Implementing a Java-Based Image and Report Distribution System in a Non-Picture Archiving and Communication System Environment

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The benefits and pitfalls of implementing a Java-based system to distribute results and images to referring physicians are addressed. The basic requirements for and barriers to implementing this system in a non-picture archiving and communication system (PACS) environment will also be discussed. The majority of radiology information systems (RIS) and hospital information systems (HIS) currently only distribute the text data for radiology examinations. This is generally adequate for low-acuity exams in a relatively healthy patient; however, many clinicians prefer to review images so they can correlate the reported findings with the image data, as well as review the exam themselves. A web-based solution eliminates the need for specialized review software and/or hardware at each review site. In addition, there is no need for support personnel to travel to each site to set up and upgrade software.

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THE FOCUS of the radiology industry is moving towards the timely delivery of the complete product, reports and images, directly to its customer, the referring physician. The majority of radiology information systems (RIS) and/or hospital information systems (HIS) currently only distribute text data for radiology examinations. This is generally adequate for low-acuity examinations in relatively healthy patients; however, many clinicians prefer to review images so they can correlate the reported findings with the image data, as well as to review the examination themselves. This report discusses the benefits and pitfalls of implementing a Java-based system to distribute results and images to referring physicians in a non-picture archiving and communication system (non-PACS) environment. A web-based solution eliminates the need for specialized review software and/or hardware at each review site. In addition, there is no need for

support personnel to travel to each site to set up or upgrade the software.

ENVIRONMENT

The method used to distribute report text and images to referring physicians is a client/server-based application with the server software currently running on a Sun Solaris (Sun Microsystems, Palo Alto, CA) platform. Clients are available for Windows 95 (Microsoft, Redmond, WA), Windows 98, Windows NT, Macintosh (Apple Computer, Cupertino, CA), and Unix environments. The imaging devices transmit Digital Imaging and Communications in Medicine (DICOM) data to the server over switched Ethernet network using the DICOM C-Store service class. Report data is obtained from the RIS via an interface device (Mitra PACS broker; Mitra Corp, Hartland, WI). Report text is sent to the PACS broker immediately after transcription and is sent again each time the status changes (ie, after they are electronically signed). Reports and image data are then matched in the server and results made available via the client software from any internet-enabled platform.

It is important to note that this environment does not require a fully integrated digital-only radiology department. In no case was an archive necessary for the adequate operations of the system. Additionally, the automatic receipt of report text from the RIS is optional. The report text may be entered directly into the system via the client. Therefore, there is no need for an institution to invest in an expensive PACS solution to gain the benefit of internet distribution of radiology reports and images.

The use of the Java programming language and web deployment of the software provides some significant advantages that should not be trivialized. First, the Java language provides an environment for writing truly platform-independent applications. While early manifestations of the Java language were limited in scope to enhancing web pages, more recent Java implementations have become stable enough to support a full-featured application. While a large percentage of desktop systems are Microsoft Windows-based, the ability

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0897-1889/00/1302-1034\$10.00/0

doi:10.1053/jdim.2000.6852

to run on Unix and Macintosh platforms provides a good deal of flexibility for the end user. A main advantage of web-based deployment using the Java language is that there is a single point of maintenance for software upgrades. As the referring physician's desktop becomes the destination of radiology information, information systems personnel are envisioning a logistics nightmare in the support and service areas. Using the web as a distribution mechanism places the responsibility of connectivity on the referring physician. Installation and upgrades are performed via the internet using well-known products coupled with Java technology. This prevents information system personnel from having to travel throughout a potentially large geographic area to perform upgrades and installations.

KEY ISSUES

There are five issues that must be addressed to develop a useful system: acquisition of report data, acquisition of image data, integration of report and image data, selection of pertinent data, and security in a wide area network environment.

The first challenge is to find a reliable way to receive report data into the system. Naturally the desired mechanism is to transfer the report to the system directly from a HIS/RIS via a standards-based communications protocol. The protocol may be Health Level 7 (HL7), DICOM Normalized Result and Interpretation Management, or DICOM Structured Reporting. For the system reported here, HL7 and DICOM Normalized Result and Interpretation Management were used with a PACS broker translating from HL7 to DICOM. The benefit of automatic transfer from the RIS is that there is a significantly lower risk of error since there is a single "owner" of the report data, namely, the RIS itself. The distribution system merely uses a copy of the data to combine with the images and distribute. The functionality provided by a full-featured HIS/RIS need not be duplicated in the report distribution system. The report distribution system provides a mechanism for the reports to be available to the referring clinician in a timely and accurate manner. In the absence of the automatic transfer of the report text, direct text entry can be performed via a simple user interface.

The second step in implementing the system is the acquisition of the image studies. This problem is significantly easier than the receipt of the report

data because the DICOM standard is now widely implemented. Using a standard DICOM C-Store service class, image studies can be sent either directly from the scanner, a review workstation, quality-control workstation, or any other DICOM C-Store service class user (SCU) capable device. The distribution server will then store the DICOM image data for as long as needed.

In a non-PACS environment, there is generally weak or nonexistent integration between the imaging devices and the reporting system. This lack of integration presents a particularly challenging problem in matching the image studies with the report. In a well-integrated, standards-based PACS/RIS environment, the matching is simplified through the DICOM Modality Worklist class. In this case, the study unique identifier (UID) in the RIS and the study UID on the imaging modality match. In the absence of DICOM Modality Worklist, it is possible to determine if a study and report belong together by comparing accession numbers assigned by the RIS to an accession number entered at the image modality or quality-control station. This approach requires a manual integration between the modality and the RIS and is certainly prone to errors. To overcome the problem of weak RIS/PACS integration, an approach has been taken to match a report and an image study based on the study date/time and patient medical record (patient ID). An image study and a report are only candidates for matching if the patient ID number is the same in the study and the report. This is an obviously insufficient approach unless every patient has exactly one study. Therefore additional criteria need to be established to allow the accurate association of an image study and report. One way this can be accomplished is by comparing the study date and time from both systems. This is best explained through a report-centric view. When a report is received into the distribution system, it contains information about the time that the study was performed. With this information a list of studies that fall within a specified time window around that time is produced. If that list contains only one study, then a match is assumed. To eliminate any potential ambiguity, if multiple studies are found in the list of time-filtered studies, then none of the studies are matched with the report.

The selection and dissemination of pertinent image information is particularly challenging. With the emergence of multislice scanners, the number

of images in a typical study can be substantial. Using a conventional modem, the transmission of all of these images (even compressed) is impractical. In addition, it is cumbersome for the referring physician to sift through the set and find the images with clinical relevance. Instead, a selected number of key images that demonstrate the pathology should be transmitted. This significantly lowers transmission time and storage requirements. The marking of the key images can be done by a number of methods. One solution is to have the review stations only push the images of interest. This adds a significant amount of work to the radiologist and is inefficient overall. However, on a suitably featured diagnostic review station, it is possible for the user to manually mark key images. The key image information can be transmitted to the results distribution server using a private DICOM image tag. The review station can then either push only the key images to the distribution server, or push all images to the distribution server. In the case where the review station only pushed key images, there is a significant reduction in network traffic and server-side storage. This is clearly beneficial. However, it is important to note that if the referring physicians need to view the entire image study, it is not available on the results distribution server and therefore must be accessed via other means.

Finally, when discussing medical information and internet distribution, the issue of security is paramount. The system described here has the ability to allow access to the information stored on

the server through an internet-enabled Java-based application. This application requires a user name and password to authenticate users of the system. In addition, strict control is placed over the information available to any user through an extensive privilege system. This grants privileges to access patient information to only those people who need it. As an example, access can be restricted so that referring physicians can only access their own patients. This is important since radiologists are increasingly called upon to provide services to several unrelated physician groups. When patient-sensitive data are transmitted over the network, the information is encrypted so that any networked monitoring devices will not be able to easily decipher the transmission. Also in place is a comprehensive auditing system to monitor user activity and make activity reports available to the appropriate personnel.

CONCLUSION

With the technology available today, it is possible to implement a Java-based image and report distribution system for a non-PACS environment. Once the system is in place it enables the radiology department to achieve its real goal: that of providing a contemporaneous radiology product. Radiologists need to be aware that our "product" is not the images, but rather the interpretation derived from the images and it is not a useful "product" until it is transferred to the referring physician in a manner timely enough to assist with patient care.