National Scalable Cluster Laboratory:

Grid Technology Brings Quantum Improvements to Medical Imaging

An On Demand Business Case Study sponsored by IBM

on demand Business Driver

Hospital radiologists needed a faster, more reliable way to share medical data to speed up and improve detection and treatment.

Business Process Adaptation

Hospital radiologists now access digital medical data in realtime, makes hospitals more responsive to patients' clinical needs.

Key Solution Elements

The solution employs a wide-area grid-based architecture that links seamlessly with hospitals' in-house networks and devices.

Why IBM

"We needed a vendor that could deliver all the basic components of a large-scale, on demand solution."

IDC

Analyze the Future

TABLE OF CONTENTS

THE NATIONAL SCALABLE CLUSTER LAB SOLUTION at a Glance

BUSINESS DRIVERS	**Customer Business Challenge**	Advances in digital medical imaging technology provide radiologists and physicians with the potential to vastly improve their ability to identify problems early and improve clinical outcomes. However, this potential has been largely unrealized due to the inability of hospitals to share patients' radiological data in a rapid, reliable and convenient way.
	on demand Business Rationale	Radiologists needed to be able to access patients' records from other hospitals in realtime, allowing them to be more responsive to the opportunities for improved diagnoses (and earlier treatment) presented by digital imaging technology.
BECOMING ON DEMAND	**Business Processes Adaptations**	Prior to deploying the grid-based solution, radiologists and physicians were required to access patients' radiological records from other hospitals through a time-consuming, paper-intensive and less reliable process. This process made it harder for physicians and radiologists to enhance their diagnoses through comparative analysis. By becoming on demand, radiologists and physicians gain realtime access to patient data. The system also enables automated analysis of imaging data, improving early detection and treatment of illnesses. This makes hospitals more responsive to the imperatives of early diagnosis and treatment.
	on demand Operating Environment	Hospitals became on demand by leveraging the NSCL's grid-based infrastructure for storing and sharing radiological data, known as the National Digital Mammography Archive (NDMA). The solution allows hospitals to plug into the grid, and to view and analyze data on existing hospital devices. The NDMA solution was designed and developed by the NSCL with collaboration from hospital radiologists.
ON DEMAND BENEFITS	**Business Benefits**	• The NDMA grid solution allows radiologists to access patient data in realtime, as compared to hours, days or weeks under the previous process. • Through the NDMA, hospitals can leverage a shared technology infrastructure, allowing them to avoid millions in infrastructure and IT management costs. • The use of digital medical imaging reduces an average hospital's X-ray film costs by millions of dollars annually.
	Technology Benefits	• Because the NDMA is an open infrastructure, hospitals are able to share patient imaging data with any other hospital on the grid. This also allows the grid to effectively be integrated into hospitals' internal infrastructures. • The NDMA grid provides hospitals with a large virtual infrastructure for storing and sharing data, allowing them to avoid upfront infrastructure costs.

SITUATION ANALYSIS

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>
> —Dr. Robert Hollebeek, Director, National Scalable Cluster Lab

Background

The National Scalable Cluster Lab (NSCL) began as a consortium of universities and corporate partners whose core mission was to develop and deploy highly scalable computing and storage platforms over a wide geographic area. The NSCL was founded in 1994 when researchers from the University of Pennsylvania, the University of Illinois at Chicago and the University of Maryland at College Park teamed up to leverage their collective expertise in large-scale computing and high-speed wide area networking technologies like ATM. From its earliest days, the NSCL has focused on developing the capability to move extremely large amounts of data between geographically remote databases to effectively create a single "virtual database." Its first projects—involving a range of scientific, economic and medical databases—were designed to create data mining, modeling and analytical tools that transparently accessed these virtual databases.

Much of the Lab's early efforts were directed at resolving the daunting technical issues presented by large-scale distributed storage platforms. The most important of these related to the organization of the data, the design of the storage infrastructure and the performance (i.e., speed) of the wide area network over which the data would be distributed. Dr. Robert Hollebeek, Director of the NSCL, sees the Lab's initial work as laying a crucial foundation for future distributed database solutions. "We learned what the necessary skills were to move and manage very large data samples over long distances—mainly how to organize them to effectively get the information out to who needs it," says Hollebeek. "But from very early on, the idea of creating large virtual databases—which at the time was really a precursor to both clustered computing and grid computing—was central to our plan."

The NSCL's mission came into sharper focus in 1998, when it began working with the University of Pennsylvania Medical Center to build a data mining application to gather and analyze brain scan data. Under the project, the NSCL acquired large volumes of functional magnetic resonance imaging (MRI) data (i.e., data used to visualize brain function by mapping changes in the chemical composition of brain areas) from the hospital's MRI devices. For the NSCL, the project led to substantial technical improvements in its ability to rapidly acquire data from external sources (i.e., MRI devices). But even more importantly, the Lab's work with UPenn underscored how effective its distributed approach to high-volume, high-speed data management could be in addressing the diagnostic imaging needs of hospitals. Hollebeek and his team wasted no time in putting this lesson to work.

Business Drivers: Faster Access, Improved Diagnoses

Soon after the MRI project, the NSCL began collaborating with UPenn radiologists to develop a better way to store and manage digital mammography images, which had arguably become the biggest driver of hospitals' digital archival "load." When hospitals began shifting from traditional X-rays to digital imaging, one of the key expected benefits was a more efficient process to archive and access these images. By storing images such as mammograms within their hospitals' Picture Archiving and Communications Systems (PACS), physicians and radiologists could now have access to patients' complete case histories without having to track them down manually—thereby improving their ability to diagnose and treat problems earlier. However, the fact that hospital PACS were generally standalone systems made the sharing of patient data *across hospitals* a relatively untenable process. Thus, the fact that PACS were effectively "islands" of patient data severely limited radiologists' ability to make the most of digital medical imaging technology. In sum, radiologists needed to be able to access patients' records from other hospitals in realtime, allowing them to be more responsive to the opportunities for improved diagnoses (and earlier treatment) presented by digital imaging technology.

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Bridging this gap became the NSCL's primary goal. Hollebeek sought to extend the scope of PACS-based digital archiving from a single-hospital scheme to one where multiple hospitals shared a common, highly scalable storage infrastructure. Under this plan, hospitals would upload digital mammography data from their devices to a secure, centrally managed archive. Users of the system—chiefly physicians and radiologists—would download patient data from *any hospital in the network* to workstations where they can, for example, compare current and older images to seek potential abnormalities. By allowing hospitals to plug into a wider library of patient data, this networked approach promised richer data mining capabilities than those offered by traditional PACS solutions.

At a high level, the initiative's key business driver was the need to provide radiologists in hospitals with an improved ability to share medical imaging data. Advances in digital imaging technology as promised had begun to improve the speed and accuracy with which medical imaging data could be rendered and analyzed. But a significant gating factor remained for hospitals: the cost of the infrastructure needed on the backend of medical imaging solutions. Thus was defined the initiative's other key business driver: the need among hospitals for a *leveragable* infrastructure over which they could share patient data. Driving this need were a host of factors related to both clinical and operational needs. The main clinical needs driving demand for an advanced data sharing infrastructure were the improved outcomes made possible through the advanced case tracking and analytical capabilities it enabled. Of these, the key benefit (discussed above) was an improved ability to compare a patient's mammogram records over time—even if the tests were conducted at multiple hospitals, a situation that can often break the "chain" of patient records. Other clinical benefits of the proposed archive included an ability to perform advanced diagnostic functions using analytical tools, as well as the potential to use the medical imaging data for training purposes.

The key operational factors driving demand for a scalable off-site archive was its potential to circumvent what has been the biggest barrier to hospitals' switching from analog to digital mammography—namely, the huge infrastructure investments they required. Noting the superiority of digital mammograms in terms of the capture, analysis, and management of the image, Hollebeek sees these infrastructure costs as the gating factor in digital mammography adoption. "If digital mammograms are so good, why didn't hospitals go out and buy them in large numbers? The answer is that while film costs go down, there is the requirement to build up and support an infrastructure to accept the data load generated by these machines," says Hollebeek. "It's not plausible that several hundred hospitals would be able to set up that kind of an infrastructure to handle the serious loads generated by digital imaging devices." A centralized mammography archive was seen as a way for hospitals to gain the benefits of digital mammography, while avoiding the need to build, manage and support the backend storage infrastructure.

ACTION PLAN AND DECISION PROCESS

Having secured funding from the National Library of Medicine, the NSCL set out to design and build the infrastructure for the archive. One of the most important factors impacting the team's technology choice was its goal of creating a grid-based solution with true end-to-end process integration. Such integration would enable hospitals' clinical procedures to seamlessly integrate with the solution's potent backend features. To make this possible, the NSCL needed the appropriate technology building blocks to create an on demand infrastructure; this meant tight integration, excellent manageability, and strong clustering capability. Hollebeek saw IBM as the ideal vendor to meet these exacting specifications. "We needed a vendor that could deliver all the basic components of a large-scale, on demand solution," says Hollebeek. "IBM was the only vendor that could bring all the pieces together for us."

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At the front-end of the solution (on the premises of each participating hospital) was a pair of portal servers that would act as the interface between the radiological devices that captured and displayed images and the backend archives where the images were stored. Given the need to minimize the burden on hospitals, these front-end servers needed to be simple and inexpensive to deploy as well as to maintain. Another key requirement related to simplicity was ease of monitoring. Because the overall solution called for these portal servers to be managed remotely from a central site (again, to minimize the burden on hospital IT staff), strong self-monitoring capabilities were seen as critical. Hollebeek's team selected IBM eServer xSeries x330, citing its small size, serviceability (i.e., the ease of hot swapping disks), and above all its remote manageability. "For the solution we were trying to build, remote monitoring and management capabilities were critical," says Hollebeek. "The strength of the x330's proactive diagnostics and remote capabilities made it a great fit." Hollebeek also cited the inherent redundancy of the x330 server—evidenced by its dual CPUs, power supply units and network interfaces—as a major plus.

As conceived by Hollebeek, the heart of the archive solution was a large grid of servers and storage devices that would handle image requests from the hospitals. As the number of hospitals on the network grew—Hollebeek projects as many as 2,000 eventually—the Lab would configure these backend resources in a series of regionalized clusters to optimize the performance of the network. As with the front-end servers, manageability was seen as the key criterion—given the sheer number of servers within the grid architecture. Hollebeek explains: "As the grid-based architecture of the solution grew larger and more complex, we saw the issue of manageability and serviceability becoming proportionally more important," says Hollebeek. "We were determined to minimize the resources we needed to commit to managing the solution." The team selected IBM's eServer Cluster 1600 solution, configured with 32 IBM eServer xSeries x342 servers. For storage, the team selected IBM EXP300 Storage Expansion Units, which are deployed behind nodes in the cluster. Hollebeek sees the inherent scalability of the eServer Cluster 1600 solution as one of its most powerful draws. "The beauty of this [architecture] is that we could expand the cluster from 32 to 320 nodes and it would still function in the same way," explains Hollebeek. "The xSeries cluster gives us a combination of horizontal scalability and remote diagnostic and management capabilities that we couldn't get with just any off-the-shelf server."

> "We chose Linux because it's very highly refined in terms of building distributed, scalable systems. It's just a lot easier to build and maintain clusters than the other alternatives we considered."
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> —Dr. Robert Hollebeek

As the processor of image requests, the solution's database engine would be the most critical component of the architecture, and would face the most demanding set of requirements. Scalability is at the top of the list, with the main drivers being the number of hospitals in the network and the sheer magnitude of the database (expected to approach 30 petabytes, or 30 million gigabytes). Robustness and throughput were also seen as critical attributes because of the overriding importance of delivering the "must-haves" for a hospital environment: speed and reliability. Hollebeek's team was also looking to satisfy a more specific set of requirements tied to its architectural strategy, the most important of elements of which were a reliance on clustering and parallel processing, and on the use of Linux. As Hollebeek explains, Linux was seen as far and away the optimal platform for such a large and highly distributed grid. "We chose Linux because it's very highly refined in terms of building distributed, scalable systems," says Hollebeek. "It's just a lot easier to build and maintain clusters than the other alternatives we considered." Hollebeek's team selected IBM DB2 Universal Database Enterprise-Extended Edition (EEE), citing its "uniquely powerful" parallel query processing capabilities as well as its scalability. "Performance-wise the solution needed a high-speed, robust database capable of supporting a high degree of parallelism," says Hollebeek. "This narrows the field very quickly—and DB2 EEE is at the top of that field." Hollebeek also called DB2 EEE's pricing structure, ease of administration and support of Linux key factors in its selection.

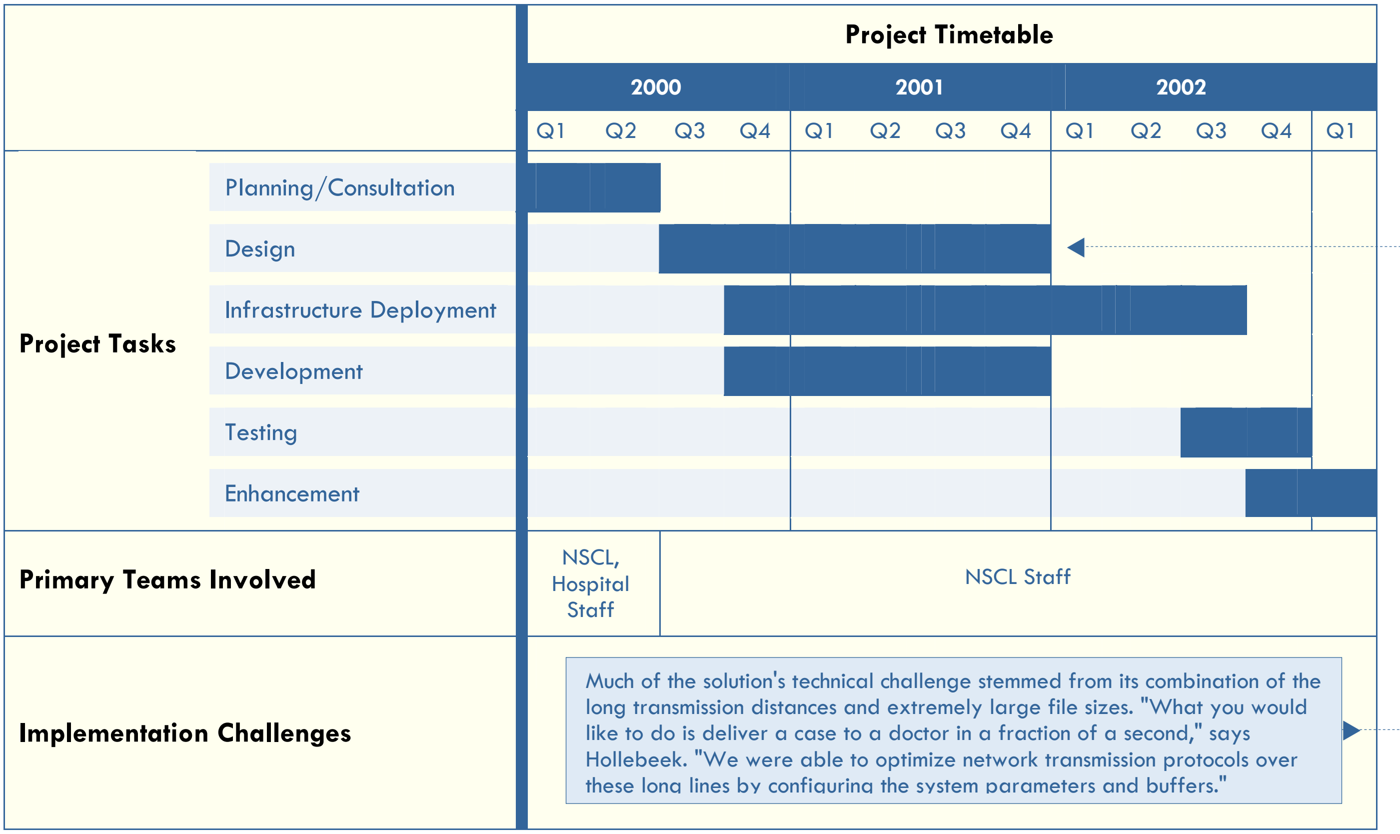
SOLUTION PROFILE AND IMPLEMENTATION STRATEGY

The Solution: Deployment Strategy and Overview

The NDMA solution was developed through the joint collaboration of Hollebeek's UPenn team, IBM, and a technical team from the Oak Ridge National Laboratory (responsible for the solution's Web front end and the security features of the system). While Hollebeek served as the project's Chief Architect, he received substantial design input from the hospitals (chiefly radiologists). Development of the NDMA solution, which began in 2000 and was completed in late 2002, occurred in three roughly year-long phases:

- In the first phase (2000), the team focused on the development and configuration of the wall plug, including the middleware that governed the wall plug's interaction with hospital devices.
- The second phase (2001) involved the actual deployment of the wall plugs in the four pilot hospitals, the establishment of their monitoring and maintenance procedures, and the design of the solution's database.

EXHIBIT 1: DEVELOPMENT TIMETABLE FOR THE NSCL SOLUTION



Source: NSCL/UPenn and IDC

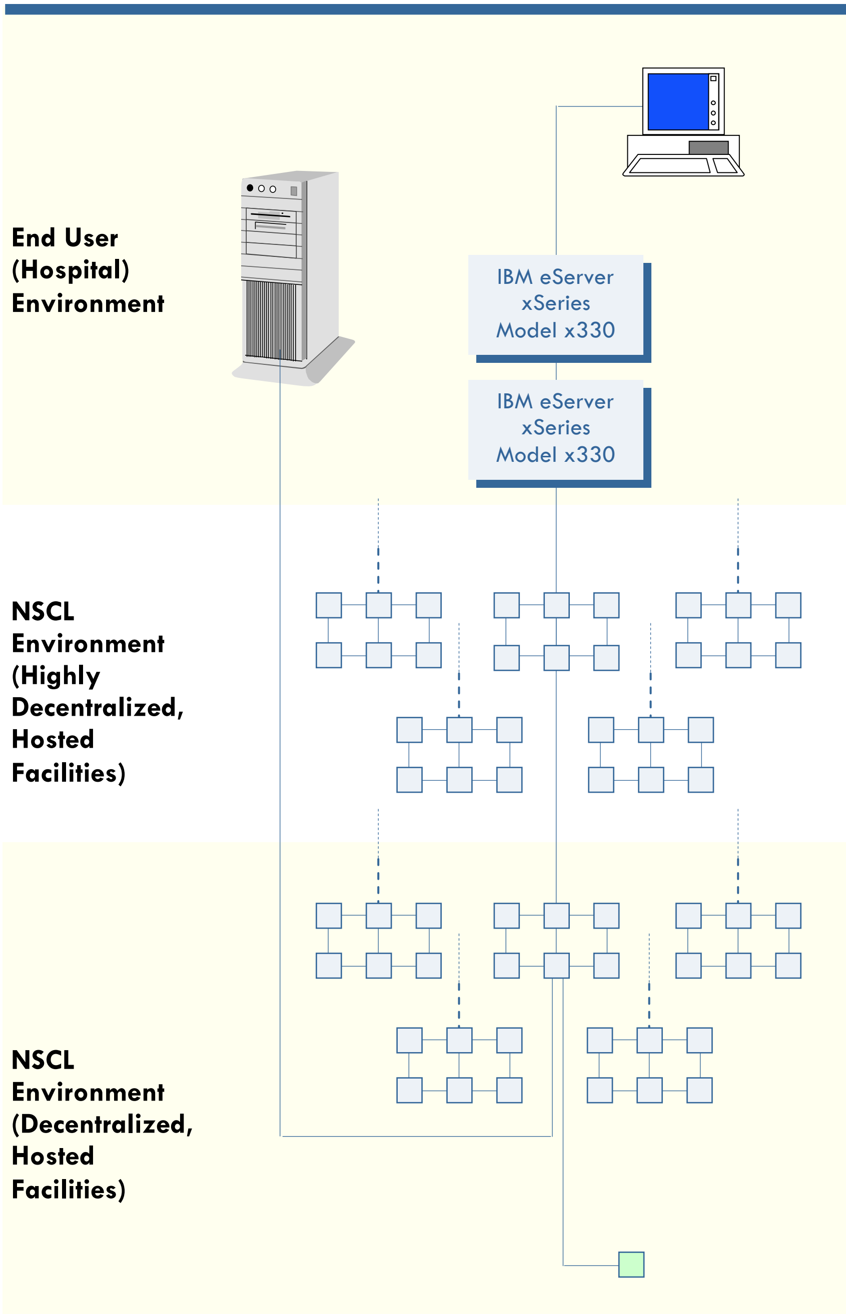
- In phase three (2002), the team finished the build-out of the grid infrastructure, completed their tests and modifications and in late 2002 got the production solution up and running.

The solution—known as the National Digital Mammogram Archive (NDMA)—allows affiliated North American hospitals to quickly and securely upload, download, and analyze digital mammogram image files regardless of where they were performed. The NDMA now connects hospitals at the University of Pennsylvania, University of Chicago, University of North Carolina at Chapel Hill, and the Sunnybrook and Women's College Hospital in Toronto. The solution's fundamental function is to store and index digital image data (i.e., mammography files) and deliver it to hospital locations on demand.

The NDMA employs a three-tiered, grid-based architecture. The first tier, known as the "wall plug," is comprised of a pair of rack-mounted x330 servers located on the premises of each of the hospitals on the network. One wall plug server caches the image data downloaded from backend archives (discussed below), while the other provides firewall functionality and integration with the NDMA's backend grid. [The Lab chose the term "wall plug" because it rightly suggested

EXHIBIT 2: BASIC ARCHITECTURE OF THE NSCL SOLUTION

Solution Topology



About Solution Elements

End User Profile

Users of the NDMA solution, typically physicians and radiologists, access the system through a secure Web portal. Users are authenticated via user name, password and digital certificate.

Customer Infrastructure

The "wall plug," a pair of x330 servers, is located at each of the hospitals on the network. One server caches the image data downloaded from backend archives, the other provides firewall functionality and integration with the backend grid.

“Metropolitan” Tier

The second tier of the architecture is comprised of a series of small IBM x342 and/or x330 clusters serving a limited number of clinical locations within specific metropolitan areas. These second tier metropolitan clusters will in turn feed into a small number of regional clusters (of x342 servers) known as "area archives."

“Area Archive” Tier

Area archives are linked to each other over T3 lines, forming (together with the metropolitan clusters) a wide-area grid, with any node in the grid able to share data transparently with any other. Area archive clusters will likely be housed in hosted facilities.

Storage

The NSCL uses the IBM General Parallel File System to manage the IBM EXP300 Storage Expansion Units (one behind each node) on which the mammography images are stored.

Databases

The solution’s database engine, IBM DB2 Universal Database EEE, serves as an index to the mammography data.

Middleware

Proprietary middleware performs the core lookup, routing and security functions of the grid, and controls the flow of data between the wall plug server and the various imaging devices in the hospitals.

Key Standards

The grid must be compatible with the DICOM (Digital Imaging and Communications in Medicine) standard, which governs the communication of imaging devices within hospitals.

Source: NSCL/UPenn and IDC

that all hospitals needed to do was plug into it.] The second tier of the architecture will (when fully deployed) be comprised of a series of small IBM x342 and/or x330 clusters serving a limited number of clinical locations within specific metropolitan areas. These second tier metropolitan clusters will in turn feed into a small number of regional clusters (of x342 servers) known as "area archives." These area archives are in turn linked to each other over T3 lines, forming—together with the metropolitan clusters—a wide-area grid, with any node in the grid able to share data transparently with any other.

"We designed the solution to have several layers of parallel systems, with processing distributed across a number of machines, each one of which operates autonomously. In addition to load balancing efficiency, this approach gives the solution a solid failover capability, which gives us the high availability that's critical to the solution."

—Dr. Robert Hollebeek,

The rationale behind this tiered structure is the need to maximize the performance of the solution by enabling the parallel processing of image requests and/or analytical applications. In designing the architecture, Hollebeek placed one of the highest priorities on avoiding single points of failure and enabling parallel throughput wherever possible. "We designed the solution to have several layers of parallel systems, with processing distributed across a number of machines, each one of which operates autonomously," explains Hollebeek. "In addition to load balancing efficiency, this approach gives the solution a solid failover capability, which gives us the high availability that's critical to the solution."

Given the importance of ensuring high levels of performance to clinical end users, it was important to deploy a file management system capable of reading and writing large image-based files to archives quickly and reliably. To this end, the NSCL deployed the IBM General Parallel File System (GPFS) to manage the local disks (IBM EXP300 Storage Expansion Units) on which the mammography images are stored. While the solution will initially employ local disks for storage, the eventual plan is to deploy a storage area network behind each node in the grid to provide more flexibility.

The NDMA grid contains two main software elements. The first is the proprietary middleware that performs the core lookup, routing and security functions of the grid. Code developed by Hollebeek and his UPenn team manages and balances the processing load across the grid, performs image data management, and provides transparency of access to end-users of the grid. Another key function of the middleware is to control the flow of data between the wall plug server (the hospital's interface to the NDMA grid) and the various imaging devices (workstations, storage devices, etc.) in the hospital environment. In managing this flow, it is critical that the hospital's systems view the grid as a peer component or, in Hollebeek's words, "just another hospital instrument" in the hospital's network. To achieve this, the grid needs to communicate with hospital devices via DICOM (Digital Imaging and Communications in Medicine), which is the standard that governs the communication of devices within hospitals. Providing this DICOM-compatible interface is a key function of the solution's middleware component.

The solution's second major software component is the database engine, IBM DB2 Universal Database EEE, which serves as an index to the mammography data. Key to the performance of DB2 EEE is its strong parallel processing capabilities, which provide the capacity for very high data performance in indexing and cataloging incoming data and supplying rapid access to the entire archive with parallel query mechanisms.

The Solution in Action

Prior to the development of the NDMA solution, radiologists needed to request medical imaging records through expensive, paper-intensive, bureaucratic procedures, resulting in a turnaround time measured in days. But one of the biggest problems in seeking records outside of a particular hospital was the strong chance of a medical record's "trail" being broken—making it effectively impossible to retrieve. Under the NDMA solution, physicians and radiologists seeking to view a patient's records can access it through the hospital's standard devices (e.g., workstations). To a hospital device like a digital imaging workstation, the NDMA grid is the architectural equivalent of just another device on the hospital network—seamlessly integrated. To access the grid, physicians and radiologists sign on through a secure Web portal. After being authenticated by the solution, users fill out an online request form and submit it. Middleware in the wall plug server assembles the request, wraps it in XML and sends it through the grid to the area archive layer. Upon arriving at the area archives, the request is unbundled and sent to the appropriate processor in the grid, which translates the XML message into a database query that is processed by DB2 EEE. On the return side of the transaction, processed requests are again wrapped in XML (via the solution's middleware) and sent back to the wall plug on the hospital's premises.

To a hospital device like a digital imaging workstation, the NDMA grid is the architectural equivalent of just another device on the hospital network—seamlessly integrated.

When the response arrives at the wall plug, the solution initializes a second layer of authentication checking designed to comply with the strict patient privacy requirements of the Healthcare Insurance Portability and Accountability Act (HIPAA) of 1996. The purpose of this authentication query is to verify that the "receiving" hospital has patient authorization to move his/her records to the hospital's records system. Once approval has been granted by the hospital in initial possession of the mammography file, the image file is released from the wall plug, where it had been cached pending the receipt of approval.

Security

Given the overriding importance of patient privacy in general and the requirements of HIPAA in particular, providing adequate security was critical to the solution's viability. The NDMA's security issues fell into three categories:

- *Authentication*—One of the most critical authentication requirements was the need to differentiate between doctors and radiologists (who were approved to look at patient records) and administrators (who are not). To address this, the Lab used smart cards, which provided PIN numbers, passwords and digital certificates which specify user roles.
- *Firewall*—For hospitals to be comfortable having a device connected to the outside world located in their IT environments, that device (i.e., the wall plug) needed to provide a secure barrier. To achieve this, the wall plug employed two servers linked in a standard firewall configuration (i.e., between the servers), thereby separating the grid from the hospital.
- *Encryption*—HIPAA requires that all medical information transported over networks be encrypted to maximize the security of the information in transit. In designing the solution, it was critical to design an encryption approach that would neither impose a burden on hospitals nor diminish the performance of the solution. The Lab's solution was to create a self-

contained VPN from the wall plug to the grid using hardware-based encryption.

BUSINESS RESULTS

Business-Level Benefits

By participating in the NDMA, hospitals stand to gain significant benefit both from operational improvements and from improvements in clinical capabilities. In the area of hospital operations, the archive's biggest payoff is that it makes the move to digital mammography much easier. By removing what has been a major barrier to digital mammography adoption by hospitals—the need to invest in expensive image storage infrastructures and the IT staff to administer it—the NDMA has the potential to change the economics of medical imaging overall. Given the fact that the average hospital spends $4 million annually to develop analog X-ray films, the potential payoff is enormous. And it's the economies of scale that lie at the root of the solution that make it all possible.

Even when compared to hospitals now using digital mammography within a traditional PACS environment, the NDMA promises significant improvements in screening and diagnostic capabilities.

Even when compared to hospitals now using digital mammography within a traditional PACS environment, the NDMA promises significant improvements in screening and diagnostic capabilities. The reason: unlike a single-hospital, PACS-based approach, NDMA can access a patient's complete mammogram history regardless of its hospital of origin. By making mammogram data portable, hospitals are at a much lower risk of "losing the trail" when tracking down old results. This, coupled with the sheer speed with which images can be retrieved, gives doctors a powerful tool for identifying potential problems and diagnosing illnesses.

Technology Benefits

The technology-related benefits of the solution are seen firstly in the general architectural approach employed for the archive, and secondly in the choice of technology components deployed. In the area of architecture, the decision to deploy an open, grid-based solution (instead of a centralized solution) provided the Lab with the ability to grow it horizontally—in step with the growth of its user base and, by extension, its backend resource requirements. This reflects the inherent scalability of grid-based architectures. The other major benefit of using a grid-based architecture was its strong support for parallel processing. By relying on parallel processing to handle archive queries, the Lab is able to optimize the speed at which they are handled—thus fulfilling hospital's requirement of minimal network latency and fast delivery of image data.

Yet another benefit of a grid architecture is its intrinsic support for standards. To illustrate this, Hollebeek points to the other viable way that hospitals could share image data—creating point-to-point linkages between hospitals' PACS systems. "The heterogeneity across hospital PACS systems would seriously complicate this kind of integration," Hollebeek notes. "Our grid-based approach neutralizes the issue posed by proprietary systems and makes integration a non-issue for hospital IT staff."

A large part of the Lab's technology benefits stem from its specific product and technology choices. Consider, for example, the IBM xSeries servers at the hospital site (i.e., wall plugs) and at the heart of the grid. As Hollebeek points out, the

EXHIBIT 3: OVERVIEW OF BUSINESS RESULTS FOR THE NSCL SOLUTION

Business-Level Benefit(s)	Enabling Process Changes	Linkage to Solution
Cost Avoidance/Reduction—By making the adoption of digital mammography easier, the NDMA solution will allow the average hospital to save millions annually in film costs.	Hospitals moving from analog film-based mammograms to digital mammograms.	The NDMA solution eliminates the need to invest in expensive image storage infrastructures and the IT staff to administer it.
Improved Clinical Outcomes—The NDMA solution promises significant improvements in screening and diagnostic capabilities.	Hospitals gaining access to a broader database of clinical records, as well as a base of advanced analytical applications.	Unlike a single-hospital approach, NDMA can access a patient's complete mammogram history regardless of its hospital of origin. This gives doctors a powerful tool for identifying potential problems and diagnosing illnesses.
Technology Benefit(s)	**Key Product Attribute(s)**	**Underlying Product or Technology**
Scalability—Deploying an open, grid-based solution provided the Lab with the ability to grow it in step with the growth of its user base (and corresponding resource requirements).	Grid Architecture Overall DB2 Universal Database EEE	**eServer xSeries**—Ability to easily configure into a grid architecture. **DB2** -- Parallel processing capabilities
Manageability—The servers' out-of-the-box manageability allowed the Lab to create a high degree of self-reliance within the architecture, reducing administrative demands on the Lab.	eServer xSeries	**eServer xSeries**—Strong self-monitoring, self-diagnosis and self-healing capabilities.
Standards Support—The Lab's grid-based approach neutralizes the issue posed by proprietary systems and makes integration a non-issue for hospital IT staff.	Grid Architecture Overall	**eServer xSeries**—Strong open standards support. **DB2** -- Strong open standards support.
Performance—By relying on parallel processing to handle archive queries, the Lab is able to optimize the speed at which they are handled.	DB2 Universal Database EEE	**DB2**—Parallel processing capabilities.

Source: NSCL/UPenn and IDC

xSeries's out-of-the-box manageability allowed his team to create a high degree of self-reliance within the architecture—such that it imposed no burden on hospitals, and few administrative demands on the Lab. "For hospitals, one of biggest values of the archive is the ability to obtain the power of the grid as a utility-like service, without the need to actively maintain anything on-site," says

Hollebeek. “As operators of the grid, we needed to keep our administrative requirements in check, even as the number of hospitals and the scale of the grid grew. IBM xSeries servers allowed us to build strong self-monitoring, self-diagnosis and self-healing into the infrastructure.”

The grid also benefits from the use of IBM DB2 Universal Database EEE, whose strong parallel processing capabilities complement the grid’s distributed approach to query processing. A key source of DB2 EEE’s strength is its cost-based query optimizer, which automatically selects the most efficient method of processing complex queries on very large databases. This optimization is central to the grid’s ability to meet hospital’s exacting performance requirements.

CASE EPILOGUE

“We needed reliable hardware and open systems software that provide fast data retrieval, scalability, and security. These needs are directly addressed by the power and versatility of IBM’s technology.”

—Dr. Robert Hollebeek

Going forward, Hollebeek’s team plans to expand the scope of the digital archive’s deployment, as well as its functionality. In the near term, the Lab hopes to add approximately 100 new medical facilities, including hospitals as well as smaller clinics. In the area of new functionality, the Lab is developing a new set of analytical and diagnostic capabilities that employ automated image comparison and recognition algorithms. The continued development of advanced analytical capabilities—coupled with the ongoing expansion of the archive driven by new clinical facilities signing on—promises to dramatically expand the payoff to hospitals and patients alike.

“We are proud to partner with IBM on the grid project,” says Hollebeek. “We needed reliable hardware and open systems software that provide fast data retrieval, scalability, and security. These needs are directly addressed by the power and versatility of IBM’s technology.”

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