On the Need for Dependability Research on Service Oriented Systems*

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Abstract

Web services (WS) — the most prominent technology for realizing service oriented architectures — are broadly pushed by vendors and are likely to be deployed in dependability demanding areas such as air traffic control, health care, or transportation in the near future. However, although a plethora of WS standards exists, only few of them address dependability, namely specifications for transactions and reliable messaging. In addition, some research (but not standardization) efforts have been spent on other dependability techniques such as replication. However, most of this work is only appropriate in homogeneous settings but is insufficient for systems of the future characterized by massive scale and heterogeneity. Thus, in this paper we shortly discuss existing WS dependability standards and identify missing dependability specifications. Our aim is to encourage the DSN community to focus some of their research efforts on dependability of service oriented systems.

1. Introduction

The paradigm of service oriented computing allows to build large scale, complex systems in heterogenous environments by composition of basic services which encapsulate their business logic behind well-defined interfaces and are loosely coupled. The success of service oriented architectures is among others caused by standardization efforts of both (commercial) software vendors and academia. Today, WS are the most widely used technology to realize service oriented architectures. The core specifications for WS — which are broadly supported by vendor products — are SOAP [12] and WSDL (WS Description Language [12]). SOAP is an XML-based messaging protocol for communication across heterogeneous environments and WSDL is used to describe the functionality of WS.

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WS standards bodies are OASIS (Organization for the Advancement of of Structured Information Standards [8]), W3C (World Wide Web Consortium [12]), WS-I (WS Interoperability Organization [13]), and IETF (Internet Engineering Task Force [5]). As of Q1 2007, InnoQ [4] lists more than seventy WS standards/specifications focusing on issues such as messaging, interoperability, management, business processes, metadata, resource access, presentation, security, reliability, and transactions. Unfortunately, although such a large number of (sometimes contradictory) specifications exists, only few of them address dependability. Consequently, specifications for failure detection, membership monitoring, reliable multicast, and replication in (Web) service-based environments are still missing, although they are required if dependability shall be ensured in service oriented architectures of the future characterized by massive scale and heterogeneity.

2. Web service dependability standards

Transactions: The WS coordination framework (WS–Coordination [8]) provides a foundation layer for consensus between WS, where specific consensus protocols can be built upon, e.g. distributed transactions. Two particular specifications build upon the WS-Coordination framework: WS-AtomicTransaction [8] for short running ACID transactions and WS-BusinessActivity [8] for long running transactions with weaker guarantees for atomicity and isolation.

The WS Composite Application Framework (WS-CAF [8]) is a competing set of specifications comprising WS Context (WS-CTX), WS Coordination Framework (WS-CF), and WS Transaction Management (WS-TXM). Within the latter, three kinds of transaction models are supported: ACID transactions, long running transactions, and business transactions.

Reliable messaging: WS-Reliability [8] specifies a SOAP-based protocol for reliable message delivery with at-least-once, at-most-once, and exactly-once semantics. The first option guarantees that a message is delivered, the second one that duplicates are eliminated, and the third one combines both requirements. Moreover, an ordering con-

straint can also be imposed on a group of messages. That is, a sequence of messages sent is delivered in the same order at the receiver (FIFO ordering).

WS-ReliableMessaging [8] is a competing specification providing similar reliability guarantees.

3. Required research

While dependability is well understood in traditional critical systems [1], new research is required to face the challenges of heterogeneity, massive scale, and mobility. Finally, standardization efforts are necessary to deploy the results for service oriented architectures, in particular:

Failure detection and membership management: As Birman [2] points out, failure detection and agreement on membership is essential for dependable distributed systems. That is, services need to be monitored and interested nodes need to be informed on the current membership status. Traditionally, this has been achieved by group membership services which build upon some kind of failure detector.

Vogels and Re [11] proposed WS-Membership, a framework based on WS-Coordination [8] for monitoring of WS and provision of membership information. Unfortunately, the proposed framework has not be standardized and seems to have ceased to exist. Nevertheless, a standard for failure detection and membership monitoring would be highly beneficial for WS based environments due the inherent heterogeneity of such systems.

Reliable communication: So far, specifications for reliable message delivery between a sender and a receiver exist. However, many distributed algorithms for fault tolerance techniques such as replication require reliable multicast with configurable ordering guarantees. Again, if such multicast protocols are to be deployed in a heterogenous setting, standardization would be highly beneficial.

Replication: Several WS replication frameworks (e.g. [10]) have been proposed but none of the approaches has been standardized. One of the reasons for this is that replication is hardly applied across administrational boundaries today. Thus, replicas of a certain service can reside in a homogenous environment and replication middleware can be optimized for a certain kind of WS technology. Therefore, today's replication frameworks for WS can reuse many of the concepts of traditional (homogenous) replication frameworks used in distributed object systems or database systems as we have argued in previous work [9]. We anticipate systems of the future such as ultra-large-scale systems will require additional research and standardization effort if replication in a "true" service oriented manner — especially with respect to heterogeneity, scale, and mobility — is required.

4. Related work

Moser et al. [7] discuss how fault tolerance techniques can be applied to components of a service oriented architecture. As we do, Birman [3] stresses the importance for more research on dependable service oriented architectures, including data replication in such settings. In contrast to us, these researchers are argumenting on a more general level and do not identify the need for particular WS standards.

5. Conclusion

Currently, only some progress has been made to make service oriented architectures highly dependable as it is required for critical systems such as air traffic control. WS standards for reliable point to point message delivery and transactions are the most notable efforts so far. However, standards for other dependability mechanisms such as failure detection, membership monitoring, reliable multicast, or replication have not even been proposed although they are highly beneficial if these techniques shall be applied in large scale, heterogeneous service oriented environments. Thus, we encourage the DSN community to take a look at the problems the service oriented community is currently facing and help to close the dependability gap [6].

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