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Design and Implementation of a Local PACS and Teleradiology for General Hospital

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Abstract. Medical Imaging Informatics has begun over two or more decades. Currently, the share of X-ray, CT images used in medical diagnostics, or share medical images in collaborative research purposes and other public administrative report is one of the challenging issues for medicine and computer science. In the developing country, almost all the general hospital has been equipped with a number of modality for medical examination including an X-ray machine, CT scanner, MRI machine, Ultrasound machine. Initially, these devices were developed as a separated system and unconnected so that their digital images cannot be stored in a server, can not be shared and supported by specialized departments, and especially for Teleradiology activity. Our research proposes a topology for integrating Picture Archiving and Communication System (PACS) and Teleradiology. Design the model and deploy the local DICOM PACS and some application of Teleradiology on the system in the General Hospital. In this paper, we also propose some novel workflow and substitute for the current process which has been used by physicians at the General Hospital so far.

Keywords: e-Health, DICOM, local PACS, Teleradiology Telediagnosis, DICOM PACS, RIS,

1 Introduction

The General Hospital in some province has been equipped with a number of modality for medical examination and treatment including the X-ray machine, CT scanner, MRI machine, ultrasound machine. Initially, these devices were developed as a separated system and unconnected so that their digital images cannot be stored in a server, can not be shared and supported by specialized departments. The benefits of improved health information systems including PACS have exploded as the policymakers have begun to liberalized telecommunication sectors and health care. This trend has begun

in different part of the world, in particular, the developing countries [1, 2]. We have witnessed improvement in the healthcare service drastically with the help of information management system innovation [7]. The benefits include better health and prosperity of human beings [3, 4].

An Australian study reported that the introduction of the RIS/PACS was well received by senior clinicians, and was helpful in clinical decision-making. Patient management was improved and the time taken to arrive at clinical decisions was reduced, particularly in neurosurgery [5]. There was a strong (92%) preference for PACS vs. film (3 %, with 5% undecided) among the clinicians in the Baltimore VA Medical Center [6]. According to their surveys, the average clinician estimated that he or she saves approximately 50-70 minutes per day.

Generally view, the e-Health systems are patient-centred, where different healthcare providers (doctors, physicians, laboratories, hospitals, etc.) collaborate with one other to provide better healthcare services. For example, a physician stores the medical diagnostic laboratory information of the patient at the first time when the patient comes to the hospital. If the same patient is admitted to a hospital for other time, physicians in the hospital can access the medical diagnostic laboratory information of the patient before determining a new diagnosis and treatment. Both parties (that is, the physician and hospital) can initiate a virtual collaboration and share the patient's data. The challenge in this kind of collaboration is the data heterogeneity of the data sources.

2 Solution, Design and Implementing of local PACS and Teleradiology

2.1 Select the Solution

PACS is a system that allows a radiology clinician group serving multiple departments having connected to PACS, RIS, Reporting and other relevant IT systems to view as virtually one site and use one virtual desktop to efficiently complete all radiology work including reporting. Each radiologist can read globally, namely, fully participate in the reading workflow of their hospital. The reports generated are automatically delivered to the LIS - RIS at the department originating the study [8, 9].

The first rule to build a PACS is to consider to achieve a Teleradiology worklist with minimum burden on DICOM database and communication links is for all department to send their metadata (patient ID, patient name, study number, information without images). The local PACS then provides the synchronization of the Teleradiology worklist to all participants through their local cloud PACS. Radiology clinician may view the Teleradiology worklist on their local PACS workstation or use the local PACS Client Application provided by the local PACS. This application is web-based and may run on any desktop, including the local PACS workstation.

The second rule in architectural design for a local PACS system is that the maximum use of open source architecture and current industry standards to fit the entire local PACS design scheme also means is to minimize the software design for the development team. Maximize existing industry standards such as Linux, Windows, TCP / IP communications, SQL database management, Oracle, DICOM image data

format, data format Writing HL7, Visual Basic.NET programming language, C #.Net, C ++.Net, java.Net ...

2.2 Architecture, Design and Implement.

Using the standards for implementation local PACS will have many advantages, such as the implementation of local PACS components and modules will be simpler. Operation and maintenance of the system will be easier. In addition, defining the operation of local cloud PACS will reduce the need for computer code redundancy, thus making it easier to debug and retrieve information. In the industry standards mentioned above, the DICOM and HL7 standards are mandatory. Most importantly, they provide communication between LIS-RIS-PACS and Teleradiology, between devices of different manufacturers [10].

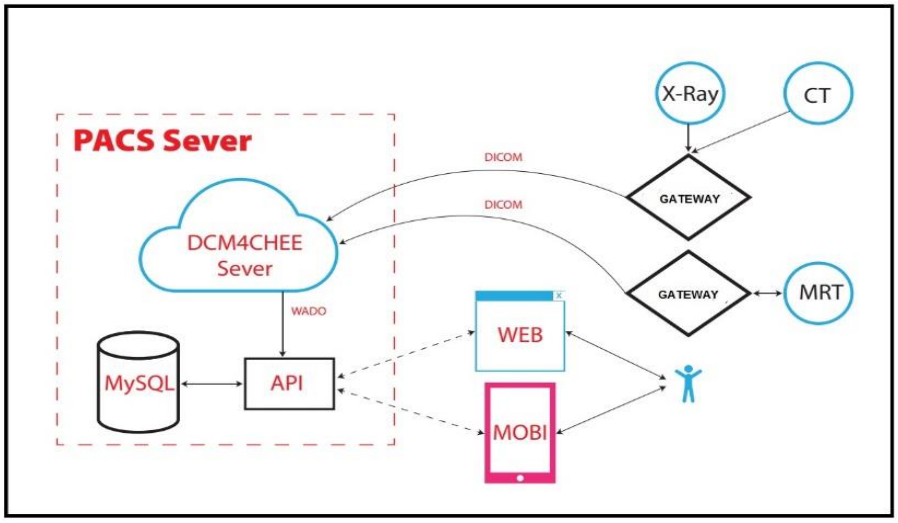

Fig. 1. The core DICOM PACS architechure

Base on those listed criteria and select the solution for developing our system. The local PACS System was built with the configuration as follows:

Server:
- Operating System: Linux CentOS OS 6.5.
- WebServer: Apache 2.2.14.
- Database management system: Oracle Standard Express 10g, version 10.2.0.0
- DICOM Server: DCM4CHEE.
- Application Server: RAID 5

Client:
- Windows operating system.
- Web browser: Chrome, Firefox, Internet Explorer.

Development tools:
- C #, .NET framework 2.0.
- Java, PHP 5.3.1

3 Deployment functional process

Core DICOM PACS has been implemented. We suggested and deployed almost all the working process for all the departments at General Hospital. Some useful workflow to the physician at some department of the General Hospital processes will be shown in this section.

3.1 Consultation Function

The client-server-based, Real Time Message Protocol -based works for voice, video, voice, search, retrieval, content sharing. HTTP protocols for retrieving images from the server. Diagnostic procedures are used to treat patients timely, in cases of difficult to diagnose and treatment, prognosis cautious and emergency.

Working process:

1. Create and chair the meeting when the request arises
2. Ask your doctor for a consultation
3. More sharing information:
    - Patient information
    - List of medical images used in the meeting
    - Number, coordinates, size of the images being used
    - Location of the area to be observed
4. The system supports text, voice and video chat among departments.
5. Consultation report.
6. Finish.

3.2 Video transmission operations functions:

Video images are transmitted from the ultrasound and HD camera (for recording the open surgery) to server storage. At the same time, computer clusters from the conference room will access the server to display the endoscope video onto the projector (or screen clusters). The endoscopic video transmission operation is based on the Client-Server model, which operates. It is based on the RTMP for voice, video, search requests, results in retrieval, meeting content sharing; and the HTTP protocol for retrieving images from the server.

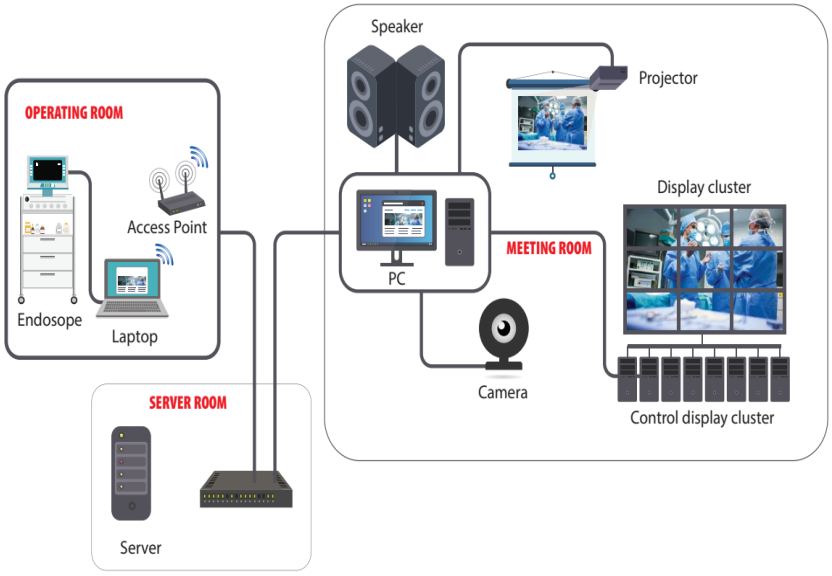

Fig. 2. Model of surgical video transmission from the surgery to the consultant physician in the hall

Fig. 3. Video transmission of endoscopic surgery with various angles

4 Conclusions

With the application of a medical imaging, processing and transmission system at the General Hospital, easy access to large amounts of profile and image information. Reduce costs for human resource management, save Information storage, human error, and data loss as well as initial infrastructure investment costs. Accurate and rapid diagnostic results are obtained through the involvement of many experts.

In our future work, we focus on the expansion of this model and the application of SaaS, PaaS and IaaS mode to construct the Tuberculosis PACS cloud architecture, it greatly reduces the IT infrastructure and gives new management facilities to multisite hospitals with shares Tuberculosis PACS cloud for the network of the selected General Hospitals in the Tuberculosis Prevention Program which have been managed by the Public Health Association.

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