Revolution In Healthcare Systems Using Cloud Computing

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ABSTRACT: A revolution is coming in the healthcare sector due to the invention of cloud computing. A recent survey reports shows that most of the healthcare organizations using cloud computing for their short and long term plans. The healthcare industry is in a period of accelerating change that requires continual innovation. The chronic disease epidemic, changing population demographics and advancements in medical technologies are key contributors to escalating costs. All stakeholders expect more value for their money. And, patients are beginning to play greater roles in managing their care. Driven by economics, emerging care and business models aligned with personal values and well-being are signaling a major shift in how healthcare organizations will compete and operate in the years ahead. Cloud computing can play a critical role in containing healthcare integration costs, optimizing resources and ushering in a new era of innovations. Current trends aim towards accessing information anytime, anywhere, which can be achieved when moving healthcare information to the cloud. This new delivery model can make healthcare more efficient and effective, and at a lower cost to technology budgets (Horowitz, 2011), but also, it brings certain obstacles due to concerns related with safeguarding confidential patient information and compliance with key regulations such as HIPAA. Despite these security and privacy risks, healthcare organizations can certainly take advantage of cloud computing solutions and bring tremendous benefits such as help to improve patient quality of service and reduce overall healthcare costs (Muir, 2011). Compared to other industries, the healthcare industry has significantly underutilized technology to improve operational efficiency. Most healthcare systems still rely on paper medical records. Information that is digitized is typically not portable, inhibiting information sharing amongst the different healthcare actors. Use of technology to facilitate collaboration and to coordinate care between patients and physicians, and amongst the medical community is limited.

1. INTRODUCTION:

The advent of cloud computing and its business models have been some of the biggest changes impacting not only the computer industry but also several others. It is predicted that around 80% of the businesses from today‚s world will be moved to the cloud by the year 2020. Organizations that do not have enough resources to invest and build infrastructure and platforms to deploy their applications can now take advantage of the cloud services to suit their specific needs. When considering a move to use cloud computing, healthcare consumers must have a clear understanding of unique benefits and risks associated with cloud computing, and set realistic expectations with their cloud

provider. Consideration must be given to the different models of service delivery: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) as each model brings different requirements and responsibilities. Cloud deployment models (private, public, and hybrid) will also weigh heavily in strategic decisions [12]. Around the globe, healthcare reform has mandated that it is time for healthcare information technology (HIT) to be modernized and cloud computing is at the center of this transformation. The healthcare industry is shifting toward an information-centric care delivery model, enabled in part by open standards that support cooperation, collaborative workflows and information sharing. Cloud computing provides an infrastructure that allows hospitals, medical practices, insurance companies, and research facilities to tap improved computing resources at lower initial capital outlays. Additionally, cloud environments will lower the barriers for innovation and modernization of HIT systems and applications. Cloud computing caters to the key technology requirements of the healthcare industry. The aim of this guide is to provide a practical reference to help enterprise information technology (IT) and business decision makers of the healthcare industry as they analyze and consider the implications of cloud computing on their business. The paper includes guidance and strategies, designed to help these decision makers evaluate and compare cloud computing offerings in key areas from different cloud providers, taking into account different requirements from various factors including medical practices, hospitals, research facilities, insurance companies and governments

Data analytics, Security, Mobility, Collaboration with patients, and Collaboration among peers are the five ways by which the healthcare industry benefits from cloud computing. Cloud computing is a new computing model that lets organizations pay for only the resources they need, when they are needed [9]. With cloud computing, shared resources are allocated dynamically to create a highly flexible environment. This enables organizations to treat infrastructure as service, rather than an expensive capital expenditure. When considering a move to use cloud computing, healthcare consumers must have a clear understanding of unique benefits and risks associated with cloud computing, and set realistic expectations with their cloud provider [4]. Consideration must be given to the different models of service delivery: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) as each model brings different requirements and responsibilities. Cloud deployment models (private, public, and hybrid) will also weigh heavily in strategic decisions.

2. HEALTH CARE USING CLOUD COMPUTING:

Cloud computing in healthcare can be specified by applications, deployment models, service models, pricing models, and components. Applications in healthcare are of two main types; Clinical Information Systems (CIS) and Non Clinical Information Systems (NCIS). CIS includes EMR, CPOE, PACS, RIS, LIS, PIS, and others while NCIS includes Revenue Cycle Management, Automatic Patient Billing, cost accounting, payroll management, and claims management. Since the real life businesses

and organizations normally build applications in quite a complex environment that involves networking, security, physical servers, firewalls etc. and transactions worth millions of dollars, they expect same or higher level of service provided by the cloud service providers and the cloud so their data is protected and the businesses are not negatively impacted. More and more tools are being built on the Internet that is important to run a business. Healthcare industry has been one of the businesses that traditionally repelled outsourcing mainly because of the security and privacy concerns [5]. The member„s privacy and medical records are highly sensitive and the companies spend millions in protecting them while following the federal regulated guidelines. However, rising medical costs might change the way this business is performed. Most healthcare organizations today need to modernize their IT infrastructure, to be able to provide safer, faster and more efficient healthcare delivery. This requires massive up gradation of their existing IT infrastructure and involves huge upfront capital expenditure and sizeable operating expenses. Cloud technology mitigates the need to invest in IT infrastructure, by providing access to hardware, computing resources, applications, and services on a „per use' model, which dramatically brings down the cost and simplifies the adoption of technology. Several EMR vendors are offering their solutions as a cloud-based offering, providing an alternative approach to help hospitals better manage the otherwise massive capital IT investments that would needed to support EMR implementations.

2.1 Evolution of Cloud Technology:

Technology has penetrated in human lives so much that it has started to become an intrinsic part now. Mobile phones have brought in a revolution in the way we live. We increasingly look to social media to inform our personal and business decisions. Our expectations on communications, data, content, and applications have increased dramatically and we look for instantaneous and ubiquitous access to information, 'anytime', 'anywhere' access to information has become an essential requirement in today's world. The combination of rising expectations and a rapid rate of change, pose a challenge to traditional approaches for information technology (IT) [6]. A new approach is needed to free individuals and organizations from the constraints of traditional IT. Cloud is a new computing paradigm. In Cloud, IT resources and services are abstracted from the underlying infrastructure and provided on-demand and at scale in a multi-tenant environment. Cloud has several characteristics:

a. IT, from infrastructure to applications, is delivered and consumed as a service over the network.

b. Services operate consistently, regardless of the underlying systems.

c. Capacity and performance scale to meet demand and are invoiced by use of Cloud.

d. Services are shared across multiple organizations, allowing the same under-lying systems and applications to meet the demands of a variety of interests, simultaneously and securely. Applications, services, and data can be accessed through a

wide range of connected devices (e.g., smart phones, laptops, and other mobile internet devices) Cloud encompasses several variations of service models (i e., IaaS, PaaS, and SaaS) and deployment models (i.e., private, public, hybrid, and community clouds), as defined below.

2.2 Infrastructure as a Service (IaaS) provides users with processing, storage, networks, and other computing infrastructure resources. The user does not manage or control the infrastructure, but has control over operating systems, applica-tions, and programming frameworks.

Figure 1: Infrastructure as a Service Healthcare Model

2.3 Platform as a Service (PaaS) enables users to deploy applications developed using specified programming languages or frameworks and tools onto the Cloud infrastructure. The user does not manage or control the underlying infrastructure, but has control over deployed applications.

Figure 2: Platform as a Service Healthcare Model.

2.4 Software as a Service (SaaS) enables users to access applications running on a Cloud infrastructure from various end-user devices (generally through a web browser). The user does not manage or control the underlying Cloud infrastructure or individual application capabilities other than limited user-specific application settings. An example set of services that are provided to a Cloud consumer is shown in the accompanying figure (Source: NIST Cloud Computing Reference Architecture Ver1.0).

Figure 3: Software as a Service Healthcare Model

2.5 Why do we need the cloud in healthcare?

Cloud solutions can help us address certain societal challenges more efficiently and address the current lack of sustainability in healthcare systems.

a. Rising healthcare expenditure and unsustainable healthcare systems: Health spending continues to rise faster than economic growth in most OECD countries. Health spending reached 9.5% of GDP on average in 2009, up from 6.6% in 1980.

b. Rise of chronic diseases: Chronic diseases cost around 75% of healthcare budgets and account for 85% of premature deaths in Europe.

c. Medication errors: Over 5 million outpatient prescription errors could be avoided yearly through the use of electronically transferred prescriptions.

d. Medical errors due to poor communication: Poor communication is the causal actor in over 60% of medical errors. Increased adoption of IT in healthcare has led to a rise in the adoption of cloud computing by the Global Healthcare industry. Though there are significant challenges such as high initial investment and shortage of skilled workforce, cloud computing is expected to witness a significant rise in its adoption by healthcare providers. There is also increased need for integration of data to enable healthcare providers make effective and accurate decisions [1]. The increased adoption of IT in healthcare has led to an urgent need for storage devices to store the enormous amount of data that is being generated. Cloud solutions for storing and retrieving data are expected to significantly reduce the IT expenditure of healthcare institutions. As healthcare companies weigh up the potential opportunities and risks around cloud computing, they can be sure that their competitors are now evaluating cloud solutions and quite possibly adopting them. Over the next few years, those players that fail to move fast to seize the cloud opportunity will face losing the competitive edge which will quickly translate into lost customers and market share. Even among those healthcare companies that are aggressively adopting cloud, some do not yet have a clear strategy. But they know they have to start averaging the technology, and are doing so at pace. Put simply, the healthcare industry''s migration to cloud is inevitable driven by an irresistible blend of

competitive realities and patient demand. And in any step-change in business or technology, early movers tend to reap the lion''s share of the benefits. It is time for healthcare organizations to embrace cloud computing to ensure that when the game changes, it does so in their favor

3. PERSONALIZED HEALTHCARE

Cloud computing helps in the storage of information, medical records, files, and images of patients in a digital format. Mobile devices are gaining popularity with the adoption of BYOD policies by various organizations in the Healthcare industry. Apart from healthcare providers and physicians, patients can also access their medical data. Medical records and images can be shared with medical practitioners worldwide in real time and treatment and outcomes can be monitored remotely [8]. If an individual falls ill while travelling, her/his medical records can be accessed by local doctors on the cloud.
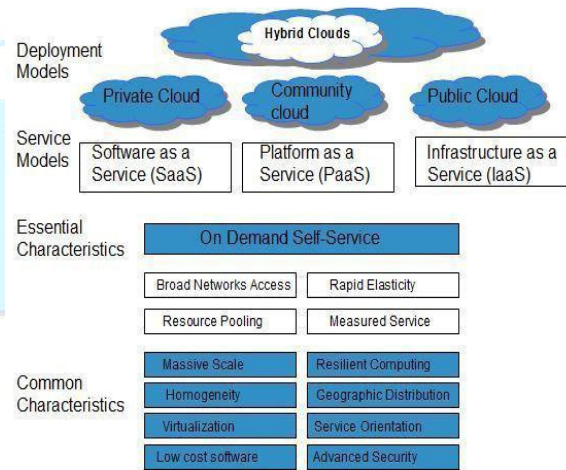

Figure 4: Cloud Computing On-demand Services

3.1 Availability of Healthcare Services at Remote Locations:

The treatment of chronic diseases is more expensive than the treatment of acute illnesses as patients with a chronic condition are often admitted to a hospital or a healthcare facility. Healthcare providers can deploy mobile devices that could be linked to the cloud platform, and continuously monitor patients in remote locations, thereby reducing costs incurred by patient visits. Providing healthcare services to remote locations with the help of cloud computing has one more key application area. As healthcare infrastructure and services in rural areas of many developing countries are very basic, mobile devices can be used by patients to access information about local clinics and hospitals.

3.2 Benefits of Cloud Computing for Healthcare:

The "Benefits of Cloud Computing for Healthcare" section discusses specific IT trends in the healthcare industry that are addressed most effectively, both technically and economically, by cloud computing as opposed to traditional IT environments [10]. In the process the hospitals, insurance companies, entrepreneurs and government bureaucrats will discover that the cloud will provide them with some important benefits that they haven"t yet even imagined. To understand why this might be, we need to take a closer look at the state of healthcare in America today, and where it needs to go.

"Patient centricity" has become the key trend in healthcare provisioning and is leading to the steady growth in adoption of electronic medical records (EMR), electronic health records (EHR), personal health records (PHR), and technologies related to integrated care, patient safety, point of care access to demographic and clinical information, and clinical decision support. Availability of data, irrespective of the location of the patient and the clinician, has become the key to both patient satisfaction and improved clinical outcomes. Cloud technologies can significantly facilitate this trend. Cloud computing offers significant benefits to the healthcare sector: doctor"s clinics, hospitals, and health clinics require quick access to computing and large storage facilities which are not provided in the traditional settings [11]. Moreover, healthcare data needs to be shared across various settings and geographies which further burden the healthcare provider and the patient causing significant delay in treatment and loss of time. Cloud caters to all these requirements thus providing the healthcare organizations an incredible opportunity to improve services to their customers, the patients, to share information more easily than ever before, and improve operational efficiency at the same time.

a. Clinical Research: Many pharmacology vendors are starting to tap the cloud to improve research and drug development.

The "explosion of data" from next generation sequencing as well as the growing importance of biologics in the research process is making cloud-based computing

"an increasingly important aspect of R&D"

[2]. Currently, pharmacy firms do not have the capacity to run large datasets especially DNA sequencing as the size of the data can overwhelm their computers. Commercial cloud vendors have developed pharmacy-specific clinical research cloud offerings with the goal of lowering the cost and development of new drugs.
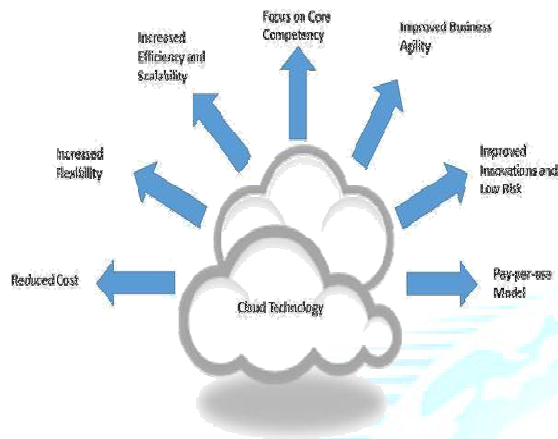
Figure 5: Cloud Computing Healthcare Model benefits.

b. Electronic Medical Records: Hospitals and physicians are starting to see cloud-based medical records and medical [7] image archiving services coming on line. The objective is to offload a burdensome task from hospital IT departments and allow them to focus on supporting other imperatives such as EMR adoption and improved clinical support systems.

c. Collaboration solutions: Early successes of cloud-based physician collaboration solutions such as remote video conference physician visits are being trialed. Extending such offerings to a mobile environment for rural tele-health or disaster [7] response is becoming more real with broader wireless broadband and smart phone adoption. Cloud technology supports collaboration and team-based care delivery and the ability to use applications based on business model requirements and a common set of clinical information.

d. Telemedicine: With the increase in availability of mobile technologies and intelligent medical devices, telemedicine has

grown to include not only tele-consultations and tele-surgeries, but also health record exchange, video-conferencing, and home monitoring. Cloud computing and the related ease of services deployment and data storage is an enabler for telemedicine.

e. Big Data: Healthcare organizations turn to cloud computing to save on the costs of storing hardware locally. The cloud holds big data sets for EHRs, radiology images and genomic data for clinical drug trials. Attempting to share EHRs among facilities in various geographic areas without the benefits of cloud storage could delay treatment of patients [11].

f. Analytics: Cloud computing facilitates practice and population scale information and insights are available in near real-time. This availability ensures that the most current [8], complete insights and clinical knowledge are available to support care provider decisions and to enable a focus on value creation related to improving outcomes rather than consumption. Information contained within a cloud can also be better analyzed and tracked (with the proper information governance) [3] so that data on treatments, costs, performance, and effectiveness studies can be analyzed and acted upon. Information can be harvested and repurposed for more appropriate referrals and medical research to b support the promise of personalized health and care.

g. Health Information Exchange: Health information exchanges help healthcare organizations to share data contained in largely proprietary EHR systems. CIOs may accelerate the deployment of HIE via a linkage to a strategic cloud implementation.

4. STRATEGIC RECOMMENDATIONS

Cloud computing requires an integrated and orchestrated strategy. A strategy assessment is fundamental to the thoughtful definition of how you will take advantage of cloud computing and the value it will create for your healthcare organization. This will include:
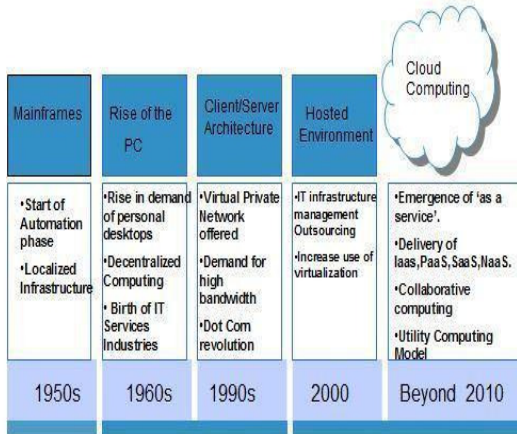

Figure 6: Cloud computing revolution.

4.1 Use public procurement to support the adoption and deployment of cloud solutions in healthcare:

Innovative technologies such as e-Health, telemedicine and cloud computing present many demonstrable benefits. However, their adoption and implementation can be lengthy for a variety of reasons: they require a change of habits, an initial roll-out cost and time to put new processes in place. Public authorities have a role to play in supporting this initial effort.

4.2 Do not delay investments:

In difficult economic times, minds are easily distracted by short-term fixes. Cutting costs today often means postponing those fundamental investments and opportunities to secure better care, provide broader access

and faster delivery. Collectively, we must dare to provide better care through innovation and efficiencies with real impact, given the amount of money available in the system.

4.3 Accelerate digitalization and provide online access to patient's records:

If properly implemented, today''s technologies would allow a full digitalization of medical notes, medical records, laboratory results, prescription, etc.

They would also enable patients'' access to their medical records online, as called for by the Digital Agenda [13].

However too many medical processes are still handwritten (e.g. prescriptions, general practitioners'' patient records). Laboratory results are often transmitted by postal mail, and scanned by the medical professional, instead of being transmitted electronically.

4.4 Adopt a legal framework that allows the flow of health data and accommodates the specific needs of the cloud business community:

Trust in cloud is essential if there is to be significant take-up and adoption by end-users, especially when medical data may be stored, accessed and processed in remote locations. A clear legal framework on privacy and data protection and adapted governance models are needed to build trust.

4.5 Balance regulation:

A thorough assessment of the risks, costs and benefits should be undertaken. Regulation should intervene when the risks outweigh the benefits brought by the cloud. Any regulation should be technology-neutral, future-proof and should accelerate

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the adoption of enabling technologies and allow the internal digital market to exist:
Allow the flow of data between countries and beyond the EU borders
Harmonies the internal digital market rules

4.6 Build it skills among healthcare professionals:

Health professionals do not always have the necessary ICT skills to use e-Health solutions [9] or leverage the benefits of cloud computing solutions. This can result in a significant barrier to the adoption of innovative technologies in the medical field.

5. MAJOR CHALLENGES IN USING HEALTHCARE CLOUD COMPUTING

Security issues and data privacy concerns including unauthorized access or loss of sensitive patient information is a key challenge affecting the ability of cloud service providers to gain the confidence of healthcare providers [10]. Modifications to HIPAA privacy, security, enforcement, and breach rules have been introduced to ensure patient data security and privacy.

This is yet to be fully realized and comprehended by cloud providers as organizations are looking for the most reliable partner who can sign the BAA, while the ones who market themselves with only standards such as the HIPAA standard are bound to lose to the emerging competition since they can associate only with the HIPAA compliant providers. Healthcare institutions prefer private clouds over public clouds because of security concerns, though public clouds do offer the necessary data privacy and security assurance. Although the e-Health Cloud could provide valuable benefits to the health care industry, it unfortunately inherits the major challenges of HIT and CC together and adds more weight to these challenges as it is used to store and process sensitive medical data. Here we summarize the technical and non-technical challenges particularly faced by the e-Heath Cloud.

CONCLUSION

Cloud computing services are increasingly moving into the future in health care. However, the protection and security of private data are two of the main reasons why the healthcare sector is generally slow to adopt new technologies. Market researchers at Market sand Markets assume that the health care industry will invest $5.4 Billion in Cloud Computing by 2017. Cloud computing offers significant benefits to the healthcare sector; Doctor"s clinics, hospitals, and health clinics require quick access to computing and large storage facilities which are not provided in the traditional settings, moreover healthcare data needs to be shared across various settings and geographies which further burdens the healthcare provider and the patient causing significant delay in treatment and loss of time. Cloud caters to all these requirements thus providing the healthcare organizations an incredible opportunity to improve services to their customers, the patients, to share information more easily than ever before, and improve operational efficiency at the same time, the report said. In general, rather than just looking to cut costs, experience shows there are value in investing to save money in the future. This includes investing in architecture, tools and governance to fully leverage the benefits of cloud computing, by

anticipating the move to a cloud broker model.

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