

Internet2 Status

Strategy Discussion
2/6/2001



Tomorrow's Internet

- Billions of users and devices
- Convergence of today's applications with multimedia (telephony, video-conference, HDTV)
- Interconnect personal computers, servers, and imbedded computers
- New technologies enable unanticipated applications (and create new challenges)



Today's Internet Doesn't

- Provide reliable end-to-end performance
- Encourage cooperation on new capabilities
- Allow testing of new technologies
- Support development of revolutionary applications



Why Internet2?

- The Internet was not designed for:
 - Millions of users
 - Congestion
 - Multimedia
 - Real time interaction
- But, only the Internet can:
 - Accommodate explosive growth
 - Enable convergence of information work, mass media, and human collaboration
- Internet2 is focused on the Internet's potential for our future



What Is Internet2?

- A project of the university community working with our corporate colleagues and government to close the gap between the potential and reality of the Internet



Why University Leadership?

- The Internet came from the higher research university community
 - Stanford -- the Internet protocols
 - NSFNet -- the scaled-up Internet
 - CERN -- The WWW protocols
 - University of Illinois -- The Web browser
- Research universities require an advanced Internet and have demonstrated they can develop it

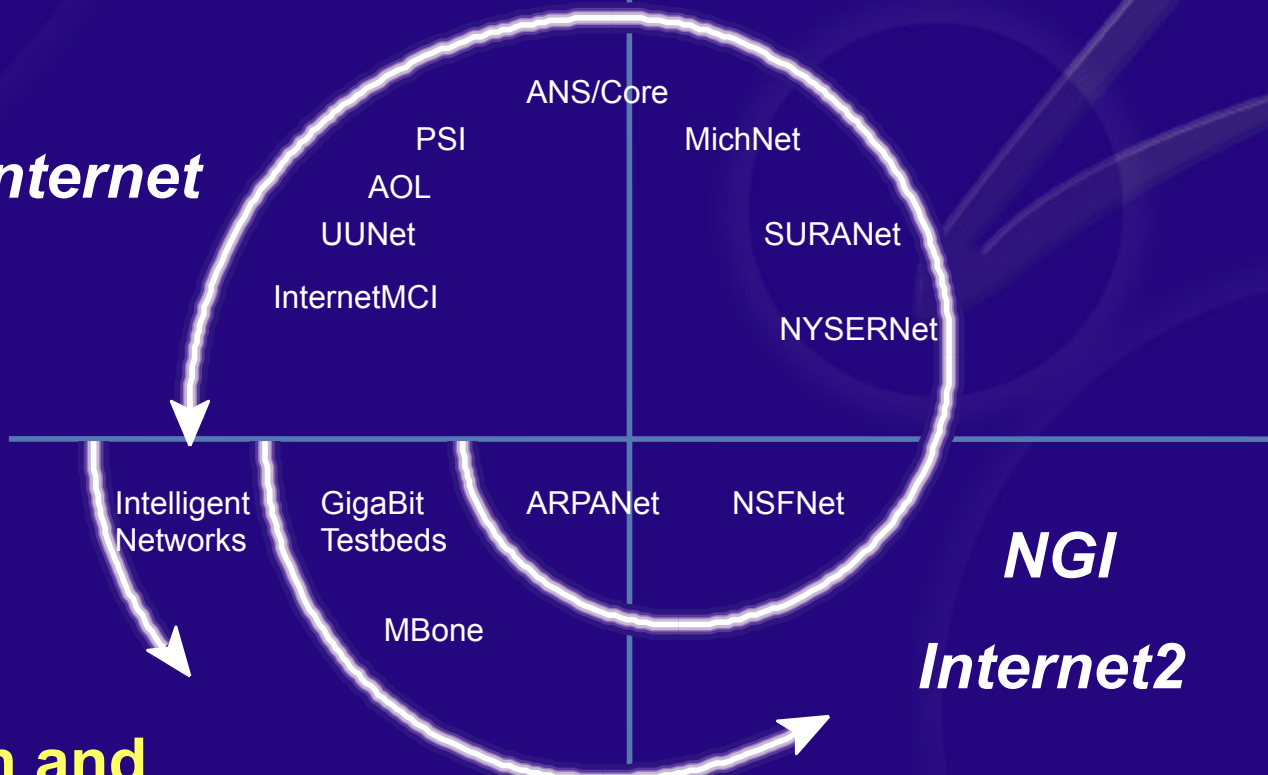


Internet Development Spiral

Commercialization

Privatization

Today's Internet



NGI

Internet2

Partnerships

Research and Development



Internet2 Mission

- **Develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet.**



Internet2 Goals

- Enable new generation of applications
- Re-create leading edge R&E network capability
- Transfer technology and experience to the global production Internet



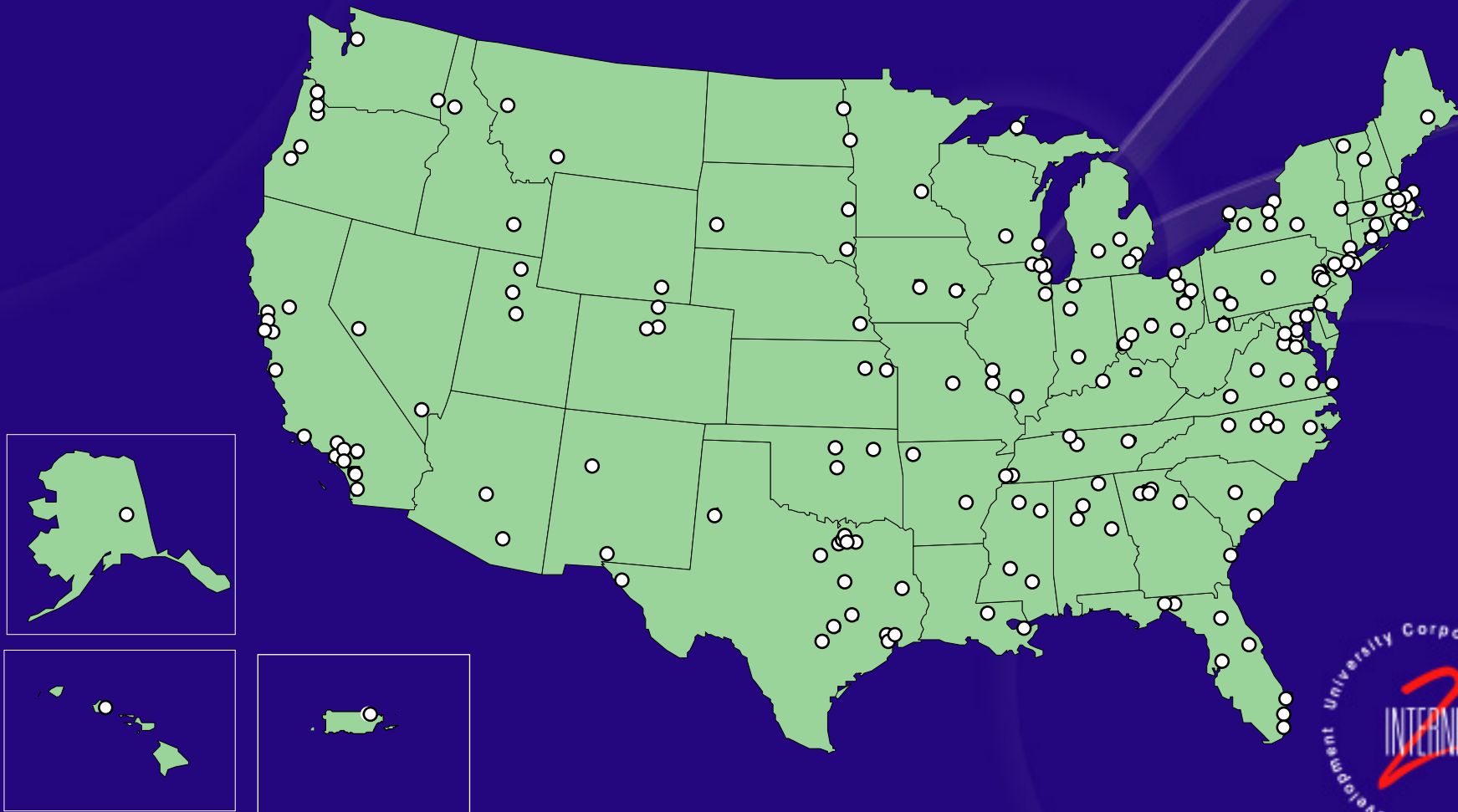
Organization: Membership

- Regular members: >180 U.S. research universities
- Corporate members: >70 companies
- Affiliate members: >30 non-profits supporting Internet2



Internet2 Universities

185 Universities as of February 2001



Requirements for Regular Membership

- Campus Infrastructure -- more than 100 million bit/second network
- Connectivity to national Internet2 backbone -- 155 million bit/second or greater
- Share Internet2 backbone expense
- Support for application development and common software
- \$1-2 million/year typical expenditure



Organization: Funding & support

- University & large corporate member dues \$25,000/year = ~\$6,000,000
- Affiliate & small corporate member dues \$10,000/year = ~\$500,000
- Participant cost sharing for projects (Abilene) = ~\$12,000,000
- Corporate in kind contributions = ~\$150,000,000

Enabling advanced applications...



Promoting Advanced Applications Development

○ Collaboration

- Interactive video
- Remote instrument access
- Data mining and visualization

○ Access to rich media

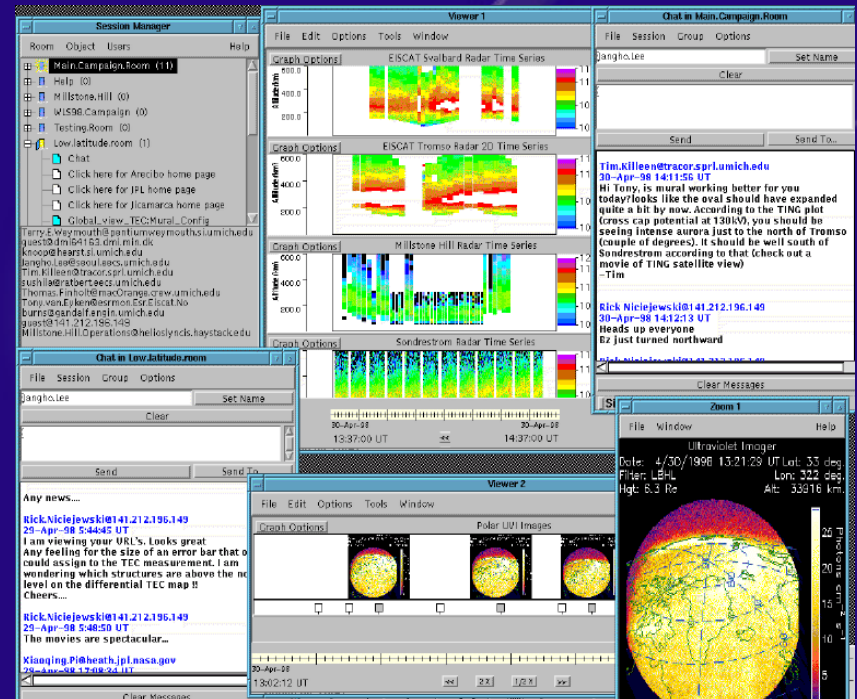
- Internet2 Digital Video Initiative
- Peer to peer applications
- Digital libraries

○ Supporting the large scale computing community



Collaborations

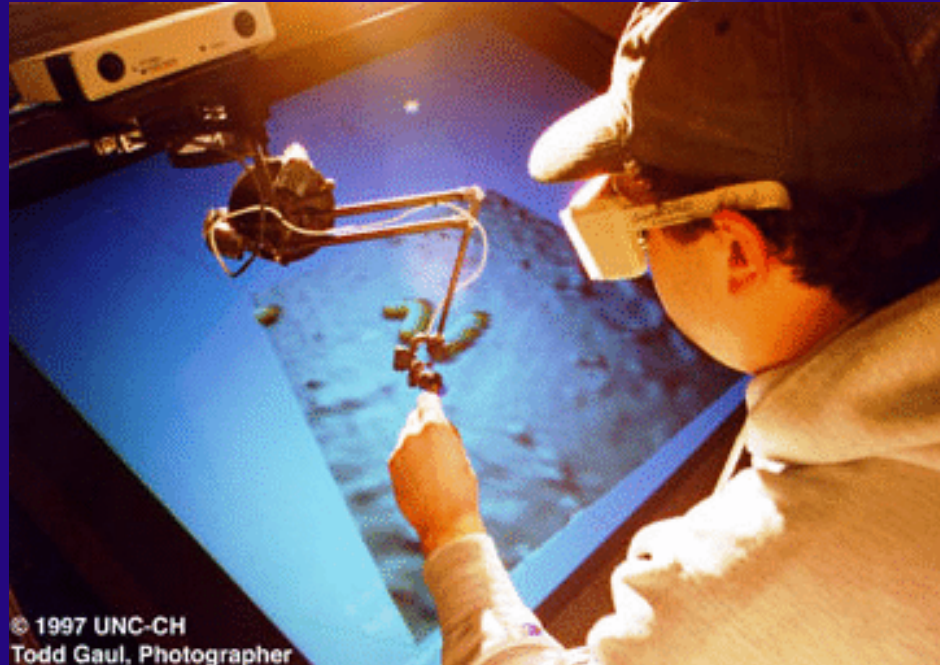
- Link instruments, data sources, researchers and students



Virtual Laboratories

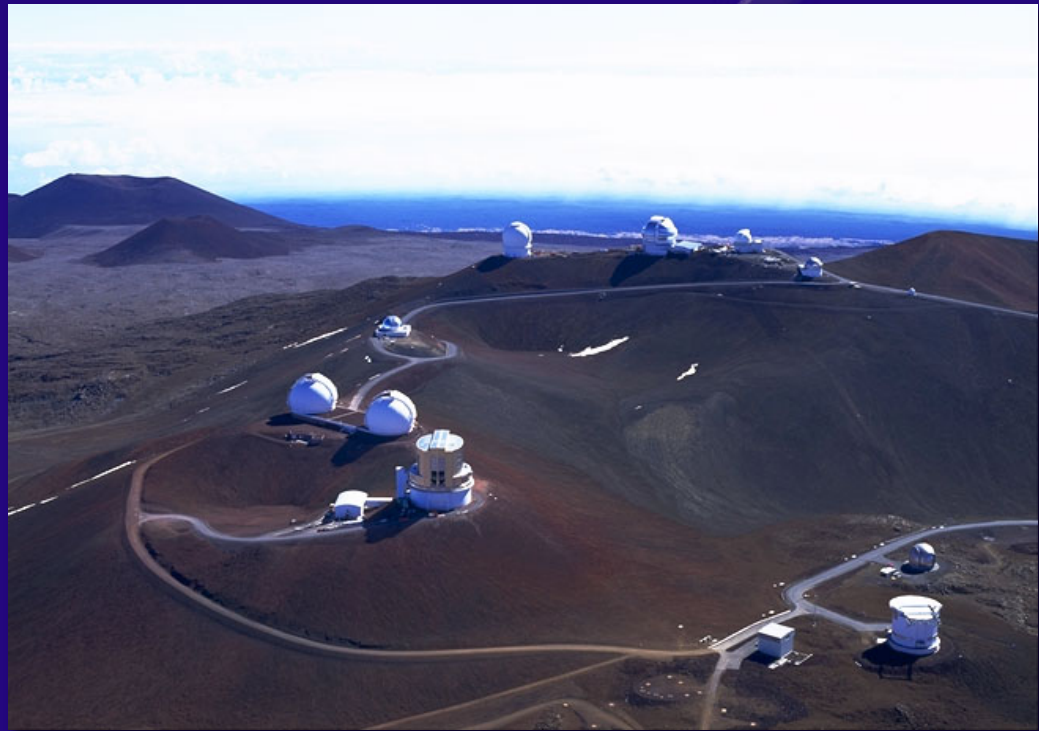
- Real-time access to remote instruments
- University of North Carolina, Chapel Hill

*Distributed
nanoManipulator*



Virtual Laboratories

- Mauna Kea Observatories
- AURA
- University of Hawaii



Teleimmersion

- **Telecubicle -- The distributed virtual office**
 - **Work led by Advanced Network & Services**
 - Brown University
 - Naval Postgraduate School
 - University of North Carolina Chapel Hill
 - University of Pennsylvania
- **Using Inperceptible Light and VR CAVE technologies**



The first generation telecubicle



Middleware

- A layer of software between the network and the applications
 - Authentication
 - Identification
 - Authorization
 - Directories
 - Security

Internet2 Middleware Initiative

○ Internet2 community has unique needs and capabilities

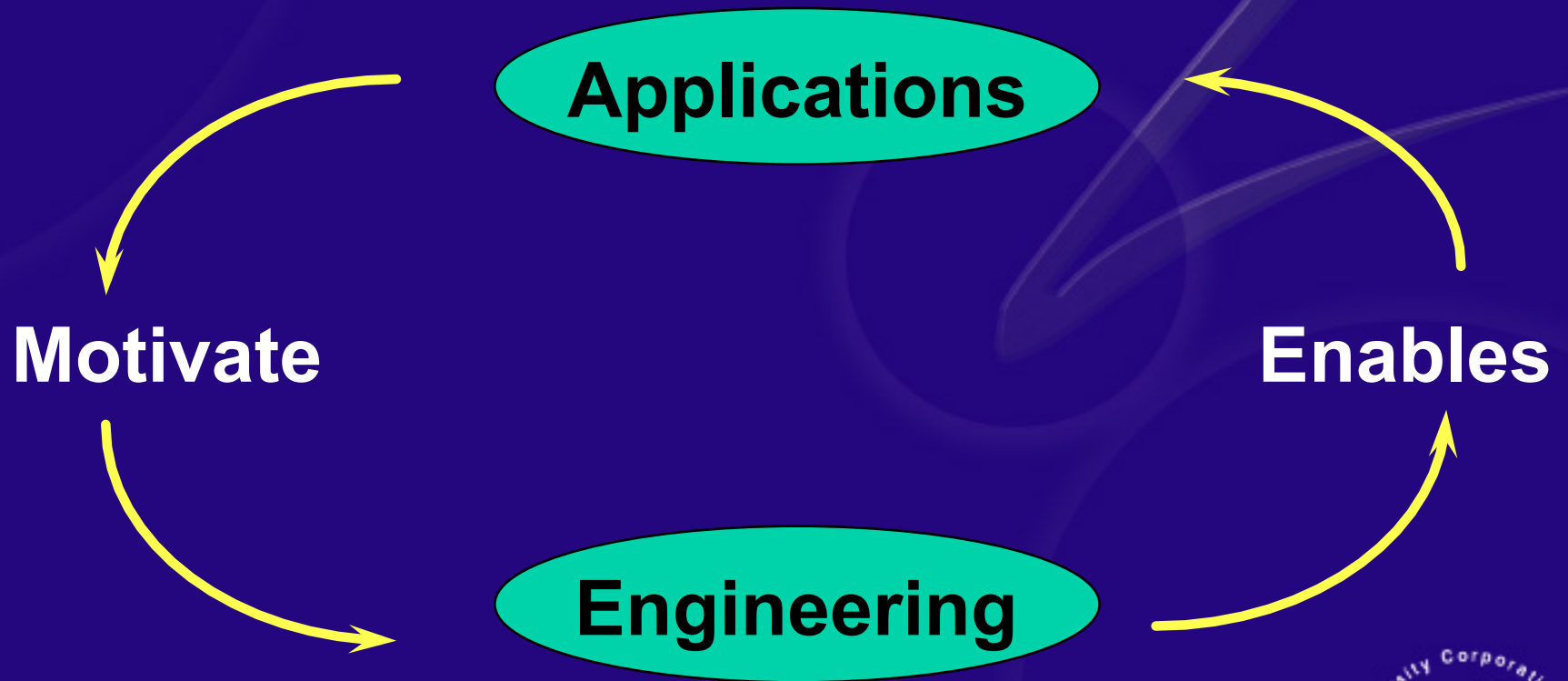
- Middleware Architecture Committee for Education
- Early Harvest and Early Adopters
- Internet2 PKI Labs
- Shibboleth (authentication)
- Computational middleware (Beta Grid)
- Medical middleware
- Directories



Re-creating leading edge networking capabilities...



Applications and Engineering



Engineering

- **Quality of Service: QBone**
 - <http://www.internet2.edu/qbone/>
- **Scalable IP Multicast**
 - <http://www.internet2.edu/multicast/>
- **IPv6**
- **Network Security**
- **Network Management**
- **Measurement**

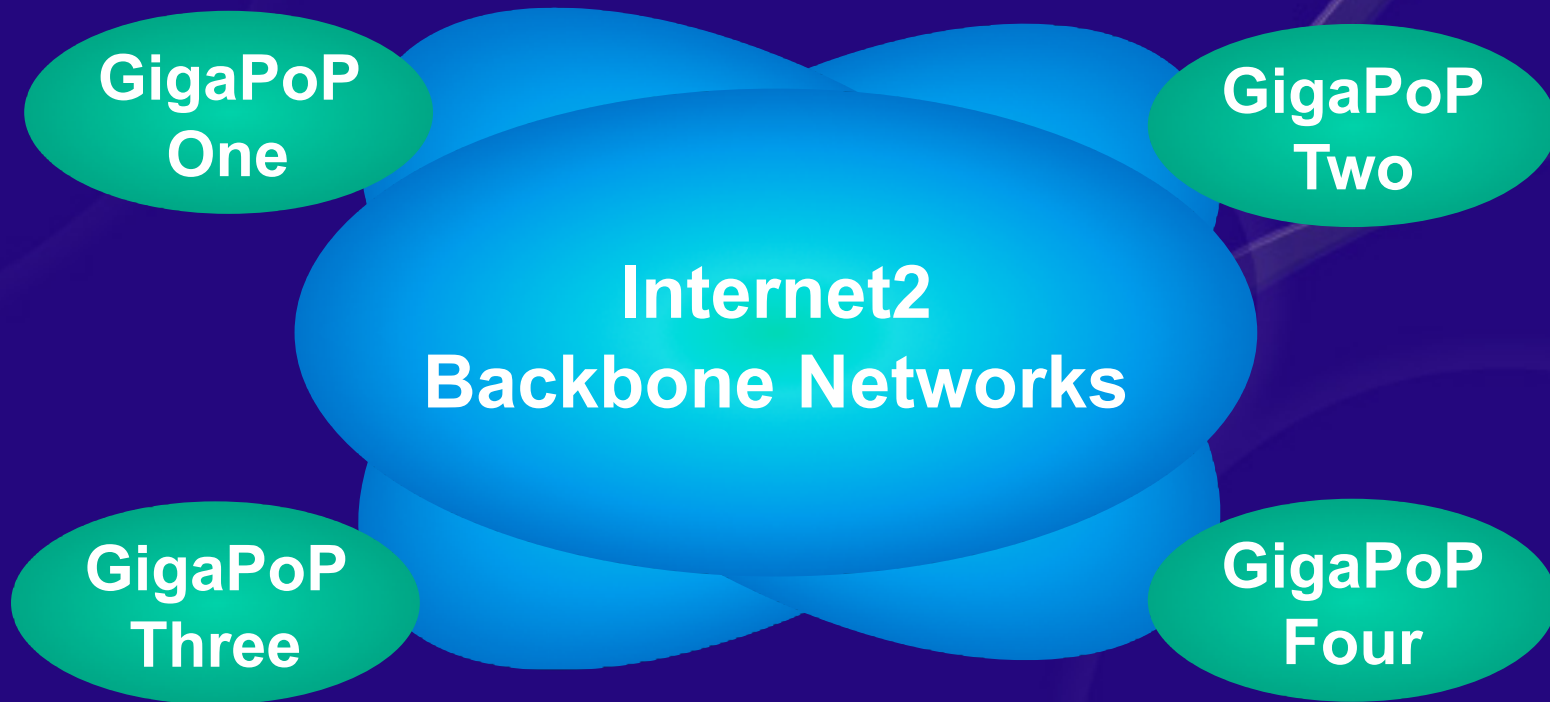


Internet2 Network Infrastructure

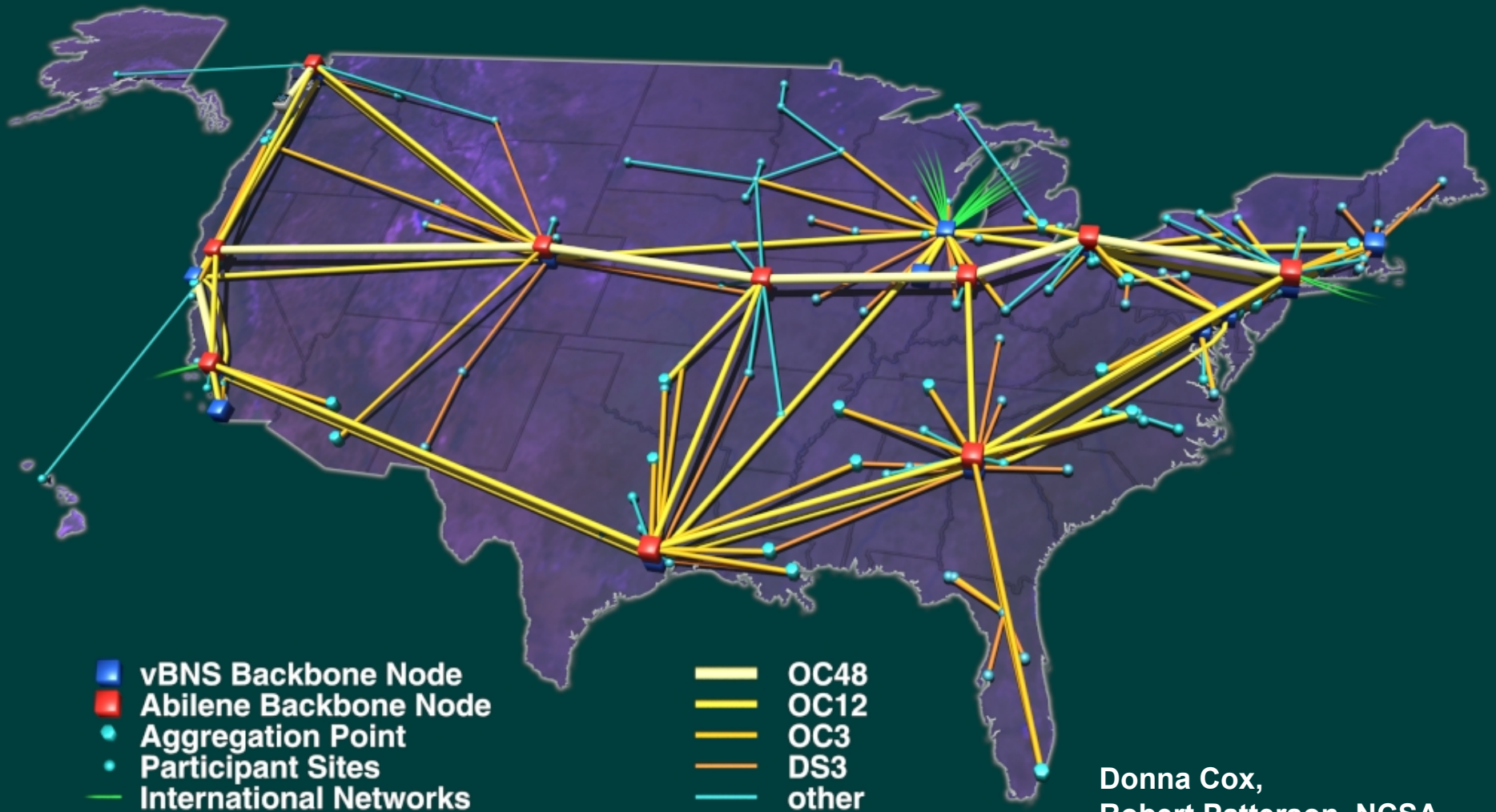
- Backbones operate at 2.4 Gbps (OC48) capacity today
- GigaPoPs provide regional high-performance aggregation points
- Local campus networks provide 100 Mbps to the desktop
- >40 connections, >180 participants



Internet2 Network Architecture

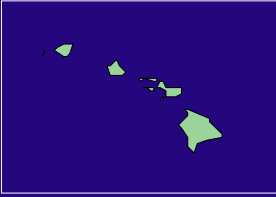
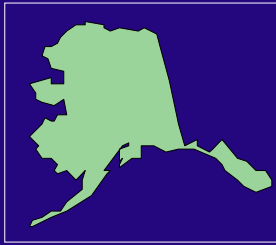


Internet2 Backbone Networks



Donna Cox,
Robert Patterson, NCSA

Abilene Network



Internet2 Working Groups

- IPv6
- Measurement
- Multicast
- Network Management
- Network Storage
- Quality of Service
- Routing
- Security
- Topology



Internet2 and the Next Generation Internet Initiative

Internet2 University-led

Developing education and research driven applications

Building out campus networks, gigapops and inter-gigapop infrastructure

Interconnecting and interoperating to provide advanced networking capabilities needed to support advanced research and education applications

NGI Federal agency-led

Agency mission-driven and general purpose applications

Funding research testbeds and agency research networks



**Transferring technology and
experience...**



Internet2 Corporate Partners

- 3Com
- Advanced Network & Services
- Alcatel
- Ameritech
- AT&T
- Cisco Systems
- IBM
- ITC^Deltacom
- Lucent Technologies
- Marconi
- WorldCom
- Microsoft
- Newbridge Networks
- Netcom Systems
- Nortel Networks
- Qwest Communications
- SBC Communications
- WCI Cable



Internet2 Corporate Sponsors

- Bell South
- Compaq
- Ericsson (formerly Torrent Networking Technologies)
- Litton Network Access Systems
- Novell
- SBC Technology Resources
- StorageTek



Internet2 Corporate Members

- Alcatel Telecom
- Apple Computer
- AppliedTheory Communications
- Bell Atlantic
- British Telecom
- Deutsche Telekom
- Fujitsu Laboratories of America
- GTE Internetworking
- Hitachi
- IXC Communications
- KDD
- Motorola
- Nexabit Networks
- Nokia Research Center
- NTT Multimedia
- Pacific Bell
- Project OXYGEN
- RR Donnelley
- Siemens
- Sprint
- Sun Microsystems
- Sylvan Learning
- Tachyon
- Telcordia Technologies (formerly Bellcore)
- Telebeam
- Teleglobe
- TransMedia Communications
- VTEL
- Williams Communications Grp.
- Worldport Communications Inc.



Additional Participation

- Over 70 Internet2 Corporate Members
- Over 30 Affiliate Members
- Over 30 International Partners



International Activities

- Ensure global interoperability of advanced networking technologies and applications
- Enable collaborations between US researchers at Internet2 institutions and their non-US counterparts



Internet2 International Collaborations

- Building peer to peer relationships
- Looking for similar goals/objectives and similar constituencies
- Mechanism: Memoranda of Understanding
- Implementation: Peering and Connection Agreements
- Collaboration: Projects and Applications



Internet2 International Partners

- AAIREP (Australia)
- APAN (Asia-Pacific)
- APAN-KR (Korea)
- ARNES (Slovenia)
- BELNET (Belgium)
- CANARIE (Canada)
- CERNet, CSTnet, NSFCnet (China)
- CESnet (Czech Republic)
- CUDI (Mexico)
- DANTE (Europe)
- DFN-Verein (Germany)
- Fundacion Internet 2 Argentina (Argentina)
- GIP RENATER (France)
- GRNET (Greece)
- HEAnet (Ireland)
- HUNGARNET (Hungary)
- INFN-GARR (Italy)
- Israel-IUCC (Israel)
- JAIRC (Japan)
- JISC/UKERNA (UK)
- NORDUnet (Nordic countries)
- POL-34 (Poland)
- RCCN (Portugal)
- RedIRIS (Spain)
- RESTENA (Luxembourg)
- REUNA (Chile)
- RPN2 (Brazil)
- SingAREN (Singapore)
- Stichting SURF (Netherlands)
- SWITCH (Switzerland)
- TAnet2 (Taiwan)
- TERENA (Europe)



New Initiatives

- **End to end performance**
 - Design Team working
 - Director search underway
- **Expanded Access & K-20**
 - Built on Sponsored Educational Group Participation in Abilene
 - Exploratory meetings scheduled



www.internet2.edu