A survey on Software as a service (SaaS) using quality model in cloud computing

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Abstract: Cloud computing is a kind of distributed computing over the internet i.e. it can run a program or application on more than one computer at the same time. It is divided into three categories namely: (i) Infrastructure as a service (IaaS), (ii) Platform as a service (PaaS), and (iii) Software as a service (SaaS). Software as a service is a kind of service which provides many benefits to the service consumers. A customized quality model is necessary to evaluate the quality of SaaS cloud service. In this paper we identify the features of SaaS. The traditional quality model does not consider features of SaaS like security and quality of service. So, In this paper, we propose a new quality model for the security, quality of service, and software quality for software as a service. Moreover the results are used as identification for the SaaS quality management.

Keywords*:* Cloud computing, Software as a Service (SaaS), Quality model, Software metrics.

1. Introduction

Cloud computing includes sharing of resources like hardware, software and network. It involves delivering hosted services accessed through internet. It has three services namely: Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS). The services are sold on demand either by a minute or hour and the customer can access services as their wish for a particular given time. The services are managed by the service provider or companies like Amazon, Google, and IBM etc.

Cloud can be public, private and hybrid. A public cloud sells everything over the internet. A private cloud is a data center or proprietary network which provides services to few people. Hybrid cloud is a cloud computing environment where organization gives and manages few resources internally and others externally.

Software as a service is a type of cloud service which gives software services via internet. SaaS is generally used and it gives many advantages to service customers. To realize these benefits, it is important to generate the quality of SaaS and

Manage the higher level of its quality which depends on the generated result. So, the demand is high for producing a quality model to generate SaaS services. Software as a service, occasionally indicated to as "on demand software", is a software model in which software and related data are put on the cloud centrally. SaaS is typically gain access by users consuming a thin client through a web browser. SaaS has turn into a public distribution prototypical for several business applications, containing accounting, association, enterprise resource planning (ERP), invoicing, content management (CM), human resource management (HRM), customer relationship management (CRM). [12]

Advantages of the SaaS model have:

- Less difficult administration
- Compatibility.
- Less difficult collaboration
- worldwide accessibility

Conventional frameworks for measuring quality such as ISO 9126 would be limited in evaluating the quality of SaaS, mainly due to the gap between the conventional computing

paradigms and CC paradigm. That is, conventional quality measurement frameworks do not effectively evaluate CC-specific quality aspects. However, widely accepted quality model for evaluating SaaS and supported instructions are yet to come.

So, the demand is very high for generate anew quality model to evaluate SaaS services which have characteristics such as supporting commonality, internet-based invocation, virtualization and data management on server side. In this paper, we propose a comprehensive quality model for evaluating SaaS. Using this new SaaS quality model, it can be evaluated by service providers. Moreover, the results are used as an identifier for SaaS quality management.

In section 2 we have described the related works that have been done for quality on SaaS service and key features of SaaS. In the key features we have included new features of SaaS apart from the existing features. In section 3 we have discussed about SaaS architecture. In section 4 we have explained about the quality model of SaaS services which includes security, quality of service and software quality metrics. Finally conclusion and future work in section 5.

SECTION 2

2.1 Related Work

ISO 9126 is an international standard for the evaluation of product quality [9]. This standard provides three aspects for evaluating software products; internal quality, external quality, and quality in use. And, there are sixteen characteristics for three types of qualities. However, this standard focuses on evaluating quality of conventional products. Hence, it is required that the standard is customized and extended to evaluate the quality of SaaS. Jureta's work proposes a quality model, called QVDP, to measure the quality of Service-OrientedSystem [10]. This model consists of four sub models; quality characteristic, characteristic value, quality dependency, quality Priority. These represent dependencies and priorities between qualities dimensions and quality characteristics. However, this work considered services-oriented application as a target of quality model and identifies issues related to them at conceptual level. Kim's work defines a model for web services quality management and quality factors in the process of developing and using web services [11]. This work suggests six quality factors and their several sub factors. Also, it provides metrics to measure quality factors. Hence, it is required that this model is customized and extended to evaluate the quality of SaaS. Most of current works are not for SaaS but for certain targets such as a conventional software or SOA based system. Due to the situation, it is hard to evaluate quality of SaaS and judge which SaaS is good. Therefore, our work provides a quality model to evaluate SaaS.

2.2 Key Features of Software-as-a-Service

In order to define a quality model for evaluating SaaS, it is a required to identify key features of SaaS. From our evaluation on current references in cloud computing [4] [5], the key features are given intheFigure1;
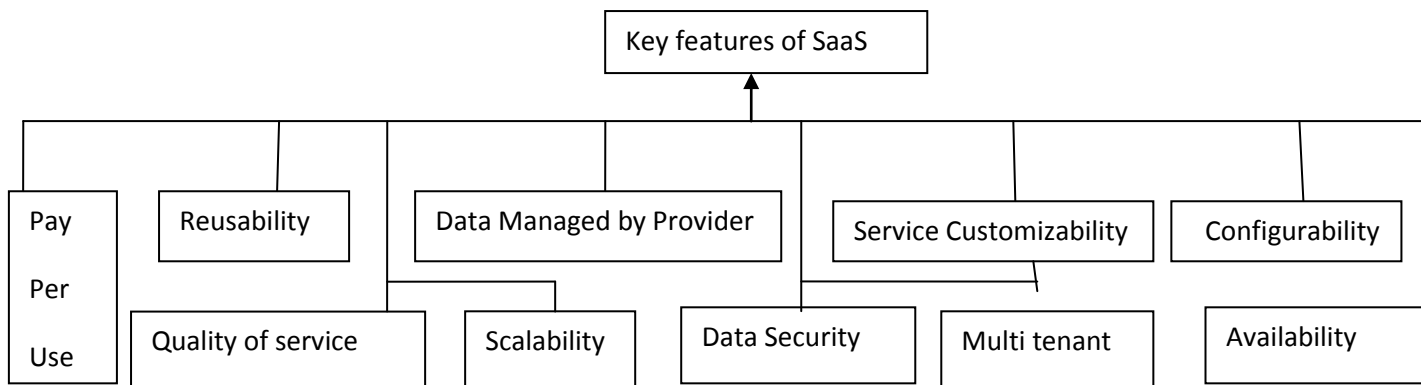

Figure 1: Key features of SaaS

2.2.1 Reusability: In software engineering, reusability is the ability of software elements to serve for the construction of many different applications. The main motivation of cloud

computing is to reuse various types of internet based services [4]. In case of SaaS, software itself is a target of reuse and it is delivered to service consumers over the Internet. That means, one-to-

many relationships are used when delivering SaaS services. For example, Google map service provides a set of operations to utilize shared information on map and local, which can be used by various customers [6].

2.2.2 Data Managed by Provider: SaaS is a model of software deployment where service providers license applications to consumers for using on demand services. Thus service providers are responsible for service installation and data management on their own server. So, most of the data which consumers produce is stored on service provider's data center and managed by them. Thus customers do not perceive two things in detail; where is their data stored and how the data can be managed. So that, the customers however may don't trust the services and then the service utilization becomes lower, if service providers don't provide data security and reliability function [7].

2.2.3 Service Customizability: Service customizability defined by the ability for services to be changed by service consumers based on their requirements. This characteristic allows service providers to meet the different needs of every consumer. According to the characteristics of cloud services, various consumers, can become potential users of the cloud services [8].Because of that, the major disadvantage is, it is not possible that service providers customize their cloud services for all service consumers. So, service consumers need to customize their services for their own purposes. If service providers do not provide customizable SaaS services, the only thing service consumers can is that they simply utilize the services. This will also limit the usage of SaaS services.

2.2.4 Availability: In cloud computing, the service consumers are able to access SaaS service from a Web browser via the Internet and they do not have any ownership for the SaaS which is deployed and runs on the provider's server. Because of these natures, many SaaS vendors try to achieve high availability of services. If a SaaS is not available, service consumers cannot use the functionality of the SaaS.

2.2.5Quality of service
Quality of Service is related to the provider's service level and service capabilities. Provider's service level includes availability/business continuity, performance, usability and reliability. Provider's service capabilities are composite by the capabilities to assure data security, the capabilities to manage SaaS service.

2.2.5Scalability: In software engineering, scalability is a property which is necessary for a system, a network, or a process, which means its ability to either handle growing amounts of work or can be larged. Due to the black-box nature of cloud computing services, service consumers cannot control resources which are utilized by the services, such as memory, network, or CPU utilization. That is, a service provider is a responsible for rescaling the resources according to consumer's requests without notifying the consumers in detail.

2.2.6Data Security
The data security headache are the most important reasons why organizations are un-interested in software as a service. Moreover, solving the organizations security concerns has came up as the largest challenge for adopting Subservice in the cloud

2.2.7Multi-tenant
Multi-tenant is referred to the rule in software architecture, where an instance of the software executes on a server, giving services to more than one clients (tenants). In a multitenant environment, near to all organizations or tenants and their customers receives the service from the similar technology, sharing nearly all components in the technique stack including the data model, servers, and database layers. The advantage of multi-tenant environment includes scalability, performance, service management, and service upgrades.

2.2.8 Configurability
Configurability is the main feature of any SaaS software. This aspect of SaaS software includes organizational structure, user interface, data, access control, workflow, and business logic.

2.2.9 Pay per Use: The expenses for SaaS are estimatedby using services such as the number of service invocations or duration which services are utilized. That is, service consumers can connect and use the service each time they want, and then pay for just amount of usage. So, the customer takes an activity for using the service.

SECTION 3

3.1 SaaS Architecture
Many SaaS solutions are referred to multi-tenant platform. By the help of this model, a one version of the program or application, with one configuration is utilized for nearly every consumers or tenants. In order to support scalability, the program or application is executed after installing on many computers. For few cases, another version of the program or application is made to provide to some consumers which will have the access to before released versions of the program or applications for testing. This has been compared with on-going software's, where more than one copies of the software — each have the potential of a other version, with another configuration, and customized — are executed after installation over many consumer sites. However an exception is there, some software as service solutions never use multi-tenancy, and other methods like— virtualization—to cost-effectively provide more number of consumers instead of multi-tenancy. Whether multi-tenancy is needed for SaaS is a topic which is controversial.
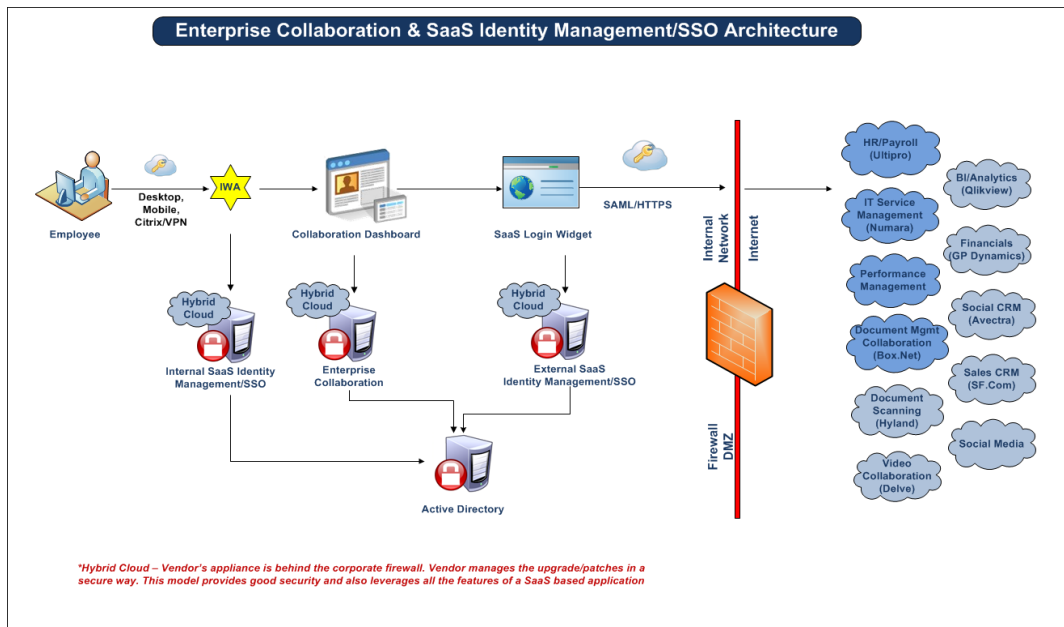
Figure 2: SaaS architecture

SECTION 4

4.1 QUALITY MODEL OF SAAS SERVICE

The quality model that we have proposed includes of three factors, i.e. security, quality of service and software quality. As SaaS service involved three roles (customer, platform and application developer), so each quality factor is categorized into three parts which will be explained in the following.

4.1.1 Security Metrics

For every consumers, security is the main issue, it needs all the three roles namely customer, platform and application developers to work together to ensure. The model that we have proposed, security metrics involves customer security, application security, and network security [2].

(1) Customer Security

Customer Security is the important measures that consumer should take. It has four metrics:

(i) Provider Evaluating. The customer should evaluate the provider before deciding to adopt SaaS service.
(ii) SLA (service level agreement). Customers should work with contracts and SLAs.
(iii) Risk Management Plan. Consumers should be having their own risk management plan in order to tackle with service unavailable.
(iv) End-point security.

(2) Application Security

Application Security is the very important measures that the developer should take into account. It has following metrics:

(i) Secure software development lifecycle. The design, coding rules, standards, and assurance tools that the developer should adopt must be secure to support the secure software development lifecycle.
(ii) The developer should take important steps in order to tackle with commonly security threats of the web application.
(iii) Authentication and Access Control.
(iv) The sensitive and critical data of application should be encrypted in order to tackle data theft.
(v) Traceability and Non-Repudiation.
(vi) The applications capability follows the security standards.

(3) Network Security

According to ISO/IEC27001 and GB/T 22239, network security has four metrics, namely, physical security and environmental security, network security and host security

4.1.2 Quality of Service (QoS) Metrics

In SaaS, quality of service is very important problem for consumers to calculate the SaaS service. In our model, QoS Metrics focuses on quality of platform (QoP), quality of application (QoA) and quality of experience (QoE) [2].

(1) Quality of Platform (QoP)

QoP is the key issues both for consumers and application developer to evaluate the SaaS platform, which consists of the following:

(i) Transparency.
(ii) Location-aware capability.
(iii) SLA management.
(iv) Portability.
(v) Data auditing.

(2) Quality of Application (QoA)

QoA consists of the characteristics of SaaS service, such as the following metrics:

(i) Multi-tenancy. In order to know whether a SaaS service is multi-tenancy or not, we can use the following guidelines:

A). allow multi-tenants to shared database or scheme.

b). allow multi-tenants to shared a single instance.

c). support for the configuration of UI, data, business logic and workflow

(ii)Configuration.

(iii)Interoperability.

(iv)Software fault tolerance.

(3) Quality of Experience (QoE)

QoE is one of the important problem to improve the satisfaction of consumer, and it includes the metrics like:

(i) Service availability.
(ii) Usability.
(iii) Performance.
(iv) Response timeliness.

4.1.3Software Quality Metrics
Software quality model consists of two different kinds of sub-models: quality in use model and product quality model. The Quality in use model composed of five characteristics, and the product quality model composed of eight characteristics. In our quality model, software quality metrics are the same as ISO/IEC

SECTION 5

Acknowledgement

Conclusion and Future work: -SaaS is one type of cloud services is emerged as an effective reuse paradigm. It provides benefits to service consumers; no initial cost to purchase software, free of maintenance/updates, accessibility through Internet, high availability, and pay-per-use pricing. Hence, evaluating the quality of SaaS becomes more important activity to a successful SaaS management. In this paper, we firstly analysis the key features and general architecture of SaaS service. Then we presented the quality attributes from the features. Then we present the quality model which measures the security, QoS, and software quality of the SaaS service, from the perspective of

platform, provider and customer separately. Through our quality model for SaaS, service providers evaluate their services and may predict their ROI. Moreover, service consumers can refer quality evaluation results to discover, subscribe and utilize SaaS. Customer can use this model to evaluate the maturity level of SaaS service, and to select qualified SaaS providers based on evaluating result. In the future we intend to complete the evaluation criteria for quality metrics in quality model, and develop software tools to measure and evaluate SaaS service.

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