RESEARCH SUPPORT | CASE STUDY

University Collaborative Research Propelled by New Advanced Cyberinfrastructure

THE PROJECT

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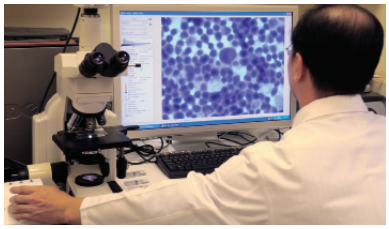
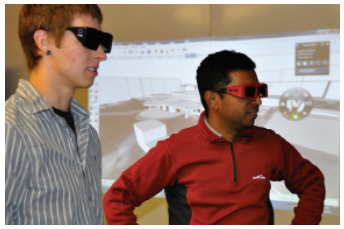




The project aims to serve as a model for next-generation, global collaborative research support by creating an innovative cyberinfrastructure environment and connecting the University of Missouri (MU) directly to the 100GE Internet2 Network via an on-campus network node. A similar environment was implemented at The Ohio State University (OSU) with a 100GE connection provided by regional network OARnet. Both MU and OSU campus and regional components were funded in part by an NSF CC-NIE grant of nearly of $1M. The new cyberinfrastructure enables globally distributed research teams to interact with scientific mentors, share massive datasets, and collaborate with sophisticated informatics tools and technologies. The ultimate goal is to provide a new level of support for researchers and their geodistributed counterparts in a bid to create new technologies that will have a major impact on the quality of life for future generations–including the acceleration of brain-imaging research innovations for better autism detection and treatment, new capabilities for real-time sensor-based elderly care, and other important university-based collaborative scientific research. This project is built upon the recent $96.5M Internet2 Network upgrade, funded in part by a federal stimulus grant through the National Telecommunications and Information Administration's Broadband Technology Opportunities Program (BTOP).

THE PROBLEM

Interdisciplinary collaboration is a fact of modern science–and that means university-based research. Many important scientific questions simply cannot be answered without computational power and networking services far beyond the ordinary. Recent advances in brain-imaging data acquisition technology are

SOLUTION SUMMARY

The University of Missouri (MU) and The Ohio State University (OSU) are creating an innovative research environment to support campus scientists who are collaborating to better detect, diagnose and treat autism with brain-imaging innovations, and enable new capabilities for real-time sensor-based elderly care. The new cyberinfrastructure aims to create a model for advancing multidisciplinary collaborative big-data science throughout the research and education (R&E) community. Both MU and OSU are implementing a portfolio of advanced Internet2 community technologies to create the new technology environment, which provides for deep geodistributed scientific research collaboration. The technology portfolio incorporates: new network infrastructure, including an on-campus network node at MU; cloud-based data storage; identity management services; and performance measurement and monitoring capabilities to support the unique requirements of big-data research.

COLLABORATORS

- **The Ohio State University (OSU) and OARnet**
- **University of Missouri (MU) and MOREnet**
- **Great Plains Network (GPN)**

PRODUCTS & SERVICES

- **Internet2 Innovation Platform: 100GE Advanced Layer 2 Service, software-defined networking (SDN) capabilities, Science DMZ**
- **Internet2 performance monitoring (perfSONAR)**
- **InCommon Federation**
- **InCommon Certificate Service**

COMMUNITY RESOURCES

- **Internet2 Research Support Center**

FUNDING RESOURCES

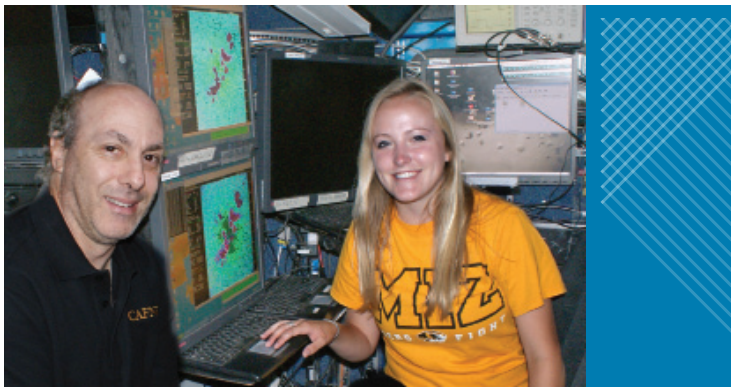
- **National Science Foundation (NSF) Campus Cyberinfrastructure Network Infrastructure and Engineering (CC-NIE) Program**
- **NTIA Broadband Technology Opportunities Program (BTOP)**
- **Campus and regional network investments**

generating ever-larger quantities of high-resolution data. Data-intensive computational technologies and tools that can handle very large-scale data modeling, transformation, integration, and analysis are in huge demand, and are critical to a better understanding of the big data generated through brain research. Scientists engaged in this research—which promises to improve the detection, diagnosis and treatment of autism—must transport, exchange, access and analyze hundreds of terabytes of imaging data on a regular basis.

These types of global collaborative projects strain modern-day network resources. In fact, they require a new magnitude of bandwidth capacity, network programmability and specialized architectures that can connect computational with storage infrastructures via trusted, federated authentication. **Being "connected" in today's world of scientific discovery is absolutely required, but places enormous demands on individual institutions to provide the level of advanced technology, connectivity and bandwidth their scientists need and expect.**

THE SOLUTION

Creating a next-generation research cyberinfrastructure requires the combination of advanced technologies and the engagement of entities with varying expertise—all focused on the common goal of creating the kind of robust environment that enables breakthrough discoveries. **At its core, this collaboration employs a new generation of cyberinfrastructure and cloud computing tools for the storage and analysis of enormous quantities of locally-generated, brain-imaging MRI data, shared across geographically dispersed resources.**



The project connects MU's network infrastructure with the Internet2 100GE national network and implements the Internet2 Innovation Platform with a 100GE pathway, Science DMZ and advanced networking services. The configuration facilitates integration of a web-based brain-imaging analysis software, "Brain Explorer"—which allows users to upload MRI images and interactively conduct quantitative brain structure analysis in a seamless, secure environment—with the management of new hardware platforms that support 100Gbps network transmission speeds. This, along with Advanced Layer 2 and Layer 3 software and middleware, permit the customization of network services within a dynamic, software-defined networking (SDN) infrastructure.

Adding perfSONAR and other monitoring tools allows the measurement and analysis of performance gains and losses resulting from dynamically changing network configurations. Expert teams will leverage the network infrastructure to optimize end-to-end data transfers over wide-area network paths. They will compare the performance of high-throughput WAN protocols, investigating the benefits they provide for transferring large volumes of data in the MU-OSU experiments. They will also study how data transfers should be managed between communicating peers across the wide-area network paths such as the one between MU and OSU—findings that will benefit the broader R&E community as well as the scientists and technologists who support it.

Another important piece of the solution is a private cloud storage infrastructure, provisioned in MU/OSU pipelines and customized for each project. **Processing applications will be "net aware," allocating collection, analysis and interpretation resources according to demand.** This will be accomplished via SDN tools and capabilities within the Internet2 Network. Applications will also be integrated with Internet2's InCommon federated identity environment, establishing a seamless trust fabric spanning all partner institutions. Security, measurement and analysis tools will be integrated to run efficiently at 100GE across a regional multi-cluster environment.

After the deployment of cyberinfrastructure equipment and tools, carefully chosen projects will be launched by researchers at MU and OSU as use cases to demonstrate the viability of this innovative approach, and **enable the project team to measure the performance and effectiveness of the new cyberinfrastructure to support a new breed of research applications.**

THE RESULT

The infrastructure model established through this project will have an immediate and profound impact on MU's and OSU's research infrastructure to support large-scale science and training in many science, technology, engineering and mathematics (STEM) related disciplines. Staying current with the technology evolution is a mandatory strategic goal of both institutions—and also of the broader R&E community.

The project model will not only provide optimal scientific big data exchange for research collaborators; it will also support a wide range of cross-disciplinary research programs. Resources developed and findings measured during the course of the project will provide a baseline for integrating other schools and students into the project—or for better enabling their own research. Shared with others through innovative online interfaces, professional publications and conferences, project deliverables will become valuable assets for both current and future researchers and educators who face similar challenges, and serve as a pattern for research cyberinfrastructures of the future. **The project provides a blueprint for other Internet2 members who need to establish similar environments, enabling broader R&E community collaboration within and across disciplines, and leading the way to future discoveries that can have profound effects on humankind.**