RESEARCH ARTICLE

Multi Tenancy and Customizations Issues in e-Health SaaS Applications

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Abstract: India has become the third largest country in number of internet service users. A lot of people are accessing the internet to search for health related information. Studies have found searching for health related information is the sixth / seventh most common activity online, pursued by 75% of internet users. A number of them use the internet to diagnose themselves. Government of India has adopted cloud technology for quick implementation of its e-governance projects by establishing GI Cloud. Some of the states has been migrating their projects on cloud. e-Health is the one of the main projects of e-Governance but only 3-4 states has implemented it and its not also in full fledge. To implement it quickly, e-Health SaaS applications can be the best technology. As SaaS application are required highly multi-tenant and customized for healthcare systems especially in India where people need customized applications in different languages, for different diseases, for different geographical locations etc. This paper is to discuss the design issues for e-health SaaS and to suggest a model for multi-tenant and customized SaaS for healthcare system.

Keywords: Customization, e-health, Multi Tenancy, SaaS Application.

I. INTRODUCTION

It is truly said that "The first wealth is health". In light of the challenges arising from an ageing population and runaway healthcare costs, e-health offers tremendous opportunities for public and private healthcare providers worldwide to optimize service delivery and enhance the quality of care being provided to patients. Even though the potential of e-health is acknowledged in academia as well as among practitioners, its application has proven to be remarkably difficult. In order for e-Health to be successful, it is imperative that it offers services which address the needs of citizens and patients. [1]

E-health (electronic health-care service delivery) is generally seen as a strategic tool for overcoming the challenges faced by health-care sectors worldwide (Chismar and Wiley- Patton, 2003). The huge potential that is attributed to ehealth to help balance an enormous and consistently growing health-care demand with limited resources, has already led to an increased use of the Internet as a source for health information and service delivery. Additionally, the market for information technology in health care is expected to grow even further (Cline and Haynes, 2001; Kerwin, 2002; Powell *et al.*, 2003; Tarre, 2003; Jai Ganesh, 2004; an, 2005). According to the Commission of the European Communities (2004) four out of five doctors in Europe had access to the Internet in 2004. A fourth of the European population used the Internet to collect health

information and around 40% considered the Internet to be a good medium for collecting such information (Commission of the European Communities, 2004). Yet there is requirement of standard and more reliable healthcare system.

"The use of emerging information and communication technology, especially the Internet, to improve or enable health and health care" (Pagliari, 2005). There are two main objectives of e-health. The first one is to give more responsibility, power and information to the patient so that he/she can be an active part in his/her own health care (Baldwin et al., 2002a; Guillen et al., 2002; Nicholas et al., 2003). The second aim is to utilize ICT in the most effective and efficient ways to support the interaction of patient and health-care provider in primary as well as in secondary care (Baldwin et al., 2002a). E-health is about improving access to and the quality of health-care services to citizens (Mukherjee and McGinnis, 2007). As stated by Mukherjee and McGinnis (2007) the future of e-health envisions patients who are empowered by current health information relative to diagnosis and treatment to make their own decisions on their health care without having to leave the house.

Even after 75 years Information Technology entered healthcare sector with telemedicine in 1940s, there is not much new technology adaption trends available in healthcare sector. Healthcare sector is one of the largest service sectors in the world. Healthcare industry depends mainly on Information Technology to provide best service and accuracy of information to their patients. Cloud technology can be used to create network between patients, doctors, and healthcare institutions by providing applications, services and also by keeping the data in the cloud. The impact of cloud computing which simplifies data availability anywhere and accessible to the patient in need of healthcare information in patient care and service especially in India is should be considered. [2]

II. CONCEPT OF CLOUD IN HEALTHCARE SYSTEM

The term "cloud" was coined from the Internet as being a cloud of servers, platforms, and software application which denotes hidden complexities from the users. Since the service providers are remote to the subscriber's organization, they are deemed to be in the Internet "cloud". Cloud computing is a form of virtualization that shares server hardware and data storage infrastructure remotely located at the service provider data centre. Today cloud computing is comprised of three major services: Software as a service (SaaS), data storage, and server platform; these services are typically offered in a subscription model with various means of pricing.[3]

Cloud technology used to create network between patients, doctors, and healthcare institutions by providing applications, services and also by keeping the data in the cloud. There are tremendous opportunities and reasons to choose Cloud Technology in healthcare. It is time to join hands with clinicians and computer specialists to proceed in order to implement the broad technology which suits small practices to large hospitals [4]

Cloud computing is the fastest growing field that provides many different services, which are provided on demand of the client over the web. Cloud computing is based on the model of pay-as-you-go. This gives the user cost reduction, fast and easy way to deploy the applications. Cloud computing usage in the Information Support Systems will facilitate businesses to run smoothly and efficiently. A number of virtual machines and applications can be managed very easily using a cloud. With the use of cloud in businesses will not only save the cost of staff required to maintain servers, but will also require lesser servers and with that less power consumption.[5]

[Figure 1]   Cloud in Healthcare

It makes sense to transition to cloud based services. Because they enable doing similar kinds of things for less money on a bigger scale. They remove inefficiencies in IT. Another strength that cloud services provide is their ease of access. Cloud service providers have been good about pushing open formats instead of closed formats. The structures and file systems employed are open and easily adaptable. This makes adopting a cloud system as a replacement for a localized one much easier, more efficient and cheaper.

III.SaaS MODEL

According to Sales Force, the founder of SaaS "Software as a service (or SaaS) is a way of delivering applications over the Internet as a service. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management". Theses SaaS applications are sometimes called Web-based software, on-demand software, or hosted software. SaaS applications run on a SaaS provider's servers. The provider manages access to the application, including security, availability, and performance. There are tremendous benefits of SaaS Model like Lower and More Predictable Cost, Simpler Security, Easier Upgrades and Updates Improved Accessibility, Better Data Exchange, Scalability, Accessibility, Upgradeability, Resilience

Characteristics of a SaaS solution:

- SaaS Application are kept on the Internet and they can be accessible via a browser running on internal systems
- Users have access SaaS applications anywhere, anytime
- They are on demand.
- SaaS applications can be controlled usage in a subscription model
- Multi-tenancy is the main feature and it supports unlimited users and scales up or down as business dictates
- Service is managed by external parties and hosted outside the organization's firewall [6]

IV.SAAS MODEL FOR HEALTHCARE

No other industry is better suited for the SaaS model than healthcare IT. Staff is overworked and budgets are tight. IT Departments must reduce costs while simultaneously improving service levels. And, unlike other industries where competitive differentiation lies in customized applications, healthcare providers benefit from standard processes and best practice application utilization. In recent years the use of Health 2.0 has migrated to mean the role of SaaS & Cloud-based technologies and their associated applications on multiple devices. Health 2.0 describes the integration of these into much of general clinical and administrative workflow in health care. As of 2014 here are currently around 3,000 companies that are offering products and services matching this definition, with venture capital funding in the sector exceeding $2.3 billion in 2013. [7]

Software as a Service (SaaS) technology deployment, also known as cloud-based deployment, web-based deployment, or Application Service Provider deployment, "allows software to be run and data to be stored [off-site]." [8] Data is stored in servers at an off-site vendor location, and SaaS users access the technology through the Internet.[9]. SaaS deployment can be leveraged for several health IT functions, including electronic health records (EHRs), medical practice management systems, and health information exchange (HIE).

### V. TECHNOLOGIES AND CONSIDERATION FOR DESIGNING E-HEALTH SAAS

For development of better quality software or product, the developer must consider some factors and issues like self-service and personalization, Multi tenancy, Integration, Operational Performance, and Security. Anyone should be able to register and can start using SaaS application without any help of technical person. It also should have personalization. The user should be able to make changes and feel of application as per their requirements. Another feature multi-tenancy is considered as the key to successful SaaS. Multi-tenancy is the concept of using or sharing one instance of application with many users. Initially it is costly but its operational cost is very low. SaaS Application also should have capacity of integration with other applications. SaaS applications will be accessed on internet so it should be always available and highly scalable and with good performance. Security is also a major concern for organization to adapt SaaS applications.

Design Issues for SaaS applications: According to David Chappell, Multi- Tenancy, Reliability and Scalability, Security, Metrics, Design for Operation, Portability, APIs, Customization, and Online Market Places are the issues which should be considered during the design of SaaS applications. Like other SaaS applications, Multi-tenancy and Customization are the main issues for e-health SaaS applications also.

VI.CUSTOMIZATION

Customization is the most important characteristics for the e-Health SaaS. It can be easy and straightforward in single-tenant SaaS applications because it has its own copy of software application. But in multi-tenant SaaS it is somehow complex and difficult. For more Customization more configuration and code and is required. It is

also true that more customization your application allow, the more complexity you will have to deal with in implementation as well as in operations.
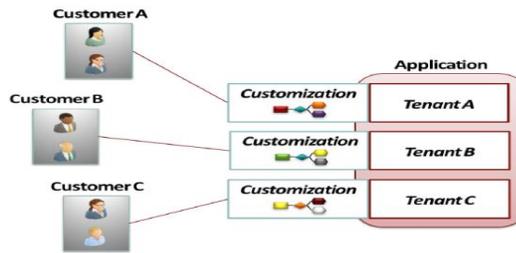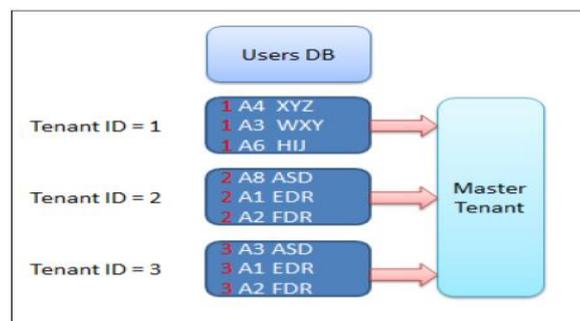

[Figure 2]: Customization in SaaS

VII.   MULTI-TENANCY

Multi-tenancy is the key feature for any SaaS application. Main difference between single tenant applications is that in single tenant each customer has its own instance of an application with its own distinct data storage and in multi-tenant applications, multiple customer share and instance of the application as well as data storage. Single tenant applications are actually SaaP running in the cloud. They are easy to implement, elastic, easily customizable and modifiable but costly in long term when no of customer increases and it is required to create more instances for each customer. On the other side Multi-Tenant applications are initially costly but its operational cost is very low even though no of customers increase.
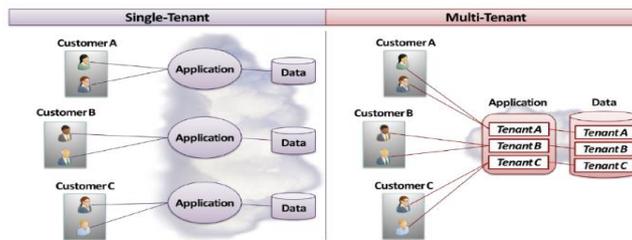

[Figure 3]Single Tenant v/s Multi Tenant

As e-health SaaS applications have wider scope of usage, they should be multi-tenant. Initially it may be single-tenant for testing purpose because current applications can be easily migrated into single-tenant cloud applications. For Multi-Tenant applications, they have to be redesigned with proper customization facility. Designing Cloud applications required three level of multi –tenancy. Infrastructure layer tenancy, Data layer tenancy and Application Layer Tenancy.   Infrastructure tenancy can be achieved by virtualization, multiprocessing or hybrid approach of both virtualization and multiprocessing. Data layer tenancy can be achieved by either sharing of database schema or sharing database logic. Multi-tenant database tables are share with all tenants and each tenant have its own partition to keep its data. Multi-Tenancy for the SaaS which is called Application Layer Tenancy in which for each tenant we can have a separate code module or a single module will be shared by all tenants. Second one is considered more appropriate. Other strategies like code partitioning can also be implemented to enhance the scalability and performance.


[Figure 4] Master Tenant shared by Multiple Tenants

VIII. PROPOSED FRAMEWORK
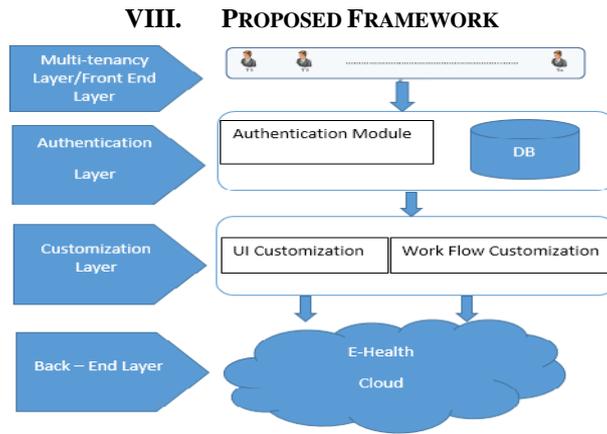
[Figure 5] Author's Compilation for e-health SaaS

    i.   Back-End Layer: - This layer is the original E-Health Cloud. It contains Application Server and Database Instances.

   ii.   Customization Layer: - This layer Contains User Interface Customization and Workflow Customization. User Interface Customization is changing the look and Feel of the application to make it tenant specific. It includes general layouts, logos, buttons, colours, and local settings like date and time Microssoft's Asp. Net master page concept can be used for this type of customization.
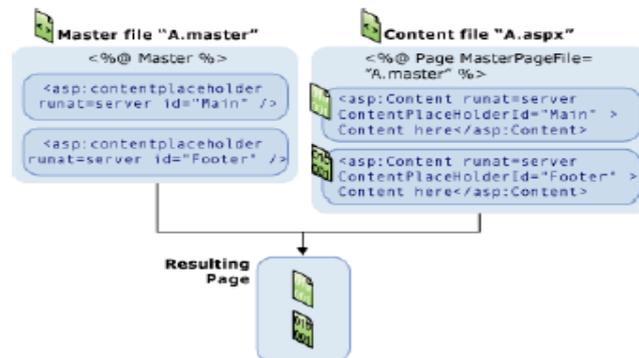
[Figure 6] Work flow customization

Work flow can be vary from one tenant to another. So, it is important to customize workflow in multi-tenant environment. Work flow customization can be achieved by first identifying the components to be customized and then changing their design in loosely coupled manner.

   iii.   Authentication layer runs the authentication module to authenticate the tenant in multi-tenant architecture using authentication database.

   iv.   In multi-tenant environment multiple user shares the same application for different purposes. Multi-tenant layer or front end layer is the interaction layer from where different users (tenant) of e-health SaaS can interact with e-Health cloud and can get customized service.

IX. CONCLUSION

In this rapidly developing world, cloud technology is very efficient for the development of next generation software applications. Software as a service (SaaS) is the cloud model for providing applications as a service. In healthcare sector, development of applications is challenging as it should be more personalized and also should be available to masses of users. Multi tenancy and customization features of SaaS can be applied to develop more efficient e-health SaaS.

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