Towards Run-time Monitoring of Web Services Conformance to Business-Level Agreements

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Abstract. Web service behaviour is currently specified in a mixture of ways, often using methods that are only partially complete. These range from static functional specifications, based on interfaces in WSDL and preconditions in RIF, to business process simulations using executable process-based models such as BPEL, to detailed quality of service (QoS) agreements laid down in a service level agreement (SLA). This paper recognises that something similar to a SLA is required at the higher business level to govern the contract between service producers, brokers and consumers. We call this a business level agreement (BLA) and within this framework, seek to unify disparate aspects of functional specification, QoS and run-time verification. We propose that the method for validating a web service with respect to its advertised BLA should be based on run-time service monitoring. This paper reports progress towards defining these goals.

Key words: run-time verification, business-level agreements, QoS, Web services, Stream X-Machines

1 Business-Level Agreement

Web services enable the partial or complete outsourcing of business processes to different service providers. Each provider may provide a similar service with different behaviour, i.e. different functional or non-functional characteristics. Before the service provision the service provider and the service consumer will have to agree on the concrete behaviour of the service.

The functional characteristics concern the concrete implementation of the individual operations in a Web service and the allowed sequence of messages. For example how a payment is being handled and what are the preconditions for performing a payment. The non-functional characteristics concern quality attributes from a technical perspective such as accessibility, responsiveness and throughput, as well as quality attributes from a business perspective such as orders fulfilled in a day and payments handled per hour For the technical aspect of the service provisioning a service-level Agreement (SLA) is often established. For the business aspect, however, we believe that another type of agreement is required that captures both the functional and the non-functional business characteristics of the service provisioning.

Inspired from what already exists in the real business world, we call this new type of agreement a business-level agreement (BLA). Another inspiration for the term is [14], according to whom, the term BLA describes an agreement between two business partners who will be participating in business processes using Web services. To clarify the need and the contents of BLA, we discuss an example in the next paragraph.

In a pharmaceutical industry, pharmacies order the medical supplies from a pharmaceutical company. The pharmaceutical company uses a third-party logistics (3PL) provider to handle the inventory and the shipment of medical supplies. A pharmacy places an order using the OrderManagmentService provided by the pharmaceutical company. After the necessary validations and in order for the ordered items to be shipped to the pharmacy, the pharmaceutical company forwards the order to 3PL using the provided OrderFulfillmentService.

Both the pharmaceutical company and 3PL have signed BLA that states the following: (i) In the case that for a particular item, contained in the pharmacy's order, there is not enough reserve in the 3PL's warehouse, 3PL should not withhold the pharmacy's order, but partially execute the order by shipping the rest of the items, while at the same time 3PL should notify the pharmaceutical company for producing the item that is out of stock. Thus, the item that was not available remains as an outstanding order that will be fulfilled when the item will be available from the pharmaceutical company. (ii) 3PL should fulfil at least 5 orders for each pharmacy on a daily basis, and (iii) 3PL should complete the fulfilment of an order within 3 hours. It is evident that the first clause concerns the functional aspect in terms how 3PL should handle the fulfilment of an order, whereas the other two clauses concern the non-functional aspect in terms of time constraints that have to be respected to impose a specific quality level for the outsourced service.

2 Run-time Monitoring of Conformance to BLAs

A BLA serves as a contract between a service provider and a service consumer that describes the agreed functional and non-functional characteristics of a Web service. In order to assure conformance of the service to its BLA, there is a need to perform monitoring during the execution of a Web service for a number of reasons: (i) Dynamic changes/upgrades in implementation may unwittingly break previous contracts after testing is formally over; (ii) Conditions at run-time may introduce non-determinism (particularly when sharing resources) that requires monitoring and compensation at run-time; (iii) The existence of a conformance monitoring capability is a kind of guarantee for the consumer that redress is possible if the BLA is not honoured.

To support run-time monitoring, a BLA representation is required which allows to express both functional and non-functional characteristics in a machine-readable way. This representation should be abstract enough to hide the actual implementation of a service, while exposing the steps, rules and dependencies that comprise the workflow of a business process, together with the qualitative characteristic of this workflow. Additionally, it should be complementary and separated from existing descriptions for Web services.

For addressing the verification of functional characteristics we use the method presented in [15], which employs the Stream X-Machines (SXM) formalism [16] for modelling the Web services. The animation of the SXM model is supported by the JSXM tool [17] and serves as an oracle for the run-time monitoring of the service. For implementing a prototype of the run-time infrastructure for verifying the conformance of Web service to BLA, we use the JBoss application server for the deployment of Web services. We use SOAP message handlers provided in JAX-WS API [18] for intercepting SOAP messages. Handlers are classes that act as pre-processors and post-processors of these messages. A handler forwards the SOAP request/response messages to an external monitoring component. The monitoring component is a Web service itself, which abstracts the forwarded messages through transformations to SXM inputs/outputs, and then it uses these perform animation of the SXM with the JSXM tool.

The run-time conformance monitoring of Web service to BLA has been inspired by the fragmented work that exists for the run-time monitoring of Web services. For instance, [1–4] address the run-time monitoring of functional characteristics of composed Web services, as well as for individual services [5–8]. Additionally, there are existing methodologies for verifying the non-functional characteristics of atomic Web services [9, 10], and approaches concerning composed services [11, 12]. Each of the aforementioned works manage to solve a small fragment of the problem, and it is therefore suggested to combine the existing approaches, in order to tackle more complex monitoring of Web services [13].

3 Future Work

As future work we plan to devise an abstract and machine-readable representation for BLAs, which will be able to express both functional and non-functional characteristics of a service at business level. Furthermore, while the SXM approach can address the verification of the functional aspect of a BLA, the great amount of monitoring methods available inspires us to consider an open architecture, which will facilitate the utilization of different monitoring methods under a common framework.

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