A Reputation-based Trust Aware Web Service Interaction Pattern for Manufacturing Grids

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Abstract

Background

Integrated service systems such as service oriented Manufacturing Grids have become new promising paradigms for enterprises distributed computing and application integration. In such environments, service providers and consumers come together to participate in service engagements in an autonomous way and thus trust problems arise. A lot of research work has been done on the theories and applications of trust and reputation management in this filed. However, the design expertise on trust aware service systems is not well documented yet. And it is not a trivial task for designers and programmers to guarantee trust in such open distributed systems.

Method

In this paper we propose to use a reputation-based trust aware service interaction pattern to represent reusable ways of interactions between service providers and consumers to solve trust problems.

Results

The main benefit of using trust patterns is that it decouples the application domain expertise from the trust expertise.

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Conclusions

Trust aware service interaction patterns are novel and efficient approach for documenting solutions for trust problems in integrated service systems. And the proposed reputation-based trust aware service interaction pattern improves modularity and reusability and can help service designers and users to solve trust problem effectively.

Keyword: Manufacturing Grids, Trust, Reputation, Service Interaction Pattern.

I. Introduction

Service Oriented Architecture (SOA) [1] has become a new promising paradigm for distributed computing. Web Service technologies are an attempt to define the building blocks for building loosely coupled, distributed applications, based on the SOA principles. A web service is a specific kind of service that is identified by a URI and utilizes open Internet standard for service description and transport. Since services may be offered by different enterprises, they provide a distributed computing infrastructure for both intra and cross-enterprise application integration and collaboration. Manufacturing Grids are such infrastructures enabling the integration and collaboration between manufacturing enterprises.

In such large integrated service systems, service consumers use services offered by providers to accomplish their task. Service providers publish their service function descriptions by which service consumers can find services. At this time, service providers are supposed, but not obliged, to deliver services in an expected quality as advertised. Thus, trust problems arise, i.e., deciding whether a service encountered can be trusted to serve the consumer's request up to a certain standard [2].

One important factor in trust decisions is a service's reputation, derived from the information about its past behavior. The most reliable reputation information can be derived from a consumer's own experience. However, much more data becomes available when reputation information is shared among a community. A larger number of reputation reports allows a better estimation of reputation information and reduces the occurrence of errors in reporting. Reputation systems provide a way for

entities to be able to trust other entities [3]. And during the past few decades, the field of trust has experienced rapid growth. There is a large pool of recent literature on the theories and applications of trust and reputation management for integrated service systems, such as service-oriented grids, service clouds, and so on. However, design expertise on trust is not well documented yet. We propose to use trust service interaction pattern as a solution for this problem.

Design patterns represent a method for presenting solutions to problems in a way that enables the reuse of existing proven design expertise. The purpose of a pattern, or set of patterns, is to capture this design expertise in a form that people can use effectively. Design patterns by Gamma et al. [4], software patterns and pattern languages have gained wide acceptance in the field of software development, because they provide a systematic reuse strategy for design knowledge [5]. Trust patterns presented in this paper represent solutions that integrate trust into applications in the context of service systems. Since applications have become increasingly complex and because the design of trustworthy systems necessitates some kind of trust expertise, we believe that patterns are a good solution to effectively convey trust concepts in analysis and design for trustworthy applications.

This paper first presents the reputation-based trust aware service pattern for documenting proven design expertise of solving service provision trust problems. Section III gives a usage scenario of the proposed service interaction pattern. Section IV gives an overview of the related research and Section V concludes the paper with possible future research directions.

II. The Reputation-based Trust Aware Service Interaction Pattern

The basic idea of reputation systems is to let parties rate each other after the completion of an interaction, and use the aggregated ratings about a given party to derive a trust or reputation score, which can assist others in deciding whether or not to trust that entity in the future [3]. In a typical reputation system, ratings about current interactions are captured, distributed and aggregated, thus giving rise to the concept of reputation. The goal of reputation systems in integrated service systems is to encourage trustworthiness in service transactions by using past behavior as a publicly available

predictor of likely future behavior. Reputation enables consumers to choose the best providers in the system. In this section we propose a reputation-based trust aware service interaction pattern which was captured from our own experience of designing trust aware service oriented Manufacturing Grids.

The Reputation-based Trust Aware Service Interaction Pattern

Name: The Reputation-based Trust Aware Service Interaction Pattern.

Context: In integrated services systems, autonomous service providers publish service functions as well as the advertised quality of service (QoS) through the Service Registry. Service consumers look up the Service Registry to get available services and their descriptions including QoS.

Problem: The consumer cannot easily predict the QoS that a given service instance will deliver. That is partly because the consumer may not be able to trust the service or its providers.

Solution: Use a mediator who will provide a reputation service, by soliciting ratings from service requesters and computing provider's reputation based on these ratings.

Structure: As shown in Figure 1, the reputation service is composed of three subsystems.

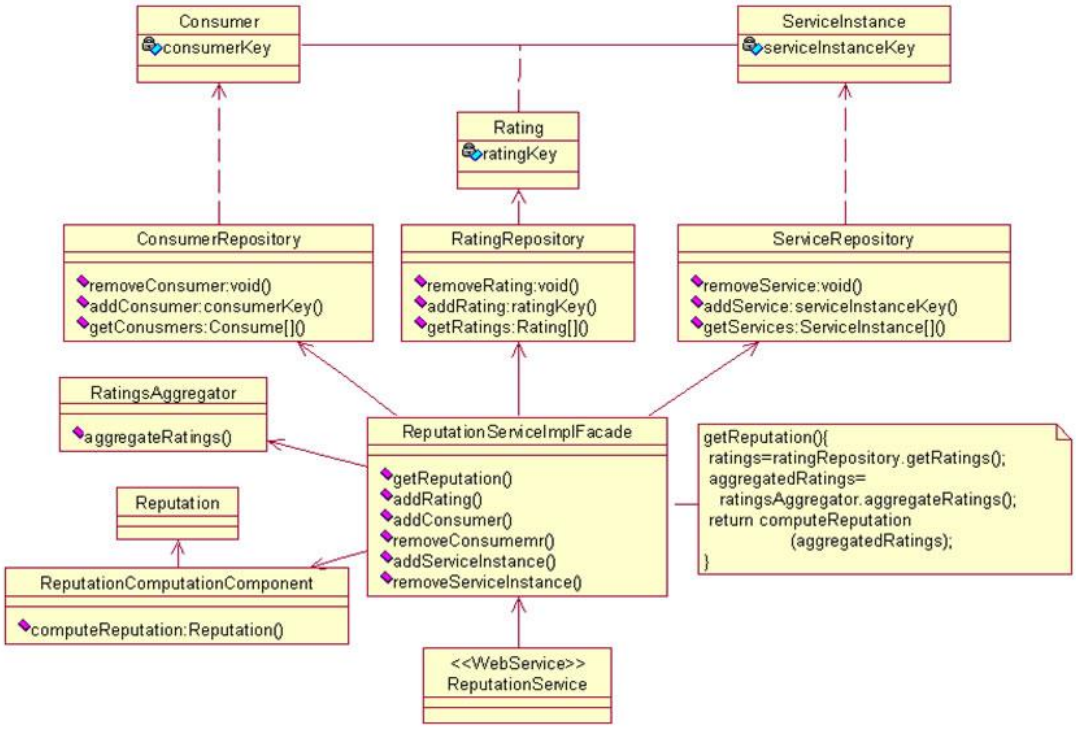

Figure 1 Class diagram of a reputation service

Dynamics: 1.The service provider registers with the mediator providing reputation services.

2. The consumer sends a service request to the provider.

3. The provider notifies the mediator of his service engagement with the consumer.

4. The mediator sends request for the consumer's rating of the service provided by the provider.

5. After service engagement with the provider, the consumer informs the mediator to give a rating for the service provided by the provider.

Implementation:

1. The mediator implements a reputation service.

2. Service providers and consumers implement their own service invocation interfaces.

Consequences: For the mediator**,** the reputation service pattern improves the modularity and reusability.

III. Usage Scenario

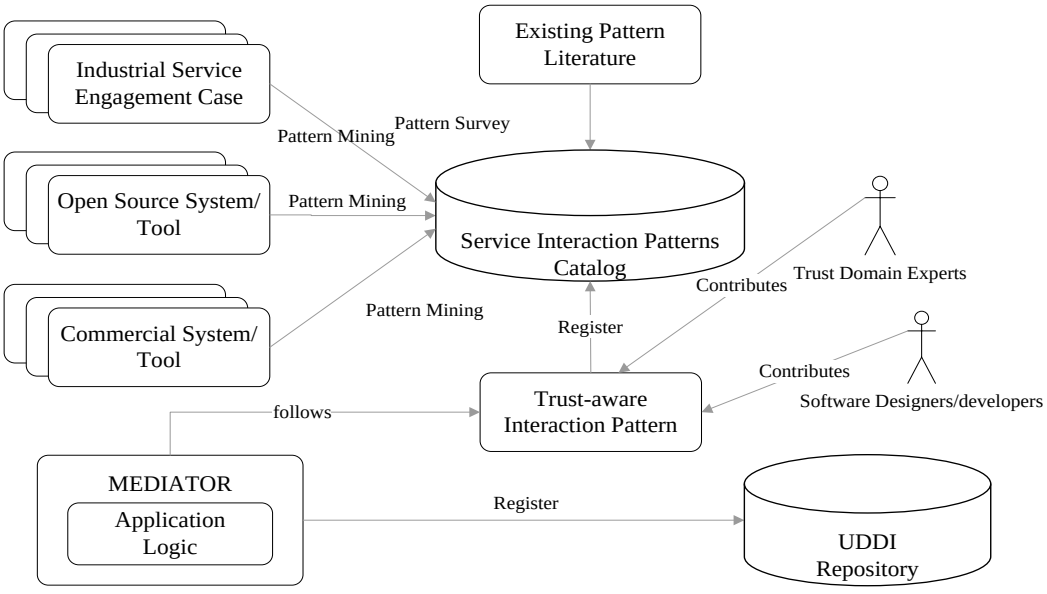

Figure 3 A usage scenario

Here, we show how our service interaction pattern can be used to guide Web service designers and developers to participate an open and integrated service system. Fig. 3 summarizes our methodology with a scenario involving a mediator interested in trust-aware service engagement mediation. Mining from the existing work and research and combining expertise of software designers and

implementers and trust domain expert, trust pattern has been specified and published to the Service Interaction Pattern repository. Then a service mediator looks up Trust aware Interaction Pattern in a pattern repository and implements the reputation service following the pattern description, with its own application logic including models and algorithms to compute a provider's reputation based on all ratings solicited from previous service consumers. And then the mediator publishes the reputation service to a UDDI registry. If a service provider wishes to provide service under trust-aware mediation, it searches the UDDI registry, finds the mediator and registers with the mediator so that a service consumer can request the service under the mediation of the reputation service provided by the mediator.

IV. Related Work

Recently, pattern-based approaches have been proposed for service oriented applications. The authors of [6] introduce a survey of technology-independent patterns that are relevant for SOAs. The authors of [7] propose architectural design patterns for service composition. Their work solves the low level problems for service oriented systems such as service synchronization, service composition and etc. To the best of our knowledge, no work on trust aware service interaction patterns has been published yet. However, there are two papers on trust patterns not under context of service oriented environments. The authors of [8] propose patterns of trust in ubiquitous computing environments. The authors of [9] propose the trust stable analysis pattern to provide a conceptual model. Compared with our work, both of these two papers focus on the abstract aspects of trust, and trust service design issues are not covered.

V. Conclusion

In this paper we discuss what trust pattern is and why we need trust patterns. And we propose a reputation-based trust aware service interaction pattern, which covers both conceptual and technical design aspects of a reputation service and solves the service provision trust problems for service

engagements in integrated service systems such Manufacturing Grids. The proposed trust aware service interaction pattern improves modularity and reusability. In subsequent work, we plan to complement the proposed pattern by solving other trust problems in service oriented environments and at last arrive at a methodology for trust aware integrated service systems.

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