Updating a Legacy PACS: Experience with Hardware and Operational Integration During Transition to a New Architecture

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THE INITIAL COMPONENTS of the West Virginia University Hospitals (WVUH) PACS were installed, beginning in 1992, in order to solve a specific, well-defined problem. This problem was the contention for film "possession" between the radiology department, the emergency department, and the intensive care units. However, the vision of the hospital and department leaders was to establish the essential components and skill sets within WVUH that would lead to the eventual solution of the more wide ranging problem of film distribution throughout the entire hospital and outpatient offices, i.e. the establishment of a system that could support filmless radiology. An indication of leadership's dedication to this vision was the decision to replace virtually all film-screen radiography with computed radiography. While this act may not seem to be very daring by 1998 standards, there were not many medical facilities, except a few within the federal government, which were willing to make this degree of commitment to a digital radiology department in 1992. Fuji was chosen as the vendor of choice for computed radiography, and General Electric Medical Systems (GEMS) was chosen as the PACS vendor. GEMS was at a very early stage of development of their PACS product in 1992, but the vision of GEMS leadership at that time seemed to be complementary to the vision of WVUH, and thus WVUH was established as the initial site at which clinical evaluation of GEMS PACS products would take place. In many ways, the ability of the WVUH leadership to see their vision become a reality has been influenced by various changes in the leadership and vision within the GEMS PACS effort.

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DESCRIPTION OF THE CURRENT INSTALLATION

Imaging Modalities

Computed Radiography scanners are located in the triage area of the hospital radiology department, in the Physicians Office Center (POC) X-ray Clinic, and adjacent to the Emergency Department Trauma Center. In the layout of the equipment and networking connections, consideration has been given to the avoidance of single points of failure and to redundancy of services. In hospital radiology, a Fuji FCR9000 and AC2 are used to support the normal workload, and an additional AC2 is used as a backup device. Each of these CR scanners is connected through a DMS cable to a dedicated Fuji HIC-654 workstation. These three Fuji workstations are located in a separate room adjacent to the triage area. Their use is to provide a retrospective capability to reprocess and reprint CR images which are maintained in a first-in-first-out priority on the workstations' hard disk storage. A fourth Fuji workstation is located in the POC to support the FCR9000 located there. Reprinting from these workstations is accomplished through the DMS connection back to the CR scanner and then to the Fuji laser printer which is connected to the CR. There are two laser printers in the triage area and one in the POC, which support the 10 × 14 inch size film used for CR images. Each of the primary CR scanners is connected to one of these printers. The backup CR scanner can be connected to either printer through an A/B switch. With this arrangement, at least one CR scanner can always be kept in operation even if any one CR scanner or laser printer is out of service. A second DMS cable connects each of the HI-C workstations to a DASM and then through a SCSI cable to a DICOM conformant QA workstation. Two of the QA workstations are manufactured by GEMS (Advantage CR QA) and two are manufactured by DeJarnette (ImageShare CR). Both products support retrieval of study related information via DICOM modality worklist management. In addition, the DeJarnette product supports direct downloading of demographics into the Fuji CR scanner. Each HI-C worksta-

tion is configured to automatically forward any incoming image to its corresponding QA workstation. In order to provide additional redundancy, images can be manually transferred between HI-C workstations using a Fuji proprietary ethernet protocol.

Two digital fluoroscopy rooms, one digital neuroangiography suite, and an MRI scanner, all manufactured by GEMS, have direct DICOM conformant connections to the PACS network. Two Siemens CT scanners are connected to the PACS network through Merge MVP DICOM protocol converters. Ultrasound studies can be sent to the PACS through an Acuson Aegis DICOM gateway, and the ability to send nuclear medicine studies to the PACS has been obtained through a recently released software upgrade to a GEMS GENIE workstation.

Workstations

Five workstations are located in the filmless intensive care units. Three additional workstations are located in the emergency department. The emergency department has not yet made the transition to filmless operation, based mainly on the requirement for older studies for comparison and some problems with the performance of the interface between the CT scanners and the network. A ninth workstation, located in radiology, is used as an adjunct to film-based diagnosis, and is used for softcopy reading of teleradiology images.

Image Distribution

Since the current PACS configuration is not interfaced to the hospital or radiology information system, routing of studies to the appropriate workstation is done manually. At the computed radiography QA stations and at the CT protocol converters, the technologist can select the appropriate ICU or ED workstation, based on the patient location indicated on the order.

Interim Archive

At one point in GEMS PACS development, an archive product (Advantage Cluster Archive) was offered. This archive, which is now a discontinued product line, was installed at WVUH in early 1997 as an interim measure until a more stable GEMS PACS configuration could be established. However, without a RIS interface either at the archive or at the modalities, the ability to reliably port this

image data to the new PACS is questionable. Currently, all CR studies are being automatically sent to this archive.

TRANSITION TO THE NEW ARCHITECTURE

When, in 1997, GEMS purchased from Lockheed-Martin the former Loral Medical Imaging Systems PACS, it seemed that a new starting point for GEMS PACS development had been established. The challenge for WVUH then became the determination of the point on this new development path to "jump in" and begin to replace our existing equipment. Three features of the PACS which seemed to be subject to future change were, a network design that could not run over TCP/IP and thus could not share a hospital network backbone, archive hardware which was not used in any other commercially available PACS, and workstations which were based on the Macintosh CPU and operating system. Based on these considerations, the transition of the WVUH PACS to the new configuration has been postponed until the summer of 1998, and is based on the following general time line.

A connection between imaging devices and the RIS, via DICOM Modality Worklist Management will be established as soon as the required hardware and network interfaces can be procured. Data stored on the interim archive with this additional RIS information included can be reliably ported to the new archive when available. We have concluded that a DICOM conformant link between the imaging devices and the RIS is an essential requirement for successful PACS implementation.

A new GEMS PACS high-speed server configuration is tentatively scheduled for production in the summer of 1998. When this hardware is available, we will install it and replace our 9 existing workstations. Reasons for waiting for this new server are its higher capacity and the reported easier conversion of its backplane configuration to support a TCP/IP network at a later date. This server should be able to keep approximately 30 days of new studies online, and will be able to continue to support our filmless intensive care units. At this stage of the installation, the PACS will be interfaced to the RIS, so that manual routing to ICU workstations will not be necessary.

A new archive device, based on a more commonly available media configuration is currently under development at GEMS. This device will be

installed at WVUH when available, and the data in the Cluster Archive (especially that data obtained from a device with a DICOM link to the RIS) will be ported over to the new archive. Since the requirement to transfer data from the Cluster Archive to the new PACS configuration is not unique to WVUH, GEMS is in the process of developing the necessary protocols.

Further deployment of PACS workstations to radiology and high volume clinical users, such as orthopedics, will be deferred until 1999, when the new CPU and operating system are available. Additional deployment of the PACS will be based

on a pending decision by the hospital to install an ATM backbone and the ability of the PACS to operate over this backbone.

CONCLUSION

The transition of the WVUH PACS to a new configuration that can support filmless radiology has been delayed by several "midcourse" corrections on the part of the primary PACS vendor. If the current product development time lines are reliable, then it will have been an 8 year process that will allow WVUH to be a filmless hospital in time for the next millennium.