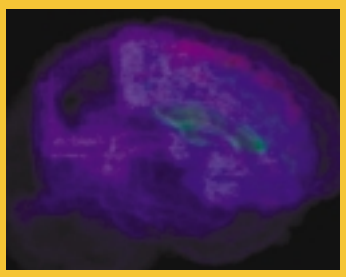
Success Story

*"With our new data storage system, we get the best of both worlds."*

—Rico Magsipoc
LONI System Administrator

# SGI and UCLA LONI: Taking Brain Research to the Next Level



Scientific data acquisition and visualization can generate huge amounts of data. A storage architecture that increases the efficiency of shared data access is crucial to the success of ongoing research. Clustered XFS™ (CXFS™)—a revolutionary clustered filesystem from SGI—is helping meet these needs, enabling SGI customers to improve their productivity with unprecedented levels of shared, high-performance data access and exceptional availability.

LONI uses a variety of imaging techniques, including magnetic resonance imaging, positron emission tomography, and optical intrinsic signals, to generate three-dimensional images of the brain and other structures. These imaging systems and subsequent analysis create a staggering amount of data. A data set from a single subject can consume hundreds of gigabytes, and total stored data is increasing at a rate of 8TB per year.

At the UCLA Laboratory of Neuro Imaging (LONI), researchers use the latest technology to visualize the brain and other neurological structures. LONI is a leader in the development and use of computer imaging systems to enhance the understanding of brain structure and function. Research at LONI is advancing human knowledge in a wide range of areas, from neurological development and brain structure to Alzheimer's disease. LONI is developing comprehensive atlases of human brain structure and function in both health and disease and pioneering techniques to help guide surgeons during brain surgery.

*"CXFS has allowed us to tremendously increase our productivity while reducing nonproductive waiting time."*

—Dr. Arthur Toga, LONI Director of Research

Researchers at LONI make frequent use of previously gathered data for comparative studies, and the same data is often used and shared by multiple projects. Enabling researchers to combine more image sets over a longer term and share them more efficiently would expand the scope of ongoing research and dramatically reduce the time to complete each study.

LONI had been using NFS for shared access to images, but NFS lacked the performance to rapidly transfer large image files, and data availability was often a problem. In addition—due to limited online storage capacity and laborious manual processes—costly man-hours had to be dedicated to data archiving and storage space management.

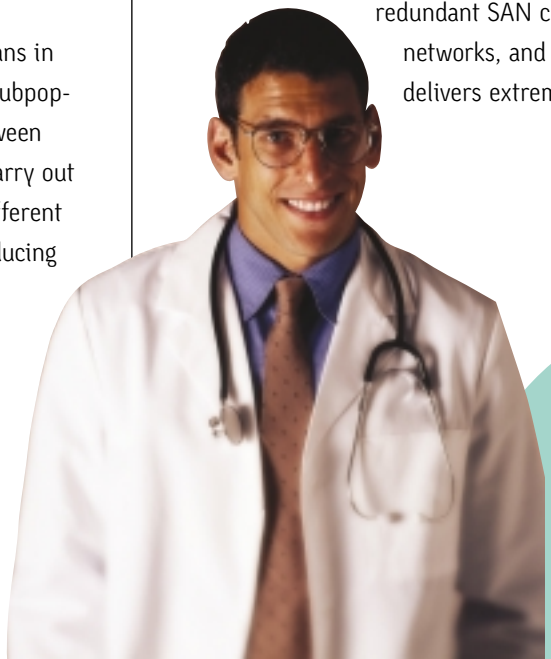
SGI helped LONI implement a complete solution with CXFS, SGI™ Data Migration Facility (DMF), and a state-of-the-art storage area network (SAN). Using CXFS and SAN technology, LONI has dramatically improved workflow and data availability, resulting in a tremendous increase in researcher productivity. The addition of SGI DMF to the solution significantly streamlined data management. DMF provides LONI with a virtually infinite storage space, allowing researchers to focus on science rather than data management.

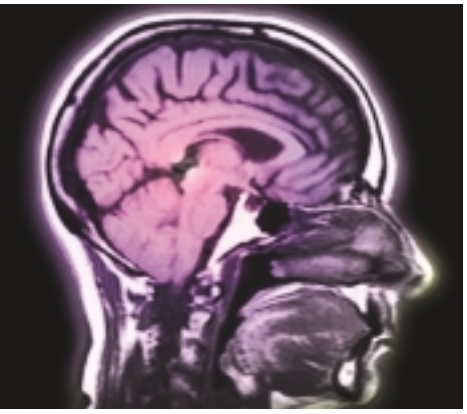
According to Dr. Arthur Toga, director of research at LONI, "The increased capacity and performance of the new storage architecture allowed LONI to accommodate thousands of scans in the database and to readily recompute atlases of various subpopulations, providing increased sensitivity to differences between populations." Dr. Toga added that "CXFS has allowed us to carry out multiple projects simultaneously using the same data on different systems, tremendously increasing our productivity while reducing nonproductive waiting time and system downtime."

## CXFS: Bandwidth and Availability Beyond NFS File Serving

SGI designed CXFS specifically for environments like UCLA LONI where shared data access is critical and network filesystems such as NFS simply cannot provide the necessary bandwidth or availability. CXFS allows all systems in a cluster simultaneous high-speed access to shared filesystems over high-speed Fibre Channel SAN connections. Unlike traditional SAN implementations, CXFS allows all systems on a SAN to access the same file/filesystem at the same time. To enable multiple system access to the same files while maintaining strict data integrity, CXFS file permissions are controlled by one of the systems in the cluster, the metadata server, while all data access goes directly over the Fibre Channel SAN between systems and storage at 100MB per second per connection.

Should a metadata server fail, a designated backup metadata server can automatically take over management of CXFS filesystems. This feature—used in combination with fully redundant SAN configurations, networks, and RAID storage—delivers extremely high availability.





## A High-Performance, Shared-Access Storage Architecture

The CXFS cluster at UCLA LONI is based on a high-speed SAN infrastructure. All links to critical systems and storage devices are redundant for increased bandwidth and availability. Two SGI™ Fibre Channel switches connect to all systems and storage devices. Alternate paths exist through the fabric so that the failure of any SAN component will not stop the flow of critical data.

Silicon Graphics® Onyx2® and Silicon Graphics® Octane® systems share several CXFS filesystems that serve as the repository for all neurological image data. A researcher working at any of the workstations within the LONI cluster has full high-speed access to LONI's vast quantity of archived image data.

## Automated Data Management with DMF

Prior to implementing the CXFS cluster, LONI system administrators devoted an inordinate amount of time to the management of online disk space and tape. A primary design goal for the LONI SAN was to streamline this process.

Advanced data management was implemented using SGI DMF, the industry's leading hierarchical storage management product. DMF automatically migrates data from online storage to tape-based storage according to user-defined criteria. Files are automatically recalled to online storage as they are accessed without user or system administrator intervention.

For its storage system, LONI utilizes 2TB of disk in SGI™ TP9100 RAID arrays and a StorageTek® PowderHorn® 9310 automated tape library with six high-speed StorageTek 9840 Fibre Channel tape drives and a total capacity of 40TB, growing by 20% each year. The combination of CXFS and DMF with this online and nearline storage results in a file server of virtually unlimited size.

According to Rico Magsipoc, LONI system administrator, "With our new data storage system we get the best of both worlds: incredible data access speed with CXFS and automated storage management with DMF."

## Onyx2 Provides State-of-the-Art Visualization

SGI hardware has been a part of the LONI solution for a long time. LONI currently employs several Onyx2 systems for advanced processing and real-time visualization of neurological data. A 32-processor Onyx2 RealityMonster® system is used by LONI researchers for real-time interactive visualization of large data sets. A six-processor Onyx2 deskside system is reserved for development and testing of visualization applications.

Five Octane workstations are also in use, providing 3D modeling, animation, and Web serving. Twenty-five Silicon Graphics® O2® systems are used as general-purpose workstations.

## A Partnership for Deployment

LONI system specialists knew they needed a solution that maintained compatibility with their existing SGI computer systems and more than 3TB of previously stored data while dramatically increasing bandwidth for stored data, improving availability, and simplifying management. LONI turned to SGI to help find the most appropriate solution.

The design and implementation of the CXFS cluster at LONI was a collaborative effort among LONI system administrators, SGI Professional Services, and LONI's local SGI systems engineers.

These groups worked together to plan and deploy the cluster. With SGI's assistance, LONI recovered all data that had previously been archived to tape and incorporated it within the new storage architecture using DMF. Data that had previously been stored on tape and managed manually is now stored in a single centralized library, and—even more important—DMF allows researchers to access that data as if it were on disk.

## Building for the Future

The use of CXFS and DMF in the storage architecture at LONI has been so successful at alleviating bottlenecks that it created a need for additional compute capacity. According to Dr. Toga, "Once our researchers discovered that the bandwidth was available to sustain multiple simultaneous projects, they quickly reached the limits of our computational servers and began requesting additional compute capacity."

LONI just upgraded its computational ability with the addition of a 64-processor SGI™ Onyx® 3800 system. Four terabytes of online storage were added to complement the additional compute capability along with the necessary SAN infrastructure to integrate it with the CXFS shared storage architecture.

SGI staff continues to participate in ongoing efforts to optimize the solution. The result is an integrated storage system that meets LONI's needs today and will accommodate its growth for the future.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