Continuity of Care in Today's PACS Environment

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Electronic medical imaging technologies are becoming increasingly sophisticated and better able to directly contribute to improved patient care. Specifically, hospital networks are integrating higher image resolutions with picture archiving and communications systems (PACS). This integration not only offers the ability of physicians to diagnose and treat previously undetected medical conditions, but also provides rapid access and retrieval of patient images by emergency physicians and surgeons working under critical, time-sensitive situations.

Rapid Adoption of PACS Contributes to Rising Demand for Archive Storage

The overall demand for radiology procedures is on the rise. In part, this is due to the growing population of older patients who are more susceptible to physical diseases and chronic ailments, and also the success of faster imaging diagnostics and acute care procedures. As a result, the adoption of PACS among medical providers is rapidly increasing and contributing to the dramatic rise in the demand for archive storage. Because of the "always-on" accessibility and rapid response made possible by online media, PACS is a critical technology in patient care.

Not only are radiology departments producing more diagnostic images, but they are producing larger images. Many departments have upgraded from the older 512 x 512 pixel matrix with an 8-bit image format and are starting to use higher 1024 x 1024 image matrix formats on newer modalities used in many of the radiology departments. As a result of using the higher image matrix, the average procedure now requires 50 megabytes of storage space, doubling the average 25 megabytes per procedure used in 2005. By 2010, the average procedure is expected to expand to 75 megabytes per procedure, representing another 45 percent increase.

Rising Storage Needs in Radiology Create Challenges

The vast majority of PACS-enabled radiology departments share both an image server and a database server. The image server stores the procedural images online for the first six months. The database server manages the image management systems, the workflow and reporting features, the information systems (both the radiology and hospital information systems) interfacing and connectivity, the analytic and reporting features, and the built-in data recovery solution. In the past, the image server used internal RAID storage and leveraged optical disk jukeboxes or magnetic tape libraries for near-line or offline archiving. However, as more detailed images

were created, this configuration proved to be difficult to scale, and set significant limitations on access times and availability for on-demand retrieval. Response times would increase and require additional jukebox implementations to ensure that data is near-line instead of off-line.

A small percentage of all PACS systems that are installed are considered enterprise. Enterprise PACS architectures are most closely aligned to the architecture of a stand alone radiology PACS solution. The image server is centralized and contains the images from various individual radiology modalities. The database management server is also centralized. Both the image server and the database management server can interface with the radiology PACS system, the radiology department, and hospital information systems, even though each department retains its own distinct applications. Today, in the majority of enterprise PACS installations, online storage is retained on the respective radiology PACS image server connected to a Storage Area Network (SAN) and longer-term archive images are stored on a second-tier media device. Rather than install these storage systems into the radiology department, a number of hospital information system administrators prefer to consolidate storage across the organization, while continuing to allow departments such as radiology and cardiology to set their own retention and access policies.
Although traditionally adopted as a stand-alone archive, departmental PACS solutions and hospitals are shifting to a centralized archiving architecture and reaping the benefits of economies of scale and reduced administrative costs made possible through shared archiving.

The growing adoption of enterprise PACS solutions is contributing to the increase in overall storage requirements among caregivers. In 2005, all U.S. radiology PACS-based systems combined stored an estimated 2.6 petabytes.

Adoption of Non-invasive CTA Technologies Requires Effective Storage Planning

While still in the early phase of adoption, greater resolution and non-invasive rapid data capture and display is quickly making Computed Tomography Angiography (CTA) imaging technologies a preferred diagnostic procedure, as compared to doing an invasive cardiac catheterization. The fast, multi-row 32 and 64 slice CTA is now able to get a 0.6- millimeter resolution and can scan the heart in 10 seconds.
The lower-cost, lower-risk, non-invasive, and high-diagnostic values afforded to both cardiologists and patients make CTA an up-and-coming technology. However, the adoption of CTA technologies will require more digital storage within existing radiology or radiology PACS systems than these systems have typically allocated. Whereas a typical catheterization procedure can take approximately 500 megabytes of space on the imaging server, axial CT images can be composed of a large number of images. For instance, a typical CTA averages 600 images, representing roughly 300 megabytes. However, some diagnostic procedures have been known to produce up to 3,000 to 5,000 images.
The adoption of three-dimensional “volumetric” CT images would increase the amount of storage needed by a PACS system and would require new ways of archiving the image as a “volumetric image” rather than as a slice.

Although 95 to 98 percent of all CTA's are still located in radiology departments, there is a small but growing demand for CTA's and PET/CTA systems in cardiology departments. There is also an interest among cardiology departments to acquire PET/CTA systems over the next few years, depending upon resolution and creation of necessary reimbursement codes for diagnostic procedures.

COMPLEXITY OF PROVIDING CONTINUITY OF CARE IN TODAY'S HEALTHCARE ENVIRONMENT

Integration into EMR Critical to Continuity of Care

Although the shift to the electronic medical record (EMR) has been in process for some time, industry sources have only just seen a strong focus on the EMR since the last quarter of 2004. Hospitals have been working hard to create a unified digital patient record. Similarly, radiology PACS providers have been developing and offering archival image solutions, report generation, report mining, report outcomes, and providing interfaces to the radiology information system, billing system, and the hospital information systems.

Just as the Digital Imaging and Communication of Medicine (DICOM) standard improved imaging communication and storage, the HL7 administrative interface will, in time, enable the radiology patient images and reports to become fully integrated into the EMR.

Need for Secure Accessibility

Remote connectivity, the ability to connect various radiology departments from many physically separated hospitals (often across multiple states), is becoming increasingly common.

Three years ago, 90 percent of remote access was based on dial-up connections. Two years ago, 70 percent of the remote users were using dial-up connections. Now, remote connections are practically site-to-site over virtual, very private networks, using specialized firewalls and routing at each end in a secure manner.

Next-generation Radiology PACS Focus on Workflow Efficiencies

The latest radiology PACS solutions now provide a number of analytics and reporting tools for modality-specific procedures, such as catheter ablation performed by the electrophysiology and cath labs, and hemodynamic monitoring and data management solutions. Integration into radiology PACS, for viewing CTA and MRA images, is also an option.

Workflow management and the ability to increase departmental efficiencies are the most critical, value-added features, and functionalities that second- and third-generation PACS are bringing to the market. The addition of order processing, scheduling, analysis, built-in reporting, and streamline interfaces to billing, has considerably reduced entry delays and billing errors. In addition, automation of billing features assists radiologists and cardiologists with previously manual tasks, which increases productivity and reducing billing time. The interface and integration with the radiology and cardiology departmental information systems have been critical to the success of next-generation PACS solutions. As a result, hospitals IT departments can now consolidate individual PACS solutions into a cohesive, centralized solution.

WHY DO RADIOLOGY DEPARTMENTS USE LONG TERM STORAGE?

The use of PACS solutions is an indispensable tool that helps doctors to diagnose quicker.
As the use of radiology and cardiology PACS solutions increases, so does the need for storage capacity planning since each image can range in size from 20 to 40 megabytes or more. Initially, these images will be placed on a high-performance primary cache SAN infrastructure; however, as these images are accessed less frequently over the course of a 30/60/90 day period there is a strong financial incentive to migrate them to a long-term, online archive storage solution.

Today's Long Term Storage

Today's long term storage solutions offer healthcare environments an online archive storage solution that provides radiology departments with fast, reliable, and on-demand access to archived PACS images. Because archived radiology PACS images may need to be referenced quickly in emergency situations, data should always be available on-demand, around the clock, at
Internet speeds. In cases when PACS images are kept on optical or tape storage, concerns arise regarding the immediate availability of images, as well as the possibility of tape failure or optical jukebox mechanical breakdown. When there is a mechanical breakdown, or in a situation where images are on tape and optical media has not already been loaded in the jukebox, retrieval can take hours or days. Images are regularly placed on near-line storage after two to three months, forcing hospital staff to call storage archive administrators to retrieve PACS images from near-line storage when the data isn't already loaded in the optical or tape jukebox.
Although many radiology departments have historically maintained a separate storage infrastructure, IT departments in leading-edge hospitals have been implementing universal archive strategies to improve operational efficiencies and optimize continuity of care for patients. This is possible because the newer, faster and cheaper storage devices able to interface with any radiology PACS, as well as other applications or databases that the hospital uses. This is made possible by providing application vendors with open Application Program Interface (API), as well as the ability to write data via industry standard protocols.

Secure Online Archiving

Through the use of an enterprise archive strategy, hospitals are able to ensure that limited financial resources are used to maximum efficiency. Simply put, sharing archive storage infrastructure with other departments enables IT staff to more easily manage storage for a regional health insurance organization and spend more time on improving data accessibility and the overall IT quality of service for physicians and specialists in the organization, including the radiology department. This translates into better accessibility for PACS data as well as the entire patient history for every clinic, office and hospital across the Regional Health Insurance Organization (RHIO).

Despite the fact that multiple departments share the long term storage, radiology PACS images cannot be manipulated, altered, or located and accessed by unauthorized viewers searching through storage volumes on a networked computer. Through the use of content-addressed storage PACS data is secure and separate from data archived by other departments.

Content Addressed Storage

Some newer long term storage providers' keep radiology PACS images secure from unauthorized viewers, modification, and accidental deletion through the use of a Content Addressed Storage (CAS) system. CAS works by storing and indexing data with a Content Address (CA) rather than using the physical or logical placement of a PACS image within the storage array. With a CA derived from the content itself, eliminates the storage of multiple copies of identical information and the possibility of accidentally overwriting critical radiology PACS data with similarly named files or directories. For business continuity within the hospital environment, as well as for governance and compliance needs, some long term storage provider's safeguards data using advanced content protection technology within the storage infrastructure. This allows it to heal itself when it detects a failing storage node and to generate new copies of radiology PACS images onto a healthy node. As the self-healing process takes place, the failing node is isolated from the system and can be hot-swapped without disruption to radiology PACS operations, and continuing to allow access to redundant copies of all PACS information stored in the system.

Non-disruptive upgrades are possible for radiology PACS storage because applications no longer require knowledge of a file system location storing PACS images. The result is a dramatic reduction in system/storage management. In the event that PACS images are accessed and altered in any way, CAS creates a different content address for the altered images before storing them in the array. The unique CA of each piece of data ensures data authenticity and verifiable audit trails, all of which are critical from a regulatory and hospital governance perspective.

This high level of data protection and storage management flexibility is crucial in the radiology PACS environment where on-demand information can save lives. Neither tape nor optical storage can offer this level of availability, reliability, and flexibility as optical jukeboxes can be prone to mechanical breakdown and tape media is known to have high failure rates.

Scalable, Networked, Management Simplicity

The ability to add hot-swappable nodes to scale above a petabyte of storage enables newer systems to easily meet the growing storage archive needs of radiology and cardiology PACS environments, as well as RHIOs. In addition, online networked storage enables asynchronous remote replication from one to many storage is easy to establish in order to ensure consistent access to information in the event of a disaster. Finally, fewer long term storage providers' offers management simplicity through its self-healing features, as well as its ability to establish application-based retention and disposition policies for data.

CONCLUSION

The increasing use of higher-definition radiology PACS is the leading drive behind demand for more effective storage solutions for healthcare organizations. Despite the business need for increased storage capacity, administrators are being forced to seek ways to improve operational efficiencies and maximize each dollar spent for IT infrastructure. As a result, universal archive storage is viewed as the best solution to meet the demands of IT administrators and doctors.

For more information about PACS or how VCS' services and solutions can help your organization please call us at 610.444.1233 or email us at vcs@getvitalized.com. You can find out more about VCS by visiting our website www.getvitalized.com