Web-Based PACS and EHR System

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ABSTRACT

We demonstrate how a cloud-based PACS can exchange information with other medical systems, including other cloud-based PACS, to provide a comprehensive and integrated view of a patient's health record. Such a consolidated report will lead to improved patient care.

Keywords: Web-based PACS/EHR, Cloud Computing

1. INTRODUCTION

A patient's clinical data is frequently maintained on a variety of systems scattered across several different healthcare facilities. This data is primarily of two types: textual and graphical. The textual content contains information comprising of billing, scheduling, laboratory test results, etc. The graphical content primarily comprises the DICOM medical image files. Textual information can be easily stored in relational databases, and securely accessed both by internal systems as well as external third party applications using a variety of standard protocols. Sharing graphical information, on the other hand, is a fraught with difficulties. Not only is it impractical to transfer large numbers of DICOM medical image files over any type of network, the availability of low-cost and DICOM viewers for diagnostics is a challenge.

Figure 1 shows the types of information contained in various medical systems.

A key factor, however, for effective patient treatment is enabling an effective and rapid physician-patient communication that includes a patient's medical history, diagnoses, medications, treatment plans, immunization dates, allergies, laboratory test results as well as DICOM medical images that when combined together forms a patient's comprehensive Electronic Health Record (EHR).[1] This vision for the EHR entails support for all medical images that reside on a variety of PACS to enable physicians with point-of-care access to consolidated imaging data.

Moreover, for a comprehensive patient health view, it's critical to present data residing on multiple institutions and integrating with images that reside on PACS[2] in a single presentation surface regardless of the provenance of the medical data.

2. URGENT NEED FOR COMPREHENSIVE EHR

To gain an appreciation of the exigency for the need for an efficient EHR, consider a typical case for a patient.

A patient may visit Institution 1 for primary care. The annual blood and urine test along with the history resides on the HIS at that Institution. A prior Breast MRI scan may have been performed at Institution 2, where the patient had undergone partial mastectomy followed by chemo treatment for breast cancer. The patient now gets admitted to a Hospital for chest complications (Institution 3). If all three institutions' systems were interlinked together so that information could be shared in a secure manner, then the attending physician at Institution 3 would be able to view the earlier radiology images to evaluate the disease progression and determine the best treatment plan.

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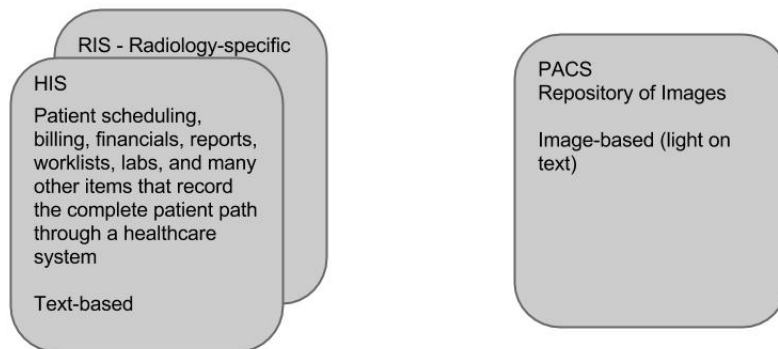Nihal Mehta: E-mail: nihal.mehta@netdicom.net, Telephone: (972) 905-NET-D (6383)

Figure 1. Schematic showing types of clinical information in various systems

Figure 2. Components of Patient's EHR.

In the absence of immediate availability of the patient's history, the physician instead ordered PET CT Tumor Whole Body followed by MRI Bilateral T without Contrast. These additional tests could have been avoided with a comprehensive EHR.

Figure 2 illustrates the above scenario. In this example, the patient medical data resides on several systems, such as Health Information Systems (HIS), Radiology Information Systems (RIS) while the actual radiology images resides on the organization's PACS.[3] Many of these systems are proprietary and are incompatible in several regards and unable to communicate or exchange information with each other using standards based communications.
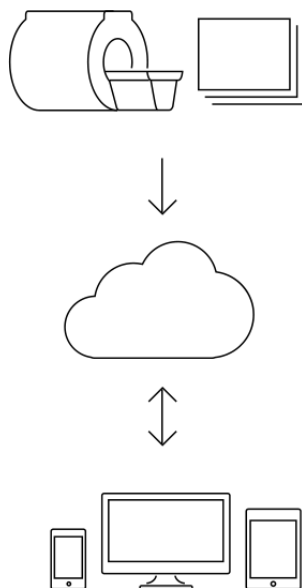
Figure 3. DICOMs residing on Cloud

3. CLOUD COMPUTING

As stated earlier, the primary challenge to have a comprehensive Electronic Health Record (EHR) for a patient is the need to handle a patient's DICOM medical images, possibly maintained by several healthcare organizations. This difficulty arises because DICOM medical images are typically maintained on LAN based PACS, or on CDs that are carried by the patient themselves when they visit doctors.

While better communication of existing medical image files outside the internal network of the medical facility is definitely required, a solution for storage is needed as well. Preferably, this solution should avoid the costs of creating large amounts of dedicated infrastructure beforehand.

A solution for ease of data access would be to move the medical image files from a LAN-based PACS to a cloud-based solution.[4] A cloud-based solution is a flexible pay-as-you-go platform that provides for scalable growth as and when needed. Figure 4 illustrates the benefits of moving from a managed on-premise web-based system to a purely cloud-based solution.

In a managed on-premise solution, the healthcare facility has to incur both human capital costs to manage the infrastructure as well as the cost to provision the various components that make up a web-based PACS. On the other hand, in a cloud-based Software as a Service model, the human capital costs are devolved to the cloud computing provider. Furthermore, with the elastic pay-as-you-go model, additional components can be provisioned as needed. Thus, costs increase only with increase in demand for service.

Commercial Cloud services, such as Microsoft's Azure,[5] are widely available today. (The Cloud Services provided by Microsoft Azure has been used as an example here; however, similar platforms are available from several other providers such as Amazon Web Services, Cloudera, Google Cloud Platform to name a few.)

Figure 5 shows the minimal components required to deploy a cloud-based PACS service.[4] At the heart of the infrastructure is a relational SQL database. Here, all the information ranging from Patient to Studies to Images is maintained once extracted from DICOM medical image files. Associated with the record of each patient are the actual DICOM medical image files stored on the file server.

Standard features of a Cloud architecture are also available and can be suitably tailored to the user needs. The solution can be deployed across different geographical regions. Furthermore, it's easy to accommodate requirements from certain countries that have legal requirements specifying geographically where the images need to reside. Similarly, data and images can be backed-up with either local, zonal or geographical redundancy as required. Even features such as the performance level of the database is customizable. Finally, analytics tools for data mining and machine learning are available for future use.
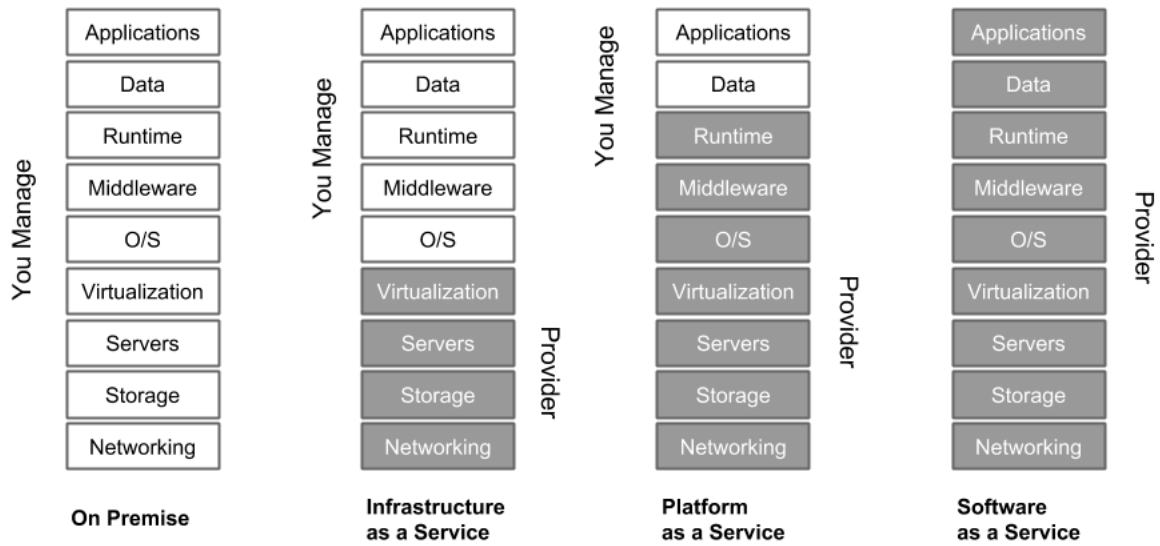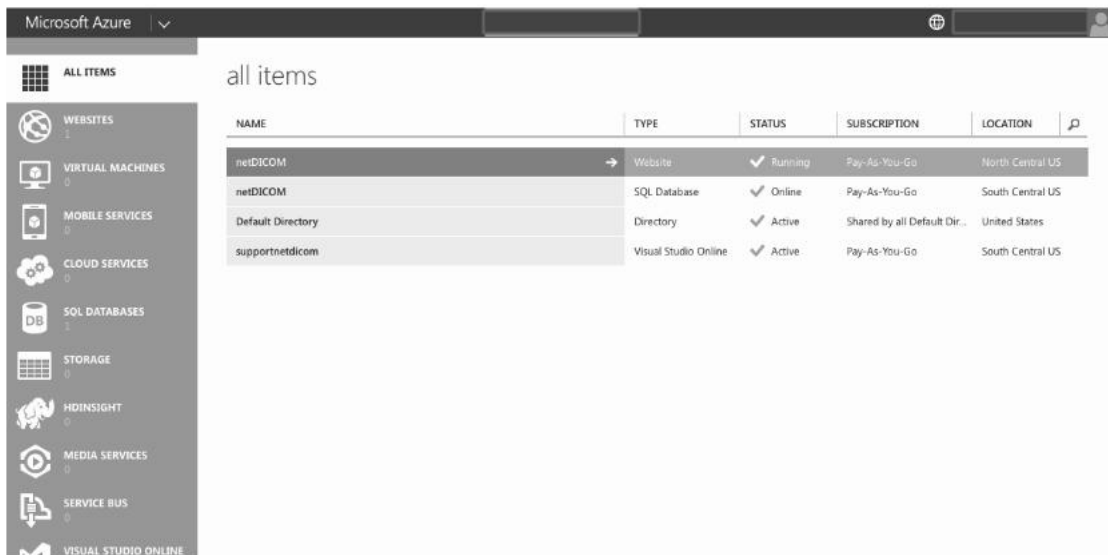
Figure 4. Levels of Cloud Services
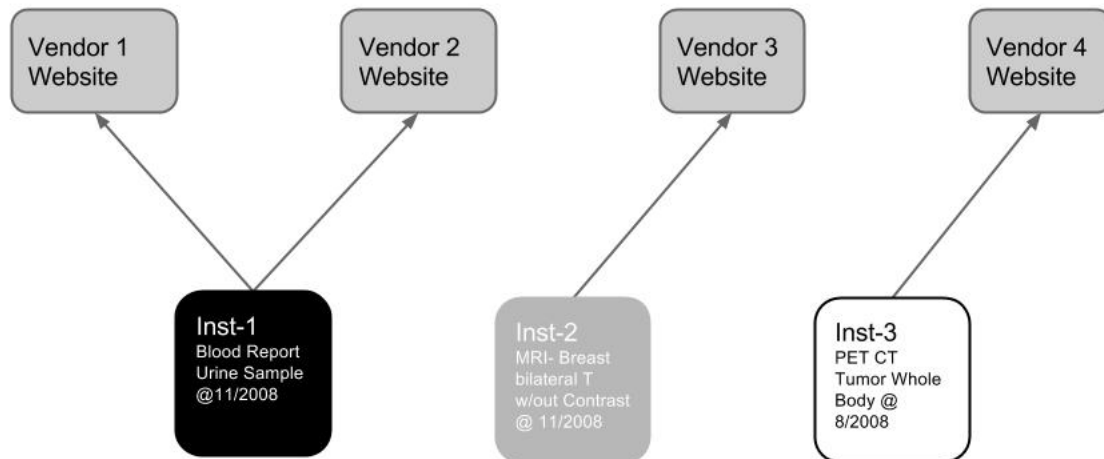

Figure 5. Minimal Components for a Cloud-Based PACS

Figure 6. Uploading Patient Data from Multiple Institutions to Multiple Vendor Systems

4. EHR ON CLOUD

Figure 6 illustrates how a Patient's EHR is distributed across multiple healthcare facilities. Each facility would transfer the patient data to some cloud-based system, which would most likely be different for different healthcare providers.

Once on the cloud, though, information across different cloud-based systems can be exchanged using standards based protocols. See Figure 7.

Finally, a patient's data obtained from multiple healthcare facilities can be shown in a single consolidated view. See Figure 8.

5. SUMMARY & CONCLUSIONS

Among the information that constitute a patients comprehensive EHR, such as medical history, diagnoses, medications, treatment plans, immunization dates, allergies, radiology images, and laboratory test results, the DICOM medical images are a dominant component. Enabling quick access to medical images that reside on any PACS would enable physicians with timely and accurate diagnosis. The key barrier to accomplish this is to combine data residing on multiple institutions and combining with the images that reside on PACS. However, a cloud-based PACS that exchanges information with other systesm in a secure manner using open standards, the ability to present a consolidated view of a patient's information in its entirety is achieved.

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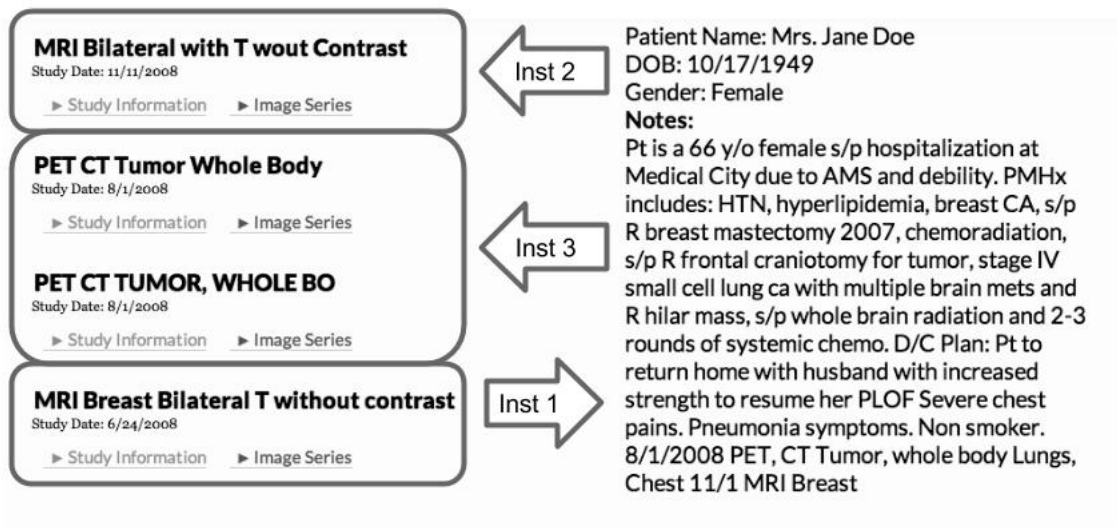
Figure 7. Exchanging Patient Data Using Standard Protocols

Figure 8. Integrated View of Patient Data Obtained from Multiple Healthcare Facilities

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