



January 16
2012

Storage Solutions for Medical Images

Overview

This white paper discusses three subjects: digitizing data, the sheer quantity and size of some types of data, and the length of time needed to retain records. There is an emphasis on choosing not only the correct media option, but an urge to employ a system that is advantageous to the entire spectrum of the data retention and data access dilemma.

Your Medical Diagnosis

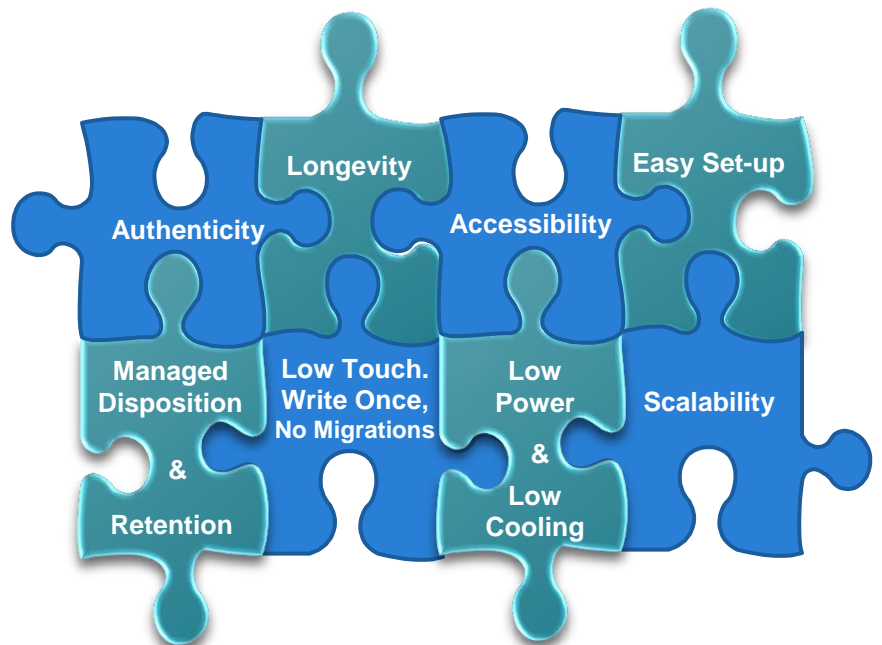
Imagine hearing one of your medical colleagues say the following:

“Your IT shows some very serious signs of symptoms that may lead to long term, if not imminent, difficulty. Patient history shows that the IT department has not been scalable or focused on the longevity of data. After looking at the physical examination of the IT, it shows there are a very large amount of data migrations and a high need for facility cooling. Furthermore, data retention may not always be of the highest quality. Therefore, the diagnosis is to use this Active Archive™ and assess to see if it fits.”

Your thoughts would be:

“Will it be easy to integrate? Will it be compatible? Will it provide excellence in data security?”

The final words are that the symptoms lead to the requirements, which were just puzzle pieces to finding the diagnosis, or in this case the solution. The strong medicine available is a very viable solution that does address the symptoms and leads to a strong, healthy, and viable data system. This paper will follow the steps that lead to the immediate need for this solution.



Digitization of Medical Data

Out with the old and in with the new. Keeping medical data in cabinets and file drawers is the way of the past. The future is digitization of those paper records. This has benefits that far outweigh any disadvantage. A patient’s health file is digitized into what is called an Electronic Health Record (EHR). EHRs and the need for storage go hand in hand. Medical data must be kept for as long as a patient’s lifetime, in some cases, remain unmodified by outside influences, and be readily available for access.

(Ragib Hasa) Medical data includes records of sensitive information about the individual's health; it can also include information about mental health and even substance abuse. (Electronic Privacy Information Center) This means that the media that stores this information must be secure and only allow the proper people to access it. Encryption of the media helps mitigate this problem in case of theft or other wrongdoing. Along with security, the data must meet Health Insurance Portability and Accountability Act (HIPAA) and/or Digital Imaging and Communications in Medicine (DICOM) standards. HIPAA "is an attempt to update the health sector and insurance record keeping in order to bring more accountability and better protection of consumer rights". (Ragib Hasa) The storage media type that is chosen will be paramount when trying to jump all these hurdles, while keeping the cost down. The Total Cost of Ownership (TCO) is calculated by adding the immediate cost with the cost of maintaining and replacing the media in case of failure in the future.

Digital Space Taken by Medical Images

Medical images differ on two fronts: resolution and dimension. The amount of space taken up on the drive depends on the type of image. Some images need higher resolution or larger dimension for clarity and distinguishing edges in the image. Below is a graph that shows common image procedures and their disk usage. (Ni, 2011)

Modality	One Image (bits)	# of image/exam	Size for 1 exam
Nuclear medicine (NM)	128 x 128 x 12 (2 bytes)	30-60	1-2 MB
Magnetic resonance imaging (MRI)	256 x 256 x 12 (2 bytes)	60-3000	>8 MB
Ultrasound (US)	512 x 512 x 8 (1 byte)	20-240	5-60 MB
Digital subtraction angiography (DS)	512 x 512 x 8 (1 byte)	15-40	4-10 MB
Digital microscopy	512 x 512 x 8	1	0.25 MB
Digital color microscopy	512 x 512 x 24 (3 bytes)	1	0.75 MB
Color light images	512 x 512 x 24 (3 bytes)	4-20	3-15 MB
Computed tomography (CT)	512 x 512 x 12 (2 bytes)	40-3000	>20 MB
Computed/digital radiography	2048 x 2048 x 12 (2 bytes)	2	16 MB
Digital X-ray	2048 x 2048 x 12 (2 bytes)	2	16 MB
Digital mammography	4000 x 5000 x 12 (2 bytes)	4	160 MB

These might seem like small amounts of disk storage; but, after thousands of patients, it starts to add up quickly. This graph only shows the images; also included in the patient file would be all their historical data, which takes up more disk space. Video and other types of functional data can make it much more of a storage burden per patient. Functional brain slides can easily be 800MB. HD video recording of a surgery for training purposes depends on the length of a surgery; the base information rate for HD is 1GB per minute of footage. (Panasonic, 2008)

Certain parts of an individual's health record must be kept for varying lengths of time. For example, all immunization records are always kept, patients with Medicare or Medicaid records must be kept for five

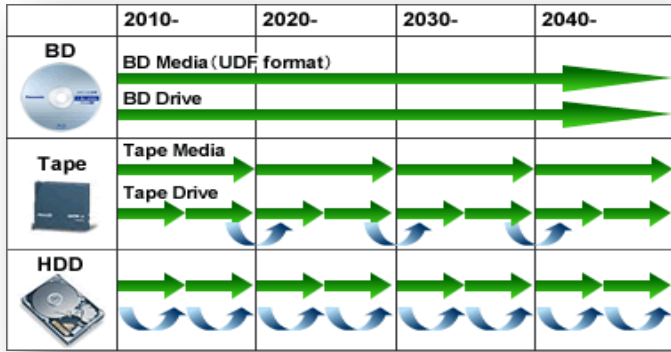
(5) years, and in the majority of states, most health information must be kept for five to ten (5-10) years or five to ten (5-10) years after the patient reaches age of majority (whichever is longer). (Association) Each state differs on length of retention for certain health information. This quick table summarizes suggested health record retention length. (Rhodes, 2002)

Health Information	Recommended Retention Period
Disease index	10 years
Operative index	10 years
Physician index	10 years
Fetal heart monitor records	10 years + after the infant reaches the age of majority
Patient health/medical records (adults)	10 years after the most recent encounter
Diagnostic images (such as x-ray film)	5 years
Patient health/medical records (minors)	Age of majority plus statute of limitations
Master patient/person index	Permanently
Register of births	Permanently
Register of deaths	Permanently
Register of surgical procedures	Permanently

Since medical data must be kept for such a long time, the lifetime of the patient in many cases, storage space for paper files is impractical, expensive, not readily accessible, and potentially unsecure. For example, in Massachusetts, the Boston Beth Israel Deaconess Medical Center does basic scans for over 250,000 patients each year. Each year they accumulate over 1 TB of text patient data and 19 TB of image data. That is a substantial amount of information that has to be kept, in this case, for fifteen (15) and seven (7) years respectively. On average, this equates to about 80 MB per patient per year. (John D. Halamka, 2011) This shows how quickly medical data storage can add up; a storage solution that can adapt with growing storage is a necessity.

Options for Storing Medical Data

There are really just four viable options for the storage of health records, optical disc (Blu-ray or BD), hard drive (HDD), solid-state drive (SSD), and magnetic tape. Due to the high cost of SSD, that option is not practical for medical storage. While magnetic tape is very inexpensive per TB, the cost per TB for both HDD and Blu-ray are also low. There are a few major drawbacks to using tape media. Tape is very sensitive to its environment, has to be kept at specific levels of temperature and humidity, cannot be randomly accessed, and tape degeneration or “Sticky Shed Syndrome” is a big concern. (Zelst, 2008) Correspondingly, a tape’s useful life is only from five to seven (5-7) years. Even though it has been the choice by many in the past, this media type is not reliable enough for medical data storage.



HDD and optical disc media are getting less expensive, while their capacities are increasing. Hard disk drives also have drawbacks. Hard disks are constantly spinning while being written to or read; this movement generates heat, which reduces performance and longevity of the media. HDD can last longer when not being used but doing this means

long latency when trying to find a

specific patient file. A Carnegie Mellon study found that 25% of HDD failed after five (5) years and jumped to 50% after six (6). Studies further show that once there is a failure with one drive that is in an array, such as a RAID system, will increase the likelihood of another drive in that array to fail. Dr. Schroeder of Google states that after the first failure, there is a multiplied factor of four for another drive to fail within the same hour. This can be detrimental for data management. Therefore, data migration must be consistent, as failure rate of hard drives do increase proportionally to the age of the drive. HDD has only a 0.5-1% Annualized Replacement Rate (APR) in the first year, which grows to 5-7% in year 5. (Ku, 2011) This does not take into account the firmware, applications, configurations, and interfaces involved. Changing any of these relations of HDD will increase the probability of failure. This naturally leads to IT managers replacing disks constantly, while installing new drives at the same time. This painful data migration cycle can be noted in the chart to the above.



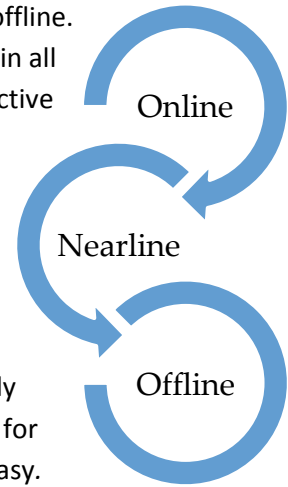
Blu-ray discs will last 50 or 100 years (re-writeable or write once respectively). These discs will not need substantial cooling because the disc creates very little heat by design. Having the ability to use WORM (Write-Once Read Many) is excellent for security of the information; the data cannot be modified after it is written. New information can always be added but

never erased so this qualifies as a very usable storage media for medical information. The discs can be encrypted while the data is burned to the disc, further enhancing security. This is very important for records of people's health and worries about their information being stolen.

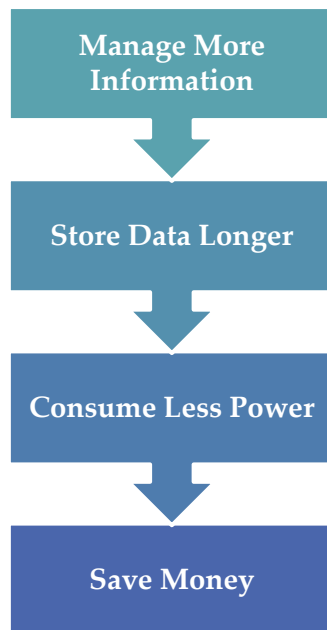
Active Archive™: A Hybrid Solution

Active Archive™ is the interchange of data access between online, nearline, and offline. (Hie Electronics, 2011) Being a hybrid of HDD and optical, Active Archive™ brings in all the advantages of data retention and speed of access while using space wisely. Active Archive™ is a system that integrates an application server, RAID cache, Blu-ray storage and archive, with easy to use plug and play software, which operates at approximately ten percent of the power of existing solutions. Now, data that is commonly needed resides in cache (HDD) and is instantly available and automatically backed-up. The vast majority of data, which is used infrequently or never but must remain available by regulation, is stored on media that has a long shelf life, can reliably retain data in ambient conditions, and is not continually requiring power to be accessible later. By using a software interface that is made for a basic user, access to any and all data, regardless of date, becomes seamlessly easy.

[Active Archive™ is a trademark of Hie Electronics.]



Viable and Strong Medical Solution



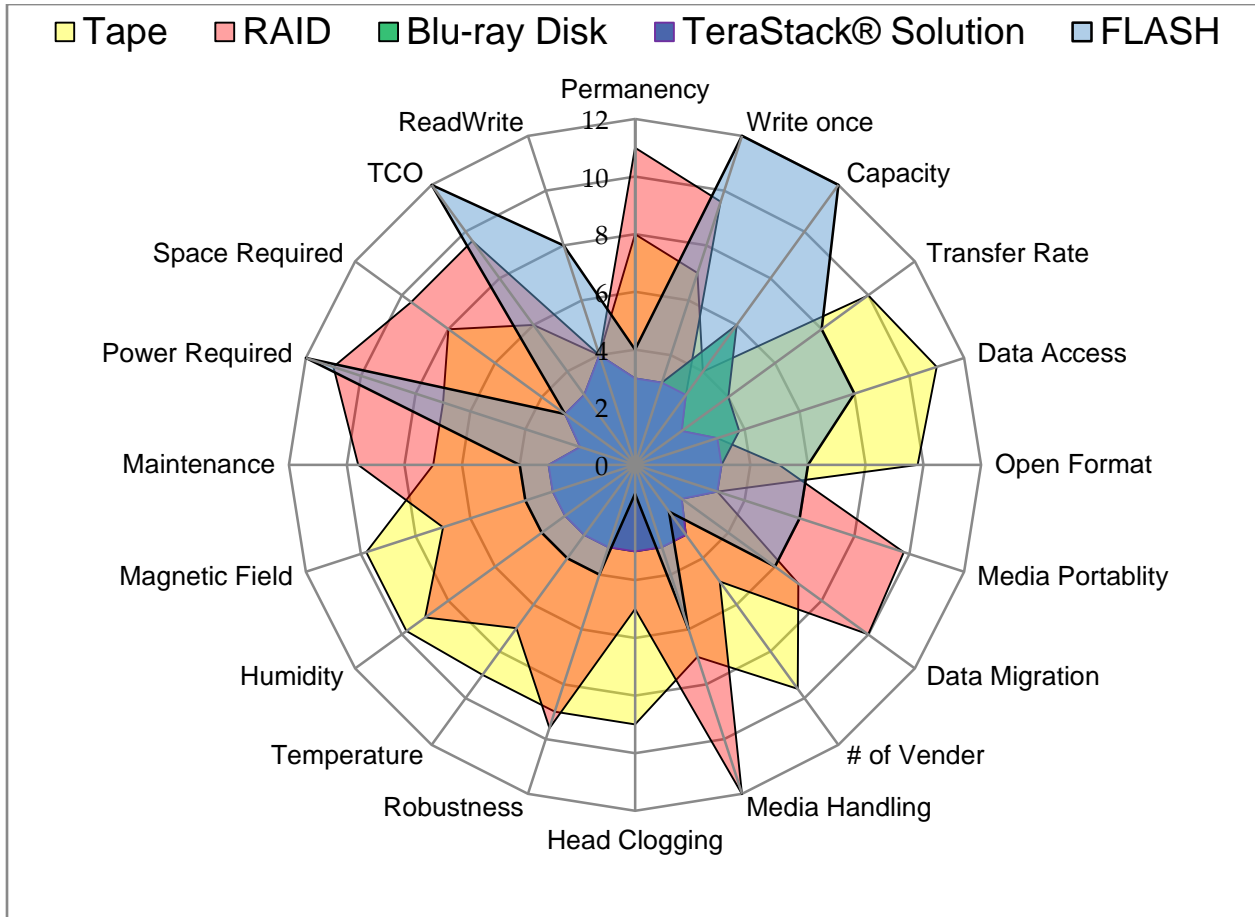
By combining the forces of Active Archive™, there is a solution. The solution must be a high density storage option. On top of this, the software interface should be easily manageable, with an open design. The solution must diminish the need for constant data migration, which substantially lowers the total cost of ownership. The solution should consider combining diverse types of solutions to allow for data integrity and energy efficiency. The media used should have a shelf life that combats against extreme environmental conditions. Finally, the solution should be low in maintenance. All of this will accomplish a cost saving for the IT department. The worries and stress of data retention will no longer exist and the breath of life can finally come back.

The viable solution is choosing the Hie Electronics' TeraStack® Solution with Active Archive™. Appendix A shows the solution on a spider chart in which the best performance is the one closest to the center in all areas. Appendix B shows the current technology options.

Conclusion

A hybrid Active Archive™ uses multiple types of media as a solution for medical data storage. This is especially important for medical images, video footage, and other patient data. Using Active Archive™ will allow continuity throughout three major areas: current data requirements, efficiency of the data, and dynamically preparing for the future. Applying both Active Archive™ and a hierarchical media structure for medical data storage will ultimately save a vast amount of resources in the long run.

Appendix A: Technology Quality Spider Chart



Note: The bulls-eye candidate is the TeraStack® Solution using Active Archive™ and is glued together by a user-friendly software interface.

Appendix B: Technology Comparison of Current Options

Technology Comparison	Total Solution App Server (Tier 1,2,3)	1 Disk WORM	2 Removable Media	3 Positive Disposition	4 Recall Performance	5 Costs CAPX	6 3 yr+ TCO /OPX	7 Scalability	8 Longevity
EMC Centera or EMC Data Domain Archiver	No	Yes	No	No	Very Good	\$\$\$	Poor	Very Good	HDD 3-5 yr
Network Appliance Snaplock	No	Yes	No	No	Excellent	\$\$\$	Poor	Very Good	HDD 3-5 yr
Nexsan Assureon	No	Yes	No	Yes	Excellent	\$\$\$	Poor	Excellent	HDD 3-5 yr
NAS as Archive	No	No	No	No	Excellent	\$	Poor	Good	HDD 3-5 yr
Tape Library as Archive	No	No	Yes	No	Poor	\$	Good	Excellent	TAPE 5-7 yr
Prostor RDX	No	Yes	Yes	Yes	Very Good	\$\$	Poor	Poor	HDD 3-5 yr
Powerfile Blu-Ray A3	No	Yes	Yes	Yes	Very Good	\$\$	Good	Very Good	BD 50 yr
Disc Blu-Ray	No	No	Yes Single Disk	No	Good	\$\$	Good	Good	BD 50 yr
HIT Blu-Ray	No	No	Yes Single Disk	No	Good	\$\$	Good	Good	BD 50 yr
ASTI Libraries UDO	No	No	Yes Single Disk	No	Good	\$\$\$	Good	Good	UDO 20 yr
Hie Electronics TeraStack® Solution	Yes	Yes	Yes TeraStack	Yes	Very Good	\$\$	Excellent	Excellent	Hybrid HDD/BD 50 yr

Works Cited

Association, A. M. (n.d.). *American Medical Association*. Retrieved July 28, 2011, from Opinion 7.05 - Retention of Medical Records: <http://www.ama-assn.org/ama/pub/physician-resources/medical-ethics/code-medical-ethics/opinion705.page>

Ayngaran. (n.d.). *eShop*. Retrieved July 27, 2011, from Ayngaran: http://eshop.ayngaran.com/ww/images/386px-Blu-ray_Disc_svg.png

Electronic Privacy Information Center. (n.d.). Retrieved July 27, 2011, from Medical Records and Privacy: http://epic.org/privacy/consumer/med_record.html

Hie Electronics. (2011). *Power and Cost Efficient Data Storage*. Retrieved July 29, 2011, from Hie Electronics:
<http://www.hie-electronics.com/whitePapers/EnergyEfficientDataStorage.pdf>

John D. Halamka, M. (2011, April 11). *Mass Device*. Retrieved July 28, 2011, from Medical data storage:
Adding up the cost of digitizing health records:
<http://www.massdevice.com/blogs/massdevice/medical-data-storage-adding-cost-digitizing-health-records>

Ku, A. (2011, July 29). *Investigation: Is Your SSD More Reliable Than A Hard Drive?* Retrieved July 30, 2011,
from Tom's Hardware: <http://www.tomshardware.com/reviews/ssd-reliability-failure-rate,2923.html>

Megalynx7. (n.d.). *1TB HDD (Hard Disk Drive) for CD/DVD Duplicators*. Retrieved July 29, 2011, from DVD
CD Duplicator Seller on Ebay: <http://cgi.ebay.com/1TB-HDD-Hard-Disk-Drive-CD-DVD-Duplicators-/140476481314#shId>

Ni, D. J. (2011, Spring). *Medical Imaging Informatics*. Iowa, United States of America.

Panasonic. (2008, January 24). *P2HD*. Retrieved July 29, 2011, from Panasonic:
ftp://ftp.panasonic.com/pub/Panasonic/Drivers/PBTS/papers/FAQ_P2HD.pdf

Ragib Hasa, M. W. (n.d.). *Requirements of Secure Storage Systems for Healthcare Records*. Retrieved July 27,
2011, from <http://www.cs.sunysb.edu/~sion/research/sion2007sdm-health.pdf>

Rhodes, H. (2002, June). *Retention of Health Information (Updated)*. Retrieved July 28, 2011, from Practice
Brief: Retention of Health Information:
http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_012545.hcsp?dDocName=bok1_012545#t3

Wysiwy, G. (n.d.). Retrieved July 27, 2011, from Examiner:
<http://www.examiner.com/images/blog/wysiwyg/image/medical.png>

Zelst, V. (2008, March). *Library of Congress*. Retrieved July 28, 2011, from Magnetic Tape "Sticky Shed"
Research: Characterization, Diagnosis, and Treatment:
http://www.loc.gov/preservation/scientists/projects/sticky_shed.html

Images Cited

Medical symbol: (Wysiwy)

Blu-ray symbol: (Ayngaran)

HDD symbol: (Megalynx7)

Sponsored by: Hie Electronics
Authors: Kyle Hodges, Garrett Bartkus
Published: January 2012