The Resource-Service-System Model

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Abstract. The Resource-Event-Agent (REA) enterprise ontology provides a conceptual basis for developing models that articulate the business logic of an enterprise. The basic REA pattern explains how an enterprise creates value through the exchange of resources. Value creation through resource exchange (*value in exchange*) contrasts with Service-Dominant Logic (SDL), which was proposed as a foundational theory for Service Science. In SDL, value is not created by transferring resources between economic actors as resources have no intrinsic value. Value is co-created by economic actors through mutually reciprocal services in which resources are integrated with other resources to increase their utility (*value in use*). To account for this new perspective on value creation, this position paper presents the Resource-Service-System model. This model presents an SDL interpretation of REA in which, conform to recent developments in service ontology, service is ontologically classified as an REA event and not as a resource (which is REA's current position).

1 Problem Statement

Service Science is the discipline that studies service systems and the value propositions that interconnect them in order to discover underlying principles which can inform service innovation, engineering, operations, and other service applications [1]. Service-Dominant Logic (SDL) has been proposed as a framework for developing a theoretical foundation of Service Science [2]. SDL is a worldview that sees all economic activity as service exchanges between service systems, in which service is defined as the application of competences by one service system for the benefit of another service system [3]. In an economic context, service systems, of which enterprises form a major category, are configurations of resources (including those that embody competences) that participate voluntarily in mutually reciprocal services with other service systems. Hence, a service system is "(1) capable of improving the state of another system through sharing or applying its resources (i.e., the other system determines and agrees that the interaction has value), and (2) capable of improving its own state by acquiring external resources (i.e., the system itself sees value in its interaction with other systems)" [3].

In the traditional economic worldview, services are only second-class goods that suffer from shortcomings like intangibility, heterogeneity, inseparability, and perishability [4]. In this worldview, referred to as Goods-Dominant Logic (GDL) to distinguish it from SDL, services are to the best possible extent, as far as allowed by their shortcomings, treated as any other kind of resource (e.g. products, goods). Like any other resource, GDL considers services to have an intrinsic value that is determined through their exchange for other resources in economic markets. In contrast, SDL sees a service as a collaborative process in which each party brings in or makes accessible its unique resources. In SDL, it is the provision of resources by one party and their acting upon the resources of another party that creates value for that other party (i.e. the service beneficiary). Table 1 summarizes the main differences between SDL and GDL.

Table 1. Comparing service concepts in SDL and GDL

	Service-Dominant Logic	**Goods-Dominant Logic**
Nature of service(s)	service is a *process*	services are *resources*
Value of service(s)	*value in use*: value creation through resources acting upon other resources	*value in exchange*: value creation through transfer of resources (including services)
Service(s) exchange	*service for service*: service systems interact in mutually reciprocal services	*resource for resource*: economic exchange of resources (including services) on the basis of economic reciprocity
Actor roles in service(s) exchanges	*resource provider* (competence applier) and *resource integrator* (service beneficiary)	*services provider* (value producer) and *services client* (value consumer)

A shift in economic worldview from GDL to SDL is a shift in *the logic of economic exchange* rather than a shift in the type of product under investigation [5]. A conceptual model of *the logic of economic exchange* is provided by the REA ontology [6].

Fig. 1 depicts an independent view model of bilateral economic exchanges. The model clearly shows that the REA ontology assumes an GDL economic worldview. Services are a subtype of economic resource under the control of an economic agent. If another economic agent desires to obtain control over the services (i.e. own the services or be able to derive economic benefit from them [7]), then both agents engage as trading partners in an economic exchange, which is a business transaction that transfers the control over the services from the first agent to the second agent. The transaction is an exchange in the sense that the first agent is only willing to give up control over the services desired by the second agent if the second agent transfers a resource of equal value (usually money) to the first agent (i.e. the principle of economic reciprocity). Conform to GDL thinking, the value of the services is determined through the exchange (usually in terms of what is being paid for them) and the provider agent produces the services (i.e. creates value) whereas the receiver agent consumes them (i.e. destroys value). The REA model requires that, apart from the services themselves, also an economic event is identified (e.g. services delivery) that transfers the control over the services from the provider agent to the receiver agent.

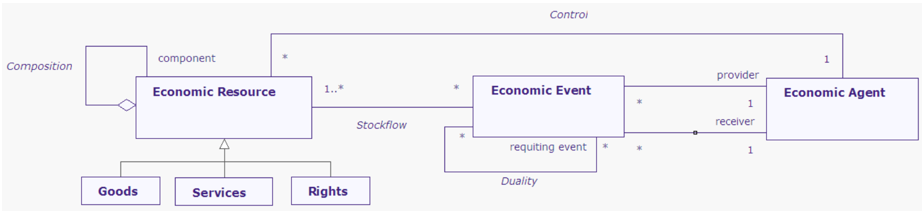

Fig. 1. Elementary REA model with some extensions (based on [6], [7], [8])

2 Position Statement

It is our position that the REA ontology can provide a conceptual model of economic exchange in SDL by classifying service as economic event instead of economic resource. Support for this position is found in Ferrario's and Guarino's service ontology [9], which presents an ontological foundation of Service Science grounded in the DOLCE upper-level ontology[1]. According to [9] "it seems legitimate to assume that goods are objects (endurants, in DOLCE's terms), while services are events (perdurants)". The ontological classification of service as event implies that a service cannot be transferred [9]. Hence an 'artificial' distinction between a service economic resource and a service (delivery) economic event (as implied by Fig. 1) is not supported by the analysis of Ferrario and Guarino.

Fig. 2 shows our SDL interpretation of the economic exchange model depicted in Fig. 1. The terms and definitions used to construct the model in Fig. 2 are taken from SDL literature ([2], [5]) and the SDL-based system theoretic definition of service system in [3]. We refer to this model as the *Resource-Service-System* model (with a blink to the *Resource-Event-Agent* ontology) to emphasize the event nature of service.

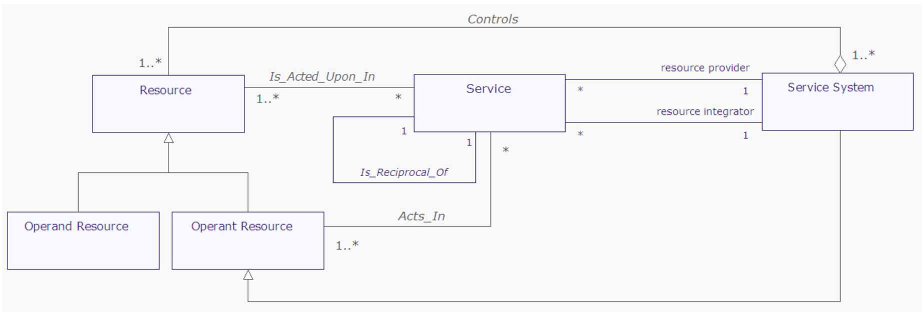

Fig. 2. The Resource-Service-System model of service exchange in an economic context

The Resource-Service-System model is obtained by replacing in Fig. 1 economic event by *service*. Like REA economic resources, a *resource* in SDL has utility (though its value is extrinsic rather than intrinsic) and is under the control of a legal or

[1] http://www.loa-cnr.it/DOLCE.html

natural person. If economic exchanges are service exchanges then the persons controlling resources are service systems (meaning configurations of resources [3]). Therefore, economic agent is replaced by *service system*. As shown in Fig. 2 by the *controls* aggregation relationship, a service system is an aggregate of resources that are controlled by the system.

A service is the acting of one or more operant resources on one or more other resources (operand, but possibly also operant [3]). Operand resources are passive resources that require action to make them valuable, whereas operant resources are active resources that embody competences (i.e. knowledge and skills) and that can act on other resources to make them valuable. According to [2], the distinction between operant and operand resources can enrich the conceptual foundation of Service Science as service systems are driven by operant resources rather than operand resources. Therefore, *resource* is specialized into *operant resource* and *operand resource* (instead of goods, services and rights as in Fig. 1). Fig. 2 shows that at least one operant resource must act in a service and at least one resource must be acted upon, meaning that service implies the application of competences which must be integrated with other resources to create value. These *acts_in* and *is_acted_upon_in* relationships replace the stockflow relationship of Fig. 1.

The Resource-Service-System model also recognizes that service systems are themselves resources, more particularly operant resources [3]. As service systems are configurations of resources, service systems can be composed of other service systems. A composition of resources needs to include an operant resource, otherwise it cannot be considered a service system [3]. The Resource-Service-System model emphasizes the component structure of service systems rather than that of economic resources by replacing the composition aggregation relationship and control relationship of Fig. 1 by a single *controls* aggregation relationship.[2]

The service systems involved in a service are explicitly identified via value co-creation roles. A *resource provider* co-creates value with another service system (i.e. a resource integrator) for the benefit of that other system by providing/applying resources. A *resource integrator* co-creates value with another service system (i.e. a resource provider) for its own benefit by integrating the resources provided/applied by the other system. These roles replace the provider and receiver roles of Fig. 1.

Finally, the model includes a bidirectional *is_reciprocal_of* relationship between services that replaces the duality relationship in Fig. 1. Mandatory participation constraints indicate that each service needs a reciprocal service. This means that when a service system provides resources for a service that benefits another service system, then this other service system must provide resources for a requiting service that benefits the first service system. So, in the requiting service the resource provider and resource integrator roles of the service systems that co-create value are switched.

To further specify the Resource-Service-System model, we also provide a set of axioms, which are compared in Table 2 to the original REA ontology axioms found in [6].[3] Some of these axioms reformulate REA axioms (i.e. the stockflow, duality and

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[2] The view that resources other than service systems can be composed of other resources does not contradict SDL, but is de-emphasized in the conceptual model as SDL stresses the component structure of service systems.

[3] Note that in [6] these axioms are formulated as dependent view model axioms.

participation axioms); others are newly introduced as they are either specific for the SDL economic worldview (i.e. the composition axiom) or implicit in the REA ontology (i.e. the control axiom).

Table 2. Comparing REA and RSS axioms

	REA axiom	**RSS axiom**
Stockflow axiom	At least one inflow event and one outflow event exist for each economic resource; conversely inflow and outflow events must affect identifiable resources.	At least one operant resource must act in a service and at least one resource must be acted upon in a service.
Duality axiom	All events effecting an outflow must be eventually paired in duality relationships with events effecting an inflow and vice-versa.	Each service is paired with another service in an is_reciprocal_of relationship; the resource provider in a service is the resource integrator in its reciprocal service and vice-versa.
Participation axiom	Each exchange needs an instance of both the inside and outside subsets.	Each service needs a resource provider and a resource integrator, which are different service systems.
Control axiom		All resources that act or are acted upon in a service are controlled by either the resource provider or the resource integrator in the service; at least one of the operant resources that act in a service is controlled by the resource provider in the service; at least one of the resources acted upon in a service is controlled by the resource integrator in the service.
Composition axiom		Each service system is composed of resources, of which at least one operant resource.

3 Challenges To Be Addressed by Future Research

A conceptual model is an abstraction and simplification of reality that emphasizes certain phenomena while de-emphasizing others. The Resource-Service-System model presented in Fig. 2 lays a filter on the complex world of service exchanges in an economic context in order to study their basic ontological structure. There are, however, many other aspects of services and service systems worth studying, like the process structure of a service and service composition, to name just a few.

Ferrario and Guarino [9] consider a service as a complex event whose parts (i.e. service commitment, bundling and presentation, acquisition, process, and value exchange) are also events. Our ontological classification of service as REA economic event does not contradict this position as the REA ontology's three-level architecture allows decomposing an economic event into workflow tasks [10] or business events, as they are referred to in the REA-based Open-edi Business Transaction Ontology [7].

Economic events (and the other elements in Fig. 1) have a defined lifecycle of states that they go through during the course of an actual economic exchange [6]. We are currently investigating (normative) service lifecycle models (e.g. the Service Value Chain model [11], the ISPAR model [3], the layered structure of service activities proposed in [9]) and business transaction lifecycle models (e.g. Open-edi Business Transaction Phases [7], DEMO's Basic Transaction Pattern [12]), connecting them with further REA ontology concepts (e.g. commitment and policy) and SDL concepts (value proposition), in order to complement our structural Resource-Service-System model with a behavioral counterpart.

Another challenge is recognizing the component structure of service, meaning that a service can be composed of other services. We believe that service component structures are heavily interconnected with service system (and possible other resource) component structures, and therefore cannot be studied in isolation. Further research is required to incorporate service composition in the Resource-Service-System model.

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