Towards Integrating Information of Service Level Agreement and Resources as a Services (RaaS) for Cloud Computing Environment

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Abstract—Cloud computing describes services and applications that are extended to be accessible through the Internet. Service Level Agreement (SLA) is a contractual agreement that has been established between the members of Cloud Service Provider (CSP) that consists of the service provider and its recipient for a specific application of services based on allocating and sharing Resources as a Service (RaaS). In this context, there are many parties who are very concerning about it, but unfortunately there is lack of a common mapping of SLA information and RaaS of best practice as a guideline that can be used by CSP in making decision for the future purposes in engaging with services in the cloud computing environment. Therefore, the main goal of this paper is to integrate information of SLA and RaaS in order to ensure everybody who are providing and receiving the services in the cloud particularly will be satisfied and getting the best maximum Return Of the Investment (ROI) in allocating and sharing resources among the service providers and recipients in cloud computing environment. As a result, some attributes such as reliability, readability and standardization of Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are found to be high.

Keywords—Cloud Computing, Cloud Service Provider, Service Level Agreement, Resource Allocation, Integrating Information, Software as a Service, Infrastructure as a Service and Platform as a Service

I. INTRODUCTION

Cloud computing describes applications that are extended to be accessible through the Internet. These cloud applications use large data centers or cloud data storage (CDS) and powerful servers that host Web applications and Web services. Anyone with a suitable Internet connection and a standard browser can access a cloud application. Cloud computing consists of multiple cloud computing service providers (CSPs). In terms of software and hardware, a cloud system is composed of many types of computers, storage devices, communications equipment, and software systems running on such devices [1, 2].

Cloud computing can be defined as “a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on

Service Level Agreement (SLA) established through negotiation between the CSP and cloud users” [3].

Service Level Agreement (SLA) is a contractual agreement that has been established between the members of Cloud Service Provider (CSP) that consists of the service provider and the recipient for a specific application of services (cloud user) based on its allocating and sharing Resources as a Service (RaaS) in cloud computing environment. This agreement is developed and produced that based on negotiation process will be describing and identifying the level of services agreement in offering RaaS between the CSP or ownership of the cloud services onto their respective recipients.

In this context, the service of resource engagement or what we called as RaaS that is given by the CSP are including the software (Software as a Service - SaaS), infrastructure (Infrastructure as a Service – IaaS), and platform (Platform as a Service – PaaS). For this particular purpose, there are many parties or members of CSP who are very concerning about it, but unfortunately there is lacking of a common mapping of SLA as a integrating information of best practice as a guideline which can be used for CSP in making decision and sustain the utilization of the RaaS for the future purposes in engaging with services in the cloud computing environment.

Therefore, this paper discusses the integrating information of SLA in order to ensure every cloud user who are providing and receiving the services in the cloud will satisfied and getting the best maximum return of the investment (ROI) in allocating and sharing resources among the service providers and recipients in cloud computing environment.

The main contribution of this paper is to propose a framework for integrating information of SLA and PaaS for cloud computing services.

This paper is organized as follows: Section II presents a discussion of the literature review. Section III provides an overview of the methodology. In Section IV, our proposed integration information of SLA for RaaS framework is described. Section V, elaborates the result analysis of the findings. Finally, section VI presents some concluding remarks.
II. RELATED WORKS

In Cloud Computing, it was promoting a lot of services that provided for the CSP with taking care by themselves in term of licensing, agreements level, and many other things in managing hardware and software as a resource. These services are including Platform as a Service (PaaS), Infrastructure as Service (IaaS), Storage as a Service (Daas), and Software as a Service (SaaS) [4,5,6,7]. SLA is a contractual agreement level that has been established between the members of the CSP that consists of the service provider and the recipient for a specific application of services based on its allocating and sharing resources as a service (RaaS) in cloud computing environment.

A common SLA as what been described by [8] is a part of a service contract where the level of service is formally defined. In practice, the term SLA is sometimes used to refer to the contracted delivery time (of the service) or performance. As an example, internet service providers will commonly include SLAs within the terms of their contracts with customers to define the level(s) of service being sold in plain language terms. In this case the SLA will typically have a technical definition in terms of mean time between failures (MTBF), mean time to repair or mean time to recovery (MTTR); various data rates; throughput; jitter; or similar measurable details.

In this practice, the SLA has also played an important role in cloud computing environment especially related to the indication and determination of the agreement level between the service provider and the recipients. In this context, the services will also based on resource as a service (RaaS) from the services provider to the potential recipients. The relationship of mapping process of the Services Agreement and Resource utilization in cloud computing environment is shown in Table 1.

<table>
<thead>
<tr>
<th>Service Agreement</th>
<th>Type of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Level Requirement</td>
<td>Software</td>
</tr>
<tr>
<td></td>
<td>Infrastructure</td>
</tr>
<tr>
<td></td>
<td>Platform</td>
</tr>
</tbody>
</table>

In the area of resource allocation challenges in clouds, Shikharesh et al. [9] describes the resource allocation challenges in clouds from the fundamental point of resource management. The paper has not addressed any specific resource allocation strategy. Patricia et al. [10], investigates the uncertainties that increase difficulty in scheduling and matchmaking by considering some examples of recent research. David Irwin et al. [11] have suggested the integration of high bandwidth radar sensor networks with computational and storage resources in the cloud to design end-to-end data intensive cloud systems. Their work provides a platform that supports a research on broad range of heterogeneous resources and overcomes the challenges of coordinated provisioning between sensors networks, network providers and cloud computing providers. Inclusion of non-traditional resources like Steerable sensors and cameras and stitching mechanisms to bind the resources are the requirement of this project. Resource allocation strategy plays significant role in this project.

III. METHODOLOGY

The methodology of this research is conducted through three steps as follow:

A. Step 1 - Performing Review of the literature:

This is involving the performing the analysis of literature regarding on SLA and the relation between SLA and RaaS in cloud computing environment.

B. Step 2 - Formulating the Integration Information of SLA and RaaS Framework:

The main components derived from the questionnaire are: SLA requirement of RaaS in cloud computing environment, the most required attributes of SaaS in RaaS of SLA environment, the most important of IaaS attributes in RaaS of SLA environment and the most required attributes of PaaS in RaaS of SLA environment. Proposed integration information of SLA and RaaS Framework shall be synthesized as follows:

- The integration information of SLA and RaaS elements are derived.
- The mapping process between SaaS and RaaS attributes are considered.
- The mapping process between RaaS and PaaS attributes are considered.
- The mapping process between RaaS and IaaS attributes are considered.

The mapping process between the SLA of the cloud services and cloud infrastructures and integrating information of SLA and RaaS are shown in Figure 1.
The SLA cluster of cloud computing, specialised in the SLA field, identified common technical requirements of the contractual agreement, based on the analysis of specific challenges presented by the CSPs. The final list of requirements for the SLA cluster in order of appearance in the SLA life cycle is:

a) **SLA Template Specification**: For a RaaS, a clear step-by-step procedure describing how to write an SLA template to provide with correct (and possible legal) service description.

b) **Publication and Discovery**: Publish the CSP offer, the cloud users’ needs, and browse/ compare offers in a federated marketplace.

c) **Negotiation**: Bargain-like transaction to agree SLA conditions between the cloud users and the CSPs.

d) **Optimization of Resource Selection**: Optimal RaaS management on the CSP side (selection of the most suitable host) improving the current scheduler solutions.

e) **Monitoring**: Provide measures of the ongoing process, i.e. system values related to the SLA for internal and external usage.

f) **Evaluation**: Comparing all the terms of the signed SLA with the metrics provided by the monitoring, in order to internally prevent upcoming violations and to externally discover potential violations.

g) **Re-negotiation**: Changing the terms of an already accepted (enforced) SLA.

h) **Accounting**: Charging the cloud user for the use of services contracted by signing SLAs.

C. **Step 3 - Conducting the preliminary survey:**

To validate the framework is mainly conducted using a preliminary survey through the expert opinion interviewed that based on those who are really involved in dealing with the cloud computing environment such as administrator, software engineer, programmers and actives end users. At this stage, a preliminary analysis has been done in formulating the SLA of information integration as a propose framework which is very close related to utilization of resource as a service (RaaS). After that, the simple measurement of the RaaS and integration information of SLA is also analyzed in determining the best criteria of service level in cloud computing environment.

IV. **A Proposal of Integration Information of SLA and RaaS Framework**

As result of our study, the proposed integration information of SLA for RaaS, can be viewed into three elements as shown in Figure 2 as follows:

![Figure 2. The integration information of SLA with Resources as a Service (RaaS)](image)

Besides that, the mapping process of integrating information of SLA and RaaS is also can be supported for the cloud computing environment is highlighting based on the following aspects:

RaaS for SaaS - Table 2 is showing the mapping attributes that may be considered for resources agreement in software as services in cloud computing environment.

**Table 2. The Mapping Process of Software Service and Resources in SLA**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Level of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warranty, licensing</td>
<td>Validation period</td>
</tr>
<tr>
<td>Compatibility, Availability</td>
<td>Time Taken</td>
</tr>
<tr>
<td>guarantees</td>
<td></td>
</tr>
<tr>
<td>Maintainability, Performance,</td>
<td>High Availability</td>
</tr>
<tr>
<td>Security</td>
<td>Authentication</td>
</tr>
<tr>
<td>Support</td>
<td>Online Help Desk</td>
</tr>
</tbody>
</table>

RaaS for IaaS – Table 3 is showing the attribute that may be considered for resources in infrastructure agreement as services in cloud computing environment.

**Table 3. The Mapping Process of Infrastructure Service and Resources in SLA**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Level of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>Highly</td>
</tr>
<tr>
<td>Openness</td>
<td>Highly</td>
</tr>
<tr>
<td>Suitability</td>
<td>Moderate</td>
</tr>
<tr>
<td>Readiness</td>
<td>Highly</td>
</tr>
</tbody>
</table>

RaaS for PaaS - Table 4 has shown the attribute that may considered for resources in platform agreement as services in cloud computing environment. A variety of software frameworks are usually made available to PaaS developers, depending on application focus. Providers that focus on Web and enterprise application hosting offer popular frameworks such as Ruby on Rails, Spring, Java 2EE, .NET and many other technology environment.
TABLE 4. THE MAPPING PROCESS OF PLATFORM SERVICE AND RESOURCES IN SLA

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Level of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization</td>
<td>Highly</td>
</tr>
<tr>
<td>Configuration</td>
<td>Moderate</td>
</tr>
<tr>
<td>Readability</td>
<td>Highly</td>
</tr>
<tr>
<td>Reliability</td>
<td>Highly</td>
</tr>
</tbody>
</table>

V. RESULT AND DISCUSSION

Based on the proposed of integration information as what been mention as above, we found the RaaS of the SLA can be served into three elements which it was contributed a major parts to the cloud computing environment. These are included SaaS, PaaS, and IaaS where each of them is depending of the user needs or demands of the services. For those of three elements, which is based on the literature and expert opinion, SaaS has played a major role in term of its services as shown in the Figure 3 as shown as below.

Figure 3. Service Level Requirement of RaaS in Cloud Environment

Figure 4 shown that the most required attributes of SaaS in RaaS in SLA environment are availability, security and warranty. Readiness and connectivity are the important of IaaS attributes in RaaS of SLA environment as shown in Figure 5. Figure 6 shown that the most required attributes of PaaS in RaaS in SLA environment are reliability, readability and standardization.

VI. CONCLUSIONS AND FUTURE WORK

As a conclusion, the information integration of SLA and RaaS in considered important in CSP that has been offered by the service provider or ownership of the cloud to their respective recipients need to be done in mutual agreement, so that it can be getting the benefits for all people especially in allocating and engaging the resources or what we called as RaaS, that are including the software (Software as a Service - SaaS), infrastructure (Infrastructure as a Service – IaaS), and platform (Platform as a Service – PaaS). In this context, there are many parties who are very concerning about it, can make use of this proposed model as a common of SLA of best practice as well as a guidelines, so that the CSP to make use for the future purposes in engaging with services in the cloud environment.

Therefore, the integration information of RaaS of SLA is also can be considered important as an alignment process for future research work in order to ensure every cloud user who are dealing and receiving the services in the cloud will getting highest satisfaction and getting the best maximum return of the investment in allocating and sharing resources among the providers and recipients in cloud computing environment.
For future work, our next step will be to complete our first simple implementation of the proposed integration information of SLA for RaaS framework, and validate it in real cloud business situations. We are also planning to stress the interoperability and technical problems raised by different types of SLA. We will also re-use existing cloud business analysis to specify in detail the market opportunities of our solution.

REFERENCES


