



The Abilene Observatory and Measurement Opportunities

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Outline

- History and Motivation
- What is the Observatory?
 - Collocation Projects
 - Internet2 and NOC Measurements
 - Data Collections
- Future Directions for Abilene Observatory
- Observatories for other projects, for example HOPI
 - MAN LAN
 - HOPI
- Internet2 Research Facilities project
- References



Current Abilene Backbone



History and Motivation

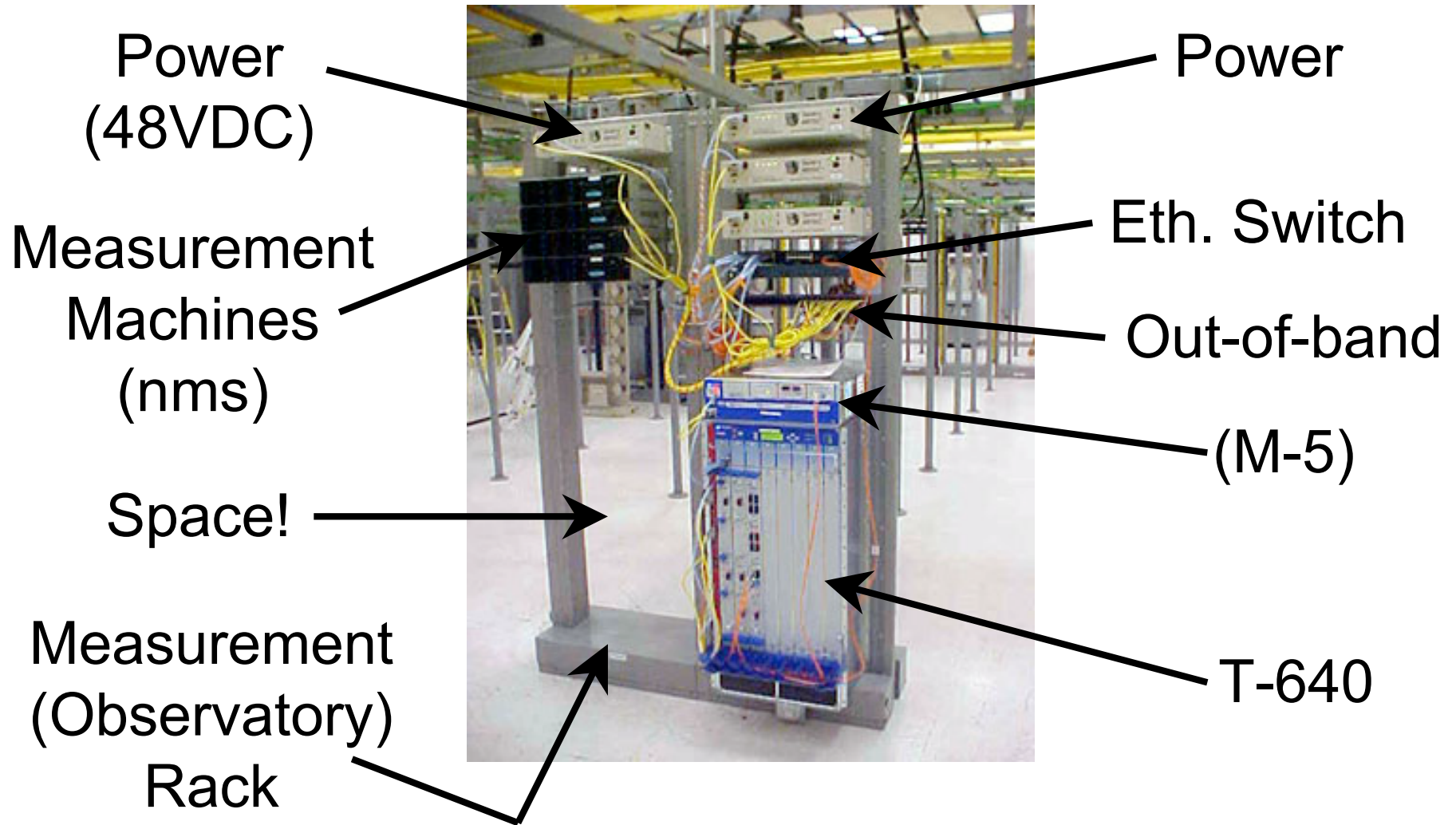
- Original Abilene racks included measurement devices
 - Included a single PC
 - Early OWAMP, surveyor measurements
 - Optical splitters at some locations
- Motivation was primarily operational
- Data collections
 - Collected and maintained by the NOC
 - How is the network performing?
 - Available to other network operators to understand network
 - It became apparent that the data was valuable for research purposes



History and Motivation

- An important decision was made during the last upgrade process (Juniper T-640 routers and OC-192c)
 - Two racks with one dedicated to measurement platform
 - Potential for research community to collocate equipment
- Created two components to the Observatory
 - Collocation - research groups are able to collocate equipment in the Abilene router nodes
 - Measurement - data is collected by the NOC, the Ohio ITEC, and Internet2, and made available to the research community

Abilene router node



■ Houston Router Node

- Network Measurement Servers (NMS)
 - NMS 1-4
 - NMS 5 in near future
- PlanetLab machines





Collocation Research Projects

- PlanetLab – Nodes installed in all Abilene Router Nodes
 - PlanetLab is a global overlay network for developing and accessing new network services
 - Goal is deploy 1000 nodes in a variety of networks
 - Designed to support both short-term experiments and long-running services
 - Larry Peterson, Princeton University is Research Lead
 - <http://www.planet-lab.org>
 - Potential new direction using MPLS L2VPNs

Collocation Projects

- The AMP Project – Active Measurement Platform, Deployed in all Abilene Router Nodes
 - More than 150 nodes deployed worldwide
 - Measurements include path, round-trip-time, packet loss and on demand throughput tests
 - Project of NLANR/MNA
 - Tony McGregor NLANR/MNA, Waikato University is Research Lead
 - <http://amp.nlanr.net>



Collocation Projects

- **The PMA Project – Passive Measurement and Analysis, Deployed at Abilene Indianapolis Router Node**
 - Analysis of header traces from over 20 sites, including OC-192 circuits in Abilene
 - Header traces of all packets in and out of the Indianapolis Abilene router – A router clamp
 - Joerg Micheel, NLANR/MNA, San Diego Supercomputer Center, UCSD, is research lead
 - <http://pma.nlanr.net>
 - <http://pma.nlanr.net/Sites/ipls-2004/>

Collocation Projects

- New project this summer - TCP flow servers at three locations across Abilene
 - Understand effectiveness of TCP flow servers across a network
 - Examining the performance problem at Layer 4
 - Martin Swaney, University of Delaware
 - References in near future



Measurement Capabilities

- One way latency, jitter, loss - OWAMP
 - IPv4 and IPv6
- Regular TCP/UDP throughput tests – ~1 Gbps
 - IPv4 and IPv6; On-demand available (see “pipes”)
- SNMP (NOC)
 - Octets, packets, errors; collected frequently
- “Netflow” (ITEC Ohio)
 - Addresses anonymized by 0-ing the low order 11 bits
 - Considering a change - what would researchers like to see?
- Routing data
 - Both IGP and BGP - Measurement device participates in both
 - Japanese research techniques on routing research were implemented
- Syslog and regularly performed router commands

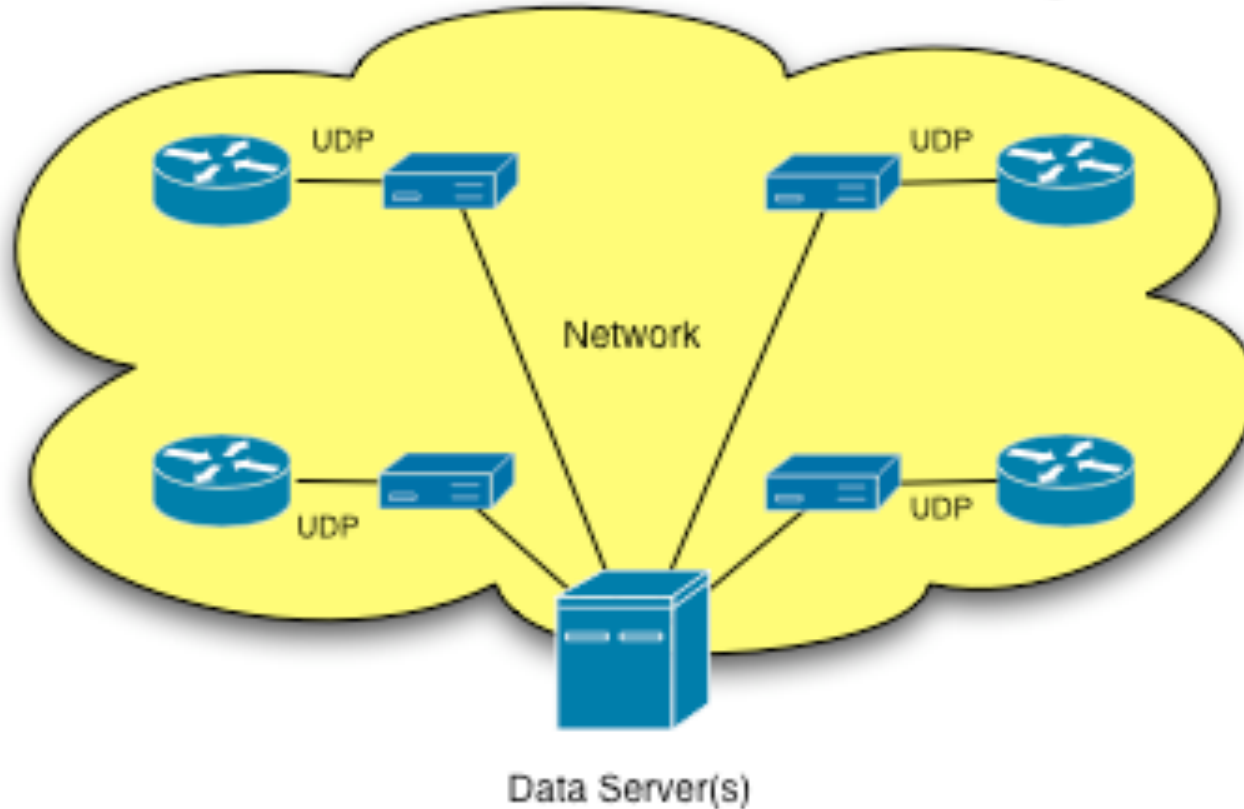
Databases – Date Types

- Data is collected locally and stored in a distributed databases
 - Example - Netflow
 - UDP collection by local NMS machines
 - TCP and UDP feeds to other data machines
 - NOC (IU) and Research (Ohio) servers

- Databases
 - Usage Data
 - Netflow Data
 - Routing Data
 - Latency Data
 - Throughput Data
 - Router Data
 - Syslog Data

Data Collection / Storage

Local Collection / Remote, Distributed Storage



Databases - Interface

- Variety of Interfaces to data
 - Simple web based for usage data
 - Rsync for netflow
 - Simple web based for routing data
 - SOAP interface for latency data
 - SOAP interface for throughput data
 - SOAP interface for Router data
 - Syslog data still under development



Examples of Research Projects

- Use of Data Collected by Abilene Network Measurement Servers
 - A complete list of projects is available from <http://abilene.internet2.edu/observatory>

■ Sizing Router Buffers

- A project to experiment with the size of buffers on several routers on the Abilene network
- The buffers are reduced using configuration commands and the effect on traffic queues is examined
- Nick McKeown is research lead
- <http://yuba.stanford.edu/~appenz/pubs/sigcomm-extended.pdf> and <http://yuba.stanford.edu/~appenz/pubs/SIGCOMM04.ppt>

■ Network Research Facilitation Project

- Distribution of Abilene routers no longer in use
- Will add at least one more router in near future

Future Directions

- **Abilene Observatory**
 - Research input on large, correlated, distributed databases?
 - Raw data or additional data sets
 - New data sets
 - Honey pot farms
 - Traffic matrix
 - Future research collocation projects?
- **Including other networks**
 - International, Federal, Regional, Campus?
- **Future infrastructures?**
 - Observatory like activities will be a requirement for other projects like MAN LAN and HOPI, and for the next generation network



MAN LAN Exchange Point

- Manhattan Landing in NYC - partnership with NYSERNet, Indiana University, IEEAF, and Internet2
- Provide a high performance exchange facility for research and education networks
- Located at 32 AoA in NYC - easy interconnection to many national and international carriers and other research and education networks
 - Same location as Abilene router node in NYC
- Peering model is open and bilateral
- Expect sixteen 10 Gig connections by the end of 2005
- Would like a measurement platform for MAN LAN

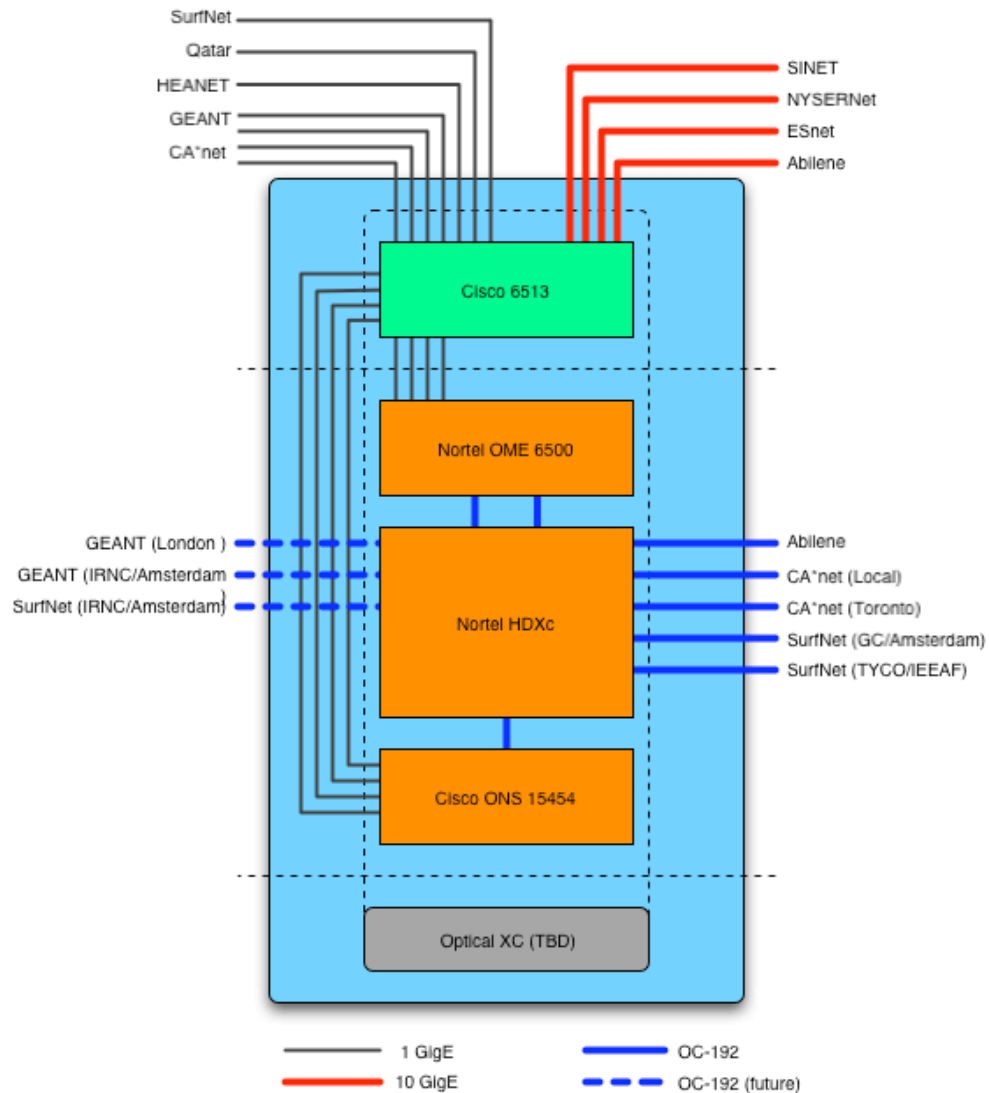


MAN LAN Facilities

- Layer 2 facilities - Ethernet switch with 1 GigE and 10 GigE interfaces
- Layer 1 facilities - SONET based optical equipment
 - Cisco 15454
 - Nortel OME 6500
 - Nortel HDXc
- Layer 0 facilities
 - Optical cross connect to facilitate changes



MAN LAN Configuration

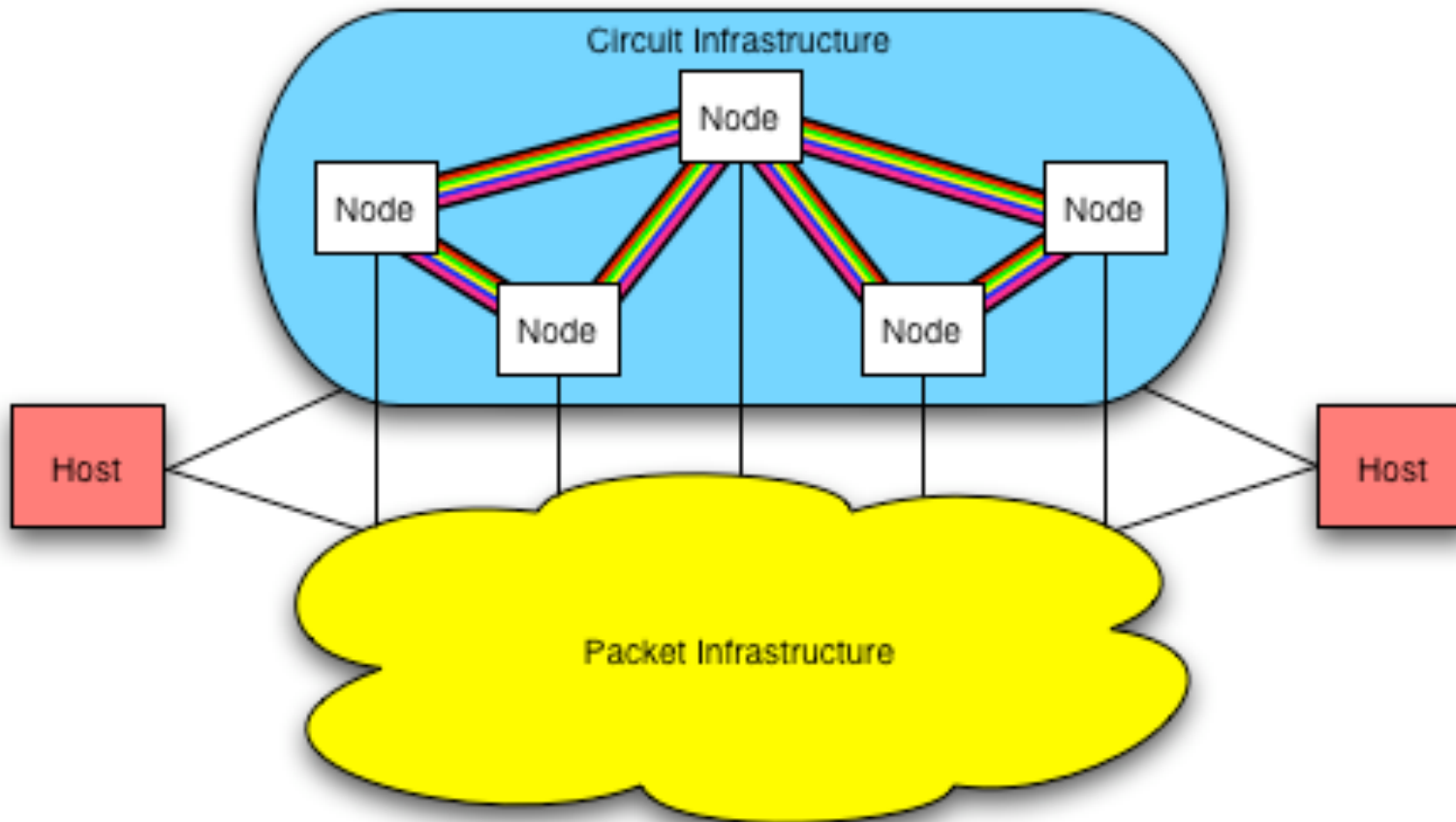




HOPI Project - Summary

- In the near future we will see a richer set of capabilities available to network designers and end users
 - Core IP packet switched networks
 - A set of optically switched waves available for dynamic provisioning
- Fundamental Question: How will the next generation architecture evolve?
- Examine a **hybrid** of shared IP packet switching and dynamically provisioned optical lambdas
- HOPI Project – Hybrid Optical and Packet Infrastructure
 - Have created a whitepaper – see <http://hopi.internet2.edu>
 - Immediate Goals
 - Implement testbed over the next year
 - Coordinate and experiment with other similar projects
 - Design Team, Corporate Advisory Team

HOPi General Problem

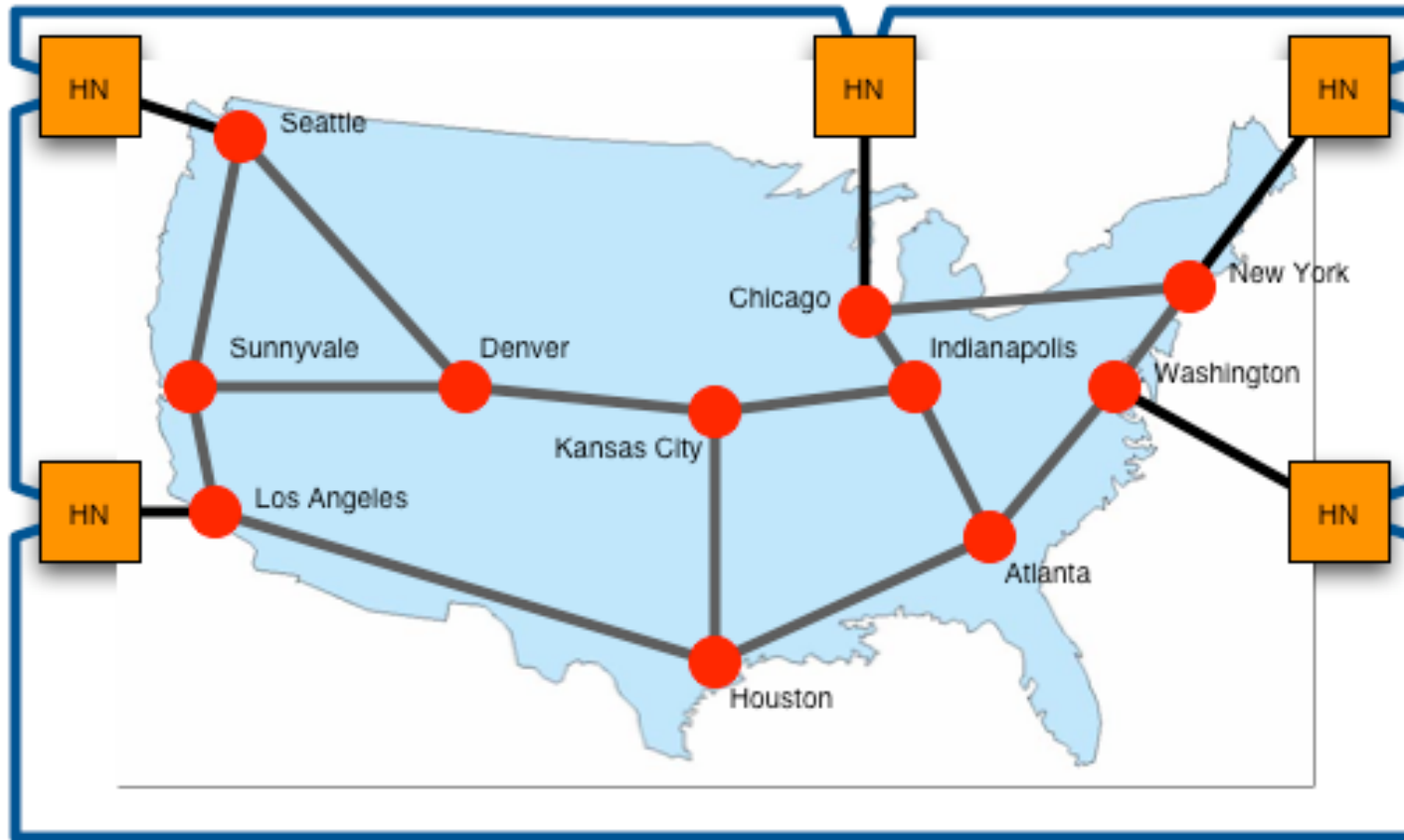




HOPI Testbed Resources

- The Abilene Network – MPLS tunnels and the packet switched network
- The Internet2 Wave on the National Lambda Rail footprint
- MAN LAN Exchange Facility in NYC
 - TYCO/IEEEAF 10 Gbps lambda NYC – Amsterdam
 - Layers 1 and 2 switching gear
- Collaborations with Regional Optical Networks (RONs), campuses and other related efforts (GLIF, UltraLight, DRAGON, etc.)
- OC-192 Circuit from NYC to London to interconnect with GEANT activities ~ July, 2005
 - ESnet and CANARIE participants

HOPi Testbed Topology



HOPi Node



Abilene Node

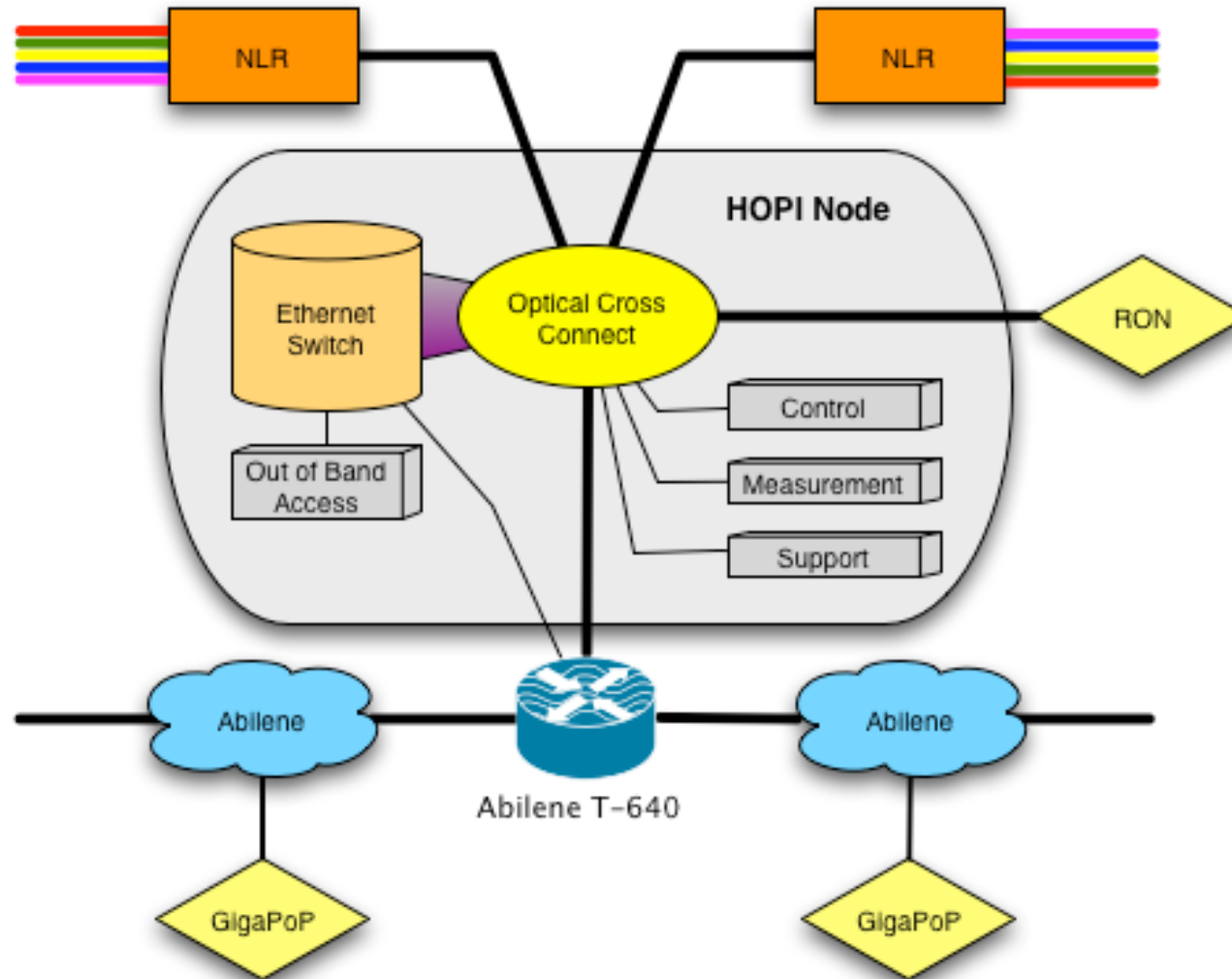


OC-192c



10 GbE

HOPi Node





Internet2 Network Research Facilities Project

- NSF funded project - Internet2 and the University of Virginia
 - Explore the facilities needed by the network research community, in particular those that Internet2 might be able to provide
 - Explore recommendations of the community regarding existing facilities
 - PIs:
 - Jorg Liebeherr, University of Virginia,
 - Matt Zekauskas, Internet2, matt@internet2.edu
 - Rick Summerhill, Internet2, rrsum@internet2.edu

- See <http://networks.internet2.edu/network-research/facilities/>
 - Interested in your input - not a survey - see us at the reception
 - Send email to network-research@internet2.edu



URLs

- <http://abilene.internet2.edu/observatory>
 - Pointers to all measurements/sites/projects
- <http://www.abilene.iu.edu/>
 - NOC home page. Weathermap, Router Proxy, SNMP measurements
- <http://netflow.internet2.edu/weekly/>
 - Summarized flow data
- <http://www.itec.oar.net/abilene-netflow/>
 - “Raw” – matrices; (Anon) feeds available on request
- <http://networks.internet2.edu/manlan>
- <http://networks.internet2.edu/hopi>
- <http://networks.internet2.edu/network-research>
- <http://networks.internet2.edu/network-research/facilities>



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