National LambdaRail (NLR) and Potential Merger with Internet2/Abilene

Unidata Seminar

Marla Meehl

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Outline

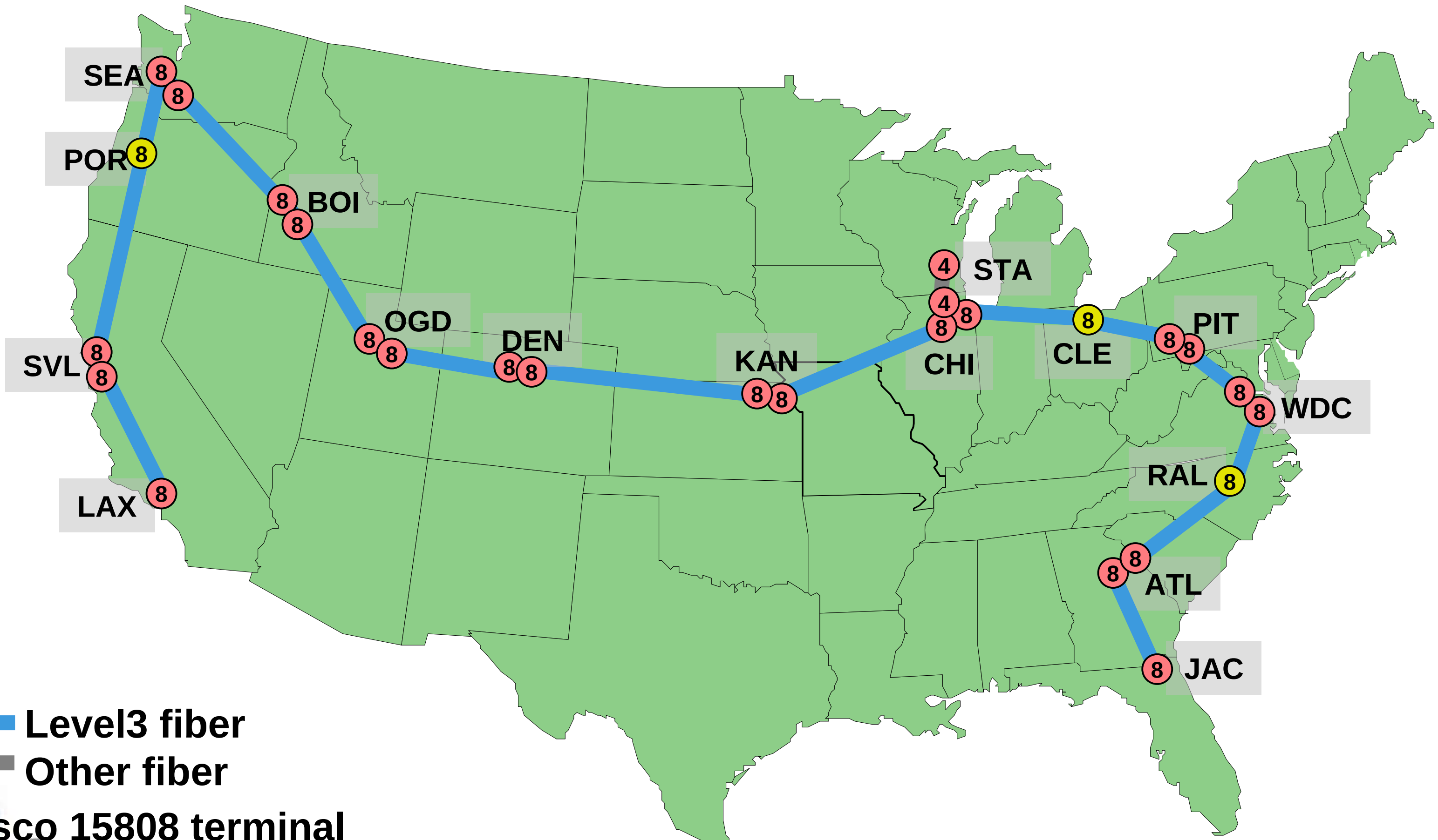
- Overview of NLR and capabilities
- Potential NLR/I2 Merge
  - Context
    - Group A
    - Group B
  - Merger process
    - Steps to date
- Discussion

National LambdaRail Update

- Layer 1 update
  - 50% of resources dedicated to research
- Layer1 Phase II Deployment Schedule
- Layer 2 design
- Layer 3 design

National LambdaRail Update

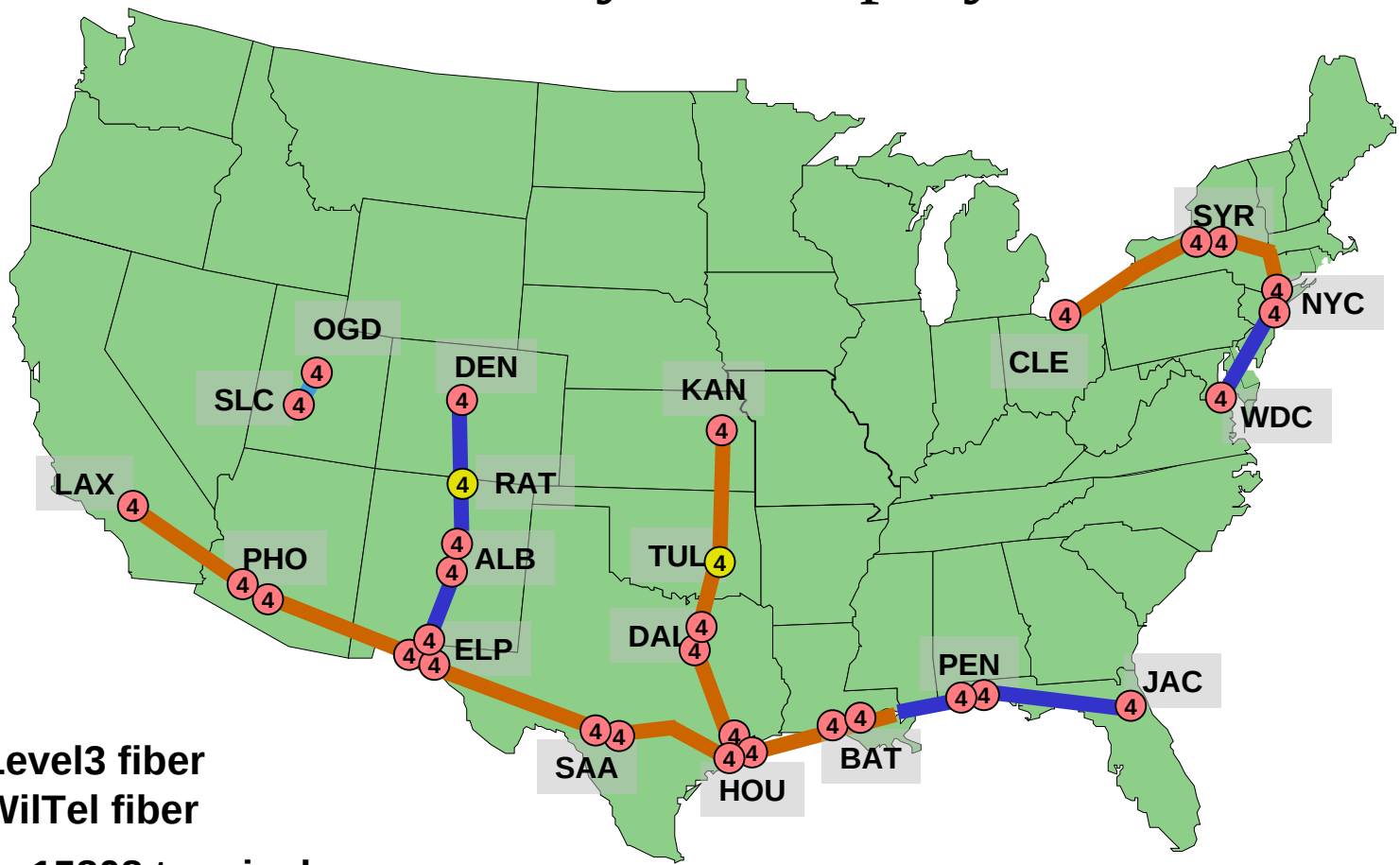
Phase I Layer 1 Deployment



Level3 fiber
Other fiber
Cisco 15808 terminal
Cisco 15808 OADM
Cisco 15454 terminal
Cisco 15454 OADM

National LambdaRail Update

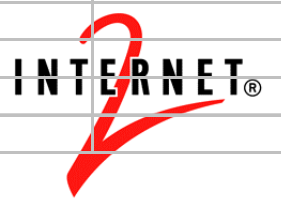
Phase II Layer I Deployment



NATIONAL LAMBDARAIL - PHASE 2 DEPLOYMENT

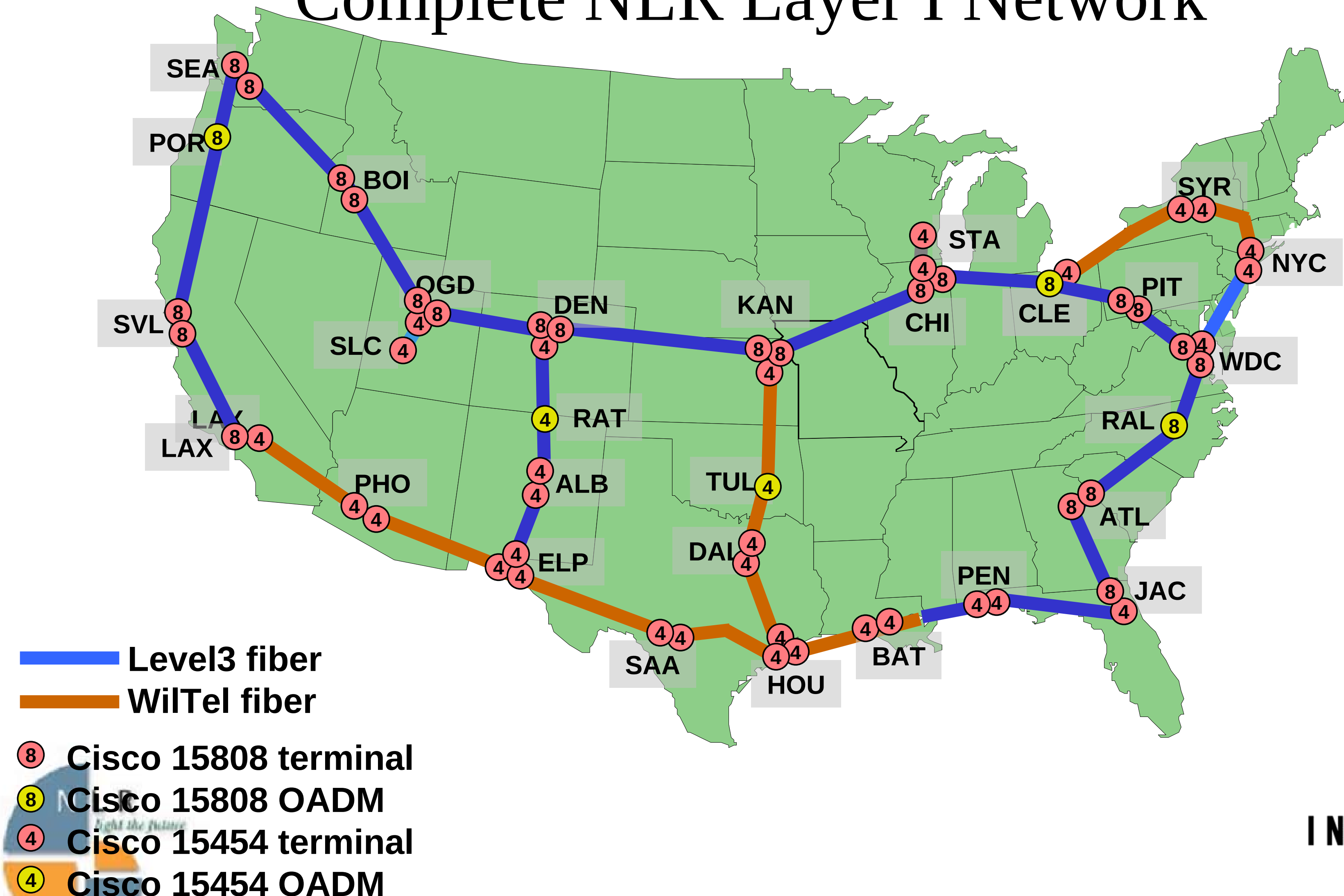
FINALIZED SCHEDULE as of 2005-03-16

	Provider	Segment	OLA Sites	OADM / Regen Sites	Terminal Sites	Pass Thru Sites	Install Start Date	Install Completion Date	Test Start Date	Test Completion Date
?	Level 3 & WilTel	Ogden to Salt Lake City		1	1		*	*	**	**
a1	WilTel	Houston to San Antonio	5		2		06/23/05	06/30/05		
a2	WilTel	San Antonio to El Paso	14		1		07/05/05	07/20/05	08/09/05	08/17/05
a5	WilTel	El Paso to Phoenix	10		1		07/19/05	07/30/05		
a6	WilTel	Phoenix to LA	11		1	1	07/29/05	08/12/05	10/07/05	10/15/05
a3	Level 3	El Paso to Albuquerque	4		1	1	08/12/05	08/20/05		
a4	Level 3	Albuquerque to Denver	7	1	1	1	08/22/05	09/07/05	09/22/05	09/28/05
	sub total		51	2	8	3				
b1	WilTel	KC to Dallas	11	1	2	1	06/28/05	07/12/05		
b2	WilTel	Dallas to Houston	6			1	07/11/05	07/19/05	07/27/05	08/04/05
b3	WilTel	Houston to Baton Rouge	6		1	1	07/19/05	07/26/05	08/22/05	08/25/05
b4	Level 3	NYC to DC	7		2	1	07/28/05	08/05/05	08/31/05	09/03/05
b5	WilTel	NYC to Syracuse	9		1	1	08/04/05	08/16/05		
b6	WilTel	Syracuse to Cleveland	10		1	2	08/16/05	08/26/05	09/08/05	09/16/05
b7	WilTel / Level 3	Baton Rouge to Pensacola	6		1	1	08/29/05	09/07/05		
b8	Level 3	Pensacola to Jacksonville	8		1		09/07/05	09/17/05	10/21/05	10/29/05
	sub total		63	1	9	8	**6/23/2005**	**9/17/2005**	**7/27/2005**	**10/29/2005**
	Totals		**114**	**3**	**17**	**11**				
		Total Sites w/ Equip	**134**							
		Total Sites in Phase 2	**145**							



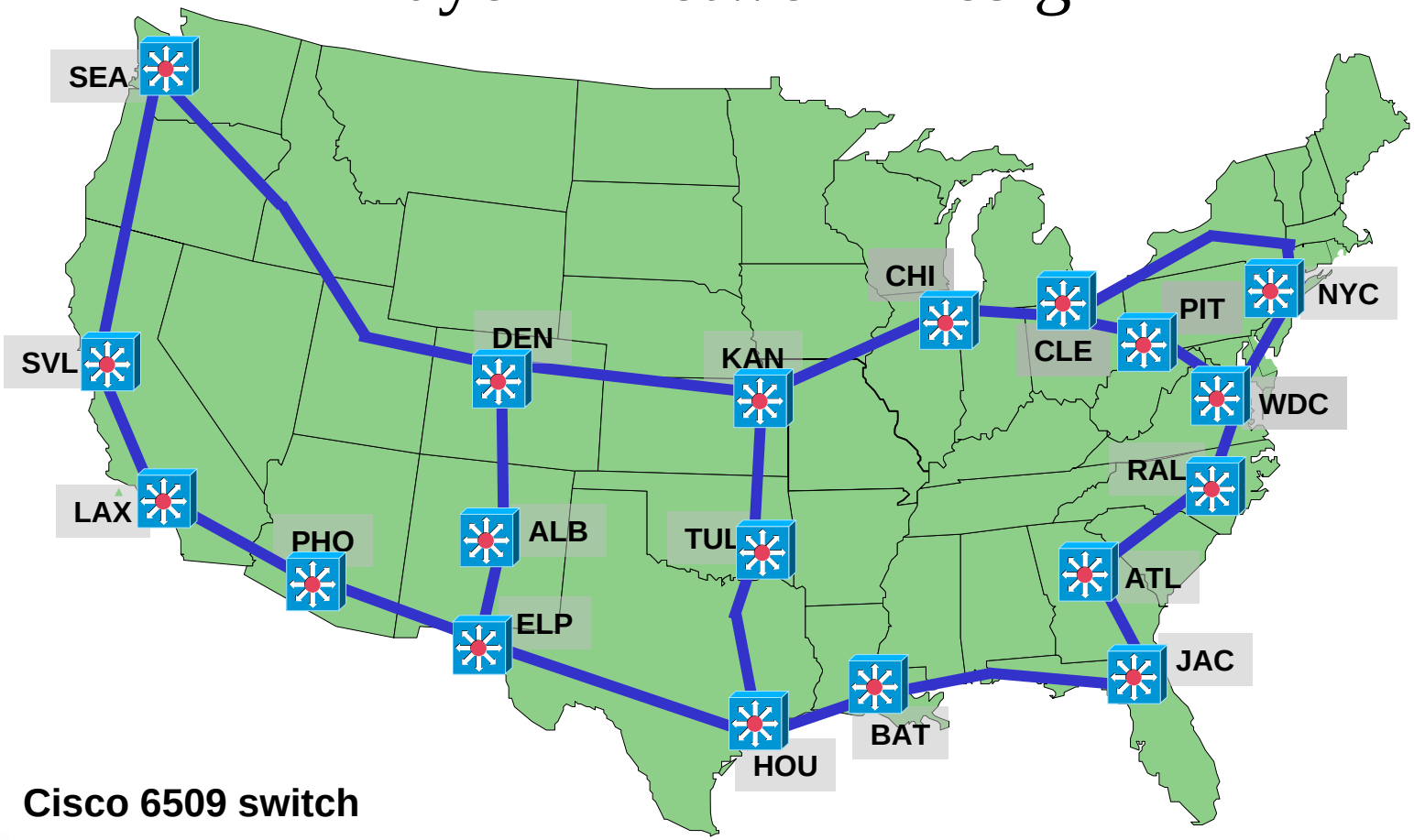
National LambdaRail Update

Complete NLR Layer I Network



National LambdaRail Update

Layer 2 Network Design



NLR Layer 2 Goals

- Facilitate point to point or point to multipoint Ethernet transport at rates at or above 1Gbps.
- Provide detailed performance measurement and real time statistics which allow the user to fully understand the performance of the transport network.
- Provide flexible infrastructure and tools which allow users to make, or signal for, service level changes to their individual Layer 2 paths, dramatically reducing provisioning delays while making more efficient use of the network. (Hybrid Optical and Packet Infrastructure (HOPI) like functionality).
- Refine these services, over time, to meet the specific needs of the research community; even where those developments would differ from what a standard service provider would be willing to do.

NLR L2 Initial Services

- National Peering Fabric – Create a national distributed exchange point, with a single broadcast domain for all members. Initial user ports will be 1GE. (Interconnect GigaPoPs/RONs)
- Dedicated Point to Point Ethernet – VLAN between 2 members with dedicated bandwidth from 1G to multiple 1G
- Best Effort Point to Multipoint – Multi-point VLAN with no dedicated bandwidth

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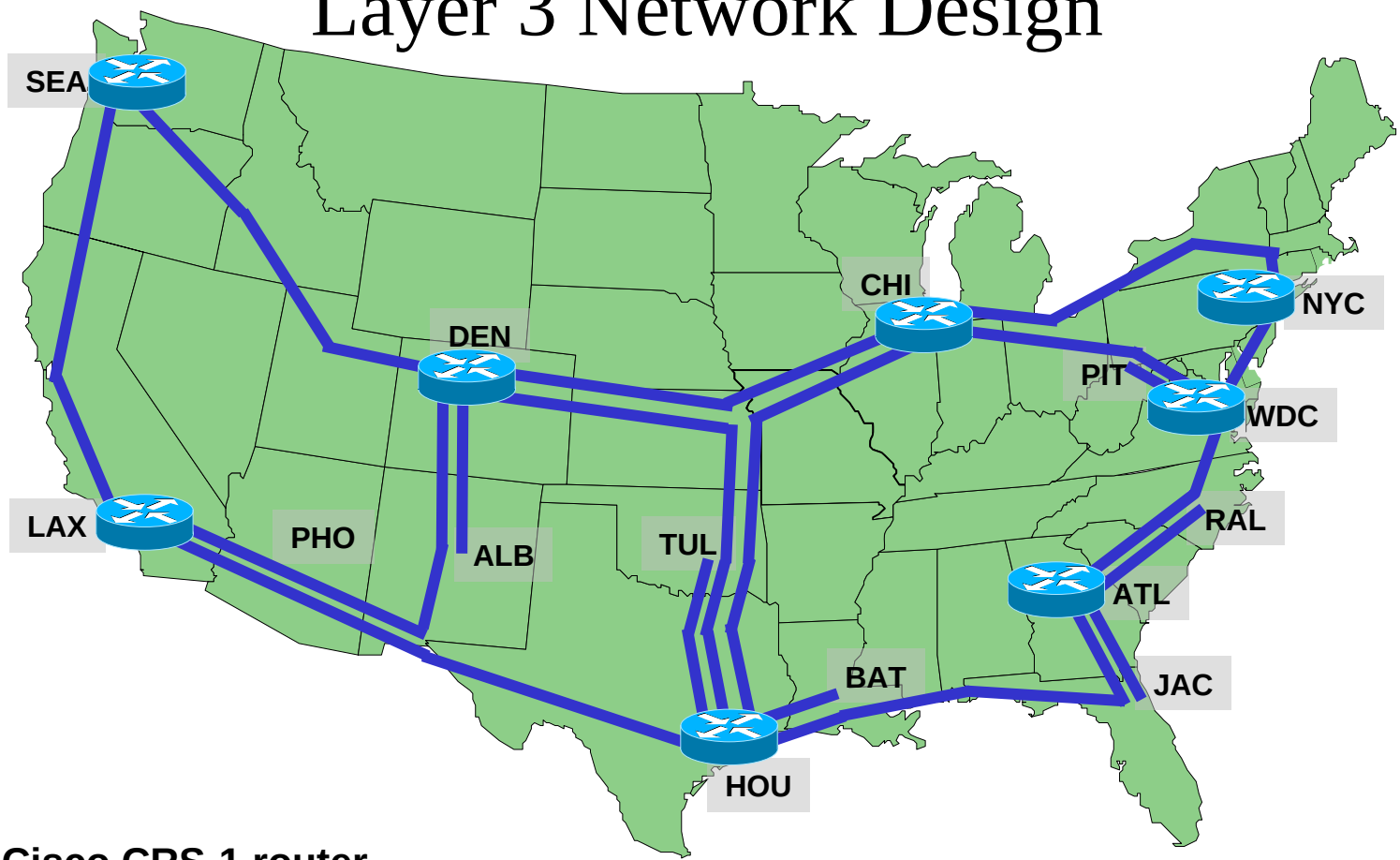
National LambdaRail Update

Layer 3 Network Design



Cisco CRS-1 router

10GE wave

NLR Layer 3 Goals

- Create a national infrastructure for network and application experiments, in a way that is not possible with current production commodity networks, network test-beds, or production R&E networks.
- Provide an advanced national "breakable" infrastructure to try out technologies and configurations. In addition, researchers will have the opportunity to create experiments and test them using live production traffic in a national backbone provider footprint.
- Provide a flexible layer 3 network supporting experiments for anything from requiring total control of the hardware to requiring access to active real-time production traffic.
- Support researchers with a level of communication and visibility to its users not seen before in other networks.

NLR Layer 3 Services

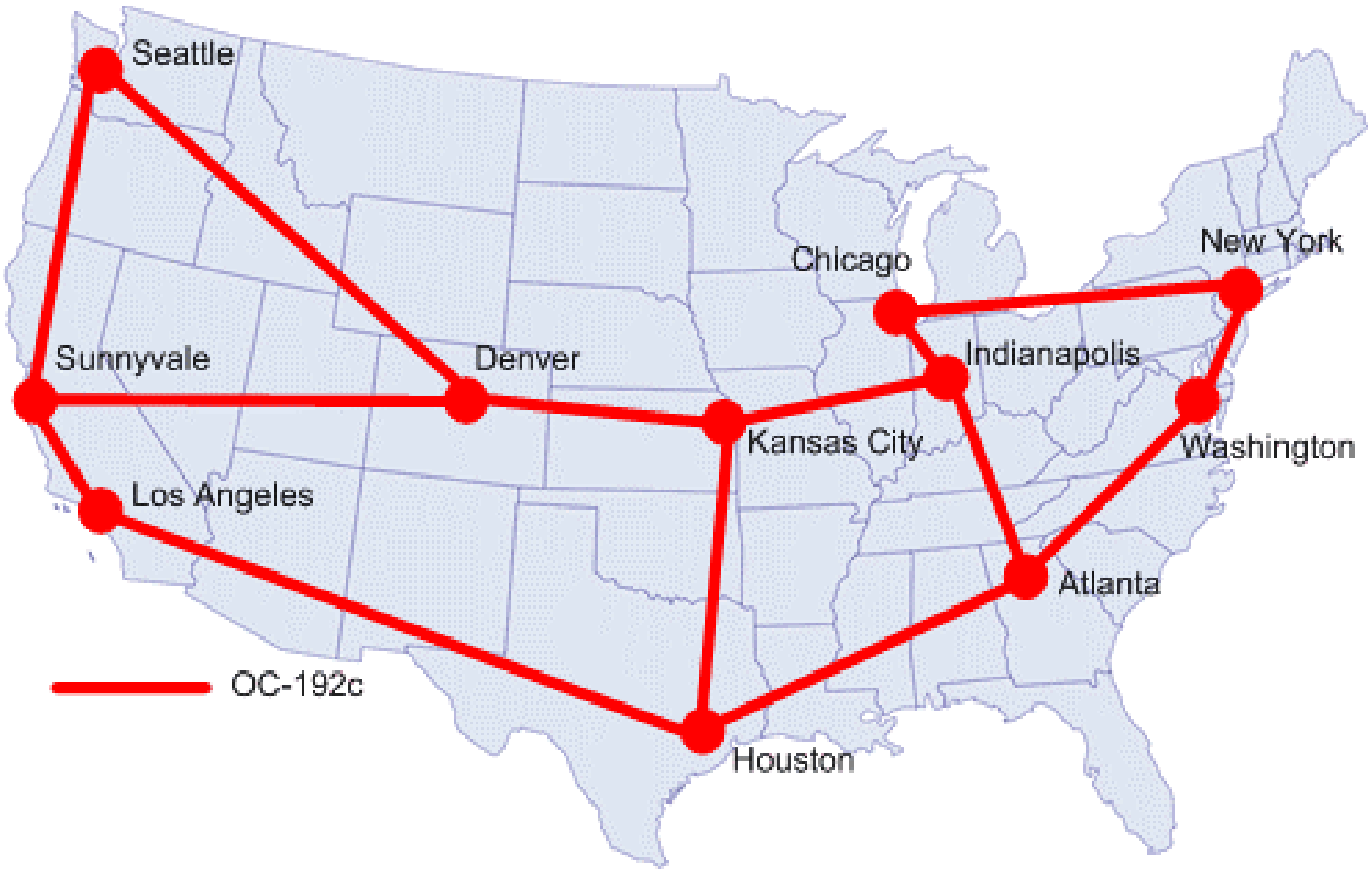
- BGP to each member
- ISIS core IGP
- IPv4 Multicast: PIM, MSDP, MBGP by default
- IPv6: BGP peering by default
- Security: Each member will be able to black-hole traffic to one of their hosts using special BGP community
- Each member gets a 10GE connection and a VLAN backhauled over the L2 network to a second node

INTERNET®

Drivers for Merge

- Abilene Qwest contract ends October 2007
  - Looking at next generation Abilene
  - Abilene acquires 10G wave across NLR per agreement
- NLR long-term financial strategy
- Overlap in network topology
  - Primary nodes in same cities
- Regional Optical Networks (RONs) have reduced the requirement for free backhaul to Abilene
- Financial limits for universities to support multiple R&E initiatives

Abilene Backbone



Abilene Network futures

- October 2007 – Anticipated expiration of Abilene transport agreement with Qwest (can be renewed for 1 more year)
  - Provides 3rd-generation network timeline
    - **Buildable** architecture: end 4Q05
    - Transport arrangement(s): end 1Q06
    - Router and other equipment selection: end 2Q06
    - Backbone deployed: end 4Q06
    - Connector transition: 2007
  - Concurrently, review service, business, and management model
- Concurrently, the HOPI *testbed* is expected to be in place for at least three years
  - Refine and evolve next generation architecture and services
- Coincidentally…
  - December 2007 – expiration of ESnet transport agreement with Qwest

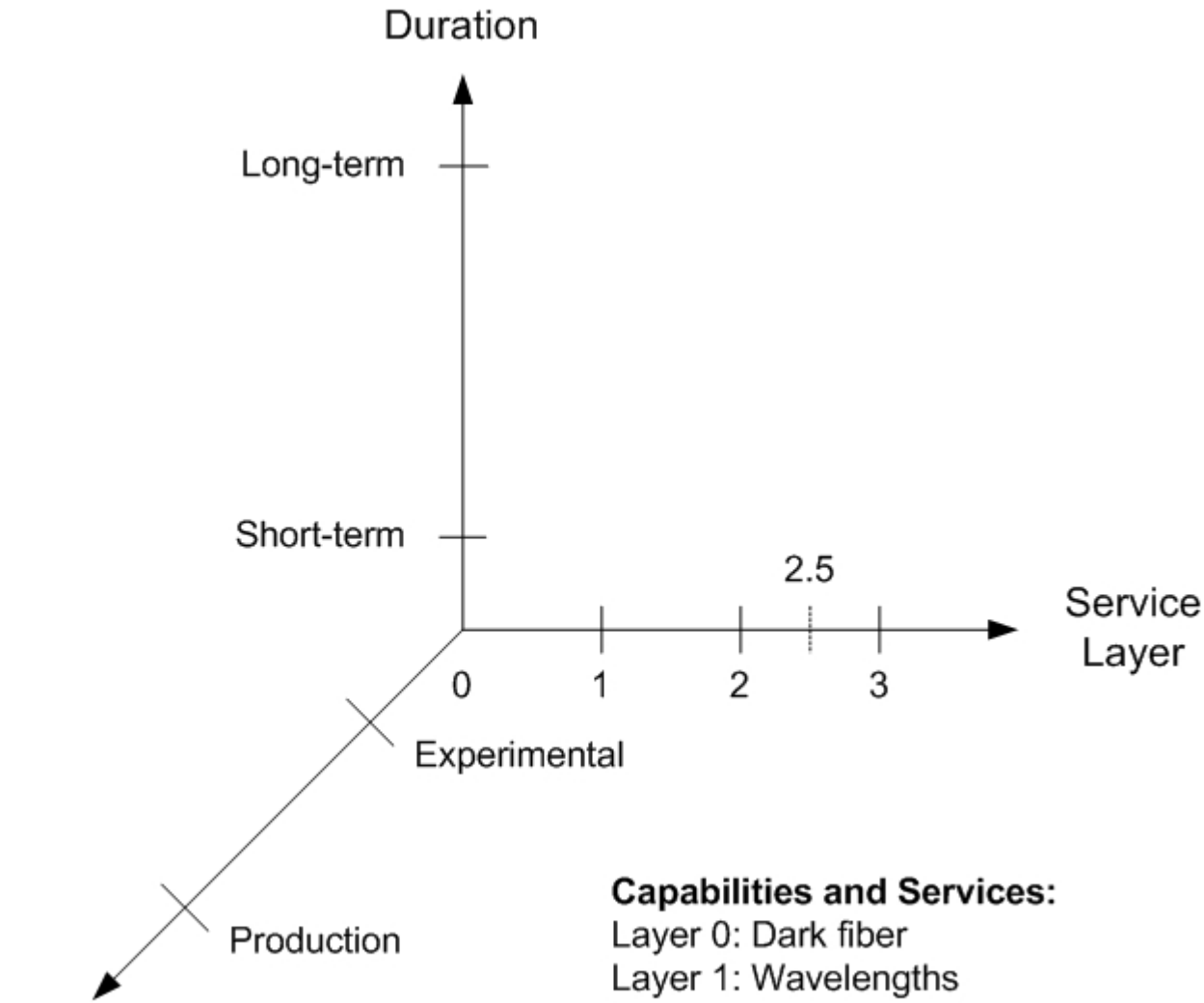
Group A membership

- Erv Blythe, Virginia Tech
- Javad Boroumand, Cisco Systems
- Steve Corbató, Internet2
- Wendy Huntoon, PSC (chair)
- Ron Johnson, Univ. of Washington
- Michael Krugman, Boston U
- Rick Summerhill, Internet2
- Doug Van Houweling, Internet2

Group A report

- Group A was sanctioned by NLR and Internet2 boards to investigate next generation architecture and service requirements
  - Chaired by Wendy Huntoon (PSC)
- Report envisioned a *far richer network service environment* over the coming five years
  - Multi-dimensional attribute space
    - Network layer (dark fiber, wavelengths, GigE and SONET circuits, MPLS, IPv4/v6)
    - Duration
    - Resilience
  - Best-effort, persistent IP service (layer 3) remains important, but is no longer a '*one-size-fits-all*' service

Potential Model for Services and Capabilities to be Offered in Next Generation Higher Education Network Infrastructure



Capabilities and Services:
Layer 0: Dark fiber
Layer 1: Wavelengths
Layer 2: GigE lightpaths
(+ SONET circuits?)
Layer 2.5: MPLS tunnels
Layer 3: IPv4/v6

Group A report

- A new view of end user support and end-to-end connectivity delivery assurance is needed
  - *Common Interconnection and Service Deployment Model*
  - Working across campus, regional & national scales
  - Effective campus penetration of new services is a critical issue
- *Regional optical networks* and *carrier-class exchange points* are critical components of the next generation infrastructure

Group B membership

- Javad Boroumand, Cisco Systems
- Bill Decker, U of Iowa
- Dave Farber, CMU/NLR
- Tracy Futhey, Duke U
- Ron Hutchins, Georgia Tech
- Greg Jackson, U. of Chicago (chair)
- Ron Johnson, Univ. of Washington
- Larry Landweber, NSF/Internet2
- Jack McCredie, Berkeley
- Doug Van Houweling, Internet2
- Tom West, NLR

Group B report

- Likewise, Group B was sanctioned by NLR and Internet2 boards to study the optimized organizational configuration to support community's advanced networking needs
- Investigated several options
  - Enhanced cooperation of separate organizations
  - Joint venture
  - New organization

Group B report

- Four key recommendations
  - Merge NLR and Internet2 as quickly as possible and as equals
  - Integrate governance
    - New Board of 40 members
    - Six committees
      - Executive, Strategy, Capabilities & Policy, Operations, Finance, Audit, Nominations & Governance
    - Four advisory councils
      - Network Research
      - Science Research
      - Applications Strategy
      - Industry Strategy
  - Continue all services of both organizations at first
    - Develop an integrated financial model over the first year
  - Organizational leadership

Recent board actions

- Nearly identical resolutions presented to both boards
  - explore possible merger options
  - authorizing formal merger discussions
  - establishing merger committee composed of both CEOs and respective board meetings
- Both boards passed the resolutions
  - NLR – June 29
  - Internet2 – June 30

- WHEREAS **,** the Board of Directors has been presented with and reviewed a Group A Report entitled, “Scoping the Future Multi-Service Advanced Network Infrastructure for U.S. Higher Education, A Preliminary Assessment” dated May 2005, and a Group B Report dated June 21, 2005, attached hereto as Exhibits A and B respectively;
- WHEREAS, the Group A and Group B teams were formed in February 2005 by National LambdaRail, Inc., (“NLR”) and the University Corporation for Advanced Internet Development, Inc. (“Internet2”) and were charged with exploring and recommending, among other things, changes to the operational structures of both NLR and Internet2 for the benefit of the U.S. Research and Education Community;
- WHEREAS, the Group B Report, among other things, endorsed the merger of NLR and Internet2;
- WHEREAS, the Board of Directors believes it to be in the best interest of the NLR to pursue merger between NLR and Internet2 as recommended in the Group B Report on such other terms and conditions as NLR deems to be in the best interests of NLR.
- NOW, THEREFORE, it is hereby resolved as follows:
- **RESOLVED,** that the Chief Executive Officer (CEO) is authorized and directed to take such actions to enable negotiations regarding the proposed merger between NLR and Internet2, as he shall determine in his judgment to be necessary, proper or advisable, in order to reach a merger agreement guided by such terms and conditions as described in the Group B Report and/or on such terms and conditions as deemed to be in the best interests of the NLR;
- **FURTHER RESOLVED,** that the CEO is authorized to execute a letter of intent on behalf of the NLR as he shall determine to be necessary, proper or advisable in order to facilitate merger discussions with NLR;
- **FURTHER RESOLVED,** that CEO and three members of the NLR Board are hereby directed to negotiate and present the terms of a merger agreement to the Board of Directors for its vote of approval or disapproval prior to the execution of any agreements , instruments or other documents relating to the proposed merger;
- **FURTHER RESOLVED** , that the Secretary of NLR is hereby authorized to certify that the foregoing resolutions were duly consented to and adopted as of the date hereof, and that the Secretary of NLR shall be, and hereby is, authorized and directed to insert, or cause to be inserted, this Resolution, or a copy thereof, in the minutes of proceedings of the Board of Directors of the NLR.

NLR/Internet2 Merger Committee

- NLR
  - Tracy Futhey, CIO, Duke University (NLR Board chair)
  - Tom West, NLR CEO
  - Erv Blythe, CIO, Virginia Tech
  - Ron Johnson, CIO, University of Washington
- Internet2
  - Larry Faulkner, President, University of Texas, Austin (Internet2 Board chair)
  - Doug Van Houweling, Internet2 CEO
  - Jack McCredie, CIO, Berkeley (NPPAC chair)
  - Don Randel, President, University of Chicago

One view of the combined organization

- The potential of the new organization here is far greater than the sum of the parts!
- NLR brings…
  - National fiber footprint and unique optical capabilities
  - Strong relationships with the computational science community
  - Infrastructure to host multiple-scale network research testbed(s), national agency networks (e.g. NOAA, DOE, NASA), dedicated point-to-point networks
  - Member-driven organization
- Internet2 brings…
  - Systems view – middleware, security, performance, diagnostics
  - Strong member/community engagement – meetings & WGs
  - Seven years of advanced IP network operations - Abilene
  - International relationships – collaboration and peering
- Both organizations bring…
  - Relationships with the emerging regional optical initiatives
    - NLR membership model
    - Internet2's hosting of the Quilt project

Conjecture of merger effects to UCAR users

- No immediate implications – Abilene will continue as is
- NLR Layer 3 and NLR Layer 2 GigaPoP Peering will slowly assume some Abilene routes
  - Does this have any implications for Unidata?
- Long term there will be an Abilene-like Layer 3 IP network running on NLR optical infrastructure
  - Roughly 75 I2 members are represented by NLR members
  - Roughly 35 UCAR members are represented by NLR members
  - Roughly 47 top 100 research universities are represented by NLR members
- There will be a richer set of national network and service offerings, e.g. Layer 2 lambdas, optical switching

For more information

- Many relevant links are available at:
  - www.internet2.edu/consolidation/
  - www.nlr.net/consolidation/
    - Groups A & B reports
    - Merger resolutions
    - CEO letters to membership

Questions/Discussion