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ECONOMIC BENEFITS OF THIN CLIENT TECHNOLOGY

The Visage® thin client solution enables radiologists as well as clinicians to leverage advanced imaging techniques on an enterprise level, and to take advantage of the three- and four-dimensional information contained in high-resolution cross-sectional images.

This article explains the motivation and benefits of deploying enterprise thin client solutions, including various reports and comments from Children's Hospital of Alabama, Dartmouth-Hitchcock Medical Center, and Massachusetts General Hospital. The luminary Visage users explain in their words how the thin client helps them increase revenue, save cost, simplify IT, improve the service offering towards referrers, enable teleradiology and distributed reading, and streamline overall imaging workflow.

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Background

The development and proliferation of multi-detector computed tomography (CT) and complex magnetic resonance imaging (MRI) techniques are improving treatment decision-making by helping clinicians understand complex anatomy and detect fine details of pathology that may influence diagnosis and guide operative planning. The techniques also support specialized clinical applications across imaging modalities and medical specialties to facilitate the analysis of vascular abnormalities, cardiac function, and combined nuclear medicine and imaging studies.

Advanced 3D imaging technologies have also, however, generated massive numbers of images for radiologists and clinicians to view. While a standard 2D study of the abdomen and pelvis yields 60 to 70 images, a multi-detector CT exam produces as many as 900 images. A 3D CT angiography (CTA) case now generates 2000 images, and a single multi-phase cardiac exam produces up to 8000 images.

Larger volumes of data from 3D CT and MR multiphase, contrast-enhanced, and functional studies are pushing the limits of existing information technology infrastructure as they strain the operation of older and slower servers, clog and interrupt the flow of data across low-bandwidth networks, and surpass the capacity of workstation memory and graphics as well as diagnostic software. For example, when configured at the conventional 512 x 512 in-plane resolution, a single 2000-slice CT runoff exam amasses 1 GB of data just for quick multi-planar image display from the main memory. A multi-phase CT cardiac exam can easily consume a total of 4 GB of memory and require more memory for post-processing imaging. When the in-plane resolution increases to 1024 x 1024 in the near future, the total amount of data will multiply by a factor of four. As this data explosion is taking place, hospitals and other clinical enterprises are searching for technologically feasible solutions that will address their needs in an economically attractive way.

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The Economic Case for Thin Client Technology

The development of high-resolution 3D multi-detector CT and image fusion technologies has vastly improved the quality of clinical images so clinicians can make more informed treatment choices. It has also, however, complicated the delivery of images to the physicians who have to make those critical decisions.

Hospitals, such as Massachusetts General Hospital (MGH), have relied on picture archiving and communications systems (PACS) for primary image interpretation and web-based distribution for transmitting images to referring physicians. That type of arrangement breaks down, however, when a hospital's radiology department starts generating high quantities of images.

MGH conducts about 750,000 exams a year for the 5000 physicians in its practice community in Boston. Factoring in outlying areas such as Martha's Vineyard, the department handles nearly 1 million exams annually. In and of itself, MGH's 3D core lab conducts about 50,000 studies a year with 3D visualization.

MGH's Amicas system, which was one of the first web-based image distribution networks in the country, just could not support such large-scale 3D remote client visualization, said Keith Dreyer, MD, PhD, vice-chair of radiology at MGH and assistant professor of radiology at Harvard Medical School.

"Trying to push 10,000 images from one exam through a web server didn't make sense, not because the web server couldn't handle them but because the referring physicians just couldn't look at 10,000 images. They needed 3D representations of the images and the ability to slice into the 3D data set for analysis. The orthopedic surgeons, neurologists, neurosurgeons, and oncologists had to be able to look at all the images, probably in even more detail than radiologists did, to assess and measure changes in lymph nodes and plan the surgical procedures that would take out specific lesions," Dr. Dreyer said.

Increasing numbers of hospitals like MGH are therefore shifting from PACS that link loosely with 3D workstations for viewing and post-processing images to a thin client system that centralizes 3D processing and incorporates streaming technology so thin clients handle all viewing and processing functions.

Thin client technology eliminates the need to send data back and forth from imaging modalities to PACS and workstations and maintains full data integrity through a centralized, single-point accessible exam database. It also frees up data flow by avoiding peak bandwidth problems. As a result, original 3D data sets are made immediately available to clinicians on their own viewing stations regardless of where they are located. Clinicians also can make use of advanced multiplanar reformatting and 3D navigation features to guide their analysis of imaging information, regardless of the speed or the memory of their workstations.

By streamlining the distribution of original 3D data sets to clinicians, thin client technology not only hastens and enhances decision-making for clinicians; it also confers economic benefits on hospitals. This paper identifies some of the economies hospitals are beginning to realize with the adoption of thin client technology.

Economic Benefits

Cost Savings. Three-dimensional thin client images are immediately available on virtually any clinical-quality personal computer. Hospitals therefore do not have to incur the costs of adding advanced hardware for 3D image viewing throughout the hospital or in remote sites.

The Pediatric Imaging Department at Children's Hospital is the fifth largest pediatric radiology department in the country. Although it is part of the University of Alabama Medical Center complex in Birmingham, it has its own radiology information/PACS system, which cannot tap into 3D advanced visualization capabilities used by the university hospital's radiology department. Two years ago, therefore, Children's Hospital chose thin client technology provided by Visage Imaging to distribute 3D images and image manipulation tools to referring physicians. The Visage solution is fully integrated with the RIS/PACS environment used at Children's Hospital, and it has been deployed in a true "plug and play" fashion – without adding any administrative overhead.

When the University of Alabama added thin client technology, it retained its high-powered workstations for doing reconstructions in the radiology department and provided standard PCs in the CT reading room. The hospital also enabled access to imaging information by physicians outside the radiology department so they could perform 3D exam manipulation and analysis on original image data sets on their existing office PCs. All that had to be added was a pair of central servers in the radiology department.

"The radiology department has always had advanced workstations for manipulating data. But if clinicians wanted to see original imaging data, they had to come to the department to view the imaging slices. Even then, the information may not have been processed in the way they wanted so they could decide how to surgically approach a tumor. Physicians now are able to efficiently utilize 3D image data sets because they have quick and easy access to them. If data access is easy, simple, and quick, then it is valuable and powerful in the way that it can transform the clinicians' understanding and approach to cases. And there is no added cost involved in obtaining extra hardware to distribute images around the hospital," said Stuart A. Royal, MD, clinical professor in the pediatric radiology section of the University of Alabama, Birmingham.

IT Infrastructure. Thin client technology does not place any additional burden on hospital information management systems. The information that creates 3D images is placed on separate servers that can be queried to perform data manipulations. Large amounts of data are not strewn across the IT system, and there is no pressure on bandwidth so 3D image manipulations do not clog or slow down the system for other image transfer purposes.

"If you get thin client technology, you don't have to reconfigure your IT infrastructure, the computers in the radiology department or the hospital, or the speed and bandwidth of the infrastructure for IT purposes. For most hospitals that are already electronically enabled, a thin client system can be put on their networks without stressing them out," said Dr. Royal.

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Clinical Efficiencies. The ability of thin client technology to speed the diagnosis and development of a plan for a patient's treatment is difficult to measure. However, the efficiencies that are created by bringing 3D data sets and post-processing capabilities to the physician's own PC are powerfully and palpably felt throughout a healthcare system. Referring physicians can obtain all the images from a CT scan of the body without waiting for them to be reconstructed in different imaging planes or traveling to the radiology department to view the images. Within minutes, the physicians can access images in any plane from any PC in the hospital, their office, or a treatment suite because the images reside in the memory of the server and anyone with appropriate security authentication can review images independent of location.

Within the radiology department of Children's Hospital, thin client technology has become a helpful tool for interpreting images from patients with complicated congenital anomalies, tumors, or fracture fragments in the extremities, chest, or head on a case-by-case, day-in and day-out basis, said Dr. Royal. Thin client technology also offered a capability that the Children's Hospital did not have: online distributed reconstruction outside the radiology department.

For referring physicians, the technology has provided easy quick-click tools for accessing and processing images for preoperative planning and trauma care. One of the top three diagnoses for Children's Hospital is hydrocephalus. Thin client technology gives surgeons an understanding of the volume and the anatomy of the ventricular system so they can decide how to place catheters to drain the fluid.

The 3D views give maxillofacial surgeons, neurosurgeons, and orthopedists a more complete understanding of traumatic fractures to the craniofacial and craniocervical areas, which can translate into more effective and more efficient surgical treatment and better, more cost effective outcomes.

"It's surprising how often physicians arrive at a different diagnosis or treatment plan when they can do 3D reconstructions versus a routine set of cross-sectional images from CT. Because of the 3D capability, they may realize there are other fracture fragments that are located adjacent to a blood vessel. It has huge ramifications for how the surgeons will do their procedures to avoid vascular and nerve injuries. But it is appropriately utilized only if physicians have quick and easy access to data manipulation tools. By making the tools distributive, they become valuable and powerful in the way they can transform a physician's understanding of cases and approach to care," Dr. Royal said.

"The extent of the economic benefit of thin client technology has yet to be proved, but it's an ideal tool to be analyzed in a clinical study to determine whether it in fact decreases length of stay, decreases morbidity and mortality and improves outcomes by improving the access to imaging data. In the next few years, this hospital and other places are going to be doing these kinds of studies and prove that it's true," said Dr. Royal.

Workflow Efficiencies. Thin client technology is improving efficiency inside as well as outside the radiology department. The technology is new to MGH; the hospital acquired Visage Imaging CS Thin Client Technology in 2006. Dr. Dreyer therefore has not had an opportunity to quantify its economic benefits. He nevertheless believes the technology will produce the same kinds of dollar cost savings that PACS, voice recognition, and web distribution have. When Dr. Dreyer analyzed the economic benefit of voice recognition, for example, he concluded that MGH should be able to save $1.5 million a year by decreasing report turnaround time and reducing errors in reports. He expects that thin client technology will also reap huge savings.

"There is a saving in cost and time by not requiring a physician to go down to the department of radiology or to some spot where there is a thick client solution. There is efficiency if you look at thin client technology versus web distribution and a standard 2D client," he said.

Within the radiology department, thin client technology is increasing productivity in several ways. Dr. Dreyer explained that technologists no longer have to handle preprocessing at the scanners. By offloading that function, MGH has been able to shift higher-salaried personnel from routine tasks at the scanners to more complex and demanding duties, conduct more cost-effective scanning by doing analysis off the scanner, and increase the utility of the scanners.

"Before, we might have had a scanner tied up doing post-processing. Now we can put in more patients for scanning. So we don't have pay millions of dollars to buy more CT scanners but we can still meet our demand," Dr. Dreyer said.
Beyond that, the process puts image analysis in the right hands - those of the clinicians and the radiologists.

"Before, it was the technologists who had to preprocess and represent the images to the clinicians who wanted to get answers to specific clinical questions. But the questions may not have been answered by the way the technologists did the processing," he said.

From an information technology infrastructure standpoint, hospitals like MGH have needed 3D visualization for at least 15 years. Until the thin client solution became available, however, hospitals could not allow images to leave the confines of the radiology department.

"We couldn't support it from the technical cost and customer satisfaction standpoint. We couldn't meet the need. Until thin client technology came along, we couldn't even consider delivering a solution outside the radiology department," Dr. Dreyer said.

Competitive Advantage. Thin client technology may give hospitals a competitive edge in attracting the best physicians to join their medical staffs.

Supplies of physicians in the United States continue dwindling. The Association of American Medical Colleges believes there will be a shortage of 85,000 to 200,000 physicians by 2020. In some communities, hospitals are already vying with one another to recruit and retain physicians.

"When physicians know that images will be immediately available to them and that they will be able to manipulate them in their offices, that is a pretty powerful marketing tool for a healthcare system," said Dr. Royal.

This becomes particularly attractive because state-of-the-art thin client systems can provide all of the same tools operating over a wide area network (WAN) or even directly via the Internet. All of the 3D tools are available from home or anywhere a broadband connection is present.

Network Resource Savings. A thin client-based configuration is able to share image processing resources because it relies on a central server and web-based deployment among large numbers of users. As a result, it reduces the time and cost of keeping data and software up to date and consistent across the healthcare enterprise. For example, instead of renewing the hardware for 12 post-processing workstations every three or five years, a hospital could renew the hardware for two render servers that host 12 concurrent users. The hardware update cost alone makes a big difference, plus there is a significant difference in having to touch twelve machines or only two.

Installation and maintenance of thin client technology also save countless staff man-hours for installation as well as for software and hardware maintenance. When Dartmouth-Hitchcock Medical Center, Lebanon, NH, installed the Visage CS solution, the new server system was linked into the hospital's computer network, and DICOM routing rules were configured to include the Visage server. Right after that, the system started processing images, and users could start downloading the thin client software to their client PCs, said Michael Tsapakos, MD, chief of body imaging.

"Whatever we wanted to put on each computer, we just logged onto the Internet and downloaded the client link onto the desktop so when physicians opened the link, it connected them directly to the server," said Dr. Tsapakos. Under a workstation environment, the hospital's technical personnel would have had to set up each workstation individually, add more entries to the DICOM routing tables, and configure the network to accept large data set flow.

Technical staff also would have had to upgrade numerous workstations with better graphics and more memory across the entire Dartmouth-Hitchcock healthcare environment on a regular basis. "With Visage CS, you obtain a truly modular and scalable system. You can simply add new application servers and stop using older ones without any downtime. The upgrade is done centrally, and all users can immediately benefit from the increased performance or larger number of concurrent users. Since the application server hardware is separate from the storage and database server hardware, the patient database and user-specific configuration data do not need to be touched when upgrading application servers. These features can make a huge difference when looking at the risk of downtime and the total cost of ownership over an extended period of time," Dr. Tsapakos said.

Flexibility. A thin client package from Visage Imaging gives hospitals the opportunity to build an enterprise solution gradually and spread costs over several budget cycles. Dartmouth-Hitchcock Medical Center purchased a starter package that allows 16 users to run thin slice-based 3D post-processing simultaneously. In the future this fully scalable system can be expanded in terms of storage volume and number of concurrent users while maintaining the same image database.

"We can now have up to 16 users accessing the server at the same time. The advantage is that people within our radiology department can simultaneously do 3D reconstructions on the server. We are planning to implement the system in other departments like orthopedics and vascular surgery to allow them to create their own 3D views and tailor them to meet their needs," Dr. Tsapakos said.

Clinicians then will have the ability to obtain multiplanar reformations, navigate through 3D data sets, and apply 3D measurement tools. Physicians will be able to choose thick or thin image slices; maximum intensity projection and volume-rendered images, and they will be able to segment, quantify, and compare images as soon as scans are completed.

Increased Revenue. By adding 3D formatting to routine CT examinations, hospitals can increase reimbursement and revenue. Dartmouth-Hitchcock Medical Center has been conducting an economic analysis of the value of 3D reformatting of CT images that calculates the time needed to perform such tasks as tumor volume measurement, the amount of additional reimbursement that may be obtained, the number of cases that may be done on a weekly, monthly, and yearly basis, and the total amount of additional revenue that may be realized. Within two months of acquiring the Visage system, the hospital doubled the number of monthly 3D reconstructions it performed and the amount it collected in revenue. The hospital had routinely been averaging about 30 3D reconstructions per month. In the first month, the number of reconstructions jumped to 58; in the second month, the number rose to 67. At a minimum, the hospital has increased reimbursement by more than $4000 a month.

"That's only from the first two months, and it's not even our full potential," Dr. Tsapakos said.

Cost-Effective Service Expansion. Thin client technology adapts easily to meet the imaging needs of growing health care enterprises.

The Nuffield Health Group, which provides health care services throughout the United Kingdom, continues to grow and expand into new areas. It encompasses 32 hospitals (31 in England and one in Scotland), an employee health and wellness center, a leading health club, Europe's largest and most modern fleet of mobile hospitals and operating theaters, and comprehensive MRI and CT imaging.

With the modernization of radiology within the Nuffield Health Group, which included the addition of 64-slice CT scanning, a cost-effective alternative to standard RIS/PACS was needed to provide 3D imaging to a far-flung and expanding network of users.

"We decided to purchase the Visage CS system because a thin client approach with an installation in our data center in London could be reached by any of 600 radiologists countrywide. This centralized approach will save us more than 100,000 pounds over a multi-year period," said Mike Leach, head of IT for the Nuffield Group."

Cost/Benefit. Thin client technology supports MGH's 3D core lab, which as a profit center generates $2 million to $3 million a year. At the same time, the technology keeps down costs by minimizing the need for acquiring additional hardware. Remote sites do not have to replace existing computers with expensive new workstations.

"It's the same technology to look at the web and to look at 3D images. In fact, you can have a less powerful network and less powerful computer because thin client technology does not produce heavy network traffic. All you need is a reasonably up-to-date PC and a decent monitor—nowadays you can get a good color monitor for $600," Dr. Dreyer said.

From an economic and efficiency point of view, therefore, thin client technology was the only tenable option for delivering images to referring physicians for MGH. Thick client solutions just were not practical in the operating room or in physicians' offices.

"The only way to get information to our referring clinicians was to pay attention to existing hardware at the remote sites and have a software solution with a zero footprint so it could be upgraded from the server and we wouldn't have to go out to all the client sites," said Dr. Dreyer. "There was no other solution."

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