Cloud Applications Versus Web Applications: A Differential Study

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***Abstract*-Cloud computing revolution started reshaping the entire ICT industry and adding new concepts; cloud application is one of these new concepts. This paper aims at differentiating between cloud applications and web applications and to position on the question "what are the differences between cloud applications and web applications?" The paper gives an overview of cloud applications and web applications and discusses differences between both of them. The paper emphasizes that although there are overlapped between cloud applications definitions and web applications definitions; there are also many differences in their characteristics. This work aims to promote the new services that cloud computing is providing nowadays due to its ability to offer many new characteristics through its cloud applications services.**

Keywords-cloud computing; cloud applications; web applications.

I. INTRODUCTION

The terms "Cloud Applications" and "Web Applications" are being used almost interchangeably, but there are real fundamental differences between the cloud applications which are cloud solutions and the web applications which are hosted solutions.

Cloud applications are developed and designed to be hosted by software as a service (SaaS), which is one of a cloud computing service delivery models.

So, what are cloud applications? What are Web Applications? How do they differ from each other? What are the general challenges and issues for both of them?

In answering these questions, this paper will explore the key concepts and characteristics surrounding cloud applications and web applications and will be focusing at differences between them.

The rest of this paper is organized as follows. Section II shows related work. Section III discusses cloud computing definition and its five essential characteristics. Section IV describes cloud computing service models. Section V focuses on the software as a service model (SaaS). Section VI presents cloud applications and its characteristics. Section VII presents web applications and its characteristics. Section VIII analyses the differences between cloud applications and web applications. Finally, Section IX is the conclusion from the finding.

II. RELATED WORK

There are many technical challenges involved in applications development. One of them is multi-tenancy, which allows a single instance of software to serve multiple organizations by accommodating their unique requirements through configuration at the same time [1].

Xuesong et al. [2] analyzed the similarities and differences between multi-tenancy and isolated tenancy applications and showed that both of them share several features in common. They are both spanning several layers from bottom to top: database, data access, business logic and web user interface. But, Multi-tenancy applications distinguish itself from isolated tenancy applications by their service pattern. The differences of their service patterns result in the differences of their technical implementations:

- The data model in isolated tenancy applications is designed for describing the business requirement, while for multi-tenancy applications besides catering to business requirement, its data model should also be able to accommodate dozens of tenants and ensure data isolation among these tenants.
- Isolated tenancy applications conduct authentication and access control just for users in single tenant, while multi-tenancy applications should also safeguard against intrusion among tenants. So tenant authentication is indispensible in multi-tenancy applications.
- Multi-tenancy applications need a tenant management console for tenant management, which does not exist in isolated tenancy applications.

The above mentioned publication discussed only the multi-tenancy and the isolated tenancy characteristics, and showed how these characteristics affect the applications development and design, and how these characteristics differ from each other, which is not enough to focus only in two characteristics. In this paper, we focus not only on the mentioned characteristics, but also on the other characteristics that make differences between cloud applications and Web applications.

III. CLOUD COMPUTING

As mentioned in Section I, cloud applications are developed and designed to be hosted on one of the cloud computing service delivery models. This section presents an overview of cloud computing.

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The overarching goal of cloud computing is to provide on-demand computing services with high reliability, scalability and availability in distributed environments [3].

Cisco Systems [3] described cloud computing as: "IT resources and services that are abstracted from the underlying infrastructure and provided "on-demand" and "at scale" in a multitenant environment." Recently, the Information Technology Laboratory at the National Institute of Standards and Technology (NIST) [4] has posted a working definition of cloud computing: "Cloud Computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

This definition includes five essential characteristics of cloud computing:

- On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
- Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
- Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.
- Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.
- Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service [5].

IV. CLOUD COMPUTING SERVICE MODELS

One of the important characteristics of cloud computing is its ability to deliver information technology (IT) capabilities or resources as a services. As shown in Fig. 1, these services are broadly divided into three service models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). This models are not new but cloud computing integrate and combine these approaches together.

1. Infrastructure as a Service (IaaS): Products offered via this mode include the remote delivery (through the internet) of a full computer infrastructure (e.g., virtual computers, servers, storage devices, etc.);

2. Platform as a Service (PaaS): To understand this cloud computing layer one needs to remember the traditional computing model where each application managed locally required hardware, an operating system, a database, middleware, web servers, and other software. One also needs to remember the team of network, database, and system management experts that are needed to keep everything up and running. With cloud computing, these services are now provided remotely by cloud providers under this layer;

3. Software as a Service (SaaS): Under this layer, applications are delivered through the medium of the Internet as a service. Instead of installing and maintaining software, simply it can be accessed via the Internet, freeing the customer from complex software and hardware management. This type of cloud service offers a complete application functionality that ranges from productivity (e.g. office-type) applications to programs such as those for Customer Relationship Management (CRM) or enterprise-resource management [6].

V. SOFTWARE AS A SERVICE (SAAS)

As mentioned before, cloud applications are hosted by SaaS, which is just one of the multiple kinds of services available through the cloud computing. These include Infrastructure as a Service, or IaaS (available through both Public and Hosted Private Communication Service Providers), Platform as a Service, or PaaS, Cloud-based Storage, and even Cloud Based Communications.

The U.S. Information Technology Laboratory at the National Institute of Standards and Technology (NIST) defines Software as a Service (SaaS) as [8]: The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The

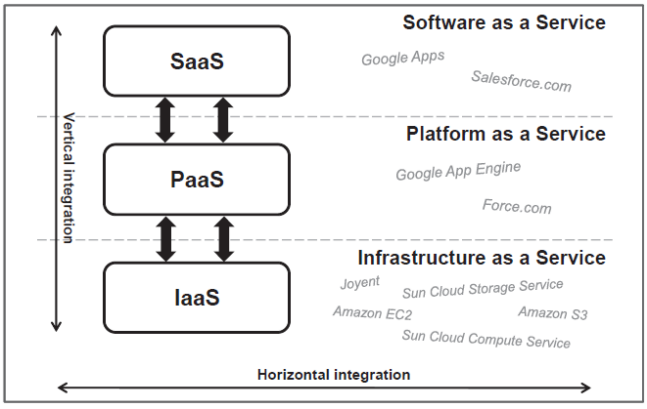

Figure 1. Cloud Computing Service Model [7].

applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

SaaS is a web-based software deployment model that makes the software available entirely through a web browser as shown in Fig. 2. The users of SaaS software do not care where the software is hosted, what kind of operating system it uses, or whether it is written in PHP, Java, or .NET. And, Also, there is no need to install a single piece of software anywhere [9].

SaaS is basically a term that refers to application in the cloud. Although not all SaaS systems are cloud application, but most of them are.

One of the essential attributes of SaaS model is multi-tenancy, which is defined as an architecture in which a single instance of a software application serves multiple customers; each customer is called a tenant. Tenants may be given the ability to customize some parts of the application, such as color of the user interface (UI) or business rules, but they cannot customize the application's code. Multi-tenancy enables sharing of resources and costs across a large pool of users thus allowing for centralization of infrastructure in locations with lower costs and peak-load capacity increases and utilization and efficiency improvements for systems that are often only 10–20% utilized.

VI. CLOUD APPLICATIONS

Cloud applications are developed and hosted by the SaaS services providers, accessed by the user customers over the Internet. The SaaS services providers own the software and run it on computers in their data centers. The customers do not own the software, but effectively rent it; usually for a monthly fee. Cloud applications are sometimes also known as hosted software or by its more marketing-friendly cousin, “on-demand”.

The essence of cloud applications is that the customer

Figure 2. SaaS Structure [8].

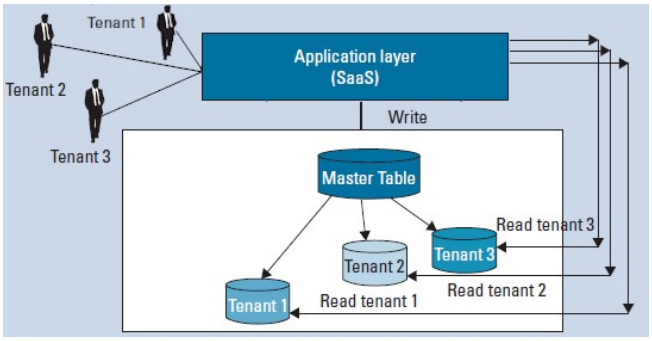

Figure 3. An overview of a general multi-tenancy cloud architecture [10].

does not buy the software, but pays for the service which it provides. The customer does not install software on the servers, but uses capacities of the developer, needing only to pay for the service, cloud server maintenance and consultation services. As a result the customer gets access to the necessary application on a cloud server of the developer which allows saving money and quickly introducing the software to the business. It is needless to say that as a result everyone wins: customers do not need to spend money on system administration, and suppliers, thanks to software installation on their cloud hosting, quickly provide the clients with the necessary service [9].

Mäkilä et al. [10] mentioned five characteristics which are associated with the cloud applications definitions:

1) The application is used through a web browser.
2) The application is not tailored made for each customer.
3) The application does not include software that needs to be installed at the customer’s location.
4) The application does not require special integration and installation work.
5) The pricing of the application is based on actual usage of the software.

Multi-tenancy is becoming a key technology for the success of cloud applications since clients reduce the cost of software use by sharing expenditures, whereas software vendors maximize sales profits. As shown in Fig. 3, multi-tenancy Architectures (MTA) allows multiple customers (tenants) to be aggregated into the same application. Tenants share not only application, but also capital and operational expenses. Moreover, tenants are also able to customize their applications both in endpoint presentation and data structure according to their particular needs but they cannot customize the application's code [11].

VII. WEB APPLICATIONS

A web application is an application that is invoked with a web browser over the Internet. Ever since 1994, when the internet became available to the public, and especially in 1995, when the world wide web put a usable face on the Internet, the internet has become a platform of choice for a large number of ever-more sophisticated and innovative web applications. In just one decade, the web has evolved from being a repository of pages used primarily for accessing

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static, mostly scientific, information to a powerful platform for application development and deployment; see Fig. 4.

New web technologies, languages, and methodologies make it possible to create dynamic applications that representing a new model of cooperation and collaboration among large numbers of users. Web applications development has been quick to adopt software engineering techniques of component orientation and standard components [12].

Also, web applications can be defined as applications that are accessed over a network such as the internet or an intranet. The term also mean a computer software application that is coded in a browser-supported language (such as JavaScript, combined with a browser-rendered markup language like HTML) and reliant on a common web browser to render the application executable.

It is utilizing web browser technologies to accomplish one or more tasks over a network, typically through a web browser.

Web applications are popular due to the ubiquity of web browsers, and the convenience of using a web browser as a client, sometimes called a thin client. The ability to update and maintain web applications without distributing and installing software on potentially thousands of client computers is a key reason for their popularity, as is the inherent support for cross-platform compatibility. Common web applications include webmail, online retail sales, online auctions, wikis and many other functions [13].

Web applications software and database reside on a central server rather than being installed on the desktop system and is accessed over a network.

The benefits of a web applications start with relieving the developer of the responsibility of building a client for a specific type of computer or a specific operating system. Since the client runs in a web browser, the user could be using an IBM-compatible or a Mac or mobile device. They can be running Windows XP or Windows Vista. They can even be using Internet Explorer or Firefox, though some applications require a specific web browser.

Web applications commonly use a combination of server-side script (ASP, PHP, etc.) and client-side script (HTML, Javascript, etc.) to develop the applications. The client-side script deals with the presentation of the information while the server-side script deals with all the hard stuff like storing and retrieving the information [12].

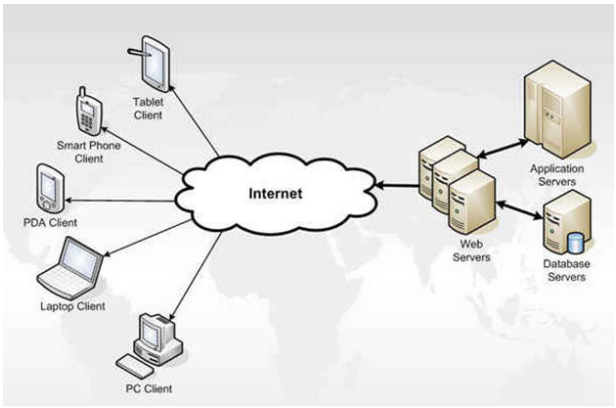

Figure 4. Web application Model.

VIII. THE DIFFERENCES

A cloud application has an architecture that has the data and the majority of the compute cycles happening in a data center somewhere; all the components of a cloud application are supported by a sophisticated back-end that ensures uptime, security and integration with other systems and supports as many access methods as necessary [14], while a web application is an application program that is stored on a remote server and delivered over the Internet or an intranet through a browser interface.

The following major characteristics play a primary role in the success of the cloud applications, but they are not available in the web applications: inherently scalable and very high uptime.

- Inherently Scalable is an absolute requirement for cloud applications. The cloud applications are written in such a way that it takes full advantage of the underlying platform to be scalable; it must not have limits on number of users or workloads. On the other hand the web applications are generally written for a given platform and are limited by the scalability.
- Very high Uptime is also extremely important for the cloud applications. With a mirrored installations in multiple locations the cloud applications are been deployed, so that the applications are always available (~100% uptime). This high availability architecture calls for hardware redundancy, data mirroring and rapid data synchronization. On the other hand the web applications installed in one location and limited by the availability (uptime).

Most of the web applications - online banking, e-ticketing, flight status checking etc. are really web applications and are limited by scalability and availability.

The cloud applications is essentially a platforms that provide a particular services while the web applications are essentially services that can be accessed over the internet from anywhere on any device.

The cloud applications can be installed on a public cloud or a private cloud and accessed there; conversely, the web applications can be installed on Internet or intranet and accessed there.

Although web applications share some of the same characteristics of cloud applications, they are located elsewhere and are accessible from almost anywhere. Web applications may help in accessing cloud services, but this does not mean they are the same as shown in Table 1. They can be standalone things, too, like applications that allow converting bitmaps to vectors, add drop shadows to images or find out who's stopped following you on Twitter.

Box [15], Dropbox [16], ShareFile [17] and Sugar Sync [18] are almost universally considered cloud apps and, while they have a web interface, they are in no way web applications. They run on back-end systems designed to

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TABLE I. COMPARISON BETWEEN CLOUD APPS AND WEB APPS

	Cloud Application	Web Application
1	The application is accessed through the internet or other computer network	The application is accessed through the internet or other computer network
2	All cloud applications are web applications	Not all web applications are cloud applications.
3	Majority of the compute cycles happening in a data center somewhere	Located elsewhere and are accessible from almost anywhere
4	Inherently Scalable	Limited by scalability
5	Very high Uptime	Limited by availability
6	User Data & Business Process store in a multiple replicated data centers	User Data & Business Process store in single data center
7	Can run on the users' computing systems or the provider's web servers.	Only run on the provider's web servers.
8	The provided application is standardized for all customers	Each customer uses its own instance of the application.
9	Multi-tenancy solution.	Isolated -tenancy solution.

scale and support many users with different requirements. A web interface is just another way to use these services.

Email is also a cloud application. In fact, it was a cloud application back when it was called E-Mail, even though we did not know it. We use Outlook, Mail.app and other mail applications that allow us to access our email stored in Gmail (widely considered a cloud application), Exchange (almost never considered one), Zimbra (if work for VMware) and all the other back ends out there.

Let us consider SalesForce.com; it is accessed primarily over the web, like many other solutions that could be considered web applications, but if the access method is what determines the classification of the application, then you cannot ignore the mobile applications designed to make it easier to use SalesForce or an expense tracking and travel system like Concur [19] (which owns TripIt).

In both cloud applications and web applications, the application is accessed through the Internet or other computer network and the vendor charges service fees [10]. One of the differences is that in cloud applications the provided applications are standardized for all customers, whereas in web applications each customer uses his own instance of the application.

The main difference between cloud applications and web applications is the multi-tenancy. Without the multi-tenancy the solution cannot get the cost efficiencies of true cloud computing, and truly cost effective elasticity and reliability. Web applications could provide elasticity and reliability in a hosted environment, but in practice this is often not truly provided as the costs are too great without multi-tenancy.

IX. CONCLUSION

Although the cloud applications definition is overlapping with many web applications concepts, this paper discussed the major features of cloud applications that make them different from web applications. The locations where we can store the "user data" and the "business process" is one of the key factors for differentiate between cloud application and web application. Scalability is the key enabler technology of clouds, as it is the basis for cloud application features. Availability is also an important property of cloud applications. Also, the security enhancements for sensitive data which have been added to cloud environments make the cloud applications different from the web applications.

The simple rule is that if a solution is not multi-tenant, it is not a cloud application and it will not give all the benefits that flow from being true cloud application.

Cloud computing has the potential to transform the way information technology (IT) departments relate to, and even think about their role as providers of computing services to the rest of the enterprise. The emergence of cloud computing as an effective software delivery mechanism creates an opportunity for IT departments to change their focus from deploying and supporting applications to managing the services that those applications provide. Successful cloud applications providers produce more value for the business by providing services that draw from both internal and external sources and align closely with business goals.

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