FUTUREWEI Whitepaper

Healthcare Focus: PACS and Storage Use Case

V 0.1	6/28/21 initial draft L. Lai

ABSTRACT

The introduction and wide acceptance of digital technology in medical imaging has resulted in an exponential increase in the amount of data produced by the medical imaging department from healthcare providers. There is an insatiable need for storage space to archive this ever-growing volume of image data. Healthcare facilities should plan the enterprise storage system that they need to integrate with the modern PACS system, based not just on the volume of data but also on considerations such as the speed and ease of access, redundancy, security, costs, as well as the longevity of the archival technology. This article provides an overview of PACS and its associated image storage systems, exploring new use cases at Canadian's regional healthcare system.

1 PACS AND STORAGE

PACS (picture archiving and communication system) is a medical imaging technology used primarily in healthcare organizations to securely store and digitally transmit electronic images and clinically relevant reports. The use of PACS eliminates the need to manually file and store, retrieve and send sensitive information, films, and reports. Instead, medical documentation and images can be securely housed in off-site servers and safely accessed essentially from anywhere in the world using PACS software, workstations, and mobile devices.

Medical imaging storage technologies such as PACS are increasingly important as the volume of digital medical images grows throughout the healthcare industry and data analytics of those images becomes more prevalent.

While radiologists have predominately used PACS -- radiology traditionally being the most prolific producer of X-ray images -- PACS technologies have been incorporated into other departments, such as nuclear medicine imaging, cardiology, pathology, oncology and dermatology.

Medical images are taken and reviewed for clinical analysis, diagnosis, and treatment as part of a patient's care plan. The information collected can be used to identify any anatomical and physiological abnormalities, chart the progress of treatment, and provide clinicians with a database of normal patient scans for later reference.

Having digital access to the most updated version of a patient's medical images, clinical reports and history can expedite and improve care, lessening the likelihood of treatment and prescription errors and preventing redundant testing. Digital access can also improve patient safety and save both the healthcare facility and the patient time and money.

Nearly all the major medical imaging equipment manufacturers and medical IT companies offer PACS. This system is used to store, retrieve, present, and share images produced by various medical hardware modalities, such as from an X-ray, computed tomography (CT) scan, magnetic resonance imaging (MRI) and ultrasound machines.

The modern use of PACS can be attributed to DICOM (Digital Imaging and Communications in Medicine), which is a standard protocol for the management and transmission of medical images and related data. DICOM was originally developed by the National Electrical Manufacturers Association (NEMA) and the American College of Radiology (ACR). In 1983, ACR and NEMA formed a joint committee in hopes of developing medical imaging technology standards and to facilitate the development and expansion of PACS.

PACS Architecture

PACS has four major components: hardware imaging machines; a secure network for the distribution and exchange of patient images; a workstation or mobile device for viewing, processing, and interpreting images; and electronic archives for storing and retrieving images and related documentation and reports.

PACS has four main uses. The technology:

- replaces the need for hard-copy films and management of physical archives.
- allows for remote access, enabling clinicians in different physical locations to review the same data simultaneously.
- offers an electronic platform for images interfacing with other medical automation systems such as a hospital information system (HIS), electronic health record (EHR), and radiology information system (RIS).
- allows radiologists and other radiology and medical personnel to manage the workflow of patient exams.

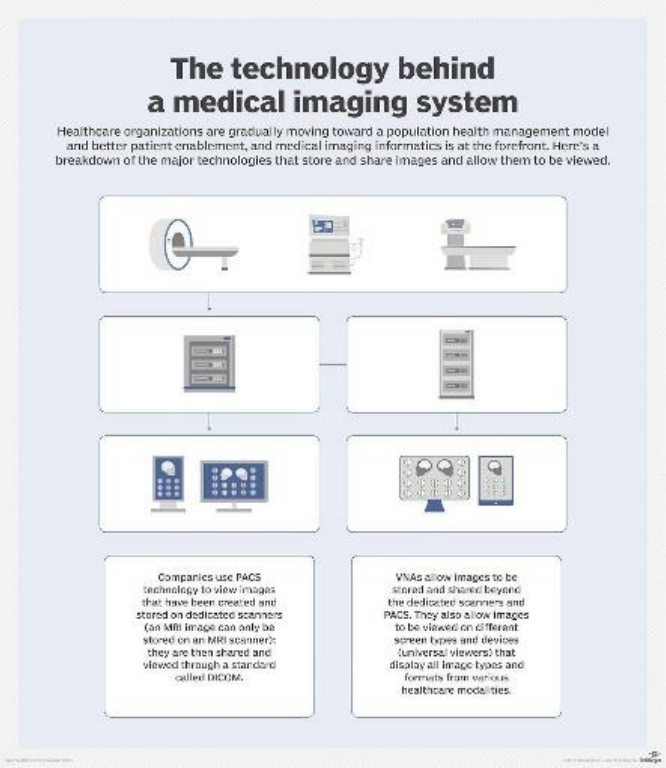

Image archival and backup

Digital medical images are typically stored locally on a PACS for retrieval. It is important (and required in the United States by HIPAA) that facilities have a means of recovering images in the event of an error or disaster.

While each facility is different, the goal in image back-up is to make it automatic and as easy to administer as possible. The hope is that the copies will not be needed; however, disaster recovery and business continuity planning dictates that plans should include maintaining copies of data even when an entire site is temporarily or permanently lost.

Ideally, copies of images should be maintained in several locations, including off-site to provide disaster recovery capabilities. In general, PACS data is no different than other business critical data and should be protected with multiple copies at multiple locations.

Images may be stored both locally and remotely on off-line media such as disk, tape, or optical media. The use of storage systems, using the most advanced data protection technologies has become increasingly common, particularly for larger organizations with greater capacity and performance requirements.

Storage systems may be configured and attached to the PACS server in various ways, either as Direct-Attached Storage (DAS), Network-attached storage (NAS), or via a Storage Area Network (SAN). However, the storage is attached, enterprise storage systems commonly utilize RAID and other technologies to provide high availability and fault tolerance to protect against failures.

In the event that it is necessary to reconstruct a PACS partially or completely, some means of rapidly transferring data back to the PACS is required, preferably while the PACS continues to operate.

Modern data storage replication technologies may be applied to PACS information, including the creation of local copies via point-in-time copy for locally protected copies, along with complete copies of data on separate repositories including disk and tape-based systems. Remote copies of data should be created, either by physically moving tapes off-site, or copying data to remote storage systems. Whenever HIPAA protected data is moved, it should be encrypted, which includes sending via physical tape or replication technologies over wide area networks (WAN) to a secondary location.

The back-up infrastructure may also be capable of supporting the migration of images to a new PACS. Due to the high volume of images that need to be archived many rad centers are migrating their systems to a Cloud-based PACS.

Cloud-based PACS

Imaging information systems like PACS have replaced the need to store and manage hard-copy films and reports in space-consuming shelving and rooms. Instead, medical images and non-image data can be securely stored digitally on premises or in the cloud.

Cloud-based PACS store and back up an organization's medical imaging data to a secure off-site server. This is required in the U.S. by the HIPAA Security Rule, which governs the privacy of patient information. A cloud PACS also enables medical staff to view medical imaging data from any approved devices, such as a smartphone.

Providers often use a hybrid cloud system, in which primary images are stored on-premises and backups are kept in the cloud. Additional types of storage architectures may be configured and attached to the PACS server, such as direct-attached storage (DAS), network-attached storage (NAS) or via a storage area network (SAN), each allowing for upgradeability, connectivity, improved protection against failure and added security.

Other Important and Related Medical Imaging Technologies

Although PACS processes are widely adopted in healthcare, vendor neutral archive (VNA) technology has replaced PACS in some healthcare settings and integrates with PACS in others.

PACS vendors employ various syntaxes within DICOM, which makes it hard for data from one system to work in another system. VNAs enable data integration by deconstructing data from an originating PACS and then migrating the data to the new system with the proper syntax.

DICOM enables imaging technologies to connect with and transfer health data to systems at other healthcare organizations. A RIS, a networked software system for managing medical imagery and associated data, is often used with PACS and VNAs to manage image archives, image orders, record-keeping, and billing.

PACS Vendors

The following are the leading players in the medical imaging equipment and software market:

Agfa HealthCare, Carestream, Cerner, Conesus, Fujifilm, Synapse, GE Healthcare, Merge Healthcare, Philips, Sectra, Siemens

PACS vendors typically provide an entire integrated system including a backup storage system. It is common for enterprise storage vendors to provide fully tested, certified storage systems as OEM products to PACS partners.

2 STORAGE REQUIREMENT FOR PACS

The introduction of picture archiving and communications systems (PACS) for archival, migration, and display of digital images has resulted in increased productivity by expediting image-based workflow. The data storage system is the

heart of the PACS system and, most often, its costliest component. A reliable data storage system with a large capacity, which provides immediate access to the entire imaging archive with minimal operator intervention, forms the foundation of any PACS installation.

The ever-evolving imaging landscape sees growing demand for digitalization of pathology slides, the increase in the number of images being generated, the trend of departmental PACS toward enterprise imaging solutions and the increase in encounter-based imaging at the point-of-care.

Some of the challenges that healthcare providers are facing for medical imaging are performant access to medical imaging, exponential growth of imaging data, sprawl of storage silos and disparate system management and the concern about patient data security and privacy.

To successfully enable enterprise imaging, healthcare providers need a simplified storage architecture that is flexible enough to manage the variety and volume of structured and unstructured data, with the performance needed to provide rapid access to this data. All-flash array (AFA) designs promise to address storage issues and are rapidly taking over from legacy designs. Flash-optimized storage platforms offer compelling advantages in performance, availability, efficiency, economics, and reliability relative to conventional storage platforms and overcome many of their shortfalls, namely performance bottlenecks.

Healthcare organizations no longer need to choose between price and performance. Falling flash storage prices combined with secondary economic benefits such as a smaller footprint, lower energy costs, and fewer servers to license mean that all-flash can be used for primary storage beyond only mission-critical health applications. In addition to the IT benefits — resiliency, durability, performance, and optimized virtualization — all-flash storage will help change how clinicians' practice because they will have faster access to health information and clinical insights than ever before at the point of clinical decision making. For most healthcare IT organizations, the decision is not whether to use all-flash storage, but which critical workloads will move to flash first.

To help address the medical challenges, the enterprise Imaging solution vendors including storage vendors need to find ways to manage Images and Data Better. That includes provide solution to improves reliability, performance & workflow, enhances speed & uptime, lowers TCO, reduces IT complexity, protects & future-proofs data.

3 USE CASES FOR CANADIAN REGIONAL HEALTHCARE ASSOCIATION

The Canadian health care system includes a diverse group of professionals and organizations; family doctors, specialists working in hospitals and community clinics, pharmacies, and diagnostic test facilities, to name a few. When Canadians receive care across the system our information has frequently become fragmented, leading to efficiency, quality, and safety issues due to disconnected care. Connecting health information has been an important foundation for improving the system and health care for Canadians.

Canada Health Infoway (Infoway) brings a pan-Canadian focus on improving the patient experience and health of populations, thus unlocking value for the health care system. Infoway is an independent, non-profit organization funded by the federal government and governed by its members, who are the 14 federal, provincial and territorial Deputy Ministers of Health.

Infoway's early investments in digital health were made around 'foundational' elements and included infrastructure and core clinical systems. These core systems store information electronically, including client and provider demographics, diagnostic images and reports in hospitals, profiles of dispensed drugs, laboratory test results, and clinical reports or immunizations. This set of information constitutes the individual components of an interoperable electronic health record (iEHR) system. Each Canadian province and territory have implemented such a system.

In addition to the iEHR investments, provinces and territories, regional health delivery organizations, hospitals, clinics, and ancillary health care partners have been deploying a range of technologies that support collecting, and providing access to, health information across the continuum of care. These organizations have invested in applications and processes that allow a wide range of stakeholders to access health information gathered from several sources both from within their point of care systems and using portals, messaging, and other means.

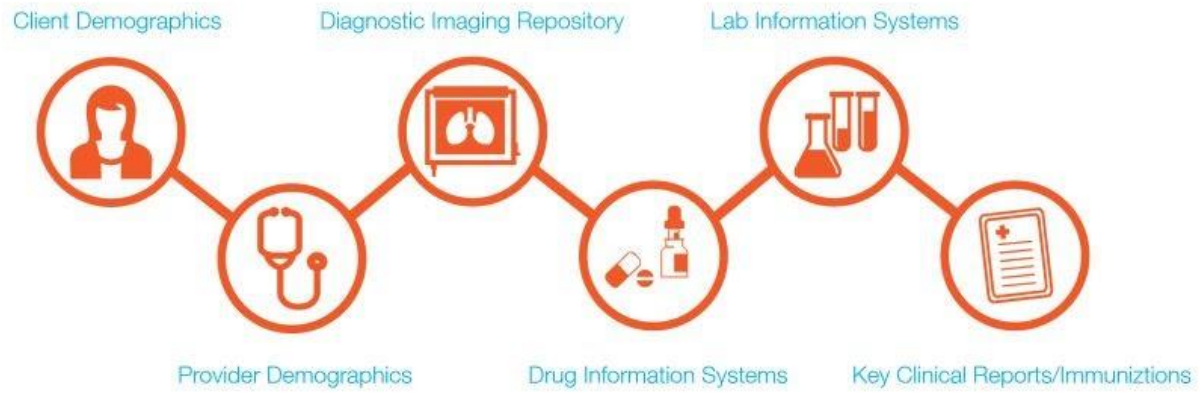

Figure 1. Components of the Infoway Interoperable EHR

Connected Health Information Landscape

Infoway tracks each jurisdiction's progress on availability of data in each of the six core EHR components individually (i.e., client and provider demographics, diagnostic imaging in hospitals, profiles of dispensed drugs, laboratory test results and clinical reports or immunizations), then uses the average of these values to represent the jurisdiction's overall EHR availability.

There has been significant growth in clinicians' access to connected health information over the past decade. As of January 2017, an estimated 301,000 health care professionals (more than half of all potential users) were accessing one or more sources for patient information in the iEHR (e.g., laboratory tests, diagnostic imaging, clinical reports, prescription information). Access to this information was either through regional systems or jurisdictional viewers that provide connected health information on patients.

This is a significant increase from 2006, when less than 20,000 health care professionals (less than 4% of estimated potential users) were actively accessing this information (Figure 2). The next 10 years saw a flurry of activity in connecting health information by all other jurisdictions, resulting in the significant growth of active iEHR users.

Jurisdictions have also been focusing in recent years on extending access to connected health information from acute care settings to community and long-term care settings. In addition, efforts have continued to extend the completeness and quality of the information making up the iEHRs as well as other solutions to give clinicians the information they need for patient care. Jurisdictions are now also turning their attention and investments toward increasing the utilization of these powerful information resources to transform

care management and delivery processes. This is being done to increase access, enhance quality of care, enhance population health outcomes, and manage costs.

A similar growth trajectory has taken place with Infoway funding digitization of physician offices and ambulatory clinics in Canada. In 2006, when digital health activities were just beginning in Canada, less than one quarter (24%) of primary care physicians were using EMRs. By 2017, EMR use had grown to 85% of primary care physicians. Investments in hospital information systems, pharmacy systems, and other provincial and regional infrastructure have similarly created conditions for successfully connecting health information.

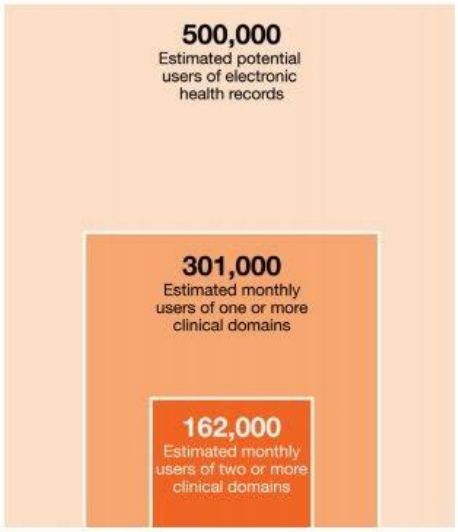

Figure 2. Active and estimated potential monthly users of electronic health records in 2017

Storage Use case for Infoway

Among all types of electronic healthcare records, the amount of storage needed for diagnostic Imaging Depository has increased the most due to the number and size of high-density medical images.

There is no doubt that as many hospitals started to migrate their PACS systems to enterprise medical imaging systems, due to the strong demand of enterprise level archiving/backup system, enterprise storage systems have found their new homes in the healthcare industry. This motivates storage vendors to come up with most advanced products and solutions that can meet the needs of the healthcare sector.

Take one example: the health care sector has high requirements for storage systems in terms of supporting critical applications such as the Epic EMR and long-term workload growth. The storage system is expected to support 800K+ IOPS per disk array with four controllers. The average read latency of Epic production Caché® is less than 2milliseconds. Many hospitals and clinics rely on the Epic EMR system for its clinical services. Service interruption would pose a great threat to patients' health and safety as well as the organization's reputation. Similar level of requirement is also on supporting PACS systems.

To meet healthcare provider's requirements, storage vendors should provide a complete solution based on these general configurations:

• For core services, all-flash storage should be used to provide ultra-high IOPS and ultra-low latency, ensuring a good front-end service experience.

• For NAS (Network-Attached Storage) requirements such as PACS (Picture Archiving and Communications System), all-flash NAS should be used to provide fast file access.

• Provides cost-effective hybrid storage for backup, enabling quick backup and long-term storage of massive data.

• With two data centers located at each of the two hospital sites, all storage systems should be constructed in active-active mode if possible, ensuring ultimate reliability

Typically, in a small and medium size hospital environment, one or few of these low-tier or mid-tier enterprise NAS storage systems should be well equipped to handle the workload and meet the expansion needs (similar to Huawei OceanStor T-series storage systems).

There could be needs for scale-out NAS storage systems that has even more storage capacities for larger hospitals and regional medical image systems like Canada Info Way. Government mandate from the regional level to store medical images for all patients from all hospitals within the region should create new use cases for these large scale-out NAS storage system (like Dell EMC Isilon™ or Huawei OceanStor 9000).

5. REFERENCES

1. HIPAA Rules
2. Canada Health Infoway
3. Perfect Imaging