ISSN: 2321-7782 (Online)
e-ISJN: A4372-3114
Impact Factor: 6.047

Volume 5, Issue 5, May 2017

International Journal of Advance Research in Computer Science and Management Studies

Research Article / Survey Paper / Case Study

Available online at: www.ijarcsms.com

A Study on Service Level Agreement Management Techniques in Cloud

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Abstract: ***Cloud computing is internet-based on-demand computing, where in hardware resources, software and platforms for developing an application are provided to customers on demand. Cloud computing provides servers, storage, applications to organization through internet. Due to its characteristics such as flexibility, on-demand service, scalability, broad network access and so on, it is being adopted in many IT industry. An entity responsible for delivering the cloud computing services is called cloud service provider and an organization or an entity which makes use of cloud computing are called customers. Providers who are providing service and customers who are using services establish a trust between them. The established trust between the client and the cloud service providers appears in the form of a legal document called as Service Level Agreement (SLA). SLA includes service quality, resources capability, scalability, obligations and consequences in case of violations. Satisfying SLA is very important and a challenging issue for the cloud providers, otherwise customers may move to other cloud providers. In this paper, different techniques used to manage the SLA proposed by the different authors are discussed.***

Keywords: Cloud Computing, Service Level Agreement, Quality of Service (QoS).

I. INTRODUCTION

Cloud Computing has become one of the important latest emerging technology in IT world. Cloud Computing technology will offers servers, storage, software and platform for developing the application to the users as a service on pay per usage basis. Customers can use these resources as and when needed, can increase or decrease resource capacities dynamically according to their requirements and pay only for how much the resource were used. Customers need not have to invest money to purchase, manage and scale infrastructures, updation of server and software and software licensing. Cloud computing means that instead of all the computer hardware and software resources that we are using on our desktop, or somewhere inside our company's network, it is being provided for us as a service by cloud service providers and accessed over the internet in a completely seamless way.

II. SERVICE LEVEL AGREEMENT

A service-level agreement (SLA) is a contract that has been made between a service provider and customers that documents what services that the provider will furnish and defines the performance standards the provider is obligated to meet. SLA establishes an agreement between providers and customers that include service quality, resources capability, scalability,

obligations and consequences in case of violations. Satisfying SLA is very important and a challenging issue. if SLA violates providers may lose customers. Thus by continuous monitoring of customer services and taking appropriate action ahead of time avoids agreement violations and can retain customers.

Metrics that are included in the SLA document are:

- Availability and uptime: the percentage of the time services will be available.
- List of services and resources that is being provided by the provider to the customers.
- Application response time.
- The schedule for notification in advance of network changes that may affect users.
- Help desk response time for various classes of problems.
- Consequences in case of violations.

III. LITERATURE SURVEY

Christopher C Lamb et al., [1] presented an approach de01scribing the different types of cloud computing models that generally exist today and how they manage services. Current cloud systems do not ignore SLA restrictions rather they are designed to support a single type of SLA. That SLA generally encompasses total system uptime and some kind of response metrics. If for some reason the cloud provider can no longer adhere to the terms outlined, some kind of compensation strategy generally applies to affected customers. This paper proposed an idea of single provider offering multiple types of SLA's and their implications. In doing so, it proposed a simple model for machine readable service level agreement and outlines specifically how this machine readable SLA can be constructed and injected into cloud infrastructures. The multiple SLA concepts allow the providers to differentiate available products service levels. For example: current architecture support uptime and availability as the primary metric from an SLA perspective. Further architectures support uptime and availability as well as specific latency, bandwidth etc parameters. This kind of SLA's would also continue to outline penalties when the conditions of that SLA are violated. So this proposed idea becomes important for next generation systems as well as customers. But the downfall of the proposed idea is that in general case injecting policies into cloud infrastructure is NP complete problem.

Mohammed Hussain et al., [2] discussed that cloud computing is an approach that relieves businesses from the task of managing their IT infrastructure. Cloud service providers manage client data and web services in accordance to a service level agreement (SLA). Cloud service providers, however are always under pressure to remain competitive and may cheat SLA to lower cost. Cloud service providers are also tempted to hide security incidents to maintain reputation. Businesses may subscribe to a Third Party Auditing (TPA) to ensure SLA is fulfilled. This paper shows how current TPA models are susceptible to cloud service provider's deception. The weakness of current TPA models from the fact that the TPA directly accesses cloud service provider auditing which makes it feasible for deceptive provider to control when to upload an inferior SLA. Therefore, an effective TPA model should be based on TPA that audits cloud service providers indirectly. The paper presents a crowd source based TPA model for cloud computing which overcomes the providers deception problem, but the downfall of the proposed model in addition to advantages are recruitment of a crowd of volunteers to participate in auditing targeted cloud providers, communication overhead, reliability of volunteer reports etc.

Ivona Brandic et al., [3] presented an approach "Self-Manageable Cloud". Self-manageable cloud infrastructure has to focus on achieving both flexibility and user requirements based on service level agreement. Such cloud infrastructure should automatically responds to changing environment conditions, workload etc by minimizing user interactions with the system and preventing violations of agreed SLA's. In this paper, author proposed LAYSI, layered approach by which it is able to prevent violation of SLA in self-manageable cloud. First in the paper presented a novel approach for mapping low level resource metrics to SLA parameters necessary for the identification of failure sources. Next, devised layered cloud architecture for the bottom up

propagation of failures to the layer, which can react to sense violation threats are discussed. Moreover author presented a communication model for the propagation of SLA violation threats to the appropriate layer of the cloud infrastructure. The downfall of the proposed model is there is need of a function to determine whether the propagation had a positive result in preventing violation of SLA.

Jordi Vilaplana et al., [4] discussed that SLA is an agreement between a service provider and a consumer, where the provider agrees to deliver a service to the consumer under specific terms such as time and performance. In order to comply with SLA, service provider must monitor the Quality of Service (QoS) closely through the parameters throughput and response time. In the paper, author says that the SLA contract usually states that the consumer only pays for the resources and services used according to the negotiated QoS requirements at a given price, but in the paper, proposed a cloud computing framework providing QoS and high performance for a given SLA and number of high performance users. Author designed SLA and power aware scheduling algorithm. In this algorithm, it assigns as many as requests as possible to the most powerful virtual machines leaving aside the remaining ones. The unused VMs can be turned off. The method is based on the computing capacity of the virtual machines, making decision about which ones will process more requests to give the opportunity to power off idle ones in order to guarantee the SLA and save as much energy as possible. The presented algorithm were implemented based on linear programming to assign load between the most powerful virtual machines, respecting the SLA agreement and power saving as much as possible. The downfall of the proposed algorithm is there is a need to find job with different computing and communications paradigms by expanding linear programming.

Ahmed Amakrane et al., [5] discussed that an approach of cloud computing technology started in delivering large scale online services. This rapid development of cloud in recent years leads to serious concerns regarding their energy consumptions and environment impact. So monitoring and reporting this problem is very important and also effective techniques need to be developed to control the environmental impact of their applications or infrastructure. In the paper, Resource management framework allowing cloud providers to provision resources in the form of virtual data centers (VDC) is proposed. virtual data center consist of set of virtual links and virtual machines with guaranteed bandwidth .This framework specifies that carbon emissions generated by leased resources should not exceed a fixed bound.by which it is possible to achieve high profit by maximizing the use of available resources.

Rusli Abdullah et al., [6] describes an approach how integration information of SLA and Resource as a Service (RaaS) elements are derived and also describes the mapping process between SaaS, RaaS, PaaS. This paper discusses the integrating information of SLA in order to ensure every user who are providing and receives the services in the cloud will satisfied and getting the best maximum return of the investment in allocating and sharing resource among the service providers and recipients in cloud computing environment. This paper mainly proposed a framework for integrating information of SLA and RaaS for cloud services. The proposed framework has three steps which are defined as follows: they first perform analysis on literature regarding SLA and the relation between SLA and RaaS in cloud computing environment, Secondly, they formulated the integrated information as a framework. Thirdly, they perform the validation of framework using the survey by expert opinions such as administrator, software engineer, programmers and end users. At this stage, analysis has been done to show how the SLA of information integration is close to utilization of resource as a service (RaaS).Based on the proposed integration information, the RaaS of SLA has been divided into three elements they are SaaS, PaaS, and IaaS. In those three elements based on the literature and experts opinion, SaaS has played a major role in term of its services. Some important mapping attributes of SaaS are availability, security and warranty. Readiness and connectivity are important for IaaS. Reliability, readability and Standardization are important for PaaS.

Edwin Yaqub et al., [7] describes an approach how negotiation can be employed in service-based markets to dynamically negotiate SLAs. The proposed method focus on the PaaS. Several negotiation support systems have been developed to activate negotiations. To solve the web service composition problem, an agent based architecture for SLA negotiation presented in the

paper. The self-service feature of cloud allows customer to play a great role, however this restricts the SLA that cloud provider offer QoS and non-functional property (NFP) vary from customer to customer. This paper presented a robust and computationally inexpensive negotiation strategy by using agents that efficiently creates optimal SLA under time constraints. The negotiated services help in reducing the gap in SLA and also help in improving the satisfaction of participants. This presented strategy focused on PaaS cloud based services. Future work of proposed strategy evaluates the analysis of this strategy and there is a need to explore low conflict domains for fault tolerant services.

Kertesz et al., [8] proposed architecture "Service-Level Agreement-Based Service Virtualization (SSV)" This architecture is a characteristic of cloud-based services in the provision of non-functional guarantees on execution time or price. The author says because of system mal functions, due to changing work load conditions and hardware and software failures, the undertaken SLA agreement can be violated. So to avoid more SLA violations, there is a need of flexible and adaptive SLA strategies. This paper presented a self-manageable architecture for SLA based service virtualization, which gives an ease for interoperable service executions in heterogeneous distributed and virtualized type of services. Presented architecture works on three main areas: Agreement Negotiation, Brokering and Service Deployment using virtualization. First monitoring where interconnected brokers are tracked, second the analysis part where the information collector of the meta-broker is queried for broker about the availability and performance results, third planning it sees to the incoming service request and about the SLA violations, fourth the execution how the selected broker is invoked. This paper investigates how the problems could arise and gathered the requirements for a service architecture that is able to maintain these demands. Autonomic computing are incorporated to the SSV architecture to cope with the error-prone virtualization environments, and demonstrated how autonomic actions are triggered responding to various possible failures in the service infrastructure.

Suneel K.S et al., [9] proposed "A Novel Approach for SLA Compliance Monitoring in Cloud Computing". Author discussed a legal document between the client and cloud service provider is known as Service Level Agreement(SLA). Cloud Service provider can cheat the client and deliver him the services with the cheaper properties. The author also speaks about Trust. Trust is known as a complex phenomenon. Trust is associated with two metrics Risk and Interdependence. Two entities depending on one another is known as Interdependence. Risk describes the level of damage can happen to the entity. Trust between two entities can be said in three phases a building phase, A Stability phase and a dissolution phase. Trust can happen in two forms: long term and short term. As there is no trust between the client and the cloud service provider, client can move from one cloud service to another which is known as Vendor lock-in. So to bring trust between client and cloud service provider, there is a need of SLA agreement. This paper presented an algorithm which defines Information-fetch task generator function and Evaluator function. Information-fetch task generator function generates a task that contains instructions to fetch the relevant data regarding SLA compliance at the cloud. Input to this function is the SLA between cloud user and the cloud service provider. Evaluator function evaluate the percentage of SLA breach at the cloud provider side. Input of this function is the information obtained from the information-fetch task. The algorithm first generate an information-fetch task. Then send the request along with generated information-fetch task to the cloud for execution at cloud. Whenever a set of tasks arrive at cloud, their hash value is calculated and a log is generated that contains hash value of the tasks and their arrival time stamp. After successful execution, the result are obtained from cloud then using the evaluator function evaluate the SLA breach at the cloud. If the percentage of SLA breach is greater than acceptable threshold, then user will get a notification as SLA is violating. This paper mainly tells how to monitor the SLA at cloud service provider that may be implemented at client end.

Mahyar Amini et al., [10] proposed "Dynamic SLA Aware Heuristic Solution for IaaS Cloud Placement Problem without Migration". Paper relies on most of the existing works ignore the dynamic nature of the incoming stream of the VM deployment requests from cloud customers which continuously arrives to the cloud provider infrastructure and which use migration by which an efficient method for placement in an IaaS cloud which is shows the demand behavior of a VM to a candidate target lost without migration. This result shows a method which is an efficient placement with a low demand that stated in SLA. Main

advantage is an Adaptive Random a placement technique that optimizes the placement of Virtual Machine in an IaaS cloud environment under a continuous stream of delay requests without any migration.

Asma al Falasi et al., [11] proposed "A Framework for SLA Based Cloud Services Verification and Composition", primal framework which enables dynamic specification of SLA and SLA based verification and composition for verifying the function and non- functional properties of the cloud which we can prove the importance in composing and selecting in the cloud. A framework includes the components: A Third-party Cloud Directory, The cloud providers, A Trusted composition Broker. This paper addresses the issue of cloud services composition, it also tells about the distinctive aspects of cloud services have our traditional SLA services and this is the characteristics influence in the process of cloud services.

Rajkumar Buyya et al., [12] proposed a SLA Oriented Resource Provisioning for Cloud Computing Challenges, Architecture, and Solutions where a cloud computing system offers subscription-oriented, enterprise quality computing services to users. Author discussed that cloud providers need to offer differentiated services and satisfy their quality of expectations of the users. The existing resource management systems in data centers are yet to support SLA oriented resource allocation, which need to be enhanced to realize cloud computing and utility computing. Author discussed that no work has been done to collectively incorporate customer-driven service management, computational risk management, and autonomic resource management into a market-based resource management system to target the rapidly changing enterprise requirements of Cloud computing. So this paper presents the challenges, architectural elements and visions of SLA oriented resource management. This architecture supports the integration of market based policies and virtualization technologies for flexible allocation of resources. The results obtained from this proposed system gives the system feasibility and effectiveness of SLA based resource provisioning in clouds. The four main entities involved in this architecture: users/Brokers, SLA Resource Allocator, Autonomic Resource Management, Virtual Machines and Physical Machines. Users /brokers in general, the user interact with the Cloud management systems through the brokers who act on behalf of users to submit service requests from anywhere in the world to the Clouds to be processed. SLA Resource Allocator acts as the interface between the Cloud computing infrastructure and external users/brokers. Autonomic Resource Management is a mechanism that ensures that Cloud providers can serve large amount of requests without violating SLA terms. Virtual Machines can be started and stopped dynamically to meet accepted service requests, multiple VMs can concurrently run applications based on different operating system environments on a single physical machine since every VM is completely isolated from one another on the same physical machine In physical machines the data center comprises multiple computing servers that provide resources to meet service demands.The main advantage of this paper is how to solve the problem of enabling SLA oriented resource allocation in data centers to satisfy competing applications demand for computing services. As now a days, user applications are becoming more complex and need multiple services to execute instead of a single service thus by addressing SLA oriented resource allocation in data centers provides critical link to the success.

Waheed Asalam Ghumman [13] proposed method for automation of the SLA life cycle in cloud computing. The management of automated requirements of the SLA between the cloud service provider and the cloud user has increased to minimize user interaction with the computing environment. Author discussed that the challenging research issues for possible SLA violations are negotiation, monitoring and timely detection. This paper mainly concentrates on developing distributed algorithms for automated SLA negotiation, monitoring, integration and timely SLA violations detection for cloud computing. A service level agreement is a part of a service contract where different properties of the services are formally defined. It is difficult to guarantee the service from the cloud provider when mainly deal with the huge data about the negotiation of the SLA. So hereby this algorithm presents the complete human readable formalization of the SLA. The specification of SLA is given in such a way that it satisfies the level of granularity, tradeoff between expressiveness and complexity which covers the user expectations and easy to manipulate, verify and evaluate the resource allocation mechanism on the cloud. In this paper, state-of-the art SLA based framework that expresses the regular SLA in machine readable format is developed, which automates the negotiation process and helps automated SLA management enforcement, monitoring, and integration. This paper also defines about the

system cost estimation and performance evaluation. Author says that there are different approaches to utilize SLA's depending on business flow and design model: Bottom-Up SLA, Top-down SLA, Parallel SLA. The SLA automation process starts with a standardized SLA description. After that, an automated SLA negotiation between cloud users and cloud providers take place and successfully negotiated SLAs are communicated. This algorithm as specifies the reliable and error-free delivery of cloud services.

Kaiqi Xiong et al., [14] proposed SLA based resource allocation in cluster computing systems. The framework presented an approach of resource allocation for an e-business application that minimizes the total cost of resources used by a service provider in order to satisfy the QoS defined in SLA. SLA is a set of QoS metrics and a price agreed between a customer and a service provider. SLA plays an important role in e-business application. The QoS includes the properties like percentile response time, cluster utilization, packet loss rate and cluster availability, Cluster plays an important role, has been proven as an efficient computing platform that uses group of computer resources to improve the performance and availability of a computer resources. In the proposed framework, author considered clusters locating either within a single service provider or multiple service providers, predicting e-business application performance based on current computer system statistics and a customer's perceived quality which makes service provider not only to assure quality services, but also avoids over provisioning of resources to the customers to satisfy SLA. Each cluster provides computational power for each node and it consists of a group of computational servers. Here probability and cumulative distributions of a response time is calculated by M/M/1/B queue method. This method supports the customer service requests which are served in a queue in FIFO manner. The downfall of the proposed framework is request is served based on FIFO manner not on the basis of priority.

Md Sabbir Hasan et al., [15] proposed an approach cloud energy broker towards SLA driven Green Energy planning for IaaS providers. This paper presents an idea to buy green energy dynamically from the market by considering the availability and price combination to make the data center green. The result of the proposed method shows the best trade-off using energy broker by maximizing the renewable energy under the strict budget constraint to minimize the use of the brown energy to limit the overall energy consumption of data center. Proposed work is evaluated using the real work load traced by Planet Lab. In this paper by using exploiting REC market for SaaS providers or end clients for the IaaS provider by offering Green Computing services. For validated SLA cross layer a broker framework is used. The proposed method further can be improved by providing an efficient solution for run time phase.

Asam Al Falasi et al., [16] discussed that SLA is mutual contract between clients and providers. Monitoring multiple SLA in a cloud requires highly collaboration among cloud providers to satisfy client service request, which is very challenging and complex. Monitoring scheme efficiently report the performance violations and its propagation to all dependent cloud servers. Monitoring activities should be undertaken to guarantee the pre-agreed SLA. Multi-level SLA detects violations and communicates these violations to concerned providers. For example: all requirements that are needed by the client are written in a SLA document, multiple SLA between client and provider is aggregated into one SLA document. Once client request is received by the cloud service provider it examines for QoS, schedules the resources that are needed for client and frequently monitor all the resources and also monitor multiple SLAs, so that SLA is not violated in a federated cloud environment. This mainly concentrates on the SLA based cloud computing working in the framework

Attila Kertesz et al., [17] proposed a framework that consists of SLA negotiation, brokering component, automatic service deployment. Client starts a negotiation for executing a service with certain requirements, the component that manages SLA execute service with specified requirements and sends to broker. Broker matches specific requirements with available requirements. If satisfied, it will replies to the component that manages SLA, these will continue until both side agree on the terms of SLA. Automatic service deployment monitors states of virtual resources and deployed services, it also reports service availability and properties to broker. It also contains the components agreement negotiation which mainly works on negotiation of the user-MN, MN-MB, MB-B and B-ASD. Then the service brokering which focuses on SRV architecture of the brokering related aspects. It as many brokering services Grid, SOA. Then the service deployment and virtualization which is an Automatic

Service deployment (ASD) it offers the workspace service which offers the virtualization capabilities virtual machine creation, removal and manage the CGSs.

Yuhong Zhao et al., [18] proposed constraint based model which describes the relationship among channel, bandwidth allocation, cloud cost, QoS constraints and also data availability. Using this model, the researchers and developers can view how the voice-on demand works in cloud platforms from the cost of elements to assignment of resources. The algorithm provides perfect data availability, high access locality, streaming quality at only 50%-90% of the cloud cost. The algorithm also serves model and produces a budget solution that reserves a SLA violation does not happen in cloud services. This paper proposes the heuristic distributed algorithm which is used for resourcing the scheduling. It is executed within the cloud platform. This algorithm is iterative and cost effective which are the values of global maximum.

IV. CONCLUSION

To maintain the hardware, software and storage the information for users Cloud Computing is a very useful. By which we can manage our data in a secure way and they even provide many services by the cloud which is very useful to the users. Since many users started preferring cloud it is quite difficult to give all the service by the cloud service providers. So an SLA is created between the cloud user and cloud service provider for the quality of service. By managing the SLA users can easily know about their SLA violations and even it is helpful to the cloud service provider regarding their reputation.

In this paper discussed various SLA based scheduling architecture and algorithms proposed by different authors about the satisfaction of the SLA agreement between the cloud user and cloud service provider. SLA violations can be known by applying different architecture by considering the parameters like memory, storage and CPU requirements. SLA violations can be known by any strategies discussed on the above papers.

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