Service Semantics Classification: an Approach Towards Modular Service Ontology

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Abstract. Since service systems are becoming increasingly complex in emerging technology, business, legal and economics environments, service abstractions are necessary to master this complexity. However, the term 'service' means different things to different people in different disciplines, which implies that any attempt to define general purpose service abstractions must address the disambiguation of the term. Service ontologies and service knowledge management efforts mainly aim at elucidating service semantics. Each discipline has multiple biased service-related concepts, so that in order to build comprehensive multi-disciplinary service models, the service-related concepts of the involved disciplines have to be integrated and structured in a consistent way. We claim that this requires a modular approach in which general purpose service semantics can be further extended or specialised with domain-specific concepts. Service-related and domain-specific concepts can be integrated and structured in many different ways. This paper proposes a semantics classification scheme based on service aspects that are essential for a services ecosystem.

Keywords: Service Semantics, Service Ontology, Service Configuration, Service Management, Service Governance

1 Introduction

Since services are becoming more important to economies across the world, academia has launched a novel research area called *Services Science*, which is meant to coordinate the research efforts concerning services. However, in the literature, the term 'service' is still often used in different contexts with different meanings or interpretations. The business community considers a service as a value co-creation, whereas the ICT community views a service as an interoperable computing capability that enables machine-to-machine interaction. From a market viewpoint, service delivery can become more complex than simply selling manufactured goods, as service delivery requires special considerations for designing, planning, executing, managing and regulating the service operation [1].

Both academia and industry would profit from a common abstract definition of service and a unifying theory of services that are unanimously agreed and applicable to every service scenario. Semantic Web and Knowledge Management technologies are becoming rather popular nowadays and aim at addressing these issues [2]. An ontological definition of service is an important step towards the disambiguation of

the term, and can lead to a general purpose model [3]. Commonly agreed general purpose service models are becoming even more necessary with the current emergence of service ecosystems, where many types of services are offered, managed and consumed in a single virtual marketplace [4].

2 Ontological Service Definition

We consider the ontological definition of service given in [3], where service is taken as a *perdurant* and its existence can be established in the space and time dimensions. According to this ontological definition, a service corresponds to a commitment of an agent (trustee) to the execution of actions of some type by possibly another agent (producer) on the occurrence of a triggering event, in the interest of yet another agent (consumer) and upon prior agreement. Trustees, consumers, producers and facilitators are some of the stakeholders involved in various service-related activities. Considering a service on a timeline, a service commitment act is the first event in the service lifecycle, followed by some service availability act that determines the service availability. Once the service is available, the observation of an event may trigger service actions. Depending on the nature of the service, the actions can be simple activities or complex business processes. The valuable outcome of these activities corresponds to service content delivery. Service availability and commitment definitely cease to exist at some point, determining the end of the service lifecycle.

This ontological definition of service provides a starting point for developing detailed models of complex real-world services. In the business, information and computation domain, services may exhibit more specific characteristics. This requires extensions of this ontological definition to represent the domain-specific issues of these services. Uncoordinated extensions of these service models may result in heterogeneous introduction and use of concepts. Even considering that these models depart from the same founding concepts, the resulting service models may become semantically incompatible, with negative consequences for the interoperability of the systems that rely on these models.

The upcoming service marketplace requires provision, consumption, evaluation, and regulation of all possible services in a single service ecosystem. Therefore, semantic heterogeneity of service knowledge must be resolved so that all services can be utilised. This requires a framework in which the ontological definition of service can be extended but that also guarantees semantic heterogeneity. The challenge here is to define a structure in which services can be integrated in spite of their heterogeneity. These requirements call for a systematic and modular approach towards the modelling and representation of service knowledge. Considering the ontological definition of service and the lifecycle that can be implied from this definition, we identify some aspects of service knowledge that are essential for all possible services in an ecosystem. Therefore we propose a structure based on these aspects for organising the further elaboration of service knowledge. The structure is provided in the form of a content model, enumerating important features of services that allow the identification of associated stakeholders, their interactions, activities, outcomes and associated events. The proposal is made in the form of a service

semantics classification that can be adopted for a modular representation of service knowledge that is applicable to various types of services and domains.

3 Strategies for extending the service ontology

Building upon the ontological definition of service given in [3], there can be many possible strategies to extend or specialise this ontological definition. We identify below various alternative strategies that can be considered by multi-disciplinary teams of service stakeholders and knowledge engineers for the detailed elaboration of service knowledge as extension or specialisations of the definition given in [3]:

(1) *Domain concepts*: Services can often be linked to some domains, like utility, financial, medical or ICT. The concepts, stakeholders and their activities in these domains can be used as the basis for an extension strategy.

(2) *Stakeholders*: Service stakeholders concerns and activities can be used as the basis for an extension strategy.

(3) *Lifecycle*: Services have lifecycles normally defined in terms of phases and their activities. These phases and activities can be used as the basis for an extension strategy.

(4) *Service aspects*: Different types of services in a service marketplace may have stakeholders, processes and domain knowledge that are difficult to compare, but they share common features like the execution, management and governance of interactions and functions according to some domain knowledge. Generic service aspects of service can then be identified and used as the basis for an extension strategy.

Therefore, we can conclude that generic service aspects can be used in a suitable strategy for extending the ontological definition of service given in [3]. We have identified the following generic aspects, which we present as a semantics classification:

- *Interaction Semantics*: The delivery of service value is carried out in interactions among various stakeholders. The language, protocol, and rules governing these interactions determine the interaction semantics of a service.
- *Functional Semantics*: Service operation follows a certain process or workflow. The description of business logic that governs the service operation determines the functional semantics of a service.
- *Monitoring and Execution Semantics*: A service may require some configuration, which enables various service activities in a system environment. These system level attributes can be expressed as execution and monitoring semantics of services.
- *Management and Governance Semantics*: The realisation of complex services requires real-world customer and partner interactions and decisions, in activities like partnerships and service level agreements. Commitments can be made possible after considering viability and other practical issues and trade-offs. The concepts pertaining to policy and management plans towards commitments correspond to the management and governance semantics.

- *Quality Semantics*: Service delivery can be evaluated for its effectiveness in providing satisfactory service experience. There are many possible criteria and methods to determine effectiveness from business, legal, system or consumer point-of-views. The concepts and techniques for determining and describing service effectiveness correspond to the quality semantics, represented in terms of offered, expected or actual quality of a service.
- *Domain Semantics*: The theories, techniques and strategies that are established to explain, model, monitor, or improve the performance of services are outcomes of research activities carried out by domain experts and practitioners. These terms, concepts, and rules can be captured and shared as the domain semantics of a service.

Based on this general structure, detailed knowledge representation can be carried out for specific services and different domains.

4 Conclusion

This paper identifies and classifies some semantic aspects of services systems. For a given service type, knowledge management and ontology representation efforts should not only support various stakeholder viewpoints, but they also should be consistent with similar efforts for other services to be effective in the realisation of a service marketplace. We argue that knowledge engineering efforts can be systematically carried out by following a structure that is applicable to all types of services. The existing work on ontological foundation of services is taken as a basis to define and build a modular structure for the development of an ontology. A classification scheme is proposed to classify each important aspect of services thereby integrating associated stakeholders activities and their outcomes. We are currently defining ontologies for these different semantic classes, aiming at validating and refining the classification given in this paper.

References

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