NMI Integration Testbed

Case Study Series

Research Experiences for Undergraduates within the NMI Integration Testbed Program

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NSF Middleware Initiative (NMI) Integration Testbed Case Study Series

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The NMI Integration Testbed Program provided practical evaluation of NMI components within the context of real projects and application scenarios from June 2002 through November 2004. During that time, NMI Testbed sites collectively submitted over 220 evaluation reports to middleware component developers as direct feedback into the NMI development cycle. Site representatives also actively inspired, promoted and facilitated the integration of middleware throughout their institutions.

The NMI Integration Testbed Case Study Series documents the most significant influences and outcomes of NMI Testbed sites' middleware integration efforts, highlighting intersections with established projects, application contexts and influences, drivers for innovation, decision points and challenges. Through this documentation, the work of these pioneering institutions is captured to provide a breadth of insight and approaches for others to use towards successful middleware development and deployment.

This NMI Integration Testbed Case Study Series is sponsored by the National Science Foundation Middleware Initiative-Enterprise and Desktop Integration Technologies (NMI-EDIT) Consortium of EDUCAUSE, Internet2, and SURA, funded under the National Science Foundation Cooperative Agreement NSF 02-028, ANI-0123937.

Executive Summary

Funded through the National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program, undergraduate college students have been working with grid technologists on a number of projects that are part of the NSF Middleware Initiative (NMI) Integration Testbed. The work these promising REU students have contributed at the "intersection" of these two NSF programs has benefited the students, the projects, and the NMI Integration Testbed.

Managed by the Southeastern Universities Research Association (SURA) on behalf of the NMI--Enterprise and Desktop Integration Technologies (NMI-EDIT) Consortium, the NMI Integration Testbed consists of a number of universities participating in a closely coordinated effort to deploy and evaluate NMI technologies. SURA oversees the management of the REU program within the NMI Integration Testbed. REU positions have provided students with an opportunity to work with evolving NMI components and to inform and influence development. This article discusses the work of REU students at four NMI Integration Testbed sites.

- Georgia State University provided opportunities for two NSF REU students focused on several projects - a distributed muon particle detector, graphic rendering in the Georgia State Digital Aquarium and a catalog of grid applications.
- TACC (UT Austin) provided an opportunity for an REU student to work with other portal developers and application users to consult on and assist with the development of a User Portal for the NMI Testbed Grid.
- The University of Michigan REU experience focused on exploring different aspects of NMI components within the context of the two major projects at the University: ATLAS, and the Michigan Grid Research and Infrastructure Development (or "MGRID").
- The University of Virginia REU experience focused on portal security and investigating software for authorization services.

Each student contributed as an individual researcher in collaboration with the NMI Testbed project team. REU students completed their work experience with a greater understanding of the utility and importance of middleware, and the potential of these technologies to change the way scientific research is performed in the future.

For more information about Research Experiences for Undergraduates within the NMI Integration Testbed Program, contact Mary Fran Yafchak at maryfran@sura.org.

NMI Components Highlighted in this Case Study

The NMI components discussed in this case study series encompass NMI Releases 1 through 4. Information about NMI Releases can be found at **http://nsf-middleware.org/**.

Condor-G

The GRIDS Center's Condor-G is a computation management agent for the grid. Condor-G is the marriage of technologies from the Condor project and the Globus project (see below).
Home site: http://www.cs.wisc.edu/condor/; Globus (see below).

Globus

The GRIDS Center's Globus Toolkit is an open-source collection of modular technologies that simplifies collaboration across dynamic, multi-institutional virtual organizations. It includes tools for authentication, scheduling, file transfer and resource description.
Home site: http://www-unix.globus.org/toolkit/

Grid Packaging Tools (GPT)

The GRIDS Center's Grid Packaging Tools (GPT) is a collection of packaging tools built around an XML-based packaging data format. The tools provide a means for developers to easily define the packaging data and include it as part of their source code distribution.
Home site: http://www.gridpackagingtools.org/

GridPort

The GRIDS Center's GridPort enables the development of portals and applications on top of underlying distributed and grid computing infrastructure to facilitate computational science.
Home site: http://gridport.net/index.cgi

MPICH-G2

The GRIDS Center's MPICH-G2 is a grid-enabled implementation of the MPI v1.1 standard based on the popular MPICH library developed at Argonne National Laboratory. That is, using services from the Globus Toolkit(R) (e.g., job startup, security), MPICH-G2 allows you to couple multiple machines, potentially of different architectures, to run MPI applications.
Home site: http://www3.niu.edu/mpi/

MyProxy

The GRIDS Center's MyProxy is a credential repository for the grid. MyProxy provides a set of flexible authorization mechanisms for controlling access to the repository.
Home site: http://grid.ncsa.uiuc.edu/myproxy/

Network Weather Service

The GRIDS Center's Network Weather Service (NWS) is a distributed system that periodically monitors and dynamically forecasts the performance various network and computational resources can deliver over a given time interval.
Home site: http://nws.cs.ucsb.edu/

Pubcookie

Pubcookie is open source software that supports intra-institutional web initial sign-on.
Home site: http://www.pubcookie.org/

Shibboleth

The Shibboleth technology supports inter-institutional sharing of web-based resources subject to access controls.
Home site: http://shibboleth.internet2.edu

Research Experiences for Undergraduates within the NMI Integration Testbed Program

Since June 2003, five undergraduate college students have been working with grid technologists at four universities on a number of projects that are part of the National Science Foundation Middleware Initiative (NMI) Integration Testbed[1]. The work of these students was funded through the National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program. The work these promising REU students have contributed at the "intersection" of these two NSF programs has benefited the students, the projects, and the NMI Integration Testbed. The REU students have gained experience and knowledge, while their mentors gained enthusiastic team members ready to collaborate on accomplishing the goals of the NMI.

The NMI project is helping to "lay [the] foundations for middleware infrastructure and spur adoption of the advanced services that will define the networks and distributed systems of tomorrow" (1). The NMI is bringing about a national research middleware infrastructure that is globally significant and inter-operable. SURA (Southeastern Universities Research Association) developed and managed the NMI Integration Testbed as part of the NMI-EDIT Consortium (NMI-Enterprise and Desktop Integration Technologies)[2] and as an integral component of the NMI, providing practical feedback on NMI components being deployed in real life contexts. To enrich and broaden the perspective being brought to this, SURA proposed and was awarded an REU Supplement to the existing NMI Integration Testbed grant in Spring 2003. SURA oversees the management of the NMI Testbed REU program, while NMI Integration Testbed sites maintain day-to-day responsibility and mentoring for their REU students. With SURA organizing and managing the multiple REU positions under the umbrella of the NMI Integration Testbed, participating Testbed sites had a reduced administrative burden, and were able to spend more time engaging their students.

REU positions in the NMI Integration Testbed have provided students with an opportunity to contribute to this rapidly developing area of enterprise information technology. As part of the NMI Testbed site teams, REU students have been active in

[1] As part of its overall effort to develop and disseminate software that lets scientists and educators share resources across the Internet, NMI began a practical deployment and evaluation effort called the NMI Integration Testbed. Managed by SURA (Southeastern Universities Research Association) on behalf of NMI-EDIT, the testbed consisted of eight universities that participated in a closely coordinated effort to deploy and evaluate NMI technologies. http://www1.sura.org/3000/NMI-Testbed.html

[2] http://www.nmi-edit.org/

NMI component integration and assessment. The REU students worked with evolving NMI components and had real opportunities to inform and influence development. Each student contributed as an individual researcher working as part of the focused NMI Testbed project team, interacting with NMI developers, NMI program management, and the broader research community involved in grid technology and middleware. This article will explore specific activities of the REU students and how these activities contributed to project goals while increasing the students' understanding of the important role NMI components have in grid computing.

Specific REU Positions within the NMI Testbed

Georgia State University

Georgia State University has been working during the past four years to develop research and enterprise middleware capability. Dedicated to providing students with meaningful, real-world experience, Georgia State has consistently involved graduate and undergraduate students in this work. Over the last three years, Art Vandenberg of Information Systems & Technology's Advanced Campus Services (ACS), and Professor Vijay K. Vaishnavi in the Computer Information Systems department have collaborated closely to involve nearly twenty students from both Georgia State and Georgia Tech, as well as faculty from both institutions, in investigation of middleware components. Georgia State's participation in the NMI Testbed has provided a rich learning environment for several REU students, while providing funding support for the students' work. Since August 2003, by combining other funding sources (e.g., associated grants and departmental funding) with their NMI Testbed and REU support, Georgia State has provided opportunities for two NSF REU students, as well three masters' students who were directly supported by the NMI Testbed Program as part of the NMI Testbed Grid[3] project.

In addition to furthering specific evaluation and deployment goals of the NMI Integration Testbed, Georgia State student experiences – through NMI REU positions as well as other programs – serve as a valuable means for students to enhance their education and learning experience directly. Several of Professor Vaishnavi's students have completed masters' theses programs incorporating middleware topics, and currently two of his Ph.D. students are engaged in middleware research topics related to directory and grid infrastructure. A previous undergraduate student has since

[3]NMI Testbed sites are using NMI components to build an inter-institutional grid across organizations (http://www1.sura.org/3000/SURAgrid.html). This is providing a view of the application potential of grids as shared research and academic infrastructure and proof of concept for researchers and faculty. It is also enabling closer scrutiny of the issues involved in such deployments, particularly authentication & authorization (see the NMI Integration Testbed Case Study Series technical supplement *Authentication & Authorization in SURAgrid: Concepts and Technologies* at http://www1.sura.org/3000/NMI-Testbed/SURA-AuthNauthZ.pdf)

become a full-time "middleware" employee with Advanced Campus Services, and several other students (including the REU students) are potential future staff. The work of NMI REU students has also served to engage their faculty in investigation of middleware topics, as well as providing resources to evaluate technology components that administrative information technology staff often do not have time to fully explore themselves.

The two REU students chosen to work with the NMI Integration Testbed project during the 2003-2004 school year were Nicole Geiger (Physics) and Anish Shindore (Computer Information Systems). Each student worked approximately 15-20 hours per week on NMI-related research. Their work, discussed in detail below, focused on several projects - a distributed muon particle detector, graphic rendering in the Georgia State Digital Aquarium (http://www.gsu.edu/~wwwdaq/), and a catalog of grid applications. During the course of their REU experience at Georgia State, Geiger and Shindore have become skilled members of the middleware research team.

Cosmic Ray Muon Measurement Project

Dr. Xiaochun He, Physics, designed a muon detector and is using it as an outreach and education component in selected middle and high schools in Georgia. With Georgia State's participation in the NMI Integration Testbed, the concept of creating a distributed network of detectors has become a focal point for grid deployment. The goal of this project is to use grid technology to manage and access the detector's distributed resources. Geiger and Shindore worked with Dr. He in the implementation and deployment of the muon detector project in Georgia high schools, contributing to the preparation of related reports on K-12 grid deployment issues and outcomes. Geiger and Shindore also worked closely with Imran Faridi, and then Alan Tang, both NSF-NMI Intra-testbed Grid graduate research assistants, on evaluation and implementation of a grid portal. Nicole meets regularly with Dr. He and his other graduate students on a range of project topics in addition to the muon detector grid.

During Fall Semester 2003, the initial plan was to have two Windows installations and two Red Hat Linux installations of the GRIDS Center's Globus[4] in Dr. He's Cosmic Ray Lab; however, the Windows installation of Globus under Cygwin proved problematic, and was set aside in order that Nicole and Anish could focus on Linux. ACS located 43 surplus PCs that could be used as distributed grid nodes. The students assembled four of these PCs for the initial grid installation. They added additional memory and hard drives, and installed and configured the required Linux and Globus software on the machines. During the Globus installations, every procedure was documented so that, once successful installation was verified, the students were able to use their documentation to install the

[4]Globus Toolkit information: http://www-unix.globus.org/toolkit/

software the same way across the remaining PCs.

In order to practice the installation and demonstrate Globus technology further, Geiger and Shindore also installed Globus on computers (Solaris and Linux versions) in the ACS department. The students studied the installation processes and relationships for Condor, Condor-NT, Condor-G[5], and Globus. To confirm the computers were communicating properly with each other, Geiger and Shindore followed installation guidelines to perform verification and job testing steps. The installations for ACS machines included setting up dual boot drives, so that Windows or Linux could run. The students also had plenty of opportunity for engaging their troubleshooting and debugging skills. For instance, working with ACS staff to install the GRIDS Center's MPICH-G2[6] (a freely available, portable implementation of MPI, the standard for message-passing libraries) on the ACS Solaris machines led to fairly extensive debugging work. Geiger and Shindore determined that a compiler (mpicc or mpiCC) capable of "linking" was needed. They tried a creative approach of installing MPICH (not the G2 version) to get the mpicc compiler bundled with MPICH and then installing MPICH-G2. While not successful, they were able to document the problem with Solaris and MPICH-G2 and communicate it to the NMI Developers (resulting in a bugzilla posting).

Graphic Rendering with the GSU Digital Aquarium

The original goal for Georgia State's NMI Testbed site team in this project was to place the resources of the Georgia State Digital Aquarium project on a grid. The newly opened Digital Aquarium lab provides students with high-end workstations equipped with multi-media production tools. Bringing these high-end resources onto a grid could provide access that would significantly benefit students and faculty. Unfortunately, this project was delayed because of policy concerns over the access and availability of these resources, and the impact of making them more accessible. The REU students focused instead on cataloging the Digital Aquarium's resources, while learning more about policy issues related to technology and how perceptions of "the grid" may be a factor in acceptance of such new technology.

The inventory of Digital Aquarium resources (13 high-end graphics PCs and 16 high-end Apple computers) was extended to an inventory of other computing labs on campus. In all, Geiger and Shindore documented the resources of various computing labs:

- 274 computers (PCs, Macs) in 4 distributed campus labs
- 200+ estimated additional machines in classrooms
- ~200 machines estimated to be in additional college-specific labs

[5] Condor, Condor-NT and the GRIDS Center's Condor-G are all variations of a job-scheduling program that allocates available parallel computing power to data-intensive research jobs. Condor-G information: http://www.cs.wisc.edu/condor

[6] MPICH-G2 information: http://www3.niu.edu/mpi/

This inventory will prove useful as grid technology policies are developed. The REU students would like to grid-enable these lab-based computers, following the exemplar of work at other NMI institutions, as discovered through the emerging NMI Integration Testbed Catalog of Grid applications (see directly below).

The Georgia State REU students made a major contribution to the development of the Catalog of Grid Applications http://art12.gsu.edu:8080/grid_cat/index5.jsp . Beginning with Georgia State, their inventory work expanded to the web sites of all nine institutions participating in the NMI Integration Testbed. The purpose was to gather information on grid-specific or grid potential of faculty research. The search initially started using the keywords "grid" and "Globus;" however, the REU students soon expanded their keyword list to include additional grid concepts and related research (e.g., parallel processing, computational biology, simulation, neural networks, computational fluid dynamics, etc.).

Geiger and Shindore compiled a catalog draft with grid project information from the original NMI Testbed sites. The catalog, now online, is continuing to expand, including 433 researchers (at 17 universities and 2 national labs) that are working on major grid projects, including the TeraGrid[i]. In a companion project, other graduate students are creating a user-friendly web interface that will allow researchers to directly submit information about their research and projects into the catalog. Such data will be combined with the compilation that Geiger and Shindore have created thus far.

In June 2004, Nicole Geiger, Anish Shindore, and Nova Ahmed (a NMI Testbed Grid graduate research assistant) attended the Grid Summer Workshop sponsored by the Center for Gravitational Wave Astronomy, a NASA University Research Center at the University of Texas at Brownsville, the Grid Physics Network (GriPhyN), Grid Center, and the International Virtual Data Grid Laboratory (iVDGL). This was an excellent REU opportunity to study, learn and share knowledge on girds with other students and researchers. Anish said, "The workshop was just great! …We spoke to the people who could give us more information or at least show us the right way; people like Mike Wilde from Argonne, Jamie Frey from the Condor team at Wisconsin, Charles Bacon from Globus." Nicole found that they were well prepared by their experience with the NMI Testbed Program grant. "The best thing about the workshop was twofold. The first part was that all the lecturers… are very knowledgeable… The second part was that they were also very approachable. We were able to make great contacts that will help us in our endeavor for building a successful Grid at GSU."

Texas Advanced Computing Center (TACC), University of Texas, Austin

Grid Computing Portals for the NMI Integration Testbed

This REU experience is part of a multi-site project involving three NMI Integration Testbed sites: TACC, the University of Virginia and the University of Michigan. It was based on work by researchers from each institution in the area of Grid Portals, Open Grid Services Architectures, and Grid Technologies and Security. This collaborative project provided the students with several unique opportunities, including giving them exposure to several major programs in high performance computing. This exposure came through the students' interactions with research teams working in the Partnerships for Advanced Computational Infrastructure (PACI)[ii], TeraGrid and NEESgrid[iii] programs, as well as others at the Department of Energy, Department of Defense, and NASA. Students located at each site learned to work collaboratively with each other in order to develop the portal and infrastructure. Additionally, the REU students had the opportunity to work with state-of-the art technologies in web portals and grid technologies (e.g., Jetspeed/Portlet[iv], web services, Globus, GridFTP).

At TACC, researchers went through an extensive search to hire an REU, posting an announcement for the position in the College of Natural Sciences. They received over 50 resumes from prospective candidates. After initially screening the resumes to make sure they met the basic requirements, the project leads conducted phone interviews with approximately ten candidates and then met with three finalists before selecting Ashesh Sahib as their REU. Sahib is pursuing an undergraduate degree in Computer Science at the University of Texas at Austin, and expects to graduate in December 2004. Sahib was appointed as a full-time REU over the summer of 2004. Sahib was chosen because he had previous web programming experience, and had worked as a summer intern in local computer companies in previous years. He also had good communication skills, and possessed the ability to work independently with other members of the NMI Testbed team.

Sahib's main responsibility was to work with other portal developers and with application users on the NMI Integration Testbed Grid to consult on and assist with the development of a User Portal. This portal would provide users with resource monitoring and job management capabilities. Sahib initially spent time becoming familiar with grid concepts and technologies by installing and using the NMI GRIDS components. This was a learning experience, since Sahib had no prior experience in distributed computing. Sahib then used the Open Grid Computing Environments (OGCE) (2) software to create a user portal with capabilities for a grid user to monitor grid resources and to submit and manage the execution of jobs on these grid resources. As part of the effort of building the user portal, Sahib had to update the

resource monitoring scripts that provided information to the User Portal. During this time, Sahib participated in meetings with the TACC portal team, and with Art Vandenberg's NMI Integration Testbed team (including the REU students) at Georgia State University.

One of the features lacking in the OGCE toolkit is the ability for a grid user to specify a series of tasks and have the grid middleware manage the workflow on their behalf. Although several workflow tools exist, none of them has been integrated with user portal software such as OGCE. As a research component in his work, Sahib investigated Pegasus, a grid workflow management tool, and the feasibility of integrating it into a user portal toolkit. Pegasus was developed at the Information Sciences Institute at the University of Southern California, and uses several NMI components, such as the GRIDS Center's Globus Toolkit and Condor-G.

At the completion of his internship, Sahib said that he had benefited greatly from his REU experience, and had learned a lot about distributed grid computing in general, and user portals in particular, through his use of NMI GRIDS components. He expressed an interest in continuing to work in the grid computing area if the opportunity arose in future.

University of Michigan

Exploring NMI components in ATLAS and MGRID

With the funding provided by the NMI NSF REU supplement, the University of Michigan hired Karen Hayrapetyan, an undergraduate physics student. Hayrapetyan participated as an REU student from October 2003 through May 2004. The focus of his experience was to explore and learn about different aspects of NMI components, in the context of the two projects at the University of Michigan. The first project is the ATLAS[v] experiment, a particle physics experiment that will explore the fundamental nature of matter and the basic forces that shape our universe. The second project, the Michigan Grid Research and Infrastructure Development[vi] (MGRID) is developing and deploying a pilot institutional grid for the University of Michigan to demonstrate the value and utility of grid computing for the University. MGRID will be used by research projects and for other institutional purposes. The University of Michigan is using GRIDS Center components, including the Globus Toolkit, and the Network Weather Service[7] (NWS), in both the ATLAS and MGRID projects, as well as in other projects.

To begin his project work, Hayrapetyan needed to become familiar with Unix (particularly Red Hat Linux) and the ATLAS project. He did not come to the program with much experience in the area of computing in physics. Hayrapetyan began working on the

[7] NWS information: http://nws.cs.ucsb.edu/

GRIDS Center's components in Release 3[8], including downloading and installing Grid Packaging Tools[9] (GPT) components. When NMI Release 4 became available, he was responsible for removing the components of Release 3 and installing the new versions on the University machines. The installation procedures were completed for Condor-G, and all tests were performed without difficulty. For each of the new components, Hayrapetyan performed testing, troubleshooting, and provided feedback through the formal mechanism of NMI Integration Testbed evaluation reports to developers. In some cases, he contacted the middleware developers directly to ask questions regarding glitches in the installation procedures.

At the end of his internship, Hayrapetyan noted he had enjoyed the time he spent working on NMI, and had learned a great deal about the ATLAS project and "how information is processed in the scientific world." His experience included learning how information is passed over a network, how NWS works, managing operating systems such as Linux and Unix, and system security. In Hayrapetyan's opinion, "the idea of issuing and using certificates is [a] highly convenient and secure method for scientists. Overall the whole NMI project is very important and necessary project," – and one he would like to continue to study, though his REU position has ended.

Project coordinator Shawn McKee found a good deal of value in Hayrapetyan's work on the NMI releases and felt that Hayrapetyan was definitely interested in the overall concept of middleware, and the goals of the ATLAS experiment, noting that, "… He came away with a significant improvement in his understanding of computers, the Linux operating system and networking."

For the fall semester 2004, McKee has hired a second REU student, Richard French, who will continue where Hayrapetyan left off. French, a junior in aerospace engineering, will start his REU work with the goal of increasing his understanding of the NMI and ATLAS projects. His near term goals, in addition to learning about and installing NMI Release 5.1, are to review what Hayrapetyan did and to verify if Hayrapetyan's feedback was ever incorporated into subsequent NMI releases. Over the long term, French may be asked to develop some innovative uses of NMI components to solve some problems being experienced in the ATLAS grid computing model. French would then be able to present his results at an ATLAS group meeting.

[8] NMI Middleware components were issued in multiple Releases: Version 1.1 (NMI-R1.1) was issued on August 28, 2002; Version 3.2 was issued on October 9, 2003; Version 4.0 was issued on December 15, 2003, and Version 5.0 was issued on May 24, 2004.
[9] GPT information: http://www.gridpackagingtools.org/

University of Virginia

At the University of Virginia (UVa), the process of selecting the REU student was simpler than at the other three NMI Testbed sites. At the end of a spring semester 2004 class taught by project lead Marty Humphrey, Jonathan Martin, a student in the class approached Humphrey about summer research opportunities. Humphrey selected Martin for the REU position to focus on portal security and investigating the use of NMI-EDIT's Shibboleth®[10] software for authorization services. This project focus was chosen specifically to build on the REU collaboration intended with the NMI Integration Testbed site team, and was of particular interest to TACC researchers.

The specific NMI technologies that Martin investigated were the GRIDS Center's MyProxy[11] and GridPort[12], and NMI-EDIT's Shibboleth and Pubcookie[13]. He was specifically charged with investigating whether existing solutions like campus public key infrastructures (PKIs) and Pubcookie could be used for extra-campus, grid-like activities such as remote execution and access to remote data. Martin's research was very important in helping UVa to determine how to re-use existing authentication infrastructure on campus. Martin also researched available grid portals, and explored portal security. He studied existing grid portal programs such as Grid Source, an open source, "out of the box" solution, and GridPort, a science-focused program which was developed chiefly for the San Diego Supercomputer Center's NPACI program. As Martin learned in his research, "The primary concern of the portal and its software is authenticating users and controlling their access." Martin spent a few weeks investigating different security methods for portals, including PKI, MyProxy and Shibboleth and determined that the best method for identity verification (authentication) and credential management (authorization) was a combination of MyProxy and Shibboleth services.

Conclusion

In all of the above cases, the students completed their REU experience with a greater understanding of the utility and importance of middleware, and the potential of these technologies to change the way scientific research is performed in the future. The students were involved in almost every aspect of installing and testing NMI components, and were able to give feedback to their project team members and to NMI developers. Some of the students' work presented sizable challenges, but the REU students met those challenges head-on, gaining valuable experience in technology deployment, and how researchers and technologists work collaboratively to achieve technical advances.

[10] Shibboleth information: http://shibboleth.internet2.edu
[11] MyProxy information: http://grid.ncsa.uiuc.edu/myproxy/
[12] GridPort information: http://gridport.net/index.cgi
[13] Pubcookie information: http://www.pubcookie.org/

More Information

For more information about Research Experiences for Undergraduates within the NMI Integration Testbed Program, contact Mary Fran Yafchak at maryfran@sura.org.

References

(1) Alan Blatecky, former NSF Middleware Initiative Program Director, http://www.nsf-middleware.org/about_NMI on March 10, 2002.

(2) OGCE: Open Grid Computing Environment, OGCE home page, The Open Grid Computing Environments Collaboratory. http://www.collab-ogce.org/nmi/index.jsp

[i] TeraGrid is a multi-year effort to build and deploy the world's largest, fastest, distributed infrastructure for open scientific research. When completed, the TeraGrid will include 20 teraflops of computing power distributed at nine sites, facilities capable of managing and storing nearly 1 petabyte of data, high-resolution visualization environments, and toolkits for grid computing. These components will be tightly integrated and connected through a network that will operate at 40 gigabits per second—the fastest research network on the planet. http://www.teragrid.org

[ii] Started in 1997, Partnerships for Advanced Computational Infrastructure (PACI) is a program of the National Science Foundation's (NSF's) Directorate for Computer and Information Science and Engineering (CISE). PACI is creating the foundation for meeting the expanding need for high-end computation and information technologies required by U.S. academic researchers. PACI partners contribute to the development of the information infrastructure by developing, applying and testing the necessary software, tools, and algorithms that contribute to the further growth of this "national grid" of interconnected high-performance computing systems. http://www.paci.org/

[iii] NEESgrid is the Network for Earthquake Engineering Simulation (NEES), an ambitious national program to advance the study of earthquake engineering and find new ways to reduce the hazard earthquakes represent to life and property. http://www.neesgrid.org

[iv] Jetspeed is an Open Source implementation of an Enterprise Information Portal, using Java and XML. Jetspeed acts as the central hub where information from multiple sources is made available in an easy to use manner. The goal is to make Jetspeed a tool for both portal developers as well as user interface designers. http://portals.apache.org/jetspeed-1/

[v] ATLAS is a particle physics experiment that will explore the fundamental nature of matter and the basic forces that shape our universe. The ATLAS detector will search for new discoveries in the head-on collisions of protons of extraordinarily high energy. ATLAS is the largest collaborative effort ever attempted in the physical sciences. There are 1800 physicists participating from more than 150 universities and laboratories in 34 countries.

[vi] The Michigan Grid Research and Infrastructure Development[1] (MGRID) is a secure, high-speed network that provides a convenient and reliable way for campus researchers to access diverse grid resources. The goal of the MGRID initiative is to position the University of Michigan to be a leader in grid computing and to enable researchers at the University of Michigan to take advantage of the new capabilities offered by grid computing. MGRID will be used in research projects and for other institutional purposes. Units at the University of Michigan are actively collaborating with MGRID staff to develop and deploy Grid infrastructure. The University of Michigan is using NMI components, including the Globus Toolkit, and the Network Weather Service[1] (NWS), in both the ATLAS and MGRID projects, as well as in other projects. http://www.mgrid.umich.edu/