Towards a Systematic Approach for Heterogeneous Web Service Messages

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Abstract. Establishing semantic interoperability between the heterogeneous messages of Web services has been a critical issue since the emergence of Web service. So far, many approaches that are aimed at solving semantic conflicts to achieve semantic interoperability of heterogeneous messages of Web service have been proposed. However, despite the significant contributions of the current approaches, semantic conflicts remain the critical problem that prevents exchanging the data between heterogeneous messages seamlessly. In this paper, we propose a new systematic approach to solve semantic conflicts of heterogeneous messages. The proposed approach revolves around three steps; semantic conflict identification, detection and solution.

Keywords: SOA, Web service, semantic conflicts, message-level conflicts, message-level mediation.

1 Introduction

Service oriented architecture (SOA) is a new paradigm that recently emerged as a logical way for designing systems to provide services; these services have published and discoverable interface [1-2]. Web services are currently the most promising SOA based implementation technology [2-4]. SOA using Web services is considered as the latest approach that aims at providing interoperability between heterogeneous systems [5].

Web services are built based on the concept of messages exchange. However, the process of exchanging the messages between Web services is always hampered by the heterogeneities that exist between heterogeneous messages. These heterogeneities result from using different meanings and representations of the same data. In practice, semantic conflicts may arise at two levels; ontology-level and message-level. Semantic conflict at ontology-level arises when the sender and receiver Web services are described into two different ontologies with different concepts. While semantic conflict at message-level is related to the actual implementation of the sender and receiver Web services. However, the focus of this paper is on solving message-level conflicts.

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Thus, establishing successful semantic interoperability between heterogeneous messages is not an easy task. This requires bringing the source and the target message into the meaning agreement. Meaning agreement means that the output of the source message and the input of the target message should agree about the meaning of the data that being exchanged between them. Despite Web service standards and technologies (e.g., WSDL, SOAP, UDDI, SAWSDL), semantic conflict is still far to be solved using these technologies, because these technologies ignore data semantics [6].

Considerable efforts have been done to solve semantic problem that arises between heterogeneous Web service messages such as [7-10]. So far, the problem of semantic interoperability between heterogeneous Web service messages has not been sufficiently and effectively addressed. Thus, this paper aims at proposing a new systematic approach for addressing this problem. The proposed approach includes semantic conflicts identification, detection and solution.

The rest of this paper is organized as follows. Section 2 briefly discusses semantic conflicts at message-level. Section 3 presents the proposed approach. Section 4 reviews some of the related works. Finally, section 5 concludes this paper and provides some suggestions on the future work.

2 Message-Level Conflicts

Web services are provided by different organizations using different techniques. Every organization has its own polices, strategies and vocabularies. From Web service providers' view, the same term is always interpreted differently by Web services [7]. Thus, message-level conflict is related to the Web service implementation itself. The main components of the message of Web service are schema and data.

Thus, message-level conflicts would arise in data-level and schema-level of the message. Data-level conflicts arise due to multiple interpretations and representations of the same data [11-12], while schema-level conflicts arise due to the multiple structures of the message schema. However, message sender and receiver should have agreed on the meaning of the data in advance before exchanging the message can take place. Thus, this condition is very important to be met to achieve semantic interoperability in Web services messages [13].

3 The Proposed Approach

In this section, we present our new systematic approach for achieving semantic interoperability between heterogeneous messages. The proposed approach has three main steps; semantic conflicts identification (classification), detection and solution. Figure 1 illustrates the logical flow of the proposed approach. However, due to space limitations, we briefly discussed these three steps:

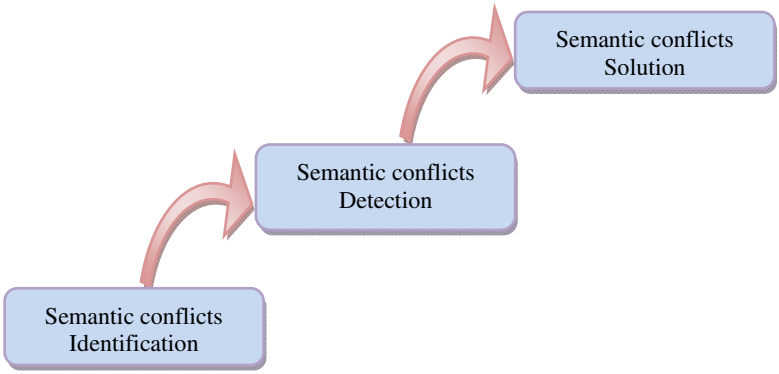

Fig. 1. The proposed systematic approach

Step 1: Semantic conflicts identification. Semantic conflicts identification is the process of identifying the likely conflicts that may arise between the heterogeneous messages under consideration. Semantic conflicts should be identified and categorized properly in the way that no contradiction between them. This is due to the fact that these conflicts play as the crucial seeds for the next steps (detection and solution), and the success of the next steps relies on the success of the semantic conflicts identification. Identifying these conflicts should be based on clear definition for each semantic conflicts, and then classify them accordingly.

Several considerable efforts have been proposed for identifying and classifying semantic conflicts in different domains, i.e., in heterogeneous databases [14-15], in heterogeneous XML data source [16], and in message-level heterogeneities of Web service [10]. In this context, we believe that identifying suitable classification for semantic conflicts is very important and useful to be used as a guideline for detecting and solving conflicts that occur between heterogeneous messages.

Moreover, such classification is helpful to divide the whole semantic conflicts problem into distinct sub-problems, which require relevant detectors and mediators. Unfortunately, this step is still done manually by the experts of the domain under consideration at design time.

Step 2: Semantic conflicts detection. The identified conflicts from the identification step should be automatically detected in this step. The main target of this step is to detect all identified conflicts at run time to facilitate the solution process. The semantic conflict classification that would be produced from the first step will be encoded, i.e., into rules at design time. Then these rules will be executed at run time to detect the conflicts at run time. In another hand, semantic conflict classification might be encoded into ontology at design time, and then this ontology will be used at run time as a key player for semantic conflicts detection, i.e. the work that has been done [17] in the area of database.

The result from the detection process is either detected or undetected conflict. Detected conflict means that the given conflicts from the identification step has been detected at run time and it will be forwarded to the next step (solution). Undetected

conflict means the detector was unable to detect the conflict that was identified in step 1. This is might be occurred due to inappropriate conflict identification or encoding. Therefore, we have to make sure that all identified conflicts are detected properly before forwarding them to the solution step.

Step 3: Semantic conflicts solution. In our proposed approach, semantic conflict solution is the process of solving all detected conflicts that are forwarded from the previous step (detection). In this respect, the process of facilitating exchanging the messages between heterogeneous Web services by solving message data and schema conflicts is called message-level mediation.

Message-mediation is used to solve semantic conflicts that arise between heterogeneous messages due to multiple interpretations and representations of the same data, and multiple structures of the message schema as well. Ontology is used as a key player in message-level mediation to provide semantics of the data that being mediated. Thus, the process of message-level mediation includes identifying the used ontology and specifying the mapping between the heterogeneous messages and the used ontology. Mappings are created between the elements of the output and input of Web services messages and the shared ontology [18] at design time. Two types of mappings are required to perform message-level mediation:

- Mapping the output message elements to the corresponding ontology concepts.
- Mapping the input message elements to the corresponding ontology concepts.

Once the required mappings are specified, the participating Web services can interoperate by using these mappings [10].

4 Related Works

Recently, there have been a significant number of approaches on handling semantic conflicts. In these approaches, the process of handling semantic conflicts is different from some approaches to another. On one hand, some approaches start with identifying (classifying) and end with solving semantic conflicts. Such as [10] proposed a solution for semantic conflicts at message level. Their solution involves around classifying semantic conflicts that occur at message level and then solving these conflicts using data mediation technique. However, they only focus on solving semantic conflicts at schema-level of the message. A solution for Web service federations was proposed in [19]. The process of the proposed solution involves around identifying and then solving message data level conflicts.

On another hand, some approaches handled semantic conflicts by detecting and solving semantic conflicts. Such as [6] proposed a technique to detect and reconcile semantic heterogeneity that arise only on message data-level during Web service composition. This approach involves the use of COIN ontology which as a lightweight ontology. The key idea for detecting semantic conflicts was based on extracting all modifiers of ontology concept, then comparing the modifiers values if

they are not equal that means context conflicts is thus determined. However, the correct interoperability in this approach is based on the modifiers availability of the ontology concepts [7].

Furthermore, some approaches focused only on the solution step. Such as, [18] proposed data mediation approach to solve message level heterogeneities by transforming the input and output messages to reference model. The transformation repository in their study is still lack of some transformation types, which means that some of semantic conflicts cannot be solved using their approach.

Another approach called context-based mediation was proposed in [7] for solving message data-level conflicts. Even though the problem of semantic conflicts has been addressed from different perspectives and using different strategies, the same problem remains as a challenge for establishing semantic interoperability between heterogeneous Web service messages.

To this end, we can see clearly the difference between the current approaches in terms of the solution process and the capability of solving the problem. Therefore, the steps of our systematic approach are structured in a logical way. This logical structure gives our approach the capability for solving semantic conflicts efficiently and effectively.

5 Conclusion

In this paper, we presented a new systematic approach for solving semantic conflicts of heterogeneous messages. This approach is revolves around three main steps semantic conflicts identification, detection and solution. Semantic conflict identification is the process of collecting and identifying the conflicts from the domain under consideration. Semantic conflict detection is the process of detecting the conflicts that have been identified in the first step. Semantic conflicts solution is the process of solving the conflicts that have been detected.

As future work, we aim at looking into the following issues. First, provide a specific semantic conflict classification, which capture all likely conflicts that may occur in Web service at message level. Second, implement semantic conflicts detector and resolver based on the given classification.

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