Cloud based Conceptual Framework of Service Level Agreement for University

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ABSTRACT

In the present world, self-motivated and knowledge based universities have a much wider role to play in creating, conserving, organizing, transmitting and applying knowledge. In this context, Education organization would have several questions and issues like, do they procure the Information technology services? What technologies do they need for grow up and when? If yes then they need with their own research capabilities, in collaboration with outside parties, or by acquiring it or licensing it from others? How can they use the abundant technological and computational opportunities to affect their mission, vision, objectives and strategies? Cloud computing is often cheaper and less labor-intensive for institution and organization too. Cloud Computing means there is no need to buy and install expensive software, only university need to pay for various online services when need it, and it also offers flexibility of various infrastructure, platform and software kind of services which can be quickly and easily scaled up and down according to Service Level Agreement.

In this Paper, we are defined Cloud Based Framework for University according to its services and users. We have also suggested Conceptual Framework of Service Level Agreement for University and best ten factors which should keep in mind at time of defining Service Level Agreement between the cloud providers and University. We also represents the SLA life cycle which is require thoroughly for contract.

Keywords

Cloud Computing, Service Level Agreement, University, SLA life cycle, Service Level Objective

1. INTRODUCTION

In cloud computing, resources and services are made available over a network with the physical location. With its focus on flexibility, dynamic demands of business and consumption based billing, cloud computing enables on-demand infrastructure provisioning and "as a- service" offering of applications and execution platforms. A cloud service has three discrete characteristics that discriminate it from traditional hosting. It is sold on demand, typically by the minute or the hour; it is elastic -- a user can have as much or as little of a service as they want at any given time; and the service is fully managed by the provider like payment and any search services.

In cloud computing, the online services are conducted to be pay-as-consumer-use. Service consumer or 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. SLA has its own life cycle to manage agreement.

Enormous changes are taking place daily in technology; this is creating a need for a digital makeover of everything as we know it. It is changing the university infrastructure; environment, processes, and needs are also increasing the velocity of academic as well as non academic task.

In this paper, section 2 defines the cloud based Architecture for University; Section 3 represents various important factors or service level objectives (SLO) for SLA between the University and Service provider, and Section 4 listing the SLA non functional requirements and various parameters which is require from University to reliable Service Level Agreement. Section 5 defines the Service Level Agreement Life Cycle which is performed by both cloud provider and cloud consumer thoroughly and Section 6 and 7 defines the conclusion, future work and references respectively.

2. CLOUD BASED ARCHITECTURE FOR UNIVERSITY

There are basically three service Models playing a vital role in cloud computing viz. Infrastructure as a Services (Iaas), Platform as a Services (Paas) and Software as a Services (Saas). See Figure 1 which indicates the university's various demands, routine procedure, and services according to three distinct model of cloud computing.

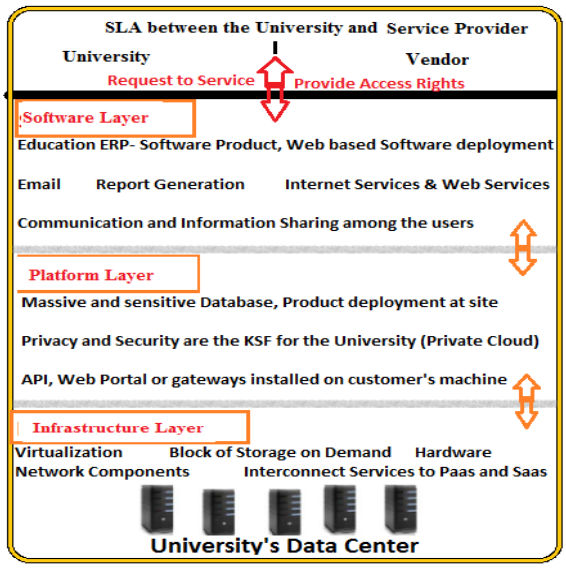

Figure1: Cloud Based Framework for University

2.1 Saas Layer

In this layer, the front end services are supplies by the vendor. Education ERP have several software modules like Admission, Examination, Attendance system, Placement, Departmental activity and staff information etc. are interacts with the users through a front-end portal. SaaS is a web-based software deployment model that makes the software available entirely through a web browser. This model also provides Internet and web Services, Blogging, email communication and Information Sharing between different users like students, Professors, Principal and indirect users. It means Cloud provide such a flexible services and elasticity as per the user demand and as per the market condition.

2.2 Paas Layer

Platform-as-a-service or platform layer in the cloud is defined as a set of software and product and tools based development hosted on the provider's infrastructure and environment. Application developers create applications on the provider's platform over the Internet. PaaS providers may use APIs, website portals or gateway software installed on the user's computer. Paas manages university's massive and confidential database management system; it also provides much and required security and privacy provision when and where it needed. Here Private cloud computing model can be deployed for the consumer. If university want to secure and to make privacy for their confidential information like Fees, Examination result, Staff salary details then they can adopt the concept of Private Cloud Computing. In Private Cloud computing data base management is handled and taken care by university expert, skilled person himself. Service provider has to only provide online, software and web services to the university, rest of the functionality managed by university itself. But this model requires accurate and precise deployment and architectural model in all the faces of environment.

2.3 Iaas Layer

Infrastructure-as-a-Service like Amazon Web Services provides the concept of virtual server or virtualization, instances with unique IP addresses and blocks of storage on demand. Cloud computing allows a university to pay for only as much capacity as is needed, and bring more online as soon as required. Infrastructure services are comprised of the basic compute, storage, hardware and network components and interconnect services to Platform and Software Layer which is needed to run applications or ERP's. Infrastructure services are updated as per the services from Platform and Software are scale up and scale down.

3. SERVICE LEVEL OBJECTIVES (SLO) FOR SERVICE LEVEL AGREEMENT

A service-level agreement is a negotiated agreement between two parties, where one is the customer or consumer and the other is the service provider or seller. This can be a legally binding formal "contract". SLA which is defines the scope of usage and provision of resources. SLA is to give a clear definition of formal agreement about various academic services, report performances, availability of services and billing. A Service level agreement is a document that includes a description of the agreed service between university and cloud provider, service level parameters for university, guarantees given by provider, and actions and remedies for all cases of SLA violations.

An SLA contains various important service level objectives (SLOs) that define objectively measurable conditions for the service; some examples include parameters of throughput and data streaming frequency, timing, availability percentages for VMs and other resources and instances, or urgency ratings to rank the importance of different SLOs (like "availability is more important than response time".

SLO expectations should vary depending on whether applications and data the applications access are hosted on the same cloud or on different ones. For Private Cloud Computing SLO may be different in terms of services. See figure 2 for detail study of various objectives which is most considerable before SLA between University and cloud provider.

See figure 2 in which three service level objectives like jurisdiction, both party's responsibilities towards SLA and data location are considered as a most sensitive and careful situations. And these should be handled and defined before two parties' comes forward for performing the services.

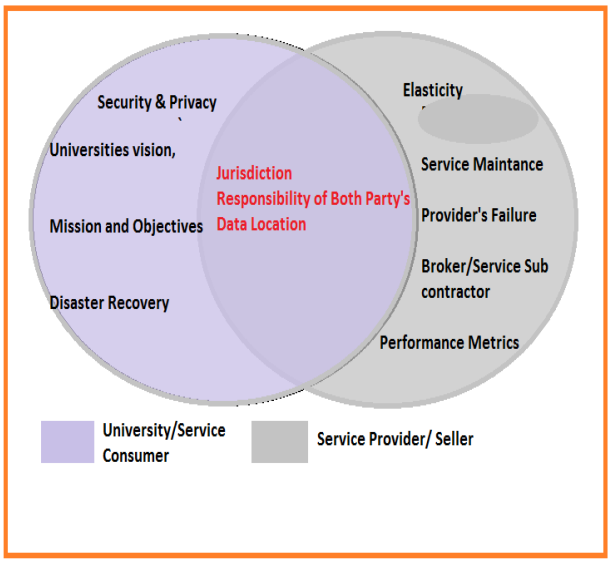

Figure2: Service Level Objective for SLA

1. *University/Organization's objectives, vision and mission:* An organization must define *why* they will use the cloud services before it can define exactly what, when and where services it will use. University's vision, mission and long time goal should be defined before using Cloud Computing services. This part is more organizational politics than technical issues: Moreover, once cloud deployment has been finished, then number of enormous changes and updating required as per the user demand. Hence, without defining university's long vision and goals cloud computing may arise problematic political issues for a long time.
2. *Responsibilities of University and Cloud Provider (Vendor):* It is important to define the balance of responsibilities between the cloud providers and the university or consumer. For example, the provider will be responsible for the Software-as-a-Service aspects in case of Private Cloud, but the academic institution may be mostly responsible for his Virtual Machine that contains licensed software and works with sensitive data and the policy of Data base management system with privacy and security. And these kinds of routine issue have to define in Service Level Agreement clearly.
3. *Service continuity and disaster recovery:* The consumer should ensure the provider maintains adequate disaster protection. Two examples comes to mind: Storing valuable and confidential student academic records as well as other sensitive data on the cloud as backup and *cloud bursting* (switchover when in-house data centers are unable to handle processing loads) should mention and protect through the services. For Example, if university's expansion are needed in terms of location has changed, in this case data center should be capable to all the procedural loads
4. *Contract of Service Maintenance:* This SLO is concern with Service Provider. One of the nicest and heaviest aspects of using a cloud is that the how the provider handles the maintenance? But university should know, when providers will do maintenance tasks:
    - Will online and important services be unavailable during maintenance time?
    - Will services be available, but with same through put or speed will be maintained?
    - And what about maintenance charges taken by cloud provider.

These are the various maintenance related issues that should keep in mind in SLA.

5. *Location of Data:* This factor is related to both party's University as well as Service Provider. When Private Cloud Computing is concern, there must be regulations that certain type's sensitive and confidential student information of data can only be stored in fixed physical locations.
6. *In case of Provider's failure:* Failing to provide various services mentioned in SLA is unhealthy condition for both parties. Such kind of urgency like at the time of examination process, report of marks should be generated in precise and timely manner. In case of provider's failure, make contingency plans and other alternative solution that take into account the financial health of the provider.
7. *Jurisdiction and Power:* Again, both parties should have understood the local laws that apply to provider as well as the university. According to country's regulation and laws provider has to bind himself in SLA. Different County has different regulations and laws.
8. *Brokers and Service sub contractor:* In case of multiple sub contractor are in SLA. It will generate more ambiguity in the contract. Service provider is only the responsible such kind of case.

4. UNIVERSITY'S NON FUNCTIONAL REQUIREMENTS FOR SLA

Functional requirements and non-functional requirements of cloud services should be met to fulfill the need of consumers. In this section, university's non functional requirements are deeply classified from the perspective of the cloud consumer and also it is presented and helping to provide a good understanding of the proposed framework.

See Table 1 which has about more than 20 non functional requirements with its details description. We can also consider these non functional requirements as Service Level Agreement parameters. And these parameters fulfill the university's requirements in terms of performance and cost. They are as below.

Requirements	**Description**
1. CPU Capacity	CPU speed of Virtual Machine
2. Storage Memory	Cache Memory for Virtual Machine
3. Scale Up Services	At the time of new year/admission process and result process Maximum Number of Virtual Machine required.
4. Scale Down Services	On Vacation time Minimum Number of Virtual Machine required.
5. Scale Up Time	Time to Increase number of VM
6. Scale Down Time	Time to Decrease number of VM
7. Auto Scaling	Boolean value of Auto Scaling
8. Virtual Machine Type	How many types of VM can be use? Small for Standard application, Professional for medium application, and Large for Enterprise application. This depends upon the growth of University.
9. Response Time	Response time for Each service related to Saas, Paas, Iaas.
10. Throughput	Amount of data that can be retrieved from system in specific unit of time
11. Customizability	If university wants to add or upgrade the software module, want to change

		in Education ERP or in services.
12.	Request Type	It defines the type or request. It comes first time from any user of university or it want to upgrade the service.
13.	Product Type	It defines the product type. Product is standard or enterprise
14.	Contract Type	**1. I**nfrastructure, 2. Platform and 3. Software. Depends upon cloud model.
15.	Contract Length	How long the university wants to services and is available to customer for a month or for a year?
16.	Number of Accounts	It contains the maximum number of accounts created by consumer particular in SaaS.
17.	Number of Records	The maximum number of records like student admission, examination, staff detail etc. a customer is able to create for each account during the transaction and this will impact the data transfer time during the service upgrade.
18.	Load Balancing	Load balancing is requiring at the time of scalable the services generally two times in year.
19.	Quality of Services	Other supported services. Like video conferencing etc.
20.	Security	How much security is provided by provider? For Example. Student has less security then professors and administrative staff.
21.	Authentication & Authorization	Level of authentication and authorization. 1. Principal 2. Professor 3. Administration 4. Students 5. Parents 6. Visitors etc.
22.	Backup and Recovery	How images and information are stored and how backup and recovery will be provided? Generally it concern with Private Cloud computing.

Table 1: University's non Function Requirement

5. SECURE SERVICE LEVEL AGREEMENT LIFE CYCLE

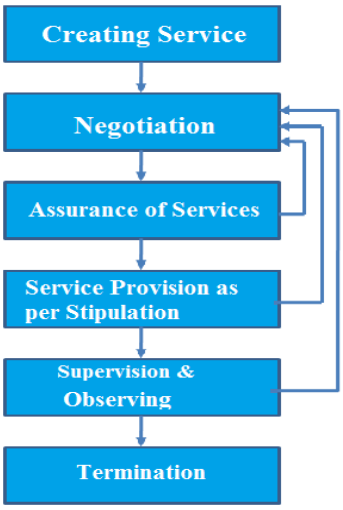

Figure 3: SLA Life Cycle

Service Level Agreement have his own life cycle and it might be changed as minor process. It is depend on the services and business. As a university or academic organization when you are going to commence or contract about SLA then you should follow the proposed Service Level Agreement life cycle. See figure 3.

1. Creating Services:

University must define *why* they will use the cloud services before it can define exactly what, when and where services it will use. Universities or organization's vision, mission, objectives and long time goal should be defined before using Cloud Computing services. The first phase includes following listed process, see figure 4.

Figure 4: Publishing Phase of SLA.

a) Service Catalogues: Service provider is generally creating and publishing service offers and details in a service catalogue, service provider is responsible to make services ready by the order of University for discovery in reality.

b) Service providers will design and prepare security SLA templates based on their technical capabilities, abilities, financial terms, business strategies and their relations with other service developers. So, University can think and make a decision either the service provider will be selected or other service provider will comes into the contract.

c) This is a dynamic phase; where service providers may frequently change their service offers, add new service and published security SLA template.

d) For a Cloud services it must minimum contain the offered security mechanisms, their costs, and possibly also the penalty (customer credit) associated with breaking the agreement. In addition the validity period should be stated in a published SLA template.

2. Negotiation

It is important to define the balance of responsibilities between the cloud providers and the university. For example, the provider will be responsible for the Software-as-a-Service aspects in case of Private Cloud, but the academic institution may be mostly responsible for his Virtual Machine that contains licensed software and works with sensitive data and the policy of Data base management system with privacy and security. And these kinds of routine issue have to define in Service Level Agreement clearly. In the negotiation phase the university and the service provider agree on the details in the security SLA.

a) A negotiation can be performed by software agents acting on behalf of the university and provider. The customer sends a list of security requirements to the service provider. And service Provider approve the requirement as per the capability and ability of him

b) In the hybrid Cloud context, the request may require resources that the service provider does not possess. The service provider will then match the stated requirements with the security SLA templates published in a service catalogue, and try to reserve resources from a number of other service providers who provide services that comply with the security requirements. The selection process can be either manual or partly automated.

c) The negotiation phase will result in security SLAs between the university and the service provider, and possibly also between the service provider and other service providers.

3. Assurance of Services:

Two examples comes to mind: Storing valuable and confidential student academic records as well as other sensitive data on the cloud as backup and *cloud bursting* (switchover when in-house data centers are unable to handle processing loads) should mention and protect through the services. For Example, if university's expansions are needed in terms of location has changed; in this case data center should be capable to all the procedural loads.

Successful negotiation phase will be followed by a commitment phase, where the security SLAs is digitally signed by all the involved partners. For a hybrid Cloud service the resulting security SLA between the university and the service provider will usually be a result of multiple chains of contracts between the service provider and other providers.

a) The provider needs to demonstrate PCI compliance by providing details of the infrastructure

b) The provider needs to provide a PCI complaint audit

c) The service provider will need to provide statistics to gauge for SLA compliance

d) The vendor has identified which employee have access to cloud resources

e) The service provider has no access to customer data

f) Testing or audit procedures will be provided

g) The data will be encrypted during communications and while being stored

h) The contract will include capabilities for migrating to a new vendor

i) The service provider will provide information or controls on how data is moved to new locations

j) The provider will allow changes to their update or patch schedule

k) The provider will provide backup capabilities

l) The client organization can specify the backup schedule

4. Service Provision as per Stipulation:

Cloud based applications are being deployed with increasing regularity. Once deployment has completed, these applications must be maintained and must evolve continuous changing business goals and objectives. Deploying new services, adding new features, or creating new compositions are common and basic maintenance and evolution tasks. If university is going to commence new programs or courses, extended his premises or enhanced his objective and vision through commence other branch as new location, then it should be evolve in cloud services. And these newly services might be considered and measured by their respective cost and performance. This is particularly important when the software is distributed, heterogeneous, and composed, as in SOA. Additional computing power may be required, or increased infrastructure, or storage capacity. New features might require revisiting security or privacy policies. New compositions or partnerships might require increased capacity. An initial SLA is negotiated to document the desired qualities of the service delivery.

a) Cloud application development environment

b) Integration of anti-similar applications

c) Virtualization and Server deployment

d) Asset management

e) Remote backup

f) Security management of servers and how to control access to servers

g) Audit / change management

h) Testing or technology advancement

i) Privacy or security concerns of a cloud computing environment

6. Supervision & Observing:

The monitoring phase is used to ensure that the details in the security SLAs are met. This phase includes detecting both past and ongoing security violations, and interpreting whether these events affect the agreed security SLAs. Detected violations of security SLAs may lead to either re-negotiating the SLAs or to termination of the service.

a) A well-organized and transparent monitoring mechanism following SLA deployment.

b) Precise detection and localization of SLA violations.

c) Trustworthy SLA compliance and violation reporting.

d) Efficient re-provisioning/alteration mechanism following violation of SLA.

e) Capability to re-negotiate service terms at any point during the service lifetime and rapidly readapt to meet newly negotiated terms.

7. Termination:

Failing to provide various services mentioned in SLA is unhealthy condition for both parties. Such kind of urgency like at the time of examination process, report of marks should be generated in precise and timely manner. In case of provider's failure, make contingency plans and other alternative solution that take into account the financial health of the provider. If any changes, alteration or violations occurs at the monitoring stage, then it will be jumped into negotiated phase. Here negotiation taking place, if it is positive then service is continuing otherwise service will be terminated.

6. CONCLUSION AND FUTURE WORK

In this paper, we have represented a clear definition of SLA and its parameters and flexible negotiation methods which can increase the reliability and trust level between cloud provider and cloud consumer. The state-of-the-art SLA frameworks are discussed. Finally, we present the 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 idea and concept be used with trust management systems for cloud computing to help consumers select the most reliable service. We will analyze ways to increase the efficiency of the algorithms in terms of total services and shall also consider the SLA negotiation process in Cloud computing environments to improve customer satisfaction levels.

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