NSFNET

NSFNET:
The Partnership that Changed the World

Celebrating 20 Years of Internet Innovation and Progress

November 29-30, 2007
Crystal Gateway Marriott, Arlington, Virginia

Contents:

The organizers wish to thank the following organizations for supporting this event:

Advanced Network & Services, Inc.
www.advanced.org

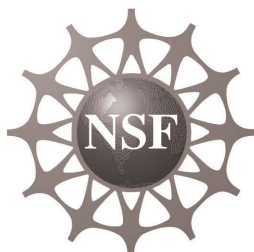*Cisco Systems, Inc.*
www.cisco.com

IBM
www.ibm.com

Internet2
www.internet2.edu

Juniper Networks
www.juniper.net

Merit Network, Inc.
www.merit.edu

National Science Foundation
www.nsf.gov

Program at a Glance (see pages 4 - 8 for detailed program)

Thursday, November 29, 2007 - General Program

7:30 - 8:30 a.m.	Registration and Continental Breakfast	
8:30 - 9:15	Welcome	Speakers: Eric M. Aupperle and Jane Caviness
	The Internet History Archive	Speaker: Doug Gale
	Introductory Comments	Speaker: John H. Marburger, III
	Keynote - *NSFNET: The Phenomenon*	Speaker: Douglas E. Van Houweling
9:20 - 10:35	Panel - *NSFNET: The Beginnings*	Moderator: Lawrence Landweber
10:35 - 11:00	Break	
11:00 - 11:55	Panel - *NSFNET: The Solicitation & The Merit Partnership*	Moderator: Jane Caviness
11:55 - 12:45	Lunch	
12:45 - 1:45	Panel - *NSFNET: The T1—The Internet Comes of Age*	Moderator: Eric M. Aupperle
1:50 - 2:50	Panel - *NSFNET: The T3 Backbone Service—The Internet Matures*	Moderator: Allan H. Weis
2:50 - 3:15	Break	
3:15 - 4:35	Panel - *NSFNET: The Community*	Moderator: Doug Gale
4:40 - 5:30	Panel - *NSFNET: The Impact on Research and Science*	Moderator: George O. Strawn
5:30 - 6:15	Program Break	

Thursday, November 29, 2007 - Evening Program

6:15 p.m.	Reception	
7:00 - 7:40	Keynote - *NSFNET: An Era Remembered*	Speaker: Eric Bloch
7:40 - 9:30	Dinner and Reflections	Emcee: Dennis Jennings
9:30 - 11:00	Afterglow	

Friday, November 30, 2007 - General Program

7:30 - 8:00 a.m.	Registration and Continental Breakfast	
8:00 - 8:05	Opening Comments and Keynote Introduction	
8:05 - 8:40	Keynote - *NSFNET: The Impact on Teaching and Learning*	Speaker: John Seely Brown
8:45 - 9:45	Panel - *NSFNET: The International Partnerships*	Moderator: Steven N. Goldstein
9:45 - 10:10	Break	
10:10 - 11:05	Panel - *NSFNET: Why Did It Succeed?*	Moderator: Robert E. Kahn
11:10 - 12:25	Panel - *NSFNET: Today's World Transformed... and a Look into the Future*	Moderators: Jordan Becker and Ann O'Beay
12:25 - 12:45	Closing - *NSFNET: The Partners*	
12:45 - 1:45	Lunch	

Thursday, November 29, 2007

General Program

7:30-8:30 a.m.   **Registration and Continental Breakfast**

8:30-9:15   **Welcoming Addresses**

Welcome

Speakers: Eric M. Aupperle and Jane Caviness

Comment

The Internet History Archives
Speaker: Doug Gale

The Internet History Archive works to create a digital archive of source materials about the creation and evolution of the Internet, particularly the transition from a specialized research network to a general-purpose network. The Archive will collect and make available documents from organizations and individuals that worked together to create the Internet. In addition, it will generate new historical material through the collection of participants' stories, observations, perspectives, and memories, obtained through online contributions, individual oral histories, and events. Mr. Gale will discuss the Archive's work and opportunities to contribute.

Introductory Comments

Speaker: John H. Marburger, III

Keynote

NSFNET: The Phenomenon
Speaker: Douglas E. Van Houweling

9:15-9:20   **Transition**

Between this and other consecutive agenda items, please take a moment to stretch and visit while the panelists convene.

9:20-10:35   **Panel**

NSFNET: The Beginnings
Moderator: Lawrence Landweber
Panelists: Vinton G. Cerf (via videotape), David Farber, Dennis Jennings, Kenneth M. King, David Mills, Kenneth Wilson

In 1979, the benefits of computer networks were not fully appreciated, even within the academic community. The ARPANET provided network services to a small group of researchers in academia and affiliated research laboratories. A number of community networks—Bitnet, CSNET, UUCP and SPAN/HEPNET—served a growing number of users in universities and industry who understood the value of network connectivity to their teaching and research missions. These early activities led to a proposal for a national ScienceNet and later for a network to connect researchers to supercomputer centers. Ultimately, the National Science Foundation initiated the NSFNET Program and constructed an initial 56 kbps NSFNET backbone network. The panel will discuss these evolutionary steps, controversies over technical and financial models, issues in providing nationwide access, the development of policies, and the emergence of a three level system consisting of a national backbone, regional connectors and campus networks.

10:35-11:00   **Break**

11:00-11:55 Panel

NSFNET: The Solicitation & The Merit Partnership
Moderator: Jane Caviness
Panelists: : John A. Armstrong, James J. Blanchard, Robert Mazza, Douglas E. Van Houweling, Stephen Wolff

On June 15, 1987, NSF issued a solicitation for the purpose of providing a T1 backbone network to connect the supercomputer centers and the mid-level networks of colleges and universities, upgrading and replacing the original 56 kbps network. The solicitation called for a cooperative agreement to run for five years with provision for the initial network to be modified as required. Proposals were received and the decision to select the proposal from Merit Network was announced in late November. Merit, representing universities in Michigan, had two corporate partners, IBM and MCI, and support from the Strategic Fund of the State of Michigan. This partnership went "live" with the network seven months later. The panel will discuss NSF's motivations for the T1 solicitation, the partners' reasons for participating, the major challenges of the project and the partnership model, the effects on the partner organizations, and the effectiveness of this public/private/educational partnership.

11:55-12:45 Lunch

12:45-1:45 Panel

NSFNET: The T1—The Internet Comes of Age
Moderator: Eric M. Aupperle
Panelists: Rick Boivie, Paul D. Bosco, Hans-Werner Braun (via videoconference), Mark Knopper, Yakov Rekhter, Walter Wiebe, Jessica Yu

The 1987 NSFNET solicitation specified implementing a nationwide T1 backbone to address the chronic congestion on the 56 kbps NSFNET and ARPANET, and to extend the new backbone's reach to include the emerging regional networks. The T1 NSFNET backbone went online in July 1988 and immediately experienced a traffic surge with traffic increasing at the rate of 20% per month. This early onrush of traffic presaged the many challenges the Merit/IBM/MCI partnership team faced and dealt with to ensure a quality backbone service. The team took innovative steps in technical and organizational areas, pioneering new router technology and utilizing telephone company circuit technology in unanticipated ways. The panel will address the challenges presented by the project, the trade-offs made as the backbone grew both in speed and coverage, the technological advances that were spawned, and the evolution of the organizational structure throughout the project.

1:50-2:50 Panel

NSFNET: The T3 Backbone Service—The Internet Matures
Moderator: Allan H. Weis
Panelists: Jordan Becker, Bharath Kadaba, John Markoff, William Schrader, Stephen Wolff

The T3 NSFNET Backbone Service was a step-change for the Internet, and it represented a new operational paradigm for the NSF as the program shifted from a specific network infrastructure to a service. This transition was driven by the rapidly escalating demand in packet volume and connecting networks. The combination of technological and operational "firsts" posed by the T3 NSFNET Backbone Service led to numerous unforeseen challenges and innovative solutions that accelerated the advancement of Internet technology during this formative period. Concurrently, the Internet began to mature and grow as a community and a business, expanding rapidly to smaller enterprises and consumers. Friends, suppliers and customers became competitors overnight as everyone struggled to become a part of the boom. Commercialization and privatization became part of the equation, and new business models were tested. The panel will discuss this period of rapid changes in technology, operational strategies, and financial models, and consider the NSFNET's path to commercialization.

2:50-3:15	**Break**

3:15-4:35	**Panel**

NSFNET: The Community
Moderator: Doug Gale
Panelists: Sidney Karin, Richard Mandelbaum, J. Mark Pullen, Glenn Ricart, Henry E. Shaffer, Jim Williams

The NSFNET Program was conceived as a three-level network of networks, with the national backbone connecting to roughly a dozen regional networks, in turn connecting to individual campus networks. The number and coverage of regional networks grew steadily beginning in 1986 until the entire country was served within a few years, including expansion to include smaller colleges, K-12s, and for-profit organizations. The financial and technical contributions of the regional and campus networks were a key component to the success of the NSFNET. The panel will discuss the challenges faced by the community in building the NSFNET and regional networks; success factors in facing those challenges; the roles of government, business, universities, and individuals; the exceptional level of cooperation between corporate interests and between private and public sectors; and lessons to be learned in replicating this success in future government, corporate, and higher education efforts to spur technological innovation.

4:40-5:30	**Panel**

NSFNET: The Impact on Research and Science
Moderator: George Strawn
Panelists: Kenneth Bishop, Chris L. Greer, Mark A. Luker, David Nelson, Harvey Newman (via videoconference)

The National Science Foundation began its networking program in the early 1980s in response to the research community's demand for greater access to advanced computational resources, specialized equipment and databases, as well as for better communication among researchers. While access to supercomputers dominated the early discussions and planning, by 1987 the NSFNET Program was clearly charged with serving the entire U.S. academic research community. The ensuing twenty-plus years of effort have made long-distance collaboration workable, provided access to unique equipment and data, increased the speed with which information is exchanged, created digital resources from analog sources, and produced advanced applications to replace early rudimentary tools. This panel of researchers from various fields will look at the impact of the network on research today, including changes in how research is done in different disciplines, areas where expected changes have not happened, and future developments that are needed to further improve research in the U.S.

5:30-6:15	**Program Break**

Evening Program *(Cocktail Dress/Business Attire)*

6:15 p.m.	**Reception—Sponsored by Cisco**

7:00 p.m.	**Keynote**

NSFNET: An Era Remembered
Speaker: Eric Bloch

7:40 p.m.	**Dinner and Reflections—Sponsored by IBM**

Emcee: Dennis Jennings
Speakers to be announced

9:30-11:00	**Afterglow—Sponsored by Juniper Networks**

Friday, November 30, 2007

General Program

7:30-8:00 a.m.   Registration and Continental Breakfast

8:00-8:05   **Opening Comments and Keynote Introduction**

8:05-8:40   **Keynote**

NSFNET: The Impact on Teaching and Learning
Speaker: John Seely Brown

8:45-9:45   **Panel**

NSFNET: The International Partnerships
Moderator: Steven N. Goldstein
Panelists: Kilnam Chon, Elise Gerich, Jan Gruntorad, Saul Hahn, David Macneil, Peter Villemoes

The early Internet included military links to European allies prior to the late 1980s, and these were augmented by a few between the NSFNET and European academic networks in the late 1980s. NSF's International Connections Management (ICM) Project, the international adjunct to the NSFNET Program, began in 1991 to connect with budding academic networks throughout the world, and by its close in 1996 ICM assisted in connecting 25 national academic networks to the U.S. academic community. The success and openness of the NSFNET provided a spark that led to the large-scale deployment of Internet technology throughout the world. This spawned significant global growth in the Internet's technical community and the internationalization of the Internet standards development process via the Internet Engineering Task Force (IETF). The panel will discuss barriers to the adoption of Internet technology outside of the U.S. in the 1980s; how these barriers were overcome by early pioneers in other countries; how the NSF and the NSFNET team helped develop partnerships that led to the internationalization of the Internet; other drivers that led to the success of international networks; and the scope of the pre- and post-NSFNET global Internet.

9:45-10:10   **Break**

10:10-11:05   **Panel**

NSFNET: Why Did It Succeed?
Moderator: Robert E. Kahn
Panelists: Jamie Kenworthy, Lawrence Landweber, Richard T. Liebhaber, Allan H. Weis, Stephen Wolff

By the early 1980s there were numerous data networking technologies. IBM's System Network Architecture (SNA) dominated the commercial world; DECNET, from Digital Equipment Corp, was widely used in the scientific and research communities; and telephone companies and firms such as Tymnet and Telenet offered network-based computer access via X.25. Other protocols, such as MMDF, RSCS and UUCP, were used to transfer electronic mail and files. In addition, a worldwide data networking standards activity, commonly known as OSI, was supported by almost all of the world's governments (including the U.S.) and telephone companies. Thus the TCP/IP-based Internet did not develop in a clean-slate environment. The competition was intense, but by the early 1990s it was clear that TCP/IP, as implemented in the NSFNET, had become the dominant form of internetworking. Today, the legacy commercial/academic networking technologies and the OSI effort are largely forgotten. The panel will review the earlier standards, explore why the TCP/IP-based Internet succeeded while the others did not, and highlight the role of the NSFNET in this process.

11:10-12:25   Panel

NSFNET: Today's World Transformed…And a Look Into the Future
Moderators: Jordan Becker and Ann O'Beay
Panelists: John Gage, Van Jacobson, Allison Mankin, Marissa Mayer, Noah Mendelsohn, Drew Perkins

Along with the development of the telephone, the automobile and the transistor, the Internet is among a handful of world-changing advances that shaped the 20th century. Our NSFNET experience shows in hindsight that even those engaged in the development of a paradigm shift like the Internet can't recognize or understand its eventual impact. But the formula and environment for generating such transformational innovations are clear to those who experienced one. This panel brings together thought leaders and innovators to consider the special combination of vision, commitment and persistence that leads to the type of innovation that NSFNET engendered. The panel will discuss the process of bringing together the right people to innovate and create world-changing solutions; obstacles or barriers to entry in our current economic, social, political and technological environment; and recent innovations that are poised to transform our way of life. Further, panelists will share their perspectives about significant developments and innovations they envision for the future; thoughts on who will lead the way; the role and potential impact of collaboration in the coming years; and the world as we might see it as we look back from a similar vantage point ten years from now in 2017.

12:25-12:45   Closing

NSFNET: The Partners
Speakers to be announced

12:45-1:45   Lunch

Speaker Biographies

John A. Armstrong was IBM director of research at the time the NSFNET cooperative agreement was awarded, and provided executive oversight for IBM's participation in both the T1 and T3 phases of NSFNET. He is a member of the National Academy of Engineering, the American Academy of Arts & Sciences, and is a foreign member of the Royal Swedish Academy of Engineering Sciences.

Eric M. Aupperle is president emeritus of Merit Network, Inc. He joined Merit as its project leader in 1969 with the responsibility of developing its initial technology. He was promoted to associate director in 1973 and then director in 1974. Merit's board named him president in 1988, a position he held until his retirement in 2001. Dr. Aupperle remains on Merit's board of directors. Merit implemented the TCP/IP protocol suite to complement its own network protocols in the early 1980s and established interconnectivity with ARPANET. This, plus Merit's experience with operating its own network, and a partnership with IBM and MCI, resulted in Merit winning the 1987 NSFNET solicitation. Merit and its partners successfully implemented and operated NSFNET from 1988 through its end in 1995. Merit along with ISI provided the follow-on Routing Arbiter functions. As Merit's president, he had overall responsibility for Merit's NSFNET project and the subsequent RA work. Dr. Aupperle is a graduate of the University of Michigan with degrees in engineering and mathematics.

Jordan Becker is senior vice president at Science Applications International (SAIC) and chief technical officer for SAIC's Information Technology and Network Services Group. He is responsible for strategy, planning, and research & development serving SAIC's commercial and federal/civil government markets. He is also a senior enterprise architect for BP. Prior to joining SAIC in March 2000, Mr. Becker was vice president with UUNET Technologies. In 1990 he was a founding executive at ANS Communications, Inc., responsible for service development, engineering, operations, market support, and strategic planning. Following the sale of ANS to UUNET, he was the acting ANS CEO overseeing the integration of the company within UUNET. He held numerous technology management positions at IBM Research during 1982-1990, including program management for the IBM Research participation in the NSFNET backbone project, supercomputing systems development, and other information technology projects. Mr. Becker holds a master of science in electrical engineering from Columbia University, and is a member of the Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers, and a pioneer member of the Internet Society.

Kenneth Bishop is professor emeritus of chemical and petroleum engineering at the University of Kansas. His research has focused on chemical reactor simulation, process control system analysis and design, and modeling fluid flow in porous media. He has also had significant involvement in the application of computing to engineering research, and has conducted research on applications that require distributed collaborative practice of chemical engineering. He has participated in projects to develop and deploy Access Grid technology in support of engineering and scientific research. Dr. Bishop holds a B. S. in chemical engineering from Purdue University and an M.S. and Ph.D. in chemical engineering from the University of Oklahoma.

James J. Blanchard is a partner with the DLA Piper law firm and chair of its government affairs practice group. He joined the firm upon the conclusion of his duties as United States ambassador to Canada in 1996. He was named ambassador to Canada in 1993, after serving two terms as governor of Michigan (1983-1991) and four terms as a member of the United States Congress (1975-1983). During his term as governor he was instrumental in enabling a $5 million allocation from the Michigan Strategic Fund to the Merit/IBM/MCI NSFNET partnership. He is also former chairman of the Democratic Governors Association and the National Democratic Platform Committee, as well as a former member of the National Governors Association's executive committee. Prior to his election to Congress, Governor Blanchard was assistant attorney general of Michigan (1969-1974). He also serves on the board of directors of several corporations and in 2005 co-chaired the American Assembly project on US-Canada relations, which was hosted and sponsored by Columbia University.

Eric Bloch is a director of The Washington Advisory Group, where he advises on corporate R&D management and strategic planning for academically based research enterprises and other not-for-profit organizations. He also serves as a member of the President's Council of Advisors on Science and Technology (PCAST), and is the Distinguished Fellow at the Council on Competitiveness. As director of the National Science Foundation from 1984–1990, Mr. Bloch oversaw the foundation's $3 billion annual budget and the award of 12,000–14,000 research grants in natural and social sciences, education, and engineering. Previously he was IBM corporate vice president for technical personnel development, following several managerial and executive appointments. He was awarded the National Medal of Technology for his role in the development of the IBM System 360 and is a recipient of the IEEE Founders Medal, NSF's Vannevar Bush Award, and the National Academy of Engineering's Arthur M. Bueche Award. Mr. Bloch received his education in electrical engineering at the Federal Polytechnic Institute of Zurich and earned a B.S. in electrical engineering from the University of Buffalo.

Rick Boivie is an IBM Distinguished Engineer and manager of advanced Internet and security technologies at IBM's T. J. Watson Research Center. He received a B.S. and M.Eng. in electrical engineering from Rensselaer Polytechnic Institute and an M.S. and Ph.D. in computer science from the State University of New York at Stony Brook. He had leadership roles in the development of IBM's first Unix systems and first TCP/IP systems. He was involved in the NSFNET backbone project from the development of the proposal in the summer of 1987 through the transition to the commercial carriers in April 1995. He was technical lead and later manager of the group in IBM that developed the routers for the NSFNET—which were able to accommodate the explosive growth in traffic that occurred on the Internet between 1988 and 1995. He also led the development of the routers that were used in the IBM Global Network, a top-rated, global ISP that was sold to AT&T in 1998. He has led several other Internet-related projects and several projects related to secure computer systems.

Paul D. Bosco is vice president and general manager of Cisco's video and broadband initiatives and site executive for the Cisco New England Development Center. He also co-chairs Cisco's Video & Connected Home Board and worldwide cable vertical team. In these roles he shares responsibility for the global development and execution of Cisco's strategy for video service providers and content distributors. He previously served as vice president and general manager of Cisco's cable business unit. He held earlier roles at USWest/MediaOne, Continental Cablevision and SBC/SNET involving nationwide and metro backbone services, data centers, customer provisioning, content delivery, applications hosting systems, digital television and on-demand services. Earlier at IBM he led an R&D team responsible for developing and deploying innovative routing platforms for the NSFNET and other early IP networks. IBM awarded him Outstanding Technical Achievement, Masters Fellowships and Doctoral Fellowship awards for these efforts. Mr. Bosco is a graduate of Yale University, Rensselaer Polytechnic Institute and Lehigh University.

Hans-Werner Braun is a research scientist at the University of California, San Diego and principal investigator of the High Performance Wireless Research and Education Network (HPWREN). Previously he was principal investigator of the National Laboratory of Applied Net-

work Research (NLANR), with a focus on network measurement and analysis activities. Earlier he was the chief network architect with the Teledesic Corporation, working to design a global broadband network for a system of hundreds of low earth orbit satellites. Prior to his Teledesic position he worked at the San Diego Supercomputer Center (SDSC) as a principal scientist, and retained an affiliation as senior fellow with SDSC while at Teledesic. Between 1983-1991 he worked on networking infrastructure at the University of Michigan and Merit Network. He became very involved in the early stages of the NSFNET networking efforts, and was a principal investigator for the NSFNET backbone project. Mr. Braun received his engineering degree in Germany in 1978.

John Seely Brown is currently a visiting scholar at the University of Southern California. Previously he was chief scientist of Xerox Corporation and director of its Palo Alto Research Center (PARC) for nearly two decades. His personal research interests include the impact of globalization on business, the management of radical innovation, digital culture, ubiquitous computing and organizational and individual learning. Dr. Brown is a member of the National Academy of Education, a Fellow of the American Association for Artificial Intelligence and of the American Association for the Advancement of Science, and a trustee of Brown University and the MacArthur Foundation. His most recent book, *The Only Sustainable Edge*, coauthored with John Hagel, is about new forms of collaborative innovation. It also provides a novel framework for understanding what is really happening in off-shoring in India and China and how each country is inventing powerful new ways to innovate, learn and accelerate capability building. Dr. Brown received a B.A. in mathematics and physics from Brown University and a Ph.D. from the University of Michigan in computer and communication sciences.

Jane Caviness served as NSFNET program director for the National Science Foundation from 1987-1989, where she managed the initial Merit award for NSF. She became deputy division director for the Division of Networking and Communications Research and Infrastructure (DNCRI) in 1989, continuing to be involved with the NSFNET Program in that role until 1994. In 1995 she returned to NSF as division director for DNCRI, overseeing the transition off the NSFNET backbone services. Ms. Caviness joined NSF after a career in academic computing services at the University of Wisconsin, Rensselaer Polytechnic Institute, and the University of Delaware. She had served as Chair of ACM-SIGUCCS and on the board of trustees of Educom. In 1996 she worked for Educom as vice president for networking.

Vinton G. Cerf is vice president and chief Internet evangelist for Google. He is responsible for identifying new enabling technologies and applications on the Internet and other platforms for the company. Widely known as a "Father of the Internet," he is the co-designer with Robert Kahn of the TCP/IP protocols and the basic architecture of the Internet. In 1997, President Clinton recognized their work with the U.S. National Medal of Technology. In 2005, they received the highest civilian honor bestowed in the U.S., the Presidential Medal of Freedom. From 1994-2005, Dr. Cerf served as senior vice president at MCI. Prior to that, he was vice president of the Corporation for National Research Initiatives (CNRI), and from 1982-86 he served as vice president of MCI. During his tenure with the U.S. Department of Defense's Advanced Research Projects Agency (DARPA) from 1976-1982, he played a key role leading the development of Internet and Internet-related data packet and security technologies. Dr. Cerf holds a Ph.D. in computer science from UCLA and more than a dozen honorary degrees.

Kilnam Chon received his Ph.D. in computer science from UCLA in 1974 and worked at the Jet Propulsion Laboratory on interplanetary networking in 1970s. He led computer network projects in Korea, resulting in the creation of SDN (System Development Network), a TCP/IP network, in 1982. He continued work on coordinating networking in Asia and worldwide, including AsiaNet and Asia Pacific Networking Group (APNG) in the mid-1980s. APNG facilitated the interconnection of the Asia-Pacific region with NSFNET in the late 1980s. Later in the 1990s, Professor Chon initiated APAN (Asia-Pacific Advanced Network), which coordinated with NSF for a 1 Gbps link between the U.S. and Asia-Pacific with the hub in Tokyo. Later in the 2000s, he helped to realize the GLORIAD Project, an around-the-world network with a trans-Siberia link as well as a 10 Gbps link of China-Korea-USA.

Mathew P. Dovens has worked in the field of data communications since 1981. Currently he is a senior director at SAVVIS Communications, leading the capacity management of 30 data centers and two global networks. He was previously responsible for global IP planning and implementation for Cable & Wireless. From 1996 to 1998 he managed the international marketing department at MCI's internetMCI. From 1994 - 1996, he drove the creation and expansion of the MCI vBNS program, the U.S. research network sponsored by the National Science Foundation. From 1991 - 1994 Dr. Dovens was MCI's ambassador at Advanced Network & Services, Inc., responsible for enhancing joint technical cooperation within the MCI-ANS relationship. He joined MCI in 1985 to manage the design, development and engineering of the MCI digital data network. In 1987 he headed the MCI team that helped win the NSFNET cooperative agreement. Prior to joining MCI, he worked for the General Electric Information Services Company. Dr. Dovens received a doctoral diploma in electrical engineering with a specialization in data communications from the University of Technology in Eindhoven, The Netherlands.

David Farber is distinguished career professor of computer science and public policy in the School of Computer Science at Carnegie Mellon University. In 2003, he retired from the University of Pennsylvania where he held the Moore Chair of Telecommunications. From 2000 - 2001 he was chief technologist for the FCC. He has held positions at Bell Labs, Rand Corporation, Xerox Data Systems, University of California at Irvine and the University of Delaware. His contributions to computer science include creation of the SNOBOL programming language and the first operational distributed computer, DCS. He is a Fellow of the ACM and IEEE. and serves on the board of trustees of the Electronic Frontier Foundation. Dr. Farber has served on the U.S. President's Information Technology Advisory Committee. He was awarded the Sigcomm Award for lifelong contributions to the computer communications field and Philadelphia's John Scott Award for Contributions to Humanity.

John Gage is chief researcher and director of the science office for Sun Microsystems. He is responsible for Sun's relationships with world scientific and technical organizations, for international public policy and governmental relations in the areas of scientific and technical policy, and for alliances with the world's leading research institutions. He attended the University of California, Berkeley, the Harvard Kennedy School of Government, and the Harvard Graduate School of Business. He did doctoral work in mathematics and economics at the University of California, Berkeley, and left Berkeley in 1982 to join Bill Joy at Sun Microsystems. He is a member of the Mathematical Association of America, the Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE), and the Board of Trustees of the Internet Society (ISOC). Mr. Gage has served on scientific advisory panels for the U.S. National Research Council, the National Academy of Sciences, and the Multimedia Super Corridor project of Malaysia.

Doug Gale currently serves as the president of an information technology consultancy and head of an organization archiving materials about the creation of the Internet. In 1986, while CIO and tenured faculty member in computer science and physics at the University of Nebraska, he created a 6-state network, MIDnet, which became the first fully operational regional network on the new NSFNET. In 1990 and 1991

he served as the NSFNET program officer at the NSF where he received the Director's Award for Program Officer Excellence. In 1995, while CIO at George Washington University, Dr. Gale was the co-editor of the white paper that led to the creation of Internet2 and later served on the Abilene executive committee. More recently he has been an advocate for user-owned fiber networks and is the architect of two such networks.

Elise Gerich is a senior manager at Juniper Networks in the High-End Systems business unit. Prior to joining Juniper in 2001, she held various management and technical positions at Urban Media and Excite@Home. While director of operations at Excite@Home, she was part of the original team that rolled out the first, nationwide multiple system operator (MSO) backbone network. At Merit, Elise was associate director for national networking. As associate director, she worked closely with the U.S. regional networks to ensure a smooth transition from the NSFNET backbone service to commercial service providers, served as co-PI of the Routing Arbiter Project, and founded NANOG with colleague Mark Knopper. She is a former member of the Internet Architecture Board, former chair of Internet Engineering Planning Group (IEPG), and a long-time participant in the IETF, NANOG and RIPE.

Steven N. Goldstein joined the National Science Foundation in 1989 as a program director in the Computer and Information Sciences and Engineering (CISE) Directorate's networking division. At NSF he launched the International Connections Management (ICM) project, which implemented the connection of academic networks from about 25 countries to the NSFNET and to its advanced networking successor, the vBNS. He also initiated support for the Network Startup Resource Center (NSRC); High Performance International Internet Services project (HPIIS); the Global Ring for Advanced Application Development (GLORIAD); and STAR TAP and StarLight, international networking meet-points in Chicago. Prior to joining NSF, he was a MITRE Corporation contractor to NASA, helping to establish the NASA Science Network, NASA's entry into Internet Protocol-based research networking. Dr. Goldstein earned S.B. and S.M. degrees in physics at MIT and a Ph.D. in engineering and public policy at Carnegie Mellon University. He retired from the NSF in 2003. He was selected in 2006 to serve as a board member of the Internet Corporation for Assigned Names and Numbers (ICANN). He was elected a foreign member of the Russian Academy of Sciences in 2006.

Chris L. Greer is senior advisor for digital data in the National Science Foundation's Office of Cyberinfrastructure. Previously, he has served as program director in the Division of Molecular and Cellular Biosciences, the Division of Biological Infrastructure, and the Emerging Frontiers Division. Dr. Greer recently served as executive secretary for the Long-lived Digital Data Collections Activities of the National Science Board and is currently co-chair of the Digital Data Interagency Working Group of the National Science and Technology Council's Committee on Science. He is also a member of the advisory committee for the National Archives and Records Administration's Electronic Records Archive and a member of the Digital Library Council of the Federal Depository Library Program.

Jan Gruntorad holds Dipl. Ing. and Ph.D. degrees from the Faculty of Electrical Engineering at the Czech Technical University in Prague. In 1992 he was awarded a grant by the Ministry of Education to establish CESNET, the advanced network for research and education in the Czech Republic. At that time he worked regularly with NSF staff, particularly Dr. Steven Goldstein, who contributed significantly to connecting Czech educational institutions to the Internet. The governing body for the CESNET NREN was founded in March 1996 and comprises all Czech Universities and the Czech Academy of Sciences. He is managing director of the CESNET NREN, responsible for both research and operational tasks within CESNET. From 1998-2003 he was the chairman of the CEENET (Central and Eastern European Network Association). From 1996-1999 he served on the board of directors of the EBONE Company, a pan-European Internet provider located in Copenhagen. In January 2003 he became member of the board of directors of DANTE (Delivery of Advanced Network Technology to Europe). Dr. Gruntorad represents the Czech Republic in TERENA (Trans-European Research and Education Networking Association) and is also a member of the executive committee for the GN2 project.

Saul Hahn retired in 2006 as head of the Division of Science and Technology in the Office of Education, Science and Technology at the Organization of American States (OAS). In that role he supervised a team of specialists and international consultants responsible for projects in science and technology. He directed the Hemisphere Wide Inter-University Scientific and Technological Information Network project (Red-HUCyT), which was established in 1991 to help integrate academic electronic networks in the 34 member states of the OAS. Close coordination was established with the National Science Foundation to set up many of the first Internet nodes in the Americas. Dr. Hahn holds an electronics and communications engineering degree from the National Polytechnic Institute (Mexico). He also earned an M.S. and Ph.D. in mathematics from New York University (Courant Institute). He was professor of mathematics and co-coordinator of the computer lab at the Centro de Investigacion y Estudios Avanzados (CINVESTAV) in Mexico City.

Van Jacobson leads the content-centric networking research program at the Palo Alto Research Center (PARC). He joined PARC as a research fellow in 2006, and also serves as chief scientist for packet design in the adjacent Xerox complex. Prior to joining PARC, he led networking efforts as chief scientist at Cisco Systems. He also led the network research group at Lawrence Berkeley National Laboratory and its collaboration with the Computer Science Research Group at the University of California. He is widely recognized for his pioneering achievements in the performance and scaling of IP networks. He is the author of the TCP/IP Header Compression protocol described in RFC 1144, commonly known as Van Jacobson compression, and was involved in the development of several standard network diagnostic tools. For his work, Mr. Jacobson has received recognitions including the 2001 ACM SIGCOMM Award, the 2003 IEEE Koi Kobayashi Computers and Communications Award, and election to the National Academy of Engineering.

Dennis Jennings is an Internet pioneer, having been responsible for the decisions that created NSFNET when working for the National Science Foundation while on leave from University College Dublin (UCD). In the 1980s he was actively involved in the start-up of research networks in Europe and Ireland. He has recently been appointed to the Board of the Internet Corporation for Assigned Names and Numbers (ICANN), and is currently chairman of the Oversight Board of the Irish Centre for High-End Computing. Dr. Jennings founded 4th Level Ventures, a small early stage Irish venture capital company in 2002, and is also an "angel" investor, investing in early stage technology companies. He was the director of computing services at UCD from 1977 to 1999 and interim president of the Consortium for Scientific Computing at the John von Neumann Centre in Princeton, New Jersey. Dr. Jennings holds a 1st class honors physics B.Sc. degree from UCD, and a Ph.D. obtained for a search for high-energy gamma radiation from pulsars (neutron stars).

Bharath Kadaba is vice president of media engineering for Yahoo. He is responsible for overseeing engineering for Yahoo's media projects, managing the growth of people and infrastructure while fostering the rapid introduction of new and innovative consumer products. Before joining Yahoo, he held executive positions with Siebel Systems, AritaSoft, Tristrata, Inc., News Corporation, and Delphi Internet Service. He

began his career with 14 years at IBM, primarily at the T.J. Watson Research Center. Dr. Kadaba holds a Ph.D. in computer networks from the University of Hawaii, as well as a bachelor's degree in electrical engineering and master's degree in computers and control from the Indian Institute of Science in Bangalore, India.

Robert E. Kahn is president and CEO of the Corporation for National Research Initiatives (CNRI), a non-profit organization focused on R&D for the national information infrastructure. He initiated the government's Internet program and is co-developer with Vinton Cerf of the TCP/IP protocols, the fundamental technology underpinning the Internet. In his recent work, Dr. Kahn has been developing the concept of a digital object architecture to provide a framework for interoperability of heterogeneous information systems. This work is being used in many applications such as the Digital Object Identifier (DOI). The numerous awards he has received include the Presidential Medal of Freedom, the National Medal of Technology and the A.M. Turing Award, widely considered the Nobel Prize of computing. Dr. Kahn arranged for the original connection between CSNET and ARPANET and together with Vinton Cerf initiated the standards process that was used in NSFNET and the wider Internet.

Sidney Karin was the founding director of the San Diego Supercomputer Center (SDSC) and established SDSCnet to provide access to SDSC resources for academic researchers, prior to the establishment of the NSFNET. SDSCNet nodes in the Bay Area provided the early foundation for BARRNet and nodes in southern California became the foundation for CERFNet, the latter established by SDSC staff member Susan Estrada. When NSFNET reached production status some time later, SDSC became one of the earliest nodes and indeed was one end of the first 56KB, T1 and T3 links to be brought up. While Dr. Karin was SDSC director, SDSC staff member Hans-Werner Braun established NLANR (National Laboratory for Applied Network Research) and later HPWren (High-Performance Wireless Research and Education Network), and staff member Kim Claffy established CAIDA (the Cooperative Association for Internet Data Analysis).

Jamie Kenworthy is the former executive director of the Alaska Science and Technology Foundation. He was the lead person for the State of Michigan's $5 million commitment to the original NSFNET proposal and served on the executive committee during the project. During his time at the Michigan Strategic Fund, MSF funded the industry outreach effort of two NSF Science and Technology centers, a materials processing initiative with the three domestic auto manufacturers that funded pre-competitive research, and a number of other non-profit research and industry-university consortia.

Kenneth M. King retired as executive director of the Corporation for Research and Educational Networking (CREN) in 1998. From 1987 until 1993 he was president of Educom, which managed BITNET and played an active role in organizing university support of NSFNET. From 1991-1995 he was a member of the Federal Networking Council advisory committee and from 1991 until 1993 a member of the Internet Society board of trustees. From 1980-1987 he was vice provost for computing at Cornell University. Cornell was the sixth university to join BITNET in 1983 and Dr. King was a member of its first board of trustees. In 1985 Cornell became a national supercomputer center and was a participant in the planning for NSFNET and the regional networks, and also served as a backbone node. He was co-founder of NYSERNet, the New York State regional network. Earlier positions included vice chancellor for university systems at the City University of New York; director of the Office of Computer Plans and Controls and deputy director of operations, Office of the Mayor of New York City; and director of computing at Columbia University.

Mark Knopper is a Mac developer and founder of the soon-to-be-well-known company "Bulbous Ventures, LLC" in Ann Arbor. Previously he spent 22 years as a software engineer, network engineer, and manager at various companies with offices in Ann Arbor. These included Cisco Systems, Internet Engineering Group LLC, Ameritech Advanced Data Services, and Merit Network. At Merit, he worked on the University of Michigan campus network, the MichNet statewide network, and NSFNET T3 backbone. From 1991-93 he managed the NSFNET Internet Engineering Group and was co-principal investigator on the cooperative agreement. His group submitted the proposal for Merit's Routing Arbiter initiative. From 1994-96 at Ameritech, Mr. Knopper was co-principal investigator on the NSFNET Chicago NAP activity.

Lawrence Landweber is the John P. Morgridge Professor Emeritus at the University of Wisconsin-Madison. He has been president of the Internet Society and a member of the boards of Internet2 and the Computer Research Association. He is a Fellow of the ACM and in 2005 received the IEEE Award on International Communication. He is currently a senior advisor to the National Science Foundation. He has been a leader in the development of the global Internet. In 1979, he proposed the Computer Science Network. CSNET, funded by NSF, eventually connected all US computer research groups and was the first "large-scale" Internet testbed. International activities have included helping to establish the first Internet gateways between the U.S. and many countries in Europe, Asia and Latin America. He also helped develop the plan for the USAID program that played a major role in bringing the Internet to Africa.

Richard T. Liebhaber joined IBM as an engineering trainee upon graduation from New York University in 1952 and rose through the ranks at IBM in engineering, manufacturing, product test, service and marketing. In his last position he served as IBM director of business development and policy. He retired from IBM in 1985 and joined with Bill McGowan, Bert Roberts and Orville Wright to form the office of the chairman at MCI Communications, Inc. He served as executive vice president and chief technology officer through 1995, when he retired from MCI. From 1995 through 2004, he served as a managing director at Veronis, Suhler and Stevenson, a communications specialist investment banking firm. He consulted with the Anschutz company in the formation of Qwest Communications, Inc. and served on its board from the inception of the company through 2000. Mr. Liebhaber currently serves on a number of industry boards including ILOG, JDS Uniphase, Avici Systems, Inc. and Cogent Communications Group. He serves on a number of technology development boards and as a trustee on the board of Internet2.

Mark A. Luker heads Net@EDU, the EDUCAUSE-based "thought-leadership" coalition of university CIOs and state network directors who work to advance national networking for both research and education through joint projects and federal policy. He also leads the EDUCAUSE office of government relations and policy analysis in Washington, DC, which works with partner associations to help shape the emerging policy and legal framework of the Internet, intellectual property, and other issues of importance to higher education. He served for two years as program director for advanced networking at the National Science Foundation and the federal Next Generation Internet project. For five years prior to that he worked on issues of reorganization for networked access to digital information and other services as CIO at the University of Wisconsin-Madison campus. Dr. Luker received his doctorate from the University of California, Berkeley, and served as a faculty member and a dean at the University of Minnesota, Duluth, before moving into information technology management.

Speaker Biographies

David Macneil retired as professor of computer science at the University of New Brunswick, where he served since 1967 and was director of computing services from 1979 to 2000. He also served as director of network relations at CANARIE, Canada's advanced Internet development organization. Professor Macneil has been extensively involved with organizing computer networking in Canada for the past thirty years. He has served as executive secretary of the Canadian university computer network, NetNorth, and was a founding member and vice-chair of the board of directors of CA*net. He was a founding member of the board of directors of CANARIE, a consortium of more than 100 Canadian organizations and the major federal government initiative to construct a world class research network infrastructure for Canada. Professor Macneil was a founding member and chairman of the NATO Science Council Advisory Panel on Computer Networking. He was pleased to work with NSFNET developing and extending links for the Canadian networks to the U.S. and other countries.

Richard Mandelbaum is principal of XYNETICS, a consulting firm specializing in technology assessment. In 1996, he founded APPLIEDTHEORY, a publicly listed provider of Internet and Web services, and led the firm's IPO in 1999. In 1985, he was among the founders of NYSERNet, the first NSF mid-level network. NYSERNet deployed the first TCP/IP-based T1 backbone in New York State in 1987. From 1992-1996 he was director of the Center for Advanced Technology in Telecommunications at Polytechnic University and from 1985-1992 he was vice president for computing and telecommunications at the University of Rochester. He has served on numerous government-industry panels, including the National Telecommunications Task Force, the NSF Network Policy Advisory Group and the Financial Services Technology Consortium. In 1986 he was a member of the panel that advised NSF to establish NSFNet. He was a founder and chair of FARNET, the Federation of Advanced Research Networks, from 1987-1990. He has also been a professor of mathematics, electrical engineering and computer science and published extensively on scholarly and technology topics. Dr. Mandelbaum received his Ph.D. in mathematics from Princeton University in 1970.

Allison Mankin is a program director at the National Science Foundation, collaborating with Darleen Fisher and Dave Clark on the Future Internet Design (FIND) research program. Prior to NSF, she worked for several years on efforts in large-scale infrastructure security and transition, particularly DNS security. She has been a longtime leader in the Internet Engineering Task Force. Until recently she led the Geolocation Privacy (geopriv) working group. She was an area director in the Internet Engineering Steering Group (IESG) for ten years and recently managed the emergence of the IETF's VoIP and multimedia technologies. Earlier in this role she led the IETF's design of IPv6. At MITRE, Naval Research Labs, USC/ISI and Bell Labs, she conducted research on Internet topics with funding from DISA, DARPA, NSF, Microsoft, and Sprint, in areas including TCP measurement, congestion control, scalable video, robust networks and national scale testbeds. Prior to joining the U.S. government, Ms. Mankin served as a charter member of Internet2's Abilene technical advisory committee and ICANN's security and stability advisory committee.

John H. Marburger, III, serves as science adviser to the President of the United States and director of the Office of Science and Technology Policy. Before his appointment in the Executive Office of the President, he served as director of Brookhaven National Laboratory beginning in 1998, and as the third president of the State University of New York at Stony Brook from 1980-1994. He came to Long Island in 1980 from the University of Southern California where he had been a professor of physics and electrical engineering, serving as physics department chairman and dean of the College of Letters, Arts and Sciences in the 1970s. While at the University of Southern California, Dr. Marburger contributed to the rapidly growing field of nonlinear optics, a subject created by the invention of the laser in 1960. He developed theory for various laser phenomena and was a co-founder of the University of Southern California's Center for Laser Studies. His teaching activities included "Frontiers of Electronics," a series of educational programs on CBS television. Dr. Marburger holds a B.A. in physics from Princeton University and a Ph.D. in applied physics from Stanford University.

John Markoff covers Silicon Valley for the New York Times. He began writing about technology in 1976 and joined The Times in 1988. His technology coverage during the 1980s and 1990s included several articles concerning the NSFNET and the development of the Internet.

Marissa Mayer leads the product management efforts for Google's search products. She joined Google in 1999 as Google's first female engineer and led the user interface and webserver teams at that time. Her efforts have included designing and developing Google's search interface, internationalizing the site to over 100 languages, defining Google News, Gmail, and Orkut, and launching more than 100 features and products on Google.com. Several patents have been filed for her work in artificial intelligence and interface design. Concurrently with her full-time work at Google, she has taught introductory computer programming classes at Stanford to over 3,000 students. Stanford recognized her with the Centennial Teaching Award and the Forsythe Award for her outstanding contribution to undergraduate education. Prior to joining Google, she worked at the UBS research lab (Ubilab) in Zurich, Switzerland and at SRI International in Menlo Park, California. Graduating with honors, Ms. Mayer received a B.S. in symbolic systems and M.S. in computer science from Stanford University. For both degrees, she specialized in artificial intelligence.

Robert Mazza is director of assurance programs for IBM. He has served in several director positions in product and systems development for IBM since 1979. From 1985-1990, he was IBM's director of development for university and college systems. While in that role he led the IBM team that partnered with Merit Network and MCI to propose and successfully implement the engineering of the T1 NSFNET backbone network. The resulting network sustained 70% per month compounded growth in network traffic and provided orders of magnitude enhancement of the internetworking performance available to education and research, enabling expansive growth of the Internet. He also played key roles in supporting a number of joint IBM and university information systems projects, contributing significantly to initiatives including Project Andrew (CMU), Project Athena (MIT), the National Supercomputer Center at Cornell University, and Institutional File System (University of Michigan). Mr. Mazza holds an M.S.E.E. in electrical engineering/computer engineering from Syracuse University, and an M.E. in engineering physics from Stevens Institute of Technology.

Noah Mendelsohn is a Distinguished Engineer at IBM Research in Cambridge, MA, and a member of the IBM Academy of Technology. He joined IBM in 1974. Dr. Mendelsohn is known for his work on distributed systems, operating systems, and Web-related standards. He led IBM's technical contributions to the specification for JavaBeans and initiated IBM's work on SOAP and Web Services. He is a co-author of SOAP 1.1 and a co-editor of the XML Schemas and SOAP 1.2 Recommendations from the World Wide Web Consortium (W3C). In 2004 he was named by Tim Berners-Lee to the W3C Technical Architecture Group. Dr. Mendelsohn holds an S.B. in physics from MIT and an M.S. in computer science from Stanford University.

Speaker Biographies

David Mills is professor of electrical and computer engineering and professor of computer and information sciences at the University of Delaware. He teaches graduate and undergraduate courses in data communications, network protocols, computer security, electronic circuit analysis, digital systems design and computer architecture. He leads research projects in these areas sponsored by DARPA, NSF, U.S. Navy, U.S. Army and NASA/JPL. He has been an active contributor during the technical evolution of the Internet since 1977 and served on several national level panels and advisory groups. He has for many years been an active contributor to the field of computer network time synchronization. Protocols he developed, prototyped and deployed have evolved to the Network Time Protocol (NTP), which is widely used in the Internet today. Dr. Mills holds a B.S.E. in engineering science, B.S.E. in engineering mathematics, M.S.E. in electrical engineering, M.S. in communication sciences, and Ph.D. in computer and communication sciences, all from the University of Michigan.

David Nelson is vice president for research at the World Technology Evaluation Center, Inc., where he identifies needs for research studies or other supporting activities and works with federal agencies to create viable projects. Dr. Nelson retired from the federal government after more than two decades of service, most recently as director of the National Coordination Office for Information Technology Research and Development in the Executive Office of the President. Prior to joining the White House, he was deputy chief information officer of NASA, where he served as the agency's chief information security officer; and associate director of the Office of Energy Research in the U.S. Department of Energy. In the early 1990s he was co-chair of the Large Scale Networking Working Group, which developed and implemented the President's Next Generation Internet (NGI) Initiative. Earlier, he was one of the original architects of the President's initiative in High Performance Computing and Communications (HPCC). Dr. Nelson received his A.B. in engineering sciences from Harvard University, and M.S. and Ph.D. degrees in mathematics from Courant Institute of Mathematical Sciences at New York University.

Harvey Newman is professor of Physics at the California Institute of Technology, and a Caltech faculty member since 1982. He has had a leading role in the development, operation and management of international networks and collaborative systems serving the high energy and nuclear physics communities, and served on the Technical Advisory Group for the NSFNET in 1986. He originated the Data Grid Hierarchy concept and the globally distributed computing model adopted by the four Large Hadron Collider (LHC) high energy physics collaborations in 1998-2000. He is the primary investigator (PI) of the LHCNet project, linking the U.S. and CERN in support of the LHC physics program, a PI of the DOE-funded Particle Physics Data Grid Project (PPDG) and a Co-PI of the NSF-funded International Virtual Data Grid Laboratory. He co-founded and chairs the Internet2 High Energy and Nuclear Physics Working Group. Dr. Newman received his Sc. D. from MIT in 1974.

Ann O'Beay has over 25 years of experience in telecommunications, research and education networking, human resources, corporate relations, consulting, and music education. Following a career at AT&T specializing in government, education and health care, she became MCI's senior manager for NSFNET and interface to Merit and ANS. As director of corporate relations for Internet2, she introduced a program engaging domestic and international business, industry, research and education institutions in advanced Internet development. Ms. O'Beay has held various other positions in Fortune 500 companies and has been engaged as a management and human resources development consultant. In addition to her master's and bachelor's degrees from Eastern Michigan University, she performed post graduate studies as a Rotary Foundation Scholar at Reading University in England.

Drew Perkins co-founded and serves as CTO for Infinera. Previously he was a founder and CTO of both OnFiber Communications and Lightera Networks. OnFiber developed some of the world's largest metro DWDM networks and recently merged with Qwest Communications. Lightera developed the CoreDirector optical switch and merged with Ciena. The CoreDirector is currently deployed at many of the worlds tier 1 carriers. He was also the principal architect of several TCP/IP, ATM, Ethernet hardware and software products and protocols at FORE Systems, Inc. Throughout his career, he has participated extensively in standards bodies including the IETF, IEEE, ATM Forum and OIF. Mr. Perkins earned a B.S. in electrical engineering, computer engineering and mathematics from Carnegie Mellon University.

J. Mark Pullen is professor of computer science at George Mason University, where he serves as director of the C4I Center and also heads the center's networking and simulation laboratory. He holds BSEE and MSEE degrees from West Virginia University and the Doctor of Science in computer science from The George Washington University. He is a Fellow of the IEEE, Fellow of the ACM, and licensed professional engineer. Dr. Pullen teaches courses in computer networking and has active research in networking for distributed virtual simulation and networked multimedia tools for distance education. From 1986 to 1993 he was assigned to DARPA as an Army officer. One of his assignments during that period was as manager of the Internet program, where he was responsible for transitioning all DARPA-supported sites to the commercial regional networks associated with the NSFNET.

Yakov Rekhter joined Juniper Networks in 2000, where he is a Juniper Fellow. Previously, he worked at Cisco Systems, where he was a Cisco Fellow. Prior to joining Cisco in 1995, he worked at IBM's T.J. Watson Research Center. He was one of the leading architects and a major software developer of the NSFNET backbone Phase II. He co-designed the Border Gateway Protocol (BGP). He was one of the lead designers of tag switching, BGP/MPLS based VPNs (aka 2547 VPNs), and MPLS traffic engineering. His other contributions to contemporary Internet technologies include his work on Generalized Multi-Protocol Label Switching (GMPLS), Virtual Private LAN Services (VPLS), Classless Inter-Domain Routing (CIDR), and IP address allocation for private Internets. Among his most recent activities is the work on multicast in BGP/MPLS VPNs and VPLS. Dr. Rekhter is the author/co-author of over 60 IETF RFCs, numerous papers and articles, and several books on TCP/IP and the Internet.

Glenn Ricart is co-founder and managing director of PricewaterhouseCoopers' Center for Advanced Research. His prior positions include executive vice president and CTO for Novell, program manager for DARPA, assistant vice chancellor at the University of Maryland, and co-founder and CTO of CenterBeam. Among his Internet credentials are co-founder and principal investigator for SURAnet, the first of the NSFnet regional networks; arranging for and operating the original FIX (the first open Internet exchange point); developing the first TCP/IP stack for the IBM PC; and operating the routers for the original (56 kbps) NSFNET supercomputer centers backbone. He and his teams at the University of Maryland and SURAnet were also responsible for the first Internet links to South America, including Brazil, Argentina, and Chile.

Henry E. Schaffer is professor emeritus of genetics and biomathematics and coordinator of special IT projects and faculty collaboration at North Carolina State University (NCSU). His bachelor's degree in poultry husbandry, along with an interest in poultry genetics, led to his discovery of using computers to process data. These were first generation computers, but they were very useful. Networking the next generation of computers greatly enhanced their usefulness, and developed his interest in data communications. Meeting Glenn Ricart and Morty Taragin helped fuse

his activities in computing and datacomm and led to the proposal for a network "to connect all scholars in all disciplines." This was the genesis of SURAnet, for which he served as co-PI. One of his major satisfactions has been the realization of many of the original visions for the NSFnet. Throughout his career Dr. Schaffer has participated in both research and instruction. He also led academic IT at NCSU, and comprehensive IT for the UNC System. Now, as a professor emeritus, he devotes his time to projects bridging IT, datacomm and academics.

William Schrader serves as president, CEO and board member of Synchris, Inc., a provider of virtual workspace software. Responsible for the strategic direction and day-to-day operations of the company, he has 30 years of technology management experience, including 22 years as a CEO. From 1989-2001 he was founder, chairman and CEO of PSINet Inc. At PSINet he innovated many early Internet services, including commercial Internet connectivity, Internet hosting, fiber ownership and electronic commerce consulting. PSINet operated a global system on five continents, served 30 countries, employed over 10,000 people, produced $2 billion in annualized revenue, and was one of the largest Internet providers. Prior to PSINet, he led the creation of supercomputer centers at Syracuse University and Cornell University, and the infrastructure for five national networks. Prior to 1983, he served as administrative and project manager for the Laboratory of Nuclear Studies at Cornell. He also provided consulting services directly to various government agencies throughout his career. Mr. Schrader holds a B.S. in Biology from Cornell University, and has completed course work towards an MBA also at Cornell University.

George O. Strawn, as the National Science Foundation's chief information officer (CIO), guides the agency in the development and design of innovative information technology. He Strawn has served NSF in numerous roles since joining the organization in 1991. From 1999-2002 he worked in the Directorate for Computer and Information Science and Engineering (CISE), serving three years as executive officer and one as acting assistant director. From 1995-1998 he was director of the CISE Division of Advanced Networking Infrastructure and Research. He was the NSFNET program director from 1991-1993, overseeing the progression of the NSFNET backbone network from T1 capacity to the first national T3 Internet network. From 1993-1995, he continued in a part-time capacity with NSF and was involved with defining and deploying the "new" (privatized) Internet architecture. Previously he was a computer science faculty member at Iowa State University and served as director of the ISU Computation Center and chair of the ISU Computer Science department. Dr. Strawn holds a Ph.D. in Mathematics from Iowa State University and an undergraduate degree from Cornell College.

Douglas E. Van Houweling, the founding president and CEO of Internet2 and a professor in the School of Information at the University of Michigan, has played a major role in Internet development in the United States. He was chairman of the board of Merit, Inc., when the National Science Foundation awarded it responsibility for operation and management of the NSFNET national backbone in partnership with IBM, MCI and the Michigan Strategic Fund in 1987. He was also chairman of the board of Advanced Network & Services, Inc., a not-for-profit organization that implemented and operated the world's largest Internet backbone network from 1991 until 1995. He is the recipient of the EDUCAUSE 2002 Excellence in Leadership Award, and currently serves on the boards of Advanced Network and Services, Merit Network, Altarum, and Adaptec. Dr. Van Houweling received his undergraduate degree from Iowa State University and his Ph.D. in government from Indiana University.

Peter Villemoes has worked with NORDUnet since 1985, first on its supervisory board and then as general manager from 1989 to 2005. He began his professional career as a researcher at CERN, and was then a computer university center manager until joining NORDUnet.

Allan H. Weis is the founder and president of Advanced Network & Services (ANS), a company dedicated to advancing education through the use of computer networking technology and applications. He led the ANS team that built the largest and fastest part of the Internet, which provided the underlying network for the National Science Foundation. In 1995, the assets and operations were sold, and ANS became preeminent in education and philanthropy providing tens of millions of dollars to help advance education through the use of technology. He founded ThinkQuest in 1996, the National Tele-Immersion Initiative in 1997 and several other philanthropic programs for kids, technology and education during the past years. Prior to his work with ANS, Mr. Weis spent thirty years with IBM where he held a number of positions. Mr. Weis attended MIT as an Alfred P. Sloan Fellow.

Walter Wiebe is a graduate of North Carolina State University with a professional B.S. and M.S. in product design. He worked for IBM for 34 years, holding systems development/management positions in industry custom systems, biomedical systems, academic information systems and systems technology. He also spent five years at MCNC (North Carolina's state network organization), North Carolina State University, and the National Science Foundation. Mr. Wiebe led IBM's ACIS team in the NSFNET partnership with Merit, MCI and NSF from 1987 to 1991. He was responsible for the development of the architecture of the T1 and T3 networking hardware and software, as well as for network engineering, support and technology upgrades for the NSFNET during that period. He was executive director of the Federal Networking Council, where he was responsible for the coordination of 22 federal interagency Internet activities, and chairman of the North American Coordinating Committee of Intercontinental Research Networks (CCIRN). Mr. Wiebe retired from IBM in 2006.

Jim Williams is the executive director and CEO of LEARN: Lonestar Education and Research Network, a not-for-profit initiative of 33 Texas institutions and organizations that are working together to build a next generation, facilities based optical network for higher education, research, and the health science community. Mr. Williams has a long history of service to the research and education networking community, currently serving on the board of the Quilt and NLR (National LambdaRail), the steering committee of StateNets, and on an Internet2 council. Previous posts include director of policy analysis and government relations for EDUCAUSE, executive director of the Federation of American Research Networks (FARNET), and associate director for national networking at Merit. He began his career with the University of Nevada System where he provided the inspiration and early guidance for NevadaNet, a statewide academic network based on then-revolutionary Internet technology. He failed as a biologist and more recently as a retiree.

Kenneth Wilson is a physicist and was a professor at Cornell for thirty years before moving to The Ohio State University in 1988. He has a degree from Harvard and a Ph.D. from the California Institute of Technology. He has awarded the Nobel Prize for physics in 1982. During 1985-1987, Dr. Wilson led the Cornell Theory Center, one of four supercomputer centers funded by NSF. This Center was an early supporter and booster of TCP/IP and hosted the first control center for the NSFNET. In partnership with IBM and Floating Point Systems, the Theory Center hosted the initial control center for the NSFNET. Also in partnership with IBM and Floating Point Systems, the Center was an early adopter of parallel processing techniques in scientific computing. Dr. Wilson was instrumental in encouraging NSF to adopt TCP/IP networking for the NSFNET and in encouraging IBM to move toward a parallel processing computing model.

Speaker Biographies

Stephen Wolff studied at Swarthmore College, Princeton University, and Imperial College. He taught electrical engineering at The Johns Hopkins University for ten years and subsequently spent fifteen years leading a computing- and network-related research group at the U.S. Army Research Laboratory. From 1986-1995 he was director of the Division of Networking and Communications Research and Infrastructure at the U.S. National Science Foundation, responsible for NSFNET and NSF's support programs for basic research in networking and communications. He joined Cisco Systems in 1995, where he is currently a technical manager supporting the programs of the Cisco Research Center. Dr. Wolff holds two patents and is the author of several dozen technical reports and articles. He is a member of AAAS and ACM, a Pioneer Member of the Internet Society, and a Life Member of IEEE.

Jessica (Jie Yun) Yu is currently a network architect at University of California, Irvine, responsible for network planning for UCINet. She is actively involved in UC's system-wide advanced network planning and strategies. She was one of members of the original team at Merit Network Inc. that, in partnership with IBM and MCI, built and engineered the T1 NSFNET backbone in 1987 and later upgraded it to a T3 backbone. She co-authored the CIDR specification which has become an Internet standard and served as chair and co-chair of IETF working groups. Ms. Yu also did pioneer work on BGP and CIDR and their initial deployment in the Internet. She has worked at ANS/AOL and UUNet in network architect and engineering areas.