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Cost and Benefit of the SLA Mapping Approach for Defining Standardized Goods in Cloud Computing Markets

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Abstract: Due to the large variety in computing resources and, consequently, the large number of different types of Service Level Agreements (SLAs), any market for computing resources faces the potential problem of a low market liquidity. To counteract this problem, offering a set of standardized computing resources is appropriate. Each of these standardized computing resources is defined through an SLA template. An SLA template defines the structure of an SLA, the attributes, the names of the attributes, and the attribute values. Since these SLA templates are currently static, they cannot reflect changes in users' needs. To address this shortcoming, we present the novel approach of adaptive SLA matching. This approach adapts SLA templates based on SLA mappings by allowing Cloud users to define mappings between public SLA templates, which are available in the Cloud market, and their private SLA templates, which are used for various in-house business processes of the Cloud user. Besides showing how public SLA templates adapt to the demand of users, we also analyze the benefits and costs of this approach. Costs are incurred every time a user has to define a new SLA mapping to a public SLA template due to its adaptation. In particular, within this paper, we investigate the cost depending on the use of different public SLA template adaptation methods. The simulation results show that the use of heuristics within adaptation methods helps balancing the cost and benefit of the SLA mapping approach

Keywords: Cloud economics, computing markets, market liquidity, simulation.

JEL Classification Numbers: C15, C61, C63, D40, D45, L22, L86, M15.

1. Introduction

Computing resource allocations in Clouds are based not only on functional requirements but also on different non-functional requirements. These non-functional requirements (e.g., application execution time, reliability, and availability) are termed Quality of Service (QoS) requirements and are expressed and negotiated by means of Service Level Agreements (SLAs). In order to facilitate the creation and management of SLAs, SLA templates have been introduced. SLA templates, which represent popular SLA formats, comprise elements such as names of trading parties, names of SLA attributes, measurement metrics, and attribute values [1].

In Cloud computing markets, buyers and sellers of computing resources face the problem of varying definitions of computing resources. Computing resources are described through different non-standardized attributes (e.g., CPU cores, execution time, inbound bandwidth, outbound bandwidth, and processor type) [2]. Sellers use them to describe their supply of resources and buyers use them to describe their demand for resources. As a consequence, a large variety of different SLAs exists in the market. The success of matching asks (i.e., offers of sellers) and bids (i.e., offers of buyers) becomes very unlikely [1].

Approaches tackling this plethora of SLA attributes include the use of standardized SLA templates for a specific consumer base [3][4], downloadable predefined provider-specific SLA templates [5], and the use of ontologies [6]. These approaches clearly define SLA templates and require users to agree a priori on predefined requirements. The SLA templates are static.

However, the demand of users changes over time. For example, the emergence of multi-core architectures in computing resources required the inclusion of the new attribute "number of cores", which was not present in an SLA template a couple of years ago. However, the existing approaches for the specification of SLA templates cannot easily deal with demand changes. These approaches involve heavy user-interactions to adapt existing SLA templates to changing market conditions.

In this paper, we apply adaptive SLA mapping, a new approach that can react to changing market conditions [1]. This approach adapts public SLA templates, which are used in the Cloud market, based on SLA mappings. SLA mappings, which have been defined by users based on their needs, bridge the differences between existing public SLA templates and the private SLA template (i.e., the SLA template of the user). Since a user cannot easily change the private SLA template due to internal or legal organizational requirements, an SLA mapping is a convenient workaround.

The benefits of SLA mappings for market participants are threefold. Firstly, traders can keep their private templates, which are required for other business processes. Secondly, based on their submitted mappings of private SLA templates to public SLA templates, they contribute to the evolution of the market's public SLA templates, reflecting all traders' needs. Thirdly, if a set of new products is introduced to the market, our approach can be applied to find a set of new public SLA templates. All these benefits result in satisfied

users, who continue to use the market, therefore increasing liquidity in the Cloud market. However, these benefits come with some cost for the user. Whenever a public SLA template has been adapted, the users of this template have to re-define their SLA mappings.

The five contributions of this paper are: (1) the definition of an appropriate use case to exemplify the adaptive SLA mapping approach; (2) the definition of three adaptation methods for adapting public SLA templates to the needs of the user; (3) the investigation of conditions under which SLA templates should be adapted; (4) the formalization of measures (i.e., utility and cost) to assess SLA adaptations and SLA adaptation methods; and (5) the introduction of an emulation approach for the use cases.

The remainder of the paper is organized as follows: Section 2 describes related work. Section 3 introduces the adaptive SLA mapping approach and the utility and cost model. The simulation setup, the three adaptation methods, and the simulation infrastructure are described in Section 4. Section 5 presents the simulation results and a discussion. Section 6 concludes the paper.

2. Related Work

(For the full paper, please contact the authors)

3. Adaptive SLA Mapping

(For the full paper, please contact the authors)

4. Simulation Environment

(For the full paper, please contact the authors)

5. Experimental Results and Analysis

(For the full paper, please contact the authors)

6. Conclusion and Outlook

(For the full paper, please contact the authors)

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