

# Cloud based Vendor Neutral Archive: Reduces Imaging Rates and Enhances Patient Care

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**Abstract**— The primary goal of healthcare organizations worldwide is to deliver high quality patient care while reducing costs. The challenges in achieving this goal are daunting. Specifically, with information exchange while transferring patient between hospital departments or between two different hospitals. Nowhere is this situation more compelling than with medical imaging, because exchange of medical image reduces unnecessary repeat imaging, radiation exposure and associated costs. Consequently, there is growing need for the healthcare organizations to adopt centralized medical image archives that can efficiently store and make it instantly accessible across hospital departments and partner hospitals. In this paper, we address this emerging need by taking the advantage of Vendor Neutral Archive (VNA) and Cloud computing to define an architecture for cloud based Archive that can reduce cost and complexity but at the same time enhance patient care.

**Index Terms**— Health Care, Medical Imaging, Radiation dose, Picture Archive and Communication System, Vendor Neutral Archive, Cloud Computing, Software Architecture

## 1 INTRODUCTION

Healthcare worldwide are continuously looking for new ways to deliver high patient care and gain their loyalty while reducing the associated costs. Medical Image exchange plays a vital and key role in delivering cost-effective health care especially when the patient is transferred from smaller community hospitals to larger hospitals for advanced treatments [1, 2]. For example, when doctors offer their opinion on a referred patient, its important to have previous diagnostic information at hand. Specifically in paediatric emergency case, where a doctor having the information can decide on the life and death of struggling new born.

According to literature studies [3, 4], traditionally CDROM was the most critical component in exchanging clinical information for a patient being transferred from a hospital. Radiologist place exams and reports on CDs and handoff to patients to take their treatment or second opinion. Unfortunately, the most concern with the CD/DVD solution is that the files in the CD gets corrupted in most situations. Another concern with CD is frequent loss, particularly when critical patient are transferred in ambulance it gets tuck into their personal belongings. In these situations, the patient undergoes repeat imaging which exposes the patient to unnecessary radiation and delayed treatment [5,6].

Thus there is pressing need for a faster, more reliable way of exchanging or sharing of patient files that allows patients, physicians and hospitals to electronically collect, share and view diagnostic imaging records from any PACs, which solves the issue of CD incompatibility, reduces time and cost associated with redundant exams, and avoids excessive radiation exposure for patients. Although there were several large file transfer vendors on the market, none were able to offer a method, compliant with HIPAA regulations and with a standard business associate agreement. This article outlines how we are now addressing the challenge with the relatively new technology of cloud-based medical information exchange

## 2 BACKGROUND

### 2.1 Picture Archive and Communication System (PACS)

Traditionally, Film-based imaging was followed for patient diagnosis. Offices that primarily produce film were rarely capable of creating copies. Therein, patients were responsible to carry the only original copy for their subsequent consultation. This was a cumbersome process [4]. Consequently, the emergence of PACS enabled the radiology department to acquire, store, display, and communicate radiology images in a digital format. PACS not only presented significant advantage over traditional film-based imaging but also allowed better and faster access to images with no loss [7,8].

The effective implementation of PACS in radiology discipline has boosted other departments such as ophthalmology, pathology, endoscopy and dermatology to move from their hard copy and analog files to embracing digital imaging for further aid diagnosis, workflow and patient care outcomes. Though PACS provide improvement in department workflow and

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image diagnostics, they lack in technological innovation [8, 9]. For example, the design of Cardiology PACS is different from that of Radiology PACS due to the intricate nature of imaging discipline and workflow requirements. As a result, exchange of information between PACS of different department is a nightmare due to lack of interoperability standards. This prevents departmental PACS from clinical collaboration. During the progress of the diagnosis and treatments, the patient is taken care by increasing number of different medical specialties, and information explodes. The distribution of the patient information between departments is therefore a critical point and sets a new challenge in improve patient outcome

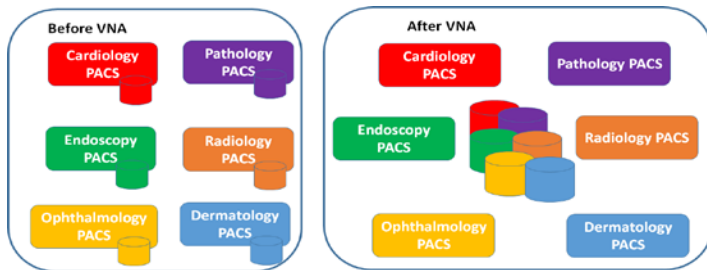


Fig. 1: VNA Model Consolidating Department PACS Silos

## 2.2 Vendor Neutral Archive (VNA)

A VNA is an enterprise archive that consolidates the patients medical image information and related clinical information in a final repository from multiple sources scattered across various clinical repositories (PACS) [9,10]. The VNA takes over data management from the PACS once the patient image has been acquired and interpreted as shown in Fig. 1. Instead of archiving the data on its own storage solution, the PACS forwards it to the VNA. Information in a VNA is stored, updated, and retrieved using industry-standard DICOM and Health Level 7 (HL7) formats. Thus VNA has three major components: univiewer, VNA Application and storage application. Its implementation consists of two data centers that are logically and geographically separated [11,12]. Each data center contains a copy of the data and an independently functioning software environment as shown in Fig. 2.

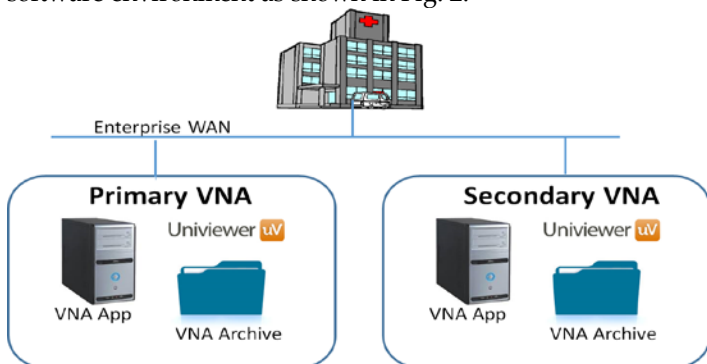


Fig. 2: Vendor Neutral Archive Implementation Model

The original objectives of the Vendor Neutral Archive (VNA) was to solve the two most obvious problems with PACS:

- The proliferation of data silos.
- The lack of data compatibility between disparate PACS.

A VNA in addition to resolving the most promising problems faced by PACS, it would be beneficial in a hospital system in several ways, not the least of which are listed below [13],

- 1) Allows to connect image records to patient records in an EHR.
- 2) Allows to switch PACS without requiring for complex data migration
- 3) Allows the physician to quickly and easily access and view ANY image from anywhere in the enterprise
- 4) Increases the workflow efficiency, saving time and labor

Despite of the ubiquitous features of VNA, one of the biggest challenge with VNA is deployment infrastructure when considering the following demands [9],

- 1) The amount of storage requirement is doubled when compared to PACS
- 2) Secondary Storage requirement for backup
- 3) Purchase of storage on as-needed basis

Because of these high capital investment, many organizations find it difficult, if not impossible, to cover a threefold increase for storage technology in a single budget year, no matter how many problems a VNA may solve. From recent literatures and studies, it was inferred that the emergence of Cloud computing providers creates a great opportunity to tackle this kind of emerging needs

## 2.3 Cloud Computing

Cloud computing is defined as a model for enabling 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 [14]. This shared pool is designed to deliver numerous advantages such as reduced cost, higher efficiency, convenience, and ease of use. Cloud is available as a) Private in which the infrastructure is operated solely for an organization, b) Community in which infrastructure is shared by several organizations and supports a specific community that has shared concerns, c) Hybrid in which infrastructure is a composition of two or more clouds and d) public in which it is made available to large group [15]. Cloud provides service at three major levels as shown in Fig. 3 and briefed below [16]

- Infrastructure as a Service (IaaS): Computation resources are delivered as a service. The resources include virtual server, virtual local area networks, virtual data centers etc. The customer can rent these the infrastructure rather than purchasing and pay on usage basis
- Platform as a service (PaaS): Platform and environment are delivered as a Service. The resources include operating system, Database management system, Server Software, tools for design and development etc. The custom-

er can use these resource to build new application and pay on subscription basis

- Software as a Service (SaaS): Software applications are delivered as a Service. The resources include application such as accounting and invoicing, performance monitoring and communications. The customer rents a software rather than purchasing it and pays either on usage or subscription basis

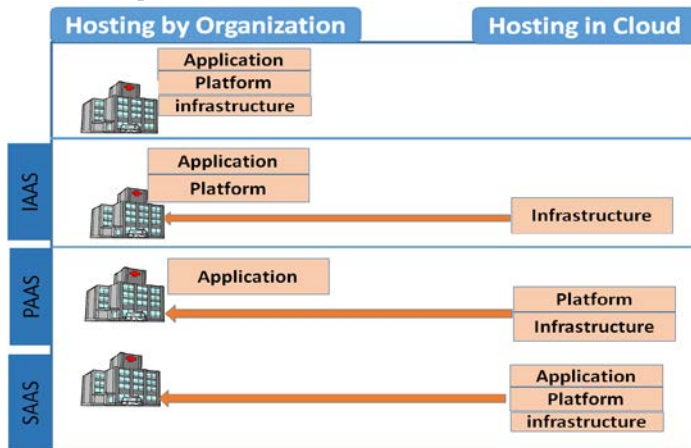


Fig. 3: Cloud Computing Service Model

At present, Cloud computing is at the leading edge of its hype curve and some of the cloud service providers Hadoop, Amazon Compute Cloud EC2, Microsoft Azure and Google App Engine. Though cloud computing provide several advantages such as reduced cost, higher storage efficiency, openness and graceful failure, convenience in control, environment sustainability and ease of use, the most promising feature of Cloud computing is that its resources are available from anywhere and at any time. The flexibility of this emerging computing service has opened many opportunities for organizations that did not exist before. Healthcare is one among those organizations. The aim of this article is to shed light on exploring the potential of cloud computing for medical image sharing between hospitals and contribute for collaborative patient care and efficiency.

### 3 VNA AS A CLOUD SERVICE ARCHITECTURE

This section taking into consideration the bandwidth of accessing the remote resources and the capital investment of healthcare providers proposes a cloud based solution for medical image sharing across hospitals for continuity care for patient. The work proposes the architecture shown in Fig. 4, which delivers the storage component of on premises secondary VNA as PAAS solution in Medical community Cloud. This reduces the associated capital costs and enables to spend cost on as-needed basis, thus maximizing storage utilization. Also in PaaS model, the content of the storage object is neither accessed nor managed by the cloud provider therein resolving security concern.

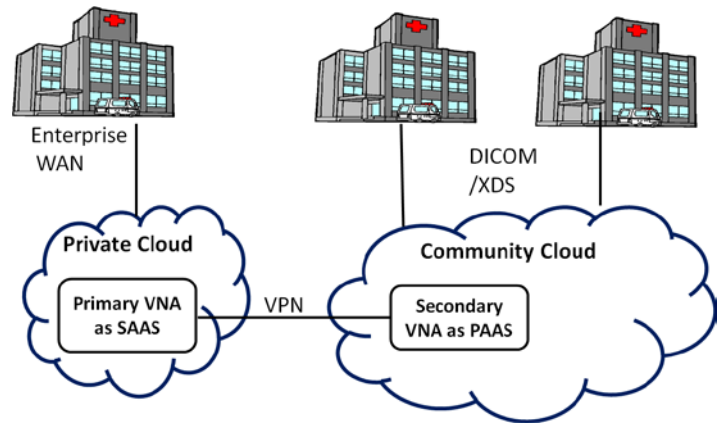


Fig. 4: VNA as Cloud Service Architecture

Next as illustrated in the Fig 4, the entire on-premises primary VNA is moved to care provider private cloud along with other clinical Application as SAAS. This facilitates the care provider have an onsite VNA with a full copy of the data along with a connection to community cloud infrastructure that enables data replication for a second copy of VNA data. Unlike the PaaS model where the cloud provider does not access storage object directly, the SaaS model is a fully managed solution by the cloud provider. This implementation requires the cloud provider with deep operating knowledge of the software and knowledge of workflow but breaks the time barrier imposed due to low bandwidth in accessing the storage data from off-site cloud.

## 4 ARCHITECTURE EVALUATION

In this section we describe benefits and limitations of our architecture

### 4.1 Flexibility

Cloud-based image sharing provides easy access to medical data by radiologists, referring physicians and most importantly patients from anywhere, anytime. It creates opportunities to reduce the chance that patient care is affected by delayed diagnosis or treatment avoiding unnecessary repeat nuclear medicine, X-ray, or CT imaging, particularly for patients who may be transferred between institutions or who receive care at multiple facilities.

### 4.2 Interoperability

Ability of two or more systems or components to exchange information and use the information that has been exchanged [8]. VNA component in the architecture provides interoperability platform that can consolidate image data onto one repository and Improve interoperability across beyond the department and even the enterprise while enabling departments to pursue best-of-breed clinical systems that may not have the interoperability functionality that a VNA provides

### 4.3 Scalability

Cloud computing is expected to provide computing capability that can scale-up or scale down dynamically based on demand. This implies VNA on cloud can grow as capacity requirements increase. Also the care providers can add new services and capabilities as need arise.

### 4.4 Integrity

VNA consolidates image from different departments and avoids data integrity issues that arise with multiple databases. It maintains the consistency of centralized data store by performing synchronized updates using differentiating patient IDs. Using cloud for image data sharing eliminates potential errors such as file loss or corrupt due to physical media such as film and CD, which contributes to data integrity. Also cloud facilitates physicians and radiologists to view images directly from the unified VNA viewer from one location, contributing to data integrity.

### 4.5 Security

Although there are significant benefits in moving VNA over cloud, the security is primary concern and risk burden that a healthcare face when placing the protected patient data on cloud.

## 5 CONCLUSION

This paper has attempted to combine the cost benefits of cloud storage solution with the robust VNA to provide VNA-as-a-Service in cloud architecture. The unique characteristics of cloud computing claimed as the best candidate to adopt in our architecture in addressing reliability and interoperability for sharing medical data across hospitals as well in reducing the capitalization of healthcare organization on local IT infrastructure. The architecture provides a consolidated patient view that allows physicians to access current and historical images at the point of care and provide better medical collaboration. Importantly the VNA cloud architecture lowers the capital investment than the heterogeneous PACS and VNA solution of the care providers without having to consider cost of future scalability and data migration. More work will be conducted on this research in future to implement and validate the proposed architecture.

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