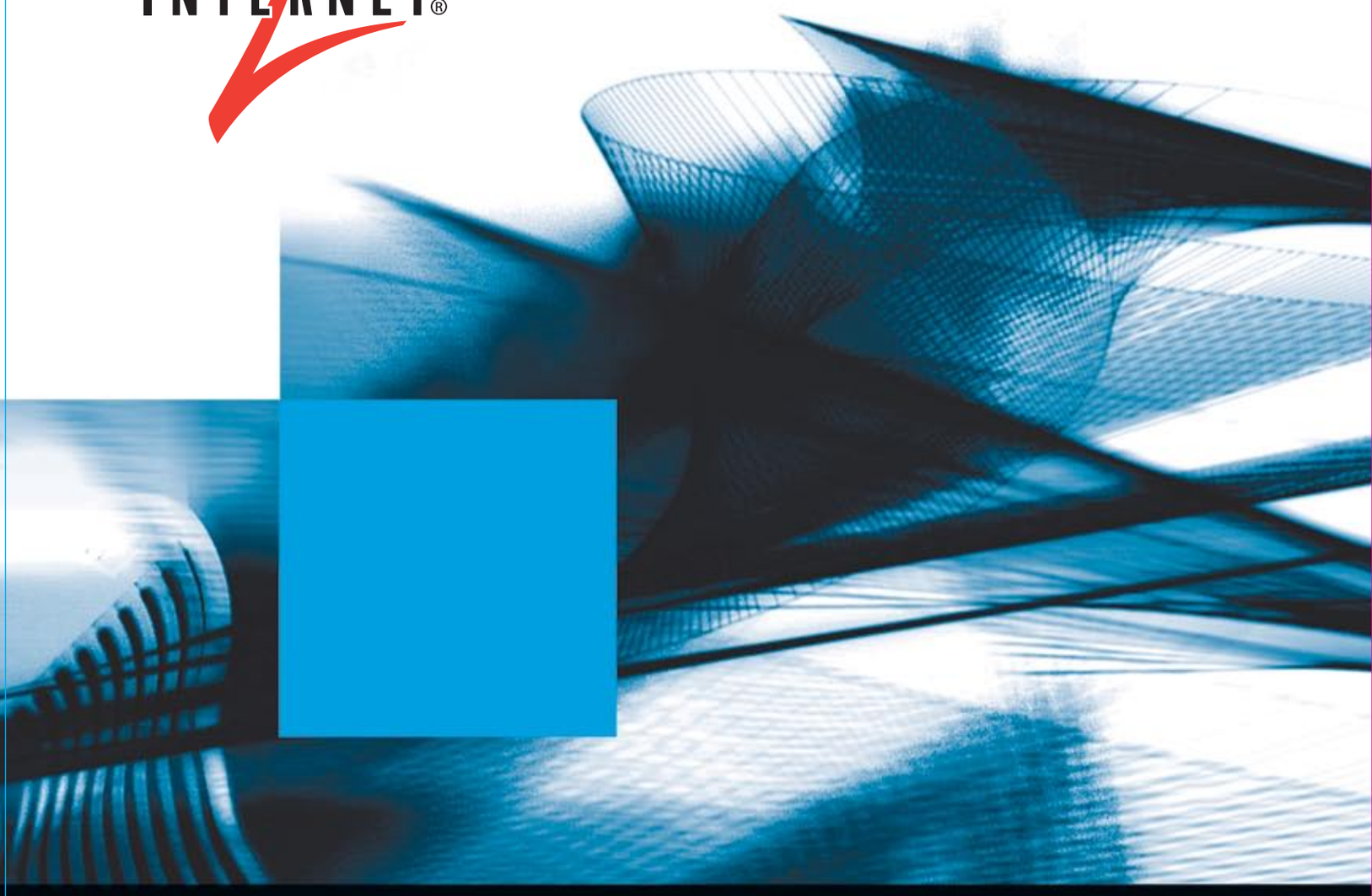
INTERNET2®



2003 ANNUAL REPORT

Internet2 develops and deploys advanced network applications and technologies accelerating the creation of tomorrow's Internet.

As a research and development consortium led by U.S. universities, and working in partnership with government and industry, Internet2 is transforming the way we work, learn, and communicate.

Internet2: A Look Back »

Dear Colleagues,

During 2003, the Internet2 community continued contributing towards a better global Internet—one that is more capable, more secure, and easier to use. We took significant new steps in optical networking, middleware, end-to-end performance, and security, and made notable progress in extending the benefits of advanced networking to students, faculty, and researchers. The result is a networking environment for research and education that is unsurpassed in its technological capabilities and geographic reach.

Teaching, learning, and progress in nearly every scientific arena today increasingly rely on networking capabilities that extend beyond those available on the commercial Internet. Educators and students in subjects from music to geography are working together to teach and learn in ways that would not be possible without the advanced networking capabilities deployed by Internet2 members. Researchers are able to construct new instruments and to conduct experiments impossible without advanced network capabilities maintained for and by the Internet2 community.

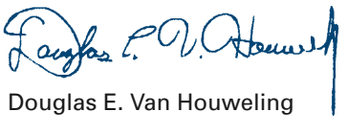
Highlights from 2003 detailed in this report include:

- The Abilene Network upgrade that, along with new efforts such as FiberCo and participation in National LambdaRail, Inc., ensured members continued access to a leading-edge network infrastructure.
- Software developed under the auspices of the Internet2 Middleware Initiative that made it easier for organizations to deploy enterprise-wide authentication capabilities.
- Work within the Internet2 End-to-End Performance Initiative that helped engineers more quickly pinpoint and resolve network performance problems.
- Services available through the Internet2 Commons that provided scholars improved and more routine access to and use of collaboration technologies.

Our collective progress has been possible because of sustained investment and effort by individual members connected by a shared vision. Collaboration among organizations from academia, industry, and government, and individuals from research, network engineering, and applications development remains a key strength of the Internet2 community. By enabling work across disciplines and technologies, Internet2 provides members a unique environment in which to pursue an integrated approach to innovation that is critical for progress in advanced networking, but difficult to achieve by an organization alone.

The Internet2 community accomplished a great deal in 2003. However, I believe our community's greatest potential lies ahead, with the coming year resulting in even more exciting accomplishments as we together create the better, faster, more reliable, and more secure Internet of tomorrow.

Sincerely,



Douglas E. Van Houweling
President and CEO
Internet2

September

1995

» Monterey Futures Group Forms

April

1996

» NTTF/FARNET Meeting

The Internet2 Community: Continuing to Grow

members.internet2.edu

As a research and development consortium of leading U.S. universities, corporations, government research agencies, and not-for-profit educational organizations, Internet2 includes more than 300 members dedicated to developing and deploying advanced networking capabilities. Internet2 membership continued to grow during 2003 with 204 university members, 66 corporate members, and 41 affiliate members at the close of the year. The complement of new members in 2003 reflected the diverse community engaged in advanced networking, including research universities, a health science institution, a state networking organization, and a company specializing in publication of electronic information.

The number of International Partners also grew during 2003 to 45, linking Internet2 members to research and education networking organizations around the world. The principal goal of Internet2 international partnerships is to enable global research and education through access to advanced international networks. Connections to the networks of International Partners helped create a global proving ground for new technologies and ensured that the next generation of Internet technologies and applications will be globally interoperable.

Sponsorship by Internet2 members provided 32 state education networks access to the nationwide Internet2 Abilene Network. These state education networks provide connections for more than 10,000 educational organizations, including elementary and secondary schools, four-year and community colleges, as well as universities and libraries. Internet2 members also individually sponsored more than 92 laboratories, clinical research centers, museums, and early-stage spin-off companies supporting collaborations with Internet2 members that would not be possible without the advanced networking capabilities of the Abilene Network.

Through its members, the Internet2 community brings together leaders who are exploring, deploying, and using advanced networking today to create a better Internet.

August

1996

» Cheyenne Mountain Meeting

October

1996

» Internet2 forms
» 34 university members
» Michael M. Roberts becomes Internet2 Project Director

Internet2 Working Groups: Collaborating to Develop Innovative Advanced Networking Technologies

www.internet2.edu/working-groups.html

Internet2 Working Groups are involved in a broad range of development activities. Working Group chairs and participants represent all Internet2 member organizations, as well as international partners. Internet2 Working Groups were very active during 2003. Here are some of the highlights:

Testing Digital Video over IP (DVIP): The ResearchChannel Working Group, Internet2 corporate member Fujitsu Laboratories, and the WIDE project (Widely Integrated Distributed Environment) in Japan were among the collaborators in a project that used Fujitsu's Comet DVIP hardware and DVTS (Digital Video Transport System) software to provide a 30 Mbps live multicast stream of a Korean dance festival, held in September 2003. The success of this multicast event resulted in several Internet2 members asking for Comet DVIP cards to experiment with, which in turn provided valuable technical feedback and development information to Fujitsu Labs.

Providing Voice Services during Disaster Recovery: Led by the Internet2 Voice over IP (VoIP) Working Group, including corporate sponsor BroadSoft and corporate member Paetec Communications, and Georgetown University, with participation by several additional Internet2 member universities, makes Internet2's Abilene Network available as an alternative pathway for voice communications for communication in disaster scenarios, when the public switched telephone network may be unavailable. During 2003, the initial system design, deployment, and testing were successfully completed.

Exploring Uses of Shibboleth in the Academic Medical Environment: The Medical Middleware (MedMid) Working Group, in conjunction with the Association of American Medical Colleges (AAMC), initiated two pilot deployments of Shibboleth: enabled secure web access to the Tufts University Sciences Knowledgebase (TUSK)—a password-protected, multimedia database containing a variety of course materials and other resources—and an AAMC online courseware project underway at the University of Cincinnati.

Developing Tools for Directory Implementations: The MACE-Dir (Middleware Architecture Committee for Education—Directories) Working Group developed a set of tools, called Grouper, for managing groups in enterprise directories. MACE-Dir published *Group Tools Architecture*, which presents a high-level architecture for this tool set, an associated data model, behavioral descriptions of the elements of the architecture, and high-level specifications for application programming interfaces. MACE-Dir also released the *Enterprise Directory Implementation Roadmap*, which draws on Working Group members' extensive experience in this area to provide guidance to campuses contemplating—or already deploying—an enterprise directory.

New Internet2 Working Groups in 2003

- Presence and Integrated Communications
- Radiology
- Integrated Infrastructure for Instant Messaging

January

1997

» 100 university members
» First Internet2 Member Meeting in Burlingame, CA
» Preliminary Internet2 applications and engineering reports
» GigaPoP Operators Workshop in San Jose, CA

Internet2 Technology Evaluation Centers: Expanding Capabilities

itecs.internet2.edu

This year, Internet2 announced two new Internet2 Technology Evaluation Centers (ITECs), doubling the number of centers committed to the development and testing of high-performance network infrastructure and of applications that require optimal end-to-end performance. The two new ITECs—located at the San Diego Super Computer Center (SDSC) and Texas A&M University (TAMU)—join already active centers at North Carolina State University and the Ohio Supercomputer Center.

The California ITEC allows us to extend the capabilities and partnerships developed through SDSC's Network Performance Reference Lab for the benefit of the entire Internet2 community. We are especially focused on working with the End-to-End Performance Initiative, and we expect our work here to benefit everyone who relies upon advanced networking, especially the community of National Partnership for Advanced Computational Infrastructure partners that use the Abilene Network to access SDSC resources.

KEVIN WALSH
Director
California ITEC

Since February 2003, the California ITEC has focused on its mission of testing and evaluating leading-edge technologies for high-performance Internet2 networks and has worked with developers to test and refine network hardware and software for optimal end-to-end network performance at data rates ranging from 10 Mbps to 10 Gbps. With a particular emphasis on end-to-end networking, the California ITEC has taken on the Wizard Gap problem, the dilemma of the average researcher with little network expertise who has trouble getting applications to perform optimally over high-performance networks. The California ITEC will focus on performance problem detection and resolution throughout the local, regional, and national networking infrastructure, with the goal that users of the network will routinely expect and experience success in their development and use of advanced networks.

In November 2003, the TAMU ITEC began to examine voice services over IP networks with three objectives: Session Initiation Protocol (SIP) compliance, network impairment, and call rerouting for disaster recovery. SIP compliance evaluations will establish a list of telephone switch features and test SIP compliance between SIP phones and SIP servers. Network impairment testing will study the impact of various levels of packet loss, jitter, and latency on the quality of voice transmissions. Call rerouting for disaster recovery will research and document the processes required to reroute inbound calls using a remote SIP gateway in the event of a catastrophic public switched telephone network failure or over loaded trunk situation caused by disaster.

The Ohio and North Carolina ITECs continue to work closely with Internet2's End-to-End Performance Initiative to evaluate best practices in the deployment of dark fiber and to monitor the performance and routing of advanced networking systems, including the Abilene Network upgrade to 10 Gbps completed in December 2003.

March

1997

» Internet2 Advisory Committee meets in Chicago, IL

April

1997

» GigaPoP Workshop at San Diego Supercomputer Center

» Cisco Systems becomes initial Internet2 Corporate Partner

H.323 Beacon Improves Videoconferencing Setup

www.itecohio.org/beacon/

The H.323 Beacon measures, monitors, and troubleshoots the performance of an H.323 videoconference. End-users, network engineers, and conference operators can debug H.323 application performance problems from the network to the host (from end-to-end).

Developed in 2003 by Internet2 and the Ohio Internet2 Technology Evaluation Center of the Ohio Supercomputer Center, the H.323 Beacon was introduced to the advanced networking community this fall. After a rigorous test period in conjunction with the annual Megaconference, the world's largest H.323 videoconference, the Beacon garnered many endorsements. It was selected for use with the Internet2 Commons H.323 videoconferencing service; it was officially recommended for performance troubleshooting by Internet2 Corporate Sponsor Polycom, Inc.; and Internet2 corporate member Apparent Networks highlighted the H.323 Beacon in a published white paper on network performance infrastructures.

Supporting Research and Funding to Meet Member Priorities

research.internet2.edu

Internet2 facilitates research collaboration across a number of areas in a variety of ways. By cultivating partnerships across the academic, government, and corporate sectors, Internet2 helps shape research priorities and targeted investigation opportunities across disciplines and geographic boundaries. During 2003, Internet2 helped members pursue funding opportunities, provided key infrastructure for member-led research projects, and organized workshops to address key areas of advanced networking development.

Internet2 helps create and support partnerships that leverage members' intellectual capital and resources to pursue funding opportunities for the development and use of advanced networking technologies. In addition, Internet2 is a direct participant in a number of awards, including a National Institutes of Health-funded project led by Internet2 university members, Montana State University and the University of Washington, to address a gap in the current high-performance research and education networking infrastructure by developing an advanced regional network for biomedical researchers in the United State's Northern Tier.

In August 2003, Internet2 organized a number of workshops that supported networking research. The Security at Line Speed workshop was made possible through a National Science Foundation (NSF) grant awarded to Internet2 in collaboration with Internet2 university members, Indiana University and the University of Washington, to develop next-generation guidelines for network security in research and higher education.

July

1997

» Internet2 Applications Workshop at University of Michigan

In December, Internet2 coordinated a workshop on Performance Measurement Architecture hosted by Internet2 university member, the University of California, San Diego, and supported by an NSF grant focused on end-to-end network performance instrumentation and measurement tools.

Internet2 is playing a key role by providing a backbone networking capability for the NSF-funded 100x100 Project. This project brings together economists, security and networking experts, network operators, and policy specialists from Internet2 Corporate Partner AT&T Research and Internet2 university members Carnegie Mellon University, Rice University, Stanford University, and the University of California, Berkeley—as well as other organizations—to create blueprints for a network that can deliver 100 Mbps bandwidth to 100 million homes. Project goals include developing a holistic network architecture designed from first principles; conducting interdisciplinary fundamental research that addresses the design of an economical, robust, secure and scalable 100x100 network; and establishing proof-of-concept network implementations to demonstrate how the network of the future can be built.

In addition, Internet2 staff participates in peer-review panels, meets regularly with government funding agencies to anticipate and respond to research trends and priorities, and partners with other organizations to catalyze discussion and define solutions. Internet2 has provided technical assistance, letters of support, and a grants cookbook to support Internet2 members as they respond to funding opportunities.

Developing Tools and Services to Facilitate Inter-institutional Collaboration

www.nmi-edit.org

In September 2003, Internet2 received funding from the National Science Foundation (NSF) for the second, three-year phase of the NSF Middleware Initiative Enterprise and Desktop Integration Technologies (NMI-EDIT) partnership. Working with close to 100 academic institutions, individual partners, and organizations, the NMI-EDIT consortium has developed tools and services that facilitate inter-institutional collaboration. Working in partnership with EDUCAUSE, Internet2's coordination resulted in the development of a core middleware structure for the worldwide research and education community. More than 80 percent of the awarded funding has been directed to higher education institutions responsible for most of NMI-EDIT's efforts.

The NMI-EDIT consortium has built upon the momentum and achievements of the project's first three years, which also included Southern Universities Research Association as a coordinating testbed partner. The consortium has developed broad campus awareness and consistent enterprise deployments of core middleware services. Many parts of the project's first phase efforts in areas such as security, inter-realm collaborations, and middleware sustainability already have become widely accepted by corporate and government sectors. The project's second phase is focusing on broad and consistent international security and directory infrastructures, and includes middleware diagnostics and authorization systems. NMI-EDIT collaborates with the Grid Research Integration Deployment and Support Center, the Open Grid Computing Environment team, and the Common Instrument Middleware Architecture team, as part of NSF's Middleware Initiative.

September

1997

» Internet2 formally incorporated
» First Internet2 Board of Trustees meeting
» Applications Strategy Council forms
» Network Planning and Policy Advisory Council forms
» Network Research Liaison Council forms
» Campus Networks Workshop at University of California, Davis

MEMBER PROFILE

New World Symphony: Building a Global Arts Community
www.nws.org

The New World Symphony (NWS) has fully integrated advanced networking into its daily operations. A high-performance network connection—combined with an in-house system of cameras, monitors, and video encoders—have enabled a dramatic expansion of the distance education and performance opportunities available to the musicians selected for the three-year fellowship program at NWS's Miami Beach campus. Live interactive music master classes, symposiums, and coaching sessions with music programs and faculty at Internet2 member universities around the country provide NWS musicians access to conductors and artists who would otherwise be unavailable due to heavy travel and performance schedules.

Through generous support from a 2001 National Endowment for the Arts Resources for Change: Technology grant, NWS began developing applications of Internet2 to music instruction and performance. A National Science Foundation (NSF) High-Performance Network Connections grant awarded in 2003—in what may be the first ever award from the NSF to a musical ensemble—allowed NWS to upgrade its connectivity to a gigabit Ethernet. This expanded network capacity is enabling NWS to broaden the technologies it uses to create immersive audio and high-definition quality experiences for participants in distance learning initiatives and to build a virtual artistic community, both national and international.

Internet2 has made possible a musical 'global village,' in which the constraints of geography dissolve, and music will be made and shared with extraordinary freedom and ease among composers, performers, audiences, teachers and students the world over.

MICHAEL TILSON THOMAS, Founder and Artistic Director, New World Symphony

October

1997

» Internet2 Member Meeting in Washington, D.C.
» CANARIE becomes first International Partner
» First advanced applications demonstrations at an Internet2 event

November

1997

» 25 corporate members
» Second GigaPoP Operators meeting
» Douglas E. Van Houweling becomes Internet2 President and CEO

Abilene: Leading-edge Backbone Networking

abilene.internet2.edu

With the completion of the next generation upgrade in mid-December 2003, the Abilene Network remained one of the premier research and education networks in the world. Increasing the bandwidth of the network, from 2.5 Gbps to 10 Gbps, provides students, researchers and faculty at Internet2 member organizations a more robust, better-performing network on which to conduct research and experiments. Internet2 worked closely with Abilene partners Juniper Networks and Qwest Communications to make the upgrade smooth and successful.

Strong partnerships continued to form the foundation for the Abilene Network, including: Indiana University for the Abilene Network Operations Center (NOC); the Ohio and North Carolina Internet2 Technology Evaluation Centers for test facilities; Qwest Communications for network infrastructure; and, Juniper Networks, Cisco Systems, and Nortel Networks for continued support of new network technologies.

Advanced network services—including IPv6, multicast, and large maximum transition unit deployment—were a critical focus during the last year.

Security on advanced networks also continued to be a major focus. With the advent of the Research and Education Networking Information Sharing and Analysis Center (REN-ISAC) at Indiana University, the Abilene Network will participate in defining the national strategy to secure cyber-infrastructure.

As a result of the upgrade, the Abilene cost recovery model was revised for 2004 to encourage upgrading the bandwidth of connections while keeping costs constant. Thus, the number of Abilene participants grew to 224 participants. Additionally, the number of connectors decreased to 47 direct connectors because several individual connectors are now behind other connectors (e.g., OC-3s going behind larger OC-12, OC-48, and higher bandwidth connections).

The advent of regional optical networking initiatives provided another vehicle for connecting to Abilene. Internet2 encouraged connectors to work with the organization and the Abilene NOC to help facilitate potential use of such networks for access to Abilene.

The number of sponsored participants and sponsored educational group participants (SEGPs) continued to show strong growth. The number of peer networks has increased to include almost all international research and education networks, and every federal research network. Most federal networks now peer at the three primary federal exchange points: NGIX-WEST at NASA Ames, StarLight/StarTap in Chicago, and NGIX-EAST at the University of Maryland. Abilene upgraded to 10 Gbps connections to key exchange points such as MAN LAN (Manhattan Landing), Pacific Wave, and StarLight, improving peering with the networks of International Partners.

January

1998

» 123 university members
» 30 corporate members
» 22 affiliate members

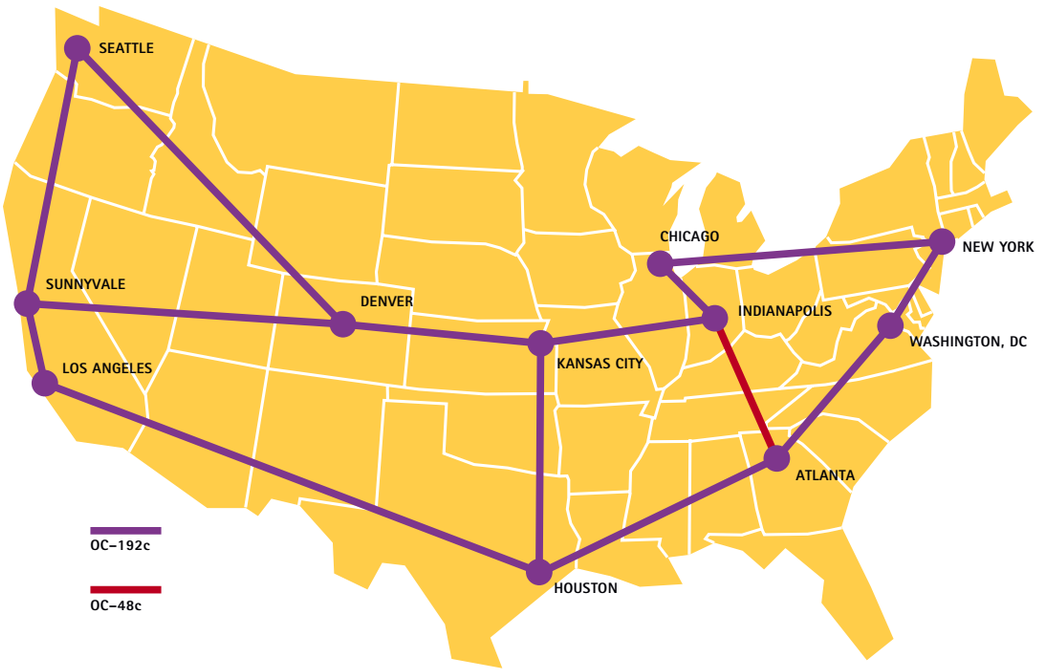
» Internet2 Working Group Meetings at University of California, San Diego

February

1998

» First Internet2 Day at MCNC

ABILENE BACKBONE NETWORK



During 2003, connectivity to the Abilene Network continued to grow, both in bandwidth utilized and in number of connected organizations (participants, sponsored participants, and SEGP organizations).

Totals as of December 31, 2003	
Participants	224
Connectors	47
Sponsored Participants	92
SEGPs	32
International Peer Networks	24
Domestic Peer Networks	6
Experimental Networks	4

April

1998

» Internet2 Abilene Network announced at White House
» Spring Internet2 Member Meeting in Washington, D.C.

May

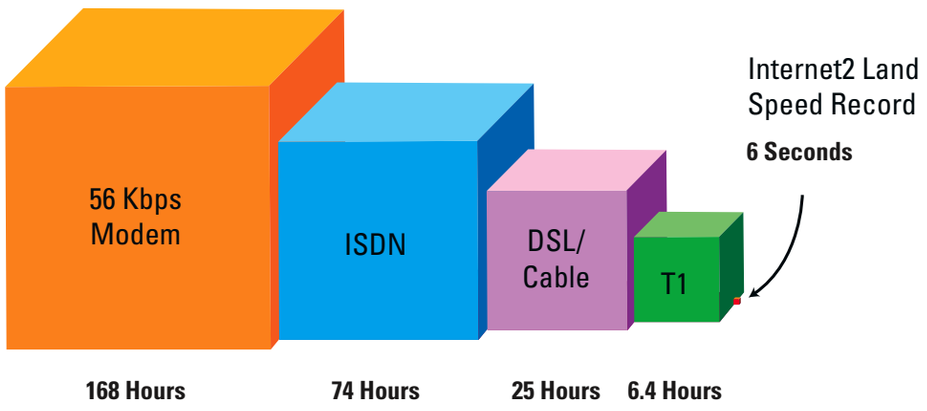
1998

» Joint Applications/ Engineering Quality of Service Workshop

INTERNET2 LAND SPEED RECORD

lsr.internet2.edu

The Internet2 Land Speed Record is an open and ongoing competition that establishes the world's highest-bandwidth, end-to-end network performance. The current record, set on November 11, 2003 by a team from Caltech and CERN and recognized by the *Guinness Book of World Records*, transferred more than one terabyte of data in less than one hour across more than 10,000 km of network—including the Abilene Network. This represents an average rate of more than 5.64 Gbps, more than 20,000 times faster than a typical home broadband connection, and demonstrates the ability of high-performance networking to enable scientists and students to work in ways not possible on the commercial Internet.



June

1998

» GigaPoP Operators Workshop

August

1998

» Internet2 Working Group Chairs Meeting

Abilene Observatory: Providing Unique Access to Operational Networks

abilene.internet2.edu/observatory/

The Abilene Observatory supports the development of an integrated data archive of the performance and network status information collected on the Abilene Network. The aim is to provide network researchers with access to operational network data that is not possible in a laboratory environment or on the commercial Internet. The Abilene Observatory project is part of the Abilene Network upgrade completed in December 2003. In addition to data collected by Abilene Network engineers, the Observatory provides for the colocation of equipment at Abilene Network nodes for network experiments and measurement servers developed by the research community.

Data collection by Abilene engineers relied on four network management servers (NMS) located in the Abilene racks. NMS are standard PC-type machines running a common version of the UNIX operating system. In general, data is collected locally and distributed to other database servers that provide a web services interface to the datasets. Researchers can automate the process of accessing the data through web interfaces, simplifying the process of data acquisition.

Datasets available to the research community include the following: Usage Statistics, Flow Statistics, Routing Data, Latency Measurements, Throughput Measurements, Router Data, and Syslog Data.

More than nine research groups at Internet2 member organizations use data collected by the Observatory, including:

- **The Wisconsin Advanced Internet Laboratory (WAIL)**: Flow sampling and anomaly detection using Abilene flow data.
- **Boston University Department of Computer Science**: Spatio-temporal network analysis.
- **Network Research Lab at Case Western Reserve University**: The presence and incidence of alpha flows in backbone links.

Two research projects have colocated equipment in the Abilene router nodes: PlanetLab, a global project providing an overlay network involving many different types of research projects, and AMP (Active Measurement Project), providing latency information between large numbers of machines across the network.

September

1998

» Industry Strategy Council forms
» Fall Internet2 Member Meeting in San Francisco, CA
» First nationwide Abilene demonstration

November

1998

» First Joint Techs Workshop at Carnegie Mellon University

MEMBER PROFILE

THE UNIVERSITY of WISCONSIN MADISON

University of Wisconsin-Madison: Supporting Leading-edge Research and Education with a 21st-Century Network
www.wisc.edu

A large part of the work and investment required to realize the goals of Internet2 is taking place on the campuses of Internet2 universities. The University of Wisconsin-Madison (UW-Madison) is implementing a highly advanced network that will extend to every network jack in each campus building. The project was launched by a gift valued at approximately $7.3 million from alumnus and Cisco Systems Chair John Morgridge that was joined by UW-Madison's own investment of approximately $14.7 million for equipment over five years. UW-Madison is making an additional investment in fiber and cable infrastructure, as well as telecommunications closet upgrades.

UW-Madison's "21st Century Network" upgrade will address performance, security and functionality requirements, and includes minimum standards for electronics, infrastructure and operational devices, as well as an expanded wireless capacity to be built out over time. The network will support redundant 10 Gbps links in the core, redundant 1 Gbps links to each telecommunications room and 100 Mbps connections to servers, workstations, and labs.

With upgraded physical hardware and a multi-gigabit network backbone in place, UW-Madison will be able to provide advanced network services campus-wide, and support emerging advanced network applications, including streaming video, a new digital television service, and Voice over IP.

This network upgrade enables the world-class researchers at the University of Wisconsin-Madison to use grid computing, real-time videoconferencing, and high-speed data transfers in their work as part of key national and international research collaborations and initiatives tackling leading-edge challenges in fields such as high-energy physics, cybersecurity, atmospheric sciences, education, biotechnology, and public health.

ANNIE STUNDEN, CIO and Director of the Division of Information Technology, University of Wisconsin-Madison

National LambdaRail: Leveraging a New Optical Infrastructure to Explore Cutting-edge Networking

www.nationallambdarail.org

NLR light the future

In May 2003, Internet2 joined a consortium of U.S. research universities and private sector technology companies to form National LambdaRail, Inc. (NLR), a not-for-profit corporation dedicated to building a national scale infrastructure for research and experimentation in networking technologies and applications. When complete, NLR will be the largest higher education owned and managed optical networking and research facility in the world. NLR will initially include four

January

1999

» Abilene Network operational

March

1999

» Joint Techs Workshop at New Mexico State University

» Distributed Storage Infrastructure Applications Workshop

10 Gbps lightwaves provisioned across approximately 10,000 route miles of dark fiber.

Internet2 has committed $10 million over five years to this effort and is actively engaged in NLR's governance and initial rollout. In recognition of its substantial support, Internet2 will receive the right to use one 10 Gbps wavelength on the national NLR footprint for the first five years of operation. This resource, in conjunction with the Abilene Network, will provide the Internet2 community a foundation for exploring approaches to developing and deploying a hybrid optical packet infrastructure.

NLR's fundamental mission is to provide an enabling network infrastructure for new forms and methods for research in science, engineering, health care, and education. Unlike other national research and education networks, NLR is based on facilities that are owned rather than services obtained from a network provider, allowing for the deployment of many wavelengths. Individual wavelengths will exist side-by-side in the same fiber optic cable pair but will be physically and operationally independent. A wavelength dedicated to a particular project or set of problems provides researchers with the freedom and flexibility to stress the network, to use applications, and to identify solutions without disrupting the work of other communities.

NLR deployment began in early September 2003, with the first segment of 674 fiber miles between Chicago and Pittsburgh operational in November. The first completed link connected the Pittsburgh Supercomputing Center to the Extensible Terascale Facility, the backplane network for the National Science Foundation's Teragrid project, through the StarLight Facility in Chicago. Full deployment is expected by early 2005.

Founding NLR members and associates include Internet2 member organizations such as:

- Cisco Systems
- Corporation for Education Network Initiatives in California
- Duke University (representing a coalition of North Carolina Universities)
- Georgia Institute of Technology

April

1999

» 154 university members
» 54 corporate members
» 27 affiliate members
» 42 Abilene participants

June

1999

» Joint Techs Workshop at Carnegie Mellon University

FiberCo™: Facilitating Regional Optical Networking for Research and Education

www.fiberco.org

In March 2003, Internet2 established FiberCo to provide a means for acquiring, holding, and assigning dark fiber optic network assets in support of the Internet2 community's goals of developing and deploying advanced network applications and technologies. Its core objectives are to provide inter-city dark fiber to regional optical networks with the benefit of national-scale agreements and aggregate price levels, and to ensure that the U.S. research university community maintains access to a strategic fiber acquisition capability on the national scale for both current and future optical networking initiatives.

FiberCo facilitates the ongoing development of regional optical networking efforts around the country, and supports both the existing Internet2 network infrastructure and efforts such as the new National LambdaRail (NLR) facility. Through agreements with Internet2 corporate member Level 3 Communications, FiberCo is able to provision dark fiber from an initial allocation of more than 2,600 route miles on Level 3's nationwide fiber footprint. FiberCo works with regional networks to acquire dark fiber assets, subsequently transferring ownership and operational responsibility for the fiber to the regional network.

In December, FiberCo made its first assignment of dark fiber to Indiana University, which will use the dark fiber pair to light two 10 Gbps circuits between Indianapolis and Chicago. These circuits will connect the IP-Grid, a collaboration between Indiana University and Purdue University, to the National Science Foundation-supported Extensible Terascale Facility in Chicago. The fiber also will support the universities' connection to NLR and ultimately other connection services to Chicago. In addition, the assigned fiber will enable additional Chicago-based peering connections for the two Indiana research institutions.

FiberCo is helping our institutions reach goals in support of continued excellence in research, teaching, outreach and lifelong learning. The fiber will guarantee our researchers, faculty and students better access to advanced networking technologies and collaboration.

MICHAEL A. McROBBIE, PhD
Vice President for Research, Vice President for Information Technology, and CIO
Indiana University

August

1999

» Internet2 Working Groups Meeting

September

1999

» Fall Internet2 Member Meeting hosted by University of Washington in Seattle, WA

» First demonstration of studio-quality HDTV across Internet2 networks

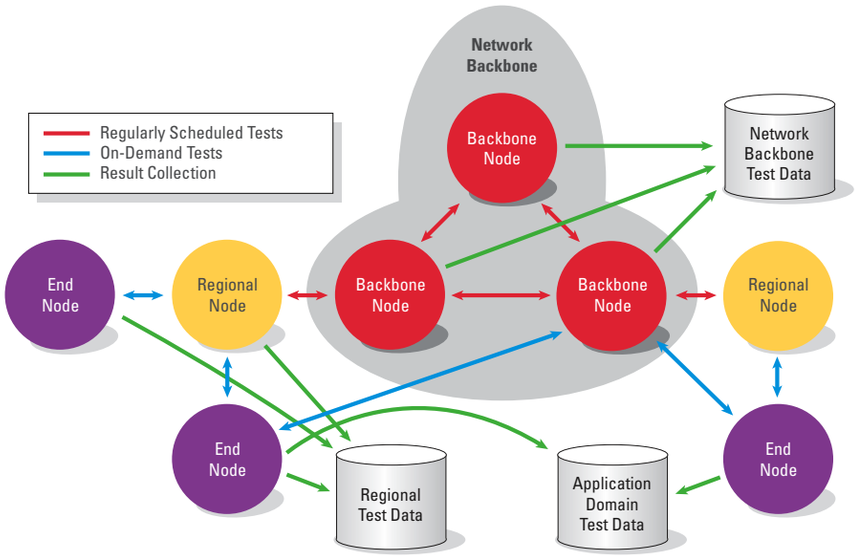
End-to-End Performance Initiative Performance Environment System

e2epi.internet2.edu/E2EpiPEs/

To help create an environment in which users have routinely successful experiences using advanced applications, Internet2's End-to-End Performance Initiative (E2Epi) is developing a distributed, scalable system to monitor, test, and report end-to-end network performance.

The system, called the End-to-End Performance Initiative Performance Environment System (E2E piPEs), will indicate performance capabilities and locate network problems along the path between two computers connected through participating campuses, regional, and backbone networks. When complete, the E2E piPEs will pinpoint a problem node or link, match the node or link with contact information in a system database, and send the result back to the end user. This will allow the end user to contact the appropriate network administrator and provide convincing data that there is a problem, significantly improving the opportunity for advanced Internet applications to operate at peak performance.

E2E piPEs ARCHITECTURE



December

1999

» Joint Techs Workshop at Florida International University

» Internet2 Technology Evaluation Center at NCNI announced

» Internet2 Technology Evaluation Center at OARnet announced

During 2003, Internet2 began implementing the E2E piPEs by creating and deploying data collection boxes at all 11 nodes of the Abilene Network; this allows the Abilene Observatory to report on the status of the network. Internet2 also completed preliminary work to rollout E2E piPEs to the University of Hawaii, the Abilene Network Operations Center at Indiana University, and the Internet2 Technology Evaluation Centers (ITECs) located at North Carolina State University and the Ohio State University.

OWAMP (latency), Iperf (throughput), and Traceroute (routing) measurement tools were added to the E2E piPEs framework. Close collaboration with U.S. Department of Energy laboratories, the high-energy and nuclear physics community, radio astronomy researchers, National Science Foundation-funded National Laboratory for Applied Network Research, the Global Grid Forum, and international partners University College of London and DANTE ensured that the framework was interoperable with measurement tools under development by these groups. As a result of Internet2's coordination, these researchers are working in concert, rather than duplicating efforts.

Internet2 also worked closely with Internet2 Corporate Partner Microsoft Research, which incorporated data-collection tools into its operating system plans. Eventually, the E2E piPEs will be able to collect data from any machine running a Microsoft operating system. This will enhance E2E piPEs' ability to solve "last mile" problems.

One-Way Active Measurement Protocol: Improving End-to-end Performance

e2epi.internet2.edu/owamp/

With roundtrip-based measurements, it is hard to isolate the direction in which network congestion is experienced. One-way measurements solve this problem and make the direction with congestion immediately apparent, allowing measurements to be more informative since traffic can be asymmetric at sites that are primarily producers or consumers of data. With better measurement tools and techniques, such as the partially National Science Foundation-funded, One-Way Active Measurement Protocol (OWAMP), network providers can better understand the exact behavior of their networks and apply resources where improvement is most likely. OWAMP was developed by members of the Internet2 engineering team as a reference implementation of a proposed standard going through the Internet Engineering Task Force (IETF).

In 2003, OWAMP underwent several revisions to make it more streamlined for use with the E2E piPEs. As part of that process, Internet2 engineers who developed OWAMP created the BWCTL (Bandwidth Control) tool to better schedule when tests are run. Use of the BWCTL tool eliminates the impact of tests on the performance of a network, such as when the network is heavily loaded with production application use.

The OWAMP data collected for the Abilene Observatory is being used by the E2E piPEs, the National Laboratory for Applied Network Research's (NLANR) Advisor tool, and the High Energy and Nuclear Physics (HENP)-funded MONitoring Agents using a Large Integrated Services Architecture (MonALISA) project. The latency data provided by OWAMP gives authorized users at the campus level a desktop view into the performance of the Abilene Network.

January

2000

» 170 university members
» Health Sciences Initiative forms

February

2000

» Internet2 Working Groups Meeting at University of California, Santa Barbara

Internet2 Commons: Increasing Inter-organizational Collaboration

commons.internet2.edu

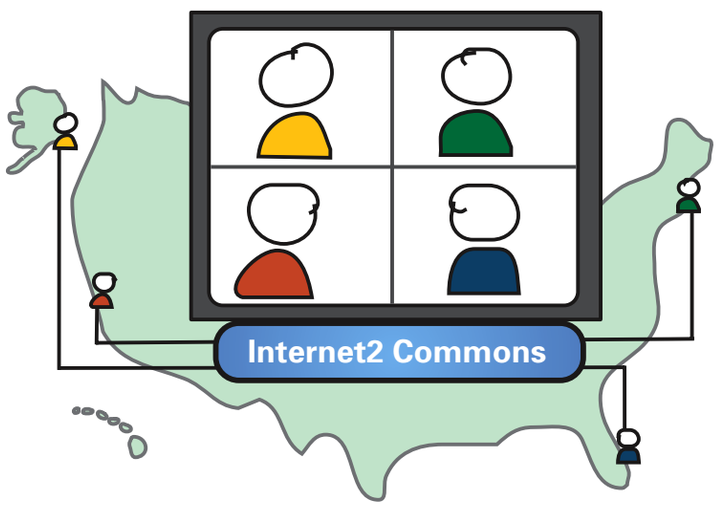
The Internet2 Commons, an Internet2 collaborative services framework, has increased the ability of Internet2 member organizations to perform inter-organizational research and teaching.

In September 2003, the Internet2 Commons launched an H.323 videoconferencing subscription service. Among its early adopters, NEES (the George E. Brown, Jr. Network for Earthquake Engineering Simulation) earthquake researchers and the Committee on Institutional Cooperation (CIC) regularly used the service to bridge many end users into one common conference.

NEES adopted the Internet2 Commons to support their distributed interactions because of the service's low cost, ease of use, quick deployment time, and ability to operate without major changes in network configurations at the participation organizations. The large and distributed NEES community regularly connected 15 to 20 sites for two to four videoconferences per month. They also relied on the Commons' advanced features, including firewall traversal, streaming, and immediate video archiving of each conference.

The CIC began an innovative pilot project, CourseShare, using the Internet2 Commons to teach a distributed nursing informatics

MULTIPOINT VIDEOCONFERENCING OVER IP



March

2000

» Spring Internet2 Member Meeting in Washington, D.C.

» First Internet2 Land Speed Record: 831 Mbps across 5626 km

April

2000

» Middleware Architecture Committee for Education established

course. Through the Internet2 Commons, this graduate level course brought together six instructors and 12 students at Internet2 members University of Iowa, University of Wisconsin-Madison, Indiana University, and University of Michigan.

This collaboration provides creative strategies that leverage the scarcity of nursing informatics faculty and at the same time offer students participation in a wealth of research projects and innovations across multiple institutions.

CONNIE DELANEY
Professor, College of Nursing
University of Iowa

In December, the Internet2 Commons provided the central multipoint control unit (MCU) services for the fifth annual Megaconference, which brought together approximately 1,000 people from more than 187 organizations in 28 countries via videoconference. Internet2 Corporate Sponsors RADVISION and Polycom, Inc. donated software and hardware upgrades to the MCUs that they previously had donated to the Commons. The new features increase the capacity of each MCU by more than a third—from 35 to 48 simultaneous sites—at a rate of 768 Kbps; support the new H.264 codec, which provides better than MPEG-2 quality video at half the bandwidth; and provide a gateway to the new protocol, SIP (Session Initiation Protocol).

Internet2 Commons in 2003:

- More than 100 Site Coordinators total throughout the Internet2 membership (videoconferencing support staff)
- Ten new members to the newly-launched subscription service
- Three training workshops to certify H.323 videoconferencing support staff

Megaconference: Leading the Way in Demonstrating H.323 Multipoint Technology

www.megaconference.org

Since 1999, the Megaconference, the world's largest videoconference across advanced networks, has led in the development of both H.323 multipoint technology and the community of educators and researchers using the technology. More than 187 institutions in 28 countries participated remotely in the fifth annual Megaconference, a 13-hour videoconference held December 10, 2003 on "Sustaining Global Communities." Megaconference organizers estimated that the number of participants reached 1,000, while more than 100 viewers watched the streaming simulcast, and several participants bridged into the conference using SIP (Session Initiation Protocol).

Individuals from many Internet2 member organizations donated their time, expertise, and equipment to help make the event a success. Internet2 recognized 16 organizations that had participated in all five Megaconferences with a special leadership award. Internet2 Corporate Sponsors

May

2000

» Joint Techs Workshop at University of Minnesota

June

2000

» Internet2 Network Research Workshop

Polycom, Inc. and RADVISION were recognized for donating hardware and software to the Internet2 Commons multipoint control units at the heart of the Megaconference's infrastructure.

Presenters at this year's Megaconference discussed education and research with an international scope. Topics included: rural and community integration and teaching through remote connections; a re-enactment of Lewis and Clark's journey using an H.323-enabled satellite trailer to connect to classrooms across the United States; an update from the United Nations World Summit on the Information Society; and other collaborative projects with international ties, such as those between the University of Wisconsin and Tyumen State University in Russia, Syracuse University and Scotland's Lockerbie Academy, and the Max-Planck-Society in Germany and the University of Auckland in New Zealand.

Remote music also highlighted the international scope of this year's conference, with jazz, classical, modern, and folk music performances from around the world, including a didjerido and guitar duet from Australia and runo singing, an ancient oral tradition of Baltic-Finic verse, from Finland.

The Megaconference really opens the doors to the kinds of collaborations worldwide that we want to have in teaching, that we want to have in research among faculty, among students.

KAREN A. HOLBROOK
President
The Ohio State University

August

2000

» Joint Techs Workshop at University of Toronto
» Arts & Humanities Initiative forms

October

2000

» Fall Internet2 Member Meeting hosted by Georgia Tech in Atlanta, GA
» First Internet2 performance event *Virtual Halloween at the Rialto*

MEMBER PROFILE

CAL POLY

California Polytechnic State University, San Luis Obispo: Using Internet2 Networking to Enhance Teaching
www.calpoly.edu

Having an ongoing "culture of support" for advanced networking activities across campus has been instrumental in helping California Polytechnic State University, San Luis Obispo (Cal Poly) realize the full benefit of Internet2 membership. After joining Internet2, Cal Poly established a group of Internet2 champions—one for each college and the Information Technology Services group—to explore and promote the use of Internet2 networking on campus. These champions conduct activities such as presentations at department meetings, host brown bag lunches, and explore opportunities for integrating advanced networking into specific disciplines. As a result of their campus-wide outreach efforts, the champions have identified problems that advanced networking can help solve and have brought together people with common needs to form interest groups in areas such as videoconferencing, remote collaboration, and GIS (geographic information systems).

Another catalyst for integrating advanced networking capabilities at Cal Poly was a series of mini-grants, which provided seed money for faculty and students to launch projects involving Internet2 networking. Some of these projects included bringing guest speakers to classes via videoconferencing, using tele-collaboration to host joint classes and projects between different universities, providing remote access to specialized instruments, and enabling access to real-time computation and large datasets. Another project was a student-produced video documentary about Internet2-related activities at Cal Poly. The mini-grant projects have also garnered visibility from major funding agencies, enabling these Cal Poly initiatives to serve as a springboard for more substantial projects.

There is great potential for Internet2 to enhance teaching at higher education institutions, but its potential is often unrealized. Having a core group of people across the institution to raise awareness of and interest in Internet2 activities is critical for realizing the benefits of advanced networking. Students, who are often more curious about new technology than faculty, are key to this process also.

FRANZ KURFESS, Associate Professor, California Polytechnic State University, San Luis Obispo

December

2000

» Campus Networking Workshop at University of California, San Diego

January

2001

» Joint Techs Workshop at University of Hawaii
» Initial E2Epi Design Team Meeting

Shibboleth: Moving Toward Production

shibboleth.internet2.edu

During 2003, Shibboleth took significant steps towards being a production service for the Internet2 community due to code advances and architectural refinements. Shibboleth version 1.0 was released in July, followed by version 1.1 in December, with contributions from many Internet2 members and international partners. Throughout the year, the Shibboleth project continued to engage other organizations to ensure interoperability and to encourage the creation of a marketplace of identity service providers.

Exciting pilot deployments demonstrated the system's viability and its ease of use. Sites with some existing middleware infrastructure successfully installed Shibboleth organization-wide within several hours. Online content providers and software system developers, such as Internet2 corporate member Blackboard, have successfully incorporated Shibboleth technology to provide attribute-based, privacy-preserving access to controlled resources.

In late 2003, InCommon, the first formal Shibboleth-based federation for U.S. higher education and its partners, was established under the guidance of an Executive Committee composed of representatives from Internet2 member universities and corporations. Federations provide a common framework for the transport of sensitive information between organizations in a secure and trusted manner.

About Shibboleth

Shibboleth facilitates the sharing of web-based, protected resources between organizations. When a user at one organization tries to access a resource at another, Shibboleth sends attributes about the user to the remote destination, rather than making the user login to that destination. Using the attributes, the remote destination decides whether or not to grant access to the user. Shibboleth preserves the user's privacy by releasing only necessary information, which may not include the user's identity. It also reduces or removes the requirement for content providers to maintain accounts for users and allows access to controlled resources by trusted federation members from anywhere in the world.

Shibboleth was developed with guidance, contributions, and resources from the Middleware Architecture Committee for Education (MACE), the National Science Foundation (NSF) and the NSF Middleware Initiative. Internet2 Corporate Partners IBM/Tivoli and Sun Microsystems, as well as Internet2 university members Carnegie Mellon University, Ohio State University, Brown University, and Columbia University played key roles in the development of Shibboleth.

March

2001

» Spring Internet2 Member Meeting in Washington, D.C.

» Initial Abilene Sponsored Educational Group Participants

April

2001

» Internet2 Network Research Workshop

May

2001

» Joint Techs Workshop at University of Nebraska

» First hands-on IPv6 Workshop

Pennsylvania State University Implements Shibboleth

et.aset.psu.edu/initiatives/shibboleth/

During 2003, Shibboleth enabled 2,300 Pennsylvania State University students to use access-controlled, web-based course grading software system at North Carolina State University. The software is used by the Penn State physics department for grading tests, quizzes, and providing real-time answers. Using Shibboleth, Penn State students authenticated locally with their Penn State Access Account, which in turn provided the software at North Carolina with the attributes needed for authorization.

During the first two weeks of the pilot, the Penn State physics department help desk experienced an 85 percent decrease in calls related to logging in.

We chose Shibboleth because not only could we integrate our existing information architectures the way we wanted to with it, which was critical to us. Shibboleth enables us to preserve the anonymity of transactions and help protect our current infrastructure.

KEVIN MOROONEY, Senior Director of Academic Services and Emerging Technologies, Pennsylvania State University

OpenSAML Provides Extensible and Interoperable Authentication and Authorization Systems

www.opensaml.org

Released in July 2003, OpenSAML 1.0 is a set of standards-based, open source software developed by Internet2 members and made freely available to help provide authentication and authorization systems that are extensible and interoperable. OpenSAML 1.0 is a building block of the Shibboleth project.

OpenSAML conforms to the specifications for Security Assertion Markup Language (SAML) 1.0 and 1.1, which is an XML (eXtensible Markup Language) framework for exchanging authentication, attribute, and authorization information published by the Organization for the Advancement of Structured Information Standards (OASIS).

OpenSAML 1.0 allows an application to use SAML messages or SAML application profiles to express and carry security information between software components and systems. OpenSAML has been tested and used under Windows XP/2000, Red Hat Linux, and Solaris 2.6. Because it deals only with SAML messages, it can be used with any authentication or attribute infrastructure.

June

2001

» 185 university members
» 74 corporate members
» 42 affiliate members
» 193 Abilene participants
» 35 international partners

July

2001

» Internet2 Video Production Workshop
» Internet2 End-to-End Performance Initiative forms

Internet2 Video Middleware Group Standard Ratified by ITU

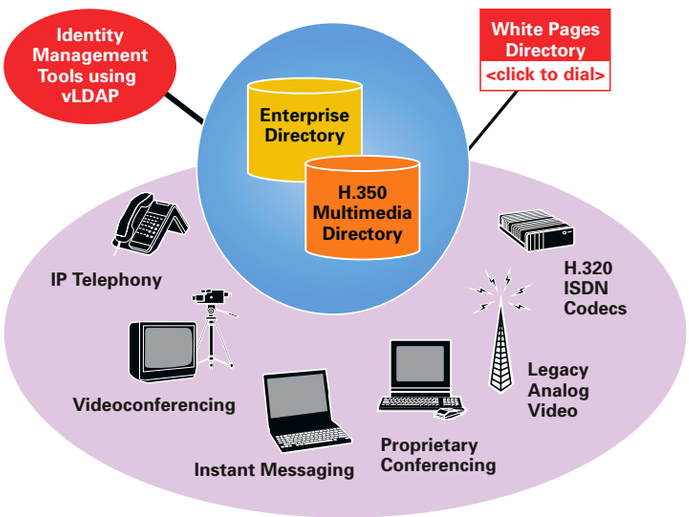
middleware.internet2.edu/video/

In September, the International Telecommunications Union (ITU) announced a new standard, H.350, resulting from the work based on the commObject middleware architecture developed by VidMid-VC (Video Middleware-videoconferencing), the Video Middleware Working Group jointly sponsored by Internet2, ViDe (the Video Development Initiative) and the ViDeNet project funded by the National Science Foundation (NSF). The H.350 standard defines the directory services architecture for storing and finding information in enterprise directories related to video and voice conferences transmitted over Internet networks.

The standard enables organizations to scale video and voice over IP (VoIP) operations from a few hundred endpoints to full enterprise deployments by linking account management and authorization automation to the enterprise directory using LDAP, the lightweight directory access protocol.

H.350 is used to store users' voice, video, and collaborative multimedia information in a way that integrates with directory and identity management systems already in place at organizations. Account configuration details, authentication and authorization are linked to the enterprise directory. It improves security

DEPLOYING H.350 DIRECTORY SERVICES FOR MULTIMEDIA



September

2001

» National Science Foundation Middleware Initiative begins

October

2001

» Virtual Internet2 Member Meeting
» Abilene upgrade begins
» Internet2 K20 Initiative forms
» Science and Engineering Initiative forms
» The Quilt is established

by providing standardized management and storage of authentication credentials. SIP (Session Initiation Protocol), H.323, H.320, and proprietary or non-standardized collaborative and conferencing protocols are all supported by H.350.

Significant support for this work was provided by a NSF grant, entitled, "ViDeNet: Middleware for Scalable Video Services for Research and Higher Education," and awarded to the University of Alabama at Birmingham in partnership with SURFnet and Internet2 members Claremont Graduate University and the University of North Carolina at Chapel Hill.

As members of the Working Group, Internet2 Corporate Partner Cisco Systems and Internet2 Corporate Sponsor RADVISION played critical roles in making the H.350 standard a success. Cisco sponsored Internet2's early work in the ITU and provided leadership in moving the standard forward. RADVISION, a strong partner in Internet2 video activities, used their involvement with Internet2 to bring the first H.350-enabled product to the market, allowing their Enhanced Communication Server to directly access university managed H.350 directories to enable voice and video over IP directly to end users.

EDUCAUSE/Internet2 Computer and Network Security Task Force: Securing Higher Education Computing Environments

www.educause.edu/security/task-force.asp

EDUCAUSE INTERNET2 | COMPUTER AND NETWORK SECURITY TASK FORCE

During 2003, the EDUCAUSE/Internet2 Computer and Network Security Task Force continued working to improve the security of college and university computing environments and to increase awareness of IT security issues across higher education. In addition to ongoing outreach and education efforts, the Task Force began several new initiatives, including the Security Education and Awareness initiative, the Effective Security Practices Working Group, the Risk Assessment initiative, and the Cyber Security Forum for Higher Education.

Continuing its work with industry, a delegation representing the Task Force met with representatives from Microsoft to discuss higher education security issues. The Task Force considered strategies for broader vendor engagement by the higher education community. In similar engagement with government, members of the Task Force attended the National Cyber Security Summit, which provided an opportunity to communicate and collaborate with the U.S. Department of Homeland Security as it moves towards developing the next stage of its cybersecurity strategy.

The Security Task Force commissioned and led the development of a number of new publications, including a white paper entitled "IT Security for Higher Education: A Legal Perspective," and an "Effective Security

November

2001

» First Internet2 Commons Site Coordinator Training

December

2001

» First Internet2 Virtual Briefing

Practices Guide," which is available online. Task Force members edited a new book, *Computer and Network Security in Higher Education*. Members of the Task Force also served on an Advisory Committee for a survey on computer and network security conducted by the EDUCAUSE Center for Applied Research, the findings from which were made available online in the fall.

Throughout the year, the Task Force helped organize and identify speakers for events, including pre-conference seminars at the national EDUCAUSE and Internet2 meetings. The Task Force also coordinated security-related presentations and online seminars for a number of higher education associations and member organizations. In April, EDUCAUSE and Internet2 hosted the first Security Professionals Workshop. Due to the success of this event, the second annual Security Professionals Workshop will take place in May 2004 in Washington, D.C.

MEMBER PROFILE

ARBOR™ NETWORKS

Arbor Networks: Members Working Together to Improve Network Security
www.arbornetworks.com

Working with Internet2 members Merit Network, Inc. and the University of Michigan in a three-year collaborative research effort, Internet2 Corporate Sponsor Arbor Networks, Inc. developed a flow-based system for detecting, backtracing, and resolving network-wide anomalies. The resulting technology provides a response to a broad spectrum of security and operational threats, such as distributed denial of service attacks, peering instability, and routing attacks to which networks, including advanced networks, are susceptible.

Arbor Networks has helped a number of Internet2 members protect their networks from infrastructure threats, including MichNet, the Research and Education Networking Information Sharing and Analysis Center (REN-ISAC) at Indiana University's Advanced Network Management Lab since February 2003, and the Abilene Network for the past three years.

Our collaboration and experience with Internet2 members and the Abilene Network was key for developing and improving the technology that help protect advanced networks from a broad spectrum of debilitating attacks.

FARNAM JAHANIAN, Founder and Chairman of the Board, Arbor Networks, Inc.

January

2002

» Joint Techs Workshop at Arizona State University
» E2E Measurement Workshop
» Peer-to-Peer Workshop

April

2002

» Campus Workshop at Texas A&M University

May

2002

» Spring Internet2 Member Meeting in Washington, D.C.

Members Rise to Meet Challenges of Ensuring Network Security

apps.internet2.edu/sals/

Internet2 member organizations are facing the growing challenges of protecting their network infrastructures from threats and attacks such as the ones that made headlines during the summer of 2003. At the same time, it remains essential to provide the advanced applications communities with network capabilities that support their research and work. It is therefore progressively more critical, though increasingly difficult, to link the performance requirements of advanced, networked applications with essential network security.

To address this mix of network security and performance issues, invited participants attended a National Science Foundation-sponsored Security at Line Speed (S@LS) Workshop held in August in Chicago. The workshop was hosted with the support of Internet2, Indiana University, the Massachusetts Institute of Technology and the University of Washington, with additional assistance from the EDUCAUSE/Internet2 Computer and Network Security Task Force. Participants, including attendees representing Internet2 Corporate Partners Cisco Systems and Juniper Networks, and Internet2 corporate member Network Associates, discussed how to implement necessary network security without compromising network performance. Participants discussed and recommended:

- Technologies supporting performance and transparency at line speed
- Effective implementation practices
- Areas for future research on network security
- Non-technical aspects critical to research computing and network security

Several key actions resulted from the S@LS Workshop, including the draft of the S@LS Workshop findings report, the formation of the Security at Line Speed Advisory (SALSA), a technical steering committee, and the anticipation of a number of Working Groups under the steering committee, which will cover issues such as network authentication and authorization, and advanced security architecture. The report contains the workshop's preliminary findings, including:

- Approaches and technologies that simultaneously support security and performance
- Case studies on how these technologies and approaches can be implemented
- Planning for high-performance security

June

2002

» First hands-on Multicast Workshop
» First Middleware Base CAMP

July

2002

» First Middleware Advanced CAMP
» Internet2 Detective 1.0 is released
» Joint Techs Workshop at NCAR
» OpenSAML is released

Security at Line Speed Advisory Setting Direction and Priorities of High-performance Security

security.internet2.edu/salsa/

The Security at Line Speed Advisory (SALSA) is a group of leading network security architects from the research and education community that sets direction and priorities in high-performance security. Internet2 established the SALSA group immediately following the Security at Line Speed Workshop held in August in Chicago. The workshop demonstrated a need within the research and education community—and beyond—for a continued focus on the intersection of high-performance networking and security. Areas of interest for SALSA include authentication and authorization, architecture, implementation, effective practices, network security research, and opportunities to work with government, international, and corporate partners on testbeds and pilot efforts.

Similar to the Middleware Architecture Committee for Education's (MACE) role in Internet2 middleware activities, SALSA will form Working Groups to address specific topics and will act as a focal point for coordinating these activities. SALSA is positioned under the umbrella of the Computer and Network Security Task Force created by EDUCAUSE and Internet2 but is independent of both organizations. SALSA's focus on the high-performance, state-of-the-art, and technical aspects of security complements the Task Force's effectiveness in promoting education, awareness, policies, and effective practices in security.

September

2002

» First IPv6 Internet2 Land Speed Record

October

2002

» Fall Internet2 Member Meeting hosted by University of Southern California in Los Angeles, CA

» H.323 Beacon 1.0 is released

Internet2 Members Receive Valuable Training at Hands-on Workshops

ipv6.internet2.edu
multicast.internet2.edu

Internet2 hands-on workshops provide attendees the opportunity to build, debug, and experiment with advanced networking technologies under the guidance of experts with extensive theoretical and operational experience. These workshops bring together the unique blend of knowledge and resources that can only take place within the context of the Internet2 community and provide this expertise to members at a small fraction of what comparable commercial training would cost. Internet2 hands-on workshops take place at member organizations, and are often held in conjunction with other events such as the Joint Techs workshops.

In 2003, Internet2 organized four multicast workshops and six IPv6 workshops, with generous financial support from Corporate Partner Microsoft Research for the continuing IPv6 workshop series. IPv6 is the next version of the Internet Protocol, the data packaging and routing standard on which the Internet is based. Multicast is a set of technologies that enables efficient delivery of data to many locations on a network. Widespread deployment of both IPv6 and multicast is essential to the continued growth and openness of the Internet. Internet2 IPv6 and multicast hands-on workshops provide opportunities for network engineers in the Internet2 community to learn about these crucial advanced networking technologies.

A major step forward for both workshop series in 2003 was the creation of a traveling equipment and information kit, which enables Internet2 members to organize and run these workshops without the direct participation of Internet2 staff. Internet2 Corporate Partners Cisco Systems and Juniper Networks both provided equipment for the kit, eliminating compatibility and configuration difficulties. In addition to equipment, the kit includes workshop materials—slide presentations, network diagrams, lab exercises, and other documents. Internet2 also offers assistance to organizations wishing to hold their own workshops. In 2003, for example, Internet2 helped the Asian Institute of Technology conduct several multicast workshops in Thailand.

Workshops for the Arts Community

Not all workshops are for network engineers. In March 2003, a group of educators and technologists gathered at the New World Symphony (NWS) campus in Miami for hands-on instruction in setting up distance learning and multi-site interactive media events. Attendees at the Performance Production Workshop used state-of-the-art production equipment to learn about the technologies involved in creating successful multi-site, interactive, digital video/audio productions. To demonstrate uses of advanced networking for real-time interaction in music education, several live master classes with remote participants were presented.

Hands-on workshops are invaluable in developing new relationships and building a network of participating universities in the arts and humanities. This will allow campuses to bridge the dichotomy between the sciences and arts, and establish a more integrated educational environment.

TOM SNOOK, Chief Technology Officer, NWS

February

2003

» Internet2 Land Speed Record breaks terabyte per hour mark
» Joint Techs Workshop at Florida International University
» E2E Measurement Workshop
» OWAMP 1.0 is released
» Internet2 Technology Evaluation Center at San Diego Supercomputer Center is announced

MEMBER PROFILE

Microsoft®

Microsoft Research: Building Partnerships to Accelerate the Creation of Tomorrow's Technology
research.microsoft.com

Microsoft Research, an Internet2 Corporate Partner, is strongly focused on promoting collaboration and developing partnerships within the Internet2 community in order to advance networking technology and applications used on the greater Internet. Microsoft researchers and developers are collaborating broadly with other Internet2 members and Working Groups to build shared knowledge in current and emerging areas of common interest. Microsoft Research is particularly focused on collaborative technologies and conferencing, security, peer-to-peer networking, IPv6, end-to-end performance, multicast, and health sciences applications.

As an Abilene Network-connected node, Microsoft Research uses the Internet2 advanced networking environment to work with researchers and educators at universities and laboratories around the world to test new technologies and applications. Cooperation with a number of Internet2 members helped develop the Conferencing Experience Project, better known as ConferenceXP, a platform for collaborative applications that integrates advanced audio, video, and network technologies to seamlessly connect multiple participants in a rich environment for conferencing, instruction, and collaboration—none of which would be possible without the advanced technologies broadly deployed throughout the Internet2 network infrastructure.

Internet2 and Abilene offer academia and corporate researchers the opportunity to work together on the technologies that will transform the Internet in the near future. We're working with key Internet2 member researchers and working groups to ensure Microsoft research and development teams are in sync with academic research as almost all of the Internet2 Working Groups touch on core services of our operating and network systems.

TODD NEEDHAM, Research Programs Manager, Microsoft Research

April

2003

» 202 university members
» 58 corporate members
» 39 affiliate members

» 221 Abilene participants
» Spring Internet2 Member Meeting in Washington, D.C.

May

2003

» FiberCo is established

June

2003

» Shibboleth 1.0 is released

Internet2 Member Meetings: Bringing Diverse Communities Together

events.internet2.edu

Every session I attended at the Fall 2003 Internet2 Member Meeting had valuable takeaways. Participating in the Rich Presence experiment was a great way to gain familiarity with a set of emerging technologies. The social events provided an opportunity to meet other members face-to-face and discuss areas of common interest.

PETER DAY
Emerging Technologies Specialist
Emory University

Member meetings provide unique opportunities for representatives from the diverse Internet2 community to meet in person. Meeting participants represent the complete spectrum of Internet2 membership including university, corporate, and affiliate members, as well as international partners. These individuals bring perspectives and experiences from research areas, teaching, engineering, administration, technical support, and numerous academic disciplines. Plenary sessions, tutorials, Working Group meetings, poster sessions, demonstrations, and technical sessions help members identify common interests and form collaborations across disciplines, technical areas, and geographic boundaries.

The Spring 2003 Internet2 Member Meeting, held in the Washington, D.C. area provided more than 600 participants the additional benefit of close proximity to federal agencies, grant providers, and key leaders in the Internet2 community. Plenary presentations delivered by Peter A. Freeman, Assistant Director of the National Science Foundation for Computer and Information Science and Engineering, and David B. Nelson, Director of the National Coordination Office for Information Technology Research and Development, outlined the programs and directions the National Science Foundation (NSF) and the federal government's High Computing Revitalization Task Force are supporting to meet the challenges for advanced networking including optical networks, middleware, and grid computing. Two additional sessions focused on the NSF's Cyberinfrastructure Report and progress toward a national optical network infrastructure.

At the most widely-attended Internet2 Member Meeting to date, more than 700 people participated in the Fall 2003 Internet2 Member Meeting hosted by Indiana University in Indianapolis, Indiana. Welcoming remarks given by both Indiana Governor Joseph E. Kernan and Michael McRobbie, Vice President for Information Technology and Research at Indiana University, were followed by a plenary presentation by Paul Messina, Distinguished Senior Computer Scientist at Argonne National Laboratory, on the promises and challenges of cyberinfrastructure. In the closing plenary, John Delaney, Professor in the School of Oceanography at the University of Washington, discussed the NEPTUNE Regional Cabled Ocean Observatory, which highlighted the importance of gathering and delivering real-time data. Sessions focused on faculty's use of advanced networking technologies and advanced applications demonstrations by 15 exhibitors and their collaborators gave attendees a first-hand look at some of these innovative technologies. Live performances included a large-scale, international music and dance event, and a demonstration of distributed antiphonal music.

August

2003

» Joint Techs Workshop at University of Kansas
» Security at Line Speed Workshop

September

2003

» Internet2 participates in National LambdaRail, Inc. launch

Conferences and Events: Showcasing Internet2 Member Achievements

events.internet2.edu

Each year, Internet2 members showcase the community's achievements at key conferences and events. During 2003, these conferences covered technical areas, including advanced networking and grid computing, as well as a variety of disciplines such as distance education, science and engineering, the health sciences, and arts and humanities. Internet2 provided support and visibility for member activities at these events through presentations, demonstrations, exhibits, interactive videostreaming, and behind-the-scenes technical assistance.

SC2003

The annual SC conference highlights the most innovative developments in high-performance computing and advanced networking. At SC2003, the Internet2 End-to-End Performance Initiative demonstrated their Performance Environment System (E2E piPES) at the Internet2 booth. The Internet2 booth also featured the University of Tennessee's Logistical Computing and Internetworking (LoCI) Laboratory project and PlanetLab, an open, globally-distributed platform for developing, deploying and accessing planetary-scale network services. Internet2 also provided technical support for SCinet, the high-performance network built each year to support the SC conference.

SC Global

SC Global, held in conjunction with SC2003, showcased achievements in the arts and sciences. Using Access Grid (AG) nodes worldwide, SC Global featured participation from 20 remote locations distributed across four continents and provided interactive global access to these presentations. Several Internet2 members presented at, or provided technical support for, SC Global sessions. Internet2 provided a dedicated video stream from SC Global for users of software from Corporate Sponsors inSORS and VBrick.

RSNA 2003

The National Library of Medicine (NLM), the Metropolitan Research and Education Network (MREN), and Internet2 collaborated to present a series of tutorials and demonstrations of advanced networking technology and its application to healthcare at the annual Radiological Society of North America (RSNA) meeting. Several Internet2 members presented during the tutorials, which were followed by hands-on sessions allowing attendees to see the technologies in action.

Internet2 members
Northwestern University,
Video Furnace, Prous

More than 40 Internet2 members exhibited throughout the show floor at SC2003

At RSNA, we presented a window into how the future of healthcare may look. The partnership with Internet2 allowed us to demonstrate the value interactivity brings to medical care, in addition to the time savings advanced networking technology provides.

DR. MICHAEL J. ACKERMAN
Chief of the Office of High Performance Computing and Communications
National Library of Medicine

October

2003

» Fall Internet2 Member Meeting hosted by Indiana University in Indianapolis, IN

» Internet2 Commons offers H.323 videoconferencing service

November

2003

» Internet2 Technology Evaluation Center at Texas A&M University is announced

Science, and others partnered to provide a live multicast of the image interpretation session, an annual tradition at RSNA, featuring a team of distinguished panelists who identify abnormal findings on imaging studies and make recommendations for further procedures or treatment. For the first time, the image interpretation session was netcast live globally through advanced network connections to the Abilene Network, with global connectivity provided through the MREN connection to the StarLight advanced optical infrastructure.

Internet2 Days: Raising Awareness of Advanced Networking Activities

events.internet2.edu/Internet2Days/

In 2003, 11 university members hosted Internet2 Days—events that generate interest in, and raise awareness of, advanced network applications and activities at Internet2 member organizations. A typical Internet2 Day features presentations from faculty, IT-support staff, and administrators on host member campuses, as well as Internet2 staff. Internet2 provides equipment, literature, and expertise to support the host member.

Members who Hosted Internet2 Days in 2003

- Case Western Reserve University
- Southern Illinois University
- Temple University
- Texas A&M University
- University of Maryland, Baltimore
- University of Memphis
- University of Missouri-Columbia
- University of New Mexico
- University of Notre Dame
- Virginia Commonwealth University
- Wichita State University

University of Maryland, Baltimore (UMB) hosted an Internet2 Day with a health sciences focus. In addition to presentations by UMB administrators and researchers, presenters from the National Library of Medicine also participated. Several presentations featured demonstrations, including the use of advanced networks to access the National Digital Mammography Archive, real-time scientific collaboration in biomedical informatics, and uses of distance learning technologies in teaching.

Southern Illinois University (SIU) at Carbondale combined their Internet2 Day with a campus telecommunications open house. In addition to raising awareness of potential applications of advanced networking technologies to many academic disciplines, the telecommunications open house provided attendees with a look at how campus departments could take advantage of advanced videoconferencing and other services available at SIU.

December

2003

» End-to-End Roadmap Workshop
» SALSA forms

» 204 university members
» 224 Abilene participants
» 66 corporate members
» 41 affiliate members

University of Missouri-Columbia was one of the co-hosts for Missouri Life Sciences Week, which raised awareness of life sciences and biotechnology activities while promoting communication and collaboration throughout Missouri's scientific community and beyond. Life Sciences Week presentations were held in three different locations in Missouri, with the Internet2 Commons providing interactive videoconferencing among the three sites. The panel discussion "Science Education for the 21st Century" was included as part of the Internet2 Virtual Briefing series. Life Sciences Week also featured a virtual poster session for online viewing, in addition to a live poster session at the University of Missouri campus.

The University of New Mexico (UNM) provided a live netcast of their daylong event, which included presentations on how advanced networks are facilitating the practice of science across international, multi-partner collaborations and how advanced networks can improve the delivery of quality health care services and education to remote, underserved areas. A special highlight during the UNM Internet2 Day was a live master class demonstration between the New World Symphony (NWS) in Miami, Florida and the University of Oklahoma. The UNM audience was able to observe as violinists at NWS received coaching from faculty on the Oklahoma campus.

The Internet2 Day was the single most effective event on our campus in raising the awareness of the breadth of Internet2 applications. The live network connection to the New World Symphony demonstrated far more than words, the potential transformative power of Internet2 in the arts and humanities.

ART ST. GEORGE
Manager for Advanced Communications Technologies
University of New Mexico

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Looking ahead . . .

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International Partners: Providing Access to Advanced International Networks

international.internet2.edu

International partnerships link Internet2 members to global research and education networking organizations. The principal goal of Internet2 international partnerships is to enable collaboration in research and education by providing access to advanced international networks. By creating a global proving ground for new technologies, and by providing channels for international Internet technology transfer, Internet2's international partnerships help ensure that the next generation of Internet technologies and applications will be globally interoperable.

Most international partners operate networks that are reachable via the Abilene Network, providing Internet2 members access to the research and higher education communities in more than 50 countries. Internet2 members and international partners use this worldwide infrastructure to support global collaboration in science, research, teaching, and learning, as well as to develop and test new technologies on a scale not possible on the commercial Internet.

Internet2 international partners bring expertise in network, middleware, and applications technologies through their participation in Internet2 member meetings, Working Groups, and projects. For example, JISC and UKERNA in the United Kingdom have funded staff to work on the Internet2 End-to-End Performance Initiative's Performance Environment System project, providing resources to the Internet2 community, and ensuring interoperability of performance measurement and monitoring infrastructures between the United States and Europe.

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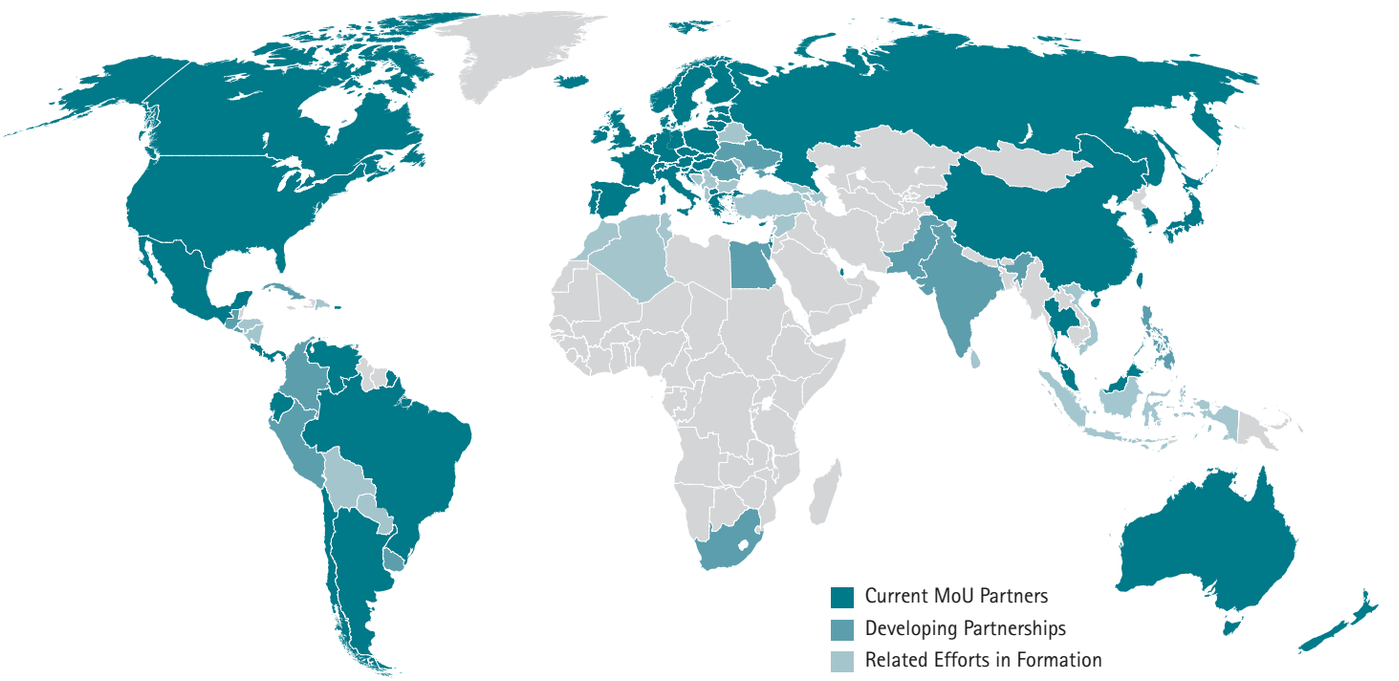

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With headquarters in Ann Arbor, Michigan, the Internet2 organization has an office and is incorporated as a not-for-profit corporation in Washington, D.C.

Nearly one-third of Internet2 staff are on loan from, or based at, Internet2 member organizations.

The work of the Internet2 community is led by the investment, commitment, and effort of individuals from member organizations.

3025 Boardwalk
Suite 200
Ann Arbor, MI 48108
+1-734-913-4250

1150 18th Street, NW
Suite 1020
Washington, D.C. 20036
+1-202-872-9119

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