Federal Next Generation Internet Initiative

A Glimpse into the Future

Public Technology, Inc.
Technology Solutions: Service Delivery
Into the 21st Century Annual Member Conference
April 8, 1999
Chicago, Illinois

Kay Howell, Director
National Coordination Office for Computing, Information, and Communications
Famous Quotes about the Future of Computing

- "I think there is a world market for maybe five computers." **Thomas Watson, chairman of IBM, 1943.**
- "Computers in the future may weigh no more than 1.5 tons." **Popular Mechanics, forecasting the relentless march of science, 1949**
- "I have traveled the length and breadth of this country and walked with the best people, and I can assure you that data processing is a fad that won't last out the year." **Editor in charge of business books for Prentice Hall, 1957**
- "But what ... is it good for?" **Engineer at the Advanced Computing Systems Division of IBM, commenting on the microchip, 1968**
- "There is no reason anyone would want a computer in their home." **Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977**
- "So we went to Atari and said, 'Hey, we've got this amazing thing, even built with some of your parts, and what do you think about funding us? Or we'll give it to you. We just want to do it. Pay our salary, we'll come work for you' And they said, 'No.' So then we went to Hewlett-Packard, and they said, 'Hey we don't need you. You haven't got through college yet.'" **Apple Computer Inc. founder Steve Jobs on attempts to get Atari and HP interested in his and Steve Wozniak's personal computer**
- "640K ought to be enough for anybody." **Bill Gates, 1981**
Explosive Growth and Adoption

The Internet’s pace and adoption eclipses all other technologies that preceded it.

- Radio was in existence 35 years before 50 million people tuned in
- TV took 13 years to reach that benchmark
- PCs took 16 years from the time the first PC kits were introduced
- *The Internet crossed that line in 4 years!*

Statistics on Internet Growth

- In 1996, fewer than 40 million people worldwide were connected to the Internet – in 1997, 100 million

- In 1997, registered domain names rose from 627,000 to 1.5 million

- In 1996, Cisco Systems made $100M worth of sales on the Internet – in 1997, $3.2B

- In 1998, it takes only 100 days for the Internet’s volume of traffic to double
Next Generation Internet (NGI)

Imagine an Internet a thousand times faster than today:

- An Internet so ubiquitous that it interconnects all Americans regardless of location, age, income, or health
- An Internet so safe and reliable that Americans confidently use it of their most important communications
- An Internet so intelligent that it can be used effortlessly to help us preserve our environment, improve our productivity, and get first rate medical care
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
How the NGI Initiative is Coordinated

Executive Office of the President
Office of Science and Technology Policy

President's Information Technology Advisory Committee (PITAC)

National Science and Technology Council

Committee on Technology

Subcommittee on Computing, Information, and Communications R&D

National Coordination Office (NCO) for Computing, Information, and Communications

High End Computing and Computation Working Group (HECC)
Large Scale Networking Working Group (LSN)
High Confidence Systems Working Group (HCS)
Human Centered Systems Working Group (HuCS)
Education, Training, and Human Resources Working Group (ETHR)
Federal Information Services and Applications Council (FISAC)

Next Generation Internet Implementation Team
# NGI Budgets
(Dollars in Millions)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DARPA</td>
<td>42</td>
<td>42</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>NSF</td>
<td>23</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>DOE</td>
<td>25</td>
<td>0</td>
<td>25</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>NASA</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>NIH/NLM</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>NOAA</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>110</td>
<td>62</td>
<td>110</td>
<td>100</td>
<td>103</td>
<td></td>
</tr>
</tbody>
</table>
## Goals and Metrics

<table>
<thead>
<tr>
<th>Initiative Goals</th>
<th>Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Promote experimentation with the next generation of network technologies</td>
<td>• Quality of service including security</td>
</tr>
<tr>
<td>2. Develop a next generation network testbed to connect universities and federal</td>
<td>• Adoption of technologies by private sector</td>
</tr>
<tr>
<td>research institutions at rates that are sufficient to demonstrate new technologies and support future research</td>
<td>• Ability of network testbed to accommodate goal 1 research results and goal 3 applications</td>
</tr>
<tr>
<td>3. Demonstrate new applications that meet important national goals and missions</td>
<td>• 100-1000 times end-to-end performance improvement</td>
</tr>
<tr>
<td></td>
<td>• About 100 research institutions connected</td>
</tr>
<tr>
<td></td>
<td>• 100+ high-importance applications</td>
</tr>
<tr>
<td></td>
<td>• Value of applications in testing networking technologies</td>
</tr>
</tbody>
</table>
NGI FY 1999 Funding by Goal

Goal 1: Increased Capability
51.9%

Goal 2: Increased Capacity
24.7%

Goal 3: Applications
23.4%
Goal 1: Networking Research

- Conduct R&D in advanced end-to-end networking technologies
  - Reliability
  - Robustness
  - Security
  - Quality of service/differentiation of service (including multicast and video)
  - Network management (including allocation and sharing of bandwidth)
Goal 2.1: 100x Testbed

- Establish and operate 100x testbed
  - To connect about 100 universities, Federal research institutions, and other research partners at speeds 100 times faster end-to-end than 1997’s Internet
  - Built on Federal 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)
  - Have connected about 150 sites as of March 1999
NSF High Performance Connections Awards by State -- 3/24/99

Non-EPSCoR  EPSCoR

[Map showing the distribution of awards by state, with states shaded in green for Non-EPSCoR and orange for EPSCoR]
Goal 2.2: 1,000x Testbed

- **SuperNet goal:**
  - Connect about 10 sites with end-to-end performance at least 1,000 times faster than the Internet of 1997

- **Built on Federal networks:**
  - 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

- Have connected about 20 sites as of March 1999
1,000x SuperNet Testbed

HSCC 2.5 to 10 Gb/s IP/SONET/WDM

Boston

BossNet dark fibers

ONRAMP Testbed

D.C.

Norton II
4 wavelengths
@ 10 Gb/s per

Seattle

Portland

San Francisco

Los Angeles

San Diego

NASA/Ames

LLNL

Sprint

BART

UC Berkeley

GST

LLNL

SRI

NASA Ames

AT&T

TCG

ASCEND

DEC

MIT

MIT Lincoln

ATDNet / MONET

20 Gb/s WDM

DIA

DISA

BA

NSA

NRL

DARPA

NASA
Goal 3: Applications (1)

- Conduct R&D in applications that require high performance networks
- This includes enabling applications technologies:
  - Collaboration technologies
  - Digital libraries
  - Distributed computing
  - Privacy and security
  - Remote operation and simulation
- And ...
Goal 3: Applications (2)

- And disciplinary applications:
  - Basic science
  - Crisis management
  - Education
  - The environment
  - Federal information services
  - Health care
  - Manufacturing
NGI Demonstrations

- 17 applications at Netamorphosis
  - March 1998 in Washington, DC

- 11 applications at SC98 (Supercomputing)
  - November 1998 in Orlando, Florida

- Next:
  - SC99 in November 1999 in Portland, Oregon
A prototype collaborative environment for carrying out interactive 3-dimensional studies of molecular structure among scientists at distant locations.

SPONSORS
- NIH: National Center for Research Resources

PERFORMERS
- Collagen Corporation
- State University of New York at Stony Brook
- University of California Computer Graphics Laboratory
- University of Washington

USERS & USES
The collaboratory is used for drug design, protein engineering, biomaterials design and fabrication, and bioremediation.

NGI RESEARCH NEEDS
Advancements in high performance network access, collaborative molecular modeling software and desktop videoconferencing.

Primary Contact: Thomas Ferrin, University of California, San Francisco

Web Site: http://www.cgl.ucsf.edu/home/research/collaboratory/
Interactive Echocardiography over the Next Generation Internet

Interactive Echocardiography (EC) generates full-motion video of cardiac structure and cardiovascular blood flow and delivers these images in real-time to physicians in remote locations.

SPONSOR
• NASA

PERFORMERS
• Cleveland Clinic Foundation Imaging Center
• NASA:
  • Ames Research Center
  • Johnson Space Center
  • Lewis Research Center

PARTNER
• NUKO Information Systems, Inc.

USERS & USES
Cleveland Clinic Foundation and satellite facilities in Ohio and Florida, and the Clinic’s outpatient labs currently use interactive echocardiography. Echocardiographs are transmitted from the cardiac operating room to remote locations so that cardiologists can provide guidance even when they are not physically present. Echocardiography images are also relayed from satellite facilities to the main facility for diagnosis. Remote echocardiography will be critical for the future International Space Station, in battlefield conditions, and in medically underserved areas around the world.

NGI RESEARCH NEEDS
Increased bandwidth and end-to-end Quality of Service guarantees to distribute 30 megabytes/second of full-screen, full-motion image data over wide-area networks.

Primary Contact: Dr. James Thomas, Cleveland Clinic Foundation
Web Site: http://www.nren.nasa.gov/echo.html
Real-time Functional MRI
Watching the brain in action

The Brain in Action allows remote viewing of brain activity while a patient is performing cognitive or sensory-motor tasks.

SPONSORS
- NIH
  - National Center for Research Resources
  - National Institute of Mental Health
  - National Institute on Drug Abuse
- NSF

PERFORMERS
- Carnegie Mellon University
- Pittsburgh Supercomputing Center
- University of Pittsburgh
- University of Pittsburgh Medical Center

USERS & USES
Neurosurgeons, neurologists, psychiatrists, and brain scientists will investigate brain function and diagnose and treat brain diseases. For example, this application will enable neurosurgeons to develop surgical plans for tumor removal based on an understanding of the cognitive and sensory-motor abilities located near a tumor site.

NGI RESEARCH NEEDS
Improvements in available capacity, interactive real-time capability, security, privacy, and integration with advanced computing to ensure high performance, wide-spread availability, online visualization, and patient confidentiality.

Primary Contact: Nigel Goddard, Pittsburgh Supercomputing Center
Web Site: http://www.psc.edu/science/goddard.html
The Scanning Tunneling Microscope (STM) can measure and manipulate atomic structures (measured in nanometers, or billionths of a meter), whose images have been magnified to a workable human scale. The Field Ion Microscope (FIM) is used to shape the STM’s probe, or tip, so it can accurately measure these structures.

SPONSOR
- NIST

PERFORMERS & PARTNERS
- EMCOR
- Kurt J. Lesker Co.
- Sandia National Laboratories
- NIST
- Topometrix
- University of Maryland

USERS & USES
Manufacturing researchers use the STM and its close relative, the Atomic Force Microscope, as quality control tools for developing standard measurements of small-scale products and their component parts, such as computer chips and their circuitry.

NGI RESEARCH NEEDS
A high-speed, secure, reliable network and simultaneous voice, video, and data transmission to make these microscopes, located at NIST’s Gaithersburg, MD campus, accessible by “remote control” to companies and universities nationwide.

Primary Contact: Theodore Vorburger, NIST/MEL
Web Site: http://www.nist.gov/mel/namt/
Octahedral Hexapod
An Information Age machine tool

The hexapod is an innovative experimental metal-cutting machine tool with the potential to deliver an unprecedented combination of versatility, speed, accuracy, and portability.

SPONSOR
- NIST

PERFORMERS & PARTNERS
- Deneb Robotics
- Ingersoll Milling Machine Co.
- NIST
- Ohio State University
- Sandia National Laboratories
- United Technologies Research Center/Pratt & Whitney
- University of Florida
- University of Maryland

Additional Hexapod User Group Partners
- Allied Signal Corp.
- Eaton Corporation
- Giddings and Lewis
- Hexel Corporation
- Massachusetts Institute of Technology
- NASA Johnson Space Flight Center
- Oak Ridge National Laboratory

USERS & USES
Industry and university researchers are working with NIST to investigate the hexapod’s potential performance advantages — from lower production costs to faster methods for making parts, molds, and dies.

NGI RESEARCH NEEDS
Real-time, full-motion video plus 15 Mbps bandwidth in a dedicated, secure environment — technology not widely available and currently prohibitively expensive for most organizations that can contribute to and benefit from network-enabled manufacturing research collaborations.

Primary Contact: Albert Wavering, NIST/MEL
Web Site: http://www.nist.gov/mel/namt/
For additional information on the NGI, visit:

http://www.ngi.gov
Key findings and recommendations:

- The total Federal IT R&D investment is seriously inadequate given growing importance of IT to our Nation

- Establish a strategic initiative in long-term R&D

- Increase the Federal IT R&D investment by approximately $1.4B per year by 2004 (current programs are approximately $1.5B)

- Four priority research areas:
  - Software
  - Scalable information infrastructure
  - High End Computing
  - Impacts of IT on society and the economy
Information Technology for the 21st Century: A Bold Investment in American’s Future

- Proposed in the President’s FY2000 Budget
- Responds to recommendations from the President’s Information Technology Advisory Committee (PITAC)
- IT² will increase Federal investments in:
  - Fundamental IT research
  - Advanced computing for science, engineering, and the Nation
  - Research in the ethical, social, and economic implications of the Information Revolution, and support for the education and training of America’s IT workforce
Major IT² Investments

IT² will increase Federal investments in:

- Fundamental IT research
- Advanced computing for science, engineering, and the Nation
- Research in the ethical, social, and economic implications of the Information Revolution, and support for the education and training of America’s IT workforce
Information Technology for the 21st Century: Fundamental IT Research

- Long-term high-risk investigations of key issues in computer science and engineering

- Research focal points:
  - Software
  - Human computer interfaces and information management
  - Scalable information infrastructure
  - High-end computing
IT² will obtain computers that are 100 to 1,000 times more powerful than those now available to the civilian research community and make them available on a competitive basis

- These systems will have several thousand processors, high speed shared and distributed memory, and state of the art switching technology

- Install and develop systems capable of 5 trillion (a thousand billion) computations per second by the end of fiscal year 2000, and 40 trillion by the year 2003
Develop scientific and engineering simulation software and tools to make these computing systems useful research tools:

- Advanced technologies in computational algorithms and methods and in software libraries
- Problem solving and code development environments and tools
- Distributed computing and collaborative environments
- Visualization and data management systems
Establish and fund multidisciplinary teams working on our most challenging problems, including:

- Predicting climate change
- Predicting severe weather
- Understanding genetic function
- Computational seismology
- Simulating combustion
- Simulating materials
- Modeling the evolution of the universe
- Simulating complex vehicles and missions
Increased research in economic and social impacts will:

- Help in the design of information systems
- Identify barriers to adopting IT and its applications
- Provide more empirical data to policymakers
- Encourage the solution of problems caused by IT

Proposed efforts in training IT workers at U.S. universities:

- Faculty access to modern curricula and instructional material
- Graduate and post-graduate traineeships
- University research grants through other components of this initiative will help support graduate students
# Information Technology for the 21st Century
## Proposed FY 2000 Budget

<table>
<thead>
<tr>
<th>Agency</th>
<th>Fundamental Information Technology Research</th>
<th>Advanced Computing for Science, Engineering, and the Nation</th>
<th>Ethical, Legal, and Social Implications and Workforce Programs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOD</td>
<td>$100M</td>
<td>---</td>
<td>---</td>
<td>$100M</td>
</tr>
<tr>
<td>DOE</td>
<td>$  6M</td>
<td>$ 62M</td>
<td>$  2M</td>
<td>$ 70M</td>
</tr>
<tr>
<td>NASA</td>
<td>$ 18M</td>
<td>$ 19M</td>
<td>$  1M</td>
<td>$ 38M</td>
</tr>
<tr>
<td>NIH</td>
<td>$  2M</td>
<td>$  2M</td>
<td>$  2M</td>
<td>$  6M</td>
</tr>
<tr>
<td>NOAA</td>
<td>$  2M</td>
<td>$  4M</td>
<td>---</td>
<td>$  6M</td>
</tr>
<tr>
<td>NSF</td>
<td>$100M</td>
<td>$ 36M</td>
<td>$ 10M</td>
<td>$146M</td>
</tr>
<tr>
<td>Total</td>
<td>$228M</td>
<td>$123M</td>
<td>$ 15M</td>
<td>$366M</td>
</tr>
</tbody>
</table>