DYNSEA – a dynamic Service-Oriented Enterprise Architecture based on S-D-Logic

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Abstract - **Enterprise Architecture is an important basis for aligning enterprise strategy with resources. Using a new perspective on economic exchange – the so-called Service Dominant logic – DYNSEA a dynamic enterprise architecture consisting of interacting service systems is developed. Central to DYNSEA is the co-creation of value with an actively involved customer, called prosumer. In DYNSEA service systems co-create services that are described by functional and non-functional properties and supplemented by meta services for managing the functional and non-functional properties of service.**

Enterprise Architecture, Service, S-D-Logic

I. INTRODUCTION

Information is an important strategic asset [1]. However not the ownership of information technology resources but the management of IT capabilities provides sustainable competitive advantage [2]. Effective management of IT is critical for the competitiveness of enterprises [3]. Especially the "consistent development of the capability to apply IT to business opportunities" enhances competitiveness [4]. An important means to do so is enterprise architecture. Enterprise architecture aims at aligning enterprise strategy with processes and resources, especially IT [5][6]. It provides a view on the organization of an enterprise facilitating planning. The architectural models of Enterprise Architectures serve as decision-making support for management [7].

There is an abundance of initiatives and approaches concerning Enterprise Architectures such as [8], [6], [9], [10]. A more and more heterogeneous landscape of different and even contradicting approaches is emerging. Also formal requirements such as the introduction of meta-modeling [11] are analyzed.

Heterogeneous and homogeneous enterprise architecture approaches can be differentiated. Heterogeneous enterprise architectures integrate different paradigms e.g. services and processes equally. On the contrary, homogeneous approaches have one dominant paradigm, e.g. service that determines the overall structure of the enterprise architecture. The existing – heterogeneous - approaches for enterprise architecture started from already available models of the enterprise such as process and organization models. Thus they integrate these models to provide an integrated view on enterprise architecture.

However they do not investigate the basic model of exchange between the enterprises. Therefore it does not surprise, that these paradigms originating from different backgrounds such as process management and organization are put together and mixed in an heterogeneous approach using layers and views e.g. in [13]. Heterogeneous approaches have an imminent problem to keep the different layers or perspectives consistent. Changes in one layer may create the need for changes in many other layers.

Also dynamic and static enterprise architectures can be differentiated. Dynamic enterprise architectures define mechanisms for adapting them to changed external conditions or to react on events. Static enterprise architectures do not. They have to be adapted using mechanisms external to the architecture. Existing architectures are predominantly static, Therefore methods such as TOGAF [14] have to be use to adapt them to changed requirements.

The contribution of this paper is to create DYNSEA a homogenous and dynamic service-oriented enterprise architecture using a new perspective on economic exchange – the so-called Service Dominant logic. DYNSEA consists of interacting service systems, co-creating value with an actively involved customer, called prosumer.

To develop DYNSEA, the paper starts with an analysis of the basic model of economic exchange of the enterprise. Based on abstract principles from the so-called Service Dominant logic (S-D logic) [1] [15][16], the macro

[1] [1] It is important to emphasize, that the term service in S-D logic is not the one used in service-oriented software architectures also called SOA [44]. A service in the context of SOA is functionality provided by an encapsulated unit of software that can be used location and implementation independent and thus something completely different than the services discussed here. Also services within so-called Service

architecture is developed. It describes the interaction of service systems as basic elements of the Enterprise Architecture. Then, the internal structure of this service system, the micro architecture, is developed. To clarify the progress achieved, the DYNSEA is compared with existing approaches and put into the context of related work. Finally a summary and outlook is given.

II. MODELS FOR ECONOMIC EXCHANGE

For a long time the predominant models in economics regarded goods as primary objects of exchange. According to these models goods are produced by enterprises without customer interaction. Enterprises create value apart from their customers and embed it into goods, sold to the customer (value in exchange). By consuming goods the consumer destroys value [17]. The efficient production of goods favors the separation from the customer by centralization of production. This view on economic exchange is also called Goods-Dominant Logic (G-D logic) [15] and regards services as less-than-ideal products. Following G-D logic services show the following "deficiencies": they are intangible, heterogeneous, their production is inseparable from consumption and perishable (IHIP-criteria from [18]).

However, recent research shows that economic exchange can be redefined, regarding services as the primary objects of exchange [16]. Thus, the proposition of services is the primary goal of enterprises. S-D logic sees value realized in service exchange enabled by the application of knowledge [19]. Following S-D logic goods are only used to deliver services. The creation of value is no longer regarded as an intramural activity of an enterprise (provider) but as a result of interaction with the customer. Value is co-created executing a service process involving a service provider and his customer, instead of producing a good and delivering it to the customer. Therefore it is better to name the role of the customer as prosumer [20][21]. This intensive co-operation of provider and prosumer aims at increasing customers' benefit and thus at a high "value in use" of services [18]. The strong integration of prosumers is particularly visible in consulting services. Results are created in tight cooperation with the customer [22].

The paradigmatic change from G-D logic to S-D logic is supported by empiric results. Offering and using services is becoming more and more important for many enterprises. Customers substitute own activities by services [23]. For example they request IT-services instead of IT-systems. Using services helps customer enterprises to restructure and thus facilitate outsourcing which allows them to concentrate on their core competencies. This increasing interest in service has created the necessity of a service science [23].

III. MACRO ARCHITECTURE

According to S-D logic, service is co-created by two so-called service systems, as shown in figure 1. Thus it is necessary to define the elements of DYNSEA in a way to support this co-creation of service. Following [24] S-D logic, a service system is defined "as an open system capable of improving the state of another system". Service systems may appear in various forms and granularity, e.g. as businesses, government agencies, people families, community groups, and open source communities [19]. The main purpose of service systems is it to "design propose, agree and realize" value propositions with other service systems [18]. Contrary to classical industrial production (G-D-Logic), S-D-Logic regards interaction with the customer not as an add-on, but as a prerequisite to render service. The interaction process is a common process between service provider and customer, who is called prosumer, due to his active involvement [20][21]. Thus, a service is not an interface to a customer but a process with the prosumer. Process interaction has to be enabled along the whole process and not only at the end of production, as common in industrialized production. Ideally, the service is collaboratively executed by prosumer and provider [25].

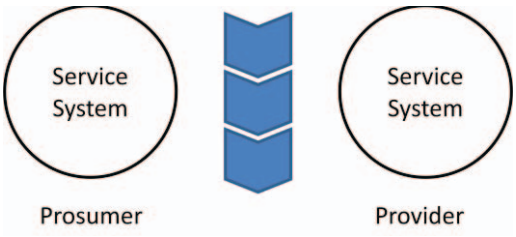

Figure 1. Service as a common process between two service systems

Based on this basic structure DYNSEA consists of a network of service systems with a 1st level service system interacting directly with the prosumer and subordinated service systems co-creating sub-services, as shown in figure 2. The sub-service systems do not have to belong to the same organization, but may belong to an external service provider. Thus the integration of outsourcing aspects [26] is facilitated.

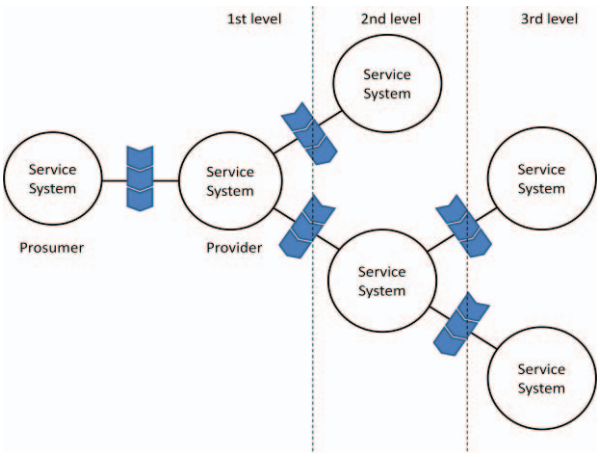

Figure 2. Figure 1: Service system network in DYNSEA

Oriented Enterprise Architecture (SOEA) [45] are predominantly software-oriented or at least G-D logic based.

To co-create service, service systems integrate and coordinate resources on their own, as shown in figure 3. Active and passive resources are involved. Active resources act on passive resources to create value. In S-D logic active resources are called operant resources; passive resources are called operand resources [24]. Certain types of resources may be regarded as operant or operand resources depending on the perspective chosen. A server system for example may be an operant resource acting on information (an operand resource). Meanwhile it may also be an operand resource acted upon by a technician (an operant resource) in a repair action. Resources applied for service provisioning do not become visible outside.

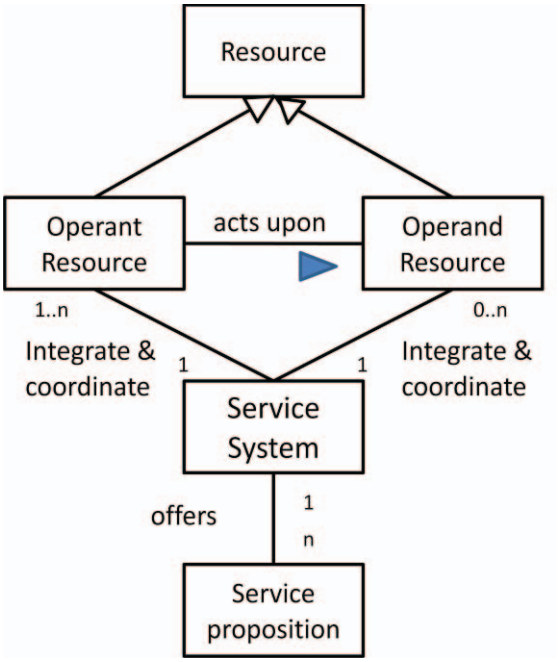

Figure 3. Service System

Resource integration in DYNSEA is shown in the following figure. The goals and strategy of an enterprise are used to create a service system network which integrates the enterprise's resources. According to [19], there are four basic types of resources, namely people, organizations, information and technology. Spohrer et al. [23] also define service systems as "dynamic value co-creation configurations of resources". Thus service systems may as well be regarded as resources themselves and can be encapsulated by other service systems [24]. Consequently, an atomic service system is one not having any other service systems as operand resources itself (e.g. an individual person).

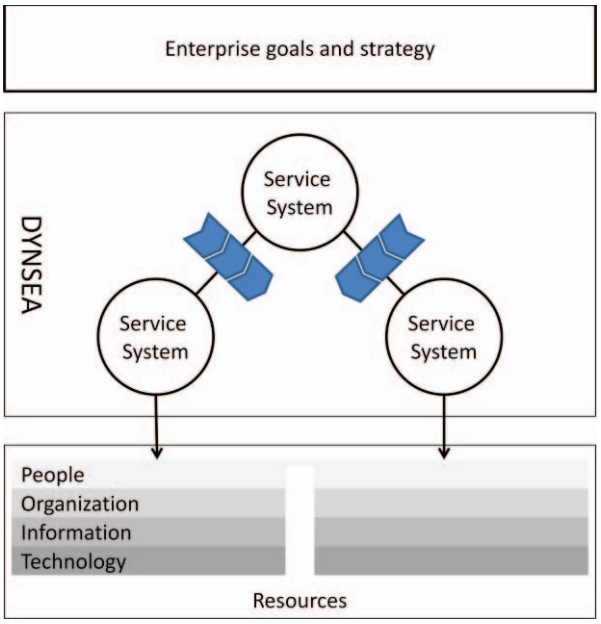

Figure 4. Resource integration

IV. MICRO ARCHITECTURE

The micro architecture of DYNSEA, that means the inner structure of service systems, is developed on the definition of service in S-D logic. In S-D logic service is "defined as the application of specialized competences (knowledge and skills) for the benefit of another entity, rather than the production of units of output" [15]. The benefit or value created by service is the key to identify three dimensions of service, as shown in figure 5. In addition to functional properties, also non-functional properties and so-called meta services contribute to the value created by service. Thus these three dimensions define a service and the volume of the spanned cube is equivalent to the service value created. The value judgment a service system applies within a particular service relationship depends on the types of service systems involved [19]. There are different forms of value judgments, as for example monetary value or reputation value [19].

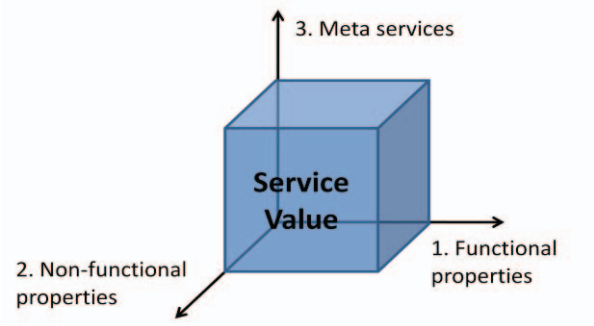

Figure 5. Service dimensions

For example, the value of train connections offered is not only determined by the transport from A to B but also influenced by the reliability of the connection. Also meta services influence the value created. Meta services are

services which operate on the functional and non-functional properties of a service. E.g. a meta service may redefine the possibility to measure the availability of a service and to redefine targets for availability. Also the possibility to complain about a service level violation is a meta service.

Based on the identification of the three service dimensions, the micro architecture of DYNSEA - the structure of the service systems - shall be developed.

A. Functional properties

The functional properties of a service can be described as a process, which – according to S-D-Logic – consists of "a series of activities where a number of different types of resources are used" [23]. Such a service process has many properties in common with ordinary business processes, [29]: The activities of a service process are part of a control flow. This control flow may contain sequence and gateway sequence elements between activities. Furthermore, there is an information flow between activities.

However, there are also a number of differences [29], as shown in figure 6 (the grey area is specific for service processes). Activities are executed by operant resources acting upon operand resources. The same entity may be both an operant and operand resource, as discussed above. Resources may be provided externally. Furthermore, there are interactions with other service systems. These interactions differ from the information flow between the activities, because they are not orchestrated but part of a choreography, as differentiated in BPMN e.g.[30].

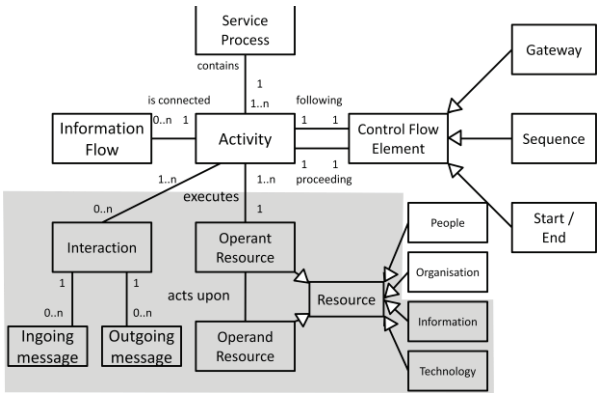

Figure 6. Service process

B. Non-functional properties

During the recent years non-functional properties of services have been widely discussed in literature as for example in the field of Software Engineering (see e.g. [29][30]). In [31] O'Sullivan examines these properties of services in general abstracting from a particular (computer) science field's perspective. According to his work non-functional properties of services are constraints associated to services' functionality and may be divided into nine different classes.

In the following these groups – namely availability, price, payment, discounts and penalties, obligations, rights, quality, security and trust – are briefly introduced.

The *availability* of a service defines the time or the location when respectively where a prosumer is able to accept a provider's proposition to co-create value. Regarding the *price* of a service there are different charging techniques a provider may select to specify the value of his work. The amount of money a prosumer is charged can depend on proposition activities (e.g. enabling service availability) as well as on co-creation activities (e.g. units of measure co-created) of the provider. The corresponding *payment* process is agreed on in the beginning of a service relationship. There may be *discounts* a prosumer receives depending on terms of payment (payment related discounts, i.e. how to pay) or on attributes of the prosumer himself (payee related discounts as e.g. membership to associations). Within the scope of their cooperation a prosumer and a provider agree to meet certain obligations (as for example to provide operand or operant resources). In case of non-compliance with these *obligations* the respective party will be *penalized* i.e. has to bear the consequences defined. By now the provider usually owns the intellectual property associated with a service process. A prosumer just has a limited set of *rights* (as for example the right to comprehend, the right to retract, the right of premature termination, the right of suspension and the right of resumption). However, the co-creation of service process specifications will bear an influence on the current legal situation. The *quality* of a service should be assessed from a prosumer's point of view. O'Sullivan recommends measuring perceived service quality along five dimensions (namely reliability, responsiveness, assurance, empathy and tangibles). *Security* aspects are of increasing interest – particularly with respect to IT-enabled services. Managing security means to reduce concerns regarding identity, privacy, alteration etc. Also mutual *trust* between the parties involved in a service relationship is of high importance.

1) Meta services

The third dimensions to be considered are meta services. Meta services are provided by specialized services systems. Typically, service systems for providing meta-services are integrated in a service-system, however, they also can be external. E.g. help desks are outsourced often. Additionally, each of the service systems may use further service systems on their own.

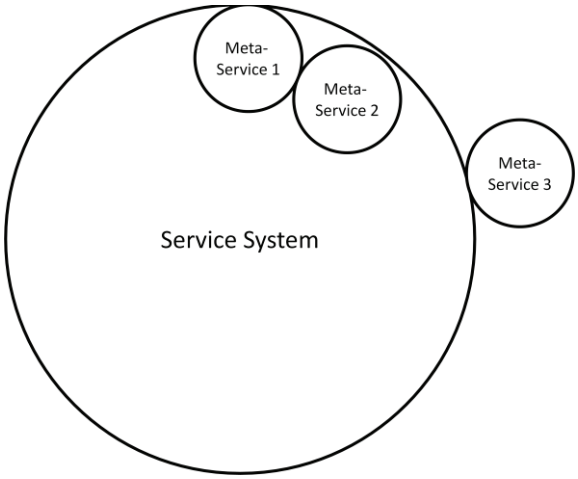

Figure 7. Meta services by specialized service-systems

Meta services can be categorized according to the service life cycle. There may be meta services in the design, transition, operation and evaluation phase.

The meta services in the design phase compromise the definition and agreement of new or changed services. The definition of new or changed services includes the assignment of operant and operand resources from both the service provider and prosumer. Furthermore the possibility to define or change service level agreements is specified. To assure their adherence, it is necessary to manage the existing capacities of resources properly. Any demand for additional resources to be procured has to be identified.

During the transition phase, the service defined is put into operation. To do so, the resources assigned in the design phase have to be provided and procedures for the service creation initiated. If external resources are required, service systems providing those resources have to be requested. During the operation phase, the concrete service delivery process is executed using the provided resources. If there are actual, foreseeable or possible violations of service level agreements, proper procedures have to be initiated to restore or to assure the defined level of service. During the evaluation phase, the aggregated results of service operation are cooperatively reviewed by service provider and prosumer. Changes to services and service level agreements are derived from review results.

V. RELATED WORK

Service-Dominant Logic is not an isolated theory, but is related to a number of emerging ideas, from which several showed their applicability. Thus, S-D logic is embedded in a stream of ideas and thoughts that emphasize the collaboration of independent individuals to co-create value, as shown below:

The co-creation of value is described in its general form, that means also for material goods, in [32] and [33]. The integration of the customer into value creation is based on the conviction, that by putting together the contributions of many, a better result can be achieved than by the decisions of some experts. Therefore, the wisdom of the crowds [34] is an important foundation for co-creation of value. The most prominent approach is the collaborative creation of software following an open source approach, following Linus' law instead of Brook's law [35]. Behind these ideas, there is the possibility to create a new kind of economy, as discussed in [36]. Co-creation of value also influences the discussion about intellectual property [37].

As already mentioned in the introduction, there is a number of existing approaches to define an Enterprise Architecture. TOGAF [8] is highly centered on IT concerns and neglects the business aspects of Enterprise Architectures. Furthermore it lacks a standardized language for describing Enterprise Architectures. GERAM [9] provides a framework to integrate different EA approaches. However it does not give hints for the practical implementation.

In [38] services are suggested as means for cohesion of business and IT structures. By integrating Enterprise Architecture as a perspective in a Balanced Scorecard, an integrated view of the whole enterprise shall be achieved. An integration approach for Enterprise Architecture and IT service management is introduced in [38]. However, this approach uses a service-oriented view only for the IT-part of Enterprise Architecture but not for the business part. The ArchiMate language [39] enables the modeling of different architectural domains (e.g. information domain, process domain and organization domain) as well as the modeling of the relationships between these domains. In contrast to the approach presented in this paper services are regarded as deliverables provided for upper layers of the enterprise architecture. There are no common processes of provider and prosumer which allow for a co-creation of value connecting different layers.

Up to now, service management approaches especially for IT services [40] follow a centralized approach. They separate the meta services from the service by creating a separate organisation executing service management processes. This approach creates a huge communication effort, because the meta-services are provided strictly separated from the services. Furthermore the meta-services are provided by an entity which is not service-oriented itself. As a consequence, highly redundant structures which are complex and inefficient are created. Another interesting drawback of approaches like ITIL [41] is, that they do only define a very superficial service architecture.

VI. SUMMARY AND CONCLUSION

DYNSEA is derived from S-D logic: according to it enterprises consists of service systems co-creating services. DYNSEA consists of a macro and a micro architecture. The macro architecture describes the interaction of service systems for providing services for customers. Complex services can be co-created in a very modular manner by creating a net of service systems co-creating supporting services. The micro architecture of DYNSEA defines the service system as entity to co-create services with the prosumer. The internal structure of services system is

derived from the three dimensions of service: functional properties, non-functional properties and meta services.

DYNSEA is dynamic, because meta-services provide operators on the functional and non-functional properties of the service. Thus changes in the requirements for the service can be implemented using the meta-services.

DYNSEA is homogeneous, because it uses services and service systems as dominant paradigm for creating enterprise architecture. Nevertheless, other entity types can be integrated as resource.

DYNSEA inverses the structure of existing Enterprise Architectures. Now, services are the first class objects, supported by processes in the service units. Within most standard BPM [42] models of enterprises, services are subordinate to processes. Furthermore DYNSEA is compatible with outsourcing approaches: There is no "impedance mismatch" between processes at the inside and services at the outside of the enterprise. It provides a homogeneous approach for integrating external partners contrary to business process management approaches where external partners need special elements for integration (e.g. choreographies in BPMN [43]).

DYNSEA allows for a much shorter innovation cycle, because innovations do not have to be propagated to central innovation management structures but may be implemented quickly in a decentralized and local manner. Nonetheless global requirements are taken into consideration through the embedding into the global architecture.

DYNSEA is symmetric. Existing service management approaches such as ITIL [41] are asymmetric because they differentiate between service system and service management system. The service management system is a system of higher order that acts upon the service system to improve it.

DYNSEA has far reaching implications which will be the topic of future research. For example, up to now, the so-called industrialization of services is regarded as de-facto-strategy for service enterprises. The industrialization of services means an optimization of service provisioning by centralization and a creation of scaling effects. Thus it also implies separation from customers, because otherwise centralization would not be possible. On the contrary, the architecture developed uses the co-creation of value and thus is complementary to service industrialization.

A further topic of future research will be the formalization of the approach presented here. For example, the integration of broadly accepted notations such as BPMN [30] for service process modeling will be an important theme.

VII. ACKNOWLEDGEMENTS

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