WHITE PAPER

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Understanding the A-D-Ds of Image Lifecycle Management

Managing images from acquisition to dissemination to disposition

Abstract

Clinical imaging plays a crucial role in healthcare today. As a diagnostic tool, it's key to confirming disease, and it's also useful for documenting the course of disease. Clinical images are used to monitor care and response to treatments. At the macro level, aggregated medical imaging is also used in population studies to improve public health and prevent disease.

An enterprise imaging system centralizes patient data—images, reports and other information—so IT can effectively store, manage and secure that data and make it available for clinical use.

But managing volumes of medical imaging data over an extended lifecycle is a challenge. Best practices in image lifecycle management (ILM)—what we call acquisition, dissemination and disposition (A-D-D)—can help. Images are acquired, disseminated and then disposed of—archived or deleted—as needed, based on a policy-, process- and practice-driven approach that aligns the value of imaging information with appropriate IT tools, systems and infrastructures for the useful life of that data.

Together with ILM, new technologies are providing a framework for effectively securing, storing, managing and moving medical images, while balancing the needs for access and cost efficiency.

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The PACS evolution and changing imaging informatics

Healthcare data will grow faster than any other sector by 2025 due to "advancements in healthcare analytics, increasing frequency and resolution of MRIs, and other image and video-related data being captured in today's advanced modes of medical care."[1]

In fact, healthcare data will top 2.3 zettabytes by 2020 and is one of the fastest-growing segments of the digital universe, growing at 48 percent per year compared to 40 percent for the overall digital universe.[2]

And medical imaging accounts for more than 70 percent of clinical data and continues to add many terabytes of new data each day.

Clinicians require immediate, secure access to this image data to quickly and effectively diagnose and treat patients.

Today, most healthcare organizations run on picture archiving and communication systems (PACS)—and many of the top PACS companies have rich histories in film and imaging. While PACS and other imaging systems have made a profound impact on healthcare on a micro level—for example, producing crisp, clear radiology images and film—there are serious limitations on a macro level.

One longitudinal online observational study captured the perspectives of PACS professionals through LinkedIn discussion groups.[3] The authors wrote that:

> "PACS implementation is marred with many issues such as difficulties in integrating multiple PACS units both within and between hospitals and integrating PACS with other hospital systems, limited storage capacity, accesses issues—e.g., synchronous, multiple and remote access—and solutions for backup and recovery, and problems in data migration."[4]

That there are continuing limitations with PACS is hardly a surprise. In 2005, Professor Heinz Lemke, recognized as the author of one of the first publications to describe the concept of PACS back in 1979, said that "computers and communications in the scanners generate vast amounts of data, so we need more computers and communication systems to process the data and display the images to radiologists and other clinicians. This is a never-ending process."[5]

This white paper explores how new technologies, along with PACS, can provide an IT framework for effectively securing, storing, managing and moving medical images over an extended lifecycle, while balancing clinical needs for access and care outcomes.

[1] *"The Digitization of the World From Edge to Core," IDC, #US44413318, 11/2018.*
[2] *"The Digital Universe Driving Data Growth in Healthcare: Challenges and Opportunities for IT," EMC Digital Universe/IDC, 2014.*
[3] *"Limitations in and Solutions for Improving the Functionality of Picture Archiving and Communication Systems: An Exploratory Study of PACS Professionals' Perspectives," Journal of Digital Imaging, Volume 32, Issue 1, pp 54-67, 02/2019.*
[4] *"Room for improvement: 6 key issues with today's PACS," RadiologyBusiness.com, 09/18/2018.*
[5] *"History validates PACS' contribution to radiology," DiagnosticImaging.com, 04/15/2005.*

The clinical imaging environment today

Enterprise imaging remains a catalyst for advancements in health IT, and the future of healthcare relies on effectively managing imaging and other data. Yet many healthcare organizations continue to lag behind other industries in the next-generation technologies that can help them effectively harness their data to better diagnose, treat or cure disease. Challenges include:

- **Growing data sets.** As previously mentioned, healthcare—and, in particular, imaging—data is growing exponentially each day.

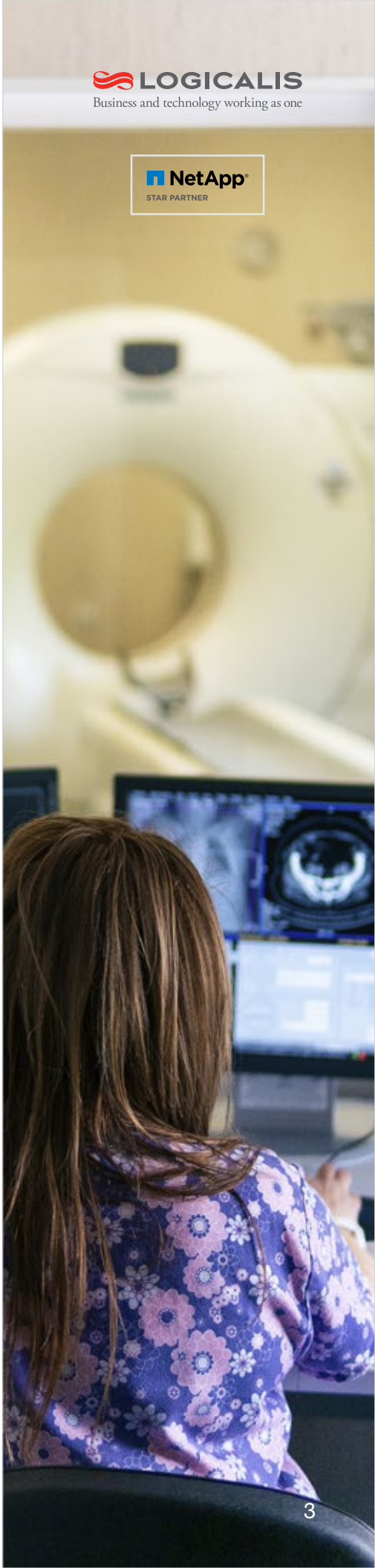
- **Siloed data.** While radiology and cardiology services dominate the production of images, the other "ologies"—cardiology, pathology, dermatology, neurology, oncology, etc.—are quickly catching up as the value of imaging increases. These units often have their own PACS or other imaging systems that may not play well with others.

  In addition, healthcare continues to undergo a record number of mergers and acquisitions. While 2017 was considered a banner year, M&A activity in 2018 was up 14.4 percent over 2017.[6] M&A deals bring their own challenges with imaging data, including system interoperability.

- **"Value-less" data.** The volume of imaging data continues to skyrocket with increasingly complex imaging done more frequently. But merely producing volumes of data doesn't necessarily give it value unless the proper infrastructure is in place to make the data useful. Realizing the value of data for more efficient workflows and better patient outcomes—or even population studies—requires digital platforms and applications for managing and analyzing this data.

- **Lack of standardized processes.** Each specialty area acquires and uses images differently. For example, cardiologists generate their own images based on patients' needs, but radiology generates images based solely on doctors' orders. These orders go into the radiology information system (RIS) and, once images are captured, they're sent to a PACS for viewing and storage. Cardiology images may never leave the cardiology department, let alone find their way into patients' electronic health records (EHRs). Medical imaging in newer care areas like dermatology typically do not have any image management workflows and lack the ability to establish them using existing methodologies from radiology or cardiology. This lack of standardized processes leads to complex, often ad hoc, workflows.

[6] *"PwC Deals: US Health Services Deals Insights Year-end 2018," pwc.com, 2019.*



- **Workload bottlenecks.** More complex imaging being done more frequently is increasing the need for interpretations at a time when radiologist burnout and shortages are at an all-time high. In addition, older radiologists are retiring and newer radiologists are adopting more flexible work schedules—or only specializing in certain modalities—which also contributes to workload bottlenecks.

- **Multiple image formats.** While radiology departments use the Digital Imaging and Communication in Medicine (DICOM) format to view, store and print medical images, other service lines generate clinical information in multiple non-DICOM formats, including PDF, MPEG, JPEG, PNG and others. These non-DICOM objects cannot be stored by PACS or VNA systems without the ability to support XDS (cross-document sharing), which has become the standard for handling non-DICOM objects. Since most image-enabled imaging systems store only traditional radiology and cardiology images, these non-DICOM formats complicate the problem of creating a comprehensive EHR, inclusive of imaging, for the clinician.

- **Fast-evolving innovations.** Finally, there's a growing reliance on imaging data to fuel artificial intelligence (AI), machine learning and analytics—as well as rapidly advancing innovations on the horizon—to improve patient outcomes and contribute to precision medicine.

To overcome these challenges and effectively harness and use image data to diagnose, treat or cure disease requires enterprise strategies for image lifecycle management. As researchers recently wrote:

> "It is essential to enable an ordinary confluence of data towards centralized repositories; such Big data should be enriched with proper clinical annotations and released with full awareness of the patient, who should be placed at the center of the diagnostic workflow."[7]

[7] *"The Challenges of Diagnostic Imaging in the Era of Big Data," Journal of Clinical Medicine, 2019, 8, 316.*

The rise of DIAM and EMRAM

With the move to value-based care, worldwide organizations have collaborated to create an infrastructure framework to support an enterprise imaging strategy.

Developed by Healthcare Information and Management Systems Society (HIMSS) Analytics—with the support of the Society of Imaging Informatics in Medicine (SIIM), the European Society of Radiology (ESR) and the European Society of Medical Imaging Informatics (EUSOMII)—the Digital Imaging Adoption Model (DIAM) is an eight-stage (0–7) adoption model. It provides "guidance for imaging and IT experts to identify and adopt the right digital strategy and improve health outcomes for patients."[8]

For example, those at DIAM Stage 0 have no or limited electronic image management, while those at Stage 7 have adopted advanced imaging analytics, clinical decision support and value-based imaging, and external image exchange and patient engagement. For most healthcare providers, there's clearly much to be done.

HIMSS Analytics also developed the Electronic Medical Record Adoption Model (EMRAM), an eight-stage (0–7) model that "harnesses technology to support optimized patient care, reduce medication errors, improve operational throughput and achieve a near paperless environment."

While EMRAM deals primarily with the EHR, it was completely revised in 2018 to increase the significance of medical images. Where the previous EMRAM version had "PACS – Radiology, Cardiology and storage of patient DICOM images" at Stage 5, the 2018 version now has it at a much earlier Stage 1. In addition, all organizations that were previously certified at Stage 5 and lower must now recertify, which makes an enterprise imaging strategy that much more critical.

These significant advances in enterprise image management call for a greater need for image lifecycle management (ILM).

What is image lifecycle management (ILM)?

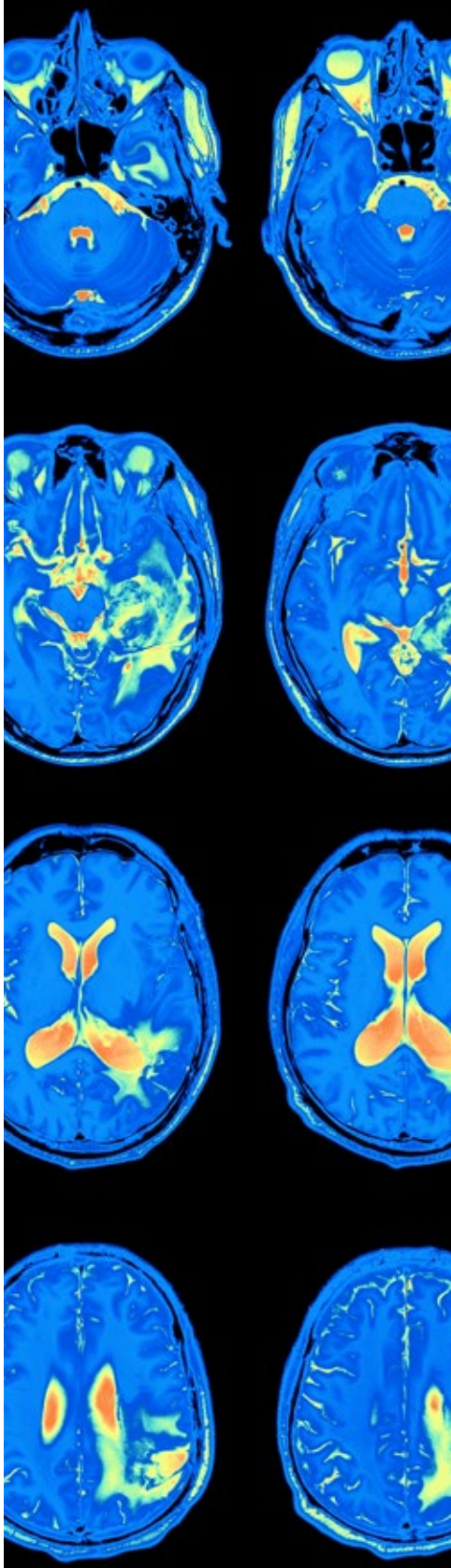
Many healthcare organizations have ignored the need for meaningful image lifecycle management (ILM). Siloed or outdated storage technologies make accessing images difficult, so it's difficult to establish ILM policies. There are also misconceived beliefs about storage that have contributed to the lack of innovation.

As storage capacities increase and new technologies like cloud are introduced, understanding the technology and benefits of choosing the proper storage tiers for the lifecycle of the image becomes even more important. Yet most healthcare organizations have a single storage tier and don't delete studies for 20 years, which makes it difficult to effectively manage the lifespan of the study, as well as the cost associated with keeping that study secure and accessible.

As IT budgets continue to shrink, data volumes continue to grow, and reliance on and the value of data continue to increase, establishing an enterprise imaging strategy with meaningful image lifecycle management now is more important than ever.

ILM is about setting and enforcing policies that govern how long image data is stored, how cost-effectively it's stored and when it can be archived or deleted. It also requires an understanding of the business value of clinical image information and how that value changes over time. In other words, a good ILM framework considers not only the expected data lifecycle, but the data characteristics needed for successful data management.

[8] DIAM datasheet, HIMSS Analytics, 2019.



Considerations for an ILM Framework

ILM is a policy-, process- and practice-driven approach to aligning the value of imaging data with appropriate IT tools, systems and infrastructures for the useful life of that data. With an ILM framework, IT organizations can appropriately acquire and ensure the accuracy of the imaging data, disseminate and make them available for clinical use and dispose of that data in accordance with their retention policy.

There are typically three stages:

Acquisition. The first stage occurs when new images are captured, so it's important to ensure that the imaging data is as accurate as possible. The data is entered into the PACS, which uses a store-and-forward model. Images reside permanently on the VNA, enabling fewer backup strategies and EHR integrations. Archiving to ensure redundancy may also take place at this stage.

Dissemination. At this point, accurate, real-time imaging data is made available for use by clinicians and others outside the system and, if using a VNA, integrated into the EHR. This data is validated and actively managed and maintained for use.

Disposition. In this last stage of the lifecycle, imaging data is retained or destroyed based on its classification in the previous step. How long data is retained before being destroyed depends on your own governance policies, industry standards and a full understanding of state and federal regulations. Because regulations change often, you may want to revisit your guidelines for destroying imaging data every 12 to 18 months to ensure compliance.

The ILM framework: Acquire, Disseminate, Dispose (A-D-D)

The ILM framework is a largely circular process that doesn't necessarily have a closed loop (i.e., image deletion). Images are acquired, disseminated and then disposed of—or put away—as needed. For example, archived images can be acquired from less expensive storage and disseminated for use in a population study before "disposal" in an archive. After a specified length of time, images may then be disposed of (deleted) altogether.

The rules that govern this process are part of the ILM framework. With an ILM framework (or governance) in place, organizations can begin to consider an enterprise imaging system that centralizes patient data—images, reports and other information—so IT can appropriately acquire, disseminate and dispose of that data and make it available for clinical use.

ILM considerations for imaging

But getting to governance requires consideration of the process that images take throughout their lifecycles. Some questions to ask include:

- **What will the images be used for?**
- **Who captured them?**
- **How long do they need to be retained?**
- **What compliance requirements need to be considered?**
- **Who needs access to these images?**
- **How quickly do they need access?**

In addition, healthcare providers with M&A strategies also need to consider whether the organizations they're acquiring already have an enterprise imaging strategy and how that—along with their images—will be folded into the new organization.

Consider some of these use cases:

- **Clinical review.** To appropriately care for patients in the present, images must be stored for up to two months so clinicians can instantly access them. These images require faster, costlier storage media.

- **Prior cases.** Different pathology benches will retain prior cases for varying amounts of time. For example, in high-volume dermatopathology, pathologists are less likely to view prior cases than surgeons in transplant cases, where prior cases may be needed for two to three years. Pathologists may be satisfied if prior images are available in four or five minutes. In many cases, regions of interest inserted into the report may suffice for future reference.

- **Education and research purposes.** For training and research purposes, specific cases may be flagged for indefinite retention and immediate access.

- **Legal or regulatory reasons.** Like ILM policies in radiology, the average case may be kept for seven to 10 years, although regulatory requirements vary from country to country. These cases may be retrieved only rarely, if ever, and could be stored on very slow storage media.

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What keeps healthcare organizations from implementing an ILM strategy?

For a variety of reasons, many healthcare organizations have yet to undertake an ILM strategy or have only taken partial steps to developing a strategy. Though it's an ultimately valuable process that can streamline clinical workflows and enable better patient care, it's not an easy one. Some of the issues that keep healthcare providers from pursuing an ILM strategy include:

- **Fast-growing data volumes.** Growth of image-related storage consumption outpaces the ability to efficiently scale to meet growing data demand.
- **Out-of-compliance legacy systems.** Outdated and proprietary imaging systems cannot effectively meet the growing requirements for patient privacy and HIPAA compliance.
- **Lack of data labeling standards.** Image-related metadata fails to adequately provide the tags needed to properly identify and filter studies eligible for deletion, research and other uses.
- **Limited adoption of public cloud solutions.** Historically, healthcare organizations have been skeptical about the ability of public cloud solutions to adequately protect patient data, thus slowing adoption. They wanted not only full control of data, but the freedom to store and move data between storage environments.
- **Lack of enterprise storage strategies.** Many healthcare institutions lack comprehensive storage strategies, including cost-effective solutions for long-term retention.
- **Security concerns.** Related to concerns about the public cloud, healthcare organizations fear that new systems will impact the security of patient data.
- **Inability to leverage data.** Research, analytics, machine learning and AI initiatives rely on large data sets with high integrity, which goes against the tendency of most healthcare organizations to delete images they "no longer need."
- **Lack of lifecycle management tools.** Finally, because most organizations lack data lifecycle management strategies, there are generally minimal or no management tools in place.

Today, the goal is to centralize all PACS images from across the enterprise within a single vendor-neutral archive (VNA). Images can then be centrally secured, accessed, stored and managed for use by next-generation technologies to drive healthcare innovation.

Lay the foundation for next-generation technologies

Because it's one of the richest and most complex sources of patient information, medical imaging has historically driven innovation in healthcare. With a centralized image repository, or VNA, newer technologies—AI, machine learning and analytics—can enable even greater healthcare innovation.

Using AI in medical imaging will increasingly move the subjective nature of interpretation into a true science. Researchers agree, saying: "With an irreversible increase in the amount of data and the possibility to use AI to identify findings either detectable or not by the human eye, radiology is now moving from a subjective perceptual skill to a more objective science."[9]

This is not to suggest that radiologists and others who interpret clinical images will be replaced by AI and machine learning. Rather, the skillset will change from one of interpretation to medical judgment, patient communications, quality assurance and more.

Already clinicians have found an ally in AI. Instead of combing through extremely high-resolution images for a potentially tiny megapixel of data, they can now accelerate both their productivity and accuracy with AI. Additional benefits of newer technologies include:

- **Improving operational efficiency.** Meeting—or exceeding—the highest standards of patient care with 3D and 4D capabilities, real-time analytics and processing accelerated by graphics processing units (GPUs).
- **Improved diagnostics.** AI programs can be trained with deep learning to see the very earliest changes in cell structure that typically develop into cancerous cells.
- **Support radiologists/prevent burnout.** Stacks of images can be "triaged" to quickly flag those that show anomalies or indicators of disease and focus on diagnosing and treating the disease instead of screening images.

[9] *"Artificial intelligence in medical imaging: threat or opportunity? Radiologists again at the forefront of innovation in medicine," European Radiology Experimental, 2:35, 12/2018.*

Top 10 Guidelines for Deploying an Information Life Cycle Management Strategy

According to Gartner, ILM "is a prerequisite of cost-effective information governance and storage infrastructure optimization. Infrastructure and operations leaders can minimize data risks and maximize value by implementing an effective ILM plan."

They suggest these guidelines:

1. Gain executive leadership support for ILM
2. Establish a cross-functional team
3. Define access, retention and deletion policies for instances of data
4. Construct a legal hold process as part of retention policy planning
5. Plan for how the data will be produced in response to a discovery request
6. Separate backup and archiving policies
7. Define the security requirements
8. Develop a backup and disaster recovery plan
9. Assign responsibility for managing accessibility to historical data
10. Establish ILM as a component of new application deployment

Source: "Top Ten Guidelines for Deploying an Information Life Cycle Management Strategy," Gartner Research, G00310526, 03/16/2017.

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According to one publication, the top five uses for AI in clinical images include:[10]

- Automating the detection and identification of cardiovascular abnormalities.
- Detecting hard-to-see fractures and other musculoskeletal injuries to better treat patients and avoid chronic pain, particularly in the elderly.
- Aiding in and differentiating between diagnoses of neurological diseases, such as amyotrophic lateral sclerosis (ALS). Having an earlier and more accurate diagnosis can help patients better plan for long-term care and end of life.
- Flagging thoracic diseases that, left undiagnosed, can be life-threatening.
- Screening for common cancers, such as breast or colon cancer, to speed up treatment protocols and save lives or detect metastatic cancer.

Storage trends in clinical imaging

As study sizes increase and new digital modalities are introduced, building a storage infrastructure and creating ILM policies is more important than ever. Here are some storage technologies to consider:

- **Spinning/HDD.** The slowest, cheapest image storage, spinning disk/HDD is scalable into millions of objects and accommodates multiple use cases. These types of disks are very usable for large archives where performance is not critical.
- **Flash/SSD.** Flash/SSD is the fastest, most expensive image storage. It delivers high capacity and uses less power. These are the fastest media currently available and are great for PACS tier 1 and database workloads. Flash/SSD are expensive but highly desired where performance is key.
- **Object storage.** Searchable metadata makes object storage desirable for imaging data because it offers better performance and can also be used for query searches and data analytics. It's scalable into billions of objects—and is cheaper at scale. It can also handle large amounts of unstructured data without spending time crawling through directories, as is required by file storage.
- **Hybrid cloud.** Hybrid cloud combines private cloud security with public cloud services for unlimited scalability. While it offers an OpEx model, there's also a CapEx component.
- **Cloud.** Cloud services offer an OpEx model with drastically reduced resource costs and unlimited scalability, making them ideal for exponentially growing imaging data. But lack of control is an issue for many IT teams.

[10] *"Top 5 Use Cases for Artificial Intelligence in Medical Imaging," HealthITAnalytics.com, 10/30/2018.*

Public vs. hybrid cloud

Interest in public cloud medical image storage is steadily growing as the cloud has become more readily adopted in core IT. Public clouds—such as Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP)—offer services, like AI and machine learning, so healthcare IT teams don't have to buy or own the compute and software needed for these workloads. Public cloud storage is currently more common for secondary or disaster recovery options, since healthcare providers don't have to own the resources required to maintain a second data center and staff. And using operating budgets instead of capital budgets is an attractive option.

Many healthcare organizations are also choosing a hybrid cloud approach that provides the benefits of both on-premise storage and cloud storage for their enterprise imaging strategies. This provides the best of both worlds and utilizes both CapEx and OpEx budget models.

Vendor-neutral archives (VNAs)

At a high level, vendor-neutral archives store images and clinical data in a standard format and make them accessible by systems from disparate vendors using a standard interface.

At a more granular level, VNAs decouple PACS and workstations at the archival layer to provide one viewing experience regardless of where the images come from. A VNA has a translation layer that reintroduces interoperability into the imaging environment once removed from proprietary PACS solutions. This interoperability allows healthcare providers not only to share data among multiple PACS within the same organization, but also to read files even after switching PACS vendors.

The reasons for a VNA are many:

- **Image aggregation.** Once a VNA is implemented, all PACS become caches using a store-and-forward model for images. All images reside permanently on the VNA, enabling fewer backup strategies and EHR integrations.
- **Cloud compatibility.** Cloud compatibility means secure imaging data with unlimited scalability and an efficient OpEx cost model.
- **Searchability.** Metadata is stored with data files so filters can be applied for enhanced searches.
- **Manageability.** The VNA is the foundation for an enterprise imaging strategy. An ILM strategy can then be easily adopted using multiple storage tiers and types, while allowing the VNA to manage the data movement to cheaper tiers of storage based on policies.
- **Image-enabled EHRs.** All EHRs contain medical imaging reports, but clinicians also want access to the images to provide the highest-quality care to their patients. Newer enterprise viewers allow multiple imaging types, not just the traditional radiology and cardiology images, to be viewed within the EHR.
- **Non-DICOM objects.** Most healthcare facilities store non-DICOM images within a plethora of storage types—desktop PCs, USB drives, etc.—depending on the department. A VNA allows these studies to be securely and centrally stored within the data center and included within the EHR, further adding value for clinicians and patient care.

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NetApp: Hybrid cloud storage and data management solutions for your enterprise imaging strategy

NetApp offers fast, simple, scalable and reliable data storage and management solutions—including cost-effective, easily managed on-premise and cloud storage solutions with all storage types. These solutions are validated with leading PACS and VNA providers for an affordable enterprise imaging solution that lowers your total cost of ownership and provides superior image management.

Consider these points when choosing a storage management solution. Look for infrastructure solutions that help you:

- **Optimize your IT investment** with a simple, scalable, PACS/VNA-validated solution that meets the growing demand for enterprise imaging strategies.
- **Enhance patient care** by scaling, upgrading and maintaining your storage—without downtime.
- **Optimize performance** with easily scalable bandwidth and high IOPS to support data-intensive imaging applications and files of any size without sacrificing storage space. Storage QoS ensures all applications get the proper resources all the time.
- **Maximize system flexibility** with a unified architecture that delivers more flexibility, performance and capacity in less space—and with less management overhead.

Logicalis: Your Enterprise Imaging Partner

Logicalis partners with leading technology innovators, such as NetApp, to deliver a comprehensive ILM strategy that can take your healthcare organization into the future.

With an ILM framework (or governance) in place, organizations can begin to consider an enterprise imaging system that centralizes patient data—images, reports and other information—so IT can appropriately acquire, disseminate and dispose of that data and make it available for clinical use.

Our highly skilled and certified professionals will help you ensure secure, readily available, cost-effective access to enterprise imaging data as it's needed. Services are customized to your needs and include Discovery & Assessment, Strategy Development, Requirements Identification & Solution Selection, Technical Solution Design, and Implementation & Program Management.

- 20-year dedicated healthcare practice staffed by experienced professional enterprise imaging consultants who understand the business.
- Deep technical expertise in architecting, configuring and optimizing security, storage, networking, cloud and other infrastructure solutions to support an enterprise imaging platform.
- Longtime HIMSS Platinum Corporate Member actively involved in adding its expertise to the field of clinical imaging.
- Consistently recognized as an award-winning managed services provider by CRN, Channel Partner Insight and Channel Futures.

Contact Logicalis to learn how we can help.
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