PRELIMINARY
PITAC FY00 Report to Congress on the Next Generation Internet (NGI) Initiative

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PITAC NGI Subcommittee

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Congressional Charge to the PITAC

- The Next Generation Internet Research Act (10/98), requires PITAC to review the implementation of the Next Generation Internet (NGI) initiative and report annually on:

  - **Advanced Networking Research:** Progress in NGI-funded advanced networking research

  - **NGI Testbeds:** Progress in implementing high-performance network testbeds,

  - **NGI Applications:** Progress in developing high-performance network applications

  - **Geographic Reach:** Addressing geographic penalties faced by rural institutions

  - **Minority- and Small- College Reach:** Addressing access by historically black and Hispanic-serving institutions and colleges and universities with fewer than 5,000 students

  - **Technology Transfer:** Flow of NGI ideas to industry

  - **Agency Coordination:** Effectiveness of coordination among the NGI agencies

  - **IT Leadership:** The extent to which Federal research support will maintain U.S. IT leadership

NGI Networking Applications (1)

- The NGI agencies have developed and documented more than 90 NGI applications

- More NGI applications are being developed without explicit NGI funding

  - At universities — through their access to NGI testbeds

  - Jointly by universities and industry

NGI Networking Applications (2)

The 90+ documented NGI applications organized according to the categories in the NGI Implementation Plan (many applications belong to more than one category):

Applications Technologies		Disciplinary Applications	
Collaboration Technologies	32	Basic Science	37
Digital Libraries	6	Crisis Management	1
Distributed Computing	6	Education	13
Remote Operations	17	Environment	15
Security and Privacy	4	Federal Information Services	4
		Health Care	28
		Manufacturing	9

NGI's Advanced Networking Research (1)

- NGI agencies have a strong, balanced collection of networking research projects that address most key topics:
  - Network growth engineering
    - Network modeling
    - Monitoring, control, analysis, and display
      - Adaptive network management
      - Bandwidth and traffic management
      - Middleware for visualization applications
      - Monitoring and analysis of IP packet flow and performance
      - Resource management
      - Scheduling
      - Test and measurement tools
      - Web performance
    - Integration
      - Application to network interfaces
      - Protocols and standards
    - Data delivery
      - Group communications
      - Hybrid land-based, wireless, and satellite networks
      - Multicast
      - Multimedia networking

NGI's Advanced Networking Research (2)

- Network growth engineering (continued)
  - Managing lead user infrastructure
    - Networks for data intensive applications
    - Optimizing distributed application performance
    - Smart environments

- End-to-end quality of service
    - High performance routing and switching
    - Managing denial of service
    - Managing quality of service in hybrid land-based, wireless, and satellite networks
    - Multi-protocol label switching
    - Performance trade-offs
    - Reservation of service
    - Testbeds (in cooperation with Internet2 and industry)

- Network security
  - Standards such as PKI
  - Testbeds

- New technologies
  - Hybrid land-based, wireless, and satellite networks
  - Optical networking technologies
  - Ultra high bandwidth on demand

NGI Testbeds

- ## The NGI program has established two testbeds :

  - ### The 100x NGI testbed connects more than 150 sites (goal was 100)

  - ### The 1,000x Supernet testbed will connect 15 sites (goal was 10)

- ## The 100x testbed includes:

  - ### Federal NGI networks

    — NSF's vBNS

    — DOE's ESnet

    — NASA's NREN

    — DoD's DREN

  - ### The academic sector's (Internet2) Abilene (Qwest, Nortel, Cisco, and the University of Indiana) network

Additional NGI Testbeds (1)

- NASA
  - NGIX-West — OC-3/OC-12 ATM and planned OC-48 packet over SONET connectivity point with performance measurement capabilities
  - Multicast Internet eXchange (MIX) — Test and deploy protocols that scale
  - NREN Multicast — Native multicast data distribution over wide area networks
  - NREN OC-48 — 2+ Gbps aggregate flow among three endpoints
  - CEOS/GOIN Earth Science International Demonstrations

Additional NGI Testbeds (2)

- ## DOE
  - ### EMERGE — ESnet/MREN Regional Grid Experimental testbed
    - Authentication, collaboratories, e-commerce, Globus, health sciences, multicast, QoS, remote instruments, scheduling, security, standardized tool sets, visualization, weather
    - 100 Mbps end-to-end connectivity to five universities, four DOE laboratories, and STAR TAP

- ## Multi-agency Qbone
  - ### DOE — QUALIT architecture for IP differentiated services
  - ### NASA
    - QoS mechanisms, interoperability, testing, and applications prototyping
    - NGIX-West connects multiple university networks nationwide
  - ### NSF's vBNS backbone

Most Significant Agency Accomplishments

- DARPA
  - Optical networking
  - Applications on the 1,000x Supernet testbed
- NSF
  - 100x testbed
  - Broad spectrum of applications under development
- DOE — Collaboratory technologies and tools
  - Examples are China Clipper tools and Combustion Corridors
- NASA — NGIX-West
- NIST — Collaboration with manufacturers for standards
- NIH/NLM
  - Health care applications
  - Community awareness of NGI's potential usefulness

PITAC Assessment of the NGI (1)

- NGI agencies responded to FY99 PITAC recommendations:

  - Measure network performance at NGI sites
    — NLANR is implementing standardized measurement platforms for throughput, latency, and jitter at 97 NGI sites
    — Measuring throughput on the NGI backbone
    — Developing automated standard formats for reporting performance data
    — Web100 work

  - Increase emphasis on end-to-end applications
    — *Bridging the Gap* workshop focused networking research on app needs

  - Demonstrate Gbps (Gigabits or 1,000 bits per second) applications
    — SC99 HDTV demonstration of 2.4 Gbps throughput, 54.7 TB (Terabytes or trillions of 8-bit bytes) of data transferred

PITAC Assessment of the NGI (2)

- The NGI program is also responding to the recommendations for R&D in Scalable Information Infrastructure that were made in the PITAC February 1999 report "Information Technology Research: Investing in Our Future"
  - Collect and analyze performance data
    - NGI performance measurement program
  - Model and simulate network behavior
    - DARPA and NSF research programs
  - Conduct R&D in optical, wireless, and wired technologies
    - DARPA Supernet program
  - Conduct R&D on scaling the Internet
    - DARPA and NSF research programs

PITAC's NGI Recommendations to Congress (1)

- Fund the NGI agencies at their full Presidential requests in FY01 and FY02
  - The research community needs stable multi-year funding in order to fully realize their potential contributions to advanced networking

- Complete the NGI program according to the plans set forth in the FY98 NGI Implementation Plan as updated in:
  - NGI planning documents
  - Agency NGI solicitations
  - HPCC/CIC/IT R&D Supplements to the President's Budget (Blue Books)
  - HPCC/CIC/IT R&D Implementation Plans

PITAC's NGI Recommendations to Congress (2)

- As stated in our 1999 NGI review,
  PITAC recommends that Congress consider funding a new program in which NGI research institutions act as aggregators and mentors for nearby smaller or disadvantaged institutions.

- Since this would be primarily infrastructure, not networking research, it should not be part of the NGI or IT R&D programs.

PITAC's NGI Recommendations to NGI Agencies

- It's the apps!!!
  Encourage, cajole, force,… focus on apps.
  That use   high-bandwidth,
              low-latency,
              QoS,
              security,…

- Apps need end-to-end and ubiquitous NGI
  - Measure end-to-end
  - Fix end-to-end problems

- Continue great progress on networking research

Internet Security/Dependability

- DOS attacks on commercial sites recently.

- What can USG do to improve the situation?

- Is enough research underway to improve the situation?

- Does PITAC have any recommendations in this area?