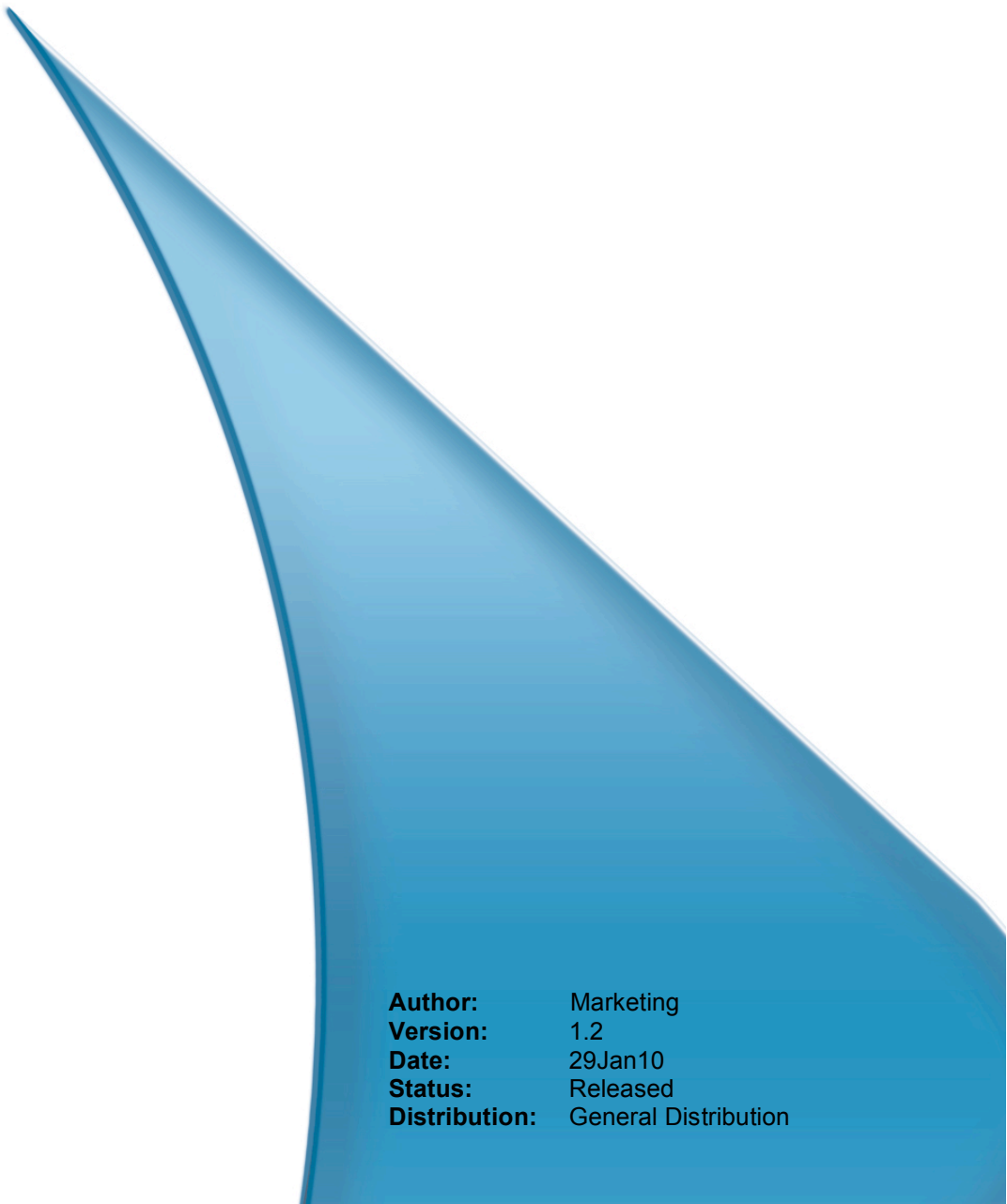




ACHIEVING A PACS-NEUTRAL ARCHIVE

Establishing PACS-Vendor and Storage-Technology Neutrality



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1 Abstract

What is a PACS-Neutral and Storage Technology Neutral Archive? Why should one consider a PACS-Neutral Archive? How does an organization achieve a PACS-Neutral Archive? This paper will answer these questions and discuss the challenges and nuances related to achieving this goal.

In an ever changing medical imaging industry, the challenge of implementing a departmental PACS solution has evolved. As more and more healthcare enterprises plan for replacement of their legacy departmental PACS solutions and associated storage hardware (either with a newer generation replacement sibling from the incumbent vendor or by a solution from a completely new vendor), organizations are faced with tough tactical and strategic decisions.

Tactically, organizations must:

- Determine how they can migrate their existing imaging data within a reasonable time frame and at an acceptable cost while ensuring all related imaging data is included and the integrity of that data is not compromised (i.e. presentation state, annotations, ROIs, etc).
- Ensure the acceptance of the new solution by the end-user community, which often proves to be a difficult challenge.

Strategically, organizations must:

- Leverage this moment of change as an opportunity to invest in a solution that will eliminate having to relive this same migration challenge 5 to 7 years into the future when the organization will once again be replacing the PACS which it is now planning to install.
- Consider the value of consolidating all medical image archives into one PACS-Neutral archive with a unified storage strategy. It is very rare for one enterprise to have only one PACS. Most have multiple PACS built around the unique requirements of the specialty area (e.g. radiology, echo, cardiology, endoscopy, cath lab, etc). Each PACS has their own unique archive, each requiring a separate archive migration when a PACS change is being considered.
- Envision the challenges of image enabling the enterprise EMR application. If medical image data is stored in each PACS domain, the customer must integrate the EMR with each PACS, and train the end users on the unique viewer associated with each PACS. These complications can add substantial time and cost to an EMR deployment. Centralizing image data in a single repository that can integrate with the EMR and present image data with a generic clinical viewer should be a strategic goal.

These tactical and strategic situations are compounded through the ongoing trend of consolidation across imaging centers and the merging of hospitals. These change trends further propagate disparate PACS, accentuate the need for strategic medical image archives and raise important questions. For example, how does an enterprise own, share, provide access and preserve their imaging data across multiple disparate PACS? Most times, the seemingly easy answer is to move forward with a “fork lift” replacement solution and enforce an enterprise PACS design across “all” departments. However, this approach is neither cost effective nor time practical. And it is not likely that one enterprise-wide PACS will satisfy all specialties and prevent future image archive migrations that involve substantially larger volumes of image data.

The reality is that investing in a PACS-Neutral Image Archive is a strategic decision that should be made at either the inception of a new PACS (green-field opportunity) or when a replacement PACS decision is considered. Doing so enables healthcare providers to own their imaging data so they can decide how to share, access and preserve their medical image data.

2 The Evolution of the PACS Archive

To appreciate the value of a PACS-Neutral Archive (PNA), it is helpful to understand the evolution of medical PACS. Over the past decade, most of the major radiology PACS vendors have acquired Cardiology PACS solutions, recognizing that managing imaging data was strategically important, regardless of departmental workflow challenges. Unfortunately, the acquired technology was significantly different from the incumbent PACS technology. Therefore, interoperability between the radiology and cardiology PACS solutions was not easy to attain. Listening to the market, these PACS vendors made significant investments in “integrating” their radiology and cardiology PACS solutions. “Integrating”, however, has been largely focused on the consolidation of the long-term archive. Some of these PACS vendors have been successful and the result has been the promotion of “enterprise DICOM archives”.

The concept of an “enterprise DICOM archive” is a significant improvement, but it actually doesn’t go far enough to address the strategic issues associated with long-term image ownership, sharing, access, and preservation across the entire healthcare enterprise. While PACS vendors have been busy integrating their own products, small and innovative companies have been busy building solutions to bring disparate PACS solutions together through an enterprise data management platform, a PACS-Neutral Archive. Apparent to the innovators developing this technology has been that the more representative need within the real market has been the requirement to connect disparate PACS solutions, independent of vendor.

There is nothing wrong with PACS vendors developing a technology and marketing a strategy that encourages healthcare organizations to invest in a single PACS vendor solution. However, if healthcare organizations choose to adopt a single PACS enterprise solution, they must address the following challenges:

1. A single PACS workflow solution across all imaging departments will most likely result in end-users dissatisfaction due to lost functionality and challenges related to the adoption of generic multi-department workflows.
2. Departmental and specialty physicians often prefer a specific PACS. There is not a single PACS solution on the market today that is accepted across all departments and specialties. The unique requirements of many specialties results in specialty PACS being implemented.
3. Preparations for the next long-term image archive migration should begin immediately because the need for an archive migration is inevitable. Ensuring that all of image data can be exported, including presentation state and annotations is an integral part of image migration planning. The expert knowledge of how to accomplish a successful image migration typically rests with the incumbent PACS vendor (aka: the vendor who’s PACS is being replaced). Accessing image data with a potentially non-cooperating incumbent vendor requires specialized third-party professional service skills, time and money. In many cases, when users are not able to access the “know how” skills to complete a complex image migration, key image data is forfeited.
4. A Single PACS vendor solution often dictates the storage technology that must be used and defines a proprietary interface that is locked into the PACS application. These vendor specific storage architectures preclude interoperability with other PACS vendors, increase cost and can compromise long term data preservation. They can also increase the frequency and expense of data migration by forcing customers to upgrade their storage hardware according to the support schedule of the vendor (not the customer).

A PACS-Neutral Archive solves these challenges not by replacing client-facing PACS workstations, but through interoperability and consolidation of long-term image archives across disparate PACS solutions. A PACS-Neutral Archive enhances healthcare enterprises’ current PACS investments and enables the propagation of best-of- breed departmental PACS

solutions. This neutrality can also extend to the storage hardware by providing an archive platform that is independent of the PACS application and the physical storage technology. Most important, the enterprise retains the ownership of its image data and can then establish the protocol for sharing and accessing image data.

3 Why customers buy archives from a PACS vendor

Most PACS vendors want to sell and implement their long term solution to every customer, typically offering the following reasons (possibly others):

1. Supportability – One vendor servicing the entire PACS (including the long term archive) is more effective and delivers better MTTR and MTBF.
2. Cost Savings – One vendor can provide more savings to the customer because of higher purchase volumes.
3. Integration – A single solution from one PACS vendor provides for better integration and more efficient workflow.
4. Optimization - A single vendor can optimize the performance and interaction between the PACS and the storage hardware.

While these reasons have validity, they can also be refuted:

1. Supportability – Long term image archives are comprised of software and hardware. The software is supported by one vendor, the hardware by another, and it is a rare situation when one vendor supports it all. Replacing the PACS vendor on the software support with a PACS- Neutral vendor is an even swap and enables much greater choice and flexibility.
2. Cost Savings – Most healthcare IT departments have preferred compute, network and storage vendor contracts that include attractive discounts. Allowing a customer to purchase their preferred hardware under their contracts will save money and typically will retire long term volume commitments. Competitive negotiations on long-term archive software and related software support will yield best market price and save the customer money.
3. Integration – Most “enterprise DICOM archives” supplied by PACS vendors use the same industry standards to move image data that a PACS-Neutral Archive uses: DICOM commands. If the PACS vendor states that there are additional “special” add-on values, the user should be concerned as this is a strong indicator that their “enterprise DICOM archive” is yet another proprietary solution.
4. Optimization – The PACS vendors are seldom experts on the long-term preservation of data and normally deploy storage strategies that are the simplest for them to support. This often results in a storage solution that is far from optimized, and is often better suited for short term retention and not long-term preservation.

There are other reasons why PACS vendors make compelling cases for customers to purchase their long term archive that they may not share with a customer:

1. Revenue (tactical) – Vendors make money selling long-term archive software (minimal), related hardware (lots) and on-going support and maintenance (profitable). Significant hardware revenue will motivate most vendor sales representatives who can then apply hardware sales to reaching sales quotas. And from a business perspective, more revenue, even if revenue with low profit (hardware), is good for revenue-challenged businesses.
2. Switching Costs (strategic) – PACS vendors are not PACS-Neutral Archive vendors. It is rare for a user to operate a PACS from “PACS vendor A” while using a long term

archive from “PACS vendor B”, when no PACS from “vendor B” is in operation at the customer site. In many cases, PACS sales representatives are able to convince the customer to migrate all image data from the incumbent PACS vendor’s long-term archive to the new PACS vendor’s long-term archive to ensure effective PACS vendor support. And, as previously noted, migrations are costly and time-consuming projects. Securing a PACS long-term archive is a strategically important sales goal because it virtually handcuffs the customer to a specific PACS or to the incumbent PACS vendor’s replacement product.

4 PACS-Neutral Archive Defined

New market demand is growing for PACS-Neutral Archives. “Enterprise DICOM archives”, as discussed earlier, are the response of a PACS vendor’s proprietary storage solution. A PACS-Neutral Archive is a vendor neutral and industry standards based archive solution with advanced management tools and key functions.

Understanding the value of the PACS-Neutral Archive begins with understanding the key features and functions of this new approach.

- **DICOM Storage** – Storage of imaging data in its native DICOM-standard format to enable the highest level of integration with disparate PACS solutions.
- **Enterprise Image Viewing Enablement** – A clinical viewer built on web technology to image enable the enterprise through a consolidated and simplified mechanism. No longer should an organization require separate web viewers for each disparate PACS solution.
- **Departmental Awareness** – Ability to associate imaging data to departmental origins to ensure duplication is not an issue, to enable updates of patient and exam information, and to simplify the next departmental PACS replacement .
- **HL7 Interface Support** – To maintain DICOM attributes relating to patient and exam information.
- **Storage Technology Neutral** – Not locked into proprietary storage hardware interfaces and are not required to purchase specific technology. This enables existing or new storage infrastructure and strategies to be leveraged, regardless of the vendor and solution.
- **DICOM Normalization** – Provide for the ability to harmonization image data when transferring images between PACS solutions to support DICOM attribute translation (study descriptions, exam codes, modality codes...), storage class conversion, compression, and the conversion of non-DICOM artifacts to DICOM.
- **Imaging Integration Workflow** – Provide advanced rules based image routing and pre-fetch workflow.
- **Accessibility** – Provide the support of DICOM Query/Retrieve requests from your existing departmental PACS solutions and the ability for an administrator to push data from the PACS-Neutral Archive to a newly installed departmental PACS solution or based on a physician’s request.
- **Watermark Management** – With human interaction and confirmation, provide the ability to identify imaging data that may be candidates for purging.
- **Patient Matching Support** – In conjunction with DICOM Normalization, provide the ability to manage or query for patient unique identifiers and update the appropriate DICOM attributes when moving images across disparate PACS.

- **Archive Management** – A PACS-Neutral Archive’s core competency is managing the storage and movement of images across disparate PACS solutions. With this competency, the solution should provide a comparable set of administrative tools for monitoring transactions, auditing DICOM normalization, browsing the archive, scheduling of DICOM sends, managing rules, and more.
- **Support of PACS Conversions** – When converting to a new PACS, it is most important that the PACS-Neutral Archive solution include those special utilities that enable users to inform the new PACS about patient image data that is already stored in the archive and is accessible to the new PACS. In some cases, the new PACS will need to be populated with image data from the archive for testing purposes. These tools make it much easier for enterprises to implement new PACS.

A subset of the features described above are likely available in PACS vendor provided “enterprise DICOM archives”. The ability to solve the complexities of disparate PACS integrations, however, is enabled through the additional features and functions provided by a PACS-Neutral Archive product. These key features enable ownership and deliver the ability to share, provide access and preserve imaging data across an enterprise, regardless of current or future PACS decisions.

5 DICOM Attribute Normalization

If a radiologist, cardiologist or other specialty physician was asked about the clinical outcomes he or she would like to see related to implementing a PACS-Neutral Archive, the list would likely include the following:

- The ability to access image data without the direct involvement of the PACS
- The ability for historical image data to be moved into the current PACS, without regard for the originating PACS, and have the imported study hang as a relevant prior by the current PACS
- The ability to proactively and systematically have historical images fetched to current PACS system, without regard to the originating PACS
- The ability to auto-route specialty procedures or procedures performed off hours to the most appropriate site, department, and PACS

To accomplish any of these outcomes, a consolidated view of the imaging data is required. This can be provided by implementing a PACS-Neutral Archives. Once a consolidated view has been attained, the ability to move the images from one PACS system to another is required. This feature is also standard across most PACS through the use of DICOM commands. However, once users start asking for the images to be imported such that hanging protocols may be appropriately leveraged, the need for DICOM Attribute Normalization is required.

In the most likely scenario, disparate PACS system dictionaries are not synchronized, resulting in a need to update certain DICOM attributes within each study to ensure the most appropriate hanging protocol is leveraged. For example, in order for certain hanging protocols to work effectively, study descriptions, modality types, body parts must be the same in both the source and destination PACS. The likelihood that two enterprises have coordinated these encoding protocols is low. Additionally, patient MRN and study accession numbers must be unique and given that the studies are coming from different systems, there is risk of conflict. If any of these concerns are valid, then DICOM Attribute Normalization is required as a product extension to a PACS-Neutral Archive.

To build on the concept of DICOM Attribute Normalization, more advanced features of some PACS-Neutral Archives will additionally be provided to convert Non-DICOM objects to DICOM, to compress imaging data, to convert storage classes, and in many cases, most importantly, custom converters for translating proprietary PACS vendor presentation state and annotations to standard DICOM.

6 Imaging Integration Workflow

Expanding on the clinical desires of disparate PACS integration, how does a healthcare enterprise organization implement an Imaging Integration Workflow? How does the organization gain the ability to route images to where staff is available off hours or the ability to route images at either a study or series level to a specialist when a particular procedure type is performed? Or, how does the organization gain the ability to pre-fetch historical images, regardless of the originating PACS, or regardless of where the images are currently stored hours before a procedure is performed to ensure physicians have the historical data that they need? These considerations — and others — are components of Imaging Integration Workflow.

Many systems available today support these types of workflows within their departmental PACS solution. There are few solutions available in the market today that enable intelligent routing and pre-fetching of imaging data across disparate PACS. And there are even fewer that support this functionality in combination with DICOM Attribute Normalization. As discussed earlier, it is this last nuance that ensures the imaging data is properly received and understood by destination PACS so that images are associated to the appropriate patient and hanging protocols may be leveraged.

7 Accessibility

How can a PACS-Neutral Archive simplify enterprise accessibility to your imaging data? Enterprise accessibility has two key attributes:

1. All patient image data regardless of department (e.g. rad, card, endoscopy, RF, dental, echo, wound care, etc) must be accessible from the enterprise EMR through the use of a single DICOM, web-based, smart-client, clinical viewer application.
2. All medical image data regardless of department must be viewable and accessible by any PACS system.

A PACS-Neutral Archive provides the consolidation imaging procedures performed across disparate PACS within the enterprise. With all image data now consolidated, a single clinical viewer built using current Web technology can more easily image enable the EMR. No longer are separate web viewer integrations required for each disparate PACS system. Secondly, with a PACS-Neutral Archive, the support of DICOM query/retrieve functionality provides another element of access that builds upon the sharing of data with routing and pre-fetching. Now, each disparate PACS system can obtain that desired enterprise view of imaging procedures.

8 Preservation

The physical preservation of images is a very important consideration to the long-term operation of an archive. This issue cannot be efficiently and cost effectively addressed through the exclusive use of magnetic disk storage systems as is advocated by many PACS vendors. This can range from simple RAID systems to more complex and expensive CAS (Content Addressable Storage) products. Designed for the storage of active data, magnetic disk storage systems have short lifecycles of three to four years, demand backup protection and the rewritable nature of the technology can compromise data authenticity. A storage-technology neutral archive enables a multilevel or tiered storage architecture that can

capitalize on the performance of magnetic disk storage, but also make use of the authenticity, capacity and longevity of optical and tape storage. A tiered archive architecture offers a much greater level of overall system resilience, provides the flexibility to tune performance, supports incremental capacity expansion and enables cost effective disaster prevention strategies. A storage technology neutral architecture decouples the physical storage hardware from the PACS. This approach allows the storage strategy to evolve independently which greatly reduces complex and costly artificially vendor dependencies while supporting the long-term preservation of data.

9 Support of PACS Conversions

With an understanding of the desired clinical outcomes of a PACS-Neutral Archive, the next question is how can a PACS-Neutral Archive prevent future long term archive migration challenges and lower the cost of switching to a new PACS in the future? PACS-Neutral and storage technology neutral Archives are inherently independent. Their embedded capabilities are designed for effectively managing an archive and with their accompanying toolset, a user has the ability to browse, filter, and perform image data moves using industry standard protocols.

With a PACS-Neutral Archive in place, an enterprises next departmental PACS replacement would be much simpler, as would the migration to populate the new PACS system with imaging data, in fact, it would involve the following simple steps:

1. Browse the PACS-Neutral Archive through an intuitive user interface.
2. Select 1 month of image data to be sent to the new PACS. Use this 1 month of image data for testing purposes.
3. Once testing is complete, clear the new PACS files, select the image data to be sent (e.g. all studies < 2 years) to the new PACS.
4. Schedule a send of the selected data starting with the most recent procedures, based on a flexible user defined schedule.
5. Modify DICOM attributes to conform to the new PACS standards during the send phase.
6. Maintain audit records of studies that have been sent to the new PACS
7. Physically migrate the content from the legacy storage hardware to the new archive platform.

Although there may be additional image data in the PACS-Neutral archive than what was selected to be pre-loaded e.g. (studies older than 2 years), the addition of pre-fetching functionality provided with a PACS-Neutral Archive ensures that relevant priors are sent to the new PACS when orders or on-demand requests are received.

10 Achieving a PACS-Neutral Archive – Summary

The evolving healthcare enterprise market is driving the growth of PACS-Neutral and Storage Technology Neutral Archives. Key market drivers:

1. **Own, Share, Access, and Preserve Image Data** – Image data, if archived in a PACS-dependent archive, is not owned by the user. Yes, the user has paid for it. However, access to the image data and sharing the image data are dependent on a) expert knowledge of the internal PACS and b) the relationship with the PACS vendor and c) their proprietary hardware interface.

The solution is image data stored in a PACS-Neutral Archive that can be shared and accessed in an open manner, using industry standard protocols, at the discretion of user.

2. **Archive Migration Cost/Complexities** – Users considering moving away from their incumbent PACS must address costly and time consuming archive migrations. The possible loss of critical image data just adds to user frustration.

The solution is to migrate the image data to a PACS-Neutral Archive. If you are going to migrate it once, ensure that you avoid having to do it a second time in the future. Partner with a PACS neutral technology vendor who can help minimize the loss of critical image data and provide a platform for preservation.

3. **Image Enabling the EMR Challenge** – Image enabling the EMR is complex and costly when dealing with multiple PACS. Complex integration testing involving all PACS vendors and the EMR vendor takes time. The challenge of training clinicians on the different GUIs of the different PACS viewers slows adoption.

The solution is a PACS-Neutral Archive and a single DICOM web-based clinical viewer.

4. **Storage Hardware Management** – The long-term preservation of data is highly dependent on the physical storage media and subject to the obsolescence and maintenance support of aging hardware.

The solution is to deploy a archive platform that supports multiple storage technologies independent of any PACS application.

Organizations who are considering changing PACS technology and/or vendor or who are considering an initial investment in PACS are encouraged to build a strategy that consolidates long-term image archiving as a prerequisite to selecting the replacement or new PACS technology.

Organizations that are challenged with an image migration project, should be partnering with a firm that has the expertise to migrate the data to a PACS-Neutral and Storage Technology Neutral Archive. Archive migrations are costly and time consuming, so the best approach is to migrate an image archive one time only.

When considering which PACS-Neutral and Storage Technology Neutral Archive will best meet organizational requirements, healthcare enterprises must ensure that they select a product family that includes the appropriate tools that empower self-sufficiency and reduce or eliminate vendor and technology dependencies.