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Development and Evaluation of PACS, a Parallel Operation System with Improved Fault-tolerance

Masami MUKAI[a], Takumi TANIKAWA[a], Kouji UEMURA [b], Yutaka ANDO [a]

[a] *National Institute of Radiological Sciences, Chiba, Japan*
[b] *Kawasaki University of Medical Welfare,Kurashiki,Japan*

Abstract

We developed the dual PACS to enforce the robustness and the redundancy. These PACSs were made by two different vendors. We assumed that we had to continue the service without serious problems. By the different systems, users can select the suitable interface, and the systems become inevitable for the hospital information system.

Keywords:

PACS, filmless, fault-tolerance

Introduction

The Research Center of charged Particle Therapy Hospital, affiliated to the National Institute of Radiological Sciences (hereinafter called "this hospital"), began archiving digital medical images from 1995, and launched film-less operation from the summer of 2005. Image data obtained by inspection have been stored without being deleted because they are necessary for following up radiation therapies on a long-term basis. As of October, 2006, approximately ten million images obtained from approximately 120,000 cases of inspection are available, and all of them are stored on hard disks.

This time, with the expiry of the lease period of the former version of PACS, we changed PACS's configuration into a duplex one to upgrade equipment and avoid problems. This paper reports our experiences from this system's introduction together with the current operation status.

We set the following goals as the basic premise of the system upgrade. The first goal was to maintain the volume of work procedures to be performed by engineers or medical physicians at sites where images are created. Then, for the system to be used, we judged it was difficult to immediately switch over the system because terminals exclusive to viewing images coexist with researchers' individual workstations. The second goal was therefore to allow more than one systems to operate in parallel at any time.

Methods

As the systems, the first PACS was TechMatrix's "SDS-ImageServer," and the second PACS was Fuji Film Medical's "SYNAPSE."

For the former version of PACS, image data flowed as follows: 1) Images shot by inspection equipment (modalities) are sent to an intermediate server called, "AQGW (Acquisition Gateway)." 2) AQGW checks consistency between received images and patient master images, and then sends ones from which no problem was detected to a registered image server. The sent data are saved for a particular period, and then deleted automatically. 3) The image server makes it possible for users to view saved images using the viewer function as target images to be referred to. Thus, we designed a transfer procedure as follows: 1) Expand the functions of AQGW on the network for storing images so that images can be stored in more than one servers in parallel. 2) Start up a new PACS server (the first PACS) as a server exclusive to image viewing together with the former image server. Then, transfer image data using DICOM C-STORE along the course from transfer source to transfer destination. 3) Start up the second PACS server while maintaining parallel operation with the first PACS server when possible, and transfer image data using DICOM Q/R from transfer destination to transfer source. Figure 1 shows a schematic of the current system configuration.

Results

The system transfer finished without causing major problems such as long discontinuation of services or deficiency of data. At the end of August, 2006, approximately 20,000 images obtained from 60 cases of inspection were stored a day. Images stored in the first and second PACS servers become ready to view in five to fifteen minutes after a case of inspection has ended (this depends on the category of the inspection).

For users, the range of options was broadened because it became possible to use the viewer function according to uses. For the status of system use, we observed a trend that cases were classified into two types: One is viewing images obtained from more than one patients simultaneously, such as at a conference, and the other is viewing images obtained from one patient at a session of image interpretation.

Before the system transfer, a method to set up the viewer function on each workstation should have been simplified.

For the data transfer, approximately seven million target images were transferred in 32 days when the first PACS server was started up. On the other hand, it took approximately two and a half months to transfer approximately eight million images when the second PACS server was started up. This indicated that image storing can be completed from transfer source to transfer destination in a shorter time if a suitable work environment can be prepared.

For the current operation, it is necessary to check images by comparing them to each other based on the number of the user IDs assigned to images to maintain the consistency among multiple servers.

As future issues, for the first PACS, we are considering operation transfer to image-saving using a reversible compression method to effectively use disk space for image-saving. For the second PACS, we are going to allow authentication using individual user IDs to ensure correct audit trail.

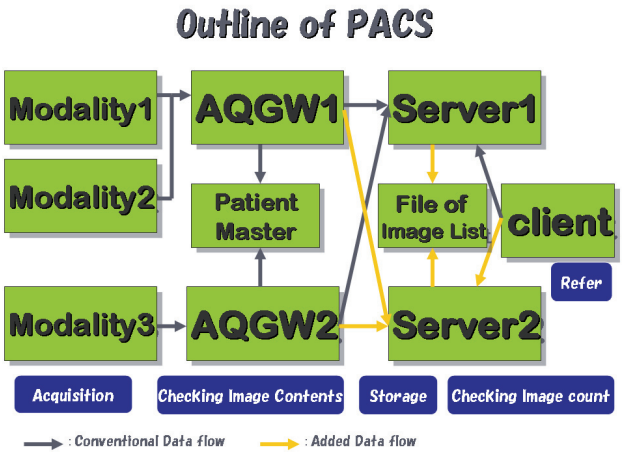

Figure 1 - Outline of PACS

Address for correspondence

Masami MUKAI
[E-mail] m_mukai@nirs.go.jp
[Telephone] +81-43-206-4629
[Address]
National Institute of Radiological Sciences
4-9-1,Anagawa, Inage-ku, Chiba-shi,
263-8555 JAPAN