DICOM Versus HL7 for Modality Interfacing

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Digital modalities such as CT, MRI, Ultrasound and Computerized Radiography systems, generating soft-copy images to be used by a Picture Archiving and Communication System (PACS), need to identify the images properly in order to retrieve and manage them. In many cases, a technologist re-enters patient demographic and study related information at the modality, even although it is usually already present somewhere in the hospital Information System (IS). In order to achieve a higher level of efficiency and uniquely identify the created image objects, it is obvious that an interface between the IS and modality to exchange this information is highly desired. There are two options for a modality vendor to implement an IS interface, either using the Health Level (HL7) or Digital Imaging Communication in Medicine (DICOM) communication standard. This paper will explain characteristics of both protocols, and demonstrate that it is preferred to use DICOM versus HL7. In addition, it will show that DICOM is supported by most modality vendors, based on the result of a poll of their Modality Worklist versus HL7 support.

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HOSPITAL INFORMATION Systems (IS) typically interconnect with a variety of other clinical systems such as laboratory systems, as well as Radiology Information Systems (RIS), using the HL7 interface. Therefore, connecting a modality to an IS system using HL7 was at first the best choice. The HL7 standard is relatively mature and is implemented widely, especially in the USA. Many implementations are based on release 2.3, and version 2.4 is about to be implemented. The next major revision will be version 3.0, which will be a major departure from the previous versions.

There are many different dialects and implementations using HL7, as well as individual customizations by users and institutions. The "looseness" of the specifications require in many cases the use of commercially available Interface Engines that translate not only different older protocols to HL7, but also different HL7 to HL7 interpretations. These Interface Engines are widely deployed, and have matured over the years to include a user friendly graphical interface allowing in many cases the institution to do their own mapping of the various input into output fields to achieve interconnectivity.

The HL7 standard is a so-called transaction based protocol. That means that a message is generated based on a certain real-life occurrence.

Examples of these occurrences are the admission of a patient, changing (transferring) a patient from location one to another, or a patient discharge. Generally, these occurrences generate "unsolicited events" which are sent out to whomever is listening on the other end of the point-to-point connection or network.

It is no wonder that the first DICOM management services that were intended to exchange scheduling, patient demographics, and status information was specified and modeled consistent with the HL7 protocol. These DICOM management services, ie, Patient, and part of Study Management, were specified early on as part of the initial DICOM 1993 version of the standard. DICOM Patient Management, for example, supports the so-called N_Event_report command which is very similar to the HL7 ADT (Admission-Discharge-Transfer) command. Events that are reported by this DICOM command are "Visit Created, Scheduled, Updated or Deleted," as well as "Patient Admitted, Transferred and Discharged." Successive DICOM N_Get and N_Set commands can be used for retrieving specific information and updating the status.

The DICOM management services are not widely implemented. Reasons for this are:

- It is not clear what the advantage is of using DICOM versus HL7 because the functionality is not much different. Why implement another protocol (DICOM), when HL7 can do the job? As stated above, the HL7 standard is not quite as rigidly defined as the DICOM standard, however, this argument does not seem to be sufficient to implement DICOM instead.
- Manufacturers, ie, IS vendors who would implement the DICOM management services, are unfamiliar with the DICOM standard.
- Probably most important, the transaction based protocol, causing unsolicited events to be

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issued to an acquisition device, does not fit the architecture and operation of the modalities. When a modality is busy doing acquisition, it wants to dedicate all its resources and computing power to the acquisition process. Unsolicited events and computer-generated interrupts are not something the modality engineers could easily handle and accommodate.

- There are some concerns about the efficiency of the specified protocol. Using an Event_Report, followed by an N_Get to retrieve the needed information is perceived to be inefficient, even causing some implementers to make up their own private DICOM SOP Classes.

Recently, the Digital Imaging and Communications Standard in Medicine (DICOM) standard has been extended to include a service to address some of these concerns, i.e. the DICOM Modality Worklist Service. The major difference between the DICOM management services and this new service is that instead of relying on unsolicited events to get updates on schedule and/or patient information, the modality can now ask for the information. This protocol is based on a “Client-Server” architecture, as opposed to the transaction based protocol of the Management services. The modality acts as the Client who requests the information from the Server (IS) using a particular information model matching the database scheme of the Service Provider. This is very similar to the protocol that is already used by the DICOM Query/Retrieve Service for interaction between devices and archives or other devices containing objects to be retrieved.

Many modality vendors are starting to implement the DICOM modality Worklist Service. There have been successful demonstrations, in Europe at the European Congress in Vienna, CAR meetings in Paris and Berlin, and recently at the RSNA. A Central testnode, which was developed by the University of Oldenburgh, allowed users to schedule a patient and then retrieve that scheduling information via the Modality Worklist feature (Fig 1). Modality vendors are installing betasites testing this new service. Interface vendors are offering HL7 to DICOM modality interface boxes, as well as software (“brokers”) who can run on the IS system, which eliminates the need for additional hardware.

How does the Modality Worklist Service work?

Fig 1. Modality worklist management information flow.

The service is structured identical to the Query/Retrieve SOP class, ie, defined as a combination of a DICOM command or service with a so-called Information model. The Information model specifies the query structure, which has keys specified at each level, in the form of unique, required and optional keys. The DICOM command, which is used, is the so-called C_FIND. The defined SOP class is therefore called “Modality Worklist Information Model—FIND.” The FIND command specifies the attributes that are requested as a response to a Query. The FIND is answered by the Service provider with multiple responses, each with a status pending, matching the requested keys. Examples of Worklists are as follows (Fig 2):

- A Worklist consisting of Scheduled Procedure Step entities that have been scheduled for a certain time period (eg, “March 3, 1998”), for the modality, where the Scheduled Procedure Step is going to be performed.
- A Worklist consisting of the Scheduled Procedure Step entities that have been scheduled for a certain time period (eg, “March 4, 1998”), and for a certain Modality type (eg, CT) or a certain Scheduled Performing Physician. This is a scenario where scheduling is related to a pool of modality resources and not for a single resource.
- A Worklist consisting of a single Scheduled Procedure Step entity that has been scheduled for a specific Patient. The rationale to retrieve this specific Worklist is to convey the most accurate and up-to-date information from the IS, just before the Procedure Step is performed.

Fig 2. One modality worklist FIND request may generate a series of responses.

DICOM is evolving beyond image exchange into a management and information exchange tool. The DICOM Modality Worklist service is a typical example of the evolution of DICOM in this area. However, as with any new interface there is the chicken and egg problem, i.e. it depends not only on the availability of the service provider (IS systems) but on the user (Modality) as well.

It can be expected that there will be a significant push for this service from the user community. In order to find out whether or not modality vendors were planning to implement this service, a poll was done to the major US modality and PACS manufacturers regarding their near term plans. The results are listed in Fig 3. As is demonstrated in Fig 3, of the 13 companies who were asked whether or not they have implemented or will introduce Modality Worklist, at least during the 1st half of 1998, 11 of the 13 companies answered "yes." In addition, 8 answered "yes" on whether or not they implemented HL7 as well. Note, however, that 5 of those who implement that use a gateway to convert the

HL7 into DICOM commands. Based on this response, it can be expected that Modality Worklist, indeed, will be the next major DICOM service, which will become available to users.

Fig 3. Survey of planned vendor support of modality worklist by method of support.