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Fog Computing-Security Platform for IoT and Cloud in-Healthcare System

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***Abstract:** The introduction of cloud computing has revolutionized business and technology. Cloud computing has merged technology and business creating an almost indistinguishable framework. Cloud computing has utilized various techniques that have been vital in reshaping the way computers are used in business, IT, and education. Cloud computing has replaced the distributed system of using computing resources to a centralized system where resources are easily shared between user and organizations located in different geographical locations. Traditionally the resources are usually stored and managed by a third-party, but the process is usually transparent to the user. The new technology led to the introduction of various user needs such as to search the cloud and associated databases. The development of a selection system used to search the cloud such as in the case of ELECTRE IS and Skyline; this research will develop a system that will be used to manage and determine the quality of service constraints of these new systems with regards to networked cloud computing. The method applied will mimic the various selection system in JAVA and evaluate the Quality of service for multiple cloud services. The FogTorch search tool will be used for quality service management of three cloud services.*

***Keywords:** cloud computing, quality of service, cloud services, FogTorch.*

I. INTRODUCTION

Quality of service (QoS) is the allocation of resources to any application to guarantee a service level that will ensure performance, reliability, and availability of the network. In earlier cloud designs there were issues with the attainment of QoS especially in the networked cloud computing technologies [1]. This paper will evaluate the This study will evaluate the applicability of quality of service into networked cloud computing and the effect on the performance on resource management. The quality of service in networked (distributed) cloud computing has been researched for a while; therefore, various methods have been used to improve the quality of service of this technology. First, virtualization techniques for cloud computing have been developed so that it can optimize the utilization of resources and the data access method. These techniques have also ensured maximum availability and restoration especially in case of disaster management and recovery [2].

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Further, this paper will provide a direction for the quality of service management while managing the security of data. The current concern for
the quality of service has been fueled by the increase in the number of the organization using the cloud for storage, backup, and distribution of computing resources [3]. For instance, large online retailers have resorted to using the cloud to ease the process of distributing their operation across the globe, for instance, the Amazon Web Services [4] [3]. The commercial sector is also among the leading users of on-demand customer relationship management (CRM) software that is managed in the cloud. Cloud management has enabled the automation of some service such as sale force, marketing document management, and analytics and custom application development [1].

Though cloud computing has numerous advantages, some challenges are associated with Quality of Service (QoS). The QoS is fundamental especially for the third-party service providers as the customers would expect to receive the services as advertised [5]. These cloud providers would use a better QoS to support the tradeoff between the quality and operation cost. The violation of the initial service level agreement will lead to loss of business to the cloud providers and the customers. Some providers indulge in over-provision so that they can ensure satisfaction of the customers in the SLA [6]. Although the method seems to be viable, it sometimes fails to optimize the utilization of resources by the private cloud users. The complexities associated with the QoS have led to researchers exploring automated QoS management techniques which will allow them to leverage the challenges encountered by the users and the cloud providers [4] [5] [2]. The reliability of cloud computing is vital to ensure ease of data access as a step towards the attainment of QoS. The QoS of the cloud is also dependent on resource usage in different environments classified as:

Public cloud computing: this is the practice of provisioning computing resources and services for open use especially public organization that host the services [1].

Community cloud computing: This is where the virtual environment resources are shared by various organization hosted externally, or it may be hosted by one of the organizations [7].

Private cloud computing: This entails the virtualization of resources for use by a single organization in a virtual environment that is either internally or externally hosted [8] [1].

Hybrid Cloud Computing: This type of computing is made of two cloud architectures that would form a unique entity while offering the benefits of multiple deployment techniques which can either be internally or externally hosted [5] [1] [3].

II. ADVANTAGE OF CLOUD COMPUTING

Self-service: Cloud Computing is beneficial as it allows the client the liberty to launch the application r utilize any resources allocated to them based on their subscription without the need for the cloud providers help [3]. The client also designs how they will access their services from the wen portals; thus the quality of service can be designed from the filtering methods.

On-demand: Cloud computing is based on the architecture that the service client can access a service based on their request which is a process that will be fulfilled automatically [1].

Pay as you go: The payment scheme of the technology is based on a cost-efficient method that will provide the user with the service they need on they pay [9]. The client can access any service as long as they pay for it; thus the unit price is defined and then inducted to the metering to measure the consumption [9] [1].

High availability and resilience: Cloud provides increased accessibility and availability of computing resources [10]. The cloud services are designed in such a way that they can be monitored effectively to give the service status.

Elastic capacity: Cloud computing possibility of elasticity; thus, the workload can be increased, or features can be enhanced any time to accommodate changes in the user requirement [1] [8]. This will save the client the need to add hardware resource while dynamically adding this feature to the cloud subscription of the user. Virtualization reduces the need for data center scalability while improving the network [9].

The architecture of cloud computing

The architecture of cloud computing entails the system design of the various software components that are contained within the delivery of the cloud computing such as the cloud computing components that collaborate to accomplish task or messages over a queue. The architecture of cloud defines the components and the specific subcomponents that are required for the operation of the cloud network [8] [6]. Technically the cloud components are made of the front-end which contain the application either desktop or mobile and the backend, i.e., the storage, service and the server [4]. Additional, the cloud system and network such as the intranet, internet and intercloud are vital in supporting the access of the computing resources. Figure 1 below illustrates a basic design of the cloud computing architecture.

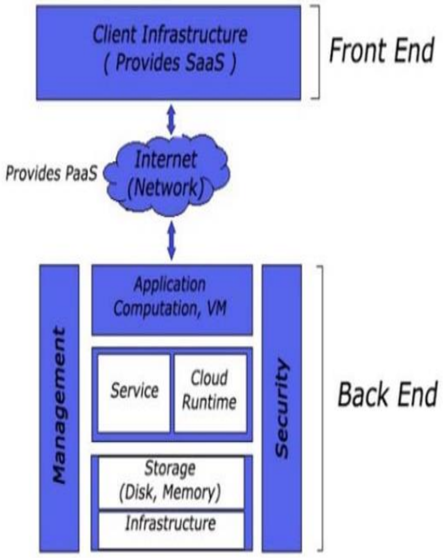


Figure 1: A simple cloud computing architecture

III.CLOUD COMPUTING MODELS

The variation and evolution in the cloud computing architecture and the distributed resources have led to the development of various deployment models such as:

Software as a service (SaaS): The technique of deployment enables the user to access different applications via the cloud provider infrastructure. The applications are accessible to the client on-demand and through various devices [11]. The software is available through a thin client interface like a web browser, android application, etc., common software as a service provider are Google App, Salesforce.com, Google Mail, etc. [3] [10].

Platform as a Service (PaaS): This method allows the user to deploy an application on to a selected development environment or on a suitable development language that is supported on the cloud [1] [6]. This technique frees the application developers from the need of installing an integrated development environment (IDE) allowing them to focus on the development and coding of the various utilities within their scope, e.g., the Amazon Elastic Compute Cloud (E3), Google AppEngine, Force.com etc., [8] [3] [4] [1].

Infrastructure as a service (IaaS): This provides the user with the facility for provisioning, storage, processing, computing resources and network that is deployed and ran arbitrarily [12]. Additionally, another system provides applications and operating system. The Amazon Private Cloud is a good example of IaaS [1].

IV. QUALITY OF SERVICE METRICS IN NETWORK CLOUD COMPUTING

Cloud computing is the latest development in the evolution of on-demand information technology services and products that are provided within the network and distributed systems [1]. Cloud computing derives heavily from the principle of grid and utility computing [6] [11]. Similarly, in cloud computing like in any technology, there is the need for a guarantee that the level of performance will always be maintained above a certain point.

The management of this quality level ensures that mechanism meets the service requirements [8]. Therefore, considering the development in the distributed system, it has become relatively easy to define the cloud and outline the various guarantees that are associated with cloud computing.

Resource Management

The network computing led to the need for resource management that can be loosely interpreted as the dynamic allocation of tasks and computing resources required a process planner, i.e., a scheduler to enhance the performance of the system [3] [10] [7]. The QoS enable in networked systems has been made is by the scheduling of tasks that ensure that the resources needs are met for each client and user. The scheduling ensures that the resources in this system are not over provisioned [6]. The sequences of the tasks are mapped as the workflow managed by graphs of precedence and constraint nodes that represents the specific order of services in which the computing resources can be processed [9]. The attainment of fully distributed cloud computing reduces the complexities associated with the algorithms used for development, path, and task monitoring and scheduling. The algorithm has also ensured that the system includes a feedback system that will always provide the schedulers with reports of the workflow [8] [6]. The feedback system evaluates the performance based on the amount of useful work done in comparison to the amount of time and resources utilized. The resource management tools are also to evaluate the fault tolerance of a system and the migration of tasks [5].

Service Level Agreement

The Service Level Agreements (SLAs) are significant as they guarantee the reliability and availability of the service and computing resources provided to the client [4] [1]. For instance, the Web Service Agreement is an example of SLA standardization. The SLA contains the following three components used in QoS in any networked system [13]: a schema used to outline the agreement, a schema for the specification of the agreement template and operations in the management of the agreement life-cycle [13] [1]. The life-cycle model is not accommodative of some factors such as facilities for negotiation and renegotiation of an agreement and the dynamic nature of the networked economy. The existing problem in the research with regards to QoS is concerned with the accommodative nature in the grid [8]. Further, the other form of the problem is concerned with risk assessment and the dependability of service providers. The cloud QoS cannot also assure the determination of issues between two parties, and thus, there is a need to improve this behavior. The standardization of the various aspects of SLAs will enhance clarity and improve the comprehension of SLAs in the cloud service [2] [5] [6].

Virtualization

This is a recent development in computer science providing an efficient way of accessing multiple computers, systems, data centers, hardware and virtual machines [1] [7]. Virtualization has made it easy to access data over a network. The virtualization of computing resources has enhanced the testing and installation of different software and operating systems that require various virtual configuration. Virtualization is affected by the increase in the memory, processing power and the input-output devices [5]. Virtualization enhances the hardware configuration without the recoding of the existing devices. Virtualization ensures reliability, availability, consistency, and security of the applications on-demand [6]. The current changes in the hardware virtualizer have led to the improvement of the flaws that were part of the initial systems through the integration of different robust improvement [7].

V. RELATED WORKS

The significance of cloud computing in today's business environment has led to continuous work being done to improve the quality of Service offered by these services. This part of the study will present a sectional overview of the research being accomplished so far [9]. Although so much has been done by educators, scholars, businesses and researchers, in attaining the quality of service in cloud computing there remains several challenges that would require a reference. These researches have come up with better approaches to monitoring the performance of a service and the quality of the same service [13]. The development of the virtualization of resources in a distributed network has introduced the need for security of the data in the cloud, consistency of the on-demand data and availability of data for restoration [12] [7]. The following are some of the developments that have been made through research to ensure the quality of data in the cloud.

Brogi and Forti (2017), developed a system that will transfer the cloud capabilities such as the computational power, communication features, storage and security to the edge of the network. This development was made with IoT in mind ensuring that the reliability of cloud will be able to support the activities of this emerging technology [8]. The technology is considered revolutionary as it will evaluate the segmentation, adaptive deployment of functionalities and distribution of things via the cloud [8]. The primary challenge encounter in the research is the intrinsic heterogeneity, the enormous scale of infrastructure and the hierarchical structure that will be exploited. The paper proposes a simplistic way of deploying a QoS-aware multicomponent application for IoT in the infrastructure [8].

Singh, Agarwal, and Mishra (2015) have acknowledged that quality of service is a vital element in the reservation of resource contained in service-oriented distributed systems such as grid computing [1]. The concept of virtualization has increased the challenges for the enhancement of the quality of service. The research acknowledges that cloud computing has become an essential technology in the most field especially in data storage and computing resource sharing over distributed networks thus there is need to improve quality management to ensure that the system operates with allowable limits [1]. The paper provides a review of the cloud and efforts taken towards the attainment of quality via emphasizing on the existence of a gap between research and practice [1].

According to Odun-Ayo, Ajayi, and Falade (2018), cloud computing is a dynamic information technology that delivers on-demand computing resources [3]. The service provider offers applications that are accessed online by the user to access the resources. The applications are not dedicated to a single user but rather shared by the users [3].

The users have no control over the system and the access to the resources thus to meet their requirements the service provider always ensure the quality of service is as in the initial agreement [3]. Therefore, it is imperative that the cloud service provider (CSP) always ensures that the quality of service is as stipulated in the Service Level Agreement (SLA). The findings of this paper are in-line with the fact that the QoS metrics are a concern of both the user and the CSP [3].

VI. ANALYSIS OF QUALITY OF SERVICE

The study of the QoS was accomplished by first evaluating the design of the selection system. The selection system contained several system and agents that were bundled to be accessed via a user interface. A processing agent handled the user query via the cloud service and the selection agent in the FogTorch application provided the data from the three cloud service provider that were selected. Figure 2 below illustrates the simple architecture of the tool used to obtain information from the cloud databases.

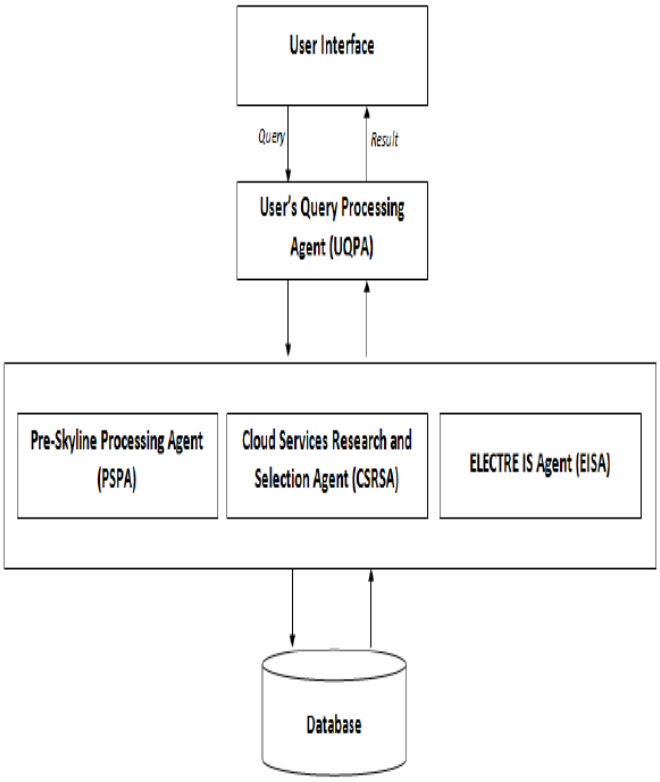


Figure 2: The Schema of the scraping tool

VII. RESULT OF DATA ACQUISITION

The result for the three cloud service providers was monitored and presented for 20 iterations as illustrated in the tables and figure below.

Results for cloud service provider A

Table 1: The resource utilization and assessment for deployment in a 1 TB environment.

	Heuristic Rank	Consumed RAM	Consumed HDD
1	54.75733	0.2	0.0625
2	59.73527	0.2	0.0625
3	44.80145	0.2	0.0625
4	39.82351	0.2	0.0625
5	94.14406	0.316667	0.09375
6	49.77939	0.316667	0.09375
7	99.122	0.316667	0.09375
8	34.84557	0.316667	0.09375
9	76.1528	0.316667	0.09375
10	71.39325	0.316667	0.09375
11	29.86763	0.366667	0.125
12	24.88969	0.366667	0.125
13	20.35076	0.483333	0.15625
14	70.34964	0.483333	0.15625
15	65.26196	0.483333	0.15625
16	15.26307	0.483333	0.15625
17	10.17538	0.483333	0.15625
18	5.087689	0.483333	0.15625
19	90.04412	0.483333	0.15625
20	84.95643	0.483333	0.15625

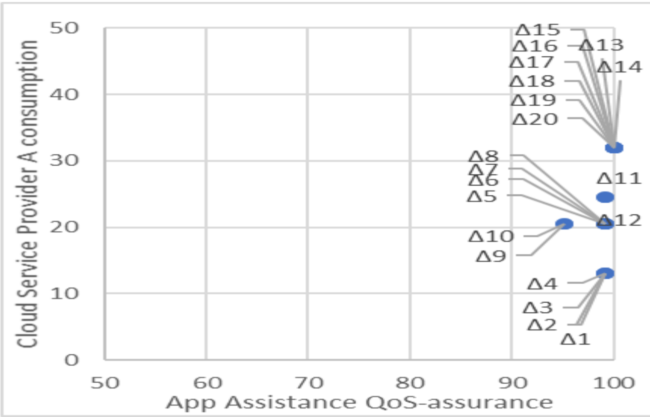
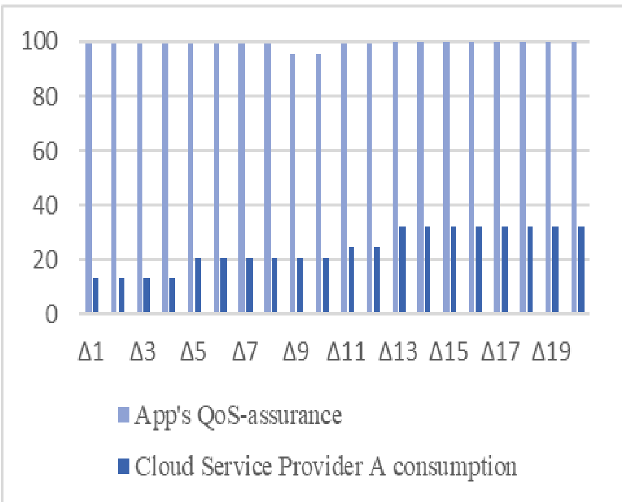


Figure 3: The application Quality of Service for the first cloud service provider

Figure 4: The resource consumption of the first cloud service provider



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Cloud Service Provider B

Table 2: The resource utilization and assessment for deployment in a 1 TB environment

Heuristic Rank	Consumed RAM	Consumed HDD
70.106225	0.2	0.0625
80.1214	0.2	0.0625
50.075875	0.2	0.0625
40.0607	0.2	0.0625
60.09105	0.316666667	0.09375
30.045525	0.316666667	0.09375
95.163	0.316666667	0.09375
85.6467	0.316666667	0.09375
20.87635	0.483333333	0.15625
10.438175	0.483333333	0.15625

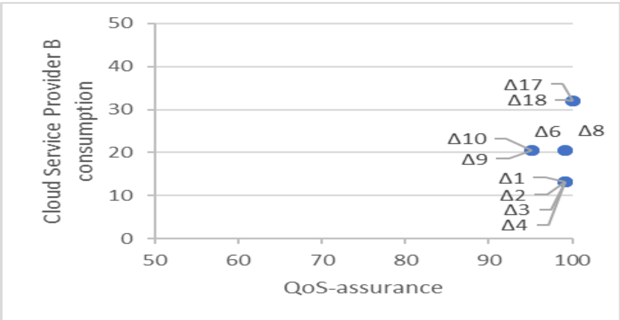

Figure 5: The application Quality of Service for the second cloud service provider

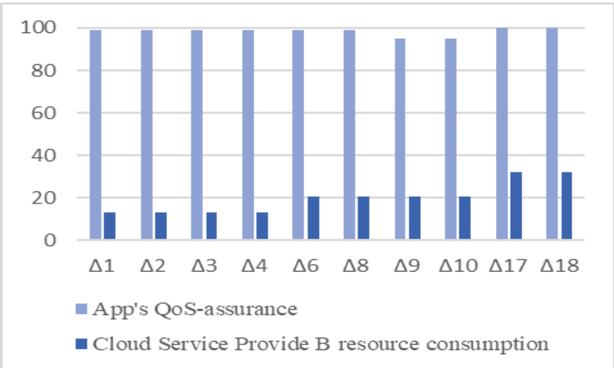

Figure 6: The resource consumption of the second cloud service provider

Cloud Service Provider C

Table 3: The resource utilization and assessment for deployment in a 1 TB environment

	Heuristic Rank	Consumed RAM	Consumed HDD
1	53.47530556	0.2	0.0625
2	58.82283611	0.2	0.0625
3	42.78024444	0.2	0.0625
4	37.43271389	0.2	0.0625
5	83.45747619	0.316666667	0.09375
6	76.64053492	0.316666667	0.09375
7	48.127775	0.316666667	0.09375
8	32.08518333	0.316666667	0.09375
9	59.62158373	0.316666667	0.09375
10	63.75	0.316666667	0.09375
11	26.73765278	0.45	0.1875
12	21.39012222	0.45	0.1875
13	73.88070198	0.566666667	0.21875
14	66.54611905	0.566666667	0.21875
15	16.43129167	0.566666667	0.21875
16	10.95419444	0.566666667	0.21875
17	5.477097222	0.566666667	0.21875
18	56.03116746	0.566666667	0.21875

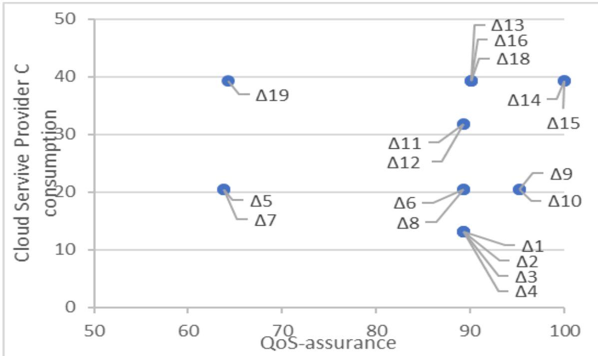

Figure 7: The application Quality of Service for the third cloud service provider

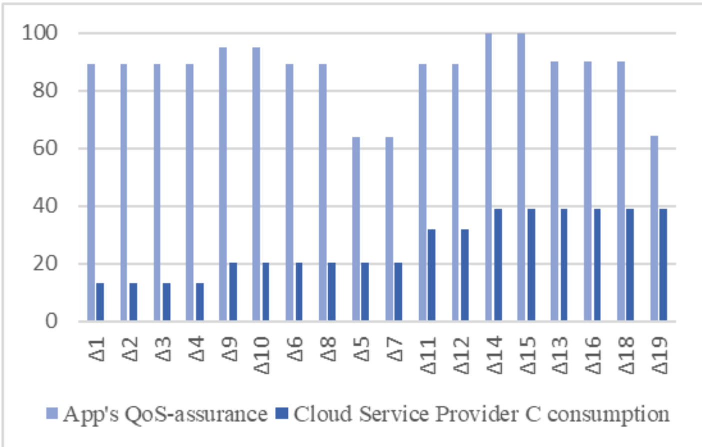

Figure 8: The resource consumption of the third cloud service provider

VIII. DISCUSSION: QOS CLOUD COMPUTING

The quality of service parameter for cloud computing will be evaluated in terms of performance, response, reliability, cost, and security [5]. The results of the evaluation have provided resource consumption, performance characteristics and application quality behavior. Cloud service provider B performed very well compared to the other two with the CSP C performing poorly especially in the heuristic ranking. In terms of application QoS assurance, the CSP has a 100% guarantee to the quality in comparison to the less than 50% resource consumption by the application that was determined. The CSP C has the largest resource consumption while CSP B had the lowest resource consumption. The implementation of the cloud deployment scheme has shown that most cloud service provider guarantees QoS and they can support some applications in their platforms. In terms of performance, the CSPs offered different solutions that are vital for the IT need of a business such as the IaaS, PaaS and SaaS [1].

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The solution offered has accuracy in response time, stability, suitability to the business needs and interoperability. The provision of QoS I these technologies ensure the satisfaction of the users. It is also evident from the investigation as there are security and privacy of data. Each application was segregated from the rest to allow the access of data and resource via their channel [12] [10] [13]. The hosting requirement led to the application of stringent security policies to alleviate breaches and access from unauthorized personnel. The cloud service providers evaluated above have also shown the usability of their cloud services which is significant in ensuring change-on-demand. The usability of a cloud service allows an organization to utilize its cloud resource while maintaining accessibility, operability, and installability [2] [6].

IX. CONCLUSION AND FUTURE WORK

The virtualization of computing resources has been associated with an increase in business performance and fast availability of these resources to an organization via the cloud services. This paper presents a quantitative evaluation of QoS of three cloud providers evaluating the availability of resources, performance, and usability of the service. The initial review illustrated that researches had been done to ensure the improvement of the quality of service in cloud service. The parameters suggested in these researches were resource consumption, power requirements, data accessibility, and the improvement of response time. The evaluation in this paper thus answers some of these questions but little has been done to determine the performance of the CSP during peak hours. This research will encourage future work to be undertaken to determine QoS during increased traffic in the cloud service provider.

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