Upgrading Legacy Systems for the Integrating the Healthcare Enterprise (IHE) Initiative

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As technology vendors have adopted standardized communication protocols, including Digital Imaging and Communications in Medicine (DICOM) and Health Level 7 (HL7), interconnectivity between various devices has been simplified. The recent Integrating the Healthcare Enterprise (IHE) initiative will further promote the use of standards for interconnectivity. Until these standards are universally accepted, we must live in a transitional world where some components will communicate without any modification, while others require upgrades to allow them to meet the new standards. In designing and implementing the network at University of California Los Angeles (UCLA) Medical Center, some integration problems were found that are common to the industry. Creating departmental workflow with only a limited number of acquisition devices supporting the DICOM worklist was the initial problem addressed. Although many manufacturers provide this function for their new scanners, upgrading existing equipment is often cost-prohibitive. To ensure the quality of the demographic information in the image data and the workflow of the system, third-party worklist components were required to upgrade the legacy acquisition devices. These worklist components provided a standards-compliant facade on top of the legacy equipment, allowing seamless integration with the remainder of the network. To support the distribution of worklist information and the feedback of procedure status, a bidirectional HL7/DICOM protocol bridge was required. Although many radiology information system (RIS) manufacturers will be providing native DICOM capabilities in future product releases, the majority of current RIS installations have no DICOM functionality. Similar to the legacy scanners, the HL7/DICOM bridge provided a DICOM-compliant facade to the non-DICOM RIS. The additional use of web-based technology for worklist display further extended flexibility of this facade. We have demonstrated standards-compliant facade technology allowing legacy components to operate seamlessly in an IHE environment at a fraction of the cost of upgrading to new equipment.

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IN A TYPICAL RADIOLOGY network, there are a number of components, including acquisi-

tion devices, information systems, diagnostic displays, and information archives. Historically, we have seen minimal integration between each of these. For this study, we focused on the integration of two key components in the radiology department: scanners (eg, computed tomography [CT] and magnetic resonance [MR] scanners, x-ray, etc), and the radiology information systems (RIS).

The current workflow in a radiology network without integration of the key components requires redundant, manual interactions between the technologists and the installed components. This redundancy introduces large numbers of errors in the system.

A typical workflow between a RIS and a number of scanners is as follows: A technologist must schedule a radiology procedure manually on the RIS. The daily scan list is printed every morning and taped to each of the scanners. When the patient arrives at a scanner, the technologist must read the printed scan list and manually enter the patient's demographic and procedure information into the scanner. Typographical errors entered at this stage of the examination are recorded permanently in the DICOM header of the images that are acquired.

After a scan has been completed, the technologist must return to the RIS to mark the procedure as having been completed. Additions or modifications to the procedure information on the RIS should also be entered at this time. Again, typographic errors or omissions can lead to erroneous patient records and bills.

The introduction of standard medical protocols, including Digital Imaging and Communication in Medicine (DICOM) and Health Level 7 (HL7), has enabled integration between the components within a radiology network. The Integrating the Healthcare Enterprise (IHE) initiative, sponsored by Radiological Society of North America (RSNA) and Healthcare Information and Management Systems Society (HIMSS), has recently published a framework that promotes the use of these standards. Using principals from the IHE Technical Framework,¹ we can revisit the workflow between the RIS and the scanners.

As in the previous example, a procedure is

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scheduled on the RIS. Each of the scanners can then query the RIS using the DICOM Worklist Management² Service Class to request a list of exams that are scheduled for that specific piece of equipment. When the patient arrives at the scanner, the technologist selects the appropriate worklist entry from the scanner screen. Demographics and procedure information from the RIS are automatically recorded without any additional manual input. Demographic information within the DICOM header of the images is now guaranteed to match the information stored on the RIS.

The scanner will also electronically inform the RIS that the scan has started using the DICOM Modality Performed Procedure Step³ (MPPS) Service Class. After the scan has been completed, the scanner again uses the DICOM MPPS Service Class to inform the RIS and to update it with additions or modifications to the scheduled procedure. Again, errors are minimized through the reduction of manual steps in the workflow process.

The benefits of integrating components within a radiology network using IHE principals are clear. Vendors are quickly adopting the IHE recommendations and most new radiology technology will provide this functionality in the near future. Most institutions do not enjoy the luxury of being able to replace all existing, non-standards-compliant technology. Therefore, they must implement a strategy for interconnectivity between new and legacy equipment to achieve IHE goals.

An approach we have developed to integrate existing legacy components follows IHE principals, even though the installed devices do not support all of the required protocols. We used this strategy at University of California Los Angeles (UCLA) Medical Center.

METHOD

The first step of our integration strategy is to associate each component within the current network with an IHE actor (component). Most commonly, we find that scanners, including CT, MR, and x-ray, provide the functionality defined for Acquisition Device actor in the IHE Technical Framework. RIS provide the role of Department System Scheduler/Order Filler actor.

The second step is to identify the missing features required by IHE for each actor. Each of the legacy components in a network may provide some, all, or none of the required functionality. For each of these, a list of features needed for the component to meet the IHE recommendations is developed.

Once we have determined the missing features, we can identify third-party components that can add these features. The third-party components provide an IHE facade around each of the legacy pieces of equipment, thereby assuring compliance with the standards specified by IHE.

At UCLA Medical Center, we used this strategy to integrate existing legacy components. We identified the RIS as a Department System Scheduler/Order Filler actor. The RIS provided required HL7 communication supporting Order Entry (IHE process step 3), as well as Procedure Scheduled (IHE process step 5). The RIS lacked DICOM Worklist Service Class Provider (SCP) required for Modality Worklist Management (IHE process step 8a), and DICOM Modality Performed Procedure Step SCP (MPPS) for Procedure Step Started (IHE process step 9) and Procedure Step Completed (IHE process step 11).

We identified a third-party HL7/DICOM bridge product that provided both DICOM Worklist and DICOM MPPS functionality. By implementing this bridge as a facade on top of the existing RIS, we created a component that now supported the IHE-defined standards.

For the installed scanners, we went through a similar process. For example, for the case of one legacy MR scanner, we first identified it as Acquisition Device IHE actor. This device provided the required DICOM communication for Images Stored (IHE process step 12a). It lacked DICOM Worklist Service Class User (SCU) required for Modality Worklist Management (IHE process step 8a), DICOM Modality Performed Procedure Step SCU (MPPS) for Procedure Step Started (IHE process step 9) and Procedure Step Completed (IHE process step 11), and DICOM Storage Commitment for Storage Commitment (IHE process step 12b).

We identified a third-party product that provided DICOM Worklist SCU and MPPS SCU functionality to legacy scanners. The particular one we chose provides keystroke emulation to download patient demographics to the scanner. Similar to the RIS, we were able to build a IHE facade around this MR scanner, thereby upgrading it to meet the IHE-recommended standards.

Once each of the installed components were identified either as supporting the IHE recommendations, or had been upgraded through the use of an IHE facade, we were able to demonstrate the integration of the entire system using IHE principals.

DISCUSSION

The strategy of upgrading legacy components within an existing network using IHE facade technology provides a number of benefits. It reduces the complexity required for integration by solving problems on a component-by-component basis.

As additional components are installed within the network that already support IHE, we are guaranteed that they will integrate with the installed components. Similarly, as legacy pieces of equipment along with the associated IHE facade are upgraded to IHE-compliant technology, there will be no need for any modification throughout the rest of the network.

Lastly, we have found that third-party technology can provide cost-effective upgrades to legacy technology. This is especially true with older scanners and RIS systems that require a system or hardware upgrade for support of current protocol standards.

CONCLUSION

The IHE Initiative has brought the goal of a truly integrated radiology network closer. The existence of legacy equipment should not deter institutions from using IHE principals within their existing networks through the use of IHE facade technol-

ogy. This can offer a cost-effective pathway for creating a seamless radiology environment.

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