

Survey paper About Quality Assurance In Cloud Computing

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Abstract—as the complexity in the cloud services increases day by day the role of brokers used in the cloud gain more importance. Here we basically resolve this issue by discussing preference based cloud service recommender that support MCDM approach.^[24] The implementation and specifications details are properly discussed in a unified way to deal with the problem. SC3 is a tool that compromises capabilities of the quality assurance dimension of CSB and also it strengthen the flexibility of cloud services. The anxieties between definition procedure and implementation procedure are separated by service completeness compliance checker (SC3). Now a days companies use cloud computing for their economic benefits and market competitions that increase the demand of “cloud computing”. So for the calculation of critical success factor of “cloud computing” we focus on plan do check act strategy.^[2]

Keywords—cloud computing, cloud broker, PuLSAR, IaaS, PaaS, SaaS, QoS, SOS.

I. INTRODUCTION

Over the last some years cloud services gain its importance and deliver many services that make the selection of cloud services among the different services a complex task for users. Cloud broker is highly valuable and act as intermediary between cloud services and users to select cloud services. Some previous work about the topic focused on ranking and competition factors. But today’s work focuses on qualitative factors. The model of cloud computing significantly comprises the use of computing resources that are remotely supplied over the Internet as a service.^[9,15] “Cloud computing” is a group of networks which can be accessed in simple and constant way and give an online environment for working without affecting the framework. The focus on change from a targeting infrastructure to provide compute resources and storage to economy based computing model to provide huge variety of resources is made cloud computing out of network computing. “Cloud computing” is a most prestigious way to connect through internet and provide cloud app services to end users.^[2,14] For qualified cloud app services hardware specification and software quality must be good enough to continuous and fast. As the environmental and market trends change rapidly the difficulties in the cloud services also increases so we use PDCA phenomenon to check the quality management cycle of qualities that we need. In future main focus is to elaborate the appliances of the proposed Cloud

based brokerage framework. Previous work done on cloud computing was all about the methods, strategies and mechanisms to allow the ranking and cloud services selection. But now as time change trends also change and existing work focuses on qualitative and quantitative characteristics. Qualitative characteristics can be response time and identified by precise metric. Quantitative characteristics are normally non-functional services and can be identified by imprecise metric.^[4]

But now this paper focused on following important things: In stage I, we describe introduction what cloud computing service, what is PDCA is, attributes of cloud computing and expected benefits. In stage II, we discuss our research literature review. In the stage III, we discuss different services models of cloud, preference based cloud service recommender and software quality assurance and standards and critical success factors. In stage IV, we discuss approach. In the stage V, we discuss recommended future work and conclusion of whole paper.

A. Cloud Computing

The term “cloud” means *internet* and “computing” means *software and services* that empowers the cloud to become so useful in our daily life. ^[2, 18] “Cloud computing” is a collection of hardware and software that provides facilities to end users by providing online opportunity. By using cloud computing user are able to access their desired files from any available device that have internet connection. For example, Google’s Gmail. Cloud can be of different types: public, private, community and hybrid.^[14]

“Public cloud” is basically canonical computing strategy which contains files and applications and facilities available to public by using internet.

“Private cloud” is made up of files and applications which are implemented and saved under the supervision of Information technology department.

“Community cloud” is basically shared by two or more than two organizations such as within a school or university.^[14]

“Hybrid cloud” as the name show hybrid cloud is a mixture of two or more public private and community cloud.^[14]

B. Plan-Do-Check-Act

“PDCA” is a cycle that was designed by American expert William Edward Deming that deals with the quality assurance principle and sometimes called as Deming cycle.^[2] This cycle consists of four steps that focus in business domain to control and enhance the regular progress of products. That contributes equally in cycle.

Plan develops and set goals to achieve the wanted results.

Do Allows plan to be represent and test new changes.

Check gather the data from plan and then compare and evaluate it.

Act called as adjust that check issues from do and check phase and improve it.

C. Attributes of cloud services upgradation

As the cloud service gain more importance so, comparing the cloud services and take a decision to choose cloud service lifecycle is very big issue. Many researchers do their research work to solve it. One of the most common and most cited works in our research work that we studied is service measurement index (SMI) that was developed with the corporation of CSMI.^[24]

SMI categorize the characteristics into seven attributes that are further refine and divide into three or more phases attributes. First level deals with brand name, service position, easiness of doing business and suitability. Second level describes robustness, reusability and performance. Third level describes technical competency and documentation work etc.

D. Expected benefits of Cloud Computing

There are many possible advantages of cloud computing technology some of them are:

^[14, 16]Low cost, improved performance, instant software updations facility, Improved document compatibility, data security, freedom to use services, access files any time from any device and anywhere internet can easily access last but not the least facility for any kind of person whether it's a teacher, student or others.

II. LITERATURE REVIEW

As the cloud computing increases sometimes it become complex for users so these complexities are managed by cloud services brokerage. The frame which provides solution for CSB with respect to virtual enterprises revolves around three general themes which include quality control, inhibition of failure and recovery, and optimization^[1]. Now a days companies use cloud computing for their economic benefits and market competitions that increase the demand of cloud computing. So PDCA research method is used as a tool to find the critical success factors for “quality assurance” in cloud computing^[2]. Brokerage capabilities and cloud services are improved through PuLSAR. It is a “preference based recommender” that uses multiple decision making approach for providing optimization as brokerage competency^[3].

In cloud based enterprises the flexibility of services is strengthen by the combination of cloud services brokerage. Due to this SC3 tool is used that provides capabilities for the quality assurance of CSB. So businesses and organizations can share their skills in a cooperative network^[5,7]. In cloud environment there is a problem of guarantee in service quality. This problem is increased by using funding platforms for multiple clouds. A model driven engineering technique is used to overcome this problem^[6]. Big data computing services are used for prediction and decision systems. Our focus is on the how to improve system testing and quality assurance in big data systems. Metamorphic testing (MT) is used for the testing program that do not have any predictions and also for the scientific applications. There are certain methods to guarantee the quality of big data applications which includes Model driven architecture (MDA), forecast, Testing and monitoring.

Now days it supports large data sets and in future it can also support difficulty of complex data sets^[8, 9]. For the quality assurance cloud computing provides services through which users can access data and resources by internet from anywhere without managing actual resources. it provides three basic services models (IaaS, PaaS, and SaaS). SoS method is used to allow “quality-of-service (QoS)” for users to access, monitor and response for enterprise systems which produce computing services by using cloud computing environment^[10, 13, 21]. Service level agreement (SLA) is used for the security issues for quality assurance of cloud computing at very low cost. Issues about SLA are followed by the Third party SLA (TP SLA) which monitors the trust and risk valuation modules. In this agreement the security requirement includes protection of account from un authorized access, maintain integrity, availability of cloud sources for authorized users^[11, 12, 16, 17, 18]. A complex infrastructure is required to run and execute the complex programming languages and software and also it is very costly. So in cloud based virtual lab framework the QoS is improved by IaaS model with respect to response time and speed^[14].

“Cloud computing” played an important role in solving complexities in organizations and for the growth of business. The main purpose of using this in business is for the reduction of cost. There is some security issues occur but to overcome these issues cloud service providers handles these cyber-attacks^[19]. The organization that used cloud service providers (CSP) have SLA which defines the levels of services includes performance and security expected from CSP. Third part auditors (TPAs) monitor the CSPs^[20]. Cloud computing provides resources like hardware, software and network to users. SaaS provides security and service quality and it can be accessed from anywhere in the world without paying any cost^[22]. The main issue in cloud computing is security, privacy, guaranteed SLA and performance of applications through the spread of resources in cloud. Our challenge for quality assurance in cloud computing is to overcome the privacy and trustworthiness issues^[23].

III. RELATED WORK

A. Cloud Computing Service Models

[24] There are three basic models of cloud computing service: *Software-as-a-Service (SaaS)*

It is a model that provides services to users through web without installing any application on their PC. The price of “SaaS” is based on monthly or annual fee so it’s easy to buy this model. Because of this organizations access services at less cost. Without internet connection SaaS is not usable. In SaaS data is safe in cloud.

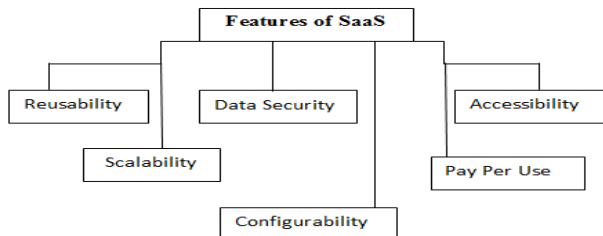


Fig 1.1 Features of SaaS

Platform-as-a-Service (PaaS)

It is a model that provides users a platform in which they can manage verify and develop applications. PaaS is used when you developed your own software and now you want to run it on publicly available platform. Development is easier in PaaS for running the application we need only PC and internet connection.

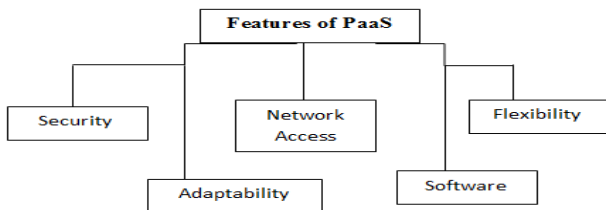


Fig 1.2 Features of PaaS

Infrastructure-as-a-Service (IaaS)

This model provides services to users to access the infrastructure according to their need like servers, storage and network and pay for it accordingly. In IaaS there is no chance of failure occurred. Without internet IaaS is unusable. “IaaS” is used when you have your own software and platform and now you want purchase hardware to run it.

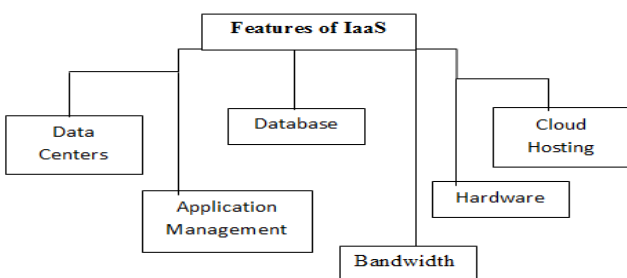


Fig 1.3 Features of IaaS

In this heading we discuss an approach that captures suggestions and preferences in both qualitative and quantitative way and also deals with ranking services. This approach contains four phases that are given below:

Phase 1

Define and show the problem related to rank in a hierarchical structure.

Phase 2

Computation the quality of services (QoS).

Phase 3

Computation the quality performance.

Phase 4

Aggregation of specific services weights.

C. Services ranking algorithm pseudo code

```

1. /* Generate criteria comparison matrices by
   considering siblings*/
2. ....
3. /* Calculate the aggregation criteria weights */
4. Criteria weight matrix create ← {}
5. Foreach {siblings, comp_matrix} in comp_matrix do {
6. Weight_vectors ← calculate relative weight
   (comp_matrix)
7. Criteria_weight_matrix U {siblings, weight_vectors}
8. }
9. Criteria_weight ← aggregate_weight
   (criteria_weight_matrix, criteria_hierarchy)
10. /* filter out the services */
11. ....
12. /* calculate the service weight/criteria */
13. Service_pairs ← get_service_pairs(services)
14. Comp_matrix ← create_comparison_matrix(service_p
   airs)
15. Weight_matrix ← {}
16. Foreach crit in criteria do {
17. Type ← get_criteria_type (crit)
18. Scale ← get_criteria_scale (crit)
19. Mandatory ← is_criterion_mandatory (crit)
20. Required_value_range ← get_required_value_range
   (crit)
21. Foreach pair in service_pair do {
22. S1 ← pair.service1
23. S2 ← pair.service2
24. S1_kpi ← get_service_att_value (S1, crit)
25. S2_kpi ← get_service_att_value (S2, crit)
26. Normalize (S1_kpi, type, value)
  
```

B. Cloud services recommendation method

```

27. Normalize (S2_kpi, type, value)
28. Comp_matrix [S1][S2] ← calculate
   _relative_service_importance (S1_kpi, S2_kpi, type)
29. Comp_matrix [S2][S1] ← fuzzy_inversion
   (comp_matrix [S1][S2])
30. Weight_vectors ← calculate_relative_weight
   (comp_matrix)
31. Weight_matrix ← weight_matrix U {crit,
   weight_vector}
32. /* rank services */
33. Overall_weight ← aggregation_weight_matrix
   (weight_matrix, criteria_weight)
34. Sort_services_by_weight (services, overall_weight)

```

This proposed approach provide the ability to explain the selection property on the basic of filtering the services. This approach first pick a number from rank the filter it and sent it to customer.

For example top ranked services has number 0.35 so number from 0 to 0.35 are acceptable and remaining can be used for further future suggestions. ^[4]

D. Preference based cloud services recommender (PBCSR)

Here we will discussed the conceptual architecture of “PulSAR”. “PulSAR” called as a red box in architectural figure. It consists of six components out of among five provide means to external software and sixth one use ranking algorithm.

Consumer preference profile management component

This component deals with users profile functionality to create, update and delete the user’s profile. In this component user preference profile is a logical container that stores the user data and problems related to the system. Selection criteria for each preference profile are different but same for selection problem.

Consumer feedback management component

As the name shows this component deals with the user’s feedback and service facilities that user used for their work. In this component user use the required service, evaluate these services on the basis of their criteria then give feedback. This component basically deals to manage changes and propose changes and updates to improve the service’s attributes.

Recommendations management component

This component used to store recommendations that come from the customer side. It collects the customer response related to services he/she used. Most important thing is, it receives the customer response based upon their ranks and filter them according to policy choose. This part of PulSAR basically manages recommendations that customer wants from the system in future.

Optimization attributes management component

This component deals with optimization attributes of the desired model and manages all these attributes. This subcomponent is responsible for CRUD means search create retrieve update delete operation in the model.

Optimization opportunity management component

It deals with the subscribing receiving and process service life cycle management called as “SLM”. SLM launch its events through special factor known as event bus. This component is responsible to check if any opportunity linked with the customer preference profile is affected then it calls the cloud service selection engine and prevent problem.

Multicriteria cloud ranking service engine

It implements the service ranking and selection algorithm that can call by both “optimization opportunity management” system and “Customer preference profile management system”.

PulSAR is not depending only the above described components it has some infrastructural capabilities that are given below:

RDF store

RDF use Jena Fuseki server because it support SPARQL queries and statement through hypertext transfer protocol. This gives us platform flexibility. Here only SPARQL can be exchange with Fuseki.

RDF persistence

It is a strategy that converts the java based objects into triplets of the form like subject, predicate and objects on the basis of these triplets it construct their desired queries and pass them to server. Then result obtained and further converted to objects to java.

Local data store

It stores the information exist in PulSAR, intermediate results and technical data but it can’t the data with any other subcomponent.

Logging strategy

It totally depends on SLF4J logging system for java.

Pu-sub mechanism

Its main functionality is to exchange the information/data to and from the components of broker’s platform.

Service governance and quality control

“SGQC” is responsible to retrieve the data related to brokers, services and “SLAS”. The updations are sent to “PulSAR to SGQC” which are then launch by using pub/sub mechanism.

Failure prevention and recovery mechanism

This mechanism basically used to prevent PulSAR from data loss. So it use FPR mechanism in order to receive and sent data to consumer in adaptation actions.

User facing component

As the name shows this component create front ends of PulSAR. They deal with GUI that becomes a platform to

provide facilities to users. Now a days this component is used as stand-alone web based application using web technologies like “DOM and JSON” etc.

E. Quality assurance and standards (IEEE)

^[2, 12]In the research paper quality assurance of cloud networking device we studied that quality assurance is related to evaluation of the developed software according to pre-defined standards, rules and approaches. “QA” includes planning, evaluation and inspection to check that developed system is according to customer’s need or not. According to IEEE std 730-2014 QA is a chain of some basic activities to ensure that software processes are suitable for intended purposes.

IEEE std 1059-1993 is for testing purpose to check the gaps between current and future needs of customer related to developed system. IEEE std 730 is basically responsible for software development, maintenance and product life cycle processes.

SEI developed three models named as “CMMI-DEV, CMMI-ACQ and CMMI-SVC” each has its own purpose. CMMI-DEV is for research and development purpose, CMMI-ACQ is related to management in cloud computing networks. CMMI-SVC is used for the discussion of research process.

F. Quality of Service Techniques

^[21]“QoS” indicates the plane of consistency, loyalty and accessibility that is offered by platform or frame and the application that cloud it. It is also important for both cloud users and providers who want providers to provide the promoted features and who need to find the transaction between the levels of QoS and its working cost. It’s not an easy task to finding out the ideal problem of transaction since it includes service “SLAs” that states the goals of “QoS” and financial drawback that is related with “SLA” violations.

The contract of SLA is signed between the service provide and customer where the restrictions to violate the SLA is very important. The tool which includes monitoring the SLA violation is reduced. Now we further exploring the methods of computerized “QoS” management which controls the complexity that are occurred in software and hardware properties.

The different researchers suggested different approaches to monitoring the automated management of QoS.

- “P.C.Hershey” suggests a “SoS” method to manage and monitor the QoS for imagination systems which can delivers the calculations by way of a facility using cloud environment.
- “M. Salam et al” suggests a “QoS oriented joined cloud computing” frame in which many free cloud providers can collaborate with each other easily to provide accessible QoS secure services.
- “W.C.Chu at al” suggests official model that not only support the enterprise cloud computing ECC services by using cloud services models which includes “SaaS, PaaS, IaaS” however also to immediate observing the “QoS” issues from its

facility suppliers and also “SLAs” for many ECC clients.

According to “W.C.Chu at el” approach the “testing and analysis model” was produced that guide the testing at run time monitoring to promise the approval towards “SLA” limitations.

- “R.Karim et al” suggest a tool that can map the users to use the accurate “QoS” conditions of “SaaS” and then map it to the finest “IaaS” facility which deals with ideal “QoS” assurances. As a result of this mapping the final results were calculated. To enable the mapping process “Analytic hierarchy process (AHP)” founded model is used.
- “S.Lee et al” suggests a design that can engage the mediator skills which can monitor the on demand “QoS” requirements and SLAs which can support the authentication and justification. In future it also support and analyzed resources division and placement.
- “L.Bin et al” suggests a “novel QoS aware data duplication and delete policy” aimed at the saving storage of disk and to maintain the cost saving. They can proof it experimentally by using dynamic data replica detection “DRDS” algorithm which can save the space of disk and maintained the cost on behalf of distributed storage system only when the concert “QoS” requirements were guaranteed.
- “P.Zhang et al” suggests a QoS system for “mobile cloud computing” and “QoS” managing method which can manage the guarantee of QoS in “mobile cloud computing”. For this purpose the “Fuzzy cognitive map (FCM)” and “QoS prediction” process are used.
- “Y.Xiao et al” proposed a well-organized “reputation based QoS provisioning” system that reduce the computing properties cost. In practical metric it can measure the arithmetical possibility of the response time. The one drawback of this approach is that it cannot be used for the security and privacy purpose

But there is a week point of all this work is the deficiency of self-learning procedure that can define the timing of automatic distribution of system properties.

G. Critical success factors

^[2]As the time passes the success factors related to specialized field differs. But in our research we studied the following success factors:

- Identify and check the critical issues related to field of research.
- Allocate different values to each factor depending on its value.
- Now calculate the value.
- Compare the factors according to each their importance.

Analysis facets	CSFs
Plan	Item pass/fail criteria
	Resource and their allocation
	Service model of cloud computing
	Performance of cloud computing device
	Security of cloud computing device
Do	Software unit test
	Verification and validation
	Cloud networking performance testing
	Cloud devices memory management testing
	Cloud service security testing
Check	Check test report
	Check test plan
	Check resources and their allocation
	Check overall abnormal behavior
	Check protection of network security
Act	Update test report
	Update test plan
	Update resources and their allocation
	Update protection of network security

Table 1.1 CSFs on each PDCA Facets

IV. APPROACH

Step 1-Define a SOS for monitoring, management and response in cloud computing

The fig 1.1 depicts that multiple administrative domains are operating with a “SOA” based system. Governance as a service provides features to administrations and enables the users who are end users to produce and consume the data using different services.

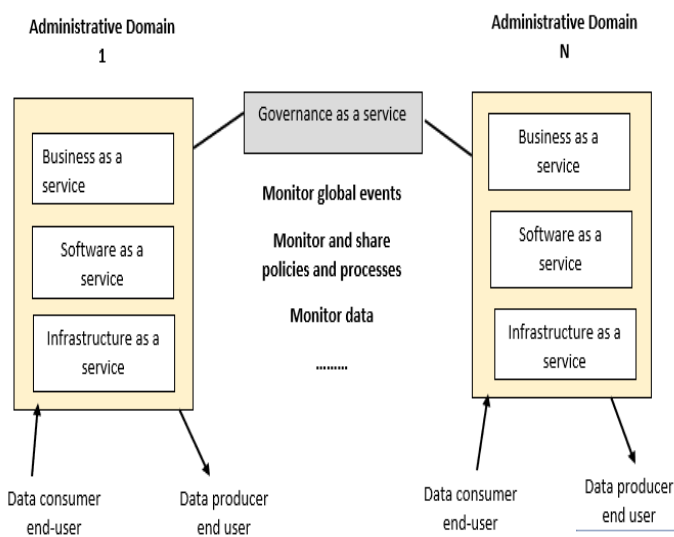


Fig 1.4 net centric “SOA based SoS”

Step 2- Derive framework for QoS monitoring, management and response

This framework is multidimensional but here we discuss three dimensions XYZ. The X dimension express the response time ranging from milliseconds, minutes, days, and beyond. The Y dimension represents the domain like IaaS, PaaS, and SaaS etc. The Z dimension represent planes and introduce a structure for monitoring and management the end to end events.

Step 3-Identify cloud computing matrix

Category	Matrix
performance	Delay
	Delay Variation
	Through put
	Information overhead
Security	Authentication
	Authorization
	Integrity
	Non-repudiation
	Information availability
	Certification & accreditation

Table 1.2 Matrices Categories

“Delay” is the expire time for a completed on in complete tasks.

“Delay variation” is the difference between delay and different time intervals.

Throughput is basically describe the amount of work completed in a time interval.

Authentication confirms the user, system and data sources.

Authorization deals with success and failure at permission level.^[13]

Step 4-Measuring performance matrix

It is responsible to check the performance of an activity at each level at design them in a matrix.

For example:

- Total time consume by database query to produce result.
- Total time consume by application and its logic to execute.
- Total time used by data to flow over the network.

Step 4: Identify suitable locations for metric detection in cloud computing

This step is responsible for security mainly. This include all about authentication, authorization, non-repudiation etc.

V. CONCLUSION

In our work we explain the cloud computing technology importance as an online networking service. By using cloud computing service universities gain more benefits of E-learning. ^[11]E-learning makes our life easier, fast, secure, more reliable, and cost effective and location independent. ^[14, 21]The usage of QoS system in infrastructure as a service depends strategy improves the performance with respect to

time and speed. Depend on this approach we explain PuLSAR because it is an outstanding multi criteria approach to make decision related to brokerage capabilities. Here we discussed its subcomponents and implementation techniques. ^[24]

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