IMPROVE PATIENT CARE AND REDUCE IT COSTS WITH VENDOR NEUTRAL ARCHIVING AND CLOUD STORAGE

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Abstract

The following paper opens with the evolution and challenges of medical image archiving. It continues by illustrating how Vendor Neutral Archive combined Atmos cloud storage enable healthcare organizations to break down PACS silos to reduce storage and archive costs, and provide secure, anywhere access to medical images on any device at the point of care.

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# Table of Contents

**Introduction** ................................................................. 4

**The Evolution and Challenge of Medical Image Archiving** .................................. 5
  - PACs Proliferation .............................................................................. 5
  - From Files to Objects: The Medical Image Archive .................................. 6
  - The Challenge of Archiving Images on File-based Storage ....................... 7
  - Object Storage: A Step Forward for Medical Image Archiving .................. 9

**The Value of a Vendor Neutral Archive** ............................................. 10

**EMC Atmos Cloud Storage Platform : The Right Fit for VNA** ....................... 11
  - Cloud Storage Architecture .................................................................. 11
  - Figure 5: EMC Atmos Cloud Storage Platform .................................... 12
  - Metadata-driven automated policies ..................................................... 12
  - Multi-tenancy for secure shared resources ............................................ 13
  - Instant access from any device ........................................................... 13
  - Federate to private or public clouds ...................................................... 14

**The Synergy of Vendor Neutral Archive and EMC Atmos Cloud Storage Platform** ...... 14
  - VNA and Atmos Deliver Financial, Operational and Clinical Benefits .......... 15

**Case Study: Kettering Health Network Improves Medical Imaging Flow** ............ 16

**Conclusion** ............................................................................. 17
Introduction

Who among us hasn’t been “in the tube” for an MRI or CT scan or in a radiology lab or dentist chair for an x-ray? There are over 800 million medical imaging procedures performed worldwide every year. That includes over 325 radiology procedures, over 60 million CT scans and nearly 30 million MRIs performed in the United States alone. The critical role of medical images for rapid diagnoses, error reduction and providing efficient, quality patient care is indisputable. Also indisputable is the need to securely and cost-effectively store this valuable data and make it accessible in real time at the point of care – wherever the point of care may be.

The explosive growth in the size and volume of medical images has exceeded even the most well-considered capacity plans. The scope of data growth, particularly image data, taxes even the most efficient IT departments. But storage capacity is not a new problem. Storage administrators are very experienced at provisioning storage and raw capacity. So, what makes the growth in medical image data a unique and more urgent issue? Simply put, it’s the scope of image data growth and the value of that data for improving patient outcomes and care delivery.

Healthcare IT leaders find themselves at the center of an IT transformation. In addition to their existing responsibilities for cost reduction, data security and compliance, they have new responsibility for pioneering ways in which big data can transform healthcare delivery and pave the way for true, personalized medicine. Healthcare delivery and payment reform, compliance mandates, and new requirements for collaboration, data sharing, and mobility are converging to create a perfect storm that is changing the healthcare landscape. To adapt and compete, healthcare organizations of all sizes and shapes need a new approach to medical image archiving that efficiently stores and protects Big Data and makes it instantly accessible from any device anywhere in the world.
The Evolution and Challenge of Medical Image Archiving

PACs Proliferation

The emergence of Picture Archiving and Communications Systems (PACS) transformed diagnostic imaging. Healthcare organizations were able to minimize film use and its associated development costs, eliminate processing chemicals and their disposal costs, and increase the speed of image capture and access. Each radiology department was also able to store all their image data in a secure, HIPAA-compliant database. Over time, however, the size and volume of image studies revealed the limitations of departmental PACS.

According to Enterprise Strategy Group, healthcare data storage will have grown 35% annually between 2010 and 2015. The largest increase being in medical imaging and electronic medical/healthcare records (EMR/EHR).

Figure 1: The Explosive Growth of Healthcare Data

Radiology, cardiology and other departments have implemented departmental PACS as the volume and value of diagnostic imaging has grown. In addition, the Health Information Technology for Economic and Clinical Health (HITECH) Act has served as additional incentive to adopt PACS. The result is a proliferation of departmental PACS that have created a host of new challenges:

- **Higher IT infrastructure and operational costs.** The sprawl of heterogeneous PACS has resulted in IT infrastructure sprawl. IT departments need to manage more servers, more client interfaces and more storage systems. And all that data needs to be secured and backed up. This necessitates complex backup infrastructure and more management tasks. And if a department wants to
migrate to a new PACS, it often means buying all new server and storage hardware and software.

- **Fewer budget resources for new initiatives.** The higher operational costs, which can be 80% of the budget, take away resources that can be used for new, strategic technology investments that can directly benefit hospital operations, workflows and the patient experience.

- **Proprietary data.** Image data is tied tightly to the PACS platform. That proprietary nature of departmental PACS makes it very difficult to share image data across department and modalities. Healthcare IT managers find themselves in a perpetual state of migration as departments upgrade or replace PACS.

- **Difficulty meeting standards for “Meaningful Use”.** Healthcare organizations that fail to meet Meaningful Use standards of EMR miss out on incentive payments today and risk financial penalties in the future. Department-specific PACS often have poor integration with EHR/EMR systems and lack many of the features, speed, and convenience required to support Meaningful Use of EMR.

- **Poor storage scalability.** Even in larger healthcare organizations that centrally manage storage resources, image data growth exceeds their ability to scale their predominantly file-based storage infrastructure that supports departmental PACS.

- **Complex workflows.** When data is tied to a particular PACS or modality, healthcare professionals need to view images on multiple viewers or multiple applications. More efficient processes mean less time interacting with equipment and IT systems, fewer errors, and more time spent with patients.

To get the challenges of PACS proliferation under control, many organizations have implemented a centralized image archive in their enterprise data center to offload image data from departmental PACS. However, there are different approaches for architecting a centralized image archive. The unique nature of medical image archiving makes it imperative to choose wisely.

**From Files to Objects: The Medical Image Archive**

Figure 2 illustrates how backup and archiving have evolved and how they will continue to evolve over the next several years. Archiving used to be a necessity (by law or other compliance mandates) and a method for moving older, seldom-used data to cheap storage. Today, the enterprise archive is a critical business asset. Specific to healthcare, the image archive has become indispensable as an information asset and critical to accurate diagnoses and error reduction. Archived image data needs to be stored securely and in compliance with industry regulations, but also accessible on-demand. Increasingly, healthcare organizations have turned to object, content-addressable storage platforms to achieve these goals.

Figure 2: The Evolution of Archiving
The Challenge of Archiving Images on File-based Storage

Many organizations, not just healthcare organizations, have relied on file-based storage for disk-based archiving. But archiving medical image data has exposed the limitations of file systems for archiving unstructured content such as medical images.

Figure 3 is a simplified illustration of a typical enterprise storage architecture utilizing two sites for redundancy. In this typical scenario, IT and storage administrators are heavily involved in provisioning storage resources for an application. For every request for storage, such as in the event of a new PACS, storage administrators need to find adequate capacity, create a drive letter, provision a file system, provision RAID and LUN and present that back to the application. Every single request needs to go through this process and the result is every storage resource has a direct, 1:1 relationship with its application. Consequently, every new application results in the creation of a new storage silo.
To further complicate matters, storage administrators also need to provision and manage replication and backup systems and processes. Typically, this involves the use of snapshots. The file system takes rotating snapshots of the data to a local disk throughout the day and the data is backed up daily. The applications and data are also fully replicated to a redundant, secondary site. Scale this to hundreds or thousands of applications and the problems only magnify:

- **Higher storage and operational costs.** The complexity inherent in this approach increases operational costs. IT needs to manage individual replication, backup and archiving schemes. Many file systems are limited to 16 terabytes (TB), meaning IT needs to provision more file systems and more hardware and software to meet data growth. Lastly, image data is still tightly tied to the PACS and underlying storage hardware, which makes it very costly to migrate data when upgrading or replacing PACS. The additional hardware and software needed to support the environment also need require more data center floor space and additional power and cooling costs.

- **Inefficient scale.** Because of the complexity and manual work, it’s very difficult to scale the environment. Every new application requires a repeat of the storage provisioning tasks listed previously.

- **Poor resource utilization and over-provisioning.** The fully redundant sites means the best outcome is 50% utilization. In truth, utilization is much lower. For example, since storage provisioning is such an onerous task, a department will request 2 TB of storage capacity for a new application, even if they only need 1 TB. And the storage administrators, also aware of how difficult it is to provision storage, will provision 3 to 4 TB to avoid having to provision more capacity sooner than anticipated. The result is 3 to 4 TB of storage dedicated to an application that only needs 1 TB. Repeat that over hundreds of applications and the costs add up quickly.
• **Increased risk.** The use of snapshots is commonplace, but can introduce risk in the case of medical images. If a file system is corrupted, rotating snapshots can result in overwritten or lost data. The amount of data that could be lost is significant. The average image size is 100 megabytes and there are approximately 3000 image studies per GB. If 3 TBs are lost, that can impact about 30,000 patient records. Imagine having to rescan 30,000 patients! Even if the data is recoverable from backup the downtime can have significant clinical impact. Inopportune data unavailability could mean rescheduling a procedure or an additional night in a hospital bed.

**Object Storage: A Step Forward for Medical Image Archiving**

The complexity and scalability concerns of file systems have lead many healthcare organizations to adopt a fundamentally different approach for medical image archiving. Content addressed storage (CAS) was pioneered by EMC with the launch of EMC Centera in 2002 as a storage platform more suited for storing and retrieving unstructured content, or, objects. CAS replaces the hierarchical addressing scheme of file systems with a flat addressing scheme (Exhibit 4). Data and its associated metadata are stored as objects. This fundamentally different architecture has had a profound effect on archiving in general, and on medical image archiving in particular.

**Figure 4: CAS and Object-based Archiving with EMC Centera**

Objects have metadata which is used to store, identify, locate, secure, and authenticate data. And every object has a unique digital fingerprint called a content address (CA). Applications don’t have to access the storage system to access data. The application only needs the address of the object. Regardless of where the object physically resides, the storage system can retrieve the data. This improves application and storage performance and enables multiple applications to use the same archive.

The bottom line is that object storage systems such as Centera, due to the nature of object storage and a flat addressing scheme can scale much more easily with much easier management and administration. Content authenticity is guaranteed and stored objects can be
accessed by applications via the CAS API. This removes the tight coupling of applications, operating systems and file systems tie data tightly to applications and increase cost and complexity. As evidence of this success of CAS, EMC Centera accounts for approximately 53% market share of storage systems used for medical image archiving.

There is a great deal of value in investing in CAS and modern storage infrastructure. For many, however, these investments alone will not address the long-term strategic challenges posed by the future of healthcare IT, new healthcare regulatory initiatives and the unending growth of image data.

Object-based storage, Centera in particular, has transformed archiving over the last decade. Centera excels at medical image archiving and compliance, but the growth in data and the number of PACS continues unabated. Healthcare organizations add more imaging centers to keep pace with demand, and consolidation through merger and acquisition results in larger hospital networks with dozens of dispersed departmental PACS. This growth creates new challenges that CAS alone does not fix. Faced with the need to consolidate and centrally manage a growing infrastructure, IT leaders look to their current suppliers; often these are file-based systems for departmental PACS.

Having had success with a CAS platform, however, it does not make sense to go back to file-based storage for medical image archiving. File systems still have the same limitations today they had years ago that prompted so many healthcare organizations to adopt object-based archiving in the first place. In addition, many PACS communicate with storage via the CAS API. Given these factors, CAS and object-based storage is still the right choice. However, healthcare organizations have new needs and new scalability requirements that necessitate a change. The good news is that there is a choice that preserves and builds on the advantages of CAS and object-based storage. Healthcare organizations are increasingly turning to Vendor Neutral Archive and cloud storage.

The Value of a Vendor Neutral Archive

A Vendor Neutral Archive (VNA), as the name implies, is a vendor-neutral and standards-based repository of medical images. A VNA enables a healthcare organization to consolidate multiple image archives into one standard DICOM image archive that can serve any PACS. The primary value of a VNA is that DICOM image data is no longer in a proprietary format tied to a particular PACS. It can consolidate PACS image silos and centrally manage image data. There are distinct advantages to a VNA:

- **Image sharing and collaboration.** A VNA can ingest DICOM data from any modality over a network connection and makes images accessible to any DICOM viewer or PACS.

- **Eliminate data migration.** Since data is in a standard, non-proprietary format, imaging department leaders can choose best-of-breed PACS without onerous data migration.
- **Integration with EMR.** A VNA makes it simpler for accurate medical images from multiple modalities to be part of patients’ electronic medical records. This has a direct impact on meeting standards for “Meaningful Use”.

- **Improve Information Lifecycle Management (ILM).** Consolidating PACS archives makes it easier to manage data centrally and apply information/image lifecycle management policies.

- **Improved PACS and image viewer performance.** By offloading infrequently used images from the PACS storage, a VNA improves the performance of each departmental PACS.

A VNA delivers image data portability and independence from departmental PACS and viewing applications. But a VNA is also vendor-neutral in terms of the storage platform used for storing and managing images. A true VNA enables the use of any storage platform. But that doesn't mean all storage platforms are the same. Far from it. To truly exploit the value and transformative potential of a VNA, healthcare organizations need a storage strategy and platform that addresses today’s tactical needs and prepares for a future of information exchange and collaboration enabled by private and public clouds.

**EMC Atmos Cloud Storage Platform: The Right Fit for VNA**

The EMC Atmos cloud storage platform builds on the foundation of CAS and object storage to deliver a cloud storage platform designed to store, manage, and protect globally distributed unstructured content at scale. Healthcare organizations have a choice of storage platforms for their VNA but Atmos is purpose-built as a cloud storage platform – whether private, public or hybrid - and provides key capabilities that efficiently store medical images and enhance the value of a Vendor Neutral Archive:

- Cloud storage architecture
- Meta-data driven automated policies
- Multi-tenancy for secure shared resources
- Instant access from any device
- Federate to private or public clouds

**Cloud Storage Architecture**

Atmos features a single global namespace that presents Atmos as a single system to applications and users. Atmos’ global namespace technology enables applications or individuals to simply call up an HTTP address to gain access to storage capacity. This is especially important when the infrastructure spans multiple sites and geographies. Regardless of the physical location of the storage resource, it is just an HTTP address away.
Rather than having a primary and secondary site with rotating snapshots and replication, Atmos is configured as an active/active system. The active/active architecture distributes objects across all nodes in the infrastructure. Rather than managing two redundant sites, IT manages the two sites as one system. There are no file system limitations or complex replication and backup schemes to manage. This means the environment can scale much more easily and results in more usable storage. IT can more easily manage a geographically distributed environment as a single system from a one management interface.

**Metadata-driven automated policies**

Atmos features customizable metadata to apply automated policies for data placement and lifecycle, protection methods, and efficiency. When certified for a VNA, the Atmos Policy Manager can apply policies based on the metadata embedded in the medical images by the VNA. DICOM tags can be passed onto Atmos from the VNA to enable Atmos to apply customizable, granular policies to automate information lifecycle management.

For example, a modality such as a CT scanner can apply DICOM tags to a medical image at creation that stipulates how that data is stored and accessed. Atmos can apply a policy that keeps that image in local storage for 30 days, then automatically archives to long-term storage or to a third party storage service provider for a set number of years.

Metadata also has a clinical value. Physicians and caregivers can access data based on metadata. Storage administrators can use listable metadata tags to easily index similar items. For example, a data query can examine the stored objects to find the one of interest. Healthcare workers could access all medical records from a specific patient or all patients diagnosed with heart arrhythmia or all patients with heart arrhythmia using an experimental anti-arrhythmic
medication. Data-driven, automated policies and the use of metadata help healthcare organizations manage medical images more effectively, reduce operational costs and can provide caregivers with better patient diagnoses and treatment information.

**Multi-tenancy for secure shared resources**

Atmos supports multiple tenants all sharing the same underlying infrastructure, while ensuring that all data is kept separate and secure. Unlike a traditional file system, the user has no knowledge of the physical location of their stored data (nor do they care). A large hospital or Integrated Delivery Network (IDN) can offer Storage-as-a-Service (StaaS); in effect, treating each member hospital or departmental imaging lab as a customer. Each modality, department, or hospital has a secure, virtual storage resource dedicated to them, but IT manages them through a single, global system.

Healthcare organizations can offer Archive-as-a-Service. IT can meter usage and provide self-service capabilities so individual tenants or applications can request additional storage resources on-demand. The Atmos data access API provides hooks directly from an application to the Atmos storage infrastructure. If an application requires additional storage, Atmos can provision automatically without IT involvement. If it is only a temporary need, the added capacity is automatically returned to the infrastructure and made available to another application. It’s efficient and eliminates over-provisioning and underutilization.

**Instant access from any device**

Atmos supports a broad range of access methods to support development and deployment of packaged or custom-built applications. In effect, Atmos is an application-agnostic archive. Many healthcare organizations will interact with Atmos through pre-integrated PACS applications. But they also have the option of using Atmos Web Services interfaces (REST and SOAP), which allow ubiquitous, scalable and full featured access to Atmos. The primary benefit is that healthcare organizations no longer need multiple viewers to access and see medical images.

Most of the Atmos VNA Partners use the Atmos REST API. Support for these web services protocols makes medical images stored in Atmos available to new Web-based and mobile applications. Access via mobile devices will become a more frequent use case as the point of care can be wherever the patient is.

In addition to REST and SOAP, healthcare organizations can also provide access to Atmos as a mounted drive via the Atmos Installable File System (Linux) and traditional file system interfaces like NFS (Network File System for Linux) or CIFS (Common Internet File System for Windows). Not only is Atmos the right architectural fit for medical image archiving but the use of traditional file system interfaces makes it a fit for consolidating multiple application archives and managing them as one single system.
Federate to private or public clouds

The rich policy management features of EMC Atmos enable healthcare organizations to federate their private cloud data with Atmos-powered public cloud service providers. For example, an image study may be old and of little further value, but compliance dictates that a hospital retain the data for an additional 10 years or, in some cases, indefinitely. The hospital can set a policy that automatically moves the image study to one of over forty Atmos-enabled cloud storage service providers. This gives storage administrators additional flexibility to store data in the most cost-effective fashion and according to policy. And they can do that while still managing both the private and public cloud resources as a single system.

In the longer term, this ability to federate to other Atmos-powered clouds will give healthcare organizations a head start at participating in private and public health information exchanges. An IDN can create competitive differentiation by virtue of an information strategy that facilitates information exchange, collaboration and efficiency that leads to better patient experiences and outcomes.

The Synergy of Vendor Neutral Archive and EMC Atmos Cloud Storage Platform

Figure 6 illustrates the synergistic relationship of VNA and EMC Atmos. Together, VNA and EMC Atmos enable healthcare organizations to not only reduce storage and archive costs, but to begin the journey towards a world of personalized medicine. The EMC Atmos cloud storage platform is optimized for VNAs so healthcare IT departments can provide secure, anywhere access to medical images on any device at the point of care. VNA and Atmos combine to deliver financial, operational and clinical benefits.
The synergies of VNA and Atmos manifest financially, operationally and clinically (Figure 7). Consolidating individual PACS into one system and multiple archive storage silos into one global archive reduce management overhead and the many manual tasks associated with proprietary data and traditional file systems. Atmos reduces much of the tedious file system management tasks and obviates the need for dedicated backup and replication systems. The result is that VNA and Atmos can reduce medical archiving total cost of ownership upwards of 30% in the following ways:

- **Application savings.** The VNA reduces application software costs by enabling healthcare organizations to reduce or eliminate departmental PACS applications and multiple image viewers.
- **Migration savings.** A VNA eliminates the dependency between image data and the PACS applications. Storage administrators no longer have expensive data migrations to execute when they purchase or upgrade a PACS.
- **Storage savings.** EMC Atmos healthcare customers reported that they’ve been able to increase storage density 3x. That translates to lower hardware and software costs, more efficient use of data center space, and reduced power and cooling costs.
- **Storage IT savings.** IT can simply offer archive capacity as a service to tenants within their organization. Gone are the manually intensive and costly tasks of provisioning storage and managing a complex, heterogeneous storage infrastructure.

The combination of VNA and Atmos make it much more efficient to manage image data from creation to the end of its useful life (EOL). Hospitals get more value out of existing PACS investments and can improve their performance as a result of offloading seldom-used PACS data from the image cache to the Atmos storage platform. Performance is also improved due to...
RESTful integration that allows certified VNA applications to initiate multi-threaded reads and writes to Atmos in parallel.

The cost savings and efficiency alone are motivation enough in many industries. However, healthcare is unique in that IT investments very often have to demonstrate direct clinical benefit. Together, VNA and Atmos consolidate and standardize medical image capture and accessibility. The bottom line is that VNA and Atmos are foundational to making every medical image study available anywhere on any device at the point of care with appropriate security controls. Better image accessibility and better information simply lead to better outcomes.

Figure 7: The Synergies of Vendor Neutral Archive and EMC Atmos

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<th>Benefits</th>
<th>Vendor Neutral Archive</th>
<th>EMC Atmos</th>
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| Financial – Reduce the cost of storing and accessing medical image data | • Consolidate individual PACS archives into one system  
• Lower TCO than heterogeneous PACS  
• Extend lifetime of existing PACS investments | • Single global namespace provides a more efficient, unlimited scale, modern storage platform  
• Automated backup and disaster recovery  
• Lower total cost to archive  
• Increased storage density = lower TCO |
| Operational – more efficiently manage image data and storage from creation to EOL | • Achieve sophisticated Information Lifecycle Management (ILM)  
• Leverage existing PACS investments and improve PACS performance  
• End perpetual migrations | • Meta data, policy driven clinical information lifecycle Management (ILM)  
• Integration of DICOM tags and Atmos meta data  
• Multi-tenancy to make storage available as a service  
• Federate to public cloud |
| Clinical – Image data available anytime, anywhere improves the patient experience and efficiency of care delivery | • Make image data available across departments and PACS  
• Integration with EHR/EMR | • Anywhere access to image data via REST, HTTPS  
• Meta-data driven data access  
• Federate and connect to future HIEs. |

Case Study: Kettering Health Network Improves Medical Imaging Flow

Kettering Health Network is a non-profit healthcare network covering the Dayton, OH area. With a network including 8 hospitals and over 60 other medical facilities 8000 employees and 1200 physicians and 1000 volunteers. Kettering grew from four hospitals to eight and needed their technology to scale in line with the increasing number of procedures and data they create.

Kettering set out to consolidate their siloed, proprietary PACs. As they were growing, they needed their information system to interact better with each other. Kettering had 3 radiology PACS and 3 cardiology PACS and creates a million image studies per year that need to be retained for 5 to 10 years. Their goal was to consolidate the multiple systems into one location and point their EMR system to that one, consolidated image archive. That way, physicians and other caregivers could access images without having a complex workflow that required 3 separate logins to get the data they needed.
Kettering chose VNA and Atmos cloud storage. Now, Kettering is able to get images quickly and securely into imaging and viewing applications, manage everything centrally, share those images across the environment, and provide a better experience to their 1200 physicians.

As further validation of the benefit of Atmos and VNA, Kettering acquired a hospital that had their own set of PACS systems. Kettering was able to migrate the acquired hospital’s systems and integrate them into the Atmos environment within six months. In addition, Atmos has been much less expensive to manage. As a result Kettering can keep data online that would have otherwise gone to tape sooner.

“We were able to provide images and drop their turnaround time from 8 hours to only a couple hours and often under an hour.”
William Hall, Imaging Applications Coordinator
Kettering Health Network

Conclusion

Individually, Vendor Neutral Archiving and Atmos cloud storage each have financial and operational benefits. VNA consolidates individual PACS archives into one system. EMC Atmos consolidates multiple file-based archive storage silos into one, global archive. However, the value of VNA and Atmos together is far greater than the sum of their individual capabilities.

Healthcare organizations and delivery networks can reduce the complexity and cost of their heterogeneous PACS environments and build efficiencies that make organic growth and growth by acquisition manageable and profitable. VNA and Atmos make IT more efficient and enable IT leaders to shift resources from tedious operational tasks to more value-adding technology initiatives aligned with their organization’s mission. VNA and Atmos facilitate information sharing and image availability across the organization and modalities to reduce costs, make caregivers more productive and improve the quality and safety of patient care. VNA and Atmos serve as a foundation on which to build healthcare clouds that facilitate the journey to truly personalized medicine.

To learn more about the Atmos product family, see http://www.emc.com/atmos