Evaluating Archive Solutions for Enterprise Image Management

This paper discusses various aspects that need to be evaluated when investing in archive solutions for enterprise image management. It provides a set of questions that will help you on your way when creating your requirement specification.

As healthcare processes become more oriented toward clinical pathways, rather than focused on specific disciplines or departments, a non-departmental specific image-management system – or vendorneutral archive (VNA) – across the enterprise is becoming a common solution. Such a strategy not only reduces life-cycle costs, but also provides a single point of access to patient data in a federated trust of departments/hospitals, without compromising patient integrity.

This document should not be treated as a complete VNA requirement specification,but simply as a set of questions that will help you on your way when specifying your own requirements.

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Capture

Any source, any SOP class

Maximum consolidation is reached through maximum versatility, so it is important that the solution has the capacity to digest medical images, film and sound clips from virtually any source.

To achieve maximum cost effectiveness, the import capabilities should be built on open standards as far as possible. But where standards do not exist or are not yet widely accepted, proprietary interfaces may be justified if their long-term value exceeds the extra cost.

Open standards - Cost-effective integration with DICOM, HL7 and XDS

The easiest and most cost-effective way to capture data from various systems is to use open standards and the IHE recommendations for integration.

»» Does the system support storage of all DICOM SOP classes?

»» How quickly can new SOP classes be added?

»» Does the VNA support DICOM Storage Commit for secure archiving?

»» Is it necessary for the VNA to supply the DICOM Modality Worklist service, to ensure minimum manual entry and highest quality of the DICOM header metadata?

»» Is there a possibility to configure automatic validation, cleansing and harmonization of incoming DICOM image tags?

»» Is tag morphing also possible for incoming HL7 messages and XDS objects?

»» How are changes to metadata handled? Will such changes be merged with the stored DICOM header upon export?

»» Does the VNA support multiple, differently configured HL7 connections?

»» Will HL7 metadata be consolidated with the DICOM header metadata? How will conflicts be handled?

»» What IHE profiles for storage are essential for your organization? What profiles have been implemented? If a profile is not fulfilled, is there an alternate solution?

»» Does the solution support modern initiatives, such as HL7 v3, IOCM, WADO, XDS-I and XDS.b?

»» How are systems managed that do not meet the latest standards? Are there legacy adapters available for older systems?

»» Does the VNA preserve private DICOM tags?

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Truly universal - Enterprise management of clinical multimedia from any ology

To gain full leverage from consolidation and economies of scale, all images, videos and other multimedia across the enterprise should be archived and managed in a single repository. Images from radiology, pathology, cardiology, dermatology, ophthalmology, dental, x-scopy, etc. should all go into the same VNA repository. To achieve this, it would be necessary to provide a means of capturing, storing, accessing and exchanging images and videos in non-DICOM formats. Having pathology included in the VNA strategy puts extra demands on the solution. It requires extensive capabilities for dealing with substantial amounts of data – approximately ten times the annual volume of radiology with single files being as large as 1 GB each. What non-DICOM formats will have to be imported, stored and managed (e.g. JPG, MPEG, etc.)?

»»Are non-image objects (e.g. PDF, ECG, text, etc.) required?

»» Does the VNA support the storage of files in their native format?

»» If so, how are these files available in viewers and presented to other systems?

»» Is there a need to capture video signals from equipment in e.g. endoscopy or the OR?

»» Is live broadcasting of video supported?

»» Is it possible to save snapshots by pressing buttons on an endoscope or a foot pedal in the OR?

»» What methods are supported for importing non-DICOM images?

»» What methods are supported for linking necessary metadata to non-DICOM images?

»» Do different departments require different metadata? Does the VNA support this?

»» What methods are supported for exporting non-DICOM images?

»» Is there a need to convert images and videos to DICOM format or to leverage from existing DICOM communication channels?

»» Will the VNA viewer itself view the non-DICOM images and videos, or will you need additional software on each viewing client?

»» Is there a need to convert images and videos to standard PC formats (e.g. JPEG and AVI) for use in presentations or teaching?

Store
Any storage, any strategy

A VNA is a long-term strategy, and significant changes will occur in the field of storage technology in the next 20 years. To gain leverage from new technology, and to optimize costs over time, the VNA should be able to handle any mix of storage technology from any mix of vendors. This gives full freedom to choose a set-up that best suits your strategy, today and in the future. A centralized enterprise image-management solution must also have sophisticated disaster resilience to ensure round-the-clock availability, 365 days of the year.

Scalable architecture – Hardware-neutral storage to handle data growth

A VNA needs to scale well to handle the large amount of information being stored. In addition, the amount of data stored in medical archives is increasing rapidly as higher resolutions and new technology are introduced. In a growing organization, this may be amplified even further by mergers and acquisitions.

It is thus imperative to establish a strategy for managing this growth. With a VNA that offers a generic interface toward any storage hardware, you have the freedom to mix and match and gain leverage from tomorrow's storage technology.

»» Does the VNA allow any mix of storage hardware from any vendors?

»» What standard interfaces are used by the VNA to connect to the storage?

»» If storage tiering is possible, does this require specific storage solutions (i.e. HP MAS, EMC Centera, etc.), or does it work independently on any storage hardware where the tiers are controlled by the VNA?

»» Does the VNA allow new storage to be added to utilize new technology innovation without system disruptions?

»» Are there any large archives based on the proposed VNA solution that demonstrate its scalability?

»» Does the solution leverage modern web-scale IT solutions as used by Facebook, Amazon, etc.?

»» What are the strategies for minimizing TCO for storage and computational resources?

»» Does the vendor have a long-term track record of growing the archive smoothly with new storage technology?

»» How many modalities can be connected?

»» How many PACS or other imaging systems can be connected?

Information lifecycle management - Optimizing cost, effectiveness and liability

Information Lifecycle Management, ILM, is a great way to improve the cost, effectiveness and liability of the medical image storage. It is often possible to decide rules for what images that can be discarded completely. Patient scheduling systems typically also provide the means to determine the likelihood that a certain patient's data will be accessed at a certain point in time. That way, the VNA can control what data should be available on faster or slower storage, balancing the demands for performance and cost efficiency.

»» Is it possible to configure separate retention policies for each data type, e.g. to handle pediatric and mammography data differently?

»» Is it possible to utilize stored clinical metadata, e.g. referring unit examination codes, in the ILM retention and purge policies?

»» Does the VNA allow cost vs. performance optimization by using tiered storage, where clinical metadata controls what tier the images should be in?

Software as a service - Offload the IT organization and maximize economies of scale

In an effort to leverage economies of scale to a completely new level many healthcare organizations are looking into cloudbased archive solutions. The web scale technology platforms used by Amazon, Facebook, Google and the like may be adopted by the VNA architecture, thus allowing multiple hospitals to reach higher resource utilization together. Software as a service solution also eliminates the need to worry about the technology life cycle management that an in-house solution would require. Cloud-based, long-term archival storage reduces the need for local IT expertise. In a cloud scenario, the responsibilities for maintenance, repairs and updates are moved to the vendor.

»» Is the solution available through the cloud as a service?

»» If so, is the cloud a public cloud solution, e.g. Azure, Amazon or such, or is it a dedicated private cloud with known physical location?

»» Is all traffic to/from the cloud solution encrypted?

»» Is all the data in storage encrypted at rest?

»» How are encryption keys managed?

»» How is patient privacy guaranteed?

»» Is the solution HIPAA compliant?

»» How many copies of the data are kept for redundancy? Are they kept in multiple physical locations with enough distance in between?

»» What are the SLA guarantees on availability?

»» What is the estimated speed of recovery from disaster in one data center?

»» What solution is used for virtualization and load balancing of computational power and storage?

High availability - Achieve maximum business continuity

Consolidating the archive takes the budget to a level where the solution can be made truly redundant with mission-critical status and a high-availability strategies in place for every single component in the chain.

»» What types of disasters must the system be protected from?

»» What would be the highest acceptable time to recover from a potential storage disaster and read from backup?

»» Does the system need to be designed without a single point of failure in all hardware and infrastructure components?

»» Will the system need to be mirrored in a different location for maximum disaster resilience?

»» Does the solution support software-based image/data duplication between disparate storage solutions?

»» In the event that a system component fails to operate, must the failover be automatic or is a manual process acceptable?

»» Does the supplier have experience in delivering mission critical systems?

»» Must storage mirrors be of the same type/brand, or is it possible to use different types/brands to achieve optimal protection against brand-specific issues, e.g. firmware update bugs?

»» Is there a built-in system monitoring toolkit that offers continuous control of the system status and can predict and report upcoming issues involving performance and/or availability?

»» What level of response should be required from the supplier's helpdesk in the event of availability-related issues?

»» Is scheduled downtime required for upgrades or service?

File formats - Maximum storage utilization and well-defined exit

For maximum cost effectiveness, the image data needs to be compressed without sacrificing image quality. With support for lossless compression, and by using an open standard such as DICOM to ensure the clinical context is embedded in the files, you will be well prepared when the entire VNA needs to be replaced. At that point, the file system may be traversed to achieve a cost-effective and rapid migration to the new storage solution.

»» Are all objects stored in DICOM part 10 format?

»» Can objects be stored in their native format?

»» How are objects in native format accessed and exchanged?

»» What compression method(s) are recommended?

»» What are the benefits or drawbacks of the compression method?

»» How good is the storage utilization, i.e. are multiple representations of the same image required or are images stored as single lossless compressed files?

»» If changes to metadata are stored in the database and not in the files, can the supplier guarantee that the changes are written to file at the time of exit?

Access and exchange
Any image, anywhere, anytime

A fundamental requirement of a VNA is that it facilitates access and exchange across. The link from the archive to diagnostic workstations is extremely important to achieving high performance. Prefetching, tag morphing and other proprietary mechanisms may improve usability even further for radiology, pathology, cardiology and other diagnostic imaging disciplines.

And enterprise-wide access to all stored multimedia can be facilitated with a universal viewer reachable straight from the EPR.

EMR integration - Universal web viewer

A cost-effective strategy for bringing images to the entire enterprise of physicians is to implement a single point of integration between the VNA and the EMR. Improved access is achieved while significantly reducing architectural complexity.

»» What are the necessary features of the universal viewer?

»» Can the viewer display or provide access to all of the content of the VNA?

»» Is the viewer capable of rendering PDF documents, MPEG videos, JPEG images, DICOM images, pathology whole slide images, etc.?

»» Is video streaming available?

»» What level of integration between the universal viewer and your EMR can be proven?

»» How well suited is the viewer for enterprise deployment, e.g. zero footprint HTML5 or mechanisms for easy installation on a vast range of computers?

»» Can content notification be sent to the EMR when images exist?

»» Is the universal viewer built on technologies that facilitate multi-site workflows across wide-area networks, enabling waiting times to be kept to a minimum even when working from home or when viewing large data sets?

»» Is the viewer an XDS consumer?

»» Does the viewer have mechanisms to push images to your local PACS?

»» Does the viewer provide easy search mechanisms with full indexing of all informatics, e.g. reports, HL7 messages,

DICOM tags, etc.?

»» Is the database an integral part of the VNA, or does it have a database or image cache of its own, that require storage or could lead to inconsistencies?

»» Is there support for tablets?

»» Can the mobile viewer upload images captured by the tablet?

PACS integration - Front-end flexibility

Separating the image storage (VNA) from the diagnostic image display and workflow solutions (PACS) has important implications. One highly positive feature of this layered architecture is that it allows replacement of a PACS without image data migration. On the other hand, you lose the proprietary client-server protocols that guarantee high performance, metadata consistency, etc., and these issues must be managed.

»» What protocol(s) may be used by the PACS to access data in the VNA?

»» Is the solution WADO RS compliant, with single image requests or even range requests for maximum performance?

»» Do the existing PACS have the capabilities to prefetch from a VNA to its local cache?

»» If prefetch is controlled by the VNA itself, what parameters may be used to create rules for determining what to prefetch (it is probably not meaningful to prefetch all the data for a certain patient).

»» Will there be a need to handle any number of ID domains? If so, how will this be handled?

»» Are there any metadata fields that must be modified for the PACS to accept them or work with them?

»» Should this metadata be modified by implementing a global policy that all connected PACS must follow, or by implementing and maintaining tag morphing that knows how to change metadata to suit a certain receiver?

»» How will changes to metadata be stored and reflected in the PACS?

»» Should all the images in the existing PACS archives be migrated?

»» How long will the migration take, and can a good workflow be achieved during this process?

»» What protocols are used between the universal viewer and the VNA?

»» If the various PACS have different MRN domains, how is this handled?

Patient privacy - Data security in a collaborative digital environment

In today's modern e-health workflows, more and more information is available in digital form and shared via networks to ensure that physicians have access to all relevant information when making clinical decisions. This creates a potential threat to the patients' integrity which must somehow be managed.

»» Does the system create an audit trail compliant with IHE ATNA on user level for all access via supplied viewers?

»» Are the audit log files secured to avoid tampering?

»» Maximum protection on mobile devices is achieved by not caching any patient information. Is this the case, or is the data protected through encryption?

»» Is all traffic between the universal viewer and the servers encrypted?

»» Are there any mechanisms available to ensure user audits or other security measures in the link between PACS and VNA?

»» What parameters are available to create logical security domains so that users and user groups only have access to certain information?

»» Does the system have a patient consent concept for unlocking sensitive information based on the patient's explicit consent?

»» Is it possible to federate authentication and authorization by integrating to external services?

»» Does the system support LDAP, making it possible to utilize an existing Active Directory for user maintenance?

»» Does the system support single sign-on using SAML tickets?

»» Is there a user-friendly interface for searching the audit trail to see what a certain user has accessed, or what users have accessed a certain medical record?

»» Is WORM storage supported (for maximum virus protection)?

»» Can you use the anti-virus software you are currently using for the rest of the enterprise?

Cross-enterprise sharing of documents - Improved collaboration across organizational boundaries

A VNA in itself is a platform for sharing data between the connected front end systems (PACS, modality workstations, etc.).

However, for interconnection between several large sites and for external communication with other VNAs, access to a centralized registry will result in fewer queries between systems to give a quick overview of all available cases for any given patient. The ultimate goal is easy access of all data throughout federations of trusted hospitals.

»» Are patients in the region likely to have data stored in other external systems, whereby the patient would benefit from doctors gaining a comprehensive view?

»» Are there any ways to restrict certain information from being shared? How is this done?

»» Is the design based on XDS.b / XDS-I.b or some other technology?

»» Does it contain an XDS repository and registry?

»» Is it XCA compliant to connect with other XDS registries?

»» Are there any limitations as to what VNA data can be shared?

Data mining - Management decisions based on facts

The drive toward a higher throughput at a lower cost requires finding and removing bottlenecks in the system, which entails sophisticated business analytics. The ability to slice and dice the information in your image storage any way you please will make it possible to discover trends, measure KPIs and continuously ensure the most efficient utilization of resources. The challenge is how to provide access to the data, while at the same time avoid jeopardizing the system availability.

»» What KPIs are necessary to measure today?

»» Does the solution provide the means to create your own custom reports to visualize any available data in a graphical design?

»» How does the system guarantee that custom data mining queries do not affect the production system performance or availability?

Solution elasticity
Supporting organizational growth and acquisition strategies

Many healthcare organizations face mergers and acquisitions, raising demands for both sharing and migrating data. In the long run, the decision is often to centralize into one VNA and one PACS solution, but in the short term that might not be possible for different reasons. In other words, you need a strategy in place for both data migration and, in the short term, for efficient means of sharing data between different systems.

»» Which tools and processes does the vendor have in place?

»» How can the vendor enable the same performance and quality of service during migration as during normal operations?

»» What tools or possibilities are there for migration of DICOM and non-DICOM data?

Future proof
Making it all work in real life

Some things can look fantastic on paper, but fail to deliver in a real installation. This has more to do with the vendor itself than the product. To avoid any nasty surprises, it is best to assess the vendors' capabilities in the medical imaging domain, as well as their reputation when it comes to living up to promised functionality and developing their platforms as technology evolves.

In fact, this is more important for a VNA than a PACS, since there is an underlying assumption that a VNA will outlast the average lifespan of a PACS. For such a long-term investment, the future direction of the system is probably even more important than what the product can do today.

»» Do you have any working relationship with the vendor?

»» Does the manufacturer have PACS in their portfolio so they have good understanding of clinical end user workflows, or do they only have VNA solutions?

»» Does the vendor have a long-term track record indicating how your system might evolve with technology without forklift upgrades?

»» Does the vendor support you in the event you would want to switch vendors at end of your contract, not only through technical features but also with processes and contractual agreements?

»» Have there been any major changes in R&D lately?

»» Has the vendor won any significant new business near term that indicates the companies commitments in VNA?

»» Does the vendor have a stable long-term financial position?

»» Does the vendor have a stable ownership structure?

»» What are the current delivery capabilities?

»» What is the vendor's level of experience in deploying VNA solutions?

»» Does the vendor have any major implementations that prove its capabilities?

»» What is the quality of the vendor's support services? Are response times guaranteed?

»» Are the vendor's support services (including phone support) located in your country?

»» Does the system have automatic monitoring that will notify system administrators or a helpdesk if hardware or software malfunctions?

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