Developing a Common Cloud Platform to Manage Ghana's Healthcare System. Case Study of Ghana Health Service (GHS)

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***Abstract*— Cloud computing integration into healthcare services can bring about significant benefits economically, and increase the formation and effective organization of integrated healthcare delivery systems. The second section contains data from different sources, takes a gander at cloud applications in healthcare from the perspective of governmental offices, researchers and computer specialists. This work sorts to create a common cloud platform that can be used to manage Ghana's healthcare delivery system. The application of innovative information technology driven services in healthcare systems has the potential to enhance operational efficiency, provide collaboration and improve patient outcomes. Available information indicates that healthcare services are in dire need of attention with respect to providing efficient, cost effective and timely delivery of healthcare services. It details different shades of opinion, experience, applicability the development, use and integration of cloud technology into healthcare systems.**

Keywords—Cloud Computing; Healthcare delivery; Infrastructure as a Service; Platform as a Service; Common Cloud Infrastructure.

I. INTRODUCTION

The previous year alone has seen a surge of enthusiasm in regards to the capability of cloud computing with numerous players set to begin moving healthcare services related applications crosswise over to cloud stages in the impending years [1]. Contrasted with different commercial ventures, the medical services industry has essentially underutilized innovation to enhance operational proficiency [7]. All over the world, healthcare services change has ordered that it is the ideal time for Healthcare Information Technology (HIT) to be restructured and cloud computing is at the focal point of this change. The healthcare sector is moving in the direction of a data driven consideration conveyance model, empowered to some extent by open gauges that bolster participation, community oriented work processes and data sharing. Fig 1 shows a cloud infrastructure [7].

Fig. 1. A cloud infrastructure.

A. Problem Statement

Healthcare delivery in Ghana over the years has improved tremendously from a few health facilities to over thousand health facilities. There are about 5,517 health facilities in the country, categories in CHPS through to Hospitals [5, 6]. It is a very good phenomenon in terms of healthcare delivery and accessibility of quality healthcare. But in spite of the numerous healthcare facilities, patient care and quality of care has always proved futile as there is no coordination of the delivery process between care providers leaving the patient isolated within the delivery chain. Cloud computing adaptation provides a better solution to the proper management of the healthcare delivery process in Ghana; it has the potential to support collaborative work among different healthcare sectors through connecting healthcare applications and integrating their high volume of information sources. Overall collecting patient's data in a central location in Cloud computing results in many benefits which includes but not limited to the following:

- The ability to provide a unified patient medical record containing patient data from all patient encounters across all operators results in improving patient care.
- Cloud computing creates a collaborative economic environment. And moreover, the flexibility to only

pay for actual resources utilization shares the overhead costs among the participant resulting in reduced cost.

- The storage of clinical data in the cloud enables health organizations to delivery of timely and quality of healthcare in terms of referrals from one facility to another as information on patients are readily available to all facilities.

But currently all the above benefits that cloud computing integration provides are absent because all the healthcare facilities in Ghana do not have a proper well laid information system infrastructure. In order to address the above challenges facing healthcare delivery in Ghana, this research is to look at the current information technology infrastructure (if any) and based on it create a common cloud infrastructure that could be used to manage health care delivery in Ghana.

II. RELATED WORKS

Within this section, references are composed of studies done into the utilization of Cloud computing in Managing Healthcare industry. Information sources, for instance, abstracts, web, workshops Scientific Journals, books, symposia and seminars will all be scrutinized.

A. Cloud Computing – Constructing an Innovative Base for Healthcare

Today cloud-delivered pilot programs are helping organizations support wellness programs and make medical information available to individuals.

In conclusion, IBM states some of the reasons why in its view organizations are deploying their services into the cloud by stating that Healthcare organizations currently drawn to cloud computing have done so because of reduced IT costs and speeds of service and infrastructure availability. It makes a pledge to implement secure delivery models, deploy platforms for industry clouds that are "secure by design." With these secure models, when healthcare organizations or communications services providers deliver services, they can trust that their services are not compromised [4].

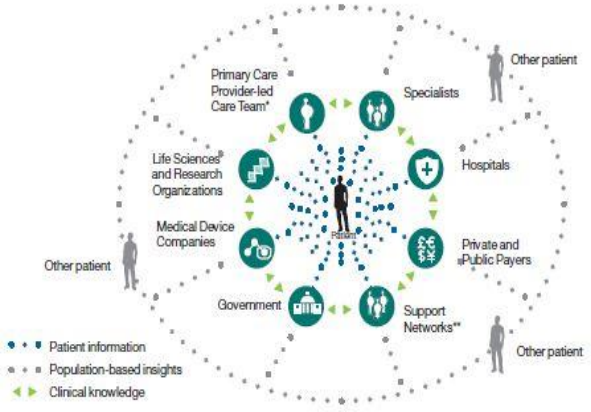

Fig. 2. IBM's vision for Cloud in Healthcare.

B. Advantages of Cloud Computing In Healthcare

Cuts expenses and Increase Efficiency - The utilization of information and communication technology in healthcare is expanding drastically; this implies that keeping in-house frameworks up to date is both extravagant and prolonged. Cloud computing can lower general expenses, build, access, and give versatility and flexibility to the interest for wellbeing administrations. Cloud computing improves server usage and drives down vitality utilization by up to 30%. This can lead to cost savings of up to 60% compared to traditional non cloud-based solutions. [3]

C. Cloud Enhanced Security Safeguards

Data security is the greatest concern toward utilizing the cloud as a part of the medical service: cloud computing providers hold gigantic measures of client information. Also, numerous efforts to establish safety are less expensive when executed on an expansive scale so the same measure of interest in security purchases and better protection. [3]

D. Cloud Computing Effect on Healthcare

Prospects and challenges according to this research work which was conducted by Nabil Sultan of Suffolk University campus of the United Kingdom and published by Elsevier Limited in 2014; Cloud computing offers a new model for remotely delivering a range of ICT services that can be provisioned in a "metered" pay-as-you-go means. In doing as such it gives adaptability and convenience to the end-users. [8]

E. Healthcare, Safety Measures Concerns with Cloud Computing

While the cloud seems to introduce numerous advantages it likewise displays practical dangers to healthcare organizations regarding confidentiality, security and ownership of data and integrity. It is essential that the cloud service givers completely comprehend these security concerns in the public cloud and attend to them healthcare institution agree to HIPAA confidentiality standards set by government regulations. [2]

III. METHODOLOGY

The key reason of this study has been to develop a common cloud platform which can be used to manage healthcare delivery in Ghana through the use of a simulation tool to indicate or show the various accessibility points and the central database center including how the various institutions can be interconnected to share computing resources in the health delivery chain. The strategy adopted was to conduct a single case study, which is the institution of Ghana Health service (GHS). The fieldwork was conducted at the site of the Kwahu Government Hospital, which is a GHS institution during the period from November 2014 to March 2015. The main data collection techniques used in this research study were depth interview and documentation analysis and simulations.

A. Instrumentation

An organized non masked profundity interview was carried out and attended to the accompanying purposes. The structure of GHS, the type of Computing and network infrastructure in use, the spread of or reach of the organization, the number of individual institutions within the organization, services on offer, level of cooperation among the various institutions and the level of IT implementation within the organization.

B. Sample

An objective sampling method was embraced to particularly recognize individuals who manage the information system directly to obtain their know-how as a lead. A stakeholder sampling method which is valuable in recognizing key stakeholders included in either, giving, accepting designing or executing a program or service being assessed. Interviews were carried-out in English dialect amid which broad notes were taken.

C. Data Collection And Analysis

Data collection was done through both secondary and primary sources and simulation results under two different scenarios. Secondary data sources, mainly covered computer security expert publications, technical documents, and reports of the companies in the cloud computing service industry. Secondary data found within various platforms such as company websites was also used.

D. Existing System And Information Technology Infrastructure

Presently, GHS does not have any common cloud infrastructure to provide Information Technology Service support for its institutions. Individual healthcare institutions sometimes have different IT services which are not linked up to any other external or affiliate institution. Institutions manage their own (if available) IT infrastructure internally.

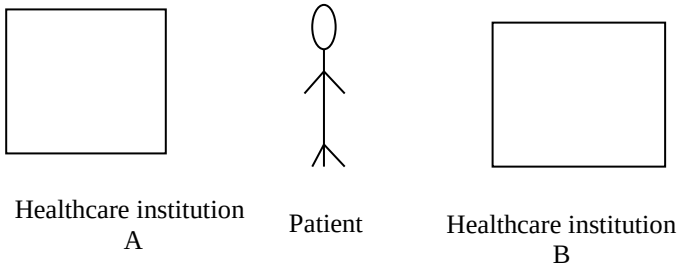

Fig.3. The current actors in the healthcare delivery system.

In the current system as shown in Fig 3, the patient who is at the center of care is completely isolated in terms of IT infrastructure and information services as they stand on their own with minimal or no interaction which sometimes leads to duplication of services.

E. Information Technology Infrastructure

Within the existing system, many of these Healthcare institutions within the GHS have little or no information technology infrastructure in managing healthcare delivery in Ghana. The few institutions with IT infrastructure runs isolated information technology driven services. They are standalone systems peculiar or confined to their individual areas of operation.

F. Proposed Ghana Health Service Cloud Network Topology Platform

In Fig. 4, different regional capitals representing the regional hospitals and teaching hospitals are interconnected in a common cloud platform to share computing resources (hardware, software, storage, network, services and applications). Greater Accra has two connections because it is being used as the headquarters of the proposed platform and to efficiently manage the anticipated network traffic, two connections (load balancer) has been created to cater for that eventuality.

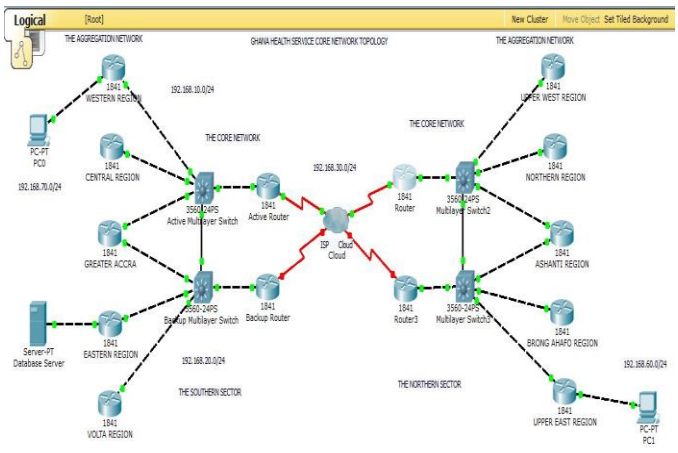

Fig. 4. The proposed common cloud platform network topology diagram.

In the proposed cloud network platform, two internet service providers (ISP) have been created with one acting as there redundancy network to prevent network failure through the same cloud environment; this is because healthcare service is a safety critical service requiring prompt and immediate attention since human lives are involved.

IV. RESULTS

After a cautious investigation of the existing information Technology infrastructure system, processes and procedures in use at the various healthcare facilities, and the results of simulations of the proposed new cloud infrastructure for the Health service, the following evaluations and analysis could be deduced from the simulations performed and are believed to have noteworthy significance to the case under study. The existing systems were perceived to be very isolated with no collaborations in places with IT infrastructure considering the

nature and importance of the role IT plays in managing healthcare delivery in the current world order.

A. The Proposed New System

In the proposed Common Cloud infrastructure platform, services and applications including hardware and software applications and storage are to be shared among all the active players within the domain. These are intended to promote collaboration, research and provide efficient delivery of healthcare services and to leverage information technology use among all the institutions within the GHS structure irrespective of geographical location. It is also to promote IT usage among the various healthcare professionals. Fig. 4 depict the proposed new system.

B. System Design

Taking after those discoveries produced using the current IT infrastructure; another configuration which seeks to attend to the deficiencies found was made to incorporate a cloud environment intended at allowing all institutions inside the GHS structure to have full access to all the available computing resources within the cloud environment. The primary focus of this design was the incorporation of the cloud infrastructure, environment and the back-up service to ensure that these safety critical services continue to run in the event of a network failure. Additionally, configurations which will allow only authenticated institutions to have full access to the shared computing resources.

C. Simulation Evaluations

The first scenario sort to demonstrate how networked resources could be shared among the various institutions of the healthcare delivery system for which pings were made from remote locations to other remote destinations of the cloud architecture with the results illustrated in Fig. 5.

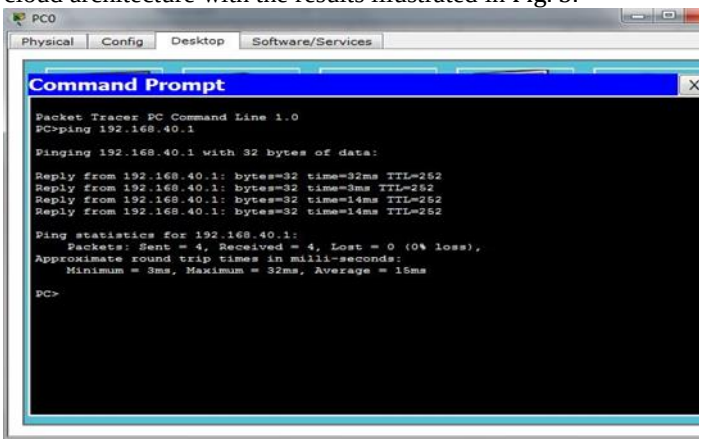

Fig. 5. Simulation Results.

In Fig. 5, a ping from pc0 in the western region to Upper West region shows a well delivered packet statistics with no data loss. The Fig. 6 demonstrates the route through which the packet went. Fig. 7 shows the main ISP route with its active links.

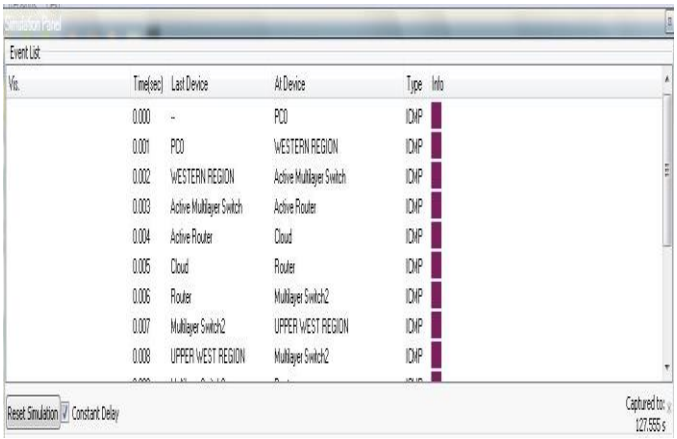

Fig. 6. The Active route through the main ISP whiles the back-up route ISP is disabled.

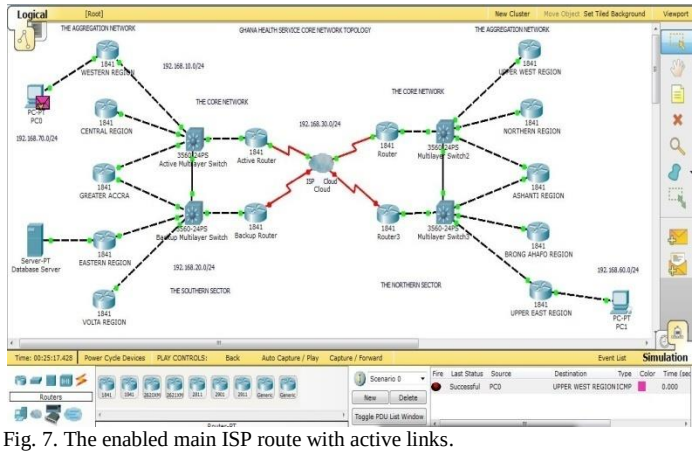

Fig. 7. The enabled main ISP route with active links.

V. CONCLUSIONS

There is ample evidence to show that in organizations throughout the World where Cloud applications are deployed as information system solutions, there have been improved service delivery, increased collaboration among healthcare professionals, increased research activity due to data concentrations and a drastic reduction in costs within these organizations. As these organizations continue to invest in Cloud applications to manage their day-to-day healthcare delivery systems, it is important that others also consider the enormous benefits that are to be gained from these applications.

With the adoption of proposed cloud computing services by Ghana Health Service, its trust border line will turn out to be alterable and moved away from the control of its IT section (depending on the service model adopted) if not properly thought through. It will be reached out into the service giver's area. This loss of control if not appropriately oversaw will cause a security threat to the setup of trusted governance and control model including the trusted source of information. To compensate for the loss of network control and to strengthen risk assurance, it is envisaged that GHS adopt the private cloud model solely for its use and purpose, so as to properly

manage its application security and user access controls, identity and accessibility systems.

A. Recommendation

The various cloud service models on offer has various forms of security risks, it is the considered view of this research that GHS adopts the private cloud service model solely for its purpose. Private Cloud computing service for GHS will provide the needed security, privacy and promote efficient delivery of services. This will help healthcare institutions manage its shared computing resources in a way that will promote efficiency.

B. Limitations of the Proposed Cloud Architecture

In this cloud architecture, due to limited space only two actual workstations were provided (Upper East and Western Regions respectively). The network diagram provided for this research is only a simulation material depicting a real-world experience and not an actual architecture. Actual software applications were not included in this project to show how the various delivery points could share this important computing resource.

C. Future Projects

This research only considered the adoption of common cloud architecture for the health service but did not consider the security implications of this adoption; a future project will consider the various security risks inherent in cloud computing adoption especially within the healthcare industry of Ghana.

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