



Monitoring and Controlling Multi Level SLA in Cloud Environment using Agent

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Abstract— *Cloud Computing is mainly used as utility where cloud user hires services on pay-per usage mode. The understanding between user and service provider is through Service Level Agreement (SLA) where all the terms and conditions are mentioned. The service provider is responsible for providing Quality of Service (QoS) as per SLA to the user. The SLA is implemented in multiple levels. Cloud provider needs to monitor and control the services being provided to user in order to avoid penalty or poor quality of service. This is possible only when all the terms and conditions are quantitative in nature. Presently, cloud service provider either monitors it manually or partially automated or service provider has to rely upon tools being used for providing cloud services like IaaS, PaaS etc. The purpose of this paper is to propose a model to monitor and control multi-level SLA in cloud environment by using software agent developed in Java Agent Development Framework (JADE).*

Keywords— *Service Level Agreements (SLA), Cloud Computing, Agents, SLA Metrics, SLA Monitoring & Controlling*

I. INTRODUCTION

In Cloud Computing environment cloud user/client avails computing resources from cloud service provider. Both the user and provider follow the terms and conditions mentioned in Service Level Agreements (SLA), so that reliable services can be availed or provided. Therefore, monitoring and controlling the services as per SLA becomes essential. This paper focuses on monitoring and controlling multi-level SLA using software agents.

A. Cloud Computing

With the exponential growth in the Information and Communication Technology (ICT) during past few decades, it has been observed that Computing is becoming the fifth essential utility after water, electricity, gas, and telephony [1]. Like other basic utilities, Computing is playing a vital role in day-to-day life of people in some form or the other. In order to support or accelerate the needs of Computing utility, various paradigms have been introduced. The latest in this is Cloud Computing paradigm and virtualization plays an important role in this paradigm. Cloud Computing is an on-demand computing where the end-users are provided with computing resources, applications and infrastructure like server, Operating System etc. as and when required or pay-per-use basis [2]. Cloud Computing is a rapidly spreading Computing paradigm which has benefits across various categories/sectors such as economic, architectural and strategic [3]. This not only reduces IT costs but it shifts the capital expenditures to operational expenditures, which leads to multi facet folds to increase the end-user satisfaction levels and gain in business goals. This helps the companies to focus on their core areas [4].

B. Service Level Agreements (SLA)

The core paradigm of today's modern and highly efficient business interaction is "Service Orientation" or "Service Oriented Architecture (SOA)". At the level, service orientation is very important for both kind of services, software and Hardware/Infrastructure [5]. Cloud Computing further exhibits a perfect way to provide on-demand Computing approach where resources are provided in accordance to predefined and pre-negotiated terms known as Service Level Agreements (SLAs). SLA not only provides exact conditions under which services are delivered but also plays an important and vital role in dynamic allocation of resources in Cloud paradigm [6]. SLAs can be managed at multiple levels in order to satisfy the pre-negotiation between the parties and avoid any confrontation in service oriented paradigm.

C. Monitoring and Controlling

Cloud Computing provides a mechanism to have an easy and efficient on-demand access to computing resources or pay-as-you-go Computing resources. This is an ad-hoc arrangement for Quality-of-Service (QoS) and hence the SLAs play a vital role in enforcing QoS. As the working of Cloud is dynamic in nature the continuous monitoring of QoS is essential [7]. It requires a volatile and dynamic monitoring agent which monitors the terms of SLA and act timely to provide QoS in cloud and ensures trust of customer in Cloud.

D. Software Agent

The agents are considered to be autonomous entities, such as software programs or robots. The agents interact with each other for cooperative goal. In other words agents can share a common interest or they can pursue their own interests. Agent can be defined as 'An Agent is an autonomous entity which performs a given task using information gathered from its environment to act in a suitable manner so as to complete the task successfully'. Agent must be able to change its behaviour based on changes occurring in its environment. An Agent is characterized by following properties.

- 1) *Reactivity* : The ability to sense and act selectively.
- 2) *Autonomy*: The ability to take decisions towards its goal.
- 3) *Collaborative behavior*: Agent can work in collaboration with other agents to achieve a common goal.
- 4) *Knowledge-level communication ability*: The ability to communicate with persons and other agents with language that is more resembling with human like "speech acts".
- 5) *Inferential capability*: Agent can act on abstract task specification using prior knowledge of general goals and preferred methods to achieve flexibility; goes beyond the information given, and may have explicit models of self, user, situation, and/or other agents.
- 6) *Adaptivity*: Being able to learn and improve with experience.
- 7) *Mobility*: Being able to migrate in a self-directed way from one host platform to another.
- 8) *Proactive*: Being able to take self-initiative to solve a problem in the environment.

Considering the above fact, an agent based system for monitoring and controlling multi level SLA has been framed and described in the paper. The paper has been organized into different sections; section II reviews the background and related work, section III describes the proposed system, section IV briefs the tools to be used in implementing the system and section V concludes and gives directions on future work.

II. BACKGROUND AND RELATED WORK

The multi facet increase in Cloud-Services, Cloud-Users and Cloud-Providers, leads to issue of load balancing and guaranteed SLA [8]. In the Cloud Computing framework, an automated SLA negotiation mechanism has been designed with Workload and Location-Aware Resource Allocation scheme (WLARA) [9]. SLA specifies the exact conditions (both functional and non-functional) under which services are or should be delivered [10]. SLA management is management of service delivery systems to meet the Quality of Service (QoS) objectives or goals specified in SLA. SLA management is a tough task. It requires all the quantifiable metrics or characteristics. Subjective parameters are also converted into quantitative characteristics. The SLA management can work efficiently after proper identification of quantitative SLA parameters [11]. SLA applies at multiple layers with SLA composition and decomposition across functional and organizational domains. SLA management covers all the stages in the SLA lifecycle i.e. SLA template design, SLA negotiation, SLA runtime and SLA (template) archiving [12]. The multi-level SLA management is essential for comprehensive management of possibly complex service stacks. In today's Cloud arena, SLAs are implemented (as desired by the Cloud users) at multiple levels to ensure the QoS standards desired by the Cloud users. In this preview SLA management is dynamic in nature [13]. The Cloud service provider aims to maximize the profit and minimize the penalties in SLA violations. Mainly the SLA violations are attributed to the unreliability of resource nodes and network connectivity [14]. Cloud provider needs to monitor and control the services being provided to user in order to avoid penalty or poor quality of service. This is possible only when all the terms and conditions are quantitative in nature. Presently, cloud service provider either monitors it manually or partially automated or service provider has to rely on tools being used for providing cloud services like IaaS, PaaS etc. Software agent is best in such an environment where various escalation levels can be defined to counter the situations. Escalation levels can be changing Virtual Machine (VM) configuration, migrating applications from one VM to another, migrating one VM from one host machine to another or creating a new VM on appropriate host machine, turn on/off host machine or outsource to other Cloud provider.

From the background and related work, it has been found that dynamic needs of Cloud users in terms of resources/services can be met with strong monitoring and controlling mechanism that ensures QoS as per SLAs at multiple levels. The software agent senses the changes happening in the environment and act accordingly.

III. PROPOSED MODEL

The proposed model consists of one agent that will monitor quality of service being given to cloud user and take appropriate action. Timely action is required to avoid any penalty imposed out of violation of SLA terms. Violations can be caused by either failure of resources (hardware or software faults) or network break. Figure 1 depict model of monitoring and controlling multi level SLA. The proposed agent named 'Monitor and Controlling Agent' (MCA) collects SLA terms and levels and then monitors the QoS being provided. Based on the tasks to be performed, MCA has two roles to play: Terms Collector (TC) and Terms Monitor (TM).

As a TC, MCA gathers the SLA terms from Cloud service provider whenever new cloud user is enrolled or registered. Along with terms, it also gathers the various levels and terms at each level. These terms are quantitative in nature. On the other hand as a TM, MCA gathers information from environment from time to time regarding QoS being provided to cloud user and compares with defined SLA terms. If any one of the terms is being violated, MCA dynamically updates the resources. The actions to be taken will also be defined in consultation with cloud service providers.

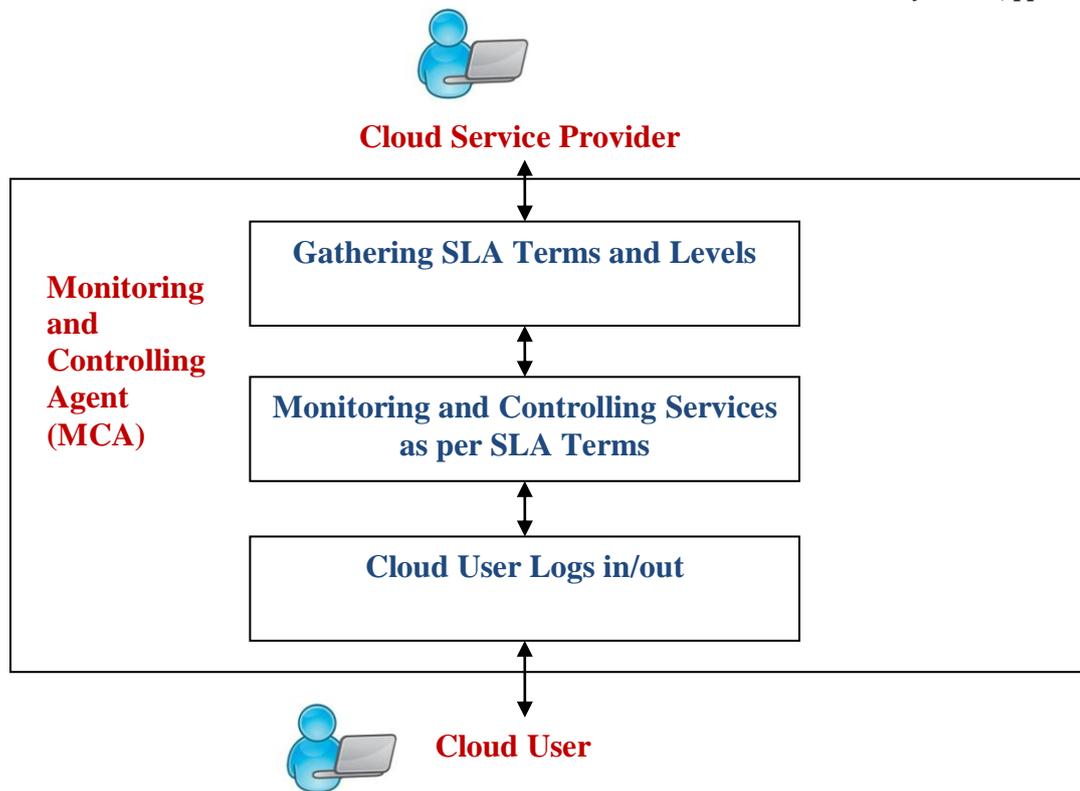


Figure 1: Monitoring and controlling multiple SLAs in cloud environment.

IV. DESIGN IMPLEMENTATION TOOLS

A. Modelling and Designing Agent based Monitoring and Controlling Tool

Agent modeling tools like Agent Unified Modeling Language (AAML) are used in modeling and designed software agent meant for Monitoring and Controlling (M & C) the services [19]. The following activities are carried out during agent designing.

- Agent splitting/merging / renaming
- Interaction specification
- Messages templates
- Description to be registered/searched
- Agent-resource interaction
- Agent-user interaction
- Internal Agent Behaviour
- Defining an ontology
- Content language selection

B. Implementation of Agent

After designing agent for M & C multi-level SLA in Cloud environment, agent has to be implemented using agent Java Agent Development Framework (JADE) and MySQL as backend database support. The agent takes care of the SLA parameters and monitor and control the implementation of various SLA terms at different levels and ensure QoS being provided.

C. Verification of Tool

In the verification phase, the simulator like CloudSim is required to test the functionality of utility considering all the possible scenarios. CloudSim is a very extensible and flexible simulation toolkit based on industry standard Java environment [20]. The CloudSim toolkit supports modeling and creation of one or more virtual machines (VMs) on a simulated node of a Data Center and further maps the jobs to suitable VMs [21]. CloudSim also allows for simulation of multiple Data Centers, migration of VMs for reliability and automatic scaling of applications [22].

D. Java Agent Development Framework (JADE)

JADE platform is a popular FIPA (Foundation of Intelligent Physical Agent)-compliant platform for the development of Multi Agent Systems [23]. JADE is software framework fully implemented in Java language. It simplifies the implementation of (Multi Agent Systems (MAS). The only system requirement for JADE is Java Run time version 1.4 or higher [24]. It simplifies the implementation of MAS through a middle-ware that complies with the FIPA specifications and through a set of graphical tools that supports the debugging and deployment phases

E. MySQL

MySQL is a world's most widely used open source multi-user relational database management (RDBMS). It runs on Windows, Linux and other major OS/platforms. It is one of the most widely used databases for web applications and central component of widely used LAMP open source web application software stack (Linux, Apache, MySQL, Perl/PHP/Python).

F. Operating System

The developed tool can be implemented on any Operating System (OS) due to its platform independent characteristics. The OS can be Windows or Linux. For the purpose of carrying out research work Windows 2008/12 will be used.

V. CONCLUSION AND SCOPE FOR FUTURE WORK

This paper describes the model to monitor and control multi level SLA in order to provide quality services in Cloud Environment using agent. The agent dynamically scales up and down the resources whenever the SLA is violated and takes action whenever required. The scope for future work includes: identification of SLAs and levels; actions to be taken in case services are violated; modeling and designing the agent; implementation in JADE and testing the developed agent.

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