

# Service Engineering in Business Ecosystems

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*Service providers are increasingly forced to cooperate to strengthen their core competencies and to create partner networks to offer required services. In order to facilitate the collaboration process, business ecosystems have been building which allow service providers to offer their own as well as combined e-services with other providers over the Internet. This paper introduces the Inter-enterprise Service Engineering methodology (ISE) which has been developed in the Texo use case<sup>1</sup> of the Theseus project<sup>2</sup> and provides a comprehensive, interdisciplinary, and model-driven approach to e-service development in business ecosystems. One major aim of ISE is to integrate business as well as technical stakeholders in the e-service development process and support them with appropriate models, methods, and tools.*

## 1. Introduction

All industrial nations feature large and fast growing service sectors. In Germany, for example, 72 percent of the labour force in 2007 earns its living within the service sector. This sector has been the fastest growing sector in Germany for more than 15 years<sup>3</sup>. In other industrial countries the situation and the trend are comparable (Maglio et al., 2006). Due to this trend, service providers reveal a strong interest for service innovations and their development which will enable them to achieve a competitive market position and to participate in future economic growth (Rai & Sambamurthy, 2006).

In order to reach a competitive advantage, companies should not offer a broad range of services but rather focus on selected core competencies. Ideally, those core competencies will enable them to offer services which their customers perceive as better than the ones from their competitors. However, customers tend to require not only partial services, but they ask for complete and integrated solutions (Bieger & Rüegg-Stürm, 2002). This trend urges companies to collaborate with partners, even with former competitors, to offer the appropriate and required services.

<sup>1</sup> <http://www.theseus-programm.de/scenarios/de/texo>

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Having this background, business ecosystems have been developed where independent companies collaborate to offer services concertedly. The ecosystems consist of highly networked social and technical resources which produce an economic value by cooperating (Kagermann & Österle, 2006). In this context, services are an integral part of a value chain network which may take up a more important role in the future. In order to realize this potential, services need to become tradable goods similar to products (Janiesch et al., 2008).

An appropriate infrastructure is needed to offer and provide these services via the Internet. The ability to combine services is a central and crucial feature to develop new and innovative services on the basis of existing ones. Services of different providers can be combined and integrated. Here, the focus lays on web-based services (so-called e-services) which are accessible via the Internet (Janiesch et al., 2008).

## **2. Objective and Structure**

Many methodologies exist to support the development process of services. Some of the approaches contain a business oriented, e.g. New Service Development and Service Engineering, others a more technical oriented service definition, e.g. software developing methodologies which are based on the OSI model or on Service-Oriented Architectures. Depending on the orientation, the approaches focus either on business or on technical aspects of the service realization. Therefore, the approaches lack an interdisciplinary perspective (Buhl et al., 2008). Nevertheless, interdisciplinary approaches emerge in the context of Service Science which aims to academically examine the field of service development (Chesbrough & Spohrer, 2006). So far, no suitable approaches from Service Science could be identified for the given problem.

The objective of this paper is to introduce a new methodology which supports the development process of e-services from their concretion in form of business models to their implementation. The methodology is called Inter-enterprise Service Engineering (ISE) and provides a basis for companies which are interested in participating in the cooperative service development process within business ecosystems.

This paper is structured as followed. In section 3, the strength and weaknesses of current business- and technical oriented approaches are shown and the need for an interdisciplinary Service Engineering methodology which covers business as well as technical aspects is explained. The ISE methodology is introduced in section 4 based on selected methods of Service Engineering and Computer Science and their integration into a broad and interdisciplinary methodology. Section 5 contains our conclusion and the description of planned work.

## **3. State of the Art in Service Development**

Prior to participating, companies need to develop an understanding of service development and integration of business partners and their services in business ecosystems. In order to facilitate this process an appropriate methodology should be drawn

which provides guidelines for the service development process for companies in business ecosystems. We have examined current approaches of service development towards their suitability. The approaches can be split into two main types which are influenced by their business or technical orientation and their service definition:

A **business-oriented service definition** contains often the following features (Corsten, 1997; Rai & Sambamurthy, 2006; Chesbrough & Spohrer, 2006):

- **Immateriality**,
- **Production and consumption happen simultaneously** (Uno-actu-principle),
- **Integration of the customer** as an external factor in the service delivery process.

When analysing e-services, the traditional service view and features may not apply. For example, the Uno-Actu-Principle might become less applicable or even obsolete if services can be offered by service providers and bought by customers in a similar way to products in e-shops. In this case, e-services are already produced prior to consuming by service requesters (Scheer et al., 2003).

From a **technical-oriented service definition** mostly the functionality of the service interfaces needs to comply with certain features (Papazoglou, 2003; Papazoglou et al., 2006):

- **Self descriptive:** The annotation of meta-data allows the assignment of descriptions or quality criteria to services.
- **Platform independent:** The service is independent of the underlying soft- and hardware.
- **Composition:** Distributed applications and their functionality can be realized by composition and linkage.
- **Application of standards:** The functionality of a service is offered via network and standardized languages and protocols.
- **Loose coupling:** Neither context information nor further information of the internal functionality are needed by the service provider and consumer. Here, a dynamic real-time (at the time of usage) integration of the services by using accepted invocation mechanisms should be sufficient.
- **Transparency of location:** The service can be found and invoked independent of the location of the service provider by registration in a service directory.

The different service definitions play an essential role when comparing the business and technical oriented approaches of service development. For identifying the strengths and weaknesses, we have setup a set of criteria on the basis of the main phases and artefacts of current service development approaches. The following criteria are compared for each type of service development approach:

- **Methodology**, which implies a routine which guides stakeholders through the engineering process,
- **Service innovation**, which involves to understand the market and to derive ideas for new services,

- **Business model**, which builds the basis for the business-oriented service description,
- **Business processes**, which introduce the service delivery process,
- **Architecture**, which provides a set of abstraction levels, views, meta models, and patterns to classify and distinguish service artifacts from an IT perspective,
- **Service ecosystems**, which indicates that services are a result of a collaboration of several business partners and thus, not only developed within one organization,
- **Model-driven architecture**, which offers an integrated technology to support the perspectives of different stakeholders in the service engineering process

### 3.1. Business-oriented Service Development Approaches

When having a closer look at business-oriented service development approaches two main streams of scientific activities exist, the New Service Development (NSD) and the Service Engineering (SE) (Daun & Klein, 2004). Since the 80s NSD has mainly been driven by Anglo-American researchers with a strong marketing focus, whereas, SE has been pushed by German researchers for the past 15 years. The main aim of SE is to provide a systematic service development by applying engineering know-how from traditional product development.

Both streams include a variety of different methodological approaches. The approaches slightly differ in their phases. In order to compare the orientation between both streams, the phases of each stream has been aggregated in Table 1: Comparison of aggregated phases of models of NSD and SE. On the one hand, approaches of NSD mention the development of a business and/or service strategy and the testing of services after development. On the other hand, some of the SE methods explicitly mention “Service Provisioning” and “Displacement”.

New Service Development	Service Engineering
Business/Service Strategy Development	-
Idea Generation	Idea Search and Evaluation
Screening and Evaluation	
Business Analysis	Requirements Analysis
Service Development	Service Concept
Testing	-
Introduction	Implementation and Introduction
-	Service Provisioning
-	Displacement

Table 1: Comparison of aggregated phases of models of NSD and SE<sup>4</sup>

<sup>4</sup> The comparison is based on (Daun & Klein, 2004).

Focus of the approaches is mainly services which feature a direct customer contact and customer interaction. Here, a part of the service delivery process takes place in front of the customers. Especially those process steps in front of and/or in interaction with customers need to be carefully planned and implemented since they strongly influence the customer's perception. However, when e-services are sold similar to products, those aspects may become less relevant.

In conclusion, the business-oriented approaches of service development show the following weaknesses (Daun & Klein, 2004):

- **Insufficient details:** In most cases only the high-level processes are described, whereas, concrete activities and methods are missing.
- **Lack of IT-centric approaches:** IT-issues are discussed to develop or support the provisioning of traditional services on the basis of a business-oriented service definition (Buhl et al., 2008). The development of pure e-services and the consideration of technical aspects as listed in the technical service definition are not in the focus.

Table 2: Strengths and weaknesses of the business-oriented approaches shows the comparison of the strengths and weaknesses of the business-oriented approaches.

	Methodology	Service Innovation	Business Model	Business Process	Architecture	Service Ecosystem	MDA
NSD	●	●	●	●	–	–	–
SE	●	●	●	●	–	–	–

(● aspect is covered, – aspect is not covered)

Table 2: Strengths and weaknesses of the business-oriented approaches

### 3.2. Technical oriented Service Development Approaches

In this section, four well-known and common approaches to technical service-oriented development are presented: SMART, SOAD, SOMA, and Motion. Each approach is briefly introduced with a focus on their strengths and weaknesses according to the criteria which are mentioned above.

#### Service-oriented Migration and Reuse Technique (SEI)

Service-oriented Migration and Reuse Technique (SMART) was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University (Lewis et al., 2005). SMART's strengths lay in migrating legacy applications into a SoA. Enterprises can apply SMART to analyze their legacy systems and to evaluate their feasibility to integrate a Service-oriented Architecture (SoA). The analysis includes stakeholder context, capability descriptions (as is), SoA description (to be), gap analysis, and development of a migration strategy. SEI argues that the approach allows to adapt legacy systems to services without affecting the involved systems while exposing functionality to a large number of client applications using standard-based interfaces.

SMART lacks support for a more business-driven approach, neglecting business models and business processes. Moreover, the solution is not intended to be offered outside a company in a service ecosystem as a product nor does it embody innovation or model transformation.

### **Service-oriented Analysis and Design (IBM)**

Service-oriented Analysis and Design (SOAD) was developed by IBM (Zimmermann et al., 2004). SOAD results from an analysis of Object-oriented Analysis and Design (OOAD), Enterprise Architecture (EA) frameworks, and Business Process Modeling (BPM) for SoA deployment. SOAD's strength lies in the combination of the previous mentioned approaches. Additionally to the mentioned approaches, SOAD offers ad hoc service composition, semantic brokering, service discovery, quality factors, and reusability. It addresses the business operational level.

Though SOAD does not merely cover technical integration strategies, it offers no innovation phase for new services, nor does it include business models. Additionally, the solution is not intended for service ecosystems nor does it offer model transformation.

### **Service-oriented Modeling and Architecture (IBM)**

Arsanjani argues that object-oriented approaches lack support for services, flows, and components. Therefore, IBM developed the approach for service-oriented modeling and architecture (SOMA) which fills these gaps (Arsanjani, 2004). Additionally, SOMA supports the service ecosystem idea and offers a separation of providers and consumers in service ecosystems. SOMA's architecture provides seven layers of abstraction, and a methodology, which guides the modeling routine.

While SOMA offers a business-driven top-down pattern, business models and service innovation are neglected. Additionally, this approach does not offer means for model-driven development.

### **Motion (Microsoft)**

The Motion (Sehmi & Schwegler, 2006) methodology was developed by Microsoft as a technology-agnostic architecture to expose organizations' business models. However, for Motion a business model merely refer to capabilities. The principle of the approach is to identify capabilities as a basis for stable projects and then derive business processes. This routine allows constructing an established view of businesses. The constructed view of an organization (i.e. the Motion Business Architecture) directs a fast decision making that is otherwise hard to reach. Motion's strengths is the well structured methodology and architecture which comprises a set of stakeholders, business capabilities, a life cycle, concepts for product and service, collaboration, and contexts.

Motion addresses the early stages of service engineering, such as business, and collaboration within a service ecosystem. The approach lacks support for service innovation, entire business models, and model-driven development.

Table 3: Strength and weaknesses of the technical oriented approaches shows the comparison of the strengths and weaknesses of the business-oriented approaches.

	Methodology	Service Innovation	Business Model	Business Process	Architecture	Service Ecosystem	MDA
SMART	●	–	–	–	–	–	–
SOAD	–	–	–	●	●	–	–
SOMA	●	–	–	●	●	●	–
Motion	●	–	–	●	●	●	–

(● aspect is covered, – aspect is not covered)

Table 3: Strength and weaknesses of the technical oriented approaches

## 4. Integrated Methodology of Service Development in Business Ecosystems

The examination of both streams of service development approaches show weaknesses either on the business or on the technical side of the service development process in business ecosystems. Therefore, the integrated methodology ISE has been developed by the authors to create and combine e-services in the context of business ecosystems. The ISE approach, its challenges and its advantages as well as limitations are introduced in the next sections.

### 4.1. Challenges of Bridging the Business and Technical Worlds of Service Development

#### Information representation (Object using Models)

Nowadays, organizations generate a wealth of information describing strategies, objectives, goals, business processes, standards, IT infrastructures, etc. This information, which can be classified as unstructured, semi-structured, and structured, constitutes a precious source to develop new e-services (the set of all the information produced by an organization is often termed as *organizational memory* (Vasconcelos et al., 2003)). Unstructured information usually characterizes documents such as Word files, spreadsheets, and presentations. Semi-structured information is generally associated with data instances which include schema information, such as XML. Finally, structured information can typify relational databases and formal models.

Depending on their background and skills, people tend to use different structures to define information. For example, business stakeholders tend to use unstructured data to describe future strategies, financial data, SWOT, Porter's 5 Forces, and balanced scorecards. On the other hand, IT professionals usually rely on semi-structured or structured information to describe formal models such as UML activity diagrams, MOF and BPMN processes (see Fig. 1).

It is clear that unstructured information drives numerous business processes but often, organizations cannot leverage this information efficiently, leading to inconsistent communications between stakeholders, duplication of effort, poor decision-making,

and higher costs. The difference between the various structure levels that are used to embody information creates a representational gap that needs to be closed in order to unify and bridge the business and IT perspectives on e-services. If this gap is not closed, unstructured information generated by business stakeholders will not be readily available to IT as part of the engineering process of e-services.

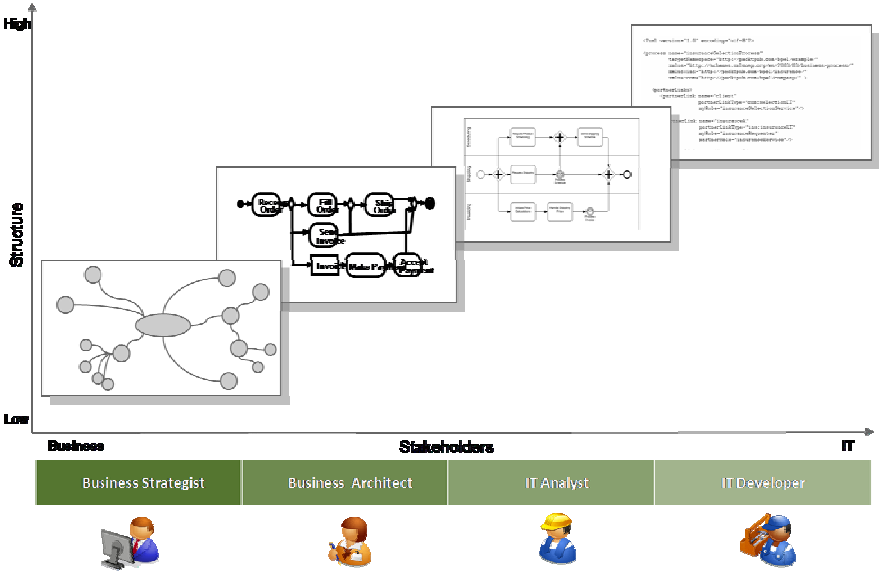


Fig. 1: Levels of structured information

**Distinct Contexts and Views (People)**

Business and technical professionals have invariably different backgrounds, skills and mindsets. This fact makes the alignment of the business and IT perspectives on e-services a challenging task. On one hand, the concerns of business and IT perspectives are distinct. Business professionals are concern with aspects related to financial assets, marketing missions, ROI, competition, value chains, and SWOT analysis. On the other hand, technical people are concerned with functions, data, components, integration, compatibility, programming, scalability, API, concepts and their relationships, formal models, UI, and rules. As a result, it is often common that different people use the same word to describe distinct entities and distinct words to refer to the same entity (see also section 3 which illustrates the different types of service definitions from stakeholders with different backgrounds).

For structuring the heterogeneous and distributed information available inside an organization appropriate meta-level descriptions are needed to represent a higher-level layer of information. In order to develop an effective methodology for e-services, it is necessary to identify, represent, and reuse existing organizational data assets. The representation of business and IT information can be captured using formal models. When a set of models is identified and their concepts are mapped and aligned, the resulting model can be classified as an ontology. An ontology is a high level formal and explicit shared conceptualization of a domain (Gruber, 1992). It is a conceptualization since it is an abstract view of a domain about real entities and their relationships. It is formal because it has a formal software specification and it is machine-readable. It is explicit since all concepts and relationships used in the ontology are explicitly defined. Finally, it is shared since entities and relationships form a consensual knowledge, that is, not related to an individual, but accepted by a group.

A suitable methodology for service engineering can use the notion of ontology to aggregate distinct models (e.g. SWOT, Porter's 5 Forces, balanced scorecards, UML activity diagrams, BPMN, etc.) for distinct communities to represent and manage both organizational information containers and contents. This option allows the representation of information in a way that it facilitates knowledge sharing and reuse between the stakeholders involved in the service development process.

### **Model Integration (How the object is represented)**

There are several ways for abstracting and representing information; entities of reality like a real world e-service come with a great variety of properties which characterizes them. By abstracting these properties the level of detail is reduced dramatically and only a selection of them is represented in one model, however they still belong to the same entity. Depending on a viewpoint specific characteristics are picked and present in a specific way. This abstraction is done using models, which contain one abstract representation of elements (information). As soon as multiple models contain representations of the same entity the need for integration rises.

The business and technical world can be separated by the level of abstraction. The more abstract level, the business, contains informal models capturing financial information, risk analysis, goal models, etc. The more concrete level, the technical world describes a services function with respect to its technical implementation. Nevertheless both worlds are representing the same service. Consequentially they represent both its properties, whereas the properties of the technical world extend the ones defined in the business world. This means there is an intersection between the properties represented. Since both worlds represent the same information it has to be 'translated' meaning one representation of the information has to be transformed into the other one. This realizes the propagation of changes between both worlds. The translation between both worlds is captured in a mapping. A mapping defines an assignment between entities of two models. So a mapping is a formal specification which elements of one world are assigned to which elements of the other one.

### **Tool support**

Tools have been used by mankind in order to simplify tasks or increase their efficiency. Many tasks, like computing weather forecast, would not have been possible without the use of tools. One of the challenges in the area of service development is tool support. In order to provide a common approach one common tool should be applied. Since this tool is used by all the various stakeholders involved, both of business and technical world, it should provide a global view on the models describing a service. This includes a shared access to multiple models in order to allow an instant synchronization and visualization of changes.

Such a tool should not only provide shared model access, but should also simplify the development process by providing assistance and guidance. Therefore roadmaps are another challenge in implementing a tool. They tell a user what to do, when and how. This means, which model should be modeled next or first and which tool component to use in which way.

Besides this, the most challenging task is a linking of innovation, design and implementation. The linking includes the transformation between different models. The entities developed in the innovation which are abstract ideas have to be mapped and transformed into structured information useful for a design approach. This is one form

of the linking between business and technical world. Afterwards the designer refines this information. This has to be passed for implementation which requires linking again. This linking should be supported by tools in order to semi-automatic support the transition from one development phase to the other. The linking also includes the challenge of integrating different technological spaces, like informal ones (e.g. pure text) and formal ones (e.g. formal MOF-models). This technical integration is another challenging task in the development of a supporting tool.

## **4.2. The ISE Framework Approach**

The idea behind the ISE framework is to take the strengths of the business- and technical oriented methodologies and combine them in the new methodology. The next two sections show which business- and technical oriented methodologies build the basis for the ISE framework approach.

### **4.2.1. Service Engineering based on Fraunhofer IAO**

For the integration of business-oriented aspects into the ISE methodology the Service Engineering approach from Fraunhofer IAO has been chosen (see Fig. 1). This approach provides a phase model based on six phases and a set of methods to model each phase in terms of product (outcome dimension), process (process dimension), resources (structure dimension), and marketing (Bullinger et al., 2003; Meiren, 2001). The approach is considered as iterative. Thus, previous phases can be refined prior to continue to the next phases.

We have chosen the SE approach of Fraunhofer IAO since its strong focus on the business-orientation in the service development process. Especially, the definition phase and the requirements analysis provide methods to design a service like a product from the idea management over feasibility studies, market and business requirements to the service, process, resource, and marketing design. In order to support the design process a service model has been developed which illustrates the main elements of a service concept. The activities in each phase lead to the development and the gradual refinement of the service model elements.

Especially for the definition phase, requirements analysis, and parts of the service design, a variety of different business-oriented methods are used to model the mentioned product, process, resource, and marketing aspects of the service model. The methods can be for example Porter's Five Forces model, Resource-Based View on strategy, SWOT-analysis, Cost-Profit-Analysis, BCG-Matrix (market growth versus Market share), Competitive Strategies of Porter, the analysis of the value chain from Porter, the Four Cs – Customer, Competition, Cost, and Capabilities, and the Four Ps – Price, Product, Place, and Promotion.

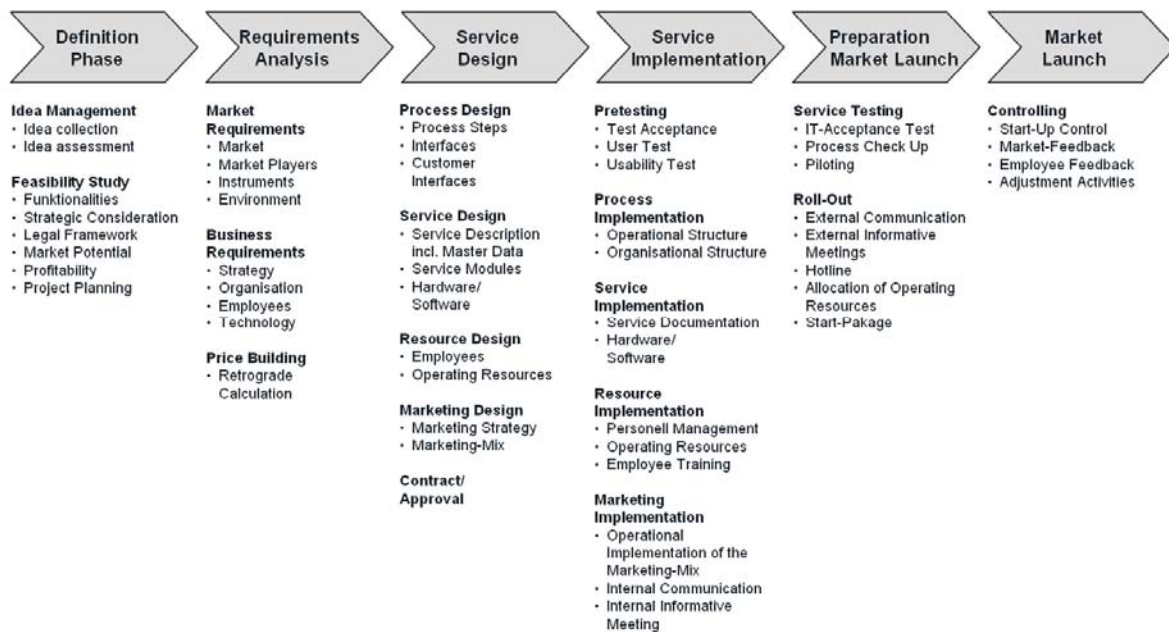


Fig. 2: Service Engineering from Fraunhofer IAO

However, the service design (partially), service implementation, market launch and its preparation mainly focus on traditional services. Since traditional services and their development concentrate on the direct customer contact and interactions, the provided models and methods by the SE approach can be further optimized and improved to develop e-services. Appropriate technical oriented models and methods should be applied.

#### 4.2.2. Enterprise Architecture Framework based on Zachman

The Information System Architecture (ISA) framework (Zachman, 1987) provides a taxonomy to relate real world concepts to Enterprise Architecture (Sowa & Zachman, 1992). Zachman describes Enterprise Architecture as means to react flexible to business changes and to manage the varied resources of an enterprise.

Zachman saw the necessity for an architecture framework arising. Information systems' complexity increased exceedingly for two reasons (Zachman, 1987): Firstly, hardware and software improved with respect to price, availability, and capacity. Secondly, information systems were not only programmed to compute, but designed and implemented to support business operations. He concluded that an architecture framework for information systems is required to integrate different perspectives of stakeholders on the architecture and, thus, to interface the different enterprise artifacts.

Therefore, Zachman breaks down an enterprise architecture to six different stakeholder perspectives and each perspective into six different descriptions as shown in Table 4 (Sowa & Zachman, 1992). For each cell in this matrix, he assigns a specific model.

Zachman (Zachman, 1987) identifies four usages for the framework. Firstly, within the information system discipline, the framework advances the communication. Secondly, it helps to understand the reasons and risks in case one or more artifacts are

not developed. Thirdly, existing tools or methodologies can be set into relation. Fourthly, it helps to develop new tools and methodologies for artifacts.

The advantages of the Zachman framework for applying in the context of service development are its model-oriented approach on breaking down a complex enterprise architecture into small models and its differentiation of specific stakeholders' perspectives.

	Data <i>What</i>	Function <i>How</i>	Network <i>Where</i>	People <i>Who</i>	Time <i>When</i>	Motivation <i>Why</i>
<b>Objective/ Scope (contextual)</b> → Role: Planner	List of Things important in the Business	List of Core Business Processes	List of Business Locations	List of important Organizations	List of Events	List of Business Goals/ Strategies
<b>Enterprise Model (Conceptual)</b> → Role: Owner	Conceptual Data/ Object Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
<b>System Model (Logical)</b> → Role: Designer	Logical Data Model	System Architecture Model	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
<b>Technology Model (Physical)</b> → Role: Builder	Physical Data/ Class Model	Technology Design Model	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
<b>Detailed Representations (Out of Context)</b> → Role: Programmer	Data Definitions	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
<b>Functioning Enterprise</b> → Role: User	Usable Data	Working Function	Usable Network	Functioning Organization	Implemented Schedule	Working Strategy

Table 4: Zachman Framework

### 4.2.3. The Integration of both Methodologies in the ISE Framework

The ISE Framework supports three phases of SE: requirements analysis, service design, and service implementation. Those phases are assigned to different abstraction layers (perspectives), i.e. strategic, conceptual, logical, and technical.

Therefore, the ISE framework provides selected models and methods for the specific players of each layer. In order to reduce the complexity each layer is not only based on one complex model, a layer is broken down in five dimensions, service description, workflow, people, data, and rules. Each dimension consists of its own model(s) (artefact) and can be separately designed from the other dimensions. The artefacts can be transformed from one abstraction layer to another.

The ISE framework is built concerning the following rules:

- The dimensions do not need to be analysed and modelled in a specific order.
- All dimensions of one layer are combined into a complete model for the layer-specific stakeholders.
- Each abstraction layer features a simple, basic, and unique model.
- The layers are separated and clearly differentiated (no overlapping).
- In order to achieve an integrated approach, information of the artefacts is transformed from one layer model to another.
- Methods are applied to fill the models given for each layer and dimension.
- The methodology is iteratively used and thus, information of one later layer can be taken to alter a previous layer.

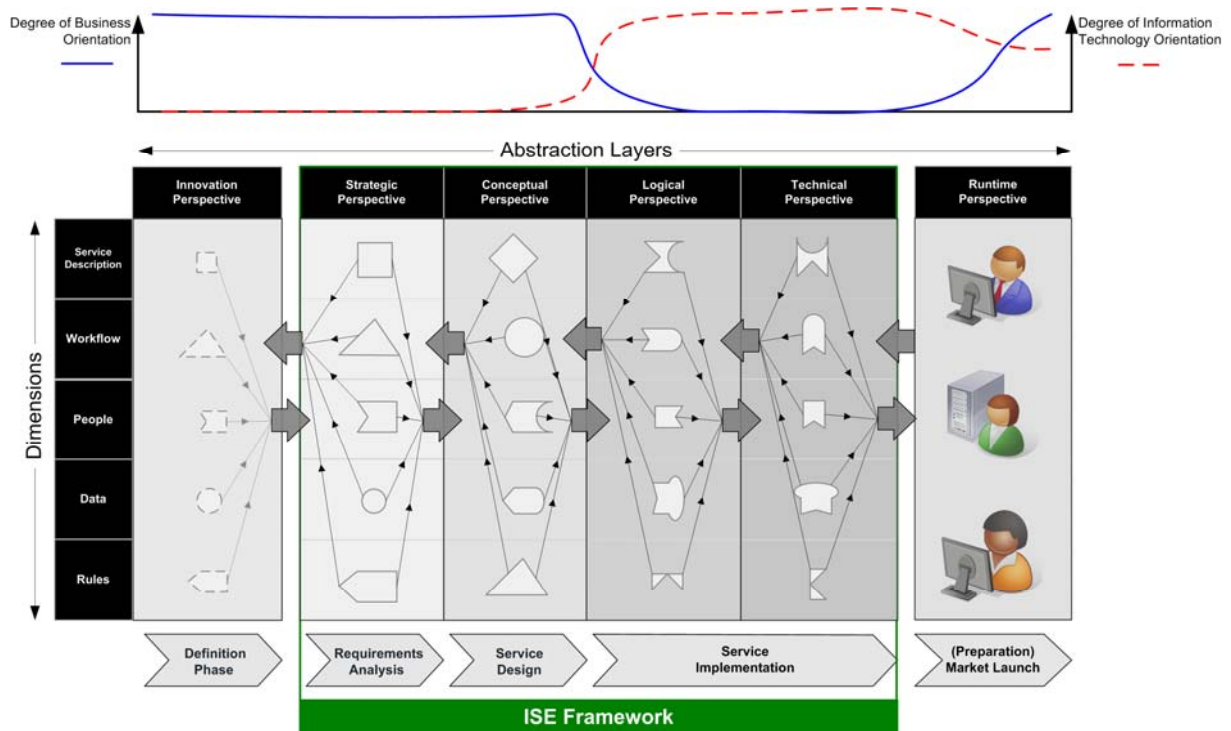


Fig. 3: ISE Framework and the degree of technical orientation concerning the level of abstraction

Fig. 3 illustrates that the degree of business-orientation is in the innovation, strategic and conceptual perspective high and decreases in the next two perspectives when the e-services are technically designed and implemented. Whereas, in the runtime perspective the e-service is launched and offered on the market and, thus, business and technical aspects become important.

The four abstraction layers of the ISE methodology are described below:

### Strategic Perspective

ISE starts with the strategic perspective on the service development process. The main aim of this perspective is the identification of requirements to the developing service which lead to a service description in form of a business model from a strate-

gic business viewpoint. Here, the issues are the service product (e.g. value proposition), the customer interface (e.g. target customer, distribution channel, relationship), the infrastructure management (e.g. value configuration, capability, partnership), and the financial aspects (e.g. cost structure, revenue model).

Prior to develop the strategic perspective, innovative service ideas are identified and evaluated with the target of filtering service ideas with a high business potential. In the strategic perspective, only the remaining service ideas are then in the focus of its activities. The strategic perspective is based on an adapted business model ontology of Osterwalder (Osterwalder, 2004) which addresses the below-mentioned issues.

We propose the following models forming the strategic layer:

- Service Description – The definition of the value proposition, the distribution channels, the relationships to customer groups, and the revenue model is in the focus of this dimension.
- Workflow – This dimension stresses the infrastructure management of a developing service and, thus, the issues of value configuration and capabilities.
- Data – A list of relevant data (immaterial resources) which are required for the service provisioning.
- People – The people model lists target customers, actors, and partners who are linked to the models service description and workflow.
- Rules – In this dimension the main policies of a developing service are listed which needs to be considered and refined during the service development and provisioning process.

In order to build a business model with an ontology, an appropriate set of methods is introduced (see 4.2.1 Service Engineering based on Fraunhofer IAO).

In this abstraction layer a strategic business model including a coarse-grained service concept is developed. This perspective mostly includes a decision-making process of an organisation's top management. Thus, the abstraction layer is built for CEOs who decide for their organisations' investments in new service offerings. They usually do not develop the business models themselves but rather assign business developers for fulfilling the task.

### **Conceptual Perspective**

The conceptual perspective follows the strategic perspective and refines its results. Whereas business models describe the exchange of value between business partners, process models show operational characteristics of how this is done (Dorn et al., 2007).

Thus, during the conceptual perspective business architect have the liability to operationalize and implement the strategic artifacts, which were developed during the business perspective. Domain experts refer here to the owner and business analysts to the architect in the Zachman Framework. Domain experts have knowledge about the market the service will be offered in, important processes, organizational structures, crucial assets, and domain constraints. They have the responsibility to analyze and express requirements for the service from this perspective. Business analysts,

however, have knowledge about models, modeling, architecture, and transformation. Their expertise and responsibility is to transform the domain expert's perceptual requirements into diagrams. These diagrams serve as a communication basis for domain experts to agree or disagree with the service design analysis (Zachman, 1987).

The models of the dimensions must comply with the following requirements:

- Service Description – Illustration of the service (Baida et al., 2004) offering in terms of functionality (Oaks et al., 2003), and monetary, quality, legal and security aspects (O'Sullivan, 2006). On this basis, potential service consumers search, rank, compare, select, and substitute services.
- Workflow – The aim of the workflow dimension is to show the service behavior. It presents tasks in sequence or in parallel which need to be carried out in order to fulfill service functionality. Tasks represent a company's capability. Additionally, workflow models make use of data, people, and rule concepts (Bhattacharya et al., 2007; zur Muehlen et al., 2007).
- People – The people dimension embodies organizations (actors), organizations' hierarchies, and roles within organizations. People own capabilities and carry out or are responsible for tasks within a workflow.
- Data – Data conceptualize information, which is necessary to perform the different tasks described in the workflow model. Information comes from within organizations (intangible resources) and from outside organizations.
- Rule – The aim of rule descriptions (zur Muehlen et al., 2007) is to implement rules and policies which a service must comply to.

The following illustrative model notation satisfies the requirements mentioned above. Though not a notation, service can be described by the service property ontology introduced by O'Sullivan (O'Sullivan, 2006) and service classification approaches such as UNSPSC<sup>5</sup>. Appropriate model notations for the workflow dimension are Event-driven Process Chains (EPC) (Scheer & Nuettgens, 2000), UML Activity Diagram<sup>6</sup>, and Business Process Modeling Notation (BPMN)<sup>6</sup>. Model notations for the people dimension are UML Use Case Diagram<sup>6</sup>, and organizational charts. Data is described by the UML Class Diagram<sup>6</sup> and the Entity-Relationship Diagram (Chen, 1977). Model notations for the rule dimension include Semantic Rule Model Notation (SRML) and Semantic Business Vocabulary (SBVR) (zur Muehlen et al., 2007).

### **Logical Perspective**

The logical layer follows the conceptual layer and therefore contains the models concerned with the abstract technical implementation of a service. The logical layer serves as a bridge for the gap between design and implementation. This means the models of the logical layer are not executable (e.g. by a workflow engine), however the focus lies on definition of technical details, which serve as a base for a transfor-

<sup>5</sup> <http://www.unspsc.org/>

<sup>6</sup> <http://www.omg.org>

mation into executable models. The logical layer consists of separated models with common elements, which have multiple representations in the models.

We propose the following models forming the logical layer:

- Service Description – Definition of technical non-functional Requirements like Quality of Service (QoS) in terms of time-based latency, availability etc., a services abstract interface and structure.
- Workflow – A notation and formalism for a graph-oriented definition of a services underlying workflow is required.
- Data – The data model should contain a data model capturing all associated information as well as data artefacts required by other models (e.g. the workflow or people model).
- People – The model contains an abstract representation of graphical interaction with a service connected to the workflow. It also captures a flow of interaction regarding the interface to the users (actors) involved with an execution of a service.
- Rules – We propose to select a visual modelling of rules using a common notation which defines constraints for the semantic data model and conditions for workflow and interface definition.

The following exemplary models satisfy the restrictions of the logical layer. A services interface can be described using UPMC, while BPMN is used to model the workflow, an OWL UML-Profile (Brockmanns, 2007) is applied to the data model. It is combining the visual notation of UML and the expressiveness of OWL, so a semantic data model can be defined. In order to define constraints for the data model we propose the usage of an F-Logic UML-Profile, which supports the modelling of logical rules using the UML notation. The people column is covered by Diamodl (Trætteberg, 2006), which supports modelling of user interaction and data flow between user interface components.

This layer involves the IT-analyst which refines and creates the final version of the

workflow in form of a process by adding constructs for error handling, fault-tolerance,

transactions, etc. Furthermore he is responsible for interaction modelling and the enrichment of the models by technical details.

### **Technical Perspective**

The technical layer is targeted at the definition of technical specifications using established standards. It serves as an aggregator of the models of abstract technical information provided by the logical layer. This formal information is transformed into executable or interpretable models. These models provide the full information in order to generate technical specifications using a model-to-text transformation (code generation). The goal is to prepare a full technical specification of a service, which enables automatic deployment and execution.

We propose the following models forming the technical layer:

- Service Description – Definition of the interface of a service including provided operations, data types, transactional behaviour, security aspects etc.
- Workflow – An executable specification of a services underlying workflow which can be run by a process engine.
- Data – A formal representation of services data artefacts, including structures used by the process, data types exposed via an interface and aspects describing a service, which should be represented in a semantic data model.
- People – A specification of an user interface allowing interaction with the service. This specification fully describes an user interface, such it is interpretable by an engine.
- Rules – The rules are derived from the graphical representation of the logical layer. Therefore this model represents the rules, such as they are interpretable by a rule engine.

We propose the use of the following standards and their according tools: WSDL and related WS-standards, like WS-Security or WS-Transaction. We chose them since they are a well established and accepted way of using XML to represent a service interface and related information. Furthermore this integrates the Web-Service world within the ISE-Framework. Using BPEL allows expressing the underlying workflow in an executable language with a variety of supporting engines. Regarding the data model we opt for OWL as a representation of semantic information. The CAP (Constantine, 2003) notation is used for describing an abstract user interface, i.e. interaction elements like buttons, text fields, output fields, etc. and their containers describing their relative alignment. Information like color, size and style is up to the generated code. Regarding the rules we propose the use of F-Logic, since it allows the definition of constraints over an ontology, which connects to the data dimension.

The role concerned with the technical layer is named IT Developer. His responsibility covers the implementation of the technology that will perform the processes, as well as the refinement of all other models.

### **Validation – ISE Workbench**

Concepts and methodologies of the last years have shown, that a theoretical foundation without tool support will not achieve acceptance. The reason is twofold. On the one hand, tool support lowers the entry barrier for users by providing them guidance and assistance. In case of very complex problems tool support may be crucial, since a user may not be able to cope with complex information and structures. On the other hand, tool support is a first validation of concepts and a methodology by proving its feasibility and revealing potential problems.

Therefore, we decided to implement the ISE-Framework in the ISE-Workbench. Since ISE is a model-driven methodology, the ISE-Workbench is implemented based on models. It offers a set of model-based tools according to the models which are defined for each ISE-layer. All of these tools are based on one common formalism (for model representation). This allows applying automatic model transformations by

using a model transformation engine. Furthermore, concepts like integrated validation, common persistency, model federation, etc. can be applied. The frame of our workbench is provided by Eclipse<sup>7</sup>, the Eclipse Modelling Framework (EMF) serves as the base for model definition. Using these constraints (Eclipse and EMF) we selected a number of existing tools like a graphical BPEL-Toolset, a graphical BPMN-Editor, graphical UML-Tools, etc.

The ISE-Workbench will provide an entry point to the ISE-Framework by visualizing the model selection and path through the model of the ISE-layers. The ISE-workbench guides a user through the development process and visualizes model dependencies. Besides providing user guidance, tool aggregation and model management, it also implements automatic support for model dependencies by using model transformation. This work is based on Query, View and Transformation (QVT).

### 4.3. Benefits of the ISE Methodology

Since the concept of e-services is still in a ramp up phase, no customized methodologies exist for the engineering of services. As a result, it is inevitable that front-runners will carry out service development planning in a manual, ad hoc, subjective, time consuming, and error-prone fashion. This will lead to service solutions which are disorganized, behind schedule, over budget, or cancelled. Therefore, the development of the ISE framework provides key design practices and artifacts to the planning of services. The nature of ISE brings a set of benefits to the creation of services:

- **Active engagement:** All stakeholders (e.g. business strategists, business architects, IT analysts, and IT developers) that can influence the engineering of services participate in the development to guarantee that business objectives are accomplished. ISE supports those stakeholders by providing specific perspectives on the service development.
- **Model-based approach:** The ISE framework supports the engineering of e-services by a set of models that describe or specify e-services structure, functionality and behavior. Each model is assigned to specific shareholders and to specific dimensions. Shareholders can visualize dependencies between models which are synchronized. Thus, an evolutionary change in one model triggers changes in adjacent models.
- **Compliance with regulations:** Since ISE strongly relies on formal models to design e-services, it provides a paradigm which may guarantee that architected services comply with relevant laws, policies, and regulations. For example, ISE provides information on billing, payment, security, and confidentiality. Therefore, financial information and security policies can be easily checked.
- **Technology standardization:** E-services must conform to existing standards in order to be compatible to data, applications, services, communications, integration, and security. Since the models devised within ISE and the main output of

<sup>7</sup> <http://www.eclipse.org>

ISE is a set of technical standards, formal models of e-services are independent of specific technological choices and thus, platforms.

- **Clear semantics:** ISE relies on two constructions to provide semantics for e-services to an architecture: using models and using a business ontology. The set of models which is made available by ISE provides strong semantics to stakeholders due to their high level of familiarity and standardization. On the other hand, the business ontology allows constructing a common vocabulary of concepts (data) consistently throughout the organization which is shared across perspectives and dimensions and is accessible for all models to perform their functions.

## 5. Conclusion and future Activities

When developing e-services, not only the technical aspects of a service's IT concept and implementation are crucial, but also the business issues need to be planned and clarified. The latter are important to create a service which can be delivered profitably and contributes positively to the activities of an organisation. ISE supports this interdisciplinary approach by a well structured methodology which considers the various views of different stakeholders when developing and delivering an e-service for business ecosystems. The basis for the structured methodology builds a set of models for each perspective in which all models are interconnected. Thus, information can be consistently refined and transformed from one perspective to another.

In order to adapt the ISE methodology, the underlying model-driven framework needs to be evaluated in different contexts, e.g. entrepreneurs versus large organisations, simple versus complex (networked) e-services, and heterarchical versus hierarchical networked partner organisations. 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.

## 6. Literature

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