NGI

Presentation to

MIT Club of Washington

January 11, 2000

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National Coordination Office for
Computing, Information, and Communications

NGI Initiative

- The Next Generation Internet (NGI) initiative is a multi-agency Federal R&D program that will:
  - Develop new and more capable networking technologies to support Federal agency missions
  - Create a foundation for more powerful and versatile networks in the 21st century
  - Form partnerships with academia and industry that will keep the U.S. at the cutting edge of information and communications technologies
  - Enable the introduction of new networking services that will benefit our businesses, schools, and homes

Government Role in NGI

- Why should the Government be involved in the NGI?
  - NGI is beyond the scope of any one institution or sector - it demands multi-agency, academic, and industry input, discussion and coordination
  - Government long-term R&D has a proven technology leadership track record
  - The Government has an opportunity to leverage its existing advanced networking programs
  - The Government must support its own critical, time sensitive mission requiring next generation technologies
  - U.S. Government leadership, in partnership with industry and academia, is needed to stimulate global technology and R&D and to maintain U.S. technology leadership

NGI Initiative Timeline

- October 10, 1996 President Clinton and Vice President Gore announced their commitment to the NGI
- May 12 - 14, 1997 Research Directions for the NGI, funded by NSF
- July 1997 NGI Concept Paper
- September 10, 1997 Hearing by the Committee on Science
- November 4, 1997 Hearing by the Committee on Commerce, Science and Transportation Subcommittee on Science, Technology and Space, U.S. Senate
- NGI Act of 1998 authorized funding through FY 2001
- Fiscal Year 1998 first year of funding for NGI
- February 1998 NGI Implementation Plan - detailed the plans, deliverables and timeframes for the NGI

Goals and Metrics

Initiative Goals

1. Promote experimentation with the next generation of network technologies

2. Develop a next generation network testbed to connect universities and federal research institutions at rates that are sufficient to demonstrate new technologies and support future research

3. Demonstrate new applications that meet important national goals and missions

Metrics

- Quality of service including security
- Adoption of technologies by private sector

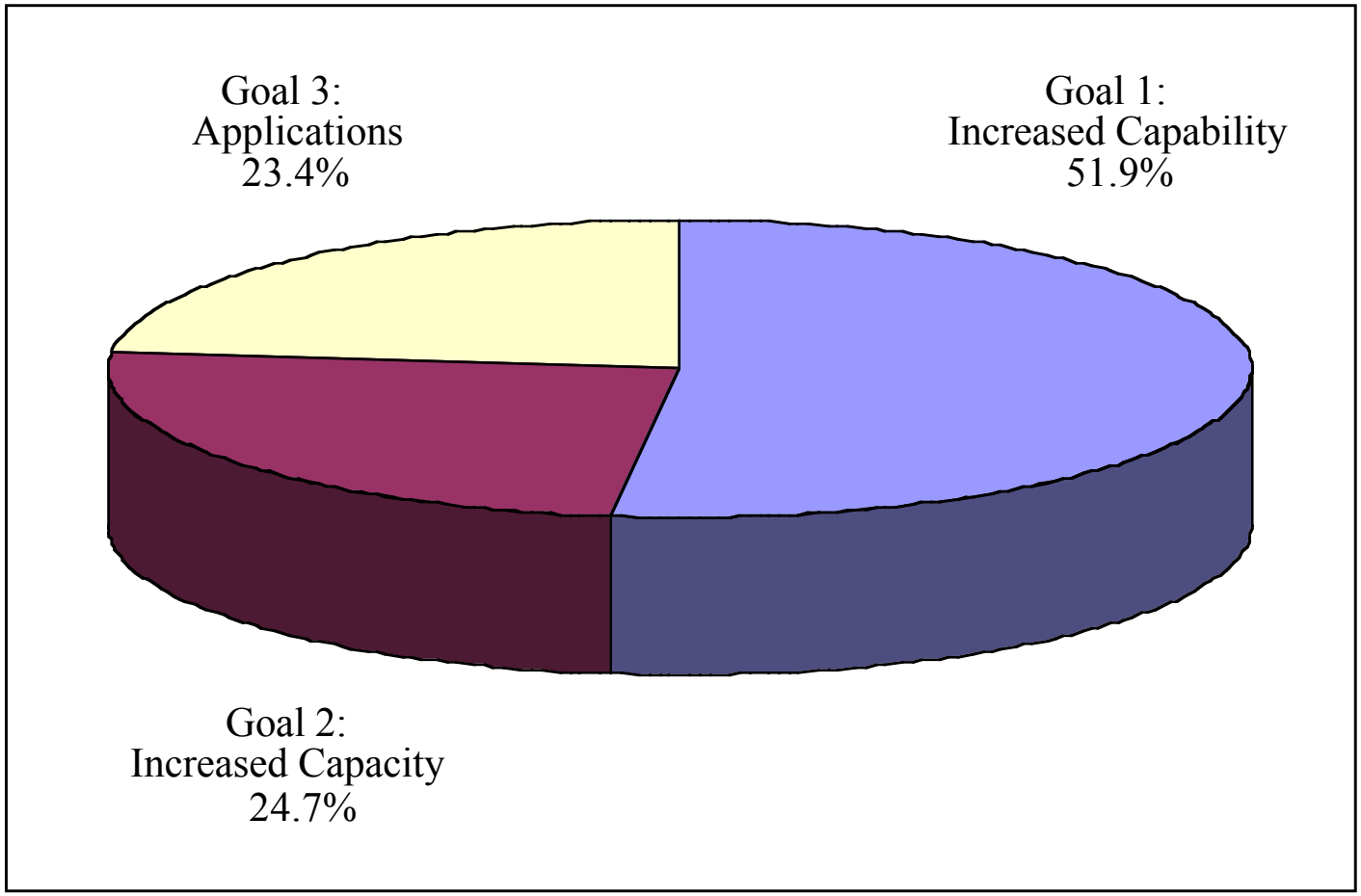
- Ability of network testbed to accommodate goal 1 research results and goal 3 applications
- 100-1000 times end-to-end performance improvement
- About 100 research institutions connected

- 100+ high-importance applications
- Value of applications in testing networking technologies

NGI Budget Profiles (Dollars in Millions)

	FY 1998		FY 1999		FY 2000	
Agency	**Requested**	**Actual**	**Requested**	**Actual**	**Requested**	**Estimate**
DARPA	$40	$42	$40	$50	$40	$36
NSF	10	23	25	25	25	25
DOE	35	0	25	15	15	0
NASA	10	10	10	10	10	15
NIH/NLM	0	5	5	5	8	5
NIST	5	5	5	5	5	5
TOTAL	**$100**	**$85**	**$110**	**$110**	**$103**	**$86**

NGI FY 1999 Funding by Goal



Advanced Networking Research (1)

- Application/network issues
  - Application to network interfaces
  - End-to-end quality of service through interface between applications QoS and network QoS
  - Group communications
  - Middleware for visualization applications
  - Multicast
  - Multimedia networking
  - Networks for data intensive applications
  - Optimizing distributed application performance
  - Smart environments
- Measurement, modeling, and analysis
  - Test and measurement tools
  - Network modeling
  - Monitoring and analysis of IP packet flow and performance

Advanced Networking Research (2)

- Network management (including differentiated service)
  - Adaptive network management
  - Bandwidth and traffic management
  - Managing denial of service
  - High performance routing and switching
  - Managing quality of service in hybrid land-based, wireless, and satellite networks
  - MPLS
  - Performance trade-offs
  - Reservations
  - Resource management
  - Scheduling
  - Web performance
- New technologies
  - Protocols
  - Optical networking technologies
  - Ultra high bandwidth on demand

Advanced Networking Research (3)

- Network security
  - Standards such as PKI
  - Testbeds
- Networking standards
- Wireless and mobile networks
  - Hybrid land-based, wireless, and satellite networks

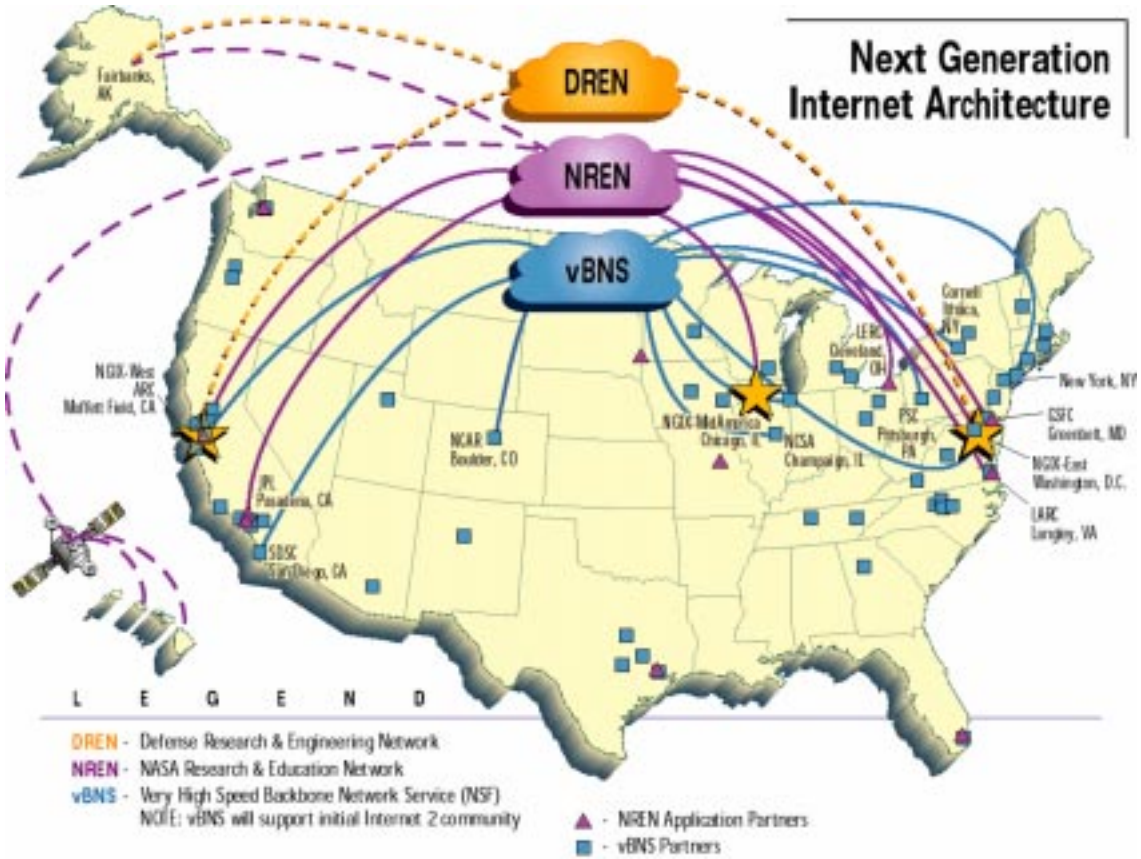
NGI Testbeds

- Two testbeds to support networking research and demonstrate new technologies
  - High Performance Connectivity
    - Deliver at a minimum 100 X current Internet performance on end-to-end basis to at least 100 NGI sites
    - Provide full system, proof-of-concept testbed
  - Ultra High Performance Connectivity
    - Deliver end-to-end network connectivity at 1+ Gbps at least 10 NGI sites
    - Lay groundwork for future Tbps networks
- Connect universities, Federal research institutes, and other research partners

NGI 100x Testbed

- 100x testbed goal:
  - Connect about 100 universities, Federal research institutions, and other research partners at speeds 100 times faster end-to-end than 1997's Internet
- Testbed includes:
  - Federal NGI networks:
    - NSF's very high performance Backbone Network Service (vBNS)
    - NASA's Research and Education Network (NREN)
    - DoD's Defense Research and Engineering Network (DREN)
    - DOE's Energy Sciences network (ESnet)
  - The private sector's Abilene (Qwest, Nortel, Cisco, and the University of Indiana) network
- More than 150 sites connected as of January 2000

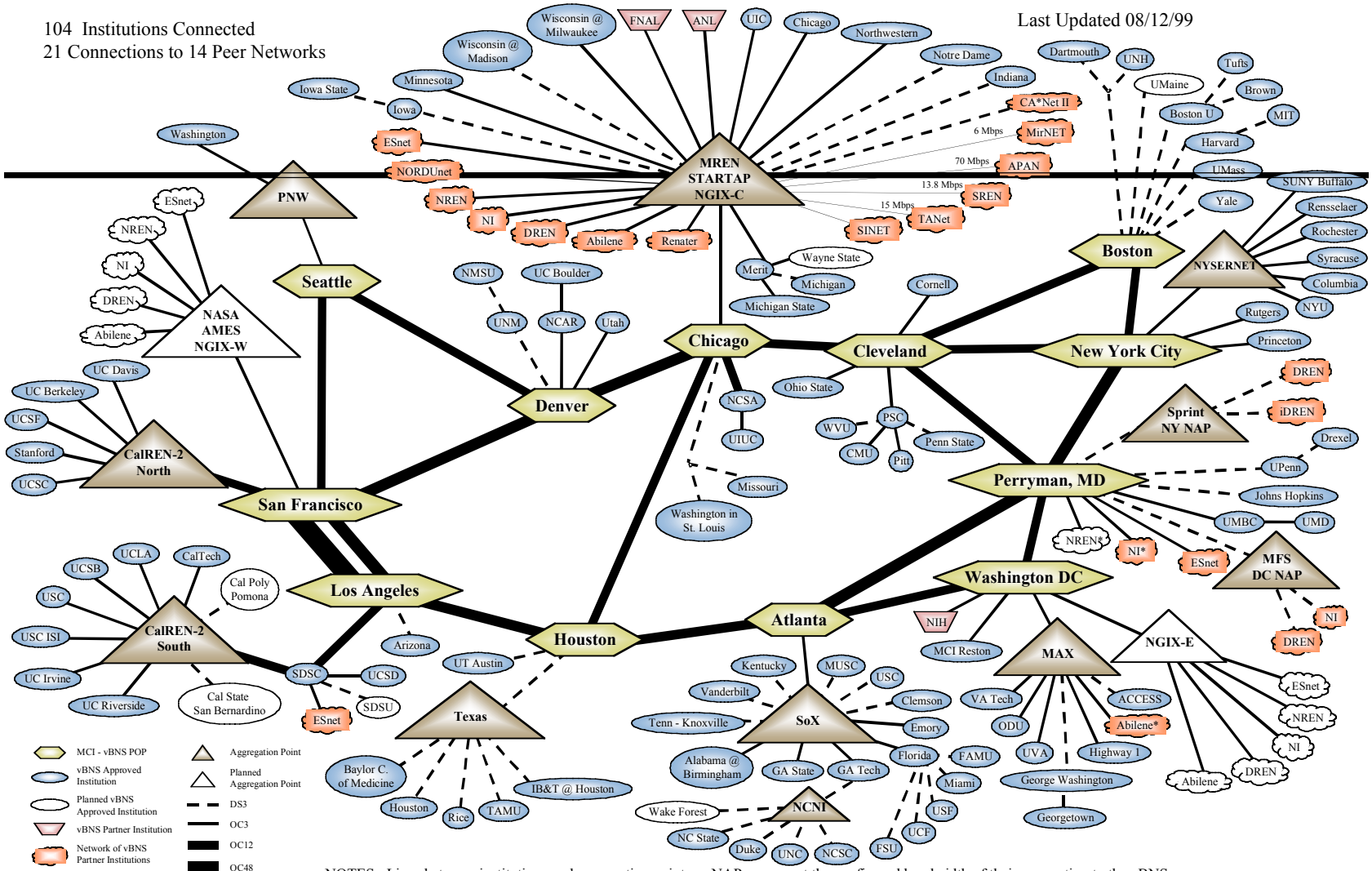
100x Next Generation Internet



vBNS Connected Sites

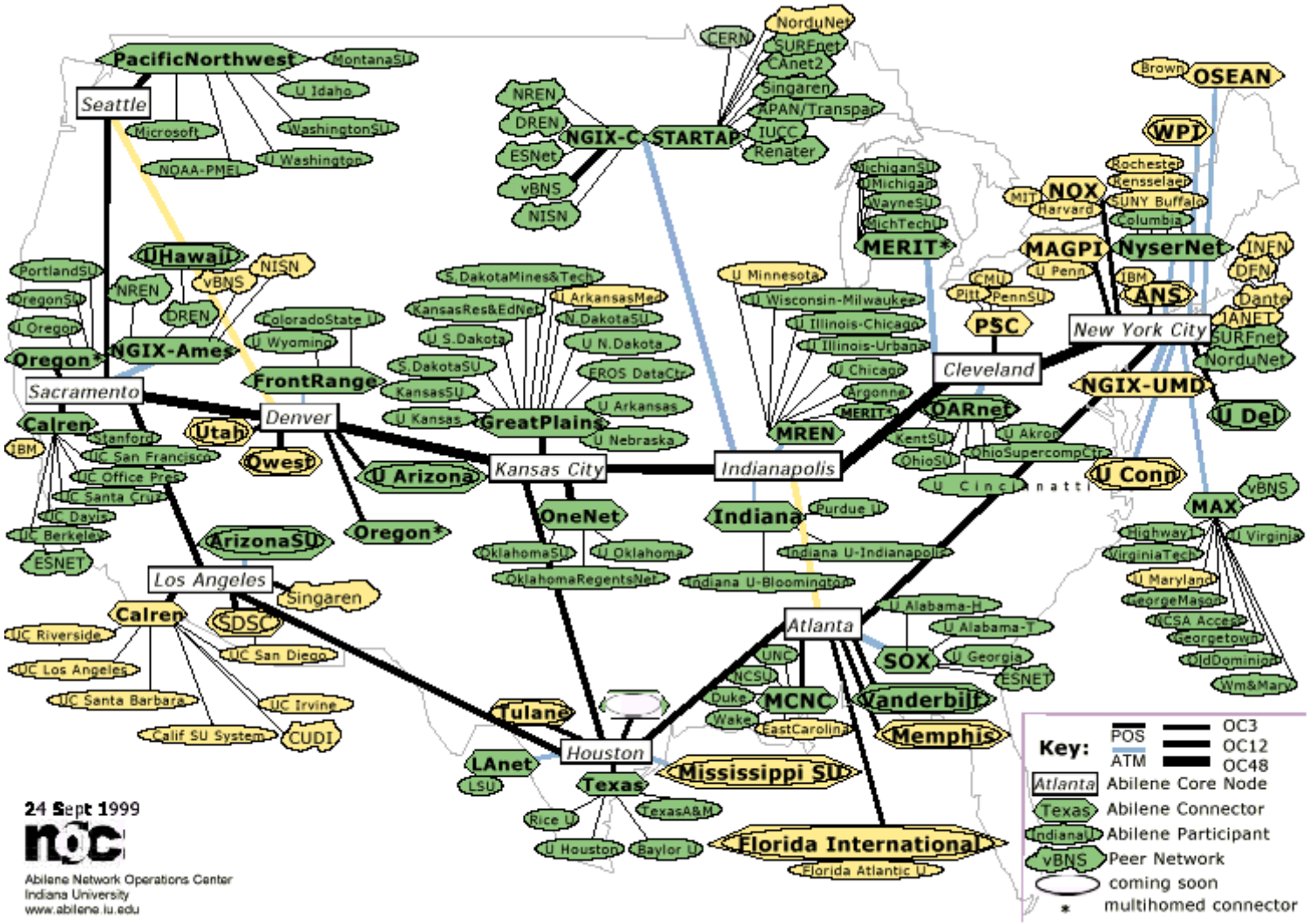
104 Institutions Connected
21 Connections to 14 Peer Networks

Last Updated 08/12/99

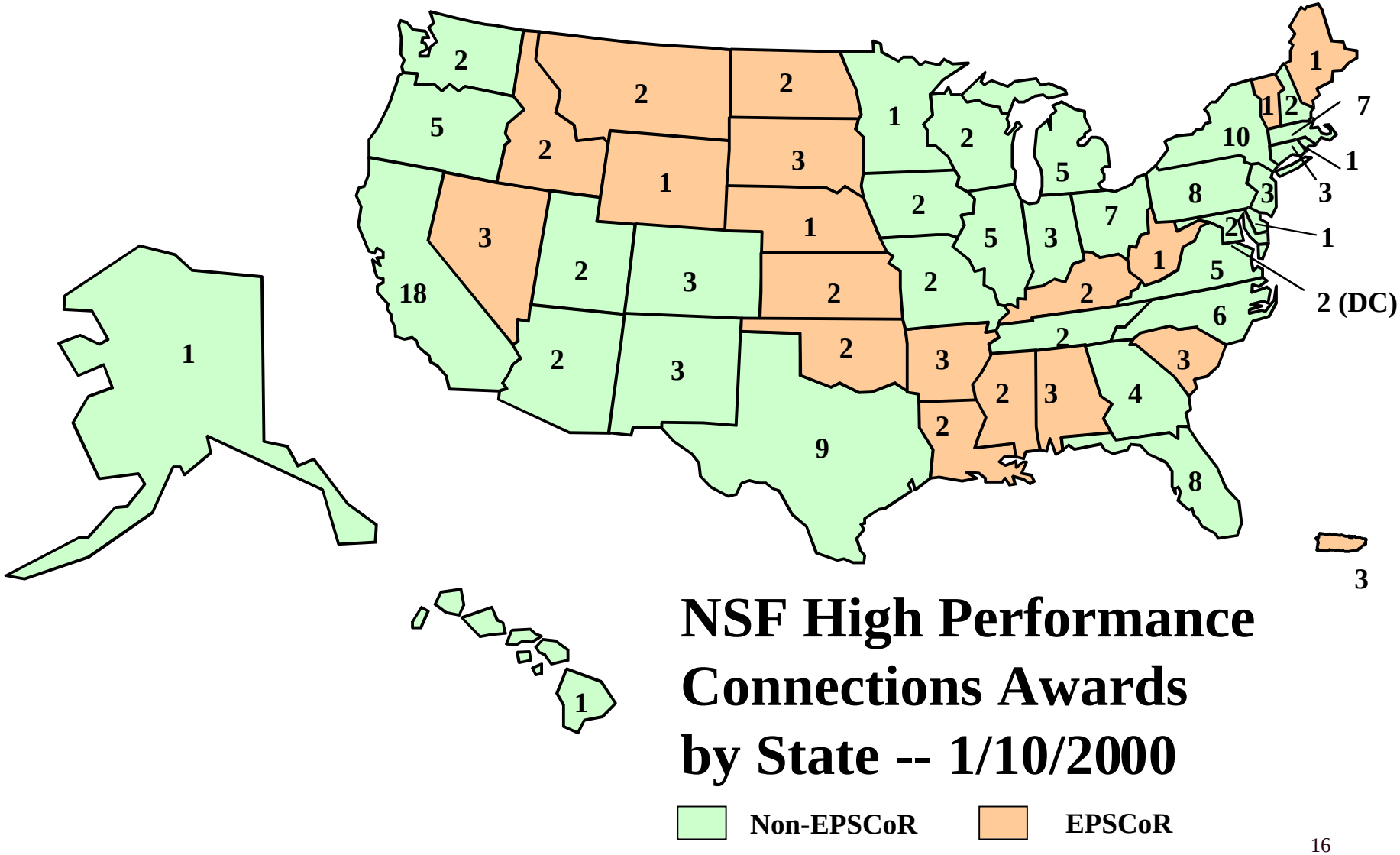


NOTES: Lines between institutions and aggregation points or NAPs represent the configured bandwidth of their connection to the vBNS.
The bandwidth of the actual circuits may be greater than shown.
*These are temporary peering points. Permanent East Coast peering with these networks will take place at NGIX-E as soon as it is operational.

Abilene Network and Connected Sites



NSF High Performance Connections Awards



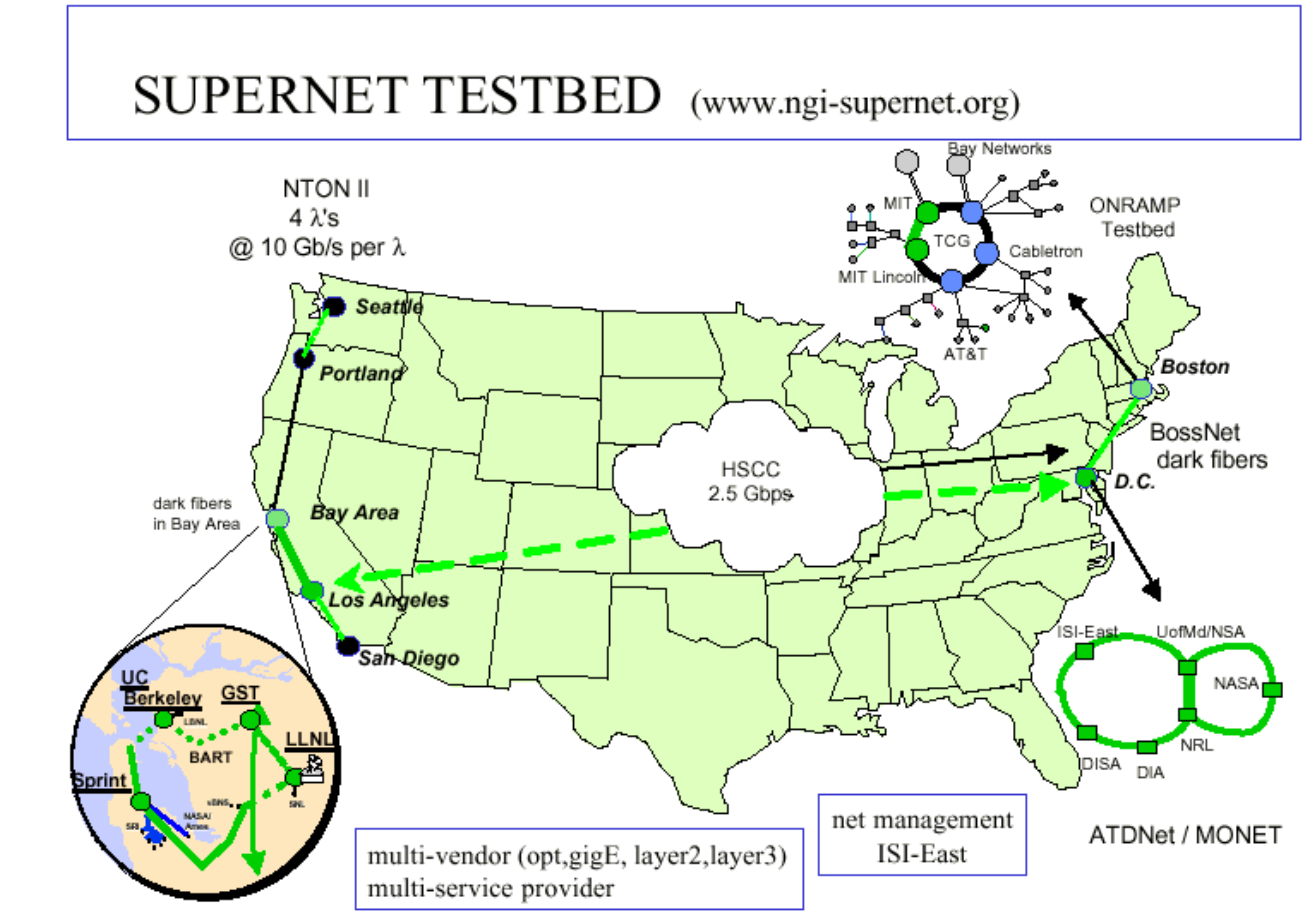
NSF High Performance Connections Awards by State -- 1/10/2000

Non-EPSCoR EPSCoR

NGI 1000x Testbed

- SuperNet goal:
  - Connect about 10 sites with end-to-end performance at least 1,000 times faster than the Internet of 1997
- Testbed includes:
  - Multi-agency Washington, DC area Advanced Technology Demonstration network (ATDnet)
  - Multi-site Boston area BossNet
  - Multi-site West Coast network (Nortel network, includes NTON)
  - Qwest fabric between West and East coasts (OC48)
- For system-scale testing of advanced technologies and services and developing and testing of advanced applications
- ~ 20 sites connected as of March 1999

Supernet Testbed



Testbeds (2)

- The 100x testbed primarily supports NGI applications development
- The 1,000x testbed primarily supports networking research
- Standard performance measurement capabilities are being deployed
- End-to-end performance improvements are being made through coordinated efforts by networking researchers and applications developers
  - NLANR identifying and reducing performance bottlenecks for end user applications
    - Protocol stacks on user workstations are being tuned
    - Problems in network performance such as routing are being resolved

Networking Applications (1)

- Develop and demonstrate revolutionary applications that:
  - Rely on advances made via the NGI research and testbeds activities
  - Meet important National goals
  - Are not possible on today's Internet
- More than 100 NGI applications under development
- A limited number of applications being developed on the 1,000 x testbed
  - World record data transfer rate of 2.4 Gbps was set at SC99 when five HDTV streams were transmitted from Seattle. Washington, to Portland, OR - 54.7 GB of data transmitted during the four-day conference
- Emphasis on performance measurement and end-to-end improvement in applications performance

NGI Networking Applications (2)

- DARPA NGI applications
  - CSU-CHILL Radar distributed data: Remote sensing and meteorological analysis
  - Matisse: Computer microvision workstations
  - Digital Earth: Open, distributed, scalable, multi-resolution 3-D representation of the Earth
  - Digital Amphitheater: Multicasting HDTV

- DOE NGI applications
  - Distributed X-ray crystallography
  - Corridor One: Distance visualization environment
  - Combustion Corridor: Remote visualization capability

NGI Networking Applications (3)

- NASA NGI applications
  - Distributed video observation of shuttle processing and launch activities
  - Tropospheric radio scattering beam communications for remote areas
  - Virtual Collaborative Clinic: Remote three-dimensional images of the human body
  - Digital Earth: see DARPA
  - Biomedical interactive images collaboratory
  - Collaborative remote electron microscopy

NGI Networking Applications (4)

- NIH NGI applications
  - Indianapolis Testbed Network: Nursing home televideo
  - IP Video Telemedicine and Pediatric Cardiology Education
  - NGI Testbed for medical imaging applications
  - Multicenter clinical trial of new therapies using NGI technology
  - Patient controlled personal medical records system
  - Remote, real-time simulation for teaching human anatomy and surgery
  - Human embryology digital library and collaboratory support tools
  - Biomedical Tele-immersion
  - Medical nomadic computing applications during patient transport
  - Pathology image recognition database remotely accessible
  - Patient-centric tools for regional collaborative cancer care using NGI
  - NGI implementation of a visible human dataset
  - Networked 3D virtual human anatomy
  - Mamography for the NGI

NGI Networking Applications (5)

- NSF NGI applications
  - International Collaboration for Virtual Reality and Telepresent Environments
  - Advanced Regional Weather Prediction System (ARPS)
  - CAVERN: Research in teleimmersion and intelligent data mining
  - Studies of Ion Channel Blockade
  - Hybrid Rocket Combustion Characterization
  - Study of Conductive Polymers
  - Tele-Veterinary Medicine/Distance Education
  - Interdisciplinary digital library for the humanities
  - Adaptive and Nonlinear Methods in Signals and Imaging
  - Tele-nanoManipulator: network services, collaboratories, visualization, remote instrumentation
  - Internet HDTV: Very high quality streaming data
  - Phase 3 Internet HDTV: Five concurrent HDTV streams
  - Digital libraries: 2.5 Tbytes, 100 processors with IBM RS/6000 (1G RAM, 4 processors) Trans-Pac: Network infrastructure to support international research and education applications requiring high performance networks
  - Collaboratories: Common component architecture toolkit
  - Direct transmission of IEEE-1394 Digital Video from commercial DV cameras encapsulated in IP
  - DIVE-3D Interactive Volume Explorer for Collaborative Investigation of Medical and Scientific Volumetric Data

NGI Networking Applications (6)

- NSF NGI applications (continued)
  - Distributed computational testbed for Maximum Likelihood Analysis of Phylogenetic Data
  - Variations Digital Music Library
  - Megaconference: Use of H.323 protocol to link network researchers at 65 institutions on three continents
  - High Energy and Nuclear Physics on the Net: Large data file transfer
  - Psychological Services to Deaf Individuals via Telemedicine
  - fMRI Image Database Project
  - ENVISAGFE: Environmental visualization and geographic exploration
  - Distance Independent Tele-Medical Diagnosis
  - Wide-area interactive teaching
  - Video Streaming: track meet events in near-TV quality streaming video
  - High Performance Distributed Computing
  - Columbia Digital Library
  - Electrical engineering instruction via IP (H.323)
  - Remote Observing: Mauna Kea observatory remotely
  - Bioinformatics: remote comparisons of molecular structures against protein, genome, and molecular trajectory data collections
  - Digital Archive: Integrate digital libraries with remote storage systems for storing collection holdings
  - Telescience: Remote Instrumentation, Collaboratories
  - Web TerraFly allows users to fly over and manipulate spatial data over the Web

NGI Networking Applications (7)

- NSF NGI applications (continued)
  - MRI: Performing real-time mesoscale numerical weather prediction modeling at 10 research institutions
  - NASA Rainfall Estimation program participant: Rainfall Predictions
  - Man computer Interactive Data Access System (McIDAS)
  - DAFFIE: Distributed Applications Framework for Immersive Environments
  - The TelePath paradigm: Telemedicine & Network Stress Testing
  - Scaling of Internet Connections to Support Research Applications
  - Collaborative Development of 3D Life Science Educational Resources
  - Large Scale Video Network Prototype (LSVNP): Architectures for video services
  - Legion: An object based distributed parallel processing system for solving large computational problems
  - Center for Advanced Spatial Technologies: Value-added distribution of very large geospatial data sets and applications
  - CERHAS: Researching use of human characters in virtual reality
  - The Space Physics and Aeronomy Research Collaboratory (SPARC)
  - Use of Parallel Computing in Ecological Modeling
  - Landsat TM Radiometry: Transfer of large data sets to facilitate instrument characterization
  - Landsat 7 Science Team: Transfer of large data sets to facilitate instrument characterization

NGI Networking Applications (8)

- NSF NGI applications (continued)
  - Remote Imaging of Electrode Surface Luminescence
  - Advanced Atmospheric Modeling
  - Oregon Gigapop - Multicast Broadcasting & Deployment
  - ICAIR: Advanced media collaboratories, visualization, remote instrumentation, e-commerce, heath sciences, weather
  - The Living Schoolbook: Education information infrastructure
  - Remote Data Mining using the information power grid
  - Project Data Space/Terabyte Challenge: Wide area data mining
  - Virtual World Data Server
  - Distributed Image Spreadsheet: Visualization, weather, collaboratories
  - Species Analyst: Tools that provide simultaneous access to multiple biological collection databases.
  - Partnership for Biodiversity Informatics collaboratory
  - Backyard Biodiversity: Knowledge network of biodiversity information
  - Public Television Internet2 Next Generation Interconnection Pilot
  - A Multicenter Clinical Trial using NGI Technology
  - Use of computers at ORNL: Studying grain boundary and heterogeneous interfaces

Minority and Small College Reach

- Four year $6 million award by NSF to EDUCAUSE to help minority-serving institutions develop campus infrastructure and national connections
  - Award addresses Hispanic, Native American, and Historically Black Colleges and Universities
  - Scope includes:
    - Executive awareness, vision, and planning
    - Remote technical support centers
    - Local network planning
    - Local consulting and training
    - Satellite/wireless pilot projects
    - New network technologies: Prototype installations
    - Grid applications

NGI and Internet2: Complementary and Interdependent

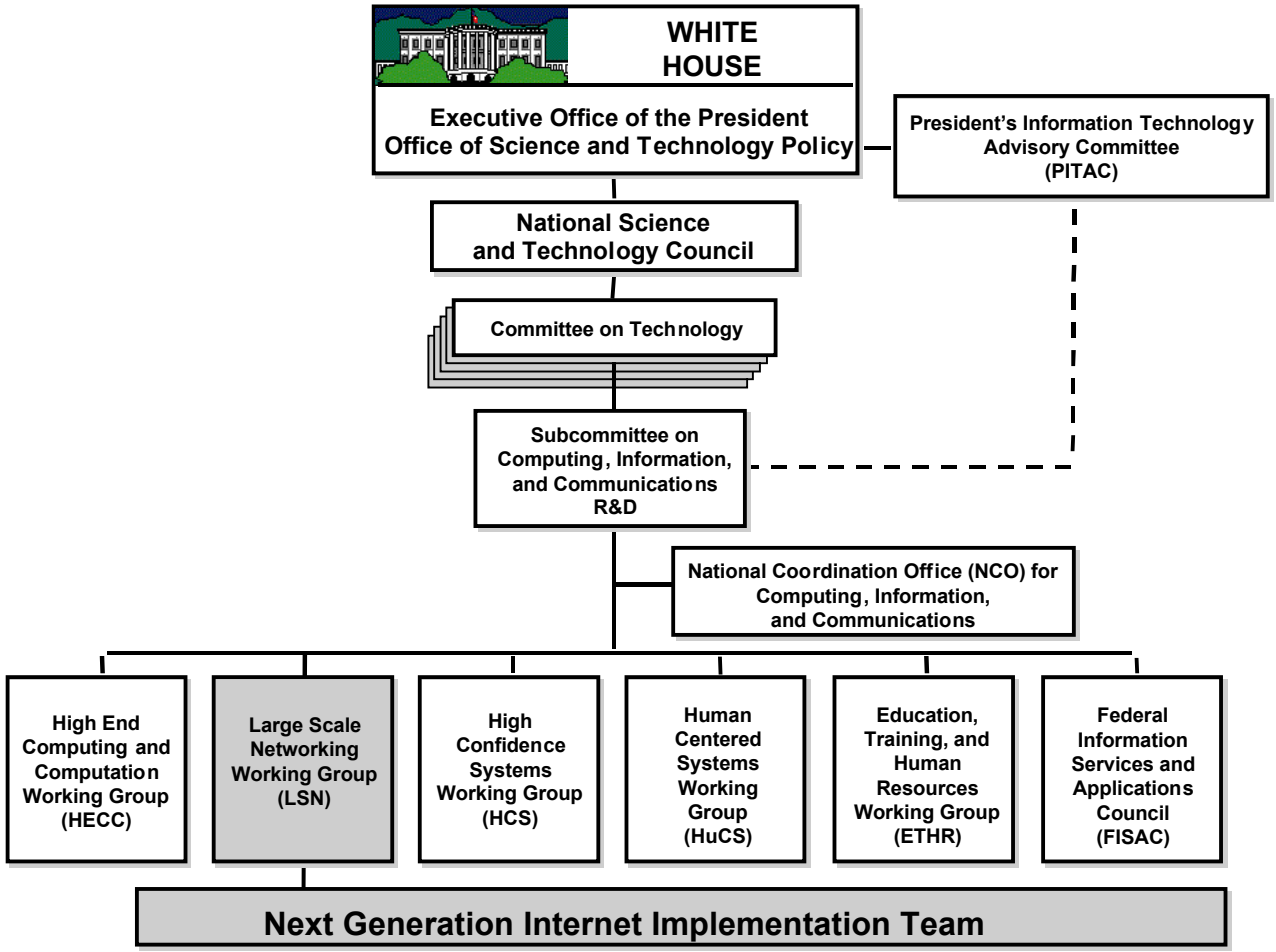
Next Generation Internet	Internet2
• Federal funding • Agency mission driven • R&D in advanced networking technologies and demonstrations on a wide-area scalable testbed, which connects to academic (including some Internet2 universities) and industry networks • Develop general-purpose and agency-specific applications	• Funded by research universities and communications and computing companies • Education and research driven • State-of-the-practice connectivity deployed at universities and GigaPOPs (Gigabit per second points of presence), and interconnected using NSF's vBNS as the backbone • Deploy networking technologies and develop a wide range of applications (many funded by Federal initiatives such as the NGI)

NGI Technology Transfer Activities

- Direct participation in NGI programs and testbeds by commercial companies
- NGI Team Collaborations
  - Networking Research Team
  - High Performance Networking Applications Team
  - Internet Security Team
- Internet2 coordination meetings
- Highway 1 Collaborations/Information
- Applications demonstrations and outreach activities at conferences
  - SC99 in Portland, OR
  - SC00 in Dallas, TX
  - Joint DARPA, NSF, NIST Principal Investigator Review, December 6-9, 1999

NGI Coordination and Management

Coordination/Management Structure



Interagency Coordination

- Large Scale Networking Coordinating Group (LSN CG)
  - Coordinates multi-agency NGI R&D
  - Participants include NSF, DARPA, NIH, DOE's Office of Science, NASA, NIST, AHCPR, NIST, NOAA, EPA
- LSN Teams
  - Joint Engineering Team (JET)
  - High Performance Networking Applications Team (HPNAT)
  - Network Research Team (NRT)
  - Internet Security Team (IST)
  - In addition to LSN agencies, Cisco, Gigapop operators, MCI WorldCom, Qwest, UCAID/Abilene, and university networking departments participate
- National Coordination Office for Computing, Information, and Communications (NCO/CIC)
  - Coordinates LSN and NGI program planning, budgeting, and assessment
  - Supports LSN CG and the LSN Teams
  - Provides single point of contact for information about the NGI program

President's Information Technology Advisory Committee

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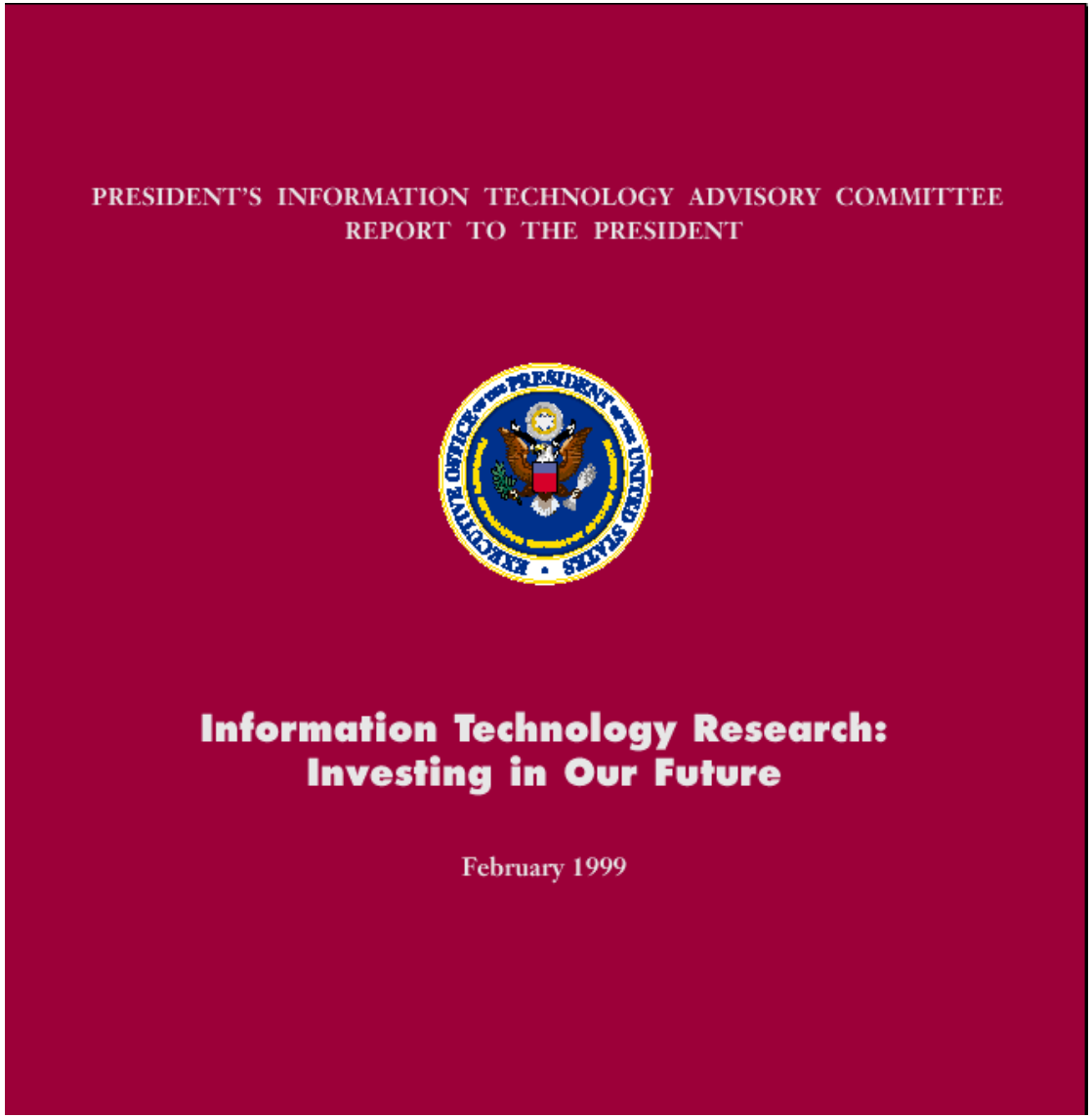
President's Information Technology Advisory Committee Report to the President



PITAC Report Principal Finding

- Underinvestment in Long-Term Fundamental Research
  - Agencies pressed by the growth of IT needs
    - IT R&D budgets have grown steadily but not dramatically
    - IT industry has accounted for over 30 percent of the real GDP growth over the past five years, but gets only 1 out of 75 Federal R&D dollars
    - Problems solved by IT are critical to the nation—science and engineering, management and design, health and medicine, defense
  - Most IT R&D agencies are mission-oriented
    - Natural and correct to favor the short-term needs of the mission
- Trend Must Be Reversed
  - Need to ensure the continued flow of ideas to fuel the information economy and society

PITAC Report
Findings On Federal IT R&D

- Assessment
  - The total Federal IT R&D investment is inadequate and focused on the short term priorities
- Recommendation
  - Create a strategic initiative in long-term IT R&D
    - Increase the IT R&D Budget
    - Diversify agency support for IT
    - Foster risk-taking
    - Increase length of funding for grants
    - Diversify types and size of projects

Summary of PITAC's Recommendations

- Increase the Federal IT R&D Investment by approximately $1.4 billion per year by 2004
  - Ramp up over 5years
  - Focus on increasing fundamental research
- Invest in Key Areas Needing Attention
  - Software
  - Scalable Information Infrastructure
  - High-End Computing
  - Socioeconomic Issues
- Develop a Coherent Management Strategy
  - Establish high-level management attention and focus for IT R&D
  - Diversify modes of support

Administration and Congressional Responses to the PITAC Report

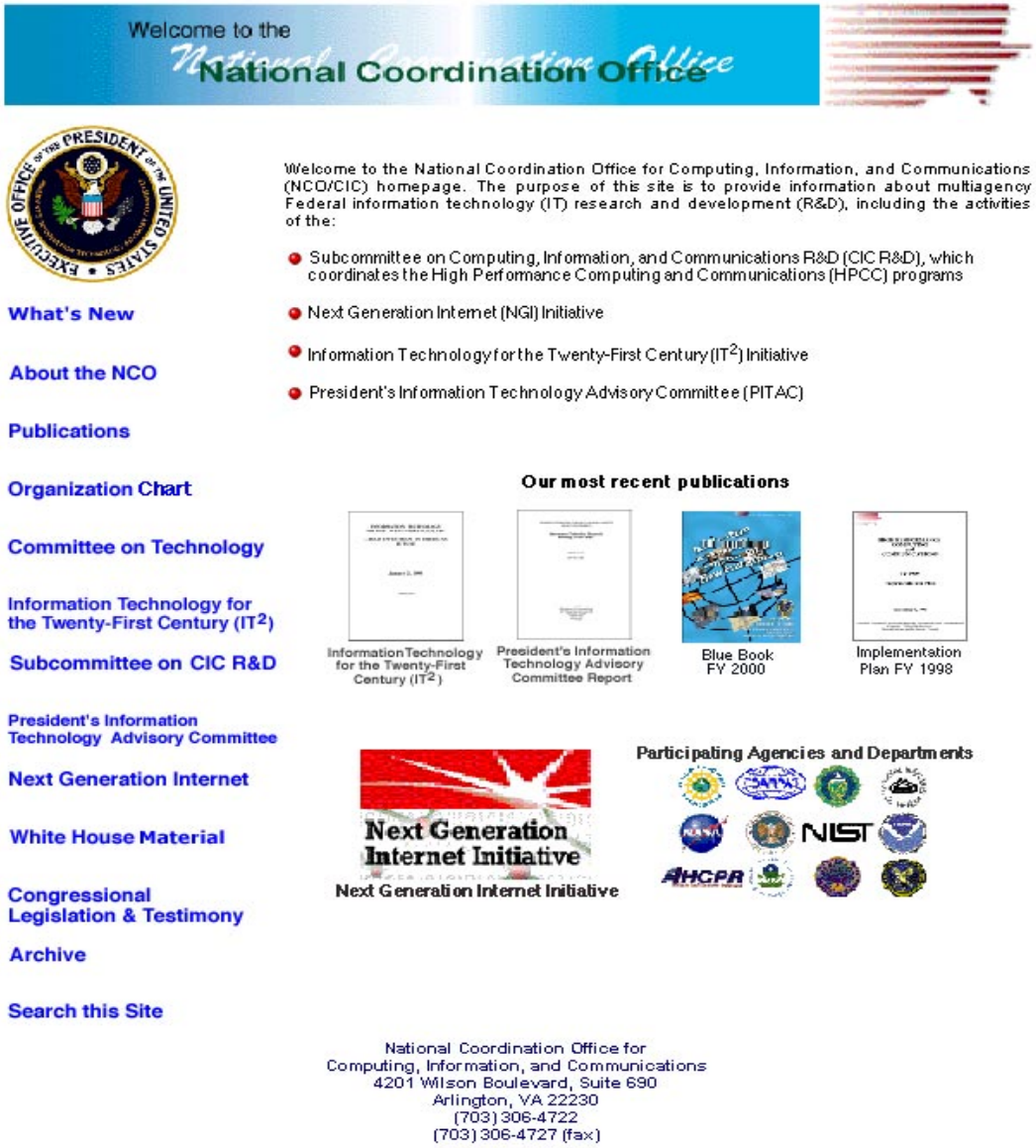
- President's Fiscal Year 2000 Budget proposed increased investments in IT R&D
  - New initiative in FY 2000: Information Technology for the 21st Century, IT^2
  - Requested $366 million in FY 2000
  - IT^2 budget prospects for successive years are unclear
- Congress
  - Proposed Authorization Bill HR 2086, Networking and Information Technology R&D
    - Introduced by J.Sensenbrenner, Chair, House Science Committee, with 25 co-sponsors
    - Would merge HPCC and IT^2 programs and authorize for fiscal years 2000 - 2004 a total of nearly $4.8B, a 92% increase over the fiscal year 1999 appropriations
    - Covers only the six agencies under the House Science Committee's jurisdiction: NSF, NASA, DoE, NIST, NOAA, and EPA
  - Appropriations actions mixed

Administration and Congressional Responses to the PITAC Report

President's Request for IT^2	
NSF	$146M
DOD	$100M
DoE	$ 70M
NASA	$ 38M
NIH	$ 6M
NOAA	$ 6M
Total	$366M

Congressional Appropriation for IT R&D	
NSF	$126M
DOD	$ 60M
DoE	$ 0M
NASA	$ 38M
NIH	$ 6M
NOAA	$ 5M
Total	$235M

For More Information



For More Information

For additional information on the NGI, visit:

http://www.ngi.gov

Next Generation Internet (NGI) Initiative Home

Next Generation Internet Initiative

NGI Initiative Home Page
Revised January 1999

Site structure

- White House on the NGI
- NGI publications
- NGI endorsements
- NGI legislation and testimony
- NGI funding opportunities
- NGI grants, awards, projects, and researchers
- Search this site
- Future NGI workshops
- NGI presentations
- Past NGI events
- Potential NGI applications
- Related NGI sites

Highlights

Announcements of DOE Office of Science (formerly Office of Energy Research) funding opportunities including solicitations for Next Generation Internet Initiative grant applications for (1) research in basic technologies, (2) applications, network technology, and network testbed partnerships, and (3) university network technology testbeds." Preapplications due by February 12, 1999, formal applications due by March 31, 1999.

- Research in basic technologies
- Applications, Network Technology, and Network Testbed Partnerships
- University Network Technology Testbeds

NCO Research Exhibit and NGI Demonstrations at the SC98 Conference (November 1998)

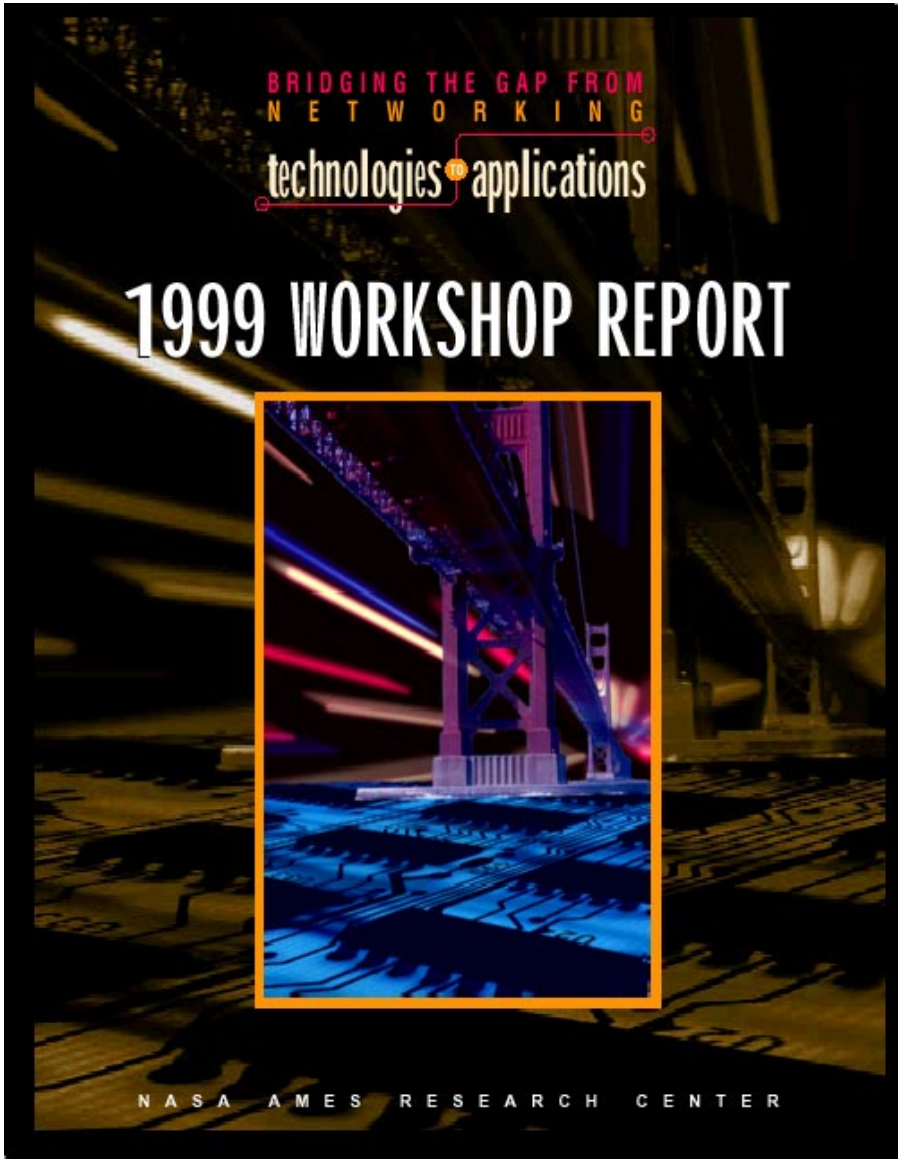
- NCO: Your Gateway to Federally-funded Information Technology R&D
- NCO News
- About the NGI Initiative
- How You Can Participate in the NGI Initiative
- Next Generation Internet Architecture
- Supernet Testbed
- SC98 NGI Exhibits Posters
- SC98 NGI Exhibitor Contacts
- Federal NGI Contacts
- Organization Chart

NASA Research and Education Network (NREN) Workshop on Quality of Service, NASA Ames Research Center, Moffett Field, California (August 18-19, 1998)

NGI Implementation Plan (February 1998)

Home | White House on NGI | Publications | Endorsements | Legis/testimony
Funding opportunities | Grants and awards | Search this site | Future workshops | Presentations
Past events | Potential apps | Solicitations | Related sites | Feedback

For More Information



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