Challenges of Business Service Monitoring in the Internet of Services

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ABSTRACT

The most industrialized countries have entered a post-industrial era where their prosperity is largely created through a service economy. There is a clear transition from a manufacturing based economy to a service based economy. In the Internet of Services (IoS) vision services are seen as tradable goods. Business services are one major asset in this context. Since they are inherently different from e.g. web services, we argue that there is a need for a specialized monitoring approach. In this paper we describe the differences between technical services and business services and discuss a number of challenges regarding their monitoring requirements.

Keywords

Business service, monitoring, Internet of Service, Web services, e-services and marketplaces.

1. INTRODUCTION

Enterprise service applications are currently experiencing a shift towards service-oriented architectures (SOA) where services are viewed as building blocks for applications. The vision of the IoS [16] takes services to the next level by making them available as tradable goods via the internet [3]. Such services are not limited to Web services but also include business services. A business service is a business activity provided by a provider to a consumer to create a value for the consumer. In traditional economies, business services are typically discovered, selected, and invoked manually, but their realization maybe performed by automated or manual means [5]. While business services are accessible via the internet in the IoS vision they are often executed manually in the real world [6].

One important challenge of the IoS is the monitoring of services based on service-level agreements (SLA). Traditional service monitoring approaches focus on quality of service (QoS) attributes [13, 10]. For business services this is not sufficient. It is also important to considere business level aspects.

In this paper we discuss the specific attributes of business services and present an approach to describing technical as well as business aspects of services. Finally, we discuss requirements for business service monitoring and identify a number of research questions to be addressed in the future.

2. WHY SERVICE MONITORING IS A HARD UNDERTAKING?

Services currently govern economies and will unquestionably become even more significant in the near future. This trend is supported by the launch of a proposal for a Directive on Services in the Internal Market [2] from the European Commission. The proposal aims to increase the market share of services by reducing regulation-based barriers to trade.

While monitoring IT services (such as WSDL or REST Web services) is usually seen mainly as a technological problem, the monitoring of business services adds the requirement of also monitoring business aspects. Monitoring IT services usually targets to measure network attributes such as latency, packet loss, throughput, link utilization, availability [8] and connectivity, one-way delay, one-way packet loss, round trip delay, delay variation, and bulk transfer capacity [9]. Moser et al. [13] recognize that Web services currently lack monitoring mechanisms and they provide a solution based on the interception of SOAP messages exchanged during runtime. The emphasis is on technical aspects. On the other hand, the monitoring of business services can only achieve its full potential when it addresses the business level and accounts for organizations' strategies. Compared to IT monitoring, business monitoring is more complex since services are intangible, often inseparable, immersive, and bipolar.

1. Intangible. Services are intangible since they do not have material existence. As a result, it is difficult to create suitable standards to model them and to define attributes to objectively measure them. *What are the fundamental aspects and characteristics of business services that need or can be monitored?*

2. Inseparable. The execution and consumption of services occurs frequently in parallel. This implies that a

rigorous match between supply and demand must be achieved. Otherwise, services are "lost" or consumers are queued and need to wait for service availability [14]. *How can monitoring provide mechanisms to dynamically detect an unbalanced match between supply and demand?*

3. Immersive. Services are often executed in collaboration with consumers. This implies that in many cases it is difficult to determine the parties responsible for the degree of success or failure of a service. *When distributed services are managed and invoked using process models and involve suppliers and consumers, how can the outcome and performance of each party be monitored and accessed?*

4. Bipolar. Services are often executed by a blend of human and technological resources. While techniques to monitor purely technological resources are already available, solutions to monitor human involvement in services' execution and the complex relationship between the human and technological dimensions has not been studied in the context of business services. *How to create universal monitoring mechanisms that account for the individual monitoring of technological resources with the individual monitoring of human resources?*

These characteristics and requirements bring a new set of challenges for the monitoring of business services. In order to better understand the important monitoring aspects that need to be considered for the IoS, ITIL [11] recommendations provide a set of best practices for monitoring services effectively. They include service level management, availability management, capacity management, financial management, and service continuity management. The multi-level management proposed by ITIL brings a set of requirements that needs to be fulfilled by business service monitoring. For example, there is the need to monitor the performance of business processes and their functions and the need to understand the impact of service disruptions in business strategies. This reveals to be a challenge since different business services may use the same infrastructure making it difficult to understand their impact on workloads and making it difficult to track service resource usage. This problem is accentuated since business services are bipolar. While ITIL is a good starting point to understand services, it is fundamental to study how the most relevant characteristics and particularities of services can be abstracted and modeled formally. Such an abstraction will enable the formalization and normalization of the intangible, inseparable, immersive, and bipolar nature of services. Furthermore, monitoring needs to account for, not only technical aspects, but most importantly business aspects, since business services are distinct from Web services due to their intrinsic business nature. Therefore, one of the first steps is to develop a conceptual structure to model business services. Such a model should be comprised of business related aspects such as pricing and legal aspects as well as technical aspects such as QoS to support the technical relization of business services in the IoS. In the next chapter we will describe our model for service description.

3. THE SERVICE DESCRIPTION FRAMEWORK

The first step to enable the development of technological infrastructures to monitor business services for the IoS is to study how the most relevant characteristics and particularities of business services can be abstracted and formally modeled. Such an abstraction will enable the formalization and normalization of the intangible, inseparable, immersive, and bipolar nature of real-world services. Therefore, this section presents a conceptual structure to model business services.

The service description framework is a result from a literature research including the following work: (1) PAS 1018 [12], (2) IEEE 830:1998 [17], (3) O'Sullivan's service properties [15], (4) Dublin Core Elements [1], and (5) QoS taxonomy [4]. Due to limited space, these approaches are not discussed any further.

For a better understanding and reduction of complexity, similar properties are grouped into facets. Figure 1 depicts the nine service facets. Each attribute applies to a specific type or metric, which is not shown here.

General Information covers the self-evident attributes of a service such as *Title*, *Identifier*, *Creator*, *Provider*, *Dates*, and *Version*.

Functionality provides the service consumer with an understanding of what can be expect from the service. Attributes include *Functions*, *Classifications* such as eCl@ss, and *Benefits*.

Business comprises monetary and marketing related attributes. These include the *Price* of a service, available *Payment* methods and *Discounts*, and the *Delivery Unit* stating how services are packaged and provided to service consumers (e.g. single use, monthly fee).

Service Interaction covers attributes describing agents' interactions with services. *User Interface* describes graphical form elements to interact with a human agent. *Message Exchange Pattern* depicts the interchange of messages between two agents. *Protocol* refers to the protocol to be used to access the service's functionality.

Legal groups lawfulness attributes stating services' terms of use. *Right* states what service consumers and providers are allowed to do with respect to the service. *Obligation* states the commitment of involved parties. *Penalty* implies a reparation imposed on any party in the case of violating obligations or rights.

Security and Trust. Security measures ensure the confidentiality and integrity of information and processes. Attributes include *Authentication* and *Encryption*. Trust is concerned with a service's overall reputation and is represented by *Escrow*, and *Insurance of Payment*.

Rating reflects opinions on services' performance from other parties. Attributes include *Community Rating*, *Expert Test Rating*, and *Certifications*.

Data groups information with respect to which *Business Objects* (representation of entities from the business domain with well-defined business semantics; e.g. Sales Order) are either manipulated by the service or need to be provided by service consumers as well as *Documentation* about the service.

Quality of Service describes services' dependability and performance. *Response Time* describes the service's ability to respond to a service request within a specified time

frame. *Capacity* describes how many requests the service can execute during a certain interval without degradation of the response time. The *Availability* of a service describes in how far a service is available for provisioning while *Reliability* states in how far a service provides its work in the expected way over time.

4. MONITORING IN THE INTERNET OF SERVICES

Monitoring service execution helps to ensure that promised service quality as well as consumer and provider obligations are met. To achieve that it is important to understand the goals of the different stakeholders (consumers, providers, marketplace provider) involved in the process and to solve some technical challenges that arise.

4.1 Goals

The service consumer wants to receive the guaranteed quality. Violation of these guarantees might jeopardise his business goals. The early detection of problems helps to reduce the negative impact. In some cases consumers may be able to claim the payment of penalties.

The service provider needs to ensure that the guaranteed SLAs are met in order to avoid the payment of penalties. The early identification of problems is a critical success factor. There is also an interest for optimizing the infrastructure for service provisioning [7] to avoid constant overfulfillment of SLAs.

The marketplace provider needs to ensure the high quality of service delivery in order to sustain a good reputation of the platform. Furthermore, monitoring results of the platform or another trusted party can serve as a base for for settling conflicts. They occur when parties disagree regarding the violation of an SLA.

4.2 Challenges

In section 2 we discussed the differences between IT services and business services which imply the need for a monitoring approach specifically taylored to business services. We identified a number of challenges of high relevance within this domain.

- **Business level monitoring:** Recent approaches to service monitoring mainly target the technical level of services, namely QoS parameters such as response time and availability [13]. Besides that there is a need for monitoring business aspects. Once there is a clear understanding regarding which parameters are relevant for monitoring at technical and business level (see Figure 1) and what is their relationship, a mapping between the parameters at both levels would be the base for automatizing the monitoring process by deriving business parameters from technical monitoring results.

- **Approach to business level monitoring:** There are mainly three different approaches to service monitoring: consumer-side monitoring, provider-side monitoring, and third-party monitoring. The disadvantage of consumer- and provider-side monitoring is that in the case of problems neither side will trust the respective other one. Third party monitoring (e.g. service market place) is one approach to tackle this issue. One drawback of this approach is the resulting bottleneck when all calls have to be intercepted by this entity. In order to avoid this one could monitor only a limited number of service calls, leading to a reduced accuracy of the results.

  In [10] a monitoring approach is presented based on consumer feedback and result validation by a trusted party. The approach requires a number of consumers to use the same service during the same timeslot under the same SLA in order to be able to do the evaluation. This assumption cannot be made in the IoS where each consumer negotiates his SLA individually and the number of concurrent service consumers might be limited. Thus, it is important to develope a suitable monitoring approach which takes care of the trust issue between service consumers and providers, is scalable to a large number of service requests while being accurate enough to handle potential conflicts, and which is flexible enough to be applicable in the dynamic context of the IoS.

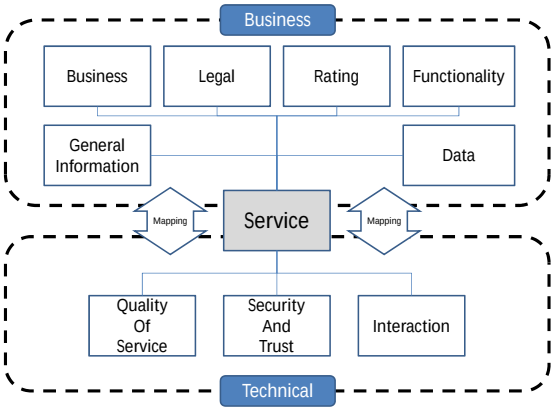

Figure 1: Business and IT aspects of services.

- **Access to monitoring data:** Another major question is to determine who needs access to which monitoring information and when. Both, service consumer and provider have a need to determine cause and responsibility of failures. At the same time it is important to keep business processes which underly service calls confidential. Thus, there is an need for a mechanism to assure that monitoring goals can be met while confidentiality regarding business information is preserved.

5. SUMMARY AND OUTLOOK

In this paper we have described the properties of business services and presented an approach for describing them. Furthermore, we have discussed the problem of monitoring and identified a number of challenges to be addressed in the future.

We are currently developing a toolset for creating services and an infrastructure for their execution and monitoring. Further research will be necessary to resolve the challenges presented in section 4 and to integrate our findings into our toolset and infrastructure.

6. ACKNOWLEDGMENTS

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