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Multifaceted trust management framework based on a trust level agreement in a collaborative cloud☆

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ABSTRACT

Cloud computing is an emerging field aimed at providing any type of service on demand -anywhere, and anytime. Advances in this field have facilitated a futuristic collaborative cloud in which many inter-connected clouds provide scalable services. A request processed by an untrustworthy provider can endanger quality of service, prompting the dissatisfaction of the customer. This paper aims to select the Trustworthy Service Provider (TSP) by evaluating trust based on in-context feedback from different sources; these sources include customer feedback, global advisory feedback and third-party feedback. Furthermore, unfair feedback is filtered to improve accuracy. Consequently, the job-success rate increases, and customers are able to obtain value-for-money for the sum paid toward selection of a provider. The present experimental work proves that the proposed model is effective and efficient in selecting a trustworthy provider in a collaborative environment.

1. Introduction

Cloud computing is an emerging field that provides on-demand web-based services on a proportional sharing basis. Cloud computing provides everything as a service (XaaS), including Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). It has become increasingly widespread by virtue of its features; a single cloud is insufficient to meet the requirements of millions of customers, particularly during peak time [1]. Based on interconnected services from multiple clouds, the collaborative cloud is a system that can meet these demands. If a single cloud is unable to meet the requests of users, the collaborative cloud is able to identify a cloud that can do so [1].

The present study attempts to provide total satisfaction to the customer by fulfilling all of its requirements. To achieve this objective, requests that cannot be supported by a particular cloud are forwarded to another cloud that provides the necessary functions, thus enhancing the job-success rate. In instances where a customer depends upon a third-party service, quality is of paramount importance. Moreover, the growth of new and similar service providers that likely have more-attractive offerings makes it difficult to choose a TSP that combines user satisfaction with guaranteed standards of quality [2,3]. In the proposed model, we consider feedback from various contexts including IaaS, PaaS and SaaS to evaluate trust.

The three major issues addressed and solved in this study are

1. Trustworthy provider selection achieved by discarding malicious customer feedback
2. Managing trust among communicating entities in a collaborative cloud comprising various clouds of differing, dynamic natures

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3. Managing the revenue shared between the Cloud Service Provider(s) that receives the request and the CSP that actually processes the request forwarded by the initial recipient CSP.

The trustworthiness of services deployed in different clouds can vary due to the different mechanisms used by those clouds. The trustworthiness of the collaborative cloud is, therefore, relatively complex in comparison to that of a single cloud. The collaborative cloud is preferred because of its high job-success rate. Trust management is essential to service providers; it maintains their reputation in the market and is invaluable to customers because it ensures reliability of services. The present work proposes a multifaceted trust management framework based on a Trust Level Agreement (TLA) in a collaborative cloud environment; its purpose is to address and solve trust-related issues. The trustworthiness of the service provider is normally computed based on customer feedback. However, in the present project, the trust value of a CSP is computed based on genuine customer feedback, third-party feedback from friends, neighbors, social networks and unknowns, and self-feedback, i.e., feedback from the global advisory. For example, Google provides many website links for a particular search, rather than referring to a single website; referring to multiple websites provides a more accurate result.

The present work should help customers identify the most TSPs based on feedback in different contexts and from different sources. Additionally, the present research model filters out unfair feedback to facilitate accurate selection of a TSP in a collaborative cloud environment. TLA serves as a guide for choosing a trustworthy CSP in the context of mutual sharing of the revenue generated among providers. The proposed model improves the job-success rate because a service request that is not fulfilled by one cloud is processed by other clouds. However, the following five major issues require attention when adopting a collaborative approach:

1. How does a customer select a TSP in a collaborative environment?
2. How can the challenge of providing trustworthy service to the burgeoning Cloud Service Customer (CSC) requests be addressed?
3. What method should be adopted for revenue sharing between two collaborating service providers?
4. How can the genuineness of customer feedback be checked?
5. What weights should be assigned to genuine customer feedback?

In response to the above questions, a multifaceted trust management framework is proposed consisting of two agents, namely the Single Cloud Agent or SCA (which manages the communication between customer and cloud service provider) and the Collaborative Cloud Agent or CCA (which coordinates communication among providers).

The salient features of the proposed framework are as follows:

- A multifaceted trust management framework based on TLA is proposed. To the best of our knowledge, this paper is the first to propose a framework in the context of a collaborative cloud environment.
- Trust results generated by the proposed model, findings from our previous model [4], and a trust evaluation model [5] are analyzed on a comparative basis and reported.
- The collected in-context feedback is used to improve the consistency and accuracy of the trust computation of CSPs.
- The proposed research model significantly increases user satisfaction and the job-success rate. The model selects a TSP after filtering malicious feedback.
- The trust value of the CSP is computed based on consolidated genuine customer feedback, third-party feedback and global advisory feedback.
- A method is proposed to identify the genuineness of customer feedback, and weights are assigned based on the percentage of matched feedback with a majority.
- The proposed weight calculation method is most suitable for a dynamic environment.
- The proposed model also facilitates mutual sharing of revenue among CSPs.

The present paper is organized under the following headings: Section 2 presents a brief literature survey. Section 3 briefly describes the proposed framework and its different modules; computation of trust value of CSPs is discussed in Section 4 to help the customer choose a trustworthy CSP. Theoretical Evaluation and Limitation is discussed in Section 5. The results generated by the proposed framework and discussion are provided in Section 6. Finally, a conclusion with suggestions for future work is outlined in Section 7.

2. Review of the literature

Much research has been conducted on trust management in cloud computing. The following section discusses some relevant research findings from the literature. The papers are divided into sections titled Trust management in cloud computing, Trust management in a collaborative cloud, and Trust management based on filtering of unfair feedback.

2.1. Trust management in cloud computing

The work of Messina et al. [2] identifies the issue of providing lower QoS services and proposes a trust model to choose a service provider based on reliability and reputation. The trust model presented by Agneli et al. [5] helps users choose the best need-based service provider by calculating final trust based on a subjective logic trust model. Ghosh et al. [6] proposed a novel framework called SelCSP, which facilitates the selection of a trustworthy and competent service provider. This

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