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Conceptual SLA Framework for Cloud Computing

Mohammed Alhamad, Tharam Dillon, Elizabeth Chang
Digital Ecosystems and Business Intelligence Institute (DEBII)
Curtin University of Technology
Perth, Australia
Mohammed.Alhamad@postgrad.curtin.edu.au,
Tharam.Dillon@cbs.curtin.edu.au, Elizabeth.Chang@cbs.curtin.edu.au

Abstract. **Cloud computing has been a hot topic in the research community since 2007. In cloud computing, the online services are conducted to be pay-as-you-use. Service customers need not be in a long term contract with service providers. Service level agreements (SLAs) are agreements signed between a service provider and another party such as a service consumer, broker agent, or monitoring agent. Because cloud computing is a recent technology providing many services for critical business applications, reliable and flexible mechanisms to manage online contracts are very important. This paper presents the main criteria which should be considered at the stage of designing the SLA in cloud computing. Also, we investigate the negotiation strategies between cloud provider and cloud consumer and propose our method to maintain the trust and reliability between each of the parties involved in the negotiation process.**

Index Terms: SLA, Negotiation, Cloud computing, Trust management

I. Introduction

Cloud computing has been a hot topic in the research community recently. In cloud computing, the online services are conducted on a pay-as-you-use basis. It is not necessary to be in a long term contract with service providers [1]. In this case, cloud customers can save large amounts of budget spent on operating, managing and transferring services. Cloud computing can be described as a new form of IT environment which provides dynamic, flexible and scalable virtualization of resources. Examples of current cloud providers include: Amazon EC2 [2] (infrastructure cloud provider), Azure [3] from Microsoft (platform cloud provider), and for an application cloud provider, there is Google Docs [4] . In cloud computing, virtualization technology is built on top of the infrastructure in order to optimize the use of resources and provide flexible solutions for users. An important element that provides some degree of assurance to both users and providers of these cloud resources is the Service Level Agreements which define the scope of usage and provision of resources. Cloud consumers need an SLA before they transfer their infrastructure to cloud data centres, to provide certainty regarding the resources provided and the ability to reach the desired level of productivity. Cloud providers need an SLA to define the trust and quality of services they provide to users as well as an agreed framework for costs and charges. The research on SLA and QoS metrics has been considered by many researchers in business and service-oriented architecture such as e-commerce and web services. However, SLA metrics in these technologies are not suitable for cloud computing as the nature and type of resources being provided and delivered is different. So, new SLA models are still required to provide flexible method for negotiation and the signing of electronic contracts between consumers and providers. The main contributions of this paper are summarized as follows:

1) Investigating and analysing the main requirements to establish an effective model for SLA in cloud computing
2) Defining dynamic SLA metrics for different groups of cloud users

The remainder of this paper is structured as follows: Section 2 defines SLAs and describes the main characteristics of SLAs in cloud computing. The existing standards for SLA contracts are presented in Section 3. In Section 4, properties and main criteria for SLA in cloud computing are described. Also, in this section, the negotiation model and negotiation scenarios for cloud computing are discussed. Section 5 concludes the paper.

II. Characteristics of Service Level Agreement

A. Definition

A Service level agreement is a document that includes a description of the agreed service, service level parameters, guarantees, and actions and remedies for all cases of violations [5]. The SLA is very important as a contract between consumer and provider. The main idea of SLAs is to give a clear definition of the formal agreements about service terms like performance, availability and billing. It is important that the SLA include the obligations and the actions that will

be taken in the event of any violation, with clearly shared semantics between each party involved in the online contract.

B. *Properties of SLAs*

The SLA is a legal format documenting the way that services will be delivered as well as providing a framework for service charges. Service providers use this foundation to optimize their use of infrastructure to meet signed terms of services. Service consumers use the SLA to ensure the level of quality of service they need and to maintain acceptable business models for long term provision of services. The following are the main requirements of the SLA:

- SLA format should clearly describe a service so that the service consumer can easily understand the operation of the services
- Present the level of performance of service
- Define ways by which the service parameters can be monitored and the format of monitoring reports
- Penalties when service requirements are not met
- Present the business metrics such as billing and stipulate when this service can be terminated without any penalties being incurred

This is the requirements for SLAs in the general environment of services. Later, we present the main requirements which the SLA should implement in order to integrate with the cloud computing architecture.

C. *Functional and non-functional requirements for cloud users*

Functional requirements and non-functional requirements of cloud services should be met to fulfil the need of consumers. In this section, classification of cloud computing requirements from the perspective of the cloud consumer is presented, helping to provide a good understanding of the proposed framework in Section 4. For each type of cloud service, there are different requirements. Figure 1 shows the categorization of cloud computing services and requirements for each service.

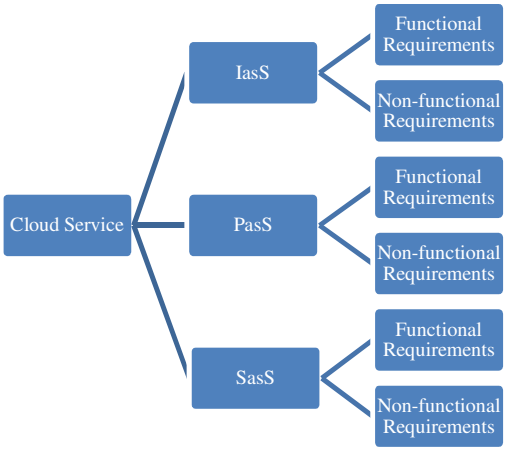

Figure 1. Categorization of requirements for cloud services

In this paper, we focus on the non-functional requirements of services such as availability, scalability and response time. Based on the more important non-functional requirements, we define the SLA parameters for each type of cloud service.

- Availability: in cloud computing, the most important criteria for quality of service is the availability of service. Availability is the probability that the cloud infrastructure or service are up and running in the specific time of utilities of the service provided for in the SLA
- Scalability: cloud consumers pay for the service only as they use it. The cloud provider should facilitate the specific resources for ease of scaling up and down. With scalability, cloud consumers can maximize revenue and cloud providers are able to optimize resources effectively.
- A clear method for cost calculation: service consumers using cloud computing are willing to pay as they use, so an annual billing period or even monthly periods are not suitable for cloud computing. A cost calculation for resource reservation method is not a unique method for each type of cloud service. For example, the storage service can be billed based on the time and size of the user's data. On the other hand, cloud CRM may be billed based on the number of users.
- The configuration of service: in cloud computing, users deal with virtual machines and these VMs should be configured in a flexible manner to enable users to execute business processes with minimal need for managing the effort of the configuration.
- Security and privacy: the critical data of a business must be stored and transferred via secure channels. If security features are not guaranteed by cloud providers, business organizations may spend too much on operating their own data centres rather than switching to cloud providers.

III. SLA Frameworks

To the best of our knowledge, scientific research in the area of SLA and trust management does not investigate the new paradigm of outsourcing of services in a pay-as-you-use framework, which is called "Cloud Computing". The main specifications which are designed to describe the syntax of SLA are: 1) Web Service Agreement (WS-Agreement) [5]. 2) Web Service Level Agreement Language and framework (WSLA) [6]. A WS-Agreement is created by Open Grid Forum (OGF) in order to create an official contract between service consumers and service providers. This contract should specify the guarantees, the obligations and penalties in the case of violations. Also, the functional requirements and other specifications of services can be included in the SLA. There are three main sections for WS-Agreement: name, context, and terms. A unique ID and optional names of services are included in the name section. The information about service consumer and service provider, domain of service, and other

specifications of service is presented in the context section. Terms of services and guarantees are described with more details in the terms section. These types of online agreements were developed for use with general services. For cloud computing, service consumers lack more specific solutions for SLA to present the main parameters of the visualization environment; at the same time these solutions should be dynamically integrated with the business rules of cloud consumers. The other specification is WSLA, which was developed to describe services in three categories, which are: 1) Parties: in this section, information about service consumers, service providers, and agents are described. 2) SLA parameters: in this section the main parameters which are measurable parameters are presented in two types of metrics. The first is resource metrics, a type of metric used to describe service provider's resources as row information. The second one is composite metrics. This metrics is used to represent the calculation of the combination of information about a service provider's resources. The final section of the WSAL specification is Service Level Objective (SLO). This section is used to specify the obligations and all actions when service consumers or service providers do not comply with the guarantees of services.

The primary shortcoming of these approaches is that they do not provide dynamic negotiation, and various types of cloud consumers need a different structure of implementation of SLAs to integrate their own business rules with the guarantees that are presented in the targeted SLA. In this paper, we propose a basic architecture for developing the service level agreement contract between service consumers and other parties such as service providers and external agents. Two main categories of SLA metrics are presented. Performance metrics show the measurements of performance parameters in cloud computing data centres such as response time and CPU capacity. The other metrics is business metrics; the main measurements of business-related aspects presented by this type of metrics includes such things as service cost and billing methods.

IV. Conceptual SLA Framework for Cloud Computing

A. *SLA Metrics*

In our proposed framework, the SLA parameters are specified by metrics. These metrics define how cloud service parameters can be measured and specify values of measurable parameters. In the cloud computing architecture, there are four types of services which providers can present to consumers. These services are: infrastructure as a service (IasS), platform as a service, software as a service, and storage as a service. The proposed SLA metrics for cloud computing consider these four types of these services. For each part of the SLA we define the most important parameters that consumers can use to create a reliable model of negotiation with this service provider. We focus on the definition of these parameters, and in our future work, we will design and implement the proposed framework followed by simulation experiments in order to validate our framework.

SLA metrics for IasS:

Companies like amazon.com provide infrastructure as a service. Most of the consumers are confused as to which important parameter should be defined in the hardware part of the SLA. We list the most important parameters for consumers who are interested in using cloud as an infrastructure service.

Table 1. SLA metrics for IasS

Parameter	Description
CPU capacity	CPU speed for VM
Memory size	Cash memory size for VM
Boot time	Time for MV to be ready for use
Storage	Storage size of data for short or long term of contract
Scale up	Maximum of VMs for one user
Scale down	Minimum number of VMs for one user
Scale up time	Time to increase a specific number of VMs
Scale down time	Time to decrease a specific number of VMs
Auto scaling	Boolean value for auto scaling feature
Max number can be configured on physical server	Maximum number of VMs that can be run on individual server
Availability	Uptime of service in specific time
Response time	Time to complete and receive the process

SLA metrics for PasS:

Platform as a service is a type of cloud computing that provides all the requirements needed to support application developers in developing, evaluating, and delivering applications and software for end users [7]. So, in this case, developers using PasS do not need to download tools or configure hardware to complete the developing tasks. For SLA metrics related to PasS, we define the main parameters that can be used as basic criteria when developers want to negotiate with PasS providers.

Table 2. SLA metrics for PasS

Parameter	Description
Integration	Integration with e-services and other platforms
Scalability	Degree of use with large number of online users
Pay as you go billing	Charging based on resources or time of service
Environments of deployment	Supporting offline and cloud systems
Servers	
Browsers	Firefox, IExplorer,..
Number of developers	How many developers can access to the platform

SLA metrics for SasS:
Software as a service is a common example of cloud services [8] if an application is hosted on a cloud platform and infrastructure to provide built-in services for end users of cloud computing. Good examples of SasS are mail, calendar, and social web sites provided by Google, Yahoo, and Microsoft. We present the common metrics parameters for SasS as an example of metrics for this type of cloud service.

Table 3. SLA metrics for SasS

Parameter	Description
Reliability	Ability to keep operating in most cases
Usability	Easy built-in user interfaces
Scalability	Using with individual or large organisations
Availability	Uptime of software for users in specific time
Customizability	Flexible to use with different types of users

SLA metrics for Storage as a service:
Online users access their data from different geographical locations. In the past few years, online storage providers were unable to maintain large size of data because of the lack of huge space in storage disks, network performance, and data management systems. Now, data storage service providers such as S3 by amazon.com configure large numbers of storage hardware and they are able to manage and serve millions of users efficiently with their method of data transferral and ensuring these data are compatible with various types of applications. The parameters for data storage service metrics are basic requirements for negotiation with storage providers.

Table 4. SLA metrics for Storage as a service

Parameter	Description
Geographic location	Availability zones in which data are stored
Scalability	Ability to increase or decrease storage space
Storage space	Number of units of data storage
Storage billing	How the cost of storage is calculated
Security	Cryptography for storage and transferring of data, authentication, and authorization
Privacy	How the data will be stored and transferred
Backup	How and where images of data are stored
Recovery	Ability to recover data in disasters or failures
System throughput	Amount of data that can be retrieved from system in specific unit of time
Transferring bandwidth	The capacity of communication channels
Data life cycle management	Managing data in data centres, and use of network infrastructure

SLA general terms:
The above section presents the main parameters for metrics in four types of services. However, there are general metrics that can be defined for SLA with any or all types of cloud users. We present the most important parameters as an example when creating the basic SLA contract between cloud computing users and providers.

Table 5. SLA general terms

Term	Description
Monitoring	Who do the monitoring and what method of monitoring
Billing	Cost of service and how can be calculated
Security	Issues like cryptography, authentication, and authorization are main requirement for cloud users
Networking	The number of IPs, throughput, and load balancing
Privacy	How the data will be stored and transferred
Support service	Cloud providers should clearly define the methods of help and support
Local and international policies	The policy standards that providers follow

B. *Negotiation Strategies*

Negotiation is the method by which the service consumer and service provider present their terms and agree or disagree upon the results of this process to reach an agreement acceptable to both sides. There is more than one way of starting the negotiation process in an online environment [9, 10]. In this section, we discuss the possible negotiation scenarios relating to cloud computing. The first scenario involves direct negotiation between the cloud consumer and the cloud service provider. In this case, the service provider may create a unique template and define all SLA criteria such as period of contract, billing, and response time. When the SLA document is ready, cloud consumers can review the SLA terms and respond by signing the SLA, renegotiating or terminating the negotiation. Direct negotiation is a common method used by most of today's cloud providers. The second scenario is negotiation via a trusted agent, that is, an agent who has sound experience in selecting the cloud providers and defining the critical parameters for the SLA. This can be a key factor when a business wants to focus on the core business activities. A number of activities can be assigned to external agents who undertake the negotiation in flexible and reliable steps. They may start with the analysis of business processes and goals and complete the negotiation by monitoring all or some of the SLA parameters. Also, the trusted agent can use other agents to carry out some activities like service discovery and monitoring of performance. In the third scenario more than

one agent is used to carry out the one type of negotiation. As we mention above, there are four different types of cloud services: IasS, PasS, SasS, and storage as a service. A cloud consumer can sign a contract with four different agents (IasS agent, PasS agent, and SasS) which take the responsibility of defining SLA parameters and complete the negotiation process. This type of negotiation can be efficient if the cloud consumer requires more than one type of cloud service.

V. Conclusion and Future Work

The effective service level agreement is the key to ensure that a service provider delivers the agreed terms of services to the cloud consumer. In cloud computing, cloud consumers with clear definition of SLA parameters and flexible negotiation methods can increase the reliability and trust level of cloud provider-cloud consumer relationship. In this paper, the non-functional requirements of cloud consumers are presented and, based on these requirements, the most important criteria for the SLA are defined in order to help cloud users maintain a reliable protocol for negotiation with cloud service providers. The state-of-the-art SLA frameworks are discussed. Finally, we present three scenarios that can be applied to the cloud computing environment when consumers need to negotiate with cloud providers. As future work, we will design SLA metrics and implement a simulation process to test our framework in the cloud computing environment. The result of this work will be the basic tool to be used with trust management systems for cloud computing to help consumers select the most reliable service.

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