Challenges of Quality of Service Monitoring in Cloud Computing Solutions

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Abstract— **The increased uptake of cloud computing solutions has led to an increase in cloud service providers, who provide similar services packaged at different rates and at different Quality of Service (QoS). This posses a challenge to the cloud users who have to make a choice or compare between two or more cloud providers in terms of performance of their cloud solutions. Whereas models exist for developing tools to measure QoS, most are vendor specific thus multi vendor performance comparison is not possible. This paper recommends development of a model that will be vendor neutral and thus enable multi vendor cloud QoS monitoring tool development to enable inter cloud QoS comparison.**

Keywords- Quality of Service, Vendor Neutral, Cloud, Cloud Computing Introduction

I. INTRODUCTION

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [1].

Cloud computing refers to applications and services that run on a distributed network using virtualized resources and accessed by common Internet Protocols and networking standards. It is distinguished by the notion that resources are virtual and limitless and that details of the physical systems on which software runs are abstracted from the user [2].

Cloud computing can also de defined as a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet [3].

The cloud is a set of hardware components, network devices, storage space, software solutions and interfaces that enable the distribution of computing as a service [4].

A key differentiating element of a successful information technology (IT) is its ability to become a true, valuable, and economical contributor to cyber infrastructure. Cloud computing embraces cyber infrastructure and builds upon decades of research in virtualization, distributed computing, grid computing, utility computing, and more recently networking, web and software services. This basically is the driving force behind cloud computing[5].

Further a powerful underlying and enabling concept is computing through Service Oriented Architectures (SOA) - delivery of an integrated and orchestrated suite of functions to an end-user through composition of both loosely and tightly coupled functions, or services often network based [5].

Based on these definitions, the cloud can be defined as a pool of virtualized computing resources that can be dynamically provisioned in a multi tenant fashion, while cloud computing can be defined as access to and use of computing resources as a service in a multi tenant fashion.

With this advancement in cloud computing technology, more and more companies are opting to adopt this technology due to lower cost of investment compared to actual purchase of hardware and software systems. With this trend by most companies, more and more cloud service providers are coming up, leading to competition for available clients.

To facilitate the client in choosing which cloud service provider offers better services, there has to be a mechanism through which clients can gauge the quality of service offered by the various cloud providers. This paper explores the various models for ascertaining the quality of service offered by various cloud providers and the shortcoming of those models.

II. QUALITY OF SERVICE MONITORING IN CLOUD COMPUTING

The term Quality of Service (QoS) is a multi discipline term used in all industries involved in providing services to the public. One of the areas where the term is widely used is in the Information and Communication Technology (ICT) sub sectors, namely telecommunication and computer Networks.

The term QoS in the context of telecomunication is defined as totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service [6].

The term QoS in the context of computer networks is defined as the capability of a network to provide better service to selected network traffic over various technologies, including Frame Relay, Asynchronous Transfer Mode (ATM), Ethernet and 802.1 networks, Synchronous Optical Network (SONET), and IP-routed networks that may use any or all of these underlying technologies, with the primary goal of QoS being to provide priority including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics[7].

In the context of cloud computing, QoS refers to the levels of performance, reliability, and availability offered by an application and by the platform or infrastructure that hosts it [8]. With the growth of public cloud offerings, for cloud customers it has become increasingly difficult to decide which provider can fulfill their QoS requirements, since each cloud provider offers similar services at different prices and performance levels with different set of features [9].

III. QUALITY OF SERVICE MONITORING MODELS FOR THE CLOUD

The various models that are used as a baseline for developing cloud QoS monitoring tools are the agent based model, The Quality of Service MONitoring as a Service Model (QoSMONaaS), CloudQual and Adaptive QoS-driven Monitoring Model. A detailed description of each model is as below.

A. Agent Based Model

This model uses agents installed in various infrastructures (Virtual Machines) in the cloud. An example of a cloud QoS monitoring tool that implements this model is the Ganglia monitoring system, initially designed for high performance computing systems such as clusters and Grids, is now being extended to clouds, by the means of sFlow agents present in the Virtual Machines [10].

A high level architecture for this model is shown in figure 1 below.

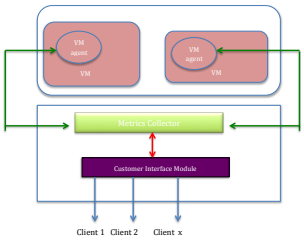

Figure 1: High Level Architecture for Agent Based Model

B. The Quality of Service MONitoring as a Service Model (QoSMONaaS)

This is a portable architecture that implements a dependable (i.e. unbiased, reliable, and timely) facility for monitoring the QoS being delivered at the business process level on top of a generic cloud platform [11]. The architecture is portable in the sense that it can be ported from one platform to another with minimal modifications. A high level architecture is as shown in figure 2 below.

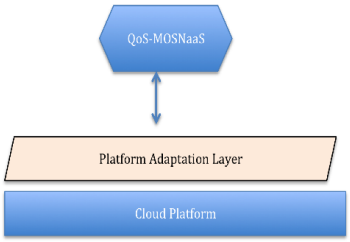

Figure 2: High Level Architecture for QoSMONaaS Model

Adapted from [11].

C. CloudQual

This is a quality model that defines six quality dimensions and five quality metrics from service perspective, i.e. an end-user's viewpoint [12]. The dimensions and metrics used in this model are usability, availability, reliability, responsiveness, security and elasticity.

A high level architectural diagram for this model is as shown in figure 3 below.

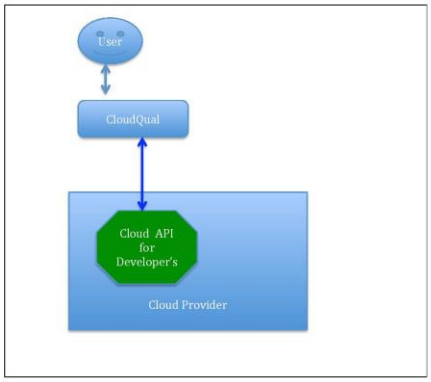

Figure 3: High Level Architecture for CloudQual.

D. *Adaptive QoS-driven Monitoring Model*

This is a model that offers flexible and dynamically reconfigurable QoS monitoring services to adapt to various cloud based service characteristics [13].

This model uses various modules, namely monitors, SLA verifier, certifier and the driver each of which has a specific role. According to Serhani et al 2014, the local and global monitors implement a set of modules (or APIs), each of which handles specific functionalities.

The Monitor module measures performances against indicators, detects violations as soon as they occur; the SLA verifier module, analyses the service agreement parameters (or thresholds) and verifies whether these parameters can be guaranteed prior to start the monitoring of a service; the Certifier module certifies that a SaaS has passed the SLA verification tests, and then grants a certificate to the verified SaaS provider and the Driver is the entity that initiates/triggers the monitoring process after passing all the necessary verification tests.

A high level architectural diagram for this model is as shown in figure 4 below.

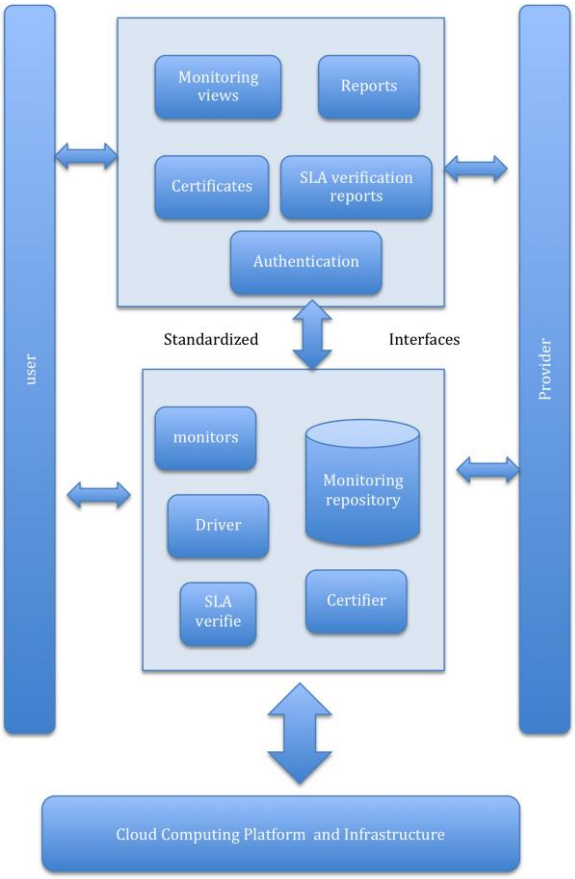

Figure 4 : High Level Architecture for Adaptive QoS Model.

Adapted from [13].

IV. CHALLENGES OF QOS MONITORING IN THE CLOUD

One of the drawbacks of cloud monitoring tools is their portability. This reinforces the fact that many cloud specific monitoring tools are commercial and vendor dependent, which makes the tools less flexible and portable and means that their results are neither extensible nor comparable to other platforms [14].

Cross check of the above cloud QoS models shows that they are tied to the physical infrastructure of the service provider and hence a monitoring tool developed using any of the above model can not be used across multiple cloud vendors. In cases where the tool monitors several vendors, it is because the tool was customized for those various cloud providers through their open APIs.

V. VENDOR NEUTRAL CLOUD QOS MONITORING MODELS

To overcome the above stated challenges, the best approach would be to develop a cloud QoS monitoring model, that is

vendor neutral and hence not dependent on the underlying infrastructure of any cloud provider and can thus be used by all cloud users to monitor the performance of any cloud solution.

VI. CONCLUSION

This paper recommends a further study on QoS Monitoring models, with an aim of developing a vendor neutral and platform independent model that can be used to develop a vendor neutral cloud QoS monitoring tool. The advantage of this model will be that monitoring tools developed from it will enable inter cloud performance comparison enabling cloud users to make informed decision on which provider to use.

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