

WHITE PAPER

**3DR LABORATORIES, LLC
A BUSINESS MODEL FOR
THIN CLIENT TECHNOLOGY**

After maintaining its own 3D image-rendering laboratory for a few years, Borgess Medical Center, Kalamazoo, Michigan, was facing a million-dollar expansion in 2007 if it wanted to replace a fat client program that had become obsolete and purchase enough new workstations to handle the increasing demand for high-quality CT post-processing. But the hospital couldn't afford the capital expenditure or the cost of pulling radiology technologists away from scanning to process images.

Baptist Hospital East, Louisville, Kentucky, was in a similar position three years earlier. The overall volume of 3D cases was increasing and so was the complexity, as the hospital's active cardiology practice began doing more functional cardiac analyses, including real-time heart wall motion examinations, and radiologists got more involved in CT/PET fusion studies. But it didn't make economic sense for radiology technologists to spend time in front of a terminal rendering a scan when they could be gaining more for the hospital in reimbursement by sending patients through a scanner.

To handle burgeoning 3D imaging volume without eroding revenue or incurring burdensome capital expenditures, both hospitals turned to 3DR Laboratories, Louisville, Kentucky. 3DR Laboratories is a 3D medical post-processing outsourcing service that provides 24 by 7 access to highly trained "Super techs" who create sophisticated 3D medical images, follow customized, physician-specific protocols, turn routine cases around in less than four hours and STAT cases in less than an hour, and process abdominal aortic aneurysm stent measurements in eight to 12 hours. Borgess Medical Center now sends 150 to 200 cases a month to 3DR Laboratories for post-processing, and Baptist Hospital East uses the company to render between 50 and 100 cases a month. It makes economic as well as clinical sense for hospitals such as Borgess and Baptist East to contract with 3DR Laboratories. Small to medium-sized hospitals can save an estimated \$250,000 in upfront workstation costs and \$25,000 in annual licensing or upgrade fees, and they can gain more than \$200,000 in yearly revenue (see Appendix A).

3DR Laboratories have been growing steadily since it was formed in 2004. Business did not begin to leapfrog, however, until the company washed its hands of fat client technology in 2007. Since then, growth has been exponential. In the last year alone, the number of 3D cases processed by 3DR Laboratories increased tenfold. The company now renders about 2000 cases a month for large as well as medium- and small-sized community hospitals, independent imaging centers, and radiology groups that provide onsite reading or interpretation services.

3DR Laboratories' rapid expansion would not have been possible without thin client technology from Visage Imaging.

The Fat Client Workstation World

When 3DR Laboratories were formed, its business model was based on the technology that was on the market at the time: fat client image-processing workstations. Although

the company gained a reputation for producing high-quality images and achieving rapid turnaround times, growth languished because reimbursables were not as high as expected and prices for post-processing with fat clients were substantial.

There was no problem with the concept behind the company. Many hospitals and imaging centers embraced the idea of outsourcing to obtain high-quality 3D image renderings in a matter of hours on a 24 by 7 basis. Holding the company back was the need to have fat client workstations.

Fat client options undermined the value a hospital might realize by outsourcing 3D image processing. A hospital would gain little if it paid for outsourcing and still had to purchase and maintain expensive workstations so physicians could provide their own input.

“Even though our radiology technologists had been extensively trained to process 3D cases, physicians didn’t want to give up the capability of adding some form of image manipulation to a case, maybe to segment another vessel or do a measurement the radiology technologist had missed or hadn’t seen or include something that wasn’t called for in a protocol. And that meant the physicians had to have access to expensive fat workstations,” said David Ferguson, chairman and senior managing director of 3DR Laboratories.

Flat client technology also interfered with 3DR Laboratories’ business strategy. The business model for an outsourced 3D image-processing laboratory was just not scalable with flat client workstations. “If the only things we had to offer were fat workstations, we not only had to hire a person every time we needed more capacity on a shift, we also had to buy another \$250,000 or \$300,000 workstation. Unless we could develop a pricing model that allowed us to charge a couple hundred dollars per case or less for rendering, we couldn’t possibly build an economic model that would work for our company,” Ferguson said.

The Thin Client Solution

Ferguson realized that 3DR Laboratories needed to use multiclient servers. “I had been using thin client solutions from the accounting and insurance worlds for years, but these solutions weren’t designed for high graphic applications. So we started looking for 3D multiuser thin client solutions in medical imaging,” Ferguson recalled. But software for 3D clinical image processing at the time was optimized primarily around fat workstations. To run on a multiuser server, Ferguson explained, vendors had to rewrite software from the ground up so it would accommodate the different speeds associated with moving data or copies of data across an Internet link rather than at the higher speed pathways available within a workstation. “If you are going to move a screen capture of a heart once every nanosecond within the circuitry of a workstation, you write the software one way. If you want to move it across a 5 megabit Internet connection, you write the software another way,” he said.

Only one vendor—Visage Imaging—from the beginning wrote software to run on a multiuser, Thin Client/Server using broadband speeds generally available to Internet users. “The Visage Imaging server was built from the ground up to be a Thin Client/Server application. The software had a lot of power, and we believed the company would move rapidly to improve the clinical capability and bundle the software to make it easier and easier for radiology technologists to use. We also found that the server was highly efficient in its requirements for Internet capacity. It worked on a very low bandwidth and needed relative low latency. It could perform well with as much as 80 or 90 milliseconds of latency. So for all practical purposes, we could handle most of what we wanted to do on the Visage Imaging Thin Client/Server as long as we had a reasonably good broadband connection,” he said.

The Thin Client/Server from Visage Imaging is being used by hospitals across the country to transfer complex 3D data sets to physicians on their own viewing stations no matter where they are located. It also allows physicians to apply advanced multiplanar reformatting and 3D navigation tools in their analysis of imaging data no matter how sophisticated or powerful their workstations are. When hospitals such as Massachusetts General Hospital, Dartmouth-Hitchcock Medical Center, and the Children’s Hospital of the University of Alabama use the Thin Client/Server to process their own 3d image data sets, they find they can reduce workstation costs, increase productivity, and accelerate diagnostic and treatment decisions. 3DR Laboratories helps hospitals that do not wish to handle 3D image data processing gain the same kinds of benefits from thin client technology.

Thin Client Technology at Work

Because of Visage Imaging’s thin client option, 3DR Laboratories could either process its clients’ 3D cases on centrally located multi-user servers or place servers in a remote location where the company’s super techs could process images by accessing the servers through a broadband virtual private network. Both Thin Client/Server configurations allowed client radiologists and referring physicians to perform additional post-processing at a fraction of the cost of a fat client workstation solution. “We could have three or four radiology techs share a box that would cost less than \$100,000 plus less than \$10,000 per year for software maintenance. So all of a sudden we had almost a ten to one cost advantage over a fat client workstation configuration. These advantages have provided 3DR with the technology infrastructure that allows us to market our central processing laboratory economically while providing client physicians with access to perform additional post-processing. We can charge rates that are 1/2 to 1/3 those of our competitors,” Ferguson said.

3DR Laboratories are now an OEM for Visage Imaging. “The Thin Client/Server capability from Visage Imaging has fulfilled just about everything we wanted it to do. It has not been economically justifiable for us to use the equipment and software that are available from other vendors because they have not been as competitive or as capable at slower speed lines as Visage’s,” Ferguson said.

Visage Imaging technology also has led 3DR Laboratories to carve out a niche educational venture that uses thin client technology to teach the next generation of radiologic technologists.

Online Education in 3D Image Processing

As 3DR Laboratories learned soon after it launched business operations, hospitals are eager to send their radiologic technologists back to school to get their radiology departments up to speed on 3D image processing. But hospitals often have difficulty finding the right educational venue.

First, Ferguson explained, hospitals try sending technologists for a three-day or a week's worth of instruction from an image-processing vendor, but they soon learn that these courses do not provide the kind of information that's needed to render 3D images. Vendor-sponsored courses provide nuts-and-bolts buttonology that acquaints technologists with the functions and operation of the vendor's proprietary workstations. But 3D image processing isn't a button-pushing exercise that directs the computer to do all the work with the click or two of a mouse.

Next hospitals try searching for online educational resources, but they soon find that these courses focus more on the challenges of imaging certain disease processes and categories of patients—not on post-image processing. Online education for radiologic technologists does not typically offer instruction on how to identify key anatomical landmarks in both two and three dimensions or provide detailed explanations of volumetric imaging techniques, such as multiplanar reformatting, curved planar reformatting, vessel tracing, and recording measurements in volumetric data sets. Nor does it expose radiologic technologists to standard protocols and best practices or allow radiologic technologists to log on and process live cases on their own PCs.

Jefferson Community Technical College (JCTC) and 3DR Laboratories, LLC, is filling the educational gap with 3DR Academy, an accredited volumetric medical imaging certificate program that provides technologists with comprehensive instruction in sectional anatomy, pathophysiology that is relevant to image post-processing, and post-processing tools both in the classroom and online by means of Visage Imaging's thin client technology.

"The Thin Client/Server has been a major value to us in setting up the Academy. We have an 18-concurrent-user setup from Visage Image that is dedicated just to support cases that are linked to the individual courses at JCTC. So we can support the students who are taking the full curriculum at Jefferson. We also support students who come online, take the course work, and see examples shown on the generic Visage Imaging Thin Client/Server screen. The Thin Client/Server allows students to log onto to a multiuser server and process case examples from home with any kind of broadband connection when they want to do a laboratory exercise," said David Ferguson, chairman and senior managing director of 3DR Laboratories, LLC, Louisville, Kentucky.

First Steps

About four years ago, 3DR Laboratories realized it needed to beef up education so it would have a steady supply of radiologic technologists who were thoroughly trained in volumetric imaging to staff its growing outsourced 3D image processing company. 3DR Laboratories approached JCTC, which already had a sizable radiologic technologist program; to develop a curriculum that would guide students through cross-sectional anatomy as well as the concepts of three-dimensional anatomy of the human body and in the process teach workstation functionalities and operations. Heather Brown, Ph.D., a bioengineer and researcher, therefore created a four-course, 16-semester-hour intensive inhouse program that would instruct and accredit radiologic technologists in volumetric image processing.

JCTC tried to expand the reach of the program to students across the country by offering courses and labwork online, but fat client technology interfered. Students from California or Florida or New York could get educational credit by taking JCTC's volumetric medical imaging courses online but they couldn't get hands-on experience with image processing unless they had access to a fat client at their hospital. Students couldn't become certified in volumetric medical imaging unless they traveled to Louisville to take their practical final examination at JCTC.

Visage Imaging's CS Thin Client/Server changed all that. A Thin Client/Server hosted by 3DR Laboratories at JCTC supports students who are taking the volumetric imaging course and working through an image-processing case on campus. More important, the Visage Imaging Thin Client/Server opens the door to remote access learning by students in their homes. The Visage Imaging CS Thin Client/Server operates on standard platforms, such as Windows 2000, XP 32 or 64 bit, or Vista, using an Intel Pentium #4 processor. It requires no special software or network connection, only a 2 Mbps bandwidth and latency of less than 80 ms. So the Thin Client/Server offers 2D and 3D image viewing anytime, anywhere over a standard, commercially available PC or notebook.

3DR Academy

The availability of the Visage Imaging CS Thin Client/Server allowed 3DR Laboratories to create 3DR Academy.com, an in-depth electronic educational resource for radiologic technologists who do 3D image post-processing.

3DR Academy serves as a self-contained virtual college accreditation program in volumetric medical imaging. The Academy offers tutorials and case work that lead to a certificate in volumetric imaging from JCTC. The four-course program is divided into a series of modules that cover cross-sectional anatomy from cadavers as well as in CT and MR images, common disease processes as depicted in clinical images, and the fundamentals and specifics of volumetric imaging techniques. Courses cover the creation and manipulation of volume-rendered images (including surface-shaded display and 3D maximum intensity projections), volume segmentation involving clip

planes, windowing, and sculpting, and tools for displaying the blood vessel lumen in CT angiography and polyps in CT colonography.

3DR Academy trains and supports 3DR Laboratories' own supertechs. "Before anyone can do live casework for us, they have to go through the bulk of the JCTC volumetric image processing program that is based on the Visage Imaging workstation. The program is also an internal education and reference material source for the supertechs we have already hired when they need to review how to do a type of case they haven't done in awhile," Ferguson explained.

In addition to 12 so-called supertechs who have graduated from the JCTC volumetric medical imaging certificate program in Louisville and become employees of 3DR Laboratories' outsourced 3d medical imaging processing company, between 40 and 50 students from coast to coast have taken 3DR Academy coursework over the Internet in just the last six months.

A version of 3DR Academy software teaches client physicians how to do post-processing. "Physicians don't need cross-sectional anatomy or disease pathology, but they do need to learn how to access and use various clinical rendering processes if they want to do additional post-processing on the Thin Client/Server," he said.

The Academy also helps to spread knowledge about volumetric imaging to an increasing population of radiologic technologists or medical professionals who want to learn about it.

Radiologic technologists who will become the supertechs of the future, who will handle 3D image post-processing and help physicians arrive at a prompt and precise diagnoses require a solid grounding in volumetric human anatomy as well as disease processes and sophisticated image-processing techniques, real-life examples of do's and don'ts, interactive practice on test cases, and the wherewithal to manipulate images, find a blood vessel even if the contrast agent isn't where it is supposed to be, manually track a center line when the software doesn't do it automatically, and know when to sculpt out a region of interest to trace a vessel in a shielded multiplanar image.

"We believe that by spreading the gospel about 3DR Academy, the Thin Client/Server, and volumetric imaging, we can improve the use of radiology and the quality with which radiologic diagnoses are made," Ferguson said.

How Outsourcing at 3DR Laboratories Works:

3DR Laboratories has two topologies: a reach-in and a reach-out option.

Reach-In. Hospitals and imaging centers using the reach-in outsourcing model transfer thin-slice DICOM files to 3DR Laboratories' Thin Client/Server in Louisville, Kentucky, via a secure virtual private network (VPN). A 3DR Lab "Super Tech" then creates images according to client-specific customized protocols and returns the processed images to the client hospital's PACS via the VPN. Radiologists and referring physicians at the client hospital access the processed images on PACS terminals for diagnosis or treatment planning. On rare occasions—about one out of every 50 or 60 cases—when a physician wishes to review a case and use image-processing tools that are available through 3DR Laboratories', he or she can log onto the Thin Client/Server and perform additional post-processing.

The reach-in option is used by hospitals and imaging centers that have a small volume of 3D image-processing cases—on the order of 200 or fewer cases per month—a small number of STAT cases, and little need for additional post-processing. About 80% of the hospitals and imaging centers that contract with 3DR Laboratories for outsourcing of 3D image processing use the reach-in model.

Reach-Out. Hospitals or imaging centers that have a high volume of 3D image-processing cases, require quick turnaround, or have frequent need for additional post-processing have a 3DR Laboratories' Thin Client/Server onsite. Instead of moving cases for image processing to 3DR Laboratories' central location, the hospitals transfer thin-slice DICOM files to their own server by means of a local area network. Super techs from 3DR Laboratories log onto the client hospital's server, prepare images according to customized protocols, and transfer the completed images to the hospital's PACS using the LAN. Radiologists and referring physicians may view rendered images from any PACS terminal or perform additional post-processing on the LAN-based server.

Baptist Hospital East, a member of the Baptist Healthcare System, has a 16-slice CT scanner that performs more than 50,000 examinations a year, the busiest CT imaging program in the state of Kentucky. The hospital began outsourcing 3D image processing to 3DR Laboratories in 2004 using the reach-in option. The hospital switched to the reach-out alternative last year not only to more easily and more economically handle steadily increasing case volumes but also to speed access to rendered images while at the same time reducing the telecommunications load on the hospital's PACS.

Borgess Medical Center, one of the flagship hospitals of Ascension Health, has streamlined 3D image processing since it contracted with 3DR Laboratories for outsourcing 3D image processing. By contracting with 3DR Laboratories to provide access to its Thin Client/Servers via the reach-in model, the hospital has speeded up image processing. Rather than having to wait until radiology technologists could carve out time for image processing—or add more staff to handle the load—Borgess Medical Center gets processed images from 3DR Laboratories that physicians can review or manipulate on any workstation in the radiology department within two hours.

APPENDIX A

Cost, Coverage, and Revenue from Inhouse 3D Image Processing and 3DR Laboratories Outsourcing

	Inhouse 3D Processing	3DR Laboratories Processing
24/7 Coverage	No	Yes
Time to Train Technologists	Minimum 9 months	Technologists Fully Trained
Upfront workstation cost	\$250,000	\$0
Annual licensing/upgrade fees	\$25,000	\$0
CT Scans per day	28	32
Revenue from CT per day	\$8,400	\$9,600
Cost of 3DR Laboratories services	\$0	\$360 (6 cases per day @ \$60 per case)
Net Revenue per day	\$8,400 less call pay for 24/7 coverage	\$9,240
Revenue per year (260 days)	\$2.16 million	\$2.4 million
The 3DR Difference		\$243,000 per year

Source: 3DR Laboratories. Figures reflect 3D imaging volume, costs, and revenue for a small- to mid-sized CT department that includes one CT scanner, one 3D image-processing computer, and two technologists working eight-hour days. Data assume six cases per day will need 3D image-processing at a workstation and will require four hours of tech time. Data also assume that two radiology technologists will be able to scan a patient every 14 minutes on a multislice CT scanner.

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