



Braving the perfect storm - Medical Image Archiving (MIA)

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Sun addresses health care informatics challenges

Quickly and cost effectively **scale your network business services**

Build effective shared services with a **services oriented architecture**

Build high **performance compute or grid infrastructures**

Securely address **regulatory and compliance** requirements

Optimize your IT assets **through virtualization and consolidation**

Address **massive data growth and volume**

Drive **cost efficiencies** through:

- Space saving, energy efficient systems
- Integration and performance improvements
- Simplification and automation of IT management

Use your IT infrastructure as a **competitive weapon for your business**

All While Effectively Integrating Open Source Technology

The Global Power of Sun

Fortune
187
Company

Java Devices
5.5+ Billion

Java Developers
6+ Million

Worldwide Employees
34,219

Annual R&D
\$1+ Billion

Annual Revenues
\$13.8 Billion
Up 6.2% Y/Y

Cash
\$5.94 Billion

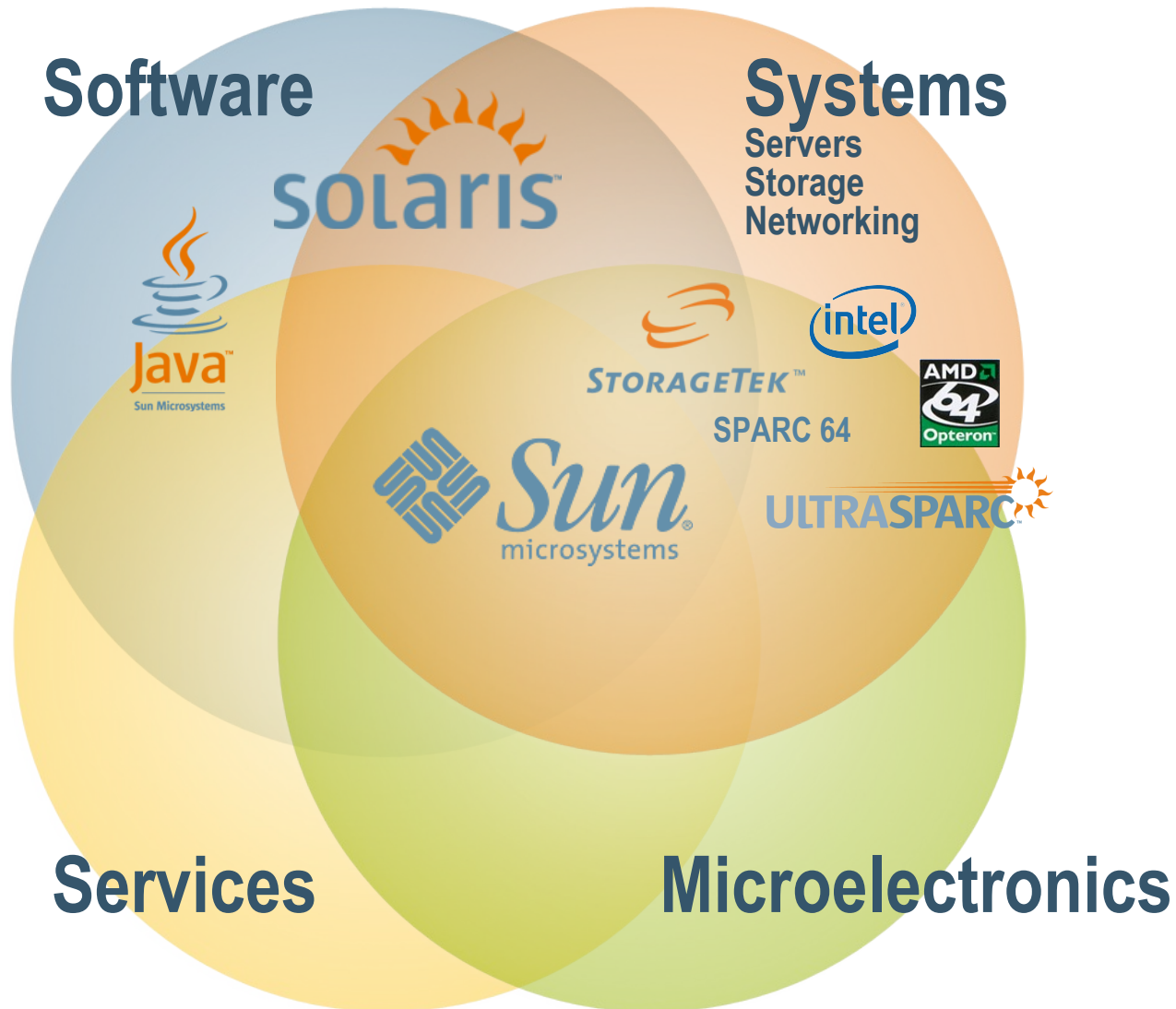
Patents
11,000+

Solaris 10
Licenses
9.3+ Million

Annual Storage
Petabytes Shipped
410

Business Presence
100 Countries

Innovation + Open + Choice = Greater Value



Healthcare Transformation Components



Health Information Exchange

Aggregate disjoint information on episodes of care to holistic patient view



Secure Data Management

Synchronize data growth, compliance and budgets



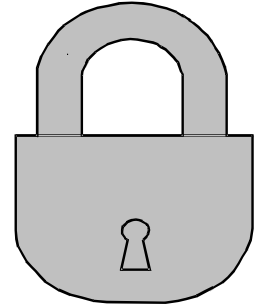
Consumer centric health info

Structure data not by episode, but by patient profile; advise for compliance



Caregiver Mobility with Security

Secure access to information compliant with workflow and privacy regulation; cost effective delivery



Compliance

Privacy, Identity Management, Access Control, Fraud detection and Activity Monitoring

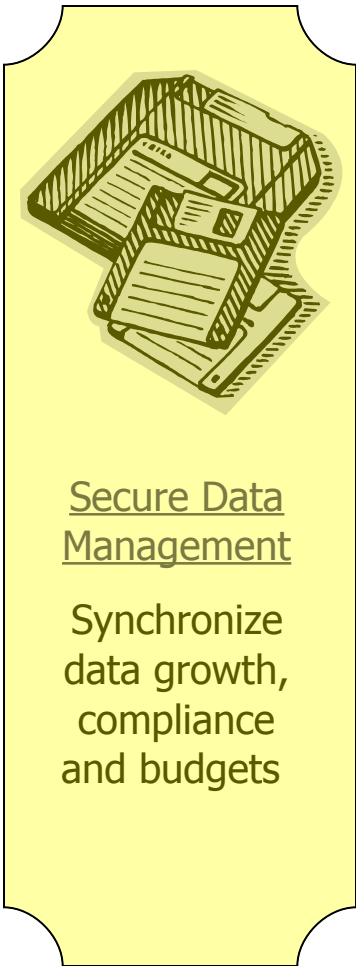


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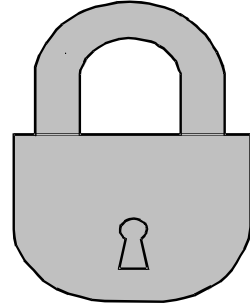
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← Identity Management →

Braving the perfect storm: media independent archiving of medical images

How to build scalable, long term archives that satisfy capacity and performance requirements of the medical staff within the budget framework approved by the CFO

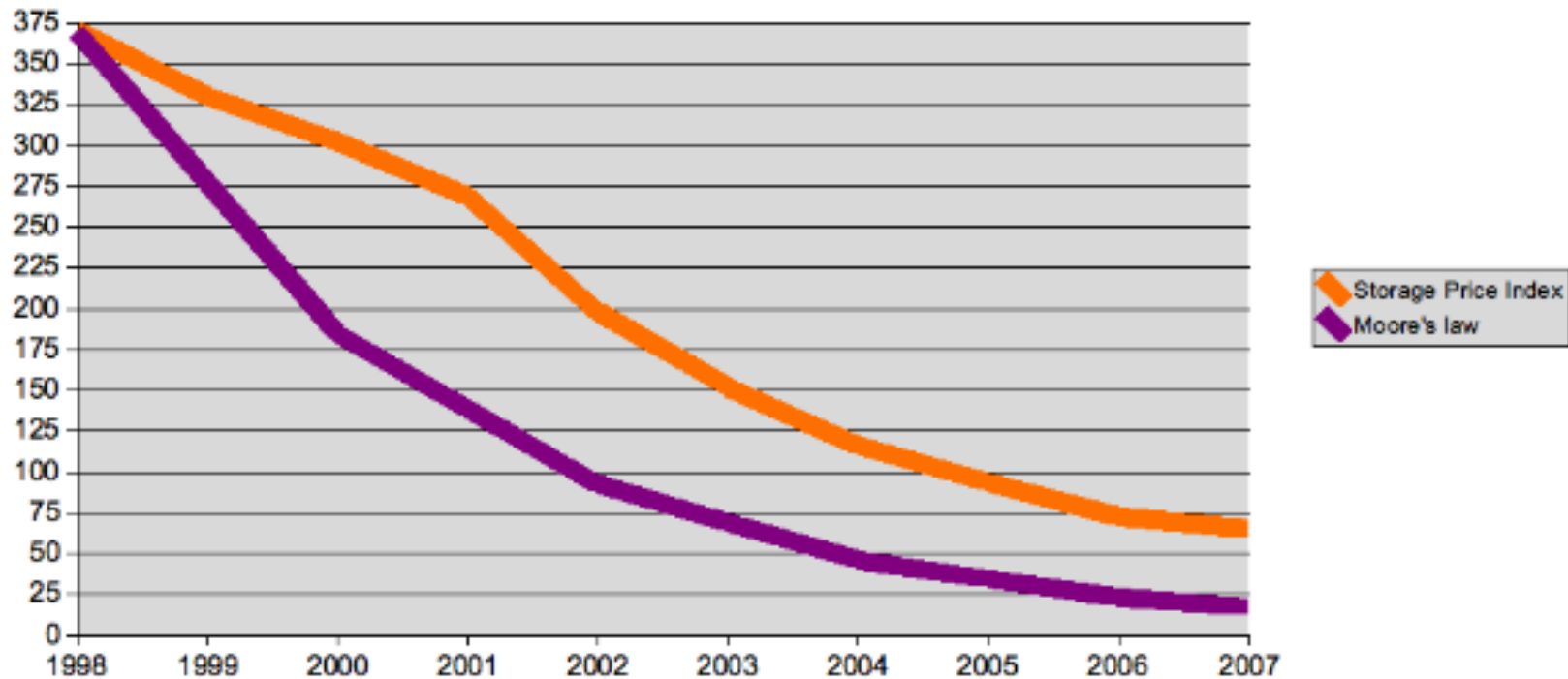
Dissecting the challenge

- “Perfect Storm” - Barry Runyon, Gartner:
 - > Improved image quality means larger images, plus
 - > more disciplines using digital technology, plus
 - > more HIS integration and re-calls create exponential growth
- Scalable: grow by adding media without need for data separation or “fork lift” upgrades
- Long-term: mandatory retention times can be 50+ years, thus outliving several generations of storage media
- Media independence
 - > Ability to add new media types with automatic data migration
 - > Should be able to accommodate different media types (for example NAS, SAN, TAPE, Future technology) based on performance and business requirements
 - > Necessary for archive longevity

Storage price decline

Storage prices decline similar, but slower than Moore's law.
50% in ~3.5 years vs. 50% in two years for transistors (Computers)

Storage price Index vs. Moore's law



Storage Price Index Source: U.S. Department of Labor Statistics, <http://data.bls.gov/PDQ>

Typical capacity planning

Modality	exams/year	images/exam	MB/image	exams/day	MB/exam	GB/day	GB/year
CR portables		3	8.00				
CR other + W/C	59,520	3	8.00	198	20	4.0	1,190
DR	13,020	3	18.00	43	45	2.0	586
CT		80	0.50				
CT multi row avg	7,212	150	0.50	24	75	1.8	541
CT multi row 3D		1,000	0.50				
MR	4,836	250	0.50	16	125	2.0	605
Digital Fluoro	5,256	10	2.00	18	20	0.4	105
Digital Angio		40	2.00				
Nuclear	1,632	40	0.06	5	2	0.0	4
Ultrasound	5,808	36	0.70	19	25	0.5	146
Cardiology	700	2,200	0.25	2	550	1.3	385
Echo -ped	6000	1	70.00	20	70	1.4	420
Echo -adult		1	50.00				
ob / vas		1	20.00				
Film Digitizer		20	1.00				
Total	103,984			347	38	13.3	3,982

Source: Don Baune, Sun Professional Services

Growth outpaces price decline

- New CT scanners produce 64 (Siemens Somatom Sensation 64) or 256 slices (Toshiba, GE) per second, versus conventional 4, 16 or 32 slices in current scanners
 - > At the same number of studies and resolution, this will increase archive size requirements by a factor of 8
- Higher resolutions with 7 Tesla MR scanners vs. 1.5 Tesla today
 - > http://medschool.ucsf.edu/news/features/research/20060410_Bioengineering.aspx
- Digital Pathology will create 5 GB studies, roughly 25 times average CT or MRI study.
 - > This could double image archive size and growth rate

Discussion

- Storage prices are falling, albeit slower than Moore's law
- Data growth rate outpaces Moore's law because of new, better modalities and new digital procedures
- If budgets are steady or moderately increasing, data archiving becomes challenging
- Tiered archives, which combine fast cache with slower, cheaper long term archive*, are the solution
 - > Tiers can be all disk with different disk system types, on-site & off-site
 - > Integration of tape can save energy costs
- Yet is the performance of tiered storage sufficient?

*Tiered PACS, refer to:

Tellis, Andriole (2001) Finding the optimal picture archiving and communication system (PACS) architecture: a comparison of three PACS designs, Journal of Digital Imaging, 2001, 14: 72-76

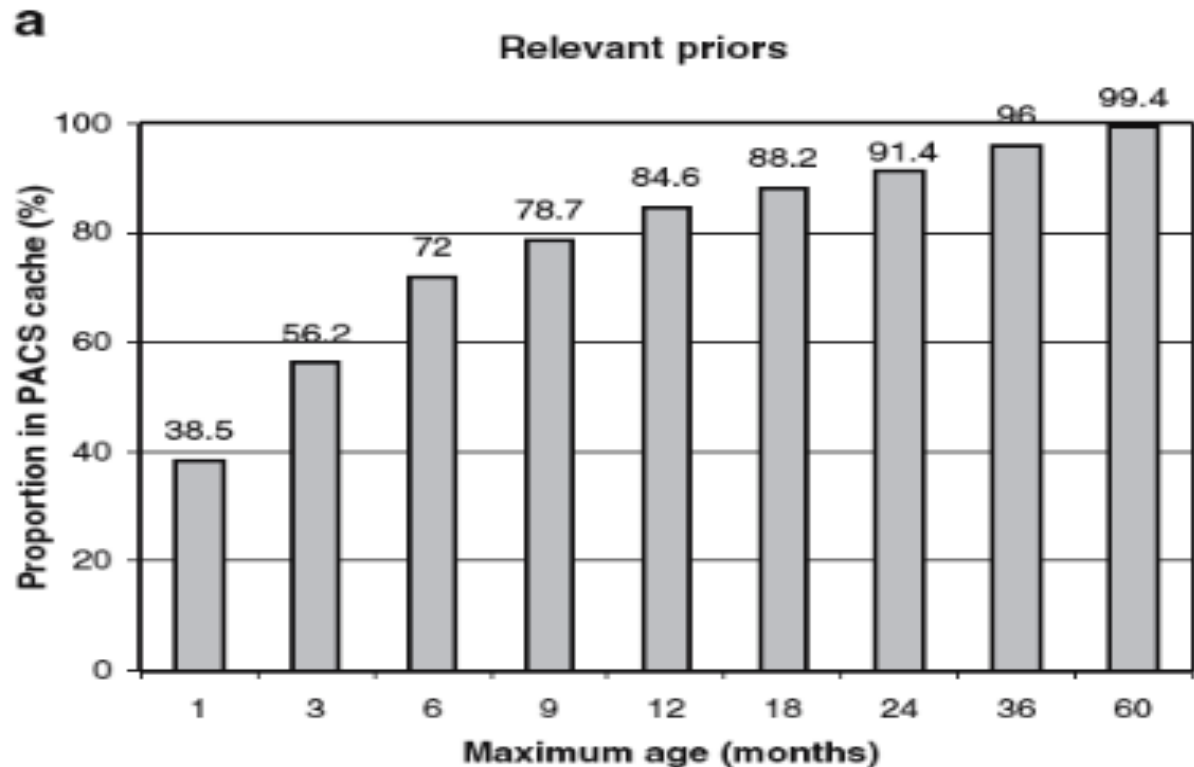
Mean age of relevant priors

Modality	Mean age of last relevant prior examination (days)	Pre-fetching strategy	Prior examinations	
			Frequency (%)	Number
CR	162.3±361.4	All prior examinations	62.2	9.4±15.8
		Same body region	52.2	7.5±12.0
		Same body region and same modality	49.4	6.9±11.4
CT	212.7±377.7	All prior examinations	54.5	7.0±11.1
		Same body region	43.7	4.1±6.9
		Same body region and same modality	26.4	2.6±3.5
MRI	284.8±453.0	All prior examinations	62.3	4.0±6.0
		Same body region	42.3	2.5±3.5
		Same body region and same modality	25.9	2.4±3.1
<i>Total</i>	<i>203.1±385.0</i>	<i>All prior examinations</i>	<i>59.7</i>	<i>7.6±12.3</i>
		<i>Same body region</i>	<i>47.5</i>	<i>5.4±8.7</i>
		<i>Same body region and same modality</i>	<i>37.3</i>	<i>4.6±7.2</i>

Source: Wirth, Treitl, Mueller-Lisse, Riege, Mittermeier, Pfeiffer & Reiser, 2006, Hard disk online caches in picture archiving systems archives: how big is beautiful?, European Radiology (2006), 16: 1847-1853

Tiered archives are effective!

- ❖ 24 months old relevant priors constitute 91.4% of cache hits, 36 months 96%
- ❖ CR and CT contribute 80% of the data,
- ❖ oldest prior for CR < 18 months, for CT < 20 months, for MRI < 26 months
- ❖ The probability (p) of finding CR and CT data in cache, if cache covers 24 months, is very high
- ❖ p of finding CR, CT and MRI data in cache, if cache covers 36 months, is very high
- ❖ Pre-fetch and thus HIS, RIS and PACS independent - pre-fetch improves cache hit ratio



Building a media *dependent* archive

Conventional system



Scanner



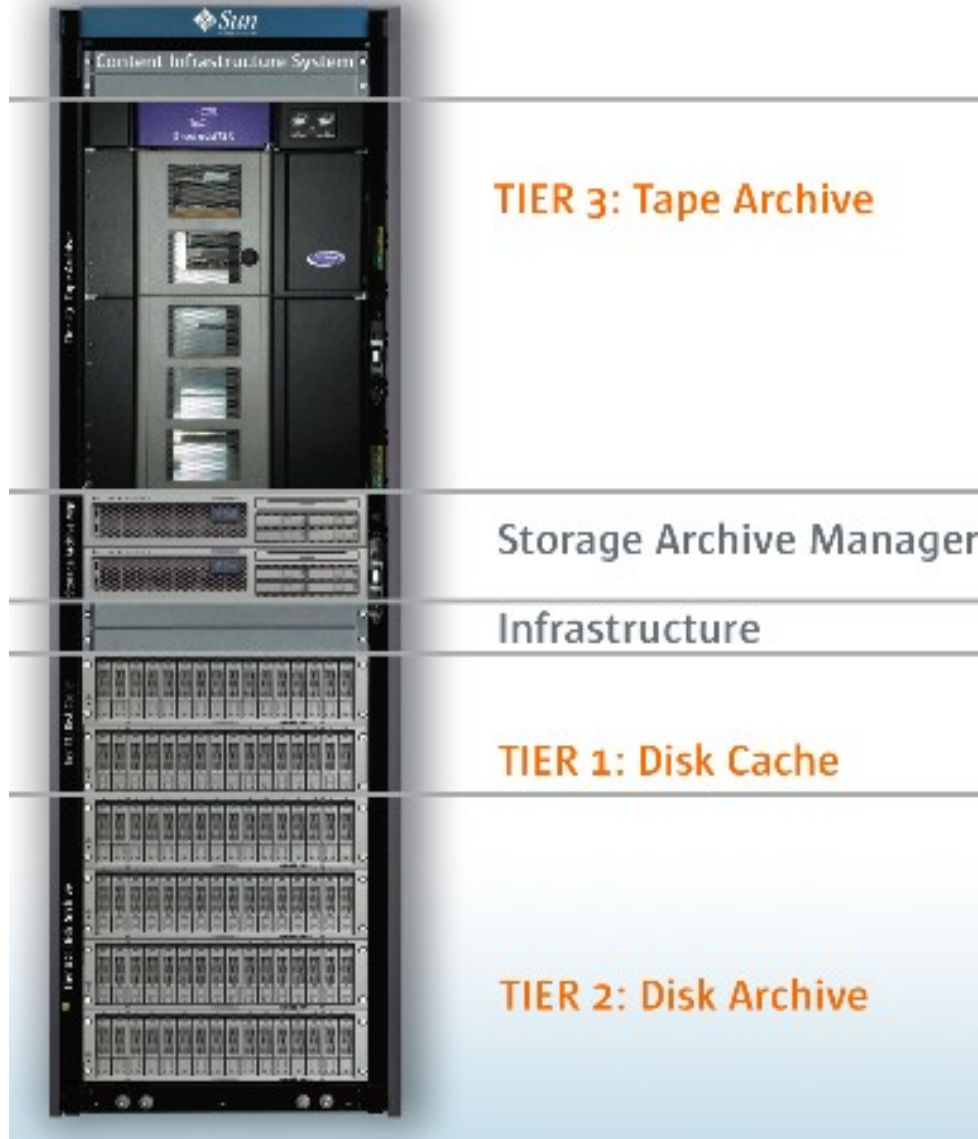
Pacs



Archive

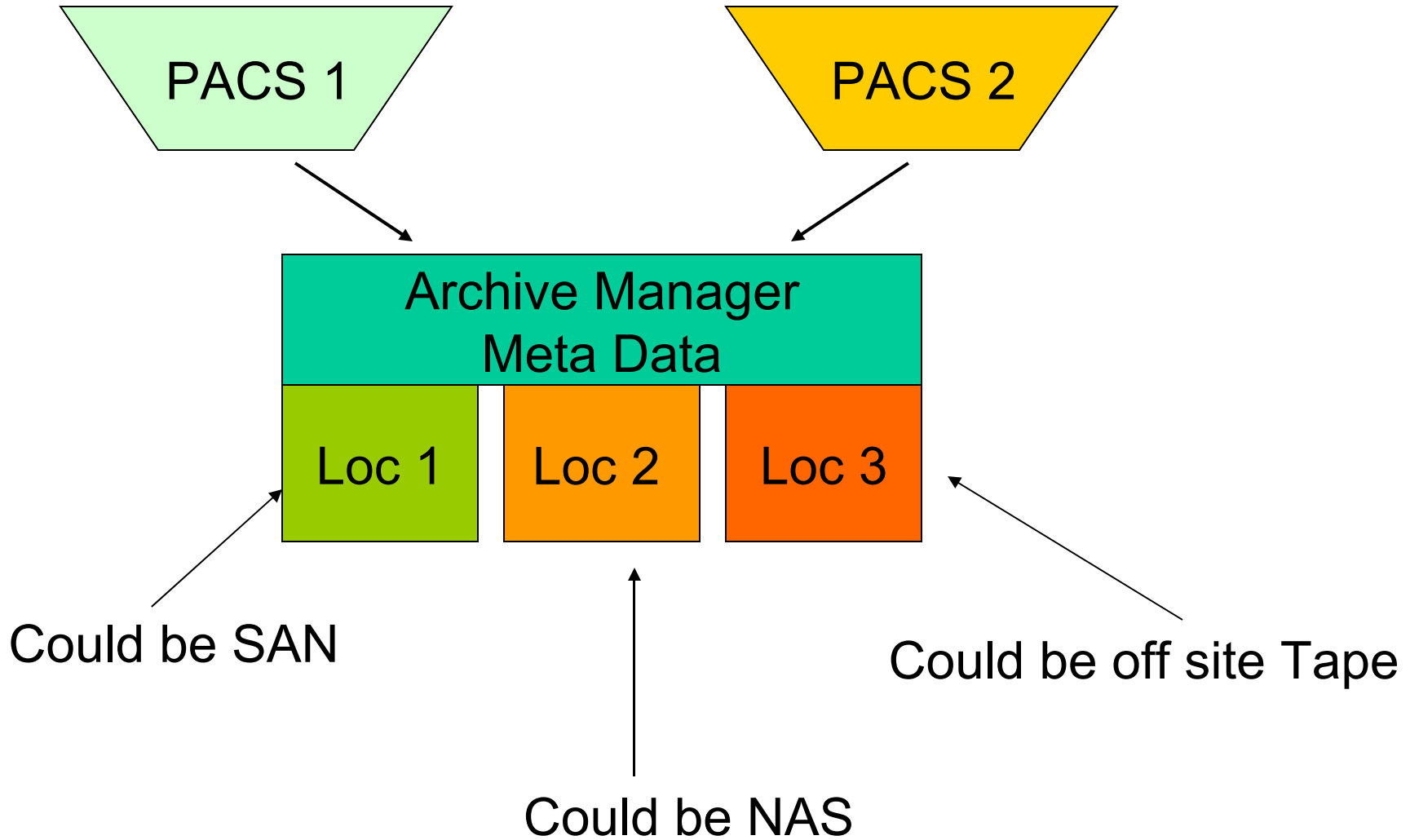
- Traditionally, one modality feeds one archive
 - NAS or SAN
 - Dependency on PACS
- Data migration to new archive requires DICOM import/export
 - PACS “owns” metadata
 - Slow & painful

Building a tiered, media independent archive

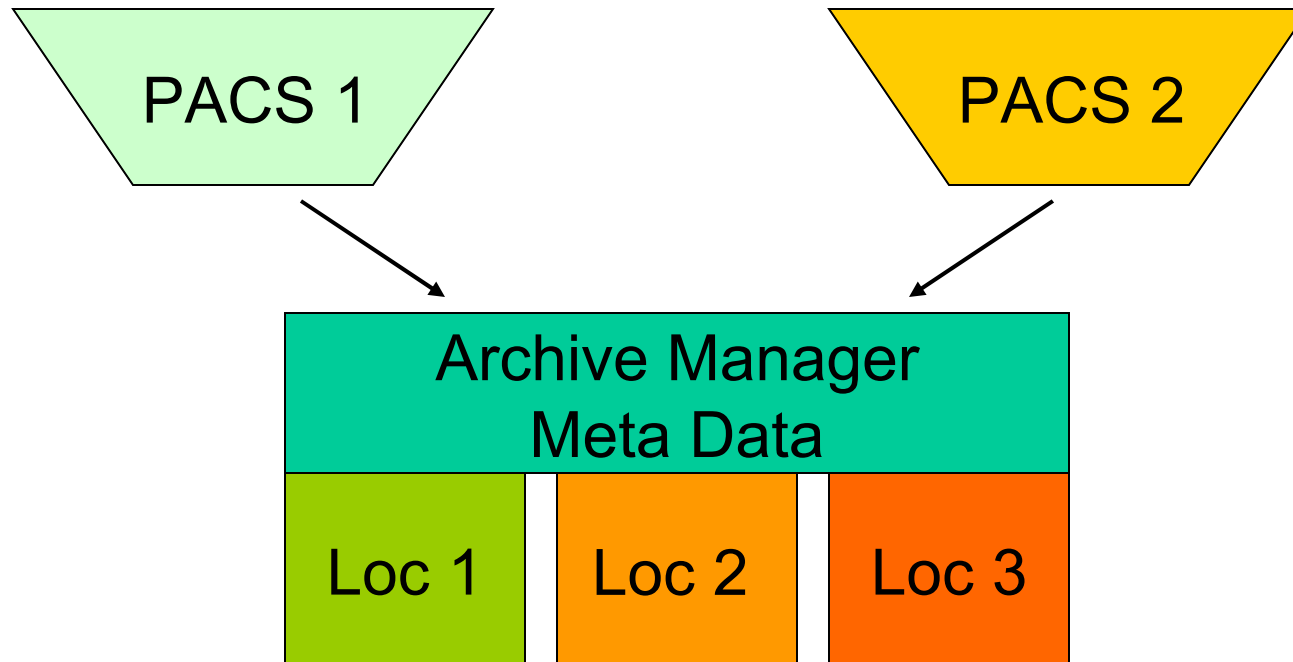


- Storage Archive Manager (SAM) maintains metadata
- Multiple storage tiers possible
- Local and remote replication
- Tiering allows cost optimization and media migration

Structure of a SAM archive



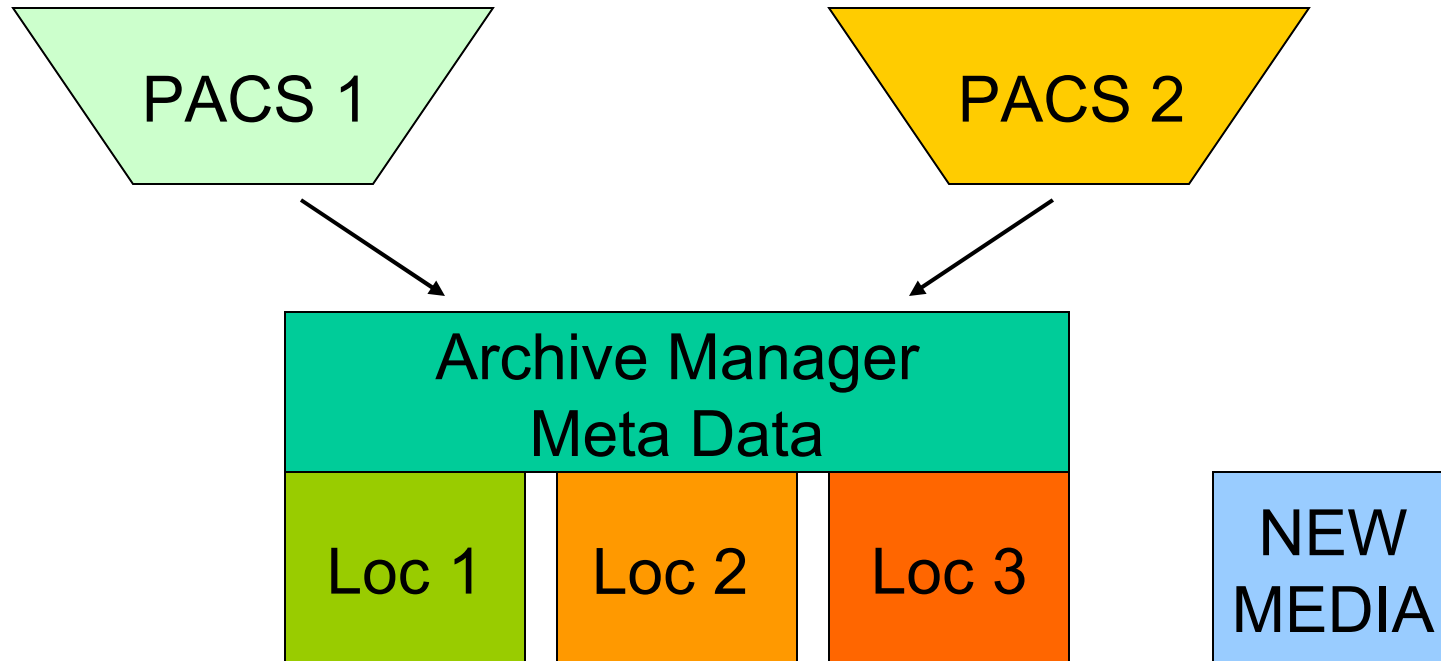
SAM Policies



Sample Policies:

- Store data from PACS 1 & 2 to Loc 1 and Loc 3
- If data from PACS 1 is not accessed for 24 months, copy to loc 2, mark for overwrite on Loc 1
- If data from Loc 1 is not available, access Loc 2

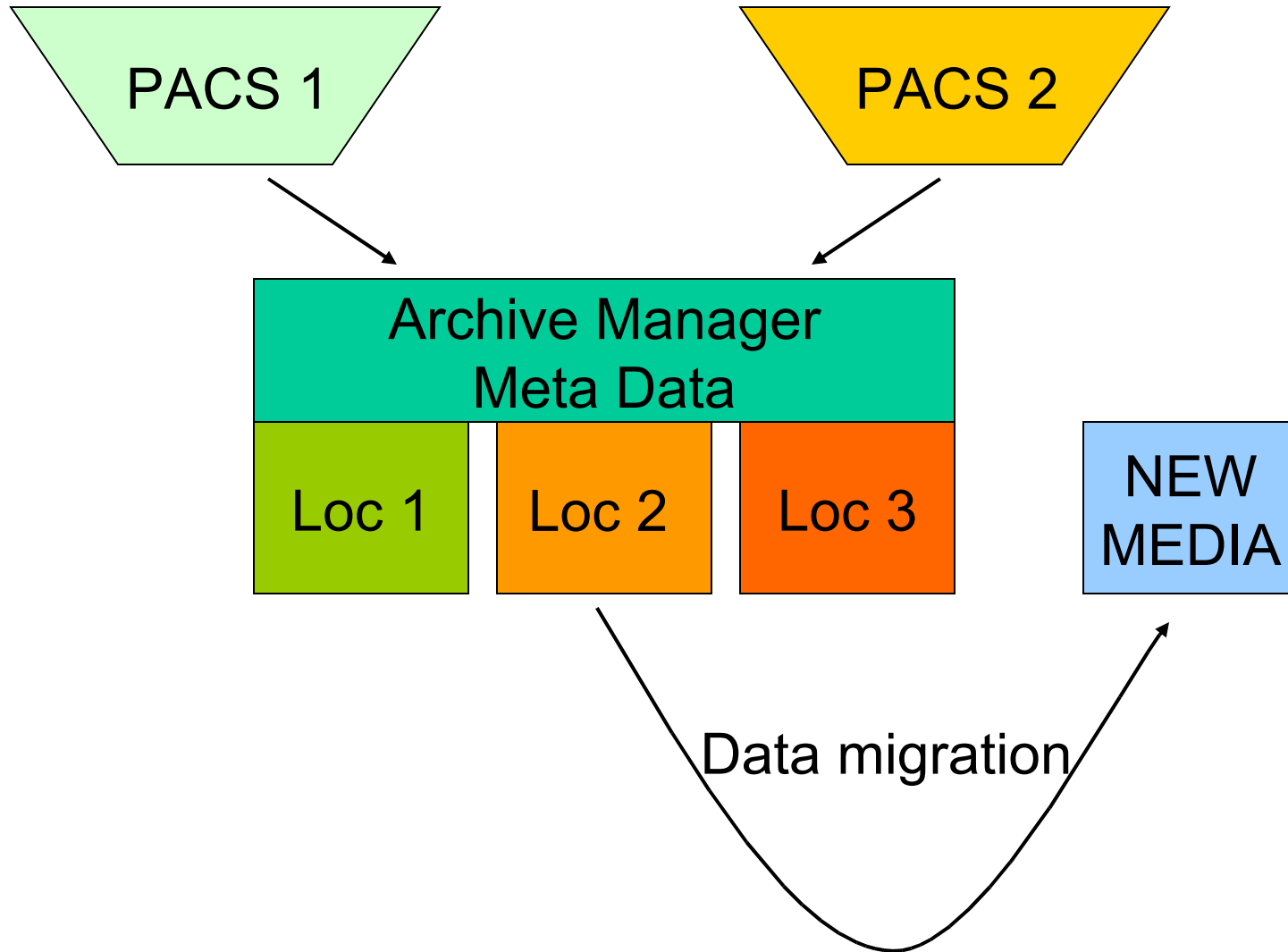
Data migration with SAM



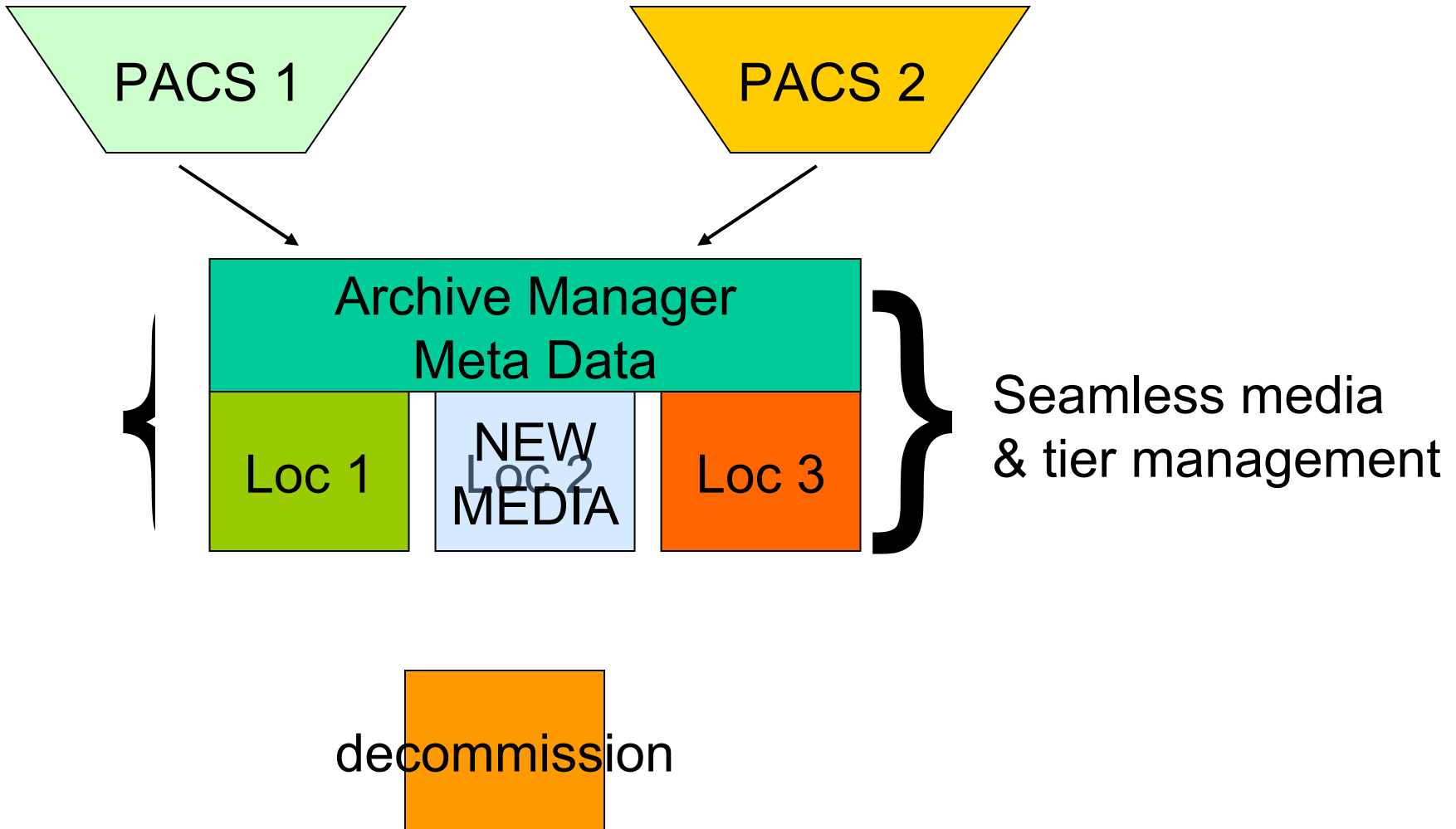
Sample Policies:

- Copy data from Loc 2 to NEW MEDIA (for example X4500)
- If data from PACS 1 is not accessed for 24 months, copy to NEW MEDIA, mark for overwrite on Loc 1
- If data from Loc 1 is not available, access Loc 2,
- if not at Loc 2, access NEW MEDIA

Data migration with SAM



New media integration with SAM



X4500: Low cost disk building block



- 36 TB <50k\$: ~ \$1.39/GB
- 48 TB <62k\$: ~ \$1.29/GB
- 2*dual core AMD
- 16 GB RAM
- 4*10/100/1000 MBit



Examples for SAM use with different PAC systems

- Cleveland Clinic
 - > PACS: Siemens Syngo
 - > http://www.sun.com/storagetek/success-stories/cleveland_clinic.xml
- Mayo Clinic
 - > PACS: Terramedica
 - > http://www.sun.com/br/healthcare_812/feature_brighter.html
- Kaiser
 - > PACS: Imageon
- Novant
 - > PACS: McKesson
 - > <http://www.sun.com/customers/storage/novant.xml>
- Kings Daughter Medical Center (KDMC)
 - > PACS: Philips
 - > <http://www.sun.com/customers/storage/kdmc.xml>
- Greenville Hospital System
 - > PACS: Agfa
 - > <http://www.sun.com/customers/storage/greenville.xml>
- Ludwig-Maximilians University, Munich
 - > PACS: Agfa
 - > Wirth et al., 2006, "Hard disk online caches in [PACS]: how big is beautiful"



Cleveland Clinic

SAM Archive with more than 300TB online, adding 1TB per week



So here's how ILM works, Cleveland Clinic-style:
"Within 15 minutes of being created, patient data is in five places," Cecil says. Data goes from the terminal where it is originally entered, to the nearest workstation, to the distributed PACS server, then on to a Sun Microsystems Inc. (...) Content Infrastructure System, and finally to a [Sun STK. (...)] tape library.

Then the data starts coming off systems in the same order. Within five days, the information is only on the Content Infrastructure System and tape. After a month, any record that hasn't been recently accessed comes off disk completely and resides only on tape.

Source: Robert Cecil, Ph.D. in http://www.byteandswitch.com/document.asp?doc_id=68310



Customer Snapshot: Healthcare

King's Daughters Medical Center (KDMC)

Sun teams with Philips Medical Systems to consolidate storage and lower upgrade costs for regional hospital

King's Daughters Medical Center, or KDMC, is a not-for-profit, 385-bed regional referral center in Ashland, Kentucky, offering comprehensive cardiac, medical, surgical, pediatric, rehabilitative, psychiatric, cancer, neurological, pain care, wound care and home care services. In 2005 and 2006, Solucient—a leading information products company serving the healthcare industry—named KDMC one of the nation's 100 top hospitals.

Business Issues

- Consolidate storage residing in disparate silos in medical departments and other functional areas
- Simplify administration of storage infrastructure
- Build in flexibility and adaptability
- Ensure timely, secure, highly available access to medical images
- Maximize value of storage investment through high utilization

Solution

KDMC relies on the EasyAccess picture archive system (PACS) from Philips Medical Systems and a Sun StorageTek end-to-end information lifecycle management (ILM) infrastructure to provide reliable, secure storage of medical images and other enterprise data.

Business Results

- Greatly simplified storage administration, resulting in less time spent on routine management tasks
- Better patient care and improved staff productivity with up to threefold decrease in time to decompress and display images
- Projected capital savings of \$400K over five years compared to nearest competitor
- 80% decrease in time to back up image database
- Enhanced compliance with HIPAA and other regulations

Products / Solutions

- » Sun StorageTek FlexLine FLX380 enterprise storage system
- » 2 Sun StorageTek FlexLine FLX280 enterprise storage systems
- » Sun StorageTek StreamLine SL500 modular library system
- » Sun StorageTek SAM-FS software
- » Sun StorageTek ACSLS Manager software
- » Sun StorageTek Business Analytics software
- » Sun StorageTek Remote Volume Mirror (RVM) software
- » Brocade SilkWorm 4100 enterprise fabric switches

**KING'S
DAUGHTERS**
MEDICAL CENTER

Taking Medicine FurtherSM





Medical Image Archive Architecture

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