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A Survey on Software as a Service (SaaS) in Cloud Computing

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Abstract: *Cloud computing enables applications and services to run across multiple systems simultaneously via the internet. It encompasses three core service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). SaaS, in particular, offers numerous advantages to consumers but also presents unique challenges in assessing its quality. This paper explores the defining characteristics of SaaS and introduces a customized quality assessment model that incorporates key aspects such as security, service reliability, and performance. The proposed model supports both providers and users in managing and evaluating the quality of SaaS offerings more effectively*

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

I. INTRODUCTION

Cloud computing is the delivery of computing services over the internet, or "the cloud", to provide on-demand access to resources like storage, servers, databases, networking, software, analytics, and intelligence. It offers businesses and individuals flexible resources, faster innovation, and economies of scale.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).

Advantages of the SaaS model have:

- Flexible
- Scalability
- worldwide accessibility
- Accessibility
- Cost Saving

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- Data Security
- Data Management
- Reusability
- Portability

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 CCspecific 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

II. SECTION 2

2.1 Characterstics of SAAS model

2.2 The software applications are maintained by the vendor.

- The license to the software may be subscription based or usage based. And it is billed on recurring basis.
- SaaS applications are cost-effective since theydo not require any maintenance at end user side.
- They are available on demand.
- They can be scaled up or down on demand.
- They are automatically upgraded and updated.
- SaaS offers shared data model. Therefore, multiple users can share single instance of infrastructure. It is not required to hard code the functionality for individual users.
- All users run the same version of the software.

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 the key features are given in the Figure1;

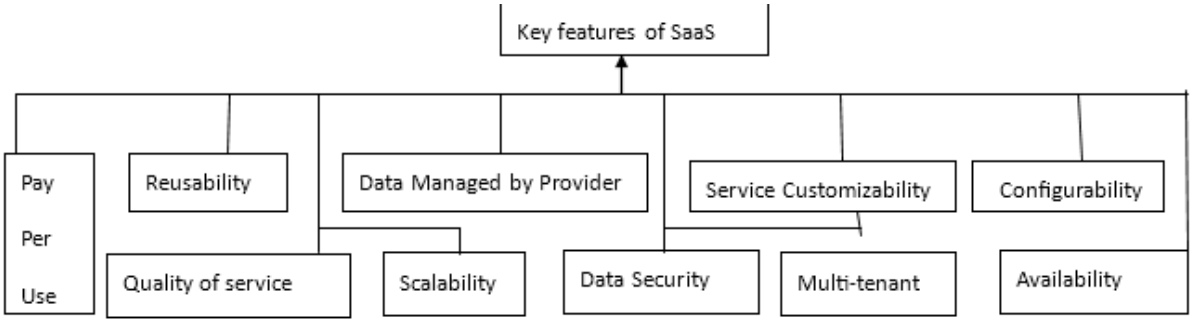

Figure 1: Key features of SaaS

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

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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

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.

2.2.5 Quality 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.

2.2.5 Scalability: 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.

2.2.6 Data 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

2.2.7 Multi-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

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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.

SaaS is a cloud computing model where the cloud provider offers ready-to-use software applications over the Internet. With SaaS, users can access and use software applications without the need to install, manage, or maintain the underlying infrastructure or software. The cloud provider handles everything, including infrastructure, software updates, and security. Users typically pay for SaaS applications on a subscription or usage basis. Examples of SaaS include customer relationship management (CRM) systems like Salesforce, productivity suites like Google Workspace and Microsoft 365, and collaboration tools like Slack and Zoom.

While AWS primarily focuses on providing infrastructure and platform services, it also hosts a growing number of Software-as-a-Service (SaaS) applications through its AWS Marketplace. SaaS applications offered on AWS Marketplace cover various domains such as data analytics, customer relationship management (CRM), content management systems (CMS), and more. Key features of AWS SaaS include:

III. 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.

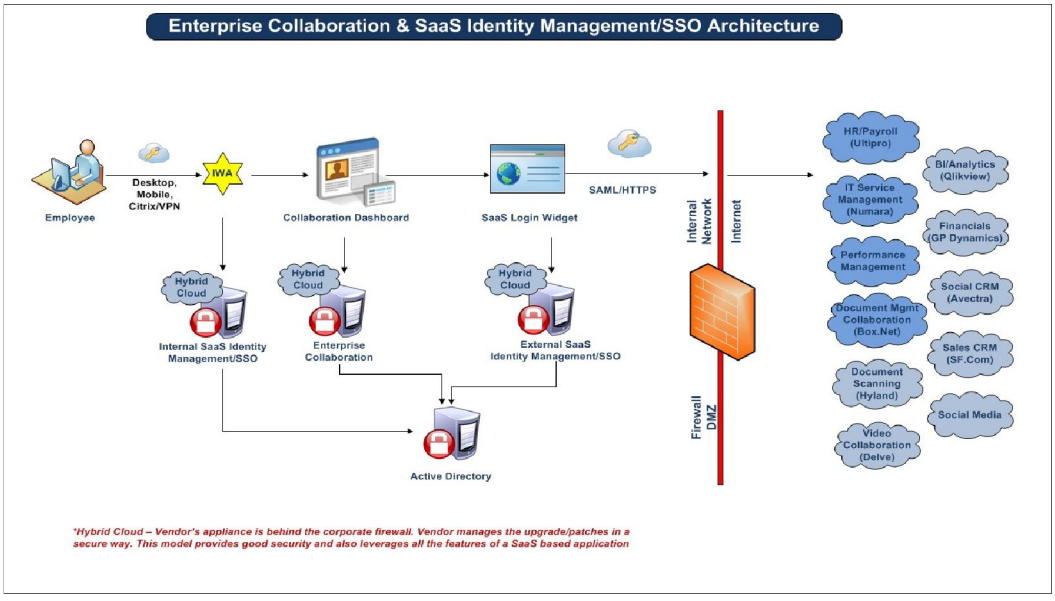

Figure 2: SaaS architecture

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

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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.

IV. 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

(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.

(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.

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(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.

4.1.3 Software 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

V. SECTION 5

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Conclusion and Future work: -
Software as a Service (SaaS) has transformed how software is consumed by enabling flexible, scalable, and cost-effective access to applications over the internet. This paper explored the fundamental features of SaaS, its architecture, and the critical need for an effective quality evaluation model. By incorporating security, service-level performance, and software quality into a unified assessment framework, stakeholders can make informed decisions regarding service selection and optimization.
In future work, we plan to refine the evaluation criteria and develop automated tools for measuring SaaS quality in real-time. This will support service providers in improving offerings and help consumers in identifying trustworthy, high-performance solutions.

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