

Integrated Service Engineering (ISE) for Service Ecosystems: An Interdisciplinary Methodology for the Internet of Services

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Abstract: In all major industrialized countries, the service sector is the largest economic segment whose features have the highest growth rate. In this context, the Internet of Services has been developed with a focus on services which are offered and in some approaches even traded over the Internet. Services of various service providers are offered and executed via an electronic service platform which is part of a Service Ecosystem. Organisations can improve their business processes by outsourcing certain process activities to external partners and by integrating services into their IT-infrastructure through such service platforms. One impediment for Service Ecosystems is the development of tradable services.

This paper introduces an interdisciplinary methodology for service engineering with a focus on business and technical aspects, and their integration. Additionally, this work elaborates on the business side and provides key questions to guide the engineering process. The methodology has been developed in the Theseus/TEXO project which is funded by the German Federal Ministry of Economy and Technology.

1. Introduction

Software development as an engineering discipline relies on formal models and methodologies. Models serve as development artefacts which can be explicitly measured, validated and adapted. Methodologies, on the other hand, control the software development process [1]. In the Theseus/TEXO project (<http://theseus-programm.de/en-us/theseus-application-scenarios/txo/default.aspx>), research has been conducted in the field of Service Ecosystems with the focus on tradable business services over the Internet. One major issue within the project is the development of such services in terms of methodology and IT-support. In this context, specific software development methodologies and models which focus on the engineering of services have been researched and compared [2].

On the one hand, various business-oriented methods could be identified which are subsumed either under the term of New Service Development (NSD) or Service Engineering (SE) [3]. On the other hand, technical-oriented methods such as Service-Oriented Migration and Reuse Technique (SMART) from Software Engineering Institute (SEI), Service-Oriented Analysis and Design (SOAD) from IBM, Service-Oriented Modeling & Architecture (SOMA) from IBM, and Motion from Microsoft have been found [2]. The analysis of those methods is based on a comparison of the following criteria, which considers models, methods, and techniques:

- *Service innovation:* Identification and assessment of new and innovative service ideas which may be further developed in the next phases.

- *Business model*: Strategic description of the value a company offers to its customers, the processes, infrastructure, and partner networks for creating marketing and delivering this value in order to generate profitable and sustainable revenue streams.
- *Business process*: Detailed conception of the service delivery process, the involved stakeholders and resources.
- *Service architecture*: IT-concept of the electronic service with its components and their relationships among each other.
- *Service implementation*: Technical implementation of the service which includes its components and the integration of external services.

	Service Innovation	Business Model	Business Process	Service Architecture	Service Implementation
NSD	●	●	●	○	○
SE	●	●	●	○	○
SMART	○	○	○	○	●
SOAD	○	○	●	●	○
SOMA	○	○	●	●	●
Motion	○	○	●	●	●

(● criterion is covered, ○ criterion is not covered)

Table 1: Comparison of Service Engineering Methodologies

Table 1 shows the comparison of the identified service engineering methodologies. It becomes obvious that none of the identified approaches covers all of the criteria listed. However, when developing and offering services in Service Ecosystems a strong market orientation is crucial in order to place services successfully on the market, meet the customers' expectations and differentiate them from services of competitors. In this way, the markets exert their influences on the offered services, on the underlying service delivery processes and IT-solutions. Therefore, an interdisciplinary approach for service engineering is needed which combines market-, business-, and technical-oriented aspects similar to the understanding and findings of Service Science [4].

2. Objectives

The main objective of the paper is to introduce a methodical framework which widely supports the electronic business service development process. For that reason, the framework differentiates between a strategic/market-oriented, a conceptual, a logical/IT-oriented, and a technical perspective which are all dedicated to different stakeholders of the development process. The methodical framework for the electronic business service development with its different perspectives is called the Integrated Service Engineering methodology.

Since several approaches exist which address the last three criteria (see Table 1), we focus on the development of the strategic/market-oriented and the conceptual perspective, and its integration in an interdisciplinary service engineering methodology for Service Ecosystems.

3. Methodology

For developing a suitable Service Engineering methodology for Service Ecosystems, current business and technical approaches for service development have been studied to

determine their suitability for developing electronic business services.

Our studies have shown that NSD and SE as business service related theories focus on the development of traditional services and, therefore, mainly on the business aspects of services. They neglect important technical aspects that are fundamental when developing electronic services, e.g. data models, technical interfaces, and technical realization strategies. When comparing current methods from the field of computer science for developing Web Services (Web Service Engineering), a lack of business orientation becomes obvious, e.g. business models and marketing concepts are not addressed in these methods.

As a result of our literature research, an adapted Zachman Framework has been chosen as the basis for ISE which integrates different existing partially adapted business and technical models and methods of service development. The Zachman Framework is built as a matrix of role-specific perspectives and relevant dimensions [5]. Additionally, the ISE methodology has been implemented in a software-tool, the ISE Workbench. Perspectives of this holistic interdisciplinary approach have been evaluated with experts who are involved in the service development process.

4. Description of the Methodology

4.1 The Basic Structure of ISE

Similar to the Zachman Framework, the ISE methodology breaks down a complex electronic business service in small parts which are connected but separately designed (see Figure 1). The methodology differentiates four basic types of stakeholders which are responsible for the core engineering process activities of electronic business services:

- *Business strategist*: Business strategists work with key service stakeholders to develop a *strategic service concept* which is also called business model. The strategic service concept is further concretized in the next steps.
- *Business analyst*: A major responsibility of a business analyst is to work with business strategists to translate their requirements into a *conceptual model*, which operationalize a business model. Furthermore, it serves as means to communicate business requirements towards IT. Conceptual models are represented with semi-formal notations, such as UML.
- *IT architect*: IT architects formalize conceptual models into *logical models*. Logical models are the technical blueprint of a service and serve as a requirement document for technical implementation. Additionally, IT architects can explain what IT developers will be doing and why they need to do it.
- *IT developer*: IT developers implement logical models constructed by the IT architects with *technical languages*. IT developers must be qualified and skilled on standards such as BPEL and WSDL, and also have sufficient interdisciplinary skills to truly meet the underlying services implementation.

Those different types of stakeholders have got their own specific perspective on the engineering process. Whereas, business strategists maintain a strategic view on the service, the focus of the IT developer is merely on technical aspects.

The main ideas behind the ISE methodology are:

- involvement of the relevant stakeholders in the service development process (business strategist, business analyst, IT architect, and IT developer),
- support by stakeholder-specific perspectives and models (strategic/market-oriented, conceptual, logic, and technical perspective), and
- division of each perspective in six dimensions (finance, service, workflow, people, assets, and rules).

The ISE methodology provides selected models and methods for the specific stakeholders of each perspective (abstraction layer). The innovation perspective is not a part of the ISE methodology. However, the ISE methodology takes innovative service ideas as a result from the innovation perspective and details them in the strategic/market-oriented, conceptual, logical, and technical perspectives. In order to reduce the complexity, each perspective is not only based on one complex model, it is rather broken down in the above-listed six dimensions. A dimension is a part of a perspective and consists of its own model(s) (artefact). The artefacts of each dimension can be transformed from one perspective to another.

The ISE framework is built concerning the following rules:

- The dimensions do not need to be analyzed and modelled in a specific order.
- The layers are separated and clearly differentiated (no overlapping).
- In order to achieve an integrated approach, information of the artefacts is transformed from one perspective to another and back (iterative approach).

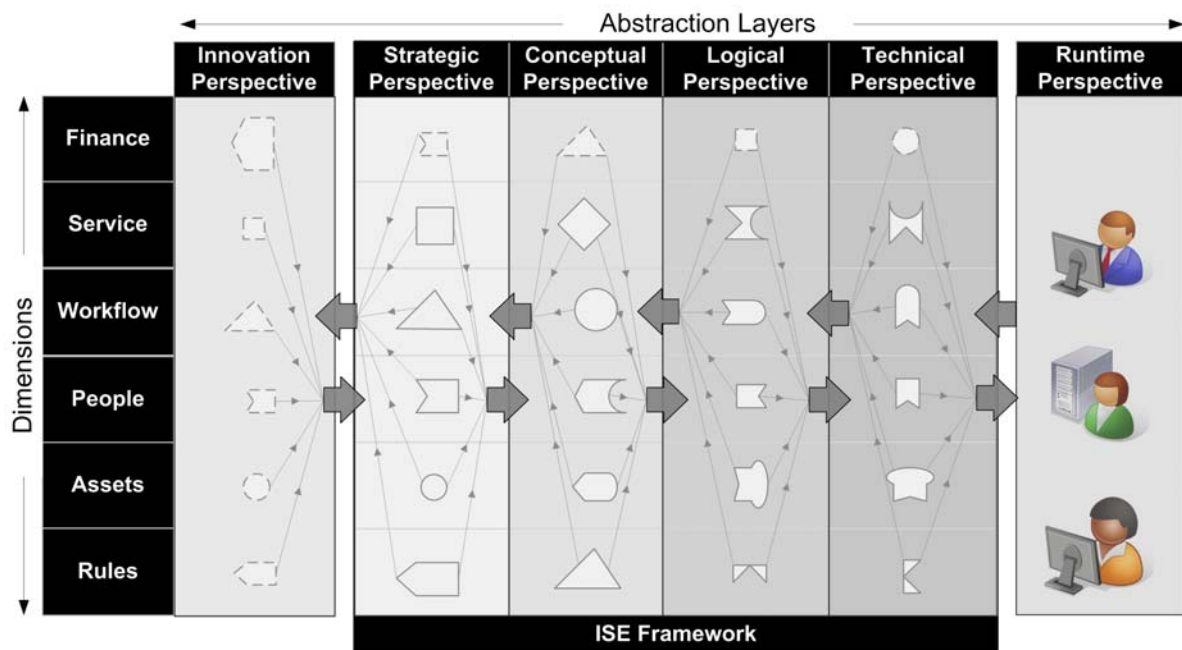


Figure 1: ISE Framework

4.2 The Strategic/Market-Oriented and Conceptual Perspective

In Figure 2, a more detailed view on the first two perspectives and some suggested models of the ISE methodology is shown. The perspectives are built on elements which provide detailed information about a specific aspect.

For the modelling activities in the strategic/market-oriented perspective, business strategists focus on service concepts, respectively, on business models (see [6]) and answer the main question of “WHAT is offered as a service?”. The conceptual perspective, on the other hand, conceptualizes business models by asking “HOW is the service offered?”. The answers to those questions shape the elements of each perspective and dimension.

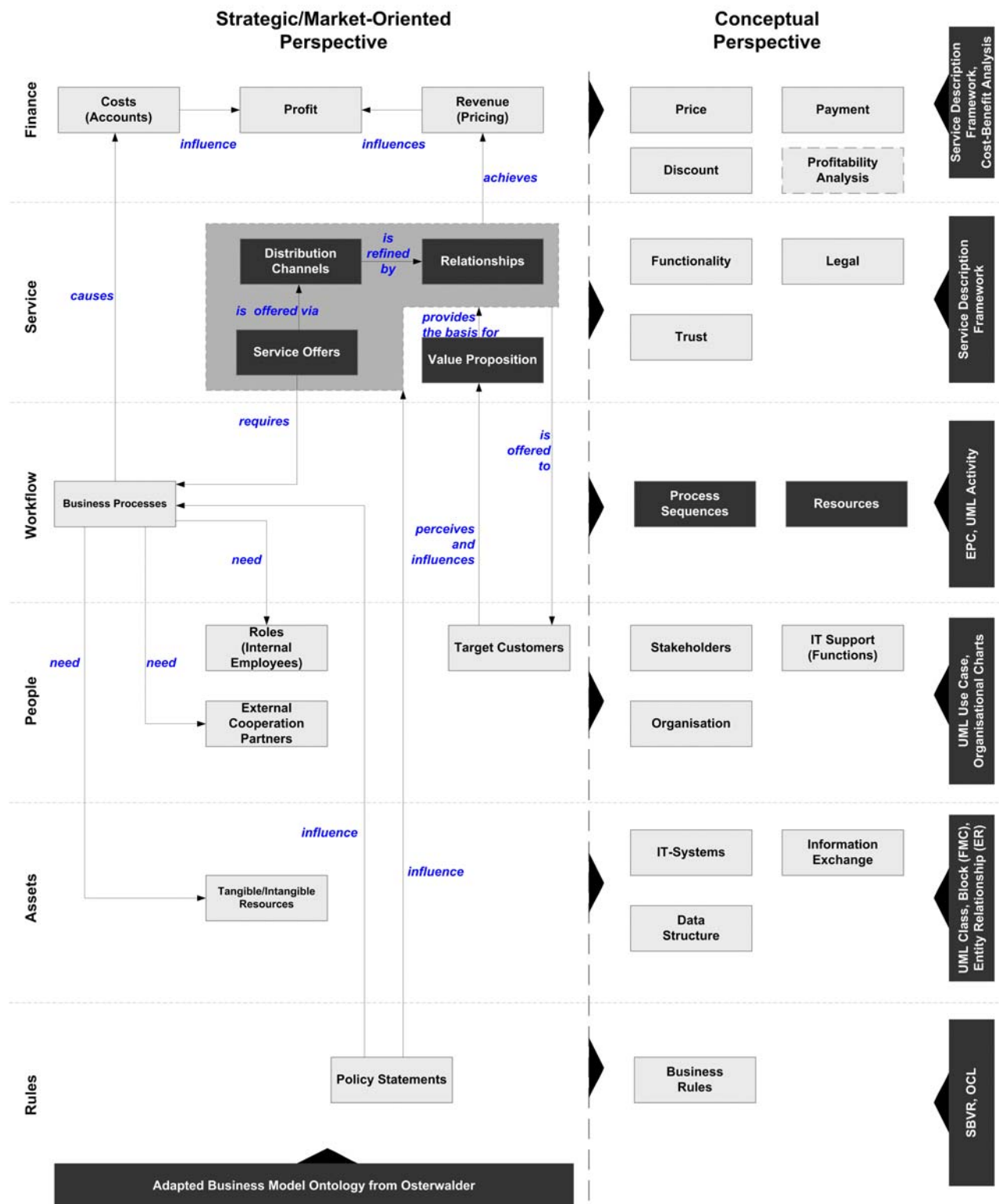


Figure 2: Integration of Strategic/Market-Oriented and the Conceptual Perspective

The main question for each perspective is broken down in several key questions which help to specify each of the elements. In Table 2, the key questions for both perspectives and dimensions are listed. In order to develop an electronic business service, the involved stakeholders should provide answers to those questions and subsequently detail the elements. In Table 2, behind each key question an element is assigned in brackets. The suggested models which are shown in the black boxes at the bottom and at the upper right hand side of Figure 2 support the structuring of the information for each element.

Dimension	Key Questions for the Strategic/Market-Oriented Perspective	Key Questions for the Conceptual Perspective
Service	<ul style="list-style-type: none"> • What value is offered to the target customers? (Value Proposition) • What service is offered to the target customers? (Service Offers) • How is the benefit of the service for the customer in comparison to the competition? (Service Offers) • What is the price level of the service? (Service Offers) • What distribution channels are used to address customers? (Distribution Channels) • What is the customer benefit of each distribution channel? (Distribution Channels) • How is the customer benefit of each distribution channel in comparison to the competition? (Distribution Channels) • What kind of customer relationship is aimed for? (Relationships) • What is the customer benefit for each kind of relationship? (Relationships) • How is the customer benefit for each kind of relationship in comparison to the competition? (Relationships) 	<ul style="list-style-type: none"> • What are the concrete capabilities of a service? (Functionality) • How can the service be described and categorized in order to be findable by the target customers? (Functionality) • What are the rights of the customer when using the service? (Legal) • What are the obligations of a service provider and the service users when applying the service? (Legal) • What are the penalties when one of the parties does not fulfil their obligations? (Legal) • What certificates assure the quality of a service? (Trust) • What is the concrete benefit of the service for the target customers which is also published in the Internet? (Trust)
Workflow	<ul style="list-style-type: none"> • Which processes are required for the service offering and delivering? (Business Processes) 	<ul style="list-style-type: none"> • How is the concrete workflow planned? (Process Sequence) • What tangible, intangible, and human resources are required for the process? (Resources)
People	<ul style="list-style-type: none"> • Which external cooperation partners are needed for conducting the process? (External Cooperation Partners) • What are the reasons for the partner cooperation? (External Cooperation Partners) • What are their competencies? (External Cooperation Partners) • How is the strategic importance of the cooperation rated? (External Cooperation Partners) • How high is the potential that cooperation partners become competitors? (External Cooperation Partners) • How tight is the integration of the partners in the own IT-landscape? (External Cooperation Partners) • How easy can a cooperation partner be replaced? (External Cooperation Partners) • What roles are needed? (Employees/Roles) • How many employees are required? (Employees/Roles) • What are their competencies? (Employees/Roles) • What customer segments are targeted with the service? (Target Customers) • What attributes characterize the customer segments? (Target Customers) 	<ul style="list-style-type: none"> • Which concrete persons are involved in the service process? (personalized Stakeholders) • What IT-support is provided to the identified stakeholders? (IT Support) • In which organisational department are they located? (Organisation)
Assets	<ul style="list-style-type: none"> • What rights are required on information, methods, and technologies (software/hardware)? (Tangible/ Intangible) 	<ul style="list-style-type: none"> • What kinds of IT-systems are needed? (IT-systems)

Dimension	Key Questions for the Strategic/Market-Oriented Perspective	Key Questions for the Conceptual Perspective
	Resources) <ul style="list-style-type: none"> • What royalties need to be possessed? (Tangible/ Intangible Resources) • What patents need to be owned? (Tangible/ Intangible Resources) • What copyrights/trademarks need to be possessed? (Tangible/ Intangible Resources) 	<ul style="list-style-type: none"> • How are the IT-systems connected? (IT-systems) • What data are needed from a business-oriented point of view? (Information exchange) • How are the data structured from a business-oriented point of view? (Data structure)
Rules	<ul style="list-style-type: none"> • What kind of policy is followed? (Policy Statements) 	<ul style="list-style-type: none"> • What constraints need to be taken into account for the processes, the required resources, and the financial aspects? (Business Rules)
Finance	<ul style="list-style-type: none"> • What costs arise due to the service? (Costs) • How high are the estimated costs? (Costs) • How is the revenue for a service achieved? (Revenue) • What are the price models for a service? (Revenue) • What is the targeted amount of revenue? (Revenue) • How high is the profit for the service? (Profit) • How is the Return-On-Investment? (Profit) 	<ul style="list-style-type: none"> • What are the concrete price models for the service? (Price) • What discounts are given? (Discount) • What payment methods are supported? (Payment) • What results are shown by a profitability analysis? (Profitability Analysis)

Table 2: Key Questions for the Strategic/Market-Oriented and the Conceptual Perspective

5. Developments

In order to support the usage of the ISE methodology, a software-tool, the ISE workbench, is implemented. It is based on the Eclipse Modelling Framework (EMF) and the Graphical Modelling Framework (GMF). The matrix with the perspectives and the dimensions builds the starting point for stakeholders of the service development process to enter the models of each of the cells depending on the user rights. The models can be designed and transformed by Query View Transformations (QVT) from one perspective to the next. After each transformation the information can be further detailed from one perspective to another.

6. Results and Business Benefits

A major target group for ISE are IT providers who offer services, such as functionality for CRM and ERP, to external as well as internal customers. When offering services to external customers with ISE the first step is to shape the service offer to specific markets in the strategic/market-oriented perspective. After having defined the service offer from a strategic view, the underlying service processes, organisation, IT-applications and service offer are further detailed and modelled in the next views.

IT providers who participated in the development of ISE emphasise the following advantages:

- A strong and clear market orientation due to the development of a strategic business model at the beginning,
- Provisioning of a framework and a common platform which supports and connects different types (strategic, business, technical) of project members who are involved in the development process,
- Relevant aspects can be well separated in the artefacts and individually discussed due to the matrix-based concept,
- Artefacts are checked for reuse when developing a new service and thus a certain harmonisation of results is achieved.

The ISE methodology is a structured approach for service engineering which differentiates between the various stakeholders by providing specific perspectives and appropriate models without neglecting the flexibility by enabling the exchange of models for each cell of the matrix. Thus, organisations can adapt the ISE methodology as well as the ISE workbench to their specific requirements and needs.

7. Conclusions and Future Activities

In the scenario of offering services for Service Ecosystems, organisations have the chance of new business opportunities by developing innovative services and offer them via service platforms in the Internet. In order to come into business with other partners, organisations need to develop services which suit the market requirements and needs better than competitors' services.

An interdisciplinary approach becomes crucial. Not only the technical aspects of designing and implementing a service need to be considered in the service development process, also strategic/market-oriented and conceptual aspects must be designed, modelled and integrated in the technical part of this process.

In order to further improve the ISE methodology, the models need to be evaluated in different contexts, e.g. entrepreneurs versus large organizations, simple versus complex (networked) services, and heterarchical versus hierarchical networked partner organizations. One result of the evaluation may be an extension of the ISE methodology in the future by including the innovation and runtime phases to support the full service lifecycle.

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