A Service Level Agreement Framework of Cloud Computing based on Cloud Bank Model

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***Abstract*—The Cloud Bank model, which is derived from Grid bank [1], is a kind of commerce model of cloud computing that provides pay-as-you-go computing resources. In this model, Cloud Bank is an agent platform of resource transaction. Cloud computing uses the concept of service level agreement (S LA) to control the use and receipt of computing resources from, and by, Cloud Bank. As computing resources are provided in the form of services, Quality of Service (QoS) mechanisms are introduced to solve any quality of service problems. This paper presents a framework of Service Level Agreements in the Cloud Bank model (CBSLA), QoS attributes is added to the CBSLA to guarantee the quality of service. All the transactions of cloud bank are based on the CBSLA agreement.**

Keywords-cloud computing; service level agreement; cloud bank; quality of service;

I. INTRODUCTION

In cloud computing, available computing resources are provided as service and generally offered as pay-as-you-go plans. Cloud computing should provide exceptional service quality. But the quality of Service (QoS) in cloud computing cannot be guaranteed because of the complexity and diversity of cloud computing environments. In order to solve the QoS issues in cloud computing, QoS parameters should be described in detail. QoS can be used to distinguish the difference between service providers. In order to assure that the consumer can get the service they pay for and obligate the provider to achieve its service promises. We introduce the Cloud Bank as a third party to help the provider and the consumer to come to an agreement which is about affair in the provider's supply and consumer's demand.

A service level agreement (SLA) is a negotiated agreement between two parties in which one is the consumer and the other is the resource provider, it is regarding the guarantees of a service. The service guarantees are about what transactions need to be executed and how well they should be executed. The SLA records a common understanding about services, priorities, responsibilities, guarantees, and warranties. The SLA may specify the levels of availability, serviceability, performance, operation, or other attributes of the service, such as billing [2]. The most important component of the SLA is the QoS attributes. The SLA reports must provide a guarantee that the QoS is being monitored and that the Cloud Bank can deal with any accident that may happen.

Because the demands of the consumer are complex, a simple "measure and trigger" process may not work for SLA enforcement. Otherwise, many other SLAs are natural language documents. These SLAs must be provisioned and monitored manually, which is very troublesome. In order to automate provision and monitor the QoS parameters, check the guarantees. We use a particular SLA template that includes automatically processed fields in an otherwise natural language-written SLA. The objective of this paper is to introduce the Cloud Bank Service Level Agreement (CBSLA), which is based on the Cloud Bank environment.

II. RELATED WORK

Significant research about QoS management and SLAs has been carried out during standardizing efforts. The Web Service Level Agreement language and framework (WSLA) [2] from IBM is a specification for describing a SLA for web services. However, the flexibility of the WSLA is limited and only suitable for a small set of variants of the same type of service using the same QoS parameters and a service offering that is not likely to undergo changes over time. And the traditional usage of SLA is not fully integrated into the Cloud system, especially not bind with distributing resources. In order to better meet the QoS, we need to deploy infrastructure SLA to resource scheduling step of the cloud bank model.

III. CLOUD BANK MODEL

Cloud Bank provides an analysis and orientation for all participants with the theory of economics from the perspective of the overall activities in cloud computing. The iteration algorithm is brought forward, which is based on the Deadline and Budget Constrained (DBC) algorithm considering the history of amendments to the current price.

It establishes the cloud architecture of the market from a macro-economic point of view. The bank stores market transaction resource from the local cloud. After analyzing these resources intelligently, some guidance information is to provider to the consumers. The upper level of bank can be macro-controlled in accordance with aggregate supply and demand in the total market from the lower level.

This model mainly includes: Resource Consumer, Cloud-Consumer-Agency (CCA), Cloud-Bank (CB), Virtual layer, Physical layer, Cloud-Resource-Agency (CRA) and Resource Provider. The logical structure is shown in Fig. 1.

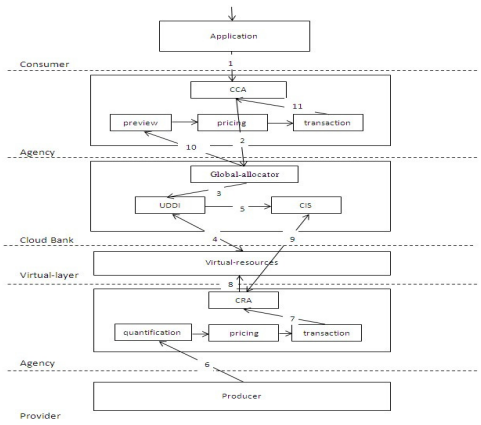

Figure 1. The cloud resource architecture based on economics[4]

CCA receives tasks from consumers and submits them to Cloud bank, and then replaces consumers to establish SLA with service providers. The content of SLA includes task completion time, QoS parameters, etc.

Cloud bank provides domanial resource management and transaction services, including:

- Global Allocator: Global Allocator is responsible for searching resources according to consumers' needs, dynamically monitoring resources and services, sending messages of resources and services to Cloud Information Server and Universal Description Discovery and Integration of Cloud market respectively (UDDI).
- Cloud Information Server (CIS): CIS is responsible for recording infrastructure resources, and giving initial prices of those resources by pricing strategies.
- Universal Description Discovery and Integration of Cloud Market (UDDI): UDDI of Cloud market is responsible for recording virtualization resources, and letting consumers' tasks match with resources.
- Pricing strategy service: it works in the process of pricing for infrastructure resources and is responsible for making pricing strategies and models, recording usage of resources, charging consumers [5].

After quantify the cloud resources, one can add them to the Service Level Agreement and let it become the certificate among parties that have the resources transaction.

SLA mentioned in this article is a combination of all above, put it in the application of management and monitoring QoS property in the Cloud bank structure. It can be used to describe the application mission with QoS property, bind the application and resources enter into a contract. Resource consumer and the consumer agent will set up SLA as long as services sets have applied for the physical resources to meet the QoS characteristics. All of the SLA and its property values can be quantified and measured by means of the method at literature [7]. The local resource management and network resource management devices can measure the corresponding property and value of the QoS in cloud bank model, determine whether of these resources and the QoS property values of the QoS property values in agreement with the SLA or not. Related resources at the SLA parameters between different layers of different manifestations through a number of inter-layer mappings been converted.

In next section, we will discuss the running process of Cloud Bank with CBSLA and the function of each essential part in details.

IV. Cloud Bank Service Level Agreement Framework

The CBSLA is designed to capture the service level agreements in a formal way in Cloud Bank environment. The life cycle process of CBSLA is shown in Fig.2 which identifies five main processes [3].

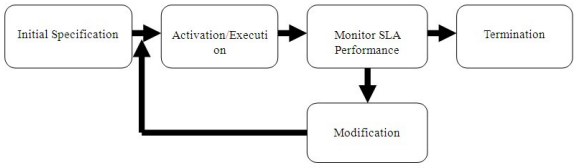

Figure 2. The life cycle if SLA

SLA initial specification is important to identify every aspect of service, such as identify business requirements, define service level goal and SLA metrics. The monitor SLA performance let Cloud Bank review current terms, metrics and updates them based on current requirements.

A CBSLA is a service definition. The CBSLA defines an agreed set of service parameters and the way to evaluate this service. There are two parts of CBSLA, one is Resource Provider-SLA (RP-SLA) which is signed by Cloud Bank and resource provider, another part is Resource Consumer-SLA (RC-SLA) which is signed by Cloud Bank and resource consumer.

The Fig.3 shows general architecture of Cloud Bank service level management (CBSLA). The provider put their resource into resource pool after quantification and graded by Service level Management (SLM), the RP-SLA contract will be signed after this process. The resources in resource pool are provided as different levels of services according to the resource grade graded by SLM, consumer signs the RC-SLA contract with Cloud Bank when they need services.

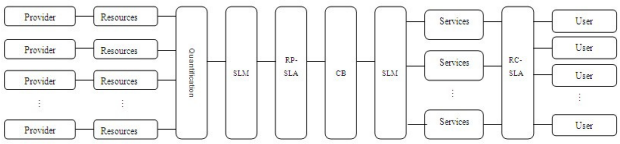

Figure 3. The architecture of Cloud Bank service level management

In this model, it can be noted that each of the activities represents an operation on resources and services. As a result, a RP-SLA can be attached to each of the activities to represent the agreement between Cloud Bank and provider.

Similarly, RC-SLA can be attached to the overall process to represent the agreement between Cloud Bank and user.

V. THE SIGNATURE PROCESS OF CBSLA CONTRACT

The whole signature process of CBSLA contract is shown as Fig.4:

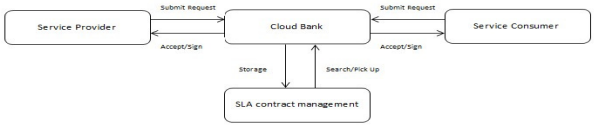

Figure 4. The whole signature process of the CBSLA contract

Because there are two kinds of CBSLA, this paper will discuss the detailed signature process in the following.

A. *The Signature process of RP-SLA contract*

In the Cloud Bank model, Cloud Bank will define most of the content of a CBSLA, provider and consumer have to agree with such information, or provide additional information. In all cases, pre-specified, fixed information and negotiable elements as well as their choices can be captured in a CBSLA template. A template can be published in a registry such as UDDI. Fig.5 illustrates the signature process of the RP-SLA contract.

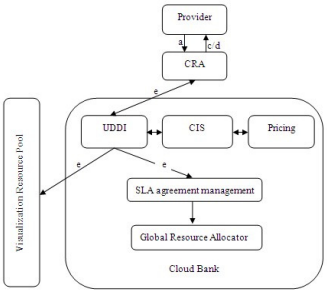

Figure 5. The signature process of the RP-SLA contract

a) Resource provider send a RP-SLA contract request named Request-RP-SLA to Cloud Bank,the contract request is received and analyzed by CRA

b) The CRA get the actual parameters of the resources from provider by quantification and then compare it to the parameters extracted from Request-CBSLA. If actual parameters are match with the parameters of Request-CBSLA or the disparities between these two parameters are acceptable, the CRA will inform Cloud Bank that this contract can be signed and then execute step d. If the disparity is unacceptable, execute step c.

c) CRA send a new RP-SLA contract with the actual parameters to the resource provider to negotiate and then execute step a.

d) Cloud Bank send the final RP-SLA contract to the resource provider to sign.

e) Once the RP-SLA contract is signed, the RP-SLA contract will be managed by SLA contract management and the information of these resources will recorded by UDDI and Global Resource Allocator.

B. *The Signature process of RC-SLA contract*

While Cloud Bank defines the parameters of a service, including definition of CBSLA measurement methods, it may offer a choice to the consumer on the details of the guarantees. Fig.6 illustrates the signature process of the RC-SLA contract.

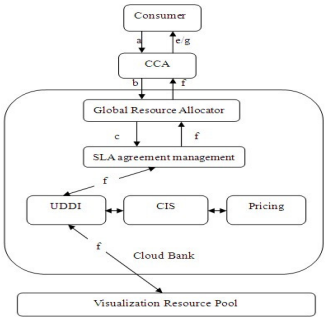

Figure 6. The signature process of the RC-SLA contract

a) Similar with the RP-SLA, resource consumer send a RC-SLA contract request named Request-RC-SLA to Cloud Bank, the contract request is received and analyzed by CCA.

b) CCA submits the parameters to Global Resource Allocator after analyzed.

c) Based on these parameters, Global Resource Allocator divide the whole task into several subtasks and compute the demand of each subtask and submit them to SLA contract management.

d) The SLA contract management searches its own database to find themost suitable RP-SLA. If find success,execute step f , else send the feedback to CCA and execute step e.

e) CCA send a new RC-SLA contract with the modified parameters to consumer to negotiate and then execute step a.

f) UDDI find the service and submit it to CCA based on the RP-SLA.

g) Cloud Bank replace resource providers to establish RC-SLA with consumers according to the RP-SLA of each subtask.

h) Finally the RC-SLA contract will be managed by SLA contract management too. After that, the Service Level Agreement monitoring will run to make sure that the total Qos of each subtask is equal to the QoS of the whole task.

VI. THE SERVICE LEVEL AGREEMENT TEMPLATE OF CBSLA

In order to define the CBSLA contract, we need to structure a CBSLA template with the QoS parameters. This template defines all parameters of a service and contains the complete details of a contract. In this paper, the CBSLA template is evolved from Web Service Level Agreement (WSLA) [6] and contains five major parts, Type describing the type of the CBSLA, Parties describing the contracting parties, Service Description containing one or more service definitions, Addition describing the addition clause and Obligations defining the parties' obligations. This paper uses the XML schema to define the CBSLA template.

A. *The hierarchical model of the CBSLA template*

The hierarchical model of the CBSLA template is shown in Fig.7 and it comprises the following major parts:

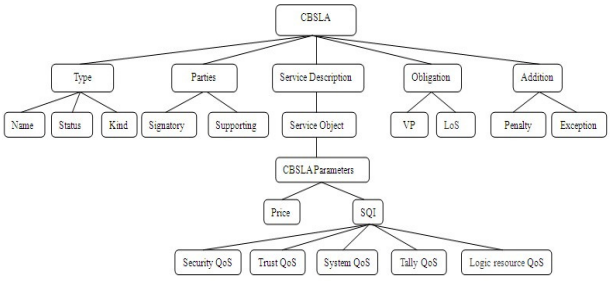

Figure 7. The hierarchical modes of the CBSLA template

1) Type: There are two kinds of CBSLAs: RP-SLA and RC-SLA. Each kind of CBSLA contains the request SLA and the final contract SLA. The final contract is separated into two categories. One is stable SLA which means the parameters of this service will not change during the entire term of the contract. Another is variable SLA which means the parameters of this service will change with time especially the price because the pricing strategy is based on the Stackelberg Leadership Model [5]. The name is RP-SLA or RC-SLA, the status could be stable or variable, the kind could be New, Alteration and Feedback.

2) Parties: In Cloud Bank model, Cloud Bank is in charge of enacting the CBSLA instance, the monitoring and supervision activities are assigned to Cloud Bank too. This paper defines two classes of parties. Resource provider and service customer are the signatory parties to the contract. They are responsible for all obligations. Cloud Bank is involved to support the enactment of the contract as Signatory parties.

3) Service Description: A service contains one or more service objects. The properties of a service object are described as CBSLA Parameters. The CBSLA Parameters are constituted by price and SQI (Service Quality Indicator).The SQI is property that is used to define the guarantees of an CBSLA and comprises the following five kinds of QoS [7]:

a) Security QoS: It is necessary to consider not only the security of data but also the safety of the environment in the complex cloud computing environment.

b) Trust QoS: Trust QoS is used to evaluate the credibility of service information; it is provided and maintained by the resource providers and Cloud Bank. Resource providers can estimate the possible bias in accordance with those of the dynamic factors of uncertainty of information, and take the initiative to provide trust QoS to Cloud Bank.

c) System QoS: System QoS is used to describe the QoS parameters impacted with the service environment which can affect the service capabilities of the cloud computing services.

d) Accounting QoS: Accounting QoS is used to describe the cost of the services and the management strategies, it is provided by service provides. Cloud Bank consumer will also consider the issue price when they select a service, they want to select the most cost-effective services.

e) Logic Availability QoS: Logic QoS is provided by resource providers and used to describe the QoS parameters of logic resources which are directly providing services in Cloud Bank. Considering the factors such as the overall services performance, the task load conditions and the sharing strategy of physical resources, it is the abstract of services performance in the cloud computing environment for physical resources.

4) Obligation: The obligation contains two types of obligations: Validity Period (VP) and Level of Service (LoS).VP defines the beginning and ending time of the contract. LoS expresses a commitment to reach the agreed level of the service in a given period.

5) Addition: The addition represents the parameters about business. Penalty defines the way how to publish the parties when they breach the contract. Exception defines the irresistible reasons which may break the contract, such as natural disaster and warfare.

B. *The design decision of CBSLA template based on XML*

We use XML schema to define the syntax of CBSLA template. All elements are defined as XML schema types. Every element must be assigned a type that defines the structure of its content. Fig.8 is the XML schema instance of the CBSLA template.

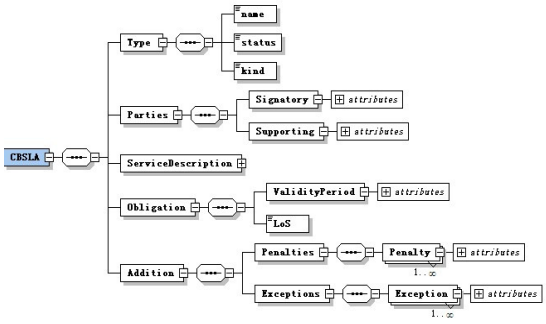

Figure 8. CBSLA XML Schema

The details of Service Object are shown as Fig.9:

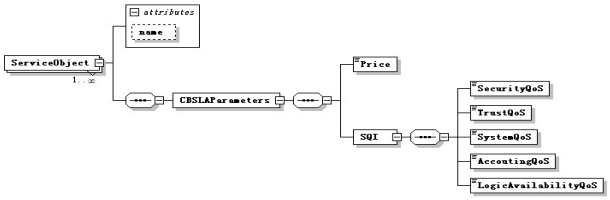

Figure 9. The details of ServiceObject

Based on this CBSLA XML schema, an CBSLA document example is shown as Fig.10:

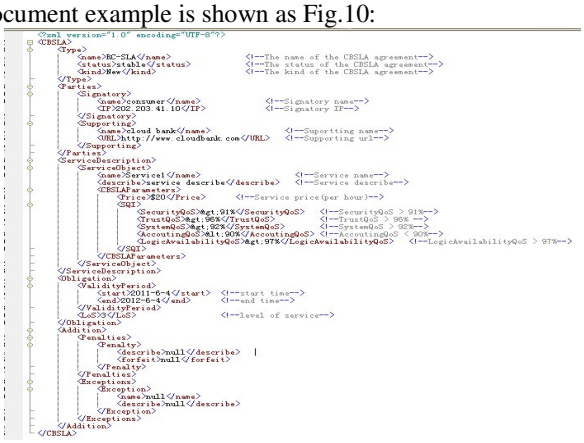

Figure 10. CBSLA document example

The example in Fig.10 illustrates a CBSLA contract document between Cloud Bank and consumer. This contract is a new RC-SLA contract and the validity period is the full year 2011. It guarantees the SQI parameters of Service1 that the Security QoS must be greater than 91%, the Trust QoS must be greater than 96%, the System QoS must be greater than 92%, the Accounting QoS must be no less than 90% and the Logic Availability QoS must be greater than 97%. Supporting parties should be evaluated the new value for the SQI parameters is available each moment. As the resources of cloud computing are dynamic and heterogeneous, in order to meet the requirement of the cloud computing, we need to restrict the parameters of CBSLA rigorous, such as the parameters 91%,96%,…97% in this example.

VII. CONCLUSION AND FUTURE WORK

As noted above, we see a clear methodology to handle SLA of cloud computing. WSLA suggests a flexible architecture for managing SLA between providers and consumers. As the needs of support services arise, some support services need to be provided but WSLA does not mandate such provisions and hence cloud bank can be introduced to provide the support services.

This paper allows signatory parties to include Cloud Bank into the supervision of the SLA. It has introduced the CBSLA framework for specifying SLAs for Cloud Bank model. The Cloud Bank helps provider and consumer to define the quality of service aspects of a service by CBSLA. This paper focuses on the main frame and the signature process of the CBSLA. The clear representation of CBSLA provides a flexible mechanism to define the obligation.

However, there are still some details to finalize, such as the process of measuring and the CBSLA parameters and how to monitoring these parameters. These issues will be discussed in future research. The current WSLA framework is based on XML and therefore limits the ability of matching in composition metrics to syntactical.

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