Towards Bottom Up Semantic Services Definition

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Abstract. This paper explores a bottom up approach to support service interoperability between distinct stakeholders. Bottom up approaches are useful in ecosystems where coming up with semantic agreements is difficult. Key here is the flexibility for the distinct stakeholders to diverge and converge by means of agreement in their service definitions, driven in an emergent dynamic process that eventually may lead to a stable service network using a bottom up approach.

Keywords: Collaborative service construction, Web Blackboards.

1 Introduction

Within this paper, we explore an approach that aims to support a group of stakeholders in their collaborative definition of information services. Although we observe that there is no wide consensus on what the exact meaning of "service" is, we still can categorize them according to their context of use, such as: (i) IT context, which regards to the implementation or specification to build semantic applications and (ii) business context, which can be seen as a theoretical model referring to real-world objects aligned to some process among stakeholders [7].

When a group of stakeholders need to define services collaboratively on decentralized environments such as the WWW, they will face numerous difficulties. To archive an effective service interaction, first they have to benefit of agreed semantics, a task that is usually not trivial. Here, each stakeholder need to express their intended meaning explicitly (i.e. agreeing on the meaning of the terms used by each service), keeping a minimal coherence between conceptual, implementation and their business directives. At the same time they have to keep a sufficient level of implementation independence between their models, methods and business requirements [4]. In order to cope with all these difficulties, we want to make use of representation mechanism called *Web Blackboard*, that will help us to incrementally convey the shared understanding on the concepts used by those services, and therefore underlying agreements about the services behavior.

Through this paper, we will explore how multiple stakeholders can represent and interlink their service descriptions using artifacts in decentralized environments. We want to explore the possible benefits of an environment where multiple stakeholders (i) collaboratively define their information services and (ii) build up a network of semantic mappings, in order to reach configurations that

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promote collaborative information sharing, (iii) allowing them to use their own terminology and conceptualizations.

This document is organized as follows: Section 2 presents a brief description of our problem. Section 3 will explore the related work on this subject. Section 4 will explain what is our current approach. Section 5 will describe the dynamics this representation mechanism. Section 6 presents our conclusions and future work.

2 Problem Description

Suppose that we have a group of stakeholders that want to provide information services concerning cultural events in a city. Consider the task of finding relevant events via the composition of multiple services, such as transport schedules services, musical events agendas etc. In this case, the stakeholders may need to compose distinct functionalities in order to provide results that are relevant to the users. Composing these services may imply (i) discovering services with one or more functionalities, (ii) retrieving definitions for these functionalities and (iii) to integrate them into a resulting service. If the stakeholders have well defined semantic interoperability requirements for all these tasks, they can integrate the information sources through the use of global interchange schemas or ontologies, which are usually built by authorities or stakeholder communities. But there will be cases where we cannot count with these central authorities. In these cases to reach agreement about schemas will be difficult. One approach to overcome this situation is to support incremental processes, where the distinct peers interact making agreements with each other within a peer to peer network. In this paper, we make use of shared artifacts used by the distinct peers, used to collaboratively convey into structures to be used by information services. A peer to peer network is characterized by its fast conceptual framework evolutions, which are common in information systems constructed socially. Therefore top-down approaches may not be sufficient to flexibly respond to the dynamic requirements present on those networks.

3 Related Work

Although service decomposition and composition techniques allow us to scale into large service networks, they may become difficult to manage in ecosystems where multiple stakeholders interact, mainly due to misinterpretation issues. These ambiguity and interoperability difficulties can be diminished by the use of semantic web services that make use of shared and explicit semantics to maintain coherence between a net of distinct stakeholders. These services make use of ontologies to facilitate an acceptable "understanding" between agents. In IT related domains, an ontology is understood as a shared, computer stored conceptualization in a formal language agreed upon a group of stakeholders that enables system interoperability [5].

The nature of the ecosystem will determine largely how these ontologies are constructed, depending on the difficulty and scope of the needed semantic agreements. The stakeholders may adopt distinct strategies to identify and determine their relevant concepts, following top-down, bottom up, or a combination of both approaches.

In the case of systems where "global interoperability" is hard to archive, then we can see the agreement processes as emerging from the interactions of autonomous agents [2], where services may profit from a web of mappings between autonomously created ontologies that follow the individual conceptions of the stakeholders. We want to support this behavior using artifacts called *Blackboards* [1] that allow the stakeholders to incrementally construct mappings between their ontological systems, seeking acceptable degrees of agreements. Within this paper we make use of a blackboard variant called *Web Blackboards* [8], that provides us higher degrees of descentralization and flexibility. Blackboards are playgrounds where the stakeholder community describe their conceptualizations, business rules, service definitions etc. Its decentralized architecture aims to support a network where the stakeholder community describe and interlink their descriptions organically and incrementally. One important characteristic of these networks is that their evolution is traced along their stakeholder community in order to support high level interactions such as service composition and orchestration.

4 Approach

Whenever some stakeholders want to share information through services, they will need a clear idea about the intended meaning of these services, meaning ideally externalized by some machine understandable representation formalism. The idea of using shared artifacts such as blackboards is to capture these representations of intended meaning. Theoretically, a blackboard can hold any implementable representation, such as a data model, decision model, a rule or business role. In this paper we will use *Service Definitions* as the studied models, where we use a blackboard to represent a single service, or to represent the dependencies between distinct services. When a stakeholder wants to make use of certain service, he may commit to the blackboard that holds its service definition (B_{sd}). Wherever a stakeholder want to make modifications, it may clone the service definition and perform the modifications in the new variant. Other stakeholders may then change their commitment to the new service definition variant. Another approach is to start a modification agreement dialog with the stakeholders that commit to the same service description blackboard.

Each time that a B_{sd} is cloned, we generate a new derived B_{sd} that will be the result of a change with respect to the previous one via a set of *change operators* applied sequentially by the stakeholders. Which change operators are going to be used to let evolve certain service elicitation is a matter of design and will depend on the nature of the service network. We may use very granular ones such as `update query` or `add new dataset`, while others may be of higher complexity such as binding two services together. The distinct change operators can be constructed via composition of granular ones via a framework of layered operators [6]. Within a blackboard network, the use of defined change operators is convenient since they allow the possibility of binding the operators to automatic verification and validation processes [3].

B_{sd} may represent services that can be grouped into different strands, each one with its own representation needs and distinct levels of formalism. Examples of these representations may be SOA, Semantic WS, SAAS, Service networks etc. The choice of which representation formalism will depend on the semantic interoperability requirements and the scope of the service integration. For example, we may need a formal and unambiguous grammar to map concepts precisely to the implementation artifacts, or natural language definitions to support general business processes. In this way, the choice of the representation mechanism depends on the distinct modeling processes. In this way, a blackboard can be seen as a design artifact, to build purposeful artifacts that address unsolved problems.

Stakeholders can perform distinct actions within the blackboard network, such as (i) to consume semantically enabled services (ii) perform individual queries (iii) to annotate content (iv) or to modify the underlying ontologies among others. The approach itself does not force specific role assignments or ontology ownership policies since this may differ from one community to another, but as a general rule, when a service is published by a stakeholder in a B_{sd}, we may say that the published commits to its artificial declaration. If another stakeholder commits to the same B_{sd}, then we can assume that he agrees with the conceptualization behind the service.

5 Blackboard for Service Definition Evolution

A B_{sd} will hold service representations contextualized within a particular task, each B_{sd} is triggered by the creation of services and is augmented with machine readable facts and terms that result from the annotations and dialogues between the stakeholders. In this way, each blackboard is divided in multiple meta levels such as agreement layer, discussion layer, service description layer, implementation layer etc.

Whenever a group of stake holders is involved in the incremental an collaborative change of a B_{sd}, the number of mappings of services in the network will increase. The diverging and merging capabilities are supported by a direct an acyclic graph model (DAG) that allow us to represent (i) the branching of a B_{sd} variant (ii) merging two B_{sd} variants and (iii) record full the traceability by means of sequences of change operators used to merge or diverge the variants. This non-linear B_{sd} development is currently used successfully in other fields (e.g., collaborative software development with version control systems such as GIT[1]).

6 Discussion and Future Work

In this paper, we treat each service description as a first-class citizen, a hub that uses each service's metadata and dynamic schemas together in order to provide

[1] http://git-scm.com/

semantically enabled services, constructed by their community of use. The stakeholders are free to create new blackboards, seeking peer-to-peer collaboration, via the definition of services and collaborative modeling.

We expect that using these blackboards as a pivot will help to improve the community's local interaction promoting adaptative self oganization for modelling and annotation activities. Full traceability is supported in order to be able of analyzing the evolution of a service network in order to observe how the consumers, mediated by a set of artifacts, are driven in a emergent dynamic process that eventually may lead to a stable service network. Finding out the characteristics of these dynamic service networks may enable us to understand better a service system. Such an approach leaves us space for further questions, such as:

(i) What should be the agreement mechanisms between the stakeholders that commit to a B_{sd}?
(ii) How we can profit from B_{sd} networks to compose and orchestrate semantically enabled services?
(iii) How these networks evolve, and how they can be observed by the stakeholders increasing their awareness?

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