



*iCRco* Imaging Technology White Paper:  
**Clarity – the clear solution for managing digital  
medical imaging data**

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August 7, 2009

### Abstract

Digital imaging technology is being rapidly adopted in medical imaging, but the information systems used to manage and display medical imaging data are expensive and complex. Clarity is a new imaging solution that transforms the clinical imaging work flow by making it easy for physicians to find, display and report on digital images and related patient information.

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## Introduction

Digital technology is being rapidly adopted in medical imaging, but the information systems used to manage and display medical imaging data are expensive and complex. Picture archiving and communication systems, or PACS, were introduced in the 1990's to enable health care providers to manage digital images and related patient information. PACS represent a breakthrough technology that enabled more efficient use of digital imaging in clinical environments.

## Historical Perspective

Digital imaging became clinically important with the widespread adoption of X-ray Computerized Tomography (CT) in the early 1980's followed rapidly by Digital Subtraction Angiography (DSA), Ultrasound (US), and Magnetic Resonance (MR) imaging in radiology, and Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) in nuclear medicine. Although the images produced by these modalities could be processed and displayed on a monitor provided with the modality, the images were typically printed onto conventional radiographic film for viewing and storage, which severely limited the use of the digital data.

PACS were initially introduced to enable imaging physicians to display and manipulate digital images on dedicated viewing stations and to reduce the cost of printing film. PACS technology quickly evolved to enable the rapid distribution and cost-effective storage of diagnostic images and

information. Contemporary PACS include a broad range of capabilities including, for example, the ability to integrate information from different modalities, quickly display and manipulate cross-sectional data as 2-D slices or 3-D images, make measurements and annotations on images, forward images to other physicians, significantly compress the data and store it across distributed archives, and save the images to portable digital media.

## Early PACS

PACS were initially developed for radiologists working in large radiology departments. A traditional PACS installation consisted of: (1) workstations at each modality to acquire and QC images and send the images to (2) a centralized server to store and distribute the images to (3) a film printer and to (4) dedicated image display workstations. Early PACS typically required extensive planning to install and configure, extended training to learn how to use the software, and significant ongoing support and maintenance. Even now, most PACS are tailored to meet the needs of radiologists working in hospitals or imaging centers, and remain difficult to install, complicated to use, and expensive to maintain.

## Contemporary Needs

Well over half of the projectional X-ray imaging procedures that are performed in the USA are performed by non-radiologists, including orthopedic surgeons, internists, pulmonologists, rhema-

tologists, podiatrists and other health care providers such as chiropractors and dentists. Veterinary medicine also accounts for a significant number of X-ray procedures. Due to the cost and complexity of traditional PACS solutions, digital image management has not been widely adopted by non-radiologists, and PACS have not been widely adopted outside of hospitals and radiology imaging centers. In addition, the initial wave of PACS implementation began in the late 1990's, and many of the early adopters in radiology departments and imaging centers are now searching for less costly and easier-to-use solutions. Lastly, hospitals in emerging economic regions such as South America, Asia, India and Eastern are making substantial investments in their health care infrastructure, and need reliable but cost-effective solutions.

### Important considerations in selecting a PACS

When evaluating PACS solutions, it is important to choose a solution that meets both the clinical and business needs of the clinical practice. Table 1 summarizes some of the most common and important factors to evaluate in the PACS selection process.

For a busy physician office, one of the most important factors to consider is how easy the Viewer is to use without requiring extensive training. A related factor is how well the viewing tools simplify access to the images and streamline comparisons and reporting (streamlining physician work flow). The PACS vendor should be able to quickly demonstrate how

to use work flow features of the system, and they should appear intuitive to the physician and easy to use and easy to remember.

Ease of use and impact on work flow
Affordability
Maintenance and Upgrades
HIPAA Compliance and Auditing
Reliability/Uptime and Technical Support
Back-up options
Interoperability

**Table 1:** Important considerations in selecting a PACS

A PACS must also be easy to maintain and administer, and the software should be easy to upgrade. The PACS vendor should demonstrate the administrative features of the PACS, including HIPAA compliance and auditing, and should be able to remotely install software upgrades.

The overall reliability of a PACS is often measured as the uptime or availability of the system. Most PACS vendors can provide statistics indicating the average availability at representative customer sites of the PACS solution that is proposed. The PACS vendor should provide a solution with the level of uptime and technical support that is demanded by the operation of the facility. Facilities that require 24x7 uptime will require a PACS solution with greater reliability and hardware redundancy. System reliability and redundancy is critical because having a 24x7 technical support contract is not a guarantee of 24x7 uptime.

It is critically important that the PACS include proven solutions for backing-up

the entire PACS archive and restoring data in the event of a catastrophic failure. In some cases, it might be very useful to keep a copy of the acquired images off-site, so the PACS should provide options for off-site back-up and remote access to the off-site archive.

Lastly, most clinical practices are very concerned with the affordability of PACS, which is not limited to the initial purchase price, but also includes the cost of maintenance, the cost of integration with other information systems such as a RIS or EMR, the cost of expanding and updating the system and, potentially, the cost of migrating data from an existing legacy PACS to the new PACS.

## The Clarity Solution

Clarity is a family of products designed to enable medical imaging providers to easily and cost-effectively manage digital patient records such as images, reports and related medical information. The Clarity family of products includes a scalable picture archiving and communication system (PACS), a radiology information system (RIS), integration with electronic medical records (EMR) and tools to access to clinical data via mobile devices.

ClarityPACS is designed to optimize imaging work flow and simplify image management for hospitals, imaging centers and medical practices using digital imaging. ClarityPACS was specifically designed to provide physicians with a simple but functional graphical interface to digital images, while reducing the cost and complexity of PACS installation and maintenance. Some

of the key advantages of ClarityPACS are listed in Table 2.

Ease-of-use improves clinical work flow & productivity
Easy to install, configure, maintain and upgrade
High reliability and uptime
Flexible back-up options
Interoperability with other information systems (e.g., EMR, RIS and Surgical Planning)
Very Affordable

**Table 2:** Advantages of ClarityPACS

## ClarityPACS Work flow and Organization

The architecture and primary components of ClarityPACS are shown in Figure 1. The ClarityPACS Archive, Viewer and Remote Monitoring software are installed on a single, easy-to-maintain and fault-tolerant Server at the customer site. As images are acquired, the modality sends the DICOM images to the Clarity Archive, which registers each image in the database and writes the image to a reliable primary storage device as well as a secondary back-up storage device. The Clarity Viewer is launched from another computer on the local network or over the Internet, pulls images over the network as it is needed, and provides easy-to-use tools for displaying the images and related information. ClarityPACS supports storage and display for all of the major imaging modalities (Table 3).

Computed Radiography (CR)
Direct Digital Radiography (DX)
Digital Mammography (MG)
Computed Tomography (CT)
Magnetic Resonance (MR)
Ultrasound (US)

**Table 3:** Modality Support

Highly reliable storage with RAID mirroring and striping options
DICOM Receive, Query/Retrieve, Storage Commit
DICOM GSPS for sharing annotations
DICOM Structured Reports
DICOM Multi-frame images
Modality Work List (RIS)
Modality Performed Procedure Step (MPPS)
Configurable, rule-based routing of images
Off-site back-up
Lossless image compression

**Table 4:** Key features of the Clarity Archive

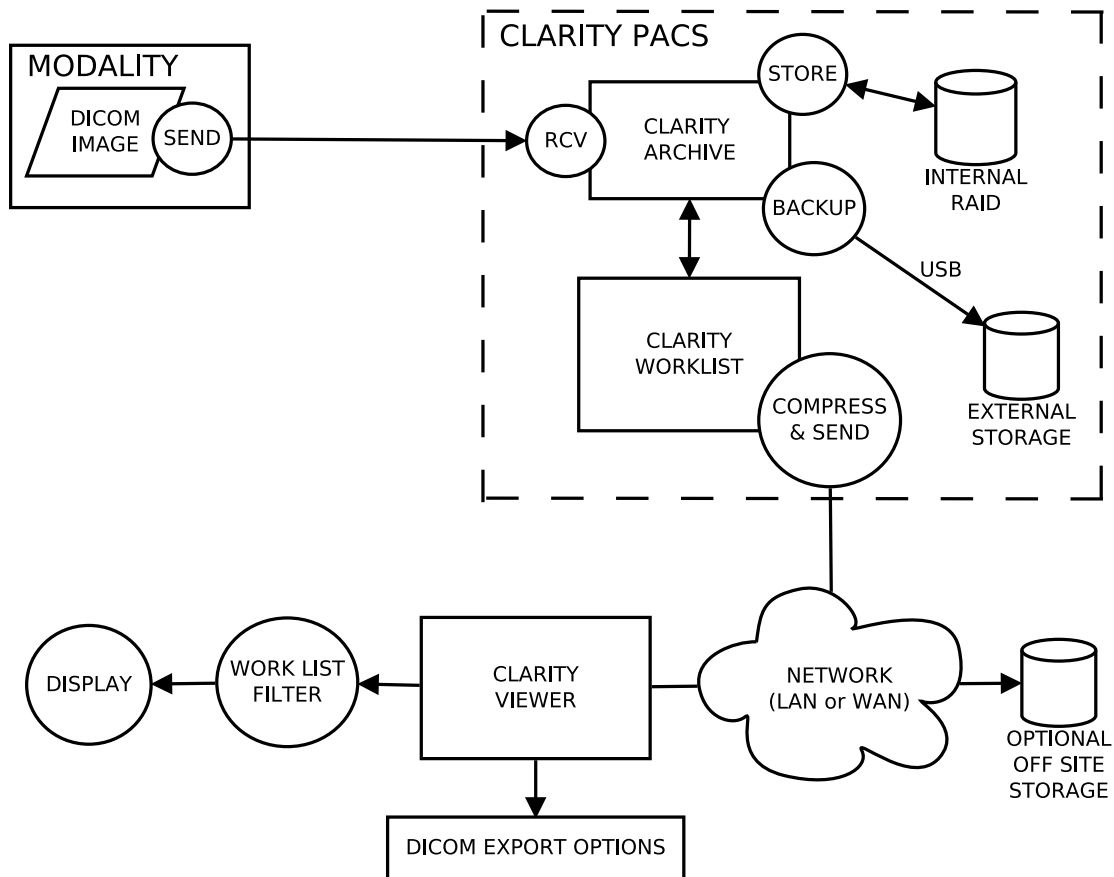
## Clarity Archive:

The Clarity Archive is a repository for DICOM images, reports and related clinical information. Some of the key features of the Clarity Archive are listed in Table 4. The Clarity Archive provides comprehensive DICOM Services including: DICOM Receive and storage Commit, DICOM Query/Retrieve, DICOM Routing, support for DICOM Structured Reports, and DICOM Grey Scale Presentation States. Clarity can also exchange data with other information systems using HL-7 messaging to receive orders from an EMR or RIS, DICOM Modality Work List (MWL) and Modality Performed Procedure Step (MPPS) messages with a RIS. This enables Clarity to easily communicate with other clinical information systems in an integrated digital environment.

## Clarity Viewer

The Clarity Viewer enables the display of medical images and related information that is stored on the Clarity Archive. The Viewer and Archive can be on the same local area network (LAN) or can be on separate networks that are connected by the public Internet or a private wide area network (WAN). The Viewer is a Java Web Start™ application that is downloaded from the Archive (via a web browser) and runs on the local workstation.

A significant advantage of this approach is that the Viewer software is installed and maintained on one Server and does not have to be manually installed and configured on every workstation. When a User launches the Viewer for the first time, the software is automatically downloaded and configured for their workstation; when the User launches the Viewer again, the local copy of the software is automatically updated as needed. In all cases, the Viewer



**Figure 1:** ClarityPACS Architecture

software runs locally on the workstation for optimal performance. Some of the key features of the Clarity Viewer are listed in Table 5.

Integrated work list with customized filters
Auto multiple-monitor configuration and side-by-side comparisons
Rapid image manipulation & display optimized for CR and with full support for CT and MR, including cross-reference lines
Measurements & annotations
Fast image processing filters
Integrated reporting

**Table 5:** Key features of the Clarity Viewer

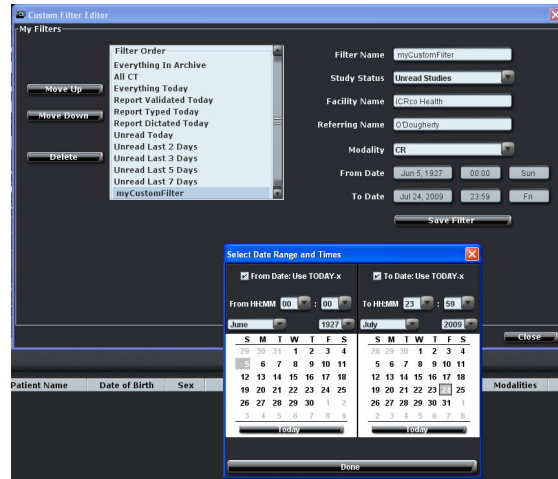
The Clarity Viewer provides a sortable and customizable work list so that physicians can quickly and easily find and manage patient information as illustrated in Figure 2.

One feature of the Clarity work list that helps to optimize clinical work flow is the Search and Filter bar at the top of the work list (Figure 2-1). The Search menu enables a quick search by Patient Name, ID, Accession Number or Study ID. The Search and Filter menus can be combined, making it easy to quickly locate relevant clinical data. Another feature of the work list is the Search Results table, which dynamically displays patient information that matches the search (Figure 2-2). Once a patient



**Figure 2:** The Clarity Viewer’s work list provides flexible and powerful search filters to quickly locate patient data.

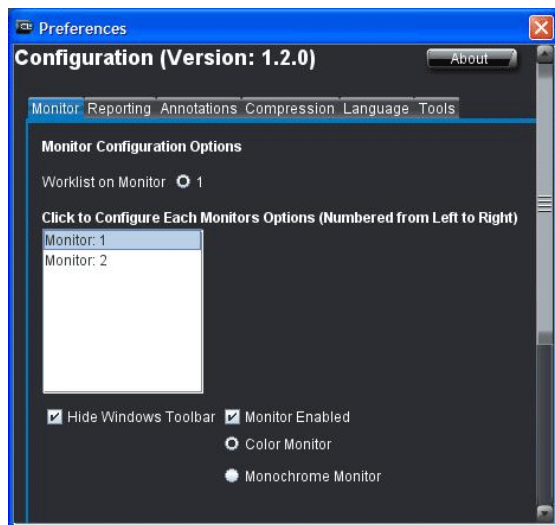
study is selected in the Search Results table, all studies stored in the archive for the selected patient are displayed in the Patient Studies table (Figure 2-3), which gives the physician easy access to all of the patient’s studies at once. When a study is selected from either the Search Results or Patient Studies tables, thumbnail previews of those studies are loaded (Figure 2-4), making it easy for the physician to locate the needed images. At any time, the physician can double click on a Study in either of the lists or on a thumbnail to load and display the images.



**Figure 3:** The User can define multiple custom search filters to tailor the work list to their specific needs.

The physician can define custom filters in the work list window in order to quickly

locate patient information(see Figure 3). The filters are used to find information based on specific criteria, such as the date, modality, facility, referring physician, or study status. Custom filters can be modified further with new search criteria, and filters can be combined to rapidly locate the desired information.



**Figure 4:** Clarity automatically detects multiple monitors, and provides tools for customizing the monitor configurations.

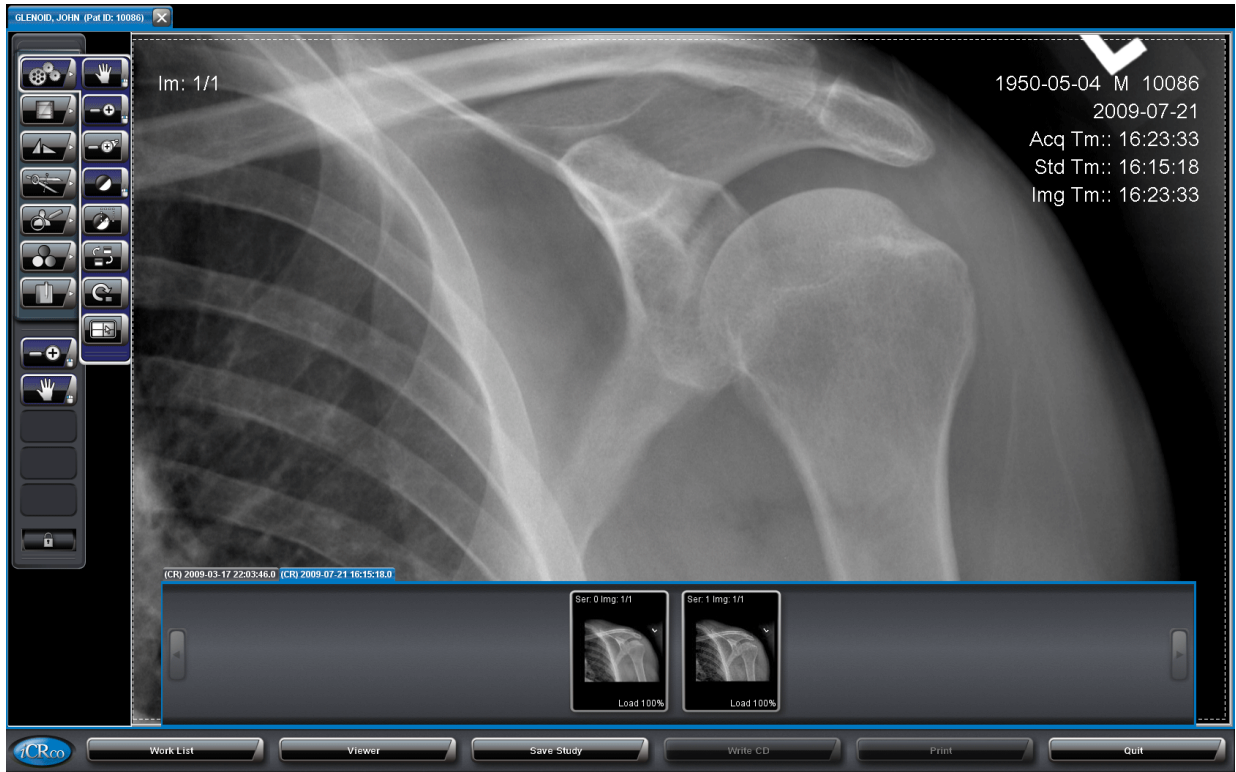
The Clarity Viewer supports color and gray scale monitors and automatically detects multiple monitors (including monitors of differing resolution). An easy-to-use graphical user interface simplifies the process of customizing the configuration of the monitors (Figure 4). For example, the work list can be displayed on a color monitor while grey scale monitors can be used exclusively for image display, and any monitor can be disabled so that Clarity will not use it.

The Clarity Image Viewing interface was specifically designed to enable a physician to focus on image diagnosis while having

rapid access to prior images and tools. For example, the Viewing interface provides a tabbed list of current and prior studies at the bottom of the screen and a cascading button list of navigation and manipulation tools on the left side of the screen. These controls are normally hidden so that the physician can concentrate on the images. However, moving the mouse to the left of the screen automatically reveals the navigation and manipulation tools. The physician can click on a toolset to reveal a grouped list of tools. Moving the mouse to the bottom of the screen reveals the tabbed study list with thumbnail views of all the patient's studies (as shown in Figure 5). The physician can drag a thumbnail preview onto the viewing pane at any time to view the images in the series. Other studies from the same patient are contained in the tabs on the top of the thumbnail preview pane, making it easy to navigate all of a patient's studies without having to switch back to the work list.

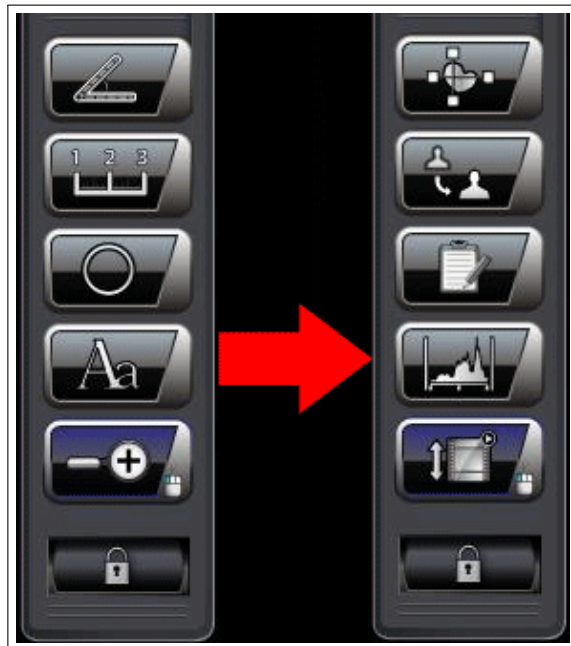
While viewing an image, it is easy to create comparison views by splitting the Viewing window into several dynamically re-sizable panes (Figure 6). The Clarity Viewer's layout tool enables the User to quickly and easily layout multiple images on one or several monitors. The User simply selects the desired number viewing panes, then drags the thumbnails into the panes to view them.

Clarity provides a robust set of cross-sectional viewing tools that are needed to quickly display and manipulate CT and MR studies. The Clarity Viewer provides support for linked cine operations, cross-reference lines, cine play-back with looped and non-looped modes (Figure 7). As the

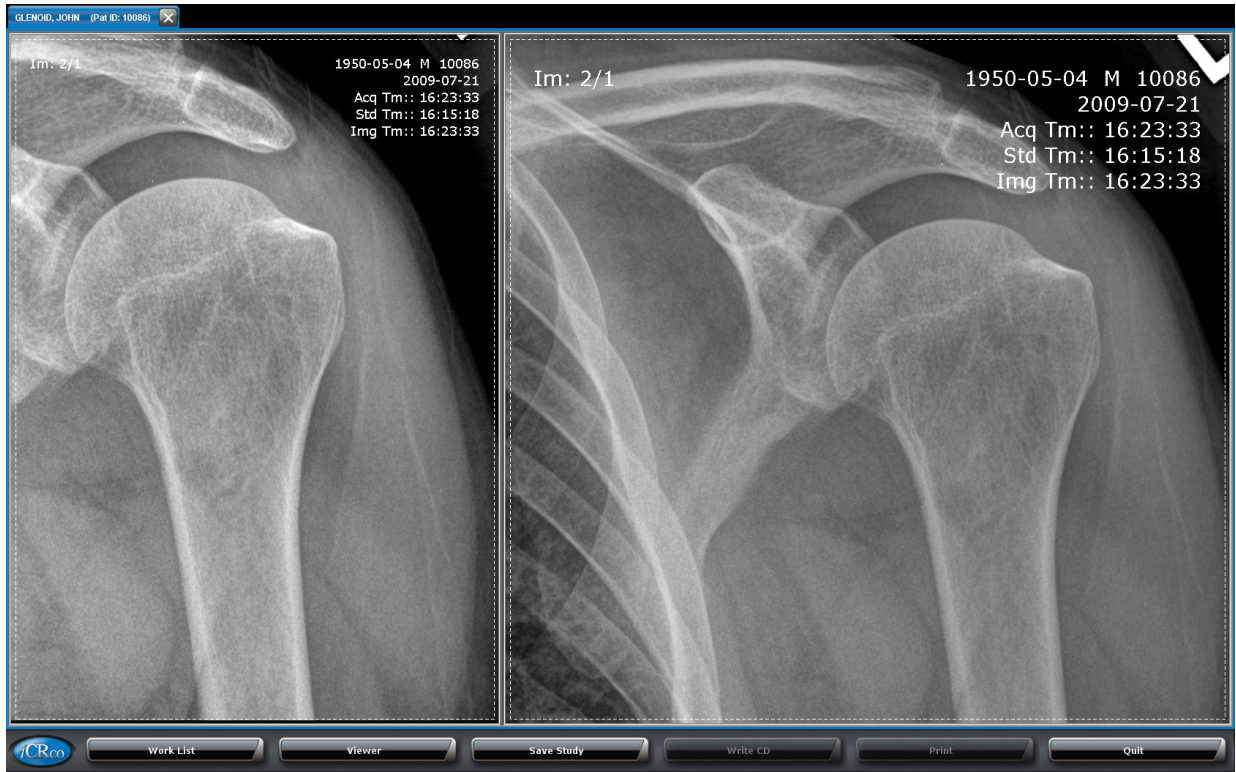


**Figure 5:** The Clarity Viewer includes several features designed to provide rapid access to images and reports and to make it easy to manipulate and compare images.

User cines through one series, the linked series automatically syncs to the first series and updates the cross-reference lines in real time.



**Figure 8:** The Clarity Viewer's Frequently Used Tools feature.

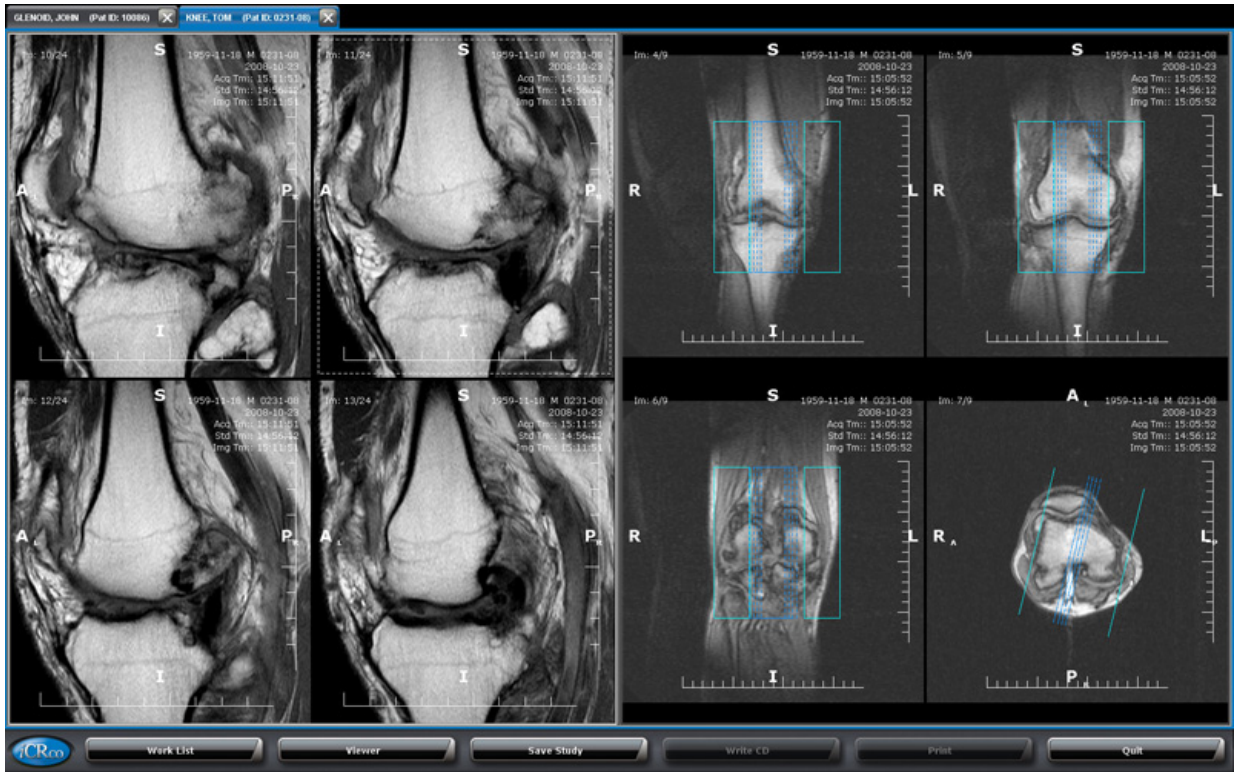


**Figure 6:** The Clarity Viewer makes it easy to create comparison views.

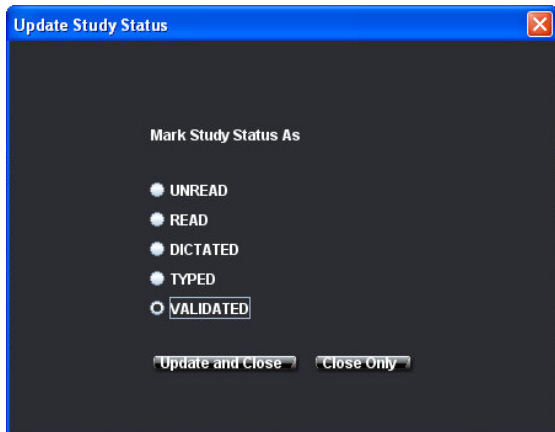
The Clarity Viewer's annotation and image manipulation tools are easy to access and use. The bottom of the toolbar is populated with frequently used tools, a dynamically updated list of tools the User uses most. The number of frequently used tools is user selectable between one and five. Frequently used tools offers the User a convenient way to access the most used tools (Figure 8). At any time the User may reset the count of frequently used tools, removing the current set of tools, then repopulating the list once the User begins manipulating and annotating again. This provides the utmost flexibility in accessing and using tools.

Storing and referencing diagnostic reports can quickly become cumbersome as the number of reports increases. Clarity provides an integrated report writer that allow

a physician to create DICOM structured reports from within the Viewer (Figure 9). The report can be saved with the images in the Clarity Archive at the study level. When the study is opened again, the report shows up in the thumbnail previews and can be opened and viewed inside the viewer. Addenda and corrections can be appended to the report as easily as the report was created. The report writer also offers report templating, so that physicians can fill out reports with a few mouse clicks.



**Figure 7:** Support for cross-references lines and cine operations provided by the Clarity Viewer



**Figure 10:** When closing a study, the Clarity Viewer can update the Study Status, providing a streamlined work flow for the reading physician.

The Study Status feature can be optionally activated from the Configuration panel. Study Status is integrated into both the work list and filters, such that the study

status can be marked as Unread, Read, Dictated, Typed or Validated (Figure 10). The status can then be used in conjunction with a custom filter to streamline the reading workflow for the physician.

### Remote Monitoring:

To maximize system uptime and reliability, *iCRco* developed an industry-leading remote monitoring system that monitors the status of each component of Clarity-PACS. The Remote Access and Configuration of Resources (RACR) system can automatically connect to a Clarity Archive at scheduled times, collect status information, and either fix a potential problem or warn the *iCRco* Customer Care Team of pending problems. RACR provides tools that enable a qualified PACS engineer to

The screenshot shows a 'Create Report' dialog box. The top bar is dark blue with the title 'Create Report' and a close button. Below the title bar, the form is organized into sections. The 'Reporting Doctor's Name' section has five input fields: Prefix, First Name, Middle Name, Last Name, and Suffix. Below this is a 'Fax' field. The 'Procedure Description', 'Patient History', 'Findings', and 'Impressions' sections each have a large, empty text area. At the bottom, there is a 'Notified' field. The footer contains four buttons: 'Create', 'Cancel', a dropdown menu currently showing 'Template\_0', and 'Apply Template'.

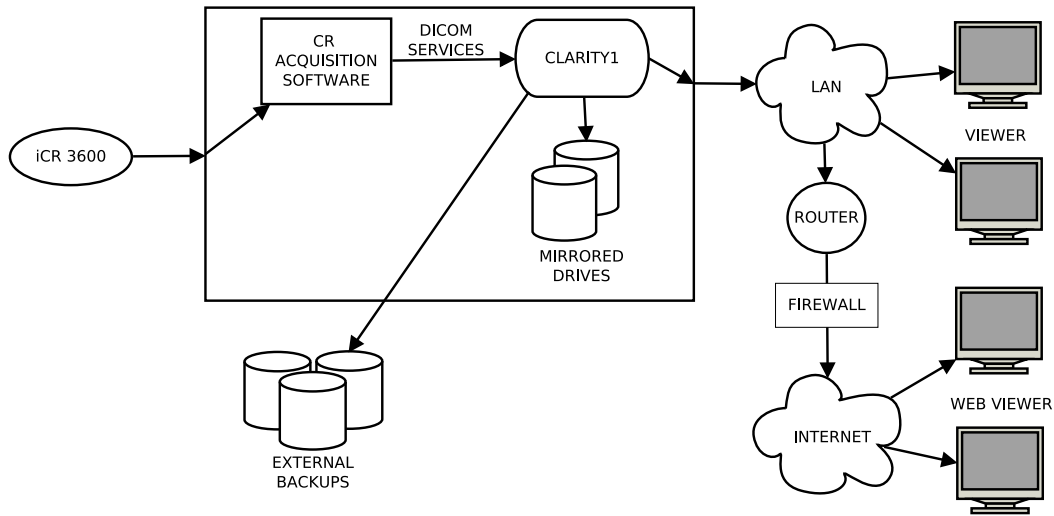
**Figure 9:** The Clarity Viewer offers flexible options for automating the repetitive task of Report Writing.

troubleshoot Clarity systems and remotely address issues without incurring down-time.

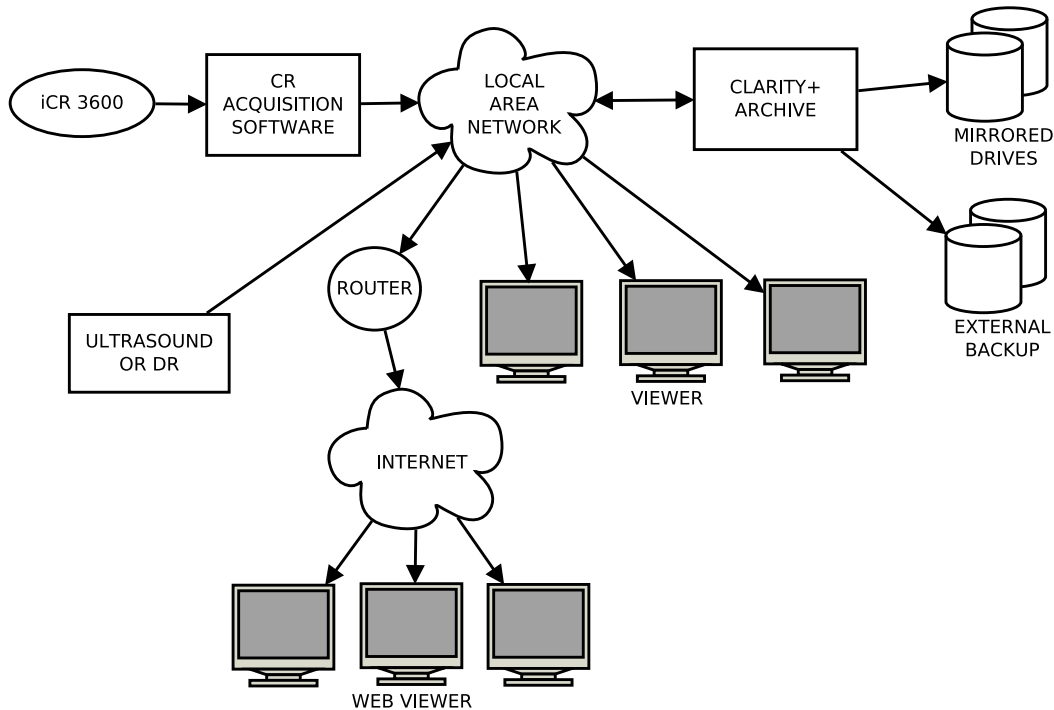
### Clarity Configurations:

Clarity is highly scalable and can be configured to meet the needs of a private physician office or a large hospital radiology department.

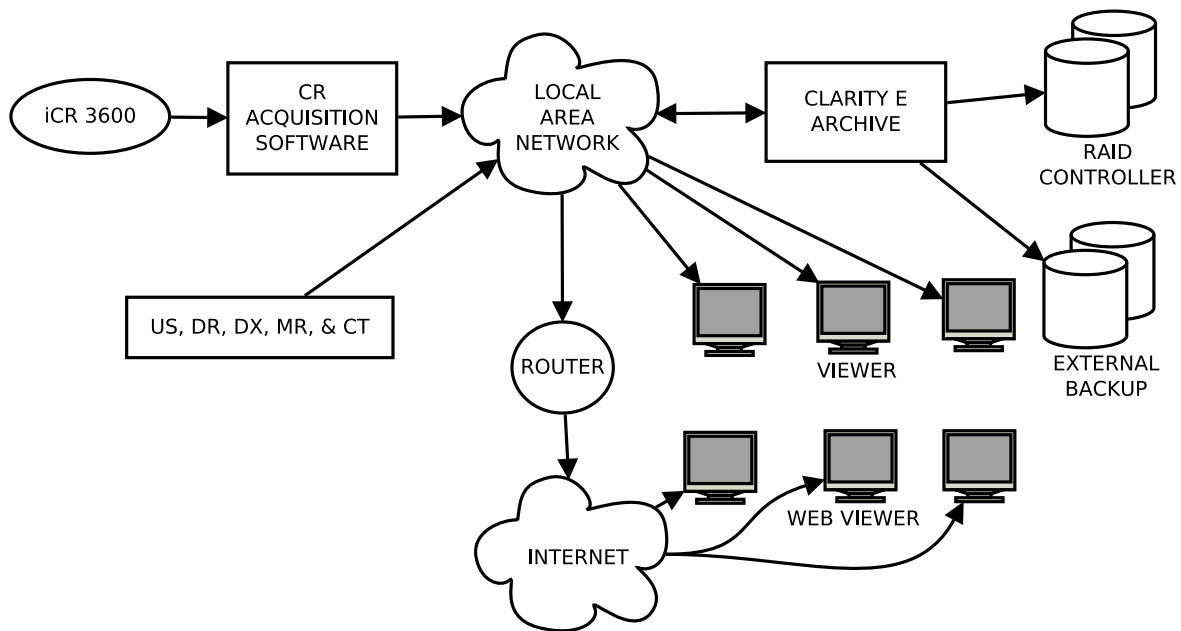
**Figure 11:** Clarity1 – Consists of a PACS integrated with the CR system. This configuration is ideal for single physician practices using only CR.



**Figure 12:** Clarity+ – Consists of a standalone PACS that can support CR and US or DR imaging modalities and additional viewers. This configuration is ideal for multi-physician medical practices using CR and Ultrasound at one or more offices.



**Figure 13: ClarityE** – This is a customizable solution that is highly scalable and can support multiple imaging modalities at multiple locations. This solution can be configured for imaging centers, small hospitals or mid-to-large hospital enterprises.



### Conclusion and Summary:

ClarityPACS is an easy to use and reliable solution for managing digital images and report information. ClarityPACS was specifically designed to optimize diagnostic work flow while reducing the cost and complexity of PACS installation, use and maintenance. The Clarity Viewer is a feature-rich Diagnostic Workstation with full multi-modality display tools, measurements, annotations, and integrated reporting tools. The Clarity Archive is a fully-featured and robust DICOM storage solution with support for multiple imaging modalities, integration with external information systems (i.e., HIS/RIS via HL7 & DICOM Modality work list), and flexible back-up options. The Clarity servers are highly scalable and can be

configured with different amounts of RAM, different levels of RAID storage, and with redundant CPU's, power supplies and network interfaces. Clarity can optionally be configured for off-site back-up, and for remote monitoring of the system status and performance.

*iCRco* offers a very complete line of digital imaging solutions, with an emphasis on service and reliability, resulting in the lowest cost of ownership in the industry. All *iCRco* products are designed and manufactured in the USA, and sold and proven globally.

Clarity is the clear solution for the management and display of digital images and patient information, and is the complete solution for your current and future digital image management needs.