raditionally, a radiologist would read a film from a lightbox or alternator. At the same time, the radiologist would browse through previous exams and reports in the patient jacket, looking for relevant information on the radiology request form, and dictate a diagnostic report into some kind of voice recorder.

That was 20th-century radiology. Each of these components—the device used to present images, the delivery of related information such as reports and requisitions, and the means to generate the report—are being replaced by digital technologies like picture archiving and communication systems (PACS), radiology information systems (RIS), and speech recognition (SR) reporting systems.

In many cases, the PACS and RIS implemented at an institution are not well-integrated, often because they are provided by different vendors. In addition to integration issues, there is also the question of which system is the “driver’s seat,” i.e., which system implements the worklist that will drive the other one — will it be the RIS driving the PACS, or the PACS driving the RIS?

This white paper discusses the interface between these systems and the differences between RIS-driven, PACS-driven, and RIS/PACS-driven worklists.

Before discussing worklists in detail, the information exchanged between the RIS and PACS should be considered.

**Diagnostic reports.** A radiologist at a PACS workstation needs ready access to prior reports. In most situations, reports are initially pushed to the RIS by the SR application, usually via an HL7 interface. If prior reports are stored in the RIS, how can they be available when a radiologist needs to look at them, for example, when reviewing a follow-up exam?

Most RIS systems cannot be queried for reports. Even though there is a query transaction specified by HL7, it is not widely implemented. Therefore, pulling the information to the PACS is not usually an option. Instead, in almost all cases, new reports are pushed from the RIS to the PACS as soon as they are verified and signed. Then, when a radiologist goes looking for prior reports, they will be ready and waiting.

Some PACS use an interface box (aka broker) between the RIS and PACS. In this scenario, reports are pushed to the broker by the RIS, and it is the broker that serves as the report repository. In this role, the broker would have a query function that could be used by the PACS. The query function is often proprietary.

If you use a totally integrated RIS/PACS, which has only a single database for images, reports, and other information, report delivery is not an issue, because there is no need to move the reports (or any other data) around. This is a major advantage from both a complexity and performance perspective.

**Technologist Notes.** These notes are ad-hoc comments about the patient condition as observed by the technologist. The notes are not typically generated for each routine exam, but, if present, they could provide critical input for the physician’s diagnosis.

Technologist notes were typically jotted on the patient x-ray jacket, or attached to the jacket with a sticky note, or kept on a piece of paper in the film jacket. In a filmless and paperless imaging environment, the electronic equivalent of technologist notes can be entered in the RIS, or entered in the PACS. In the latter case, the notes can be stored as “comments” with an image, and become part of the DICOM header for that image file.

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Another way to handle technologist notes is to capture them as separate “screen save” files, or to scan them using a paper scanner. The resulting image is attached to the study as a Secondary Capture (SC) image, and is stored with the study in the PACS.

**Requisition form.** The requisition often documents critical details such as the admitting diagnosis or reason for the study. This information is needed by the radiologist to make sure that the specific complaint or health issue is addressed. These requisition forms are typically initially entered in the RIS and need to be available at the PACS.

The requisition information is made available at the modality for a technologist as part of the DICOM modality worklist. In a system where the RIS and PACS are not integrated, the requisition is often converted by a broker from HL7 into DICOM. The requisition form can then be pushed to a PACS workstation from the RIS.

But, when an integrated RIS/PACS is used, there is no interface required between the two and the requisition is seamlessly available to the radiologist.

**Images.** There is usually no argument about the fact that the images are stored on the PACS. In some situations, a physician wants to see a report using RIS access, and also look at a significant image that illustrates the finding. In that case, images are exchanged between the PACS and RIS.

**Other clinical information (vital signs, lab results).** A radiologist might often need access to the patient’s vital signs or lab results to make a diagnosis. This information is sometimes available from a clinical information system, which often in turn makes this information available to the RIS.

**Measurements.** Some types of studies routinely include measurements. A good example is an OB/GYN ultrasound exam, in which the head of a fetus is measured to monitor growth from month to month. Traditionally, these measurements have been recorded on paper. Whether or not measurements should be part of the patient record is actually controversial; some institutions keep them, some do not, but in either case they need to be available to the radiologist.

In the future, measurement data might be captured electronically as a DICOM Structured Report. In the short term, many institutions will either scan measurement records or import them as DICOM-encapsulated PDFs. Whatever form is chosen, they can then be entered into the PACS or RIS.

**Exam status.** An exam’s status (“started,” “in progress,” “canceled,” or “finished”) needs to be available at both the RIS and PACS. The RIS needs to know when an exam is complete so it can eliminate the study from the modality worklist and initiate billing. The PACS needs to know the exam’s status so it can start the reporting. An exam’s status also typically includes the number of images generated, which is important information for the PACS.

**Report status.** Awareness of a report’s status (“started,” “prelim,” “approved”) is critical so that there is no risk for double-reporting (having the same set of images are looked at by several radiologists). The update of a report’s status to “approved” is often the trigger that determines when a report becomes available to a physician.

**Procedure updates and changes.** It is not uncommon for a procedure to be changed, e.g. adding a contrast series to a CT scan, based on observations made during the exam. Traditionally, the procedure change information would be entered at the RIS. Increasingly, this information is communicated between the modality and RIS automatically.

**Dose information.** Dose information can be exchanged between a modality and RIS so it can be tracked for patients. This is not commonly done in U.S. institutions but is a legal requirement in several European countries.

**Patient updates and reconciliation.** In emergency or unscheduled cases, there is no patient demographic and/or order information available at the RIS. Instead, patient information is entered directly at the modality, rather than pulling it from a worklist. The conventional correction method is to enter this information at the RIS after the fact; however, increasingly, this is being replaced by a Patient Update transaction, which is exchanged between the PACS and RIS.

Exam status, procedure updates and changes, and dose information can all be exchanged between a digital modality and the RIS/PACS using the DICOM MPPS (Modality Performed Procedure Step) transaction.
Of course, if there is a single integrated RIS/PACS, this is a non-issue. But if the RIS and PACS are separate, then the PACS has to forward the information to the RIS, or the RIS has to forward the information to the PACS. In this situation, it is critical to determine where this “MPPS manager” functionality resides so that there is no overlap (if provided in both the RIS and PACS) or a gap (if it is missing from either one).

Gap and overlap issues can impact any or all of the information types discussed above. That is why it is critical to determine where the information is stored, maintained, and managed. Ideally, reports, notes, measurements, requisition forms, and most importantly images should not be present at both the RIS and PACS if it can be avoided.

Some gaps can be resolved by using a gateway or broker. However, adding a broker adds cost and complexity. While this is not preferred, brokers are still very common, especially at existing installations.

To access all the images, notes, forms, and other information needed to arrive at a conclusion, radiologists their own reading worklist that is different from a modality worklist. A radiologist’s worklist contains entries for exams ready for interpretation, where entries arranged in a useful order, such as the oldest exam on the top, and with the urgent (STAT) cases clearly identified. Secondary sorting is a matter of preference, but is typically based on modality type.

A user-friendly and ergonomically designed worklist is essential because the worklist is the primary informational portal for the radiologist. All related information such as the requisition, prior reports, etc., should either be automatically displayed, or be readily available through additional tabs or icons on the screen.

Typically, radiologists do not have a good understanding where the information they use resides (RIS or PACS), nor should they need to. Radiologists just want to access needed information quickly and easily.

At an institution that does not have an integrated RIS/PACS, a worklist can be handled in two ways. The worklist can be generated by the RIS, which then relates the patient and/or exam context with the PACS, so that the corresponding images can be automatically retrieved. Or, the worklist can be generated by the PACS, which exchanges the patient contextual information with the RIS to access the relevant information. Depending on where the worklist is implemented, the worklist is typically referred to as a “RIS-driven” or “PACS-driven” worklist.

If the RIS and PACS are integrated, there is only a single integrated database with all of the information, and the worklist is provided by the integrated RIS/PACS system.

Let’s look at these scenarios in some more detail:

**PACS-driven worklist.** A PACS-driven worklist is the traditional worklist used by most PACS users today. Radiologists will see a list of exams to be read, sorted in the way they prefer to work. They pick an exam, or simply input “next,” and the images of that exam, any related prior studies, and reports are provided on the screen.

A PACS-driven worklist communicates with the worklist provider on the PACS to indicate that the procedure is being read. This prevents other radiologists from doing double-reads. When the interpreting radiologist has completed the report, the report’s status is also made available to others who are retrieving this exam in the future.

Ideally, a speech recognition (SR) application is integrated on the same device being used to interpret the images, allowing the report window to appear immediately with the patient demographics and accession number already filled in.

In most PACS-driven worklists, requisition forms are not always accessible unless they are scanned in, and technologist notes are only available when entered as comments with the images or scanned in. In most cases, access to clinical information is rather limited, if present at all.

**RIS-driven worklist.** A RIS-driven worklist is implemented on the RIS, which will have a list of all performed exams available to the radiologist. As before, the radiologist will select from that list or simply enter “next” to get to the next exam. Upon selecting the next exam, there is typically a context exchange between the RIS and PACS (in the form of an Accession Number of Patient ID) to retrieve and display any images for that exam, as well as for any related priors. Prior reports are easily accessible because they are stored in the RIS.

The same coordination is possible between the various workstation worklists to prevent double-reads and to
update the “in progress” and “final” read status. There also is no difference in the SR interface, which would preferably also be very tightly integrated with the RIS to display a pre-populated window for reporting.

The difference between this architecture and the PACS-driven worklist is that access to technologist notes, requisition forms, and other clinical information is available at the RIS to start with, eliminating scanning in additional documents into the PACS and therefore improving workflow.

**Integrated RIS/PACS worklist.** Unfortunately, many institutions already have an existing RIS and may not have the option to go with the same vendor for both the RIS and PACS. However, if an institution can select the same vendor, and if that vendor has an integrated RIS/PACS offering with a single database and front-end GUI, this provides the best of both worlds. There is no interface to be dealt with, no integration cost, and no questions about overlaps and gaps.

There is another major factor to consider when evaluating worklist options. With regard to reliability, it is obvious that a single system has a higher reliability than two systems. However, a single system also represents a single point of failure, requiring an emphasis on high-availability components, potential duplication of hardware, and sound fall-back and fail-over policies.

Another factor is that the infrastructure and support for a RIS is not traditionally as robust as the 24/7 requirements for a PACS. This is understandable: a RIS that is unavailable for 10 minutes might result in an x-ray order not being placed. However, the lack of an order doesn’t prevent a technologist from performing the exam. But if a PACS fails, not having access to images for 10 minutes in an emergency case is a major issue.

Therefore, if you are relying on the RIS to drive your worklist, you need to make sure that the same robustness and availability requirements are being applied in implementing the RIS as is typically the case with a PACS.

Note again that radiologists tend not to notice whether the worklist is driven by the RIS, the PACS, or an integrated RIS/PACS. There is no obvious difference, except for the resulting access (or lack of access) to information, which could be quite different for each of the three implementations. This distinction of being “invisible” for a user can make troubleshooting harder: A user might simply report that the “PACS is down,” while in reality the problem could be just an issue with the SR system or the RIS.

In conclusion, there are several questions to ask when determining the type of implementation for a RIS/PACS system:

1. Which system generates the worklist: the RIS, the PACS, or a truly integrated RIS/PACS?
2. Where are the reports stored: the RIS, the PACS, or in a shared RIS/PACS database?
3. How are other types of information, such as notes, forms, measurements, and exam status managed? It is critical to not only know that they are available, but also where they are maintained and managed.

If you have a choice, the truly integrated RIS/PACS has some major advantages. If you are already committed to a system with separate RIS and PACS databases, make sure that access to the information in either system is seamless and immediate.

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