



Research challenges in legal-rule and QoS-aware cloud service brokerage



Emiliano Casalicchio^{a,*}, Valeria Cardellini^b, Gianluca Interino^b, Monica Palmirani^c

^a DIDD, Blekinge Institute of Technology, Sweden

^b DICII, University of Rome Tor Vergata, Italy

^c CIRFID, University of Bologna, Italy

HIGHLIGHTS

- The problem of Legal-rule aware and QoS-aware cloud service brokerage is defined.
- The detailed design of the cloud service broker is presented.
- Broker's design choices and supporting technologies are presented.
- Research challenges are explored.

ARTICLE INFO

Article history:

Received 8 April 2016

Received in revised form

19 October 2016

Accepted 21 November 2016

Available online 2 December 2016

Keywords:

Cloud computing

Autonomic computing

Legislation compliance checking

Optimization

Quality of service

Monitoring

Service migration

Service portability

ABSTRACT

The ICT industry and specifically critical sectors, such as healthcare, transportation, energy and government, require as mandatory the compliance of ICT systems and services with legislation and regulation, as well as with standards. In the era of cloud computing, this compliance management issue is exacerbated by the distributed nature of the system and by the limited control that customers have on the services. Today, the cloud industry is aware of this problem (as evidenced by the compliance program of many cloud service providers), and the research community is addressing the many facets of the legal-rule compliance checking and quality assurance problem.

Cloud service brokerage plays an important role in legislation compliance and QoS management of cloud services. In this paper we discuss our experience in designing a legal-rule and QoS-aware cloud service broker, and we explore related research issues. Specifically we provide three main contributions to the literature: first, we describe the detailed design architecture of the legal-rule and QoS-aware broker. Second, we discuss our design choices which rely on the state of the art solutions available in literature. We cover four main research areas: cloud broker service deployment, seamless cloud service migration, cloud service monitoring, and legal rule compliance checking. Finally, from the literature review in these research areas, we identify and discuss research challenges.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

In the ICT industry service providers, developers and integrators as well as customers should be aware that law and regulation introduce functional and non-functional constraints that must be

included by-design inside the systems and maintained during their operation. In the era of cloud computing, and specifically in a public cloud scenario, this compliance management issue is exacerbated, because the customer essentially outsources data processing and storage to service providers that could be non-compliant with the customer legislation (e.g., as regards data protection).

An important role in law/regulation compliance management of cloud services can be played by a cloud broker [1–3] that works as an intermediary in the service procurement process and as a third party controller during the whole service life cycle. The broker should provide services to both customers and cloud service providers, for example: discovery of services compliant with law and Service Level Agreements (SLAs); run-time monitoring of

* Corresponding author.

E-mail addresses: emiliano.casalicchio@bth.se (E. Casalicchio), cardellini@ing.uniroma2.it (V. Cardellini), gianluca.interino@gmail.com (G. Interino), monica.palmirani@unibo.it (M. Palmirani).

¹ Part of this research was carried out when Emiliano Casalicchio was at DICII, University of Rome Tor Vergata.

service level metrics; monitoring of legislation changes; law and QoS compliance checking during the service on-boarding phase and, at run-time, during the service evolution phase; aggregation, composition, optimization, orchestration of cloud services.

In this paper we describe the detailed design of a legal-rule aware cloud service broker in the framework of the Cloud for Europe initiative [4], and we extensively discuss the emerged design and research challenges. Specifically, we focus on four of the most demanding functionalities of the broker, which we refer to also as *design challenges*, and that are:

- **F1—Legal-rule compliance checking** is the broker capability of verifying (off-line and at run-time) that cloud service providers and cloud services are compliant with a legal framework, also as a mix of different supra-national or national legislations. An example of a tool to check cloud service law compliance is described in [5]. The legal-rule compliance must be monitored during the service on-boarding phase as well as at run-time, during the service evolution phase.
- **F2—Legislation dynamic management** is the broker capability of dynamically tracking changes in legislation or changes in service features that may bring to a violation of the legal requirements.
- **F3—QoS monitoring** is the broker capability of monitoring and analyzing QoS metrics. The monitoring is functional both to check legal compliance and to verify that SLAs are guaranteed. The monitoring mechanism provided by a broker must be scalable to cope with a huge amount of data coming from many service instances.
- **F4—Seamless service migration** refers to the ability to define and deploy a cloud service migration plan for the involved services, minimizing the service downtime. Seamless service migration relies on standard data formats and platform-independent computing environments.

An important pillar for both the F3—QoS monitoring, and F4—seamless service migration, is the deployment model of cloud services and the related technologies, as we will discuss later in this paper.

Functionalities F1–F4 are strictly inter-dependent, as represented in Fig. 1. Legal rules influence the service level objectives included in the SLA, the functional requirements (e.g., service migration toward another service provider to prevent vendor lock-in) and the structure of the processes behind the service implementation. Therefore, F1 influences the SLA metrics and the monitoring procedures (F3). On its turn, monitoring of QoS metrics (F3) is not only fundamental for guaranteeing SLAs, but it also takes part in the dynamic management of legislation compliance (F2). Finally, seamless service migration (F4) requires QoS monitoring (F3) and legal-rule compliance checking (F1) support from the broker.

Hence, the need arises for an integrated framework capable to offer these functionalities and to address the related research issues in an intertwined and integrated manner.

1.1. Research contributions

In literature many research works have focused on cloud service brokerage by addressing different issues, such as interoperability [6,7], service discovery and matching [8], quality assurance and optimization [7,9–12], and legislation compliance [13]. However, those works address only one issue at a time, while only our previous works [3,14] and this paper jointly address within a unified framework the design of a broker that integrates the functionalities F1–F4.

This paper contributes to the literature as follows:

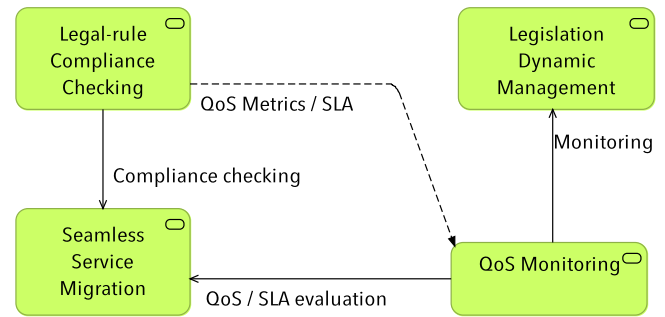


Fig. 1. Dependencies among the broker's components implementing functionalities F1–F4.

- We provide a more detailed design architecture of the broker initially proposed in [3]. The architecture proposed in our previous research has been largely extended and improved.
- We discuss our broker implementation choices selected from the state of the art solutions available in literature. We do not only address F1–F4, but we also focus on the mechanisms and technologies for the service deployment, which are functional to F3 and F4.
- We review the literature and we identify and discuss research challenges in the following areas: cloud broker service deployment, seamless cloud service migration, cloud service monitoring, and legal rule compliance checking.

Our main findings are: we strongly recommend a broker which plays an active role in the service deployment. We suggest to use container technologies supported by TOSCA-based orchestration tools to cope with portability and provide seamless service migration. TOSCA, Docker, Cloudify and Kubernetes are examples of standards and technologies for service portability, but they are still not mature and the landscape is still fragmented. Monitoring of containers, assessment of scalability and elasticity, and evaluation of consistency in Cloud data storages are three challenges in QoS monitoring, which is functional to QoS assessment. Models and tools for legal compliance checking and management are available on the scene, but they are still fragmented and not accessible as a unique framework, and here the main challenge is to deal with different legal tradition sources, legal concepts in different languages, the interpretation level, and the interface module to allow human experts to take a decision.

1.2. Paper organization

To better contextualize the use of the proposed cloud service broker and to make easily understandable the functionalities we designed, we consider a real scenario described in Section 2. The purpose of the scenario is also to make practical and focused the discussion of the research challenges. In Section 3 we discuss related work on QoS and legal-rule aware cloud service brokerage and on related enabling technologies. In Section 4 we present the detailed design of the broker. Section 5 focuses on the proposed solution to address the design challenges. Finally, we discuss research open issues in Section 6 and we conclude with final remarks in Section 7.

2. Reference scenario

Let us consider, as driving example, the problem of procurement of governmental cloud services, that have functional and non-functional requirements imposed by European, national and local legislation and regulation. In this scenario (see Fig. 2), a government agency willing to use a public cloud service needs to check

Download English Version:

<https://daneshyari.com/en/article/4950271>

Download Persian Version:

<https://daneshyari.com/article/4950271>

[Daneshyari.com](https://daneshyari.com)