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Saas Quality of Service Attributes

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Abstract: Software as a Service (SaaS) is one of the cloud computing branch and it is rapidly growing. Quality of Service (QoS) for SaaS cloud is considered as an important concern among researchers. The QoS specification, particularly, for SaaS is known as a big gap in current researches. Therefore, in this study, the main QoS attributes for SaaS consisting of 33 attributes have been reviewed. The results show a comprehensive specification of QoS attributes for SaaS which cover more aspects of QoS for SaaS excluding the business perspective. The attributes then have been classified in terms of both user and provider perspectives and can be useful as a guideline for both users and providers.

Key words: Quality of service, Software as a service, SaaS quality, QoS attributes, cloud computing

INTRODUCTION

Software as a Service (SaaS) enables the application run on the cloud eliminating the installation on the personal computer at the client side (Marston *et al.*, 2011). SaaS is a brand new selling strategy for enterprise software developers. The SaaS is a service delivery model which uses pay as you go financial model. The SaaS model is becoming increasingly popular. Large established IT firms are expressing renewed interest in this area, due in part to defensive manoeuvres needed in reply to disruptive SaaS firms. Microsoft's quite popular and competitive cloud architecture named Windows Azure has entered the SaaS arena recently. Coming to Microsoft's counterpart, Google also recently entered the SaaS movement and is promoting its SaaS services with the latest launch of their Google Apps Premier Edition. SaaS has brought considerable and productive changes in the booming business environment.

Since, the cloud computing is a generalized paradigm so, it is impossible to consider the cloud as a single set of business model which has a single set of Quality of Service (QoS). It means that the issues with a cloud should be investigated through the application in the cloud because they have specific characteristics and purposes. For example the QoS considered for the IaaS cannot be applied for SaaS even though they may have common stakeholders, service level agreement and their concerns. More to the point, we need to specify the QoS for each type of cloud services separately (Boniface *et al.*, 2010). In this study, 33 attributes have been specified for SaaS QoS in general.

QoS is a non-functional component which can be defined as the ability to provide different priority to different applications, users, data flows or to guarantee a certain level of performance. There are many users with different profiles and of course different requirements in cloud computing including SaaS. Therefore, consideration for QoS is critical to distinguish between cloud applications.

Ferretti *et al.* (2010) mentioned SaaS needs QoS because QoS is the crucial factor for the success of cloud computing and if not delivered as expected it may tarnish provider's reputation. There are few researches performed regarding to considering QoS in terms of cloud computing and particularly SaaS. However, among the researchers who proposed set of QoS attributes, Service Measurement Index (SMI) standard recently has been designed a set of Key Performance Indicators (KPIs) for cloud computing including the QoS concerns.

Service Measurement Index (SMI) (Siegel and Perdue, 2012) is a developing standard measurement framework has been designed by Cloud Service Measurement Initiative Consortium (CSMIC) to measure the cloud based services from multiple providers. The

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CSMIC was formed in 2010 to address the requirement for industry-wide and globally accepted measures to calculate the advantages and disadvantages of the cloud computing services. In another words, the industry recognized the SMI standard to determine the usefulness of a specific service based on cloud computing. There are seven categories and three or more subcategory for each attributes in SMI. The prioritized attributes are Accountability, Agility, Assurance, Financial, Performance, Security and Usability. However, these limited SMI attributes could not fully support the requirements to measure quality for SaaS. It was found that Financial and Auditability are not appropriate for SaaS and more suitable for the business side.

MATERIALS AND METHODS

The QoS attributes for SaaS cloud computing through the existing QoS models for SaaS in specific and for cloud computing services in general have been reviewed. The QoS attributes determined 33 attributes for Saas cloud services have been specified. Then, a suitable definition of each attributte according to definition adopted from literature has been presented.

RESULTS AND DISCUSSION

The main QoS attributes for SaaS cloud services from the literature have been identified. These QoS attributes including their explanation and definition have been specified.

Adaptability: Since adaptability deals with adjusting the changes with user' requirement, SaaS adaptability can be achieved through scalable user counts, quick and on-demand utilization. Organization using SaaS can reconfigure a sales team quickly or redeploy a research team to function more in line. SaaS allows organizations to quickly reconfigure a sales team or redeploy a research and development arm to function more in line based on the market needs. In fact, SaaS allows organizations to act strategically not to react defensively (Fairchild, 2012).

Extensibility: Extensibility means adding new features to the service. Extensibility can be achieved using extensible entities which have virtual properties and can specify mappings external to the entity in which the modification of mapping is without changing the entity source and redeploying entity's persistence unit. Extensible entities are useful in a SaaS environment in which a shared and generic application is used by multiple users (tenants).

Flexibility: Flexibility is ability to adopt technology to match with business needs as they flow. For example, after the Japanese tsunami in 2011, some companies in Japan having computer chips may need to quickly move to another area (Despotovic, 2011). Flexibility of SaaS improves productivity in many ways. SaaS subscription model provides optimal and sustainable Return On Investment (ROI) due to its inherent flexibility (Smart, 2013). The SaaS flexibility enables businesses to innovate and quickly respond to new challenges (SaaS, 2009).

Customizability: Since, SaaS applications accessed through a web browser eliminating installation on customer side and should serves all the users with different needs at the same time and there might not be any option of building a custom make for every users. Therefore, customizability becomes an important factor for delivering customized and personalized software to users. Customizability makes easy integration of SaaS application with the users and also empowers providers to easily configure the solution according to their own and their user's need. Customizability deals with the look and feel of User Interface (UI) since it provides an option to the user to brand the software and also can give similarity by changing the font or colour in the system to the familiar system for user (Anonymous, 2012b).

Scalability: Scalability refers to adding or reducing users and functionalities to adjust the SaaS solution according to business requirements changing (Partridge, 2011). Scalability is one of the most notable advantages of SaaS which attracts specially those who work seasonal since, it can rapidly ramp up and down according to how many licenses or seats required (Sims, 2013). SaaS application can grow with the number of users. In SaaS, based on the growth of users and the subscription, the scale of applications will grow more. SaaS has this ability to add more user and grow the application by subscription (Despotovic, 2011). According to Hoelzle (2012) when a large application is running in a data center like Gmail, it will save compute and energy when it runs at scale 100 times more rather than own email server (Hoelzle, 2012).

Changeability: Changeability in SaaS architecture is easier and faster since its configuration enables or disables all the function, setting or customer processes that Enterprise Resource Planning (ERP) systems should include. No further installation or integration needed to perform for a new module as it is done in traditional software paradigm (Link, 2013).

Composability: Composability deals with services incorporation. Composition happens when an atomic element add to the system. The decision to check the possibility of adding the element without violating safety properties is made at the moment of composition request. The data required for such a composition can be achieved through service descriptions (Werner *et al.*, 2003).

Availability: Availability is ratio of system functionality in a specific time to the total time expected to function. This can be presented as a percentages (such as 90%) or direct proportion (9/10) (Rouse, 2011). Service Availability defines the availability of the service represented in percentage (e.g., 99.95% uptime) (Shomron, 2009). An available SaaS should be compatible with desire platform or web browser. Moreover, a reliable network access at everywhere regardless of home, office or road required (ABA, 2014).

Maintainability: Maintainability is one of the critical benefits of SaaS cloud which almost overlooked. In traditional software, users are responsible for scheduling upgrades and the new version of software product must be completely tested by user so that the user make sure the new version works well. However, in SaaS the process is highly streamlined. SaaS provider handles the new released software testing instead of the users (Lawlor, 2009). In the other words, SaaS maintenance is easy because there is only one copy of the software and the software run on one environment only in which the environment is totally controlled by the supplier (Hyland Software, 2010).

Reliability: Reliability refers to ability of a service to permanently function according to its specifications. In theory, the reliable software is totally error free but it is expressed as a percentage in practice (Rouse, 2011).

Resiliency/fault tolerance: Fault tolerance means components fail of the system won't cause the whole system failure. Besides, system recovery from multiple failures should be provided. Components should over engineered or underutilized to make sure that even when the time of system outage, the system performs while performance may be affected during an outage, the system will perform under acceptable and predicted bounds (Walsh, 2013).

Recoverability: As data protection in every businesses specially those who are using cloud and SaaS is a vital issue. Companies aim to improve the way in which they can protect and manage data which involves recoverability issue in SaaS. Using cloud itself for disaster recovery can be considered as a viable option since businesses can back up data in multiple locations geographically accessible through different regions safely and accessible (Blaisdell, 2013).

Stability: Stability attributes refer to ability of the service to be resistant when a change or displacement happens. Therefore, whatever a service is more resistant to change, it is more stable.

Serviceability: Serviceability expresses the ease with which a service can be repaired and maintained. In this case, early detection of problems is critical. Some systems are able to correct automatically the problems before serious issues happen; such as built-in features of Windows XP, antivirus and etc. In fact, the downtime or disruption of maintenance and repair should ideally be minimized. Designing and considering serviceability cause to decrease the cost and increase the profitability and customer satisfaction (Rouse, 2011; McBeath, 2014).

Robustness: Robustness is about being able to handle errors and keep operating. In ideal way, a robust system should include all the failure possibilities. Most of SaaS applications may not be as robust as traditional software because of browser limitations since they might be intolerant to slow connection of Internet.

Accuracy: Accuracy is how closely get a true results. 100% accuracy means achieving the goal perfectly. The more result closer to desire goal, the more accurate will be. Accuracy is related to being adhere to the requirement.

Efficiency: The higher efficiency of SaaS applications comes from its multi-tenancy features. Efficiency means accomplishment and function perfectly using all the resources. One of the ways to have perfect efficiency and perform the function correctly for organizations is to follow the standards.

Functionality: Traditional software is undergoing revision after revision, as the technology needs change. This means that traditional software tends to have a very wide range of features and functions while it is also complicated and less-than-intuitive for new users. However, most of SaaS applications have been built fresh from the ground-up and tend to have limited feature sets but more intuitive and modern user interfaces. Functionality relates to adding new features by provider. SaaS vendors should also be open users feedback regarding changes and new features (ABA, 2014).

Response time: Response time is one of the most important factors that people should be tracking when they're looking at a SaaS provider. The response times usually correlate to the seriousness of the reported problem, so the more serious the problem, the quicker the response time. Service response time is the time takes for the response on customer enquiries (Waineright and Chaudhary, 2014; Shomron, 2009).

Suitability: Suitability refers to being appropriate and matches with the user requirement. This attributes is related to user perspective. If the service fulfill the user requirement properly and satisfy user it can be consider as a suitable service.

Data integrity: Data integrity is ensuring whether the data is maintained in any operation (like storage, transfer, or retrieval). It means the data changes only in response to authorized transactions. In fact, data integrity guarantees the consistency and correctness of the data to satisfy user (Rittinghouse and Ransome, 2009).

Data privacy: Data privacy is an ability to clear which data should be share and which one not. In data privacy, the provider can limit the use and share the data for users. Meanwhile the provider should be able to provide control over the data in a proper way to satisfy users.

Security management: Since, SaaS applications are multi-tenant and use virtualized technologies, the resource allocation should be in a fair manner across the tenants to perform the workload and if not many demanding tenant might starve the other tenants. This can result in lower service level or poor user experience and performance (Anonymous, 2010).

Accessibility: Unlike on-premise applications which may be locked behind a firewall, SaaS applications can be accessed on any devices like laptops, smart phones and tablets, anytime, anywhere with an internet connection. SaaS makes the application easier to deploy since it only requires a web-browser (no upgrades or software installation needed) (Klipfolio, 2014; Marketron, 2014; Anonymous, 2012a; Pidoco, 2013).

Learnability: Learnability is one of the criteria of usability which should take a user as little time as possible to learn and understand how the system works. Learnability can be achieved by a training way to "Learn by doing" and get real work done while user is trained to use a system. This helps to improve your quality by implementing it in your web based SaaS designs, because it provides a new, immediately gratifying and highly effective way of making

the system learnable (Erel, 2013). However, the better the learnability of an application, the less training and time it will take for a person to use it. Learnability is important factor in usability since it is vital that users can pick up how to use an application quickly (Pidoco, 2013).

Commonality: Commonality is a feature of SaaS which can be known as an extreme form of reusability and means that everyone is able to use and reuse the application. In the other word, commonality is the common features provided by SaaS that can be reuse by many users (La and Kim, 2009).

Multi-tenancy: Multi-tenancy means single copy of an application running on a server, can be used concurrently by multiple users (tenants). SaaS application can partition its data and configuration, so, that every user works with a customized and private instance of the application (Chong, 2012).

Operability: One of the important benefits of SaaS is its operability 24 h in a week. This is due to the SaaS needs to set up many plans, operations and functions in order to have successful operability (Fairchild, 2012). Operability is the ability of the service to be operated by users easily.

Agility: Agility mean ability of a SaaS provider to respond to regulatory changes that impact an application as a key indicator of their determination to track the market (Nolle, 2013).

Assurance: In (Ihalainen, 2013) the authors outline a lot of necessary things that should be implemented to ensure whether a SaaS satisfies the customer need, or to reassure prospects and customers for their data safety issues.

Performance: Performance may refer to the amount of work that is fulfilled and accomplished by a system to satisfy user. Therefore, if a system fulfills a task or obligation and could satisfy user, the system has high performance.

Security: Since, the users' data such as notes, documents, contacts, billing information etc., are stored by SaaS on a remote servers rather than user personal computers. So, the most important concern comes to mind is the security and safety of the data from any destruction or degradation (such as natural disaster, system failure, or even dissolution of business) (ABA, 2014; Ihalainen, 2013; McLellan, 2013).

Usability: Usability means providing a service according to user today' need. Usability is greatly related to who is using the service, what they expect from the service and

Table 1: QoS attributes and their definition

Attributes	Definitions
Adaptability	How properly the SaaS provider can adjust the changes with clients' requirements
Extensibility	How well provider can add new features to current SaaS service
Flexibility	How well provider can add or remove features from services
Customizability	How well SaaS services can be customized by users
Scalability	How well SaaS providers can support growth in the services scale
Changeability	How well service provider can modify the SaaS services while keeping multi-tenancy of SaaS
Composability	The degree to which a SaaS can incorporate other services to satisfy user-specific requirements easily and effectively
Availability	How well a service can function within a specific time to satisfy users' need
Maintainability	How well a SaaS provider can repair services to keep them in a good condition to work
Reliability	How well a SaaS services keep operating and functioning without failure in a given time period
Resiliency	How well a SaaS service can continue working even in the time of failure in its one or more components
Recoverability	How quickly SaaS provider can resume normal state of operation after an unplanned disruption
Stability	How well a SaaS service is resistant to change or displacement
Serviceability	How easily a SaaS service provider can perform service correcting and maintenance
Robustness	The degree to which a SaaS service keeps operating even when the data is incomplete or inconsistent
Accuracy	How well a SaaS service can adhere to its requirement
Efficiency	How well SaaS services utilize resources to perform its function
Functionality	How extensive/ inclusive are the service's features
Response time	A specific time between a service request and a service response
Suitability	How closely the ability of service is match by users' requirements
Data Integrity	How well a SaaS provider can keep the created data in its correct form to satisfy users confident regarding to accuracy and validity of data in transit
Data privacy	How much control SaaS providers should provide for users over their data
Security management	How to effectively allocates, revoke or change security controls over users and data (subjects and objects)
Accessibility	How well service is usable by users with different disabilities
Learnability	How easy the user can learn and understand the SaaS services
Commonality	The degree to which a SaaS service has the common features and can be reused by many users
Multi-tenancy	How well a SaaS service can support and handle concurrent accesses by multiple users for multiple clients
Operability	How easy a SaaS service can be operated by users
Agility	The degree of change, that is how quickly and with minimal disruption a service can adopt the changes
Assurance	The percentage that the SaaS service can be guaranteed as promised
Performance	How well a SaaS service can fulfill the obligations according to the SLA to satisfy users and shows the features and functions of the SaaS service
Security	How well SaaS providers controls on service data and access to the services
Usability	How well a service can be perceived useful and easy to use by users to apply intended purpose of users and satisfy them

Table 2: Classification of attributes based on user and provider perspectives

User side	Provider side	Both sides
Customizability	Serviceability	Composability
Suitability	Robustness	Availability
Accessibility	Data Integrity	Reliability
Learnability	Data privacy	Resiliency
Commonality	Adaptability	Accuracy
Multi-tenancy	Extensibility	Efficiency
Operability	Flexibility	Service response time
Multi-tenancy	Scalability	Stability
	Changeability	Functionality
	Composability	
	Maintainability	
	Security management	

how they use it. For many people, usability is an "Easy-to-use interface" that is self explanatory. Preferably, usability is the ability to use. Usability depends on good performance and functionality of the service because if it has slow load time or is inconvenient, it will be definitely unusable service (Shaikhatarov, 2013). Also it refers to how effectively and efficiently a user can interact with a system. The term usability incorporates a few other concepts, such as learnability, operability and etc (Pidoco, 2013).

Our research has contributed to highlight on the importance of having these specific QoS attributes for

SaaS cloud computing. The 33 QoS attributes together with their definitions have been presented here Table 1, indicates the attributes and their definitions.

The attributes mentioned for SaaS cloud services have been then classified based on the perspectives of user, provider or both sides. Based on the definition and explanation of the mentioned attributes in previous part, the attributes have been classified according to the preference and applicability of the attributes for the role of user or provider and if they related to the service itself, they include on both perspectives.

Table 2 illustrates the classification of the attributes for user side, provider side and those attributes belongs to both sides. The attributes have been classified according to their definitions which were related more to user cooperation, provider cooperation and both.

CONCLUSION

Since, it is no secret about the importance of QoS for SaaS so, considering the QoS concern for SaaS cloud has became necessary in current researches. This study has reviewed the concepts of QoS for SaaS and specified the

main QoS attributes for SaaS cloud. The 33 QoS attributes for SaaS and their definitions have been presented. The attributes based on their perspectives have been classified. The future researches may focus on exploring more about the measurements of the attributes.

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