Process Mediation in Semantic Web Services*

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Abstract. The Semantic Web Services initiatives are aiming to develop automatic and dynamic solutions for the semantically described Web services discovery, invocation and execution. The automation of all this activities is possible only if both the requestor and the provider of a service are semantically describing the requested and the provided functionalities, as well as the behavior they are going to have during the service's invocation. However, several mismatches may occur, on several levels: data, process or functionality. This paper is focusing on overcoming the process heterogeneity problems, from the processes compatibility point of view.

1 Introduction

An intense research activity regarding Semantic Web services has been going on during the last years. But only the semantic descriptions attached to data or to the Web services deployed using todays technologies does not solve the heterogeneity problems that may come up due to the distributed nature of the Web itself. As such, the heterogeneity existing in representing data and processes or in the multitude of choices in representing the requested and the provided functionalities, and in the various forms of the communication patterns (public processes) are problems that have to be solved before being able to fully benefit of the semantic enabled Web and Web services. Considering that these problems can not be avoided, dynamic mediation solutions that fully exploit the semantic descriptions of data and services are required.

As mediation is a rather broad and well-studies field at both semantic ([8], [2]) and non-semantic level ([6], [5]), this paper focuses further on only a subset, namely on process mediation in the context of Semantic Web services.

The discussion is held in the context of Web Service Modeling Ontology (WSMO)[1] [4], [3], a framework that offers all the necessary instruments to semantically describe the Web services and all the related aspects. One of the main reasons in choosing WSMO as the semantic framework for Web services is that it realizes the importance of

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[1] The author has been an active member of the WSMO working group since 2004

mediators and treats them as first class citizens. WSMO offers specific means to semantically describe concrete mediation solutions and to directly refer to them when needed (e.g. from ontologies or Web services).

This paper is further structured as follows: Section 2 presents the addressed problem, while Section 3 provides an overview of the current state of the art in the field, illustrating how the approach further described in the paper is different, and what are its advantages. The expected contribution and the research methodology followed are presented in Section 4 and Section 5 respectively. Section 6 concludes the paper.

2 Problem Definition

By process mediation we understand the action of overcoming the heterogeneity problems between two processes involved in a collaborative task (that is, one process is generating information needed by the other process). What this thesis is focusing on is finding technologies and developing tools that would allow two processes to interact, even if this interactions is not a straight-forward one.

Consider for example that one of the processes expects (from the environment) certain information in order to continue its execution. On the other hand, the other process is going to generate the needed information, but in different format, order, or in terms of a different ontology. As all the information needed by the first process exists, the process mediator will have to ensure that the data, as generated by the second process, is transformed in order to match the first process' needs.

3 State of the Art Overview

Process mediation is still a poorly explored research field, in the context of Semantic Web Services. The existing work represents only visions of mediator systems able to resolve in a (semi-) automatic manner the processes heterogeneity problems, without presenting sufficient details about their architectural elements. Still, these visions represent the starting points and valuable references for the future concrete implementations.

Two integration tools, Contivo[2] and CrossWorlds[3] seemed to be the most advanced ones in this field.

Contivo is an integration framework which uses metadata representing messages organized by semantically defined relationships. One of its functionalities is that it is able to generate transform code based on the semantic of the relationships between data elements, and to use this code for transforming the exchange messages. However, Contivo is limited by the use of a purpose-built vocabulary and of pre-configured data models and formats.

CrossWorlds is an IBM integration tool, meant to facilitate the B2B collaboration through business processes integration. It may be used to implement various e-business models, including enhanced intranets (improving operational efficiency within a business enterprize), extranets (facilitating electronic trading between a business and its

[2] http://www.contivo.com/

[3] http://www.sars.ws/hl4/ibm-crossworlds.html

suppliers) and virtual enterprizes (allowing enterprizes to link to outsourced parts). The draw-backs of this approach is that different applications need to implement different collaboration and connection modules, in order to interact. As a consequence, the integration of a new application can be done only with additional effort.

Important results are expected from a newly started European project, SUPER[4] which aims to enhance widely accepted business processes industrial standards with semantic, and to provide a comprehensive tools stack in order to support the entire life-cycle of semantically described business processes. It is exactly the outputs of this type of initiatives the process mediator designed in this thesis is able to act upon.

Through our approach we aim to provide dynamic mediation between various parties using WSMO for describing goals and Web Services. As described in this paper this is possible without relying on any hard-coded transformations.

4 Expected Contribution

The main expected results of the research carried out are as follows:

- formalization of a set of solvable mismatches - the process mediation can not aim at solving any type of mismatches that can occur during the inter-operation of two processes independently designed, but only of a sub-set; that is, some restriction have to be imposed, for example that all the needed information is provided;
- formalization of a set of unsolvable mismatches - this set is useful for determining in a timely manner whether two processes can not inter-operate;
- implementation of a prototype able to overcome the solvable mismatches.

The achievement of these goals will represent a step-forward for the process mediation from two perspectives: firstly, from the process representation perspective, none of the current approaches is addressing the semantically described process mediation, which considering the emergence of semantic technologies is nowadays an important aspect; secondly, this type of process mediation will boost the semantic Web service invocation technologies, as the automatic invocation of such a service is due to fail as soon as an inconsistency between the service's and the requestor's behavior occurs.

5 Research Methodology

The following steps need to be taken in solving the addressed problem: a)identification of solvable and unsolvable mismatches, b)formalization and resolution of the mismatches and c) prototype implementation. The focus of the research was so far in identifying an initial set of solvable and unsolvable mismatches, and in the development of a prototype able to cope with the solvable mismatches. On the other hand, formalizing the mismatches was not address yet, being still an important open issue.

[4] http://www.ip-super.org/

The first step in achieving the goals is the identification of solvable and unsolvable mismatches. Although in the beginning this identification was based strictly on theoretical assumptions and toy use-cases, the set has been extended based on the real use-cases obtained from several European and Austrian research projects [5].

A list containing the initial set of resolvable mismatches that the process mediator intends to address is provided below.

Stopping an unexpected message (Figure 1. a)): in case one process generates some information that the other one does not want to receive, the mediator should just retain and store it. This information can be send later, if needed, or it will just be deleted after the communication ends.

Inversing the order of messages (Figure 1. b)): in case one of the processes generates the information in a different order than the one the other process wants to receive. The messages that are not yet expected will be stored and sent when needed.

Splitting a message (Figure 1. c)): in case one of the processes sends in a single message multiple information and the other one expects to receive it in different messages.

Combining messages (Figure 1. d)): in case one of the processes expects a single message, containing information sent by the other one in multiple messages.

Sending a dummy acknowledgement (Figure 1. e)): in case one of the processes expects an acknowledgement for a certain message, and the other partner does not intend to send it, even if it receives the message.

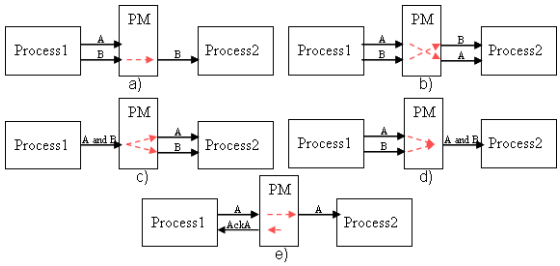

Fig. 1: Addresses Mismatches

Similarly, a set of unsolvable mismatches has been determined; due to space limitations they are not presented in this paper. For a detailed description of these unsolvable mismatches please see [1].

By combining several types of solvable mismatches previously presented more complex mismatches can be successfully solved. However, a combination of solvable mismatches with one or more unsolvable ones leads to more complex unsolvable mismatches.

A process mediation prototype able to cope with the solvable mismatches has been already developed. It is able o parse processes semantically described using Web Service Modeling Language (WSML[6]) and to deal with the heterogeneity problems previously presented. In case the two processes use different underlying ontologies the

[5] Two of the most illustrative projects from this point of view are SUPER and SemBiz

[6] http://www.wsmo.org/wsml

services of a data mediator for mapping between the ontologies (like the one described in [7]) are needed. A complete description of the algorithm implemented by this prototype, as well as its architecture is presented in [1].

6 Conclusions

This thesis is addressing the process mediation in a semantic environment. This is currently an important aspect, as the semantic description of services and service requests does not consist only of data expressed using ontologies, but also of semantically described processes. This thesis aims to develop a set of general methodologies for identifying and solving heterogeneity problems that may appear between semantically described processes.

A direct application is solving the heterogeneity problems that may occur during the invocation of a service, considering that both the invoker and the service have well defined interfaces defining their behaviors, and that they are not going to adjust these behaviors according to their conversation partner.

The prototype that is going to be delivered with this thesis implements dynamic techniques able to detect and overcome on the fly (during run-time) the mismatches existing between given semantically described processes.

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