture as “physically independent software programs with distinct design characteristics that support the attainment of the strategic goals associated with service-oriented computing.” Specifying these distinct design characteristics, Heutschi’s (2007: 22) definition of services include their ability to “provide other applications with stable, reusable software functionality at an application-oriented, business-related level of granularity using widely applied standards” (quoted in: Boerner 2012: 1). This definition implies that services in a service-oriented architecture should fulfil certain requirements. Researchers generally agree on the following service requirements: interoperability, reusability, loose coupling and composability (e.g., Erl 2008: 50; Gu & Lago 2010: 37; Huergo et al. 2014: 2, Svanidzaite 2012: 202, Börner 2012: 2-4).

B. Service Oriented Architecture

The concept of service-oriented architecture was introduced in order to cater to changing business needs (Sivakumar 2010). From the general service requirements mentioned above, a service-oriented architecture can be defined as “a framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities” (quoted in Börner 2012: 1). Opinions from researchers are diverged, whether service-oriented architecture should be viewed as a technology, a middleware or an architectural paradigm. However, a tendency towards the latter understanding can be observed from literature (e.g. Rieks: 6).

C. Service Identification

In general service identification addresses the question regarding actions of the business processes of a company that should be realized by a service (Winkler 2007: 257). It is one of the first steps in the service-oriented development process and recognized as the basis for a successful implementation (Birkmeier 2008: 256). The extent of the service identification phase varies across different approaches. Fischbach

1) Definition: ability of different systems to collaborate seamlessly (http://www.duden.de/rechtschreibung/Interoperabilitaet, accessed on 20.12.2015)
Figure 1. SLM process structure approaches (Fischbach 2014: 84)

(2014) illustrates how the tasks of different phases in a service lifecycle management process can diverge (see Figure 1).

He derives seven steps of a generic SLM process, which are identification, requirement analysis, conception, development, implementation, operation, and enhancement. Focussing on the identification phase in figure 1, it is clear that the scope of this task varies, ranging from analysis to service design. This different understanding of service identification constitutes one challenge of comparing different service identification methods. The scope of the service identification step may be measured by comparing the outputs of different service identification methods.

III. Comparison of Service Identification Methods

After providing the basis for understanding service identification processes, this section entails the focus of this research paper - the comparison of selected service identification methods. First, the methodology will be explained, which includes the procedure of selecting specific service identification methods and classification criteria for the comparison. Section 3.2 presents the comparison results tabularly.

A. Methodology

For the collection of existing service identification approaches, the main focus was on the literature review of existing comparative studies. Table 1 presents the studies, which are adopted and considered in this research paper.

A list of service identification methods presented in the literature from Table 1 can be found in the appendix (Annex 1). The process of breaking down this list was executed in two steps. First, research papers by the same author are reduced to adopt only the author’s latest research paper, underlying the assumption that the latest research by one and the same person is an update to her previous work. Research papers which are not publicly available were also disregarded. In the second step, the number of service identification methods, which were not selected for the comparison, are not included in the references.
identification methods is further reduced by applying three exclusion criteria (s. Table 2);

**Mathematically optimizing methods.** Methods based on mathematical calculations are excluded from the comparison because they tend to neglect the business perspective. As described in section 2, service-oriented architecture is a paradigm which moves the management of business processes in the centre of attention. Therefore, this study focusses on the comparison of service identification methods addressing business needs for the construction of service-oriented architectures.

**Absence of Service Hierarchies.** Recalling the service requirements named in section 2.1, composability implies the existence of different hierarchical levels. It is therefore assumed that identifying services with different granularity and differentiating them in a hierarchical way will contribute to the advantages of a service-oriented architecture.

**Absence of Service Types.** The differentiation of service types was selected as a compulsory criterion because methods, which attempt to identify different service types, are presumed to be more profound and detailed. Erradi et al. (2007: 610) argue that service classification is an important step “to guide the non-functional aspects of service design”.

A list of the selected service identification methods can be found in Annex 2. After reducing the methods by using the above-mentioned criteria, a set of comparison criteria is defined;

**Direction of Approach / Underlying Service Definition.** Depending on the underlying service definition, which can be either technical- or business-oriented, the direction of approach can be divided into three approaches; bottom-up, top-down or meet-in-the-middle.

A researcher who defines services on a technical basis will tend to identify them bottom-up, meaning that the focus is on exposing the existing application environment and modularize it from a technical perspective. Business perspective is included only in the second step, and identified modules will be matched with business needs resulting in a service. If a researcher suggests a business oriented service definition, he will rather proceed in a top-down approach. Using the top-down approach, the application domain is exposed and the services are derived from business concept models before they undergo a technical specification. Many researchers have found that choosing one of the described approaches may not yield the desired results. Neglecting either the business or the technical perspective could, for example, result in a redundant realization of functionalities as a component of different services or the realization of dependent services from a business perspective. Therefore, numerous methods with hybrid approaches, namely the meet-in-the-middle approach, were developed.

| Table 1. Existing Service Identification Method Surveys |
| --- |
| **Author** | **Year of Publication** | **Title** | **Number of approaches** |
| Gu & Lago | 2010 | Service Identification Methods: A Systematic Literature Review | 38 |
| Huergo et al. | 2014 | A systematic survey of service identification methods | 105 |
| Svanidzaité | 2012 | A Comparison of SOA Methodologies Analysis & Design Phases | 5 |
| Börner & Goeken | 2012 | Identification of Business Services - Literature Review and Lessons Learned | 5 |

| Table 2. SIM Exclusion Criteria |
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| **No.** | **Methods** | **Exclusion Criteria** |
| 1 | Mathematically Optimizing Method | This method tends to neglect business perspective and management of business processes |
| 2 | Service Hierarchies | This method does not include different hierarchical service levels |
| 3 | Service Types | This method does not differentiate service types as a compulsory criterion |
to combine both, business and technical needs in an early stage of the service lifecycle (Birkmeier et al. 2008: 259).

Superordinated Model. The comparison of the methods using this criterion can be divided into three categories; first, the method might only concentrate on the service identification process without mentioning any superordinated model (None). Second, the method focuses on the service identification process highlighting that it is one of several steps within a greater process (General). And last, the study may not concentrate on the service identification method only but suggests a method, of which service identification is one task (Specific).

Degree of Formalization. This research differentiates two types of degree of formalization. These are general guidelines and structure. While general guidelines give hints of what has to be considered when identifying services, a structured method provides a step by step process guideline.

Service Hierarchy Structure. This criterion attempts to analyze the amount of hierarchical levels used by a method. Service hierarchies are typically visualized in service layers (see Figure 2). The differentiation of composite and atomic services is regarded as a two-layers-hierarchy.

Service Types. As will be shown in the comparison tables (Table 2a-c), there are different service type classifications. Analyzing different dimensions of service type classification is a complex task and goes beyond the scope of this paper.

Type of Output. This criterion aims to highlight what is the output of each service identification method. This research differentiates three types of output; the informal service specification comprises identified services with a list of terms such as service description, input and output. A service model illustrates the service landscape in terms of diagrams, and last, the formal service specification describes the identified services using standard language, for example WSDL (Gu & Lago 2010).

Tool Support. The criterion tool support is categorized into two questions; does the suggested method mention or provide any tool support? If the method suggests a tool, is it a new tool, an amended tool or a generic tool? In the comparison tables, the tools used in the method are named.

Validation. Methods can be validated in different ways. In the course of this research the following validation possibilities were found: case study, project, and real-life application. There are also researchers who do not validate their method.

Quality Statement. Ideally, the identification method can guarantee the correctness of the results (Birkmeier et al. 2008: 261), for example by conducting qualitative and quantitative evaluation.

Elements of Situational Method Engineering. In addition to this set of comparison criteria, which are taken from other comparative studies (see Table 1), this paper attempts to break the method down into the method of engineering components, which are illustrated in Figure 3. This break down serves

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**Figure 2.** An example of service layers (Erl 2008: 43)
as a supplement to the set of comparison criteria in order to analyze the explicitness of the methods. Börner (2012) extends the conventional method engineering concept by adding two more elements, namely flexibility and configurability. These elements support the idea of situational method engineering, which argues that “methods have to be adaptable to different kinds of situations” (Börner 2012: 51). Flexibility examines whether the sequence of activities can be rearranged, while configurability reviews the possibility of choosing method elements, which depend on certain situations (Börner 2012: 256).

B. Results of the Service Identification Method Comparison

After reducing a total of 116 research papers dealing with service identification, 20 service identification methods were selected for the comparison. Tables 2 to 4 present the results of the comparison using the set of criteria described in the previous section.
| SIM | Criteria | Direction of Approach | Superordinated Model | Degree of Formalization | Service Hierarchy | Service Types | Type of Output | Tool Support | Validation | Quality Statement |
|-----|----------|-----------------------|---------------------|------------------------|------------------|--------------|--------------|-------------|------------|------------------|
| [1] | Adamopoulos et al. (2002) | top-down | specific <SE Framework> | structure | 2 layers | pre- & post-conditions of service operations | service model | none | real-life application | none |
| [2] | Alahmari et al. (2010) | bottom-up | general <SOEA project lifecycle> | structure | 2 layers | process service, business service, transactional-data service, master-data service, utility service, infrastructure service | informal service specification | IBM Rational Software Architect > UML class diagram IBM WebSphere Business Modeler > business process XML schema Rational Rose > Eclipse Modeling Framework IBM Model Transformation Framework | real-life application | none |
| [3] | Baghdadi (2006) | bottom-up | specific <RE Process> | structure | 2 layers | 2-dimensional: 1. composition types: coarse-grained web services, applications, business processes, new e-business solutions 2. operation types: create, retrieve, update, delete | formal service specification | CASE | none | none |
| [4] | Beverungen et al. (2008) | meet-in-the-middle | general <SOA concept> | structure | 2 layers | task service, entity service | formal service specification | none | project | none |
| [5] | Birkmeier et al. (2013) | meet-in-the-middle | none | structure | multiple layers | domain specific services, basic services, cross sectional services | service model | none | case study | Empirical evaluation: controlled study - quantitative result analysis - perceived usefulness questionnaire |
| [6] | Dinh & Nguyen Ngoc (2010) | top-down | specific <SO-MAIS> | structure | 2 layers | multi-dimensional: 1. informational: data-as-a-service (entity) 2. operational: action-as-a-service (task), process-as-a-service 3. legal | informal service specification | none | case study | none |
| [7] | Erl (2005 & 2008) | meet-in-the-middle | specific <SOA methodology> | general guidelines | 3 layers | entity service, task service, utility service | service model | none | case study | none |
| SIM  | Criteria | Direction of Approach | Superordinated Model | Degree of Formalization | Service Hierarchy | Service Types | Type of Output | Tool Support | Validation | Quality Statement |
|------|----------|-----------------------|----------------------|-------------------------|------------------|---------------|---------------|-------------|-------------|------------------|
| [8]  | Erradi et al. (2007) | meet-in-the-middle | specific | general | 6 layers | multi-dimensional: 1. scope: cross-business service, channel service, channel specific service 2. degree of reuse: core enterprise service, common service, specific application service 3. hierarchical: process service, application service, shared data service, infrastructure service | service model | none | case study | none |
| [9]  | Fareghzadeh (2008) | meet-in-the-middle | general | structure | 3 layers | application service, business service (task & entity service), process service (compose other services) | service model | none | case study | none |
| [10] | Huayou et al. (2009) | top-down | specific | general | 2 layers | interface service, computing service, extended service, control service | informal service specification | none | case study | none |
| [11] | Klose et al. (2007) | meet-in-the-middle | none | structure | 2 layers | basic services: entity (create, modify, view, delete) & task services | informal service specification | none | project | none |
| [12] | Kohlmann & Alt (2007) | meet-in-the-middle | none | structure | 2 layers | process service, rule service, entity service, [infrastructure service] | informal service specification | none | case study | none |
| [13] | Medeiros et al. (2010) | top-down | specific | structure | 3 layers | 2-dimensional: 1. layers: composition layer: composite service service layer: self-contained service, business-aligned service component layer: mandatory service, optional service, alternative service components (variability of a service) 2. task service, entity service, utility service | formal service specification | none | project | Empirical evaluation: - quantitative analysis - feedback questionnaire |
| SIM | Criteria | Approach | Superordinated Model | Degree of Formalization | Service Hierarchy | Service Types | Type of Output | Tool Support | Validation | Quality Statement |
|-----|----------|----------|----------------------|-------------------------|------------------|--------------|--------------|-------------|------------|------------------|
| [14] Nakamura et al (2011) | bottom-up | none | structure | multiple layers | common/uncommon, data/control-dependent, fine/coarse-granular | service model | none | case study | none |

**Table 5. SIM Comparison Existing Criteria (3)**

| SIM | Criteria | Approach | Superordinated Model | Degree of Formalization | Service Hierarchy | Service Types | Type of Output | Tool Support | Validation | Quality Statement |
|-----|----------|----------|----------------------|-------------------------|------------------|--------------|--------------|-------------|------------|------------------|
| [15] Perin-Souza et al. (2011) / Avezedo et al. (2009) | top-down | none | structure | multiple layers | operations types: create, retrieve, update, delete | informal service specification | none | case study | none |
| [16] SAP (2005) | meet-in-the-middle | specific <DDES> | general guidelines | 2 layers | component service, process service, entity/engine service, utility service | Informal service specification | none | none | none |
| [17] Shirazi et al. (2009) | meet-in-the-middle | general <SOA delivery lifecycle> | structure | 3 layers | Application services, business services (task & entity centric), process services | service model | none | case study | none |
| [18] Weigand et al. (2009) | meet-in-the-middle | none | structure | 3 layers | core services, complementary services, enhancing services (publication, access & management services), support services (informational service, utility service), coordination services (identification, negotiation, actualisation, post-actualisation service), business service, decision service | service model | none | case study | none |
| [19] Yousef et al. (2009) | top-down | none | structure | multiple layers | operations types: create, retrieve, update, delete, atomic function | service model | RACER > automatic computing of classification and satisfiability | case study | none |
| [20] Yun et al. (2009) | top-down | general <SOAD method> | structure | 2 layers | quality attribute, effect attribute, result attribute | informal service specification | none | case study | none |
### Table 6. SIM Comparison - Elements of SME (1)

| SIM                  | Criteria                  | activities                                    | roles                                  | results (inputs & outputs)                       | techniques                                                                 | flexibility                                      | configurability                                      |
|----------------------|---------------------------|-----------------------------------------------|----------------------------------------|------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------|------------------------------------------------------|
| [1] Adamopoulos et al. (2002) |                          | 1. service requirements analysis               | service developers, service designers | 1. use case                                    | 1. assemble, document, structure requirements on the service from involved stakeholders | sequence of steps > some might be done parallel | yes, because iterative and incremental service development process (continuous optimization) |
|                      |                           | 2. service analysis                           |                                        | 2. (ancillary) service conceptual models, service sequence diagram, service operation contract | 2. service decomposition, define (pre- and post-condition of service) operations | 2. candidate services                                      |                                                      |
|                      |                           | 3. service design                             |                                        | 3. service interaction diagram, service design class diagram | 3. define interacting service COs, create service interaction diagram, specify software classes with strict and informative notation | 3. combine classification and clustering metric |                                                      |
| [2] Alahmari et al. (2010) |                          | 1. analysis and re-engineering                 |                                        | 1.1 analysis model                             | 1.1 workshop, questionnaire, interview, available documents | -                                              |                                                      |
|                      |                           | 2. service elements identification             |                                        | 1.2 activity portfolio, knowledge portfolio | 1.2 review business and design documents, UML modelling | 2.2 apply clustering metrics using business logic and CRUD functions |                                                      |
|                      |                           | 3. evaluate candidate services against the SOEA meta-model |                                        | 1.3 process portfolio (legacy system behavior), knowledge portfolio, business processes model, activity diagram, Eclipse Modeling Framework | 1.3 transform UML to BPMN diagrams | 3. combine classification and clustering metric |                                                      |
| [3] Baghdadi (2006) |                          | 1. identify web services                      |                                        | 1. basic web services                          | 1. transform relation schema and its constraints to web services | -                                              |                                                      |
|                      |                           | 2. specify web services                       |                                        | 2. specified web services                      | 2. apply CRUD patterns                     | -                                              |                                                      |
|                      |                           | 3. apply CRUD patterns                        |                                        |                                                |                                                | -                                              |                                                      |
| [4] Beverungen et al. (2008) |                          | 1. preparation                                |                                        | 1. regulatory framework, process models       | 1. create regulatory framework (reference design by Meise 2001), limit object of analysis, create/amend detail process models | repetition of initial steps if necessary (e.g. if identified service is too coarse-granular) | -                                              |
|                      |                           | 2. service analysis                           |                                        | 2. analysis scheme, evaluated service candidates | 2. identify actors using outputs of step 1, analysis from business perspective using guiding questions, analysis from IT perspective using a criteria catalog | 2. candidate services                                      |                                                      |
|                      |                           | 3. service specification                      |                                        | 3. service catalog, basic services, process services | 3. categorization of service candidates, specification of categorized services based on the chosen technical form of realization for the SOA (suggestion: basic services in WSDL, process services in BPMN) | 3. combine classification and clustering metric |                                                      |
### Table 7. SIM Comparison - Elements of SME (2)

| Criteria | SIM | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
|----------|-----|------------|-------|---------------------------|------------|-------------|----------------|
| [5] Birkmeier et al. (2013) | 1. identify and bundle functionalities | business analyst | 1. initial list of functionalities | 1. bundle process activities which belong together logically using existing business process models which are relevant in the specific project context, rearrange functionalities to ensure constant granularity | - | Yes, overall process can be customized to incorporate specific modeling techniques and maturity levels |
| | 2. complete implicit functionalities | solution architect | 2. add implicit functionalities that are required to provide IT support | 2.1 reduced list of functionalities | - | |
| | 3. group functionalities into services | | 2.2 reduced business process models | 2.3 hierarchy of service candidates | - | |
| | 3.1 align with service architecture | | 2.4 detailed service profile | 2.5 validated functionalities and evaluated related business functions and sub-functions based on the business architecture | - | |
| | 3.2 remove realized functionalities | | 6. detailed solution concept | 6.1 bundle process activities which belong together logically using existing business process models which are relevant in the specific project context, rearrange functionalities to ensure constant granularity | - | |
| | 3.3 identify service candidates | | | 6.2 add implicit functionalities that are required to provide IT support | - | |
| | 3.4 identify new services | | | 6.3 mark all functionalities which can be realized through existing services, generate a reduced list of functionalities that still have to be realized in new services | - | |
| | 4. align with service architecture | | | 6.4 identify service candidates using several heuristics (partially from Avezedo et al.) | - | |
| | 5. align with business architecture | | | 6.5 evaluate each service candidate on the basis of several guidelines adopted from SAP Enterprise Services Design Guide and German Federal Enterprise Architecture Framework | - | |
| | 6. classify new functionalities and services | | | 6.6 validate functionalities and evaluated related business functions and sub-functions based on the business architecture | - | |
| [6] Dinh & Nguyen Ngoc (2010) | 1. service analysis | - | 1. overlap protocols (set of rules and procedures governing interchange of shared information between economic entities) | 1. network configuration to determine relationships between economic entities and information-intensive service requirements | - | |
| | 2. general service design | | 1. overlap situations, organization of services | 2. identify overlap situations and agree on roles and responsibilities conforming to the overlap protocol | - | |
| | 3. service implementation | | 1. UML class diagram, petri-net diagram | 3. define and model shared information, services and governance | - | |
| [7] Erl (2005 & 2008) | 1.1 analyze business models and requirements | 1.1 business analyst | 1.1 business processes & requirements | 1.2 business process decomposition, business process steps filtering, top-down analysis of enterprise business models, identification of process-specific logic using SOA layers, application of service-orientation principles, scenario documentation, mini-analysis of operation candidates using guiding questions, review current service inventory, examine logical relationships, activity scenario mapping | - | - |
| | 1.2 service modeling | 1.2 business analyst & technology architect | 1.2 service candidates | | | |
| SIM | Criteria | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
|-----|----------|------------|-------|---------------------------|------------|-------------|----------------|
| [8] | Erradi et al (2007) | 1. business service identification, application identification, existing functionality identification, reusable infrastructure services identification, service classification | - | 1. product, channel, business process, business activity, use case, to-be business process | 1. domain decomposition, business process modelling | - | - |
|     |          |            |       |                           |            |             |                |
|     |          |            |       |                           | 2. process-to-application mapping |            |                |
|     |          |            |       |                           | 3. application stakeholder interviews, tool combination |            |                |
|     |          |            |       |                           | 4. activity decomposition |            |                |
| [9] | Fareghzadeh (2008) | 1. initial analysis, in-depth analysis, make a service taxonomy, identify entity services, identify application services, identify task services, identify process services | system analyst, project stakeholders | 1. vision document, business process model, existing assets, glossary of terms, stakeholders, business actors & entity, business use case, business use case model, operation service candidate, business rules | 1. document business process which corresponds to service specific modelling conventions | - | - |
|     |          |            |       |                           | 2. business process decomposition, stakeholder separation (external & internal business partners), determine interrelate dependencies, extract operation service candidate and business rules, business use case modelling, system definition refinement |            |                |
|     |          |            |       |                           | 3.1 check existing services, separate operation service candidates related to one or more dependent entities, scale and categorize operation candidates, derive service interface using principles of service-orientation |            |                |
|     |          |            |       |                           | 3.2 implement utility service model, review existing inventory of application services, separate process steps, categorize remaining operation candidates |            |                |
|     |          |            |       |                           | 3.3 review work logic extract from business use case model and relations, define business goals and steps |            |                |
|     |          |            |       |                           | 3.4 separate business and application logics |            |                |

Table 8. SIM Comparison - Elements of SME (3)
| SIM | Criteria | Analytical Method Engineering |
|-----|----------|------------------------------|
|     | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
| [10] Huayou et al. (2009) | 1. service classification | analyst | 1. service model | 1. service model design | - | - |
|     | 2. use case script elaboration | 2. use case sentences | 2. conform use case script to description criterion | - | - |
|     | 3. extending points reduction | 4. atomic services | 3. combination of too fine-grained steps | - | - |
|     | 4. interface & computing services identification, control policy identification | 5. extended services | 4. design of atomic services description according to corresponding sentence's context | - | - |
|     | 5. extended services identification and description | 6. control services | 5. extending point and control policy as input | - | - |
|     | 6. control service construction |         | 6. service = use case, service process = main path | - | - |
| [11] Klose et al. (2007) | 1. preparation | - | 1. framework, process model, analysis scheme | 1. framework documentation, review existing process models | - | - |
|     | 1. preparation | 1.1 scope determination | 2. service candidates, usage scenarios | 2. questionnaire, SOA design principles | - | - |
|     | 1.2 process model preparation | 2. business & IT feasibility analysis | 3. specified basic services & service compositions | 3. bottom-up alignment of business and IT, proposition for basic distinction of elemental and composed services | - | - |
|     | 1.3 stakeholder identification |         |         | - | - |
|     | 2. definition of service types, operations & compositions | | | - | - |
| [12] Kohlmann & Alt (2007) | 1. model selection, identification of area of service identification | - | 1. enterprise model, process model, network model | 1. framework documentation, review existing process models | - | - |
|     | 2. service analysis | 2. service candidate | 2. deduct services top-down based on service criteria, design principles and roles, name service candidate & describe function | 2. deduct services top-down based on service criteria, design principles and roles, name service candidate & describe function | - | - |
|     | 3. service verification | 3. service candidate assessment | 3. examine, if service candidate fulfils criteria and design principles and if it fits the business needs of the process and the role | 3. examine, if service candidate fulfils criteria and design principles and if it fits the business needs of the process and the role | - | - |
|     | 3.1 check existing services | 3.2 service candidate assessment | 4. allocate candidate to one of the three service layers, affiliate service to service list, specify relations to other services | 4. allocate candidate to one of the three service layers, affiliate service to service list, specify relations to other services | - | - |
| SIM | Criteria | Situational Method Engineering |
|-----|----------|-------------------------------|
|     | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
| [13] Medeiros et al. (2010) | 1. architectural elements identification | 1. domain architect, SOA architect, business analyst | 1. interaction pattern, service model, feature model, attribute scenario, service & component candidates | 1. business process decomposition, service modelling from use cases, features modelling, ping/echo & heartbeat tactic, communication flow with SOAP/REST | design decisions documentation | product development cycle: specialization of architectural elements to a particular context |
|     | 2. variability analysis | 1.2 SOA architect | | | |
|     | 3. architecture specification | 2. domain architect | | | |
|     | 4. architectural elements specification | 3. domain architect, SOA architect | | | |
|     | 5. design decisions documentation | 4. service designer, domain designer | | | |
|     | | 5. domain architect, SOA architect | | | |
| [14] Nakamura et al. (2011) | 1. hierarchical DFD from a given program | system maintainer | 1. hierarchical DFD | 1. conventional reverse-engineering techniques (explanation out of scope) | | |
|     | 2. data flow categorization | | 2. external data, system data, module data | | |
|     | 3. data dependency analysis | | 3. dependency data flow | | |
|     | 4. apply service extraction rules | | 4. self-contained services | | |
| [15] Perin-Souza et al. (2011) / Avezedo et al. (2009) | 1. activities selection | analyst | 1. automatable activities | 1. consideration of automatable activities | - | - |
|     | 2. identification and classification of candidate services | | 2. candidate services | | |
|     | 3. consolidation of candidate services | | 3. application of consolidation heuristics on candidate services | | |
| [16] SAP (2005) | 1. scenario & business process analysis | solution designer | 1. enterprise service requirements, set of indicators that suggests how services might be beneficial | 1. set of indicators | sequence of indicators | indicators can be added |
|     | 2. service requirement analysis | | 2. list of issues that could be addressed by services | | | |

Table 9. SIM Comparison - Elements of SME (4)
### Table 10. SIM Comparison - Elements of SME (5)

| SIM | Criteria | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
|-----|----------|------------|-------|-----------------------------|------------|-------------|-----------------|
| [17] Shirazi et al. (2009) | 1. identify business process | - | 1. business requirements, business vision, business process | - | - | - |
| | 2. make business use-case model | - | 2. business actors, entity-business use case, business use case model, operation service candidate, business rules | - | - | - |
| | 3. identify entity centric services | - | 3. entity centric services | - | - | - |
| | 4. recognize application services | - | 4. application services | - | - | - |
| | 5. identify task centric services | - | 5. task centric services | - | - | - |
| | 6. recognize process centric services | - | 6. process centric services | - | - | - |

**Table: Situational Method Engineering**

| SIM | Criteria | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
|-----|----------|------------|-------|-----------------------------|------------|-------------|-----------------|
| [18] Weigand et al. (2009) | 1. value model creation or adaption | web service designer | 1. value model | - | Yes, step 3: TD or MIM |
| | 2. business service identification | - | 2. business service model | - | - |
| | 3. software service identification | - | 3. service realization model | - | - | - |

**Situational Method Engineering**

1. Business requirements, business vision, business process
2. Business actors, entity-business use case, business use case model, operation service candidate, business rules
3. Entity centric services
4. Application services
5. Task centric services
6. Process centric services

- Use case modeling
- Utilize outcome of 1st and 2nd step to identify operation candidates' dependencies, scale operation candidates & categorize as logical groups (entity centric services)
- Separate process requirements dependent on technology and application programs, check operation candidates with existing services' functionalities, categorize remaining operation candidates into logical groups (application service)
- Review and amend logic of workflow and every possible relation
- Separate business logic and application logic, recognize and separate all business rules, condition rules, exception logic and sequence logic, assign operation candidates of all controlling, conditions and exception operations, categorize related operation candidates as logical groups
| Criteria | Situational Method Engineering |
|----------|---------------------------------|
| SIM      | activities | roles | results (inputs & outputs) | techniques | flexibility | configurability |
| [19] Yousef et al. (2009) | service candidate identification | - | candidate services, software service oriented model | 1. match each pool in a BPMN process model to a business line in BPAOnt 2. match each task in the BPMN model to an atomic function in BPAOnt 3. identify matched functions that can be automated according to the BPAOnt ontology 4. tag each of the identified functions with the business line it belongs to 5. eliminate redundant functions 6. relate the resulting functions to all EBEs in the BPAOnt according to the CRUD functions 7. create the CRUD matrix 8. apply the EEAT clustering technique to group functions into services so as to enhance the correctness of mapping business services to associated software services 9. refine services according to QoSOnt; 10. validate the generated service oriented model | - | Domain Independency |
| [20] Yun et al. (2009) | 1. DFD elaboration 2. process design 3. service attribute identification 4. composite service design | - | 1. DFD 2. atomic services 3. composite services | 1. new DFD for coarse-grained atomic processes, DFD deletion for too fine-grained atomic processes, conform DFD to corresponding criterion 2. name processes (XX, writeXX, readXX) 3. view atomic processes as service and define input and output 4. add feedback line & link into DFD diagram | - | - |
and Tables 5 to 9 complete the comparison results using the Situational Method Engineering elements as described in section 3.1.

In order to summarize the results presented in Tables 2 to 9, a SIM (Service Identification Method) evaluation using MS Excel was tabulated by generating sum scores for the existing criteria on the one hand, and the SME (Situational Method Engineering) criteria on the other hand. Figure 4 illustrates the results of the SIM evaluation.

Figure 4 shows that SIM approach [13] received the highest score in both categories. Therefore, the next section will describe and explain this approach in more detail.

IV. Service Identification Method by Medeiros et al. (2010)

Medeiros et al. (2010) developed a method called SOPLE-DE, designed in the context of service-oriented product line engineering. This method aims to combine software product line and service-oriented architecture because they share common goals like flexible and cost-effective software systems and reusability of existing software (Medeiros et al. 2010: 70). In the following, the approach is described using the comparison criteria explained in section 3.

SOPLE-DE uses the identification of services from business processes as a starting point (Medeiros et al. 2010: 72). Therefore, it follows a top-down approach. Legacy systems are disregarded in this approach, but they are mentioned in the conclusions as an aspect for future work (Medeiros et al. 2010: 78). The superordinate model can be classified as specific since SOPLE-DE is a method fully developed by Medeiros et al. (2010) and goes beyond service identification. However, recalling the different definitions of service identification (section 2.3), one might also conclude that a superordinate model is non-existent if SOPLE-DE is regarded as a pure service identification approach leaving out the operational part of the service lifecycle. Looking at the degree of formalization, the approach suggests a clear structure. As argued by Medeiros et al. (2010: 71), “the key difference of the work […] is the systematization of the design, which provides a set of sequential activities and sub-activities with clearly defined inputs and outputs”. SOPLE-DE is based on a service hierarchy which is commonly used in SOA (Service Oriented Architecture). It is divided into three different layers: service composition, services, and components (Medeiros et al. 2010: 71).

Medeiros et al. (2010: 71, 75) suggest a two-dimensional classification of service types. First, they differentiate services according to the service oriented architectural layers. While the composition layer consists of composite/orchestrate services, services in the service layer are separated into self-contained and business-aligned services, and the component layer comprises of mandatory, optional and alternative service components depending on their variability. These services in turn are classified according to their type of logical extension of reusable potentials, and their relation to other existing domains into entity, task and utility services (Erl 2008: 43). Entity services manage information, whereas task services processes tasks (Birkmeier et al. 2008: 260). Utility services, in contrast, are not business-centric, but provide utility functionality (Erl 2008: 46). The output of SOPLE-DE is clearly defined in section 2 of Medeiros et al.’s (2010: 71) study. It is classified as a formal service specification because an architecture document is generated with the help of UML (Unified Modeling Language) models to represent the behavior of the architectural elements. The research does not mention any specific tools to support the activities. SOPLE-DE underwent an extensive validation process using quantitative and qualitative methods. An experimental study was conducted, which was evaluated using four metrics – a) service coupling, b) service instability, c) lack of service cohesion, and d) applicability problems – for the purpose of quantitative validation.

3) Definition of Software Product Line: “Set of similar service-oriented systems that supports the business processes of a specific domain and can be developed from a common platform or set of core assets.” (cited in Medeiros et al 2010: 70).
The qualitative analysis was based on a feedback questionnaire using four aspects— a) training analysis, b) usefulness, c) quality of the documentation and instruments, as well as d) quality of the architecture document produced by the participants (Medeiros et al. 2010: 78). The research is concluded with a quality statement derived from the experimental study stating that the analysis is not conclusive, but achieved positive results if users have experience in software projects (Medeiros et al. 2010: 78).

Figure 5 serves to illustrate the explicitness of SOPLE-DE with respect to the Situational Method Engineering concept. The illustration follows the ME (Method Engineering) concept shown in figure 3 complemented by an emphasis on the configurable and flexible parts of the method. Missing Method Engineering element is highlighted in blue.

In conclusion, except for a specific tool support, the approach delivers input for all selected comparison criteria.

V. Conclusion

The aim of the present study was to compare existing service identification approaches with respect to its relevance in the design of a cohesive service-oriented architecture. When explaining the basic concepts related to service identification, it becomes evident that finding an explicit definition and scope of the service identification process is a difficult task. This challenge was especially observed when attempting to extract the activities from the approaches. As explained in the previous section, the degree of formalization can be interpreted differently depending on the extent of the service identification. Future research may therefore set one specific frame for service identification and analyze the existing approaches according to it, so that a more appropriate comparison can be conducted.

Another challenge was to reduce the numerous existing approaches to a reasonable number for a
detailed comparison. For this purpose, criteria selected need to be fulfilled in order for a service identification approach to be considered in the comparison procedure. By putting the focus on the degree of explicitness and practicability of an approach, nine comparison criteria were chosen from existing comparison studies. The comparison was complemented by analyzing the situational method engineering elements, which helped to examine the structure and the extensive details of an approach. The Service Identification Method by Medeiros et al. (2010) is adopted as an example to explain the comparison criteria in further detail.

In summary, this research contributes to a relatively detailed description of various service identification approaches with an adequate set of comparison criteria. In order for the comparison to be more precise, it is suggested that the service identification process be defined with a specific scope, which shall serve as a guideline to describe different approaches.

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## Appendix

### Annex 1. List of Service Identification Methods

| Research Paper                                                                 | Compared in                        |
|--------------------------------------------------------------------------------|-----------------------------------|
| Abdelaziz EF, Mustapha A, Mohammed S (2011) A service oriented approach for information systems development. In: Proceedings of the 2011 international conference on multimedia computing and systems (ICMCS 2011). IEEE, USA, pp 1–6 | Huergo et al. 2014                |
| Abdelkader M, Malik M, Benslimane SM (2013) A heuristic approach to locate candidate web service in legacy software. IntJ Comput Appl Technol 47(2–3):152–161 | Huergo et al. 2014                |
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| Antonia Albani, Jan L.G. Dietz und Johannes Maria Zaha. Identifying Business Components on the basis of an Enterprise Ontology. In D. Konstantas, J.-P. Bourrieres, M. Leonard und N. Boudjilida, Hrsg., Interoperability of Enterprise Software and Applications, pp. 335–347, Geneva, Switzerland, 2005. Springer Verlag. | Birkmeier et al. 2008             |
| Antonia Albani und Jan L.G. Dietz. The Benefit of Enterprise Ontology in Identifying Business Components. In IFIP World Computing Conference, Santiago de Chile, Chile, August 2006. | Birkmeier et al. 2008             |
| Alizadeh K, Seyyedi MA, Mohsenzadeh M (2011) Mapping service concept and enterprise ontology in service identification. In: Proceedings of the 7th international conference on networking computing (INC 2011), pp 22–27 | Huergo et al. 2014                |
| Andersson B, Johannesson P, Zdravkovic J (2009) Aligning goals and services through goal and business modeling. Inf Syst e-BusManag 7(2):143–169 | Huergo et al. 2014                |
| All Arsanjani. Service-oriented modeling and architecture - How to identify, specify, and realize services for your SOA. IBM developerWorks Web services zone, Nov. 2004. | Birkmeier et al. 2008             |
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| Asadi M, Mohabbati B, Kaviani N, Ga´sevi´c D, Bo´skovi´c M,Hatala M (2009) Model-driven development of families of service-oriented architectures. In: Proceedings of the first international workshop on feature-oriented software development (FOSD’09). ACM, New York, pp 95–102 | Huergo et al. 2014                |
| Asadi M, Mohabbati B, Ga´sevi´c D, Bagheri E (2011) Developing families of method-oriented architecture. In: Ralyté J, Mirbell, Deneckère R (eds) Proceedings of the 4th IFIP WG 8.1 working conference on method engineering (ME 2011). IFIP advances in information and communication technology, vol 351, pp 168–183. International federation for information processing (IFIP)/Springer, Berlin | Huergo et al. 2014                |
| Aversano L, Cerulo L, Palumbo C (2008) Mining candidate web services from legacy code. In: Proceedings of the 10th international symposium on web site evolution (WSE 2008). IEEE, Piscataway,pp 37–40 | Huergo et al. 2014                |
| Research Paper                                                                 | Compared in                                      |
|-------------------------------------------------------------------------------|--------------------------------------------------|
| Azevedo LG, Santoro F, Baião F, Souza J, Revoredo K, Pereira V, Herlain I (2009): A method for service identification from business process models in a SOA approach. In: Halpin T, Krogstie J, Nurcan S, Proper E, Schmidt R, Softer P, Ukor R (eds) Proceedings of the 10th international workshop on business process modeling, development and support (BPMDS 2009) and 14th international conference on exploring modeling methods in systems analysis and design (EMMSAD 2009). Lecture notes in business information processing, vol 29, pp 99–112. Springer, Berlin | Huergo et al. 2014                                |
| Baghdadi Y (2006) Reverse engineering relational databases to identify and specify basic web services with respect to service oriented computing. Inf Syst Front 8(5):395–410 | Huergo et al. 2014                                |
| Bao L, Yin C, He W, Ge J, Chen P (2010) Extracting reusable services from legacy object-oriented systems. In: Proceedings of the 2010 IEEE international conference on software maintenance (ICSM 2010). IEEE, USA, pp 1–5 | Huergo et al. 2014                                |
| Daniel Beverungen, Ralf Knackstedt und Oliver Müller. Entwicklung Serviceorientierter Architekturen zur Integration von Produktion und Dienstleistung - Eine Konzeptions-methode und ihre Anwendung am Beispiel des Recyclings elektronischer Geräte. Wirtschaftsinformatik, 50(3):220–234, 2008. | Birkmeier et al. 2008                            |
| Bianchini D, Cappiello C, De Antonellis V, Pernici B (2009) P2S: a methodology to enable inter-organizational process design through web services. In: van Eck P, Gordijn J, Wieringa R (eds) Proceedings of the 21st international conference on advanced information systems engineering (CAiSE 2009). Lecture notes in computer science, vol 5565, pp 334–348. Springer, Berlin | Huergo et al. 2014                                |
| Bianchini D, Cappiello C, De Antonellis V, Pernici B (2013) Service identification in inter-organizational process design. IEEE Trans Serv Comput 7(2):265–278 | Huergo et al. 2014                                |
| Birkmeier DQ, Gehlert A, Overhage S, Schlauderer S (2013): Alignment of business and IT architectures in the German Federal Government: a systematic method to identify services from business processes. In: Proceedings of the 46th Hawaii international conference on systems sciences (HICSS 2013). IEEE Computer Society, Piscataway, pp 3848–3857 | Huergo et al. 2014                                |
| Böhmann, T. and Krcmar, H. (2005) Modularisierung: Grundlagen und Anwendung bei IT-Dienstleistungen, in Thomas Herrmann, Uwe Kleinbeck and Helmut Krcmar (Eds.) Konzepte für das Service Engineering. Modularisierung, Prozessgestaltung und Produktivitätsmanagement, Heidelberg | Börner 2012                                      |
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| Brzostowski K, Rekuč W, Sobiecki J, Szczurowski I (2010): Service discovery in the SOA system. In: Nguyen NT, Le MT, Swiat J (eds) Proceedings of the second international conference on intelligent information and database systems (ACIIDS’10)—part II. Lecture notes in computer science, vol 5991, pp 29–38. Springer, Berlin | Huergo et al. 2014                                |
| caetano A, Silva AR, Trbolet J (2010) Identification of services through functional decomposition of business processes. In: Abramowicz W, Tolksdorf R (eds) Proceedings of the 13th international conference on business information systems (BIS2010). Lecture notes in business information processing, vol 47, pp 144–157. Springer, Berlin | Huergo et al. 2014                                |
| Canfora G, Fasolino AR, Frattolillo G, Tramontana P (2008): A wrapping approach for migrating legacy system interactive functionalities to service oriented architectures. J Syst Softw 81(4):463–480 | Huergo et al. 2014                                |
| Chaari S, Biennier F, Favrel J, Benamar C (2007) Towards aservice-oriented enterprise based on component models. In: Gonçalves RJ, Müller JP, Mertins K, Zelm M (eds) Enterprise interoperability II. Part V. Springer, United Kingdom, pp 495–506 | Huergo et al. 2014                                |
| Chang SH (2007) A systematic analysis and design approach to develop adaptable services in service oriented computing. In: Proceedings of the 2007 IEEE congress on services (SERVICES2007). IEEE Computer Society, Piscataway, pp 375–378 | Huergo et al. 2014                                |
| Research Paper                                                                 | Compared in               |
|-------------------------------------------------------------------------------|---------------------------|
| Chen F, Li S, Yang H, Wang CH, Chu WCC (2005) Feature analysis for service-oriented reengineering. In: Proceedings of the 12th Asia-Pacific software engineering conference (APSEC’05). IEEE Computer Society, Piscataway | Huergo et al. 2014        |
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| Cho M, Je C, Rim KH, Hong SG, Keceli Y, Park JY (2008) Service identification and modeling for service oriented architecture applications. In: Proceedings of the 7th WSEAS international conference on software engineering, parallel and distributed systems (SEAPADS’08), pp 193–199. World Scientific and Engineering Academy and Society (WSEAS), Stevens Point | Huergo et al. 2014        |
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| Gacitua-Decar V, Pahl C (2012) Automatic business process pattern matching for enterprise services design. In: Proceedings of the 2012 world conference on services—part II (SERVICES-2012). IEEE Computer Society, Washington | Huergo et al. 2014        |
| Gordijn J, Yu E, van der Raadt B (2006) e-Service design using* and e3 value modeling. IEEE Softw 23(3):26–33 | Huergo et al. 2014        |
| Guan Q, Feng S, Ma Y (2012) A network topology clustering algorithm for service identification. In: Proceedings of the 2012 international conference on computer science and service system (CSSS’12). IEEE Computer Society, Washington, pp 1583–1586 | Huergo et al. 2014        |
| Research Paper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Compared in                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
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