



Internet2 Update for the 2nd eVLBI Workshop

T. Charles Yun
Program Manager
May 2003

Introduction

• A year ago to today...	5 min
• Internet2 Update	10 min
• Abilene	
• NLR, FiberCo	
• Things to do...	5 min
• Conclusion, Q&A	5 min
Total Time	~25 min

A year has gone by...

- e-VLBI meeting at Haystack Observatory, April 2002
- What does Internet2 have to offer for the astronomy community?
 - Access to advanced, high-performance network
 - Find parallels with work being done by other communities
 - Connections to researchers & peers around the world (BOF/Working Group)
 - Loaner hardware, expert advice, etc.
- Concluded my talk with a challenge:
 - Fill the pipes... we dare you...

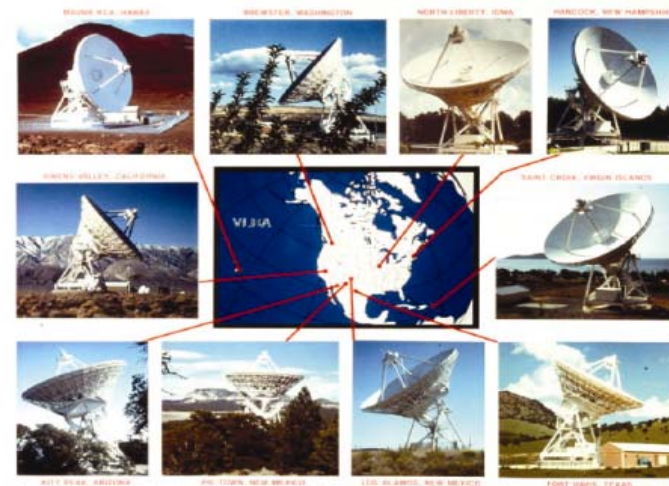
Where are we now?

- High speed tests of real time VLBI
- Beginning to see cooperation between different groups:
 - VLBI, HENP, participation in international network meetings
- Working group activity beginning to emerge
- Have not followed through on loaner equipment...
- VLBI is now part of the standard Internet2 Apps talk (see next slide)

- Filling the pipes?
 - You are rising to the challenge...
 - ...and we are a bit scared

The VLBI Slide...

- Electronic Very Long Baseline Interferometry
 - Multiple antennae from multiple physical locations transmit data to a central correlation facility
 - Previously recorded data to tape; goal is to send all data dynamically over Abilene
 - Data rates are projected at 1Gb/s per telescope
- Successfully tested between points (in the United States) at rates of 800 Mb/s



Interesting:
Successfully ran 788 Mbps sustained test between sites in U.S. Working on prototype experiment to test their ability to run data to Europe and Japan.

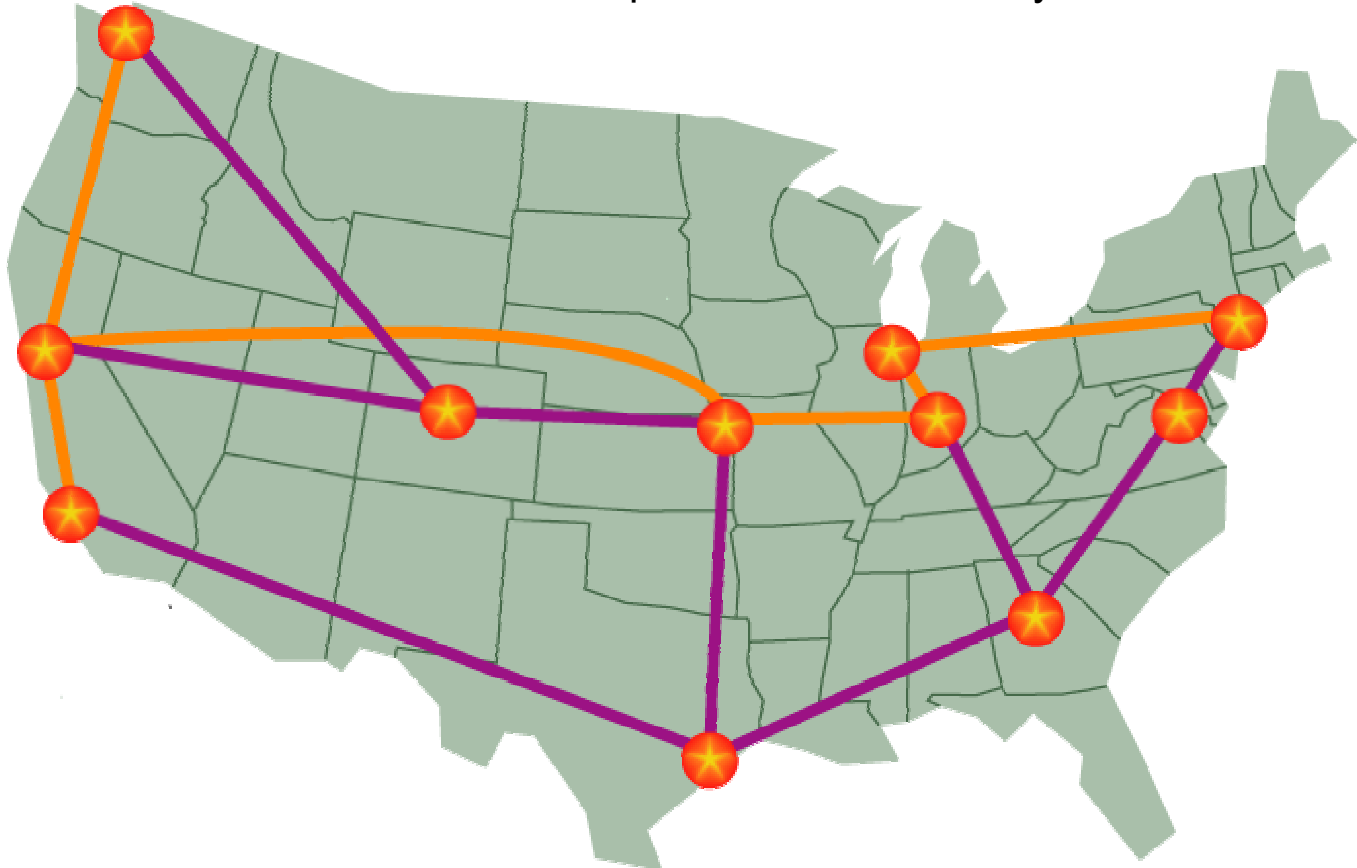
- A year ago to today... 5 min
 - Internet2 Update 10 min
 - > **Abilene**
 - NLR, FiberCo
 - Things to do... 5 min
 - Conclusion, Q&A 5 min
- Total Time ~25 min

Core features

- Higher ed's network
- IPv4+v6 common bearer service
- Bandwidth availability & utilization incentive
- Peering limited to national & int'l R&E nets
- Regional aggregation model
- "3-4 Nines" reliability
 - Advanced service deployment, 7x24 NOC
- Open measurement platform

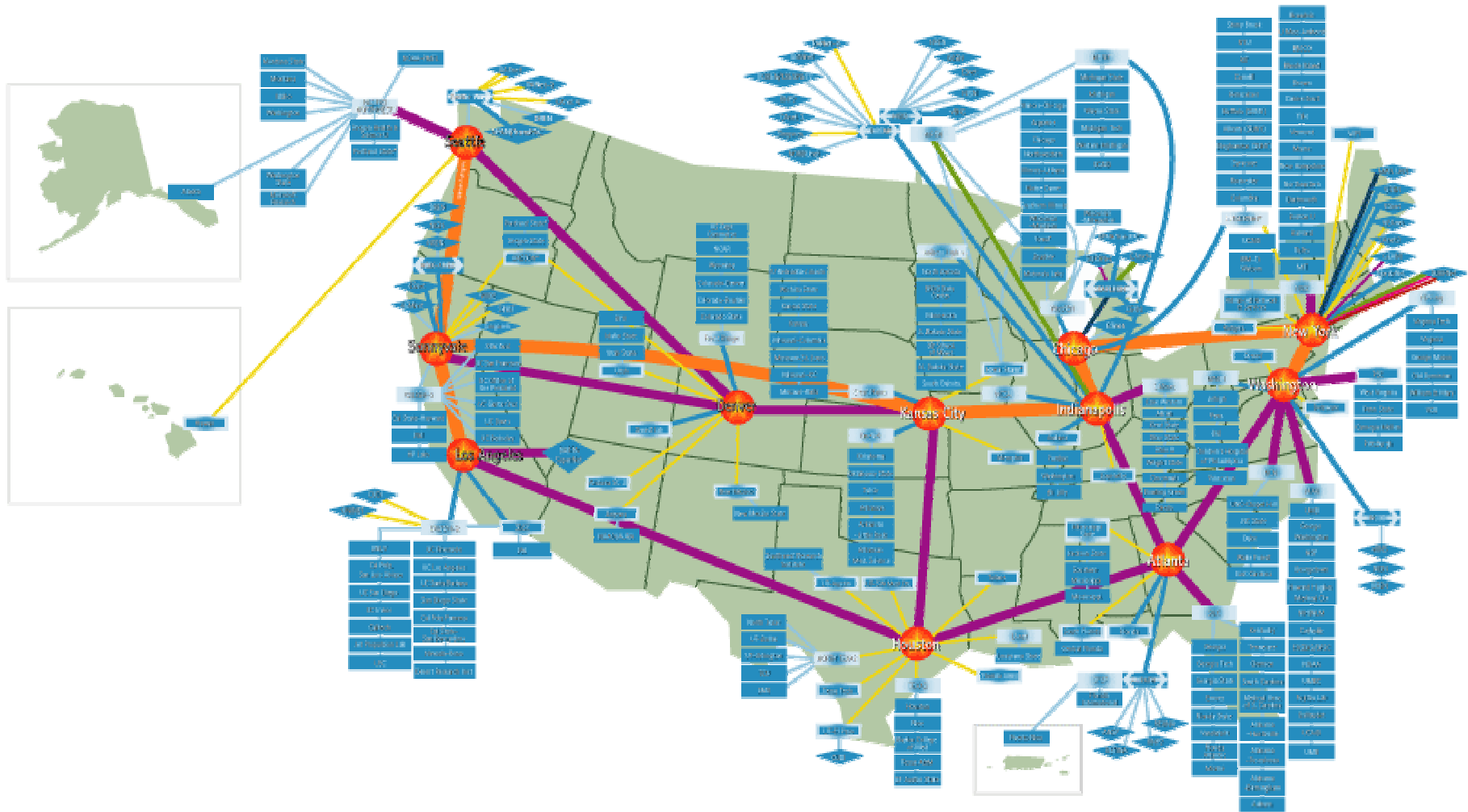
Backbone Capacity

Partners: Qwest, Cisco, Nortel, Juniper, Indiana University



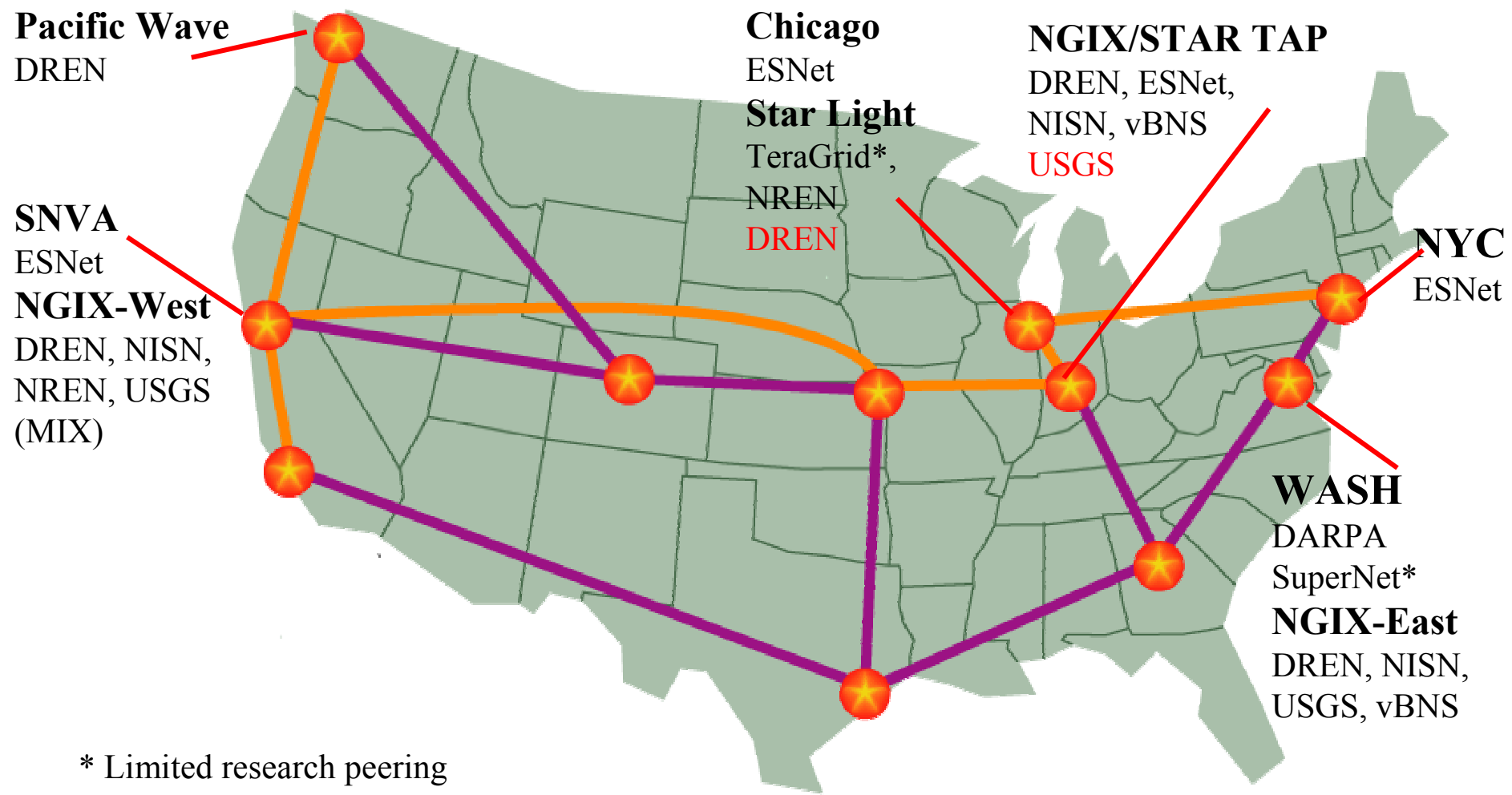
Today: OC48 (2.5Gbps) and OC192 (10Gbps) Packet over Sonet, multicast, IPv4 & IPv6, QOS (DiffServ)

Logical Network Map



Boomer 2002

Federal/Research Peering



International Peering

Pacific Wave

AARNET, APAN/TransPAC†, CA*net, TANET2

STAR TAP/Star Light

APAN/TransPAC†, CA*net, CERN, CERNET/CSTNET/NSFCNET, NAUKAnet, GEMnet, HARNET, KOREN/KREONET2, NORDUnet, SURFnet, SingAREN, TANET2

SNVA

GEMNET, SingAREN, WIDE(v6)

NYC

GEANT*, HEANET, NORDUnet, SINET, SURFnet

L.A.

UNINET

OC12

AMPATH

ANSP, REUNA2, RNP2, RETINA (REACCIUN-2)

San Diego (CALREN2)

CUDI

El Paso (UACJ-UT El Paso)

CUDI

*ARNES, ACONET, BELNET, CARNET, CERN, CESnet, CYNET, DFN, EENet, GARR, GRNET, HEANET, IUCC, JANET, LATNET, LITNET, NORDUNET, RENATER, RESTENA, SWITCH, HUNGARNET, GARR-B, POL-34, RCST, RedIRIS, SANET, SURFNET | † WIDE/JGN, IMnet, CERNet/CSTnet/NSFCNET, KOREN/KREONET2, SingAREN, TANET2, ThaiSARN

Abilene Upgrade- Fall 2003



Abilene Focus Areas

- Advanced, high-performance services
 - Multicast and Native IPv6
- Facilitating end-to-end performance
- Supporting network research – Abilene Observatory
- Experimenting with MPLS/VPN on backbone
- Supporting large MTUs
- Security

Advanced Services

- Multicast (SSM only)
 - Deployed on backbone
 - Problems persist at the edges of the network
 - Need to provide better debugging tools
 - Measurement infrastructure to include multicast
- IPv6
 - Fully deployed on all Abilene Routers
 - Native, dual stack service
- Multicast and IPv6 Workshops
 - Hands on sessions
 - Focus on debugging
 - <http://multicast/ipv6.internet2.edu/>

End to End Performance

- Bulk TCP flows
 - 2.3 Mbps (median)
 - 6.6 Mbps (90%)
 - 31 Mbps (99%)
- Support of piPEs architecture implementation
- Provide interactive access to measurement platform for network administrators as part of the Abilene Observatory

Abilene Observatory

- A program to provide enhanced support of network research over Abilene
- Two Components of the Observatory
 - Measurements and data collected by the NOC and Engineering Team – The Abilene Measurement Infrastructure (AMI)
 - Access to Router Nodes for other projects through collocation
- Access to network data archive:
 - One-way latency, Jitter, Loss, Reachability, Netflow, SNMP Data (NOC), Routing Data, both IS-IS and BGP, E2E Performance Beacons
 - Open to recommendations for additional data types

MPLS Experiments

- Experiment is limited in duration lasting only a few months
- Goals (basically solving a routing issue)
 - Use Abilene to emulate a circuit
 - PSC/Chicago use similar IP routing when lambda is in place
 - Opportunity to experiment and measure
- Experiment and Testing
 - IP solution with change of routing
 - Opportunity for perform measurements under 3 scenarios:
 - Basic IP routing; MPLS solution; Comparison with lambda solution when installed

Large MTUs

- Matt Mathis formula: Throughput is directly proportional to MTU
 - To achieve large flows, support large MTUs
 - Relatively easy to support on backbones/regional networks; Difficult at the edges of the network
 - Fairly easy to support 9K MTUs, but larger MTUs are almost impossible at this time
- Very Large MTUs on Abilene
 - May be able to support large MTUs on SONET backbone links
 - Some test equipment available, but none with “stacks” (only have packet blasters that use SONET interfaces)
 - Interest in gaining access to such devices

Security at the Backbone

- Writing a security document
 - Preparations for security issues
 - Incidence response
 - Incidence reporting
- Relationships to REN-ISAC
 - Information Sharing Analysis Center
 - Define Abilene/NOC/REN-ISAC relationships
 - Policy and procedures concerning securities issues
- Especially important to define this on an network providing advanced services

- A year ago to today... 5 min
 - Internet2 Update 10 min
 - Abilene
 - > **NLR, FiberCo**
 - Things to do... 5 min
 - Conclusion, Q&A 5 min
- Total Time ~25 min

NLR, FiberCo

- National Lambda Rail
 - Sparse National Backbone
 - Internet2 is a founding member
- FiberCo
 - Compliment to NLR
 - Purpose is to allow regional networks the ability to access fiber on reasonable terms
 - Organization to hire/hold/assign light paths
- Both are in early stages and developing quickly
 - Rate of change makes both difficult to describe

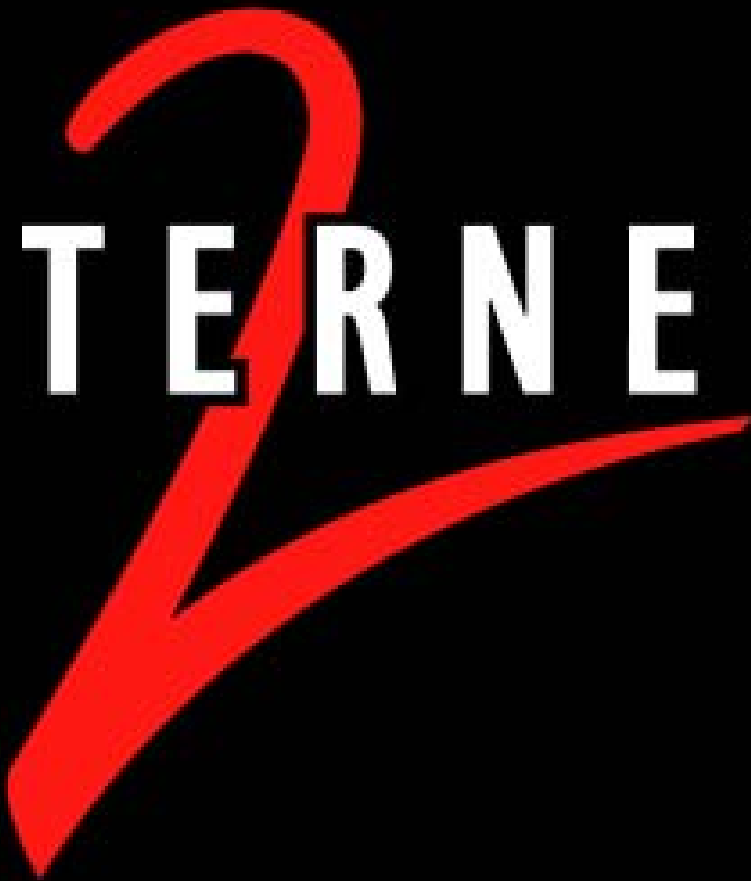
- Fundamental objectives:
 - Provide an enabling hybrid experimental infrastructure for new forms and methods for research and the development of new Internet technologies, protocols and services
 - Support experiments at the networking and applications levels
 - Enhance ability for international, collaborative projects and efforts
- Legally, a “Not-For-Profit” organization
 - This is the same way thatUCAID (Internet2) is organized
- Partnerships
 - Cisco, Level 3 Communications

Things to do...

- Identify observatories/antennae and connectivity
 - List the most important
 - Identify current network connectivity, network paths
 - Results from tests Europe-Asia-United States tests
 - Tests to South America (?)
- Test connections
 - Run test flows between observatories
 - Identify path characteristics
- Experiment
 - Begin regular communication between VLBI and networking groups
 - Extraction and decomposition, or can we turn this into a GRID project?

Contact Info, Q&A

- More information:
 - <http://www.internet2.edu/>
 - <http://abilene.internet2.edu/>
- Contact Info:
 - T. Charles Yun
 - tcyun@internet2.edu
- Questions?



INTERNET®

www.internet2.edu