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Update on National LambdaRail

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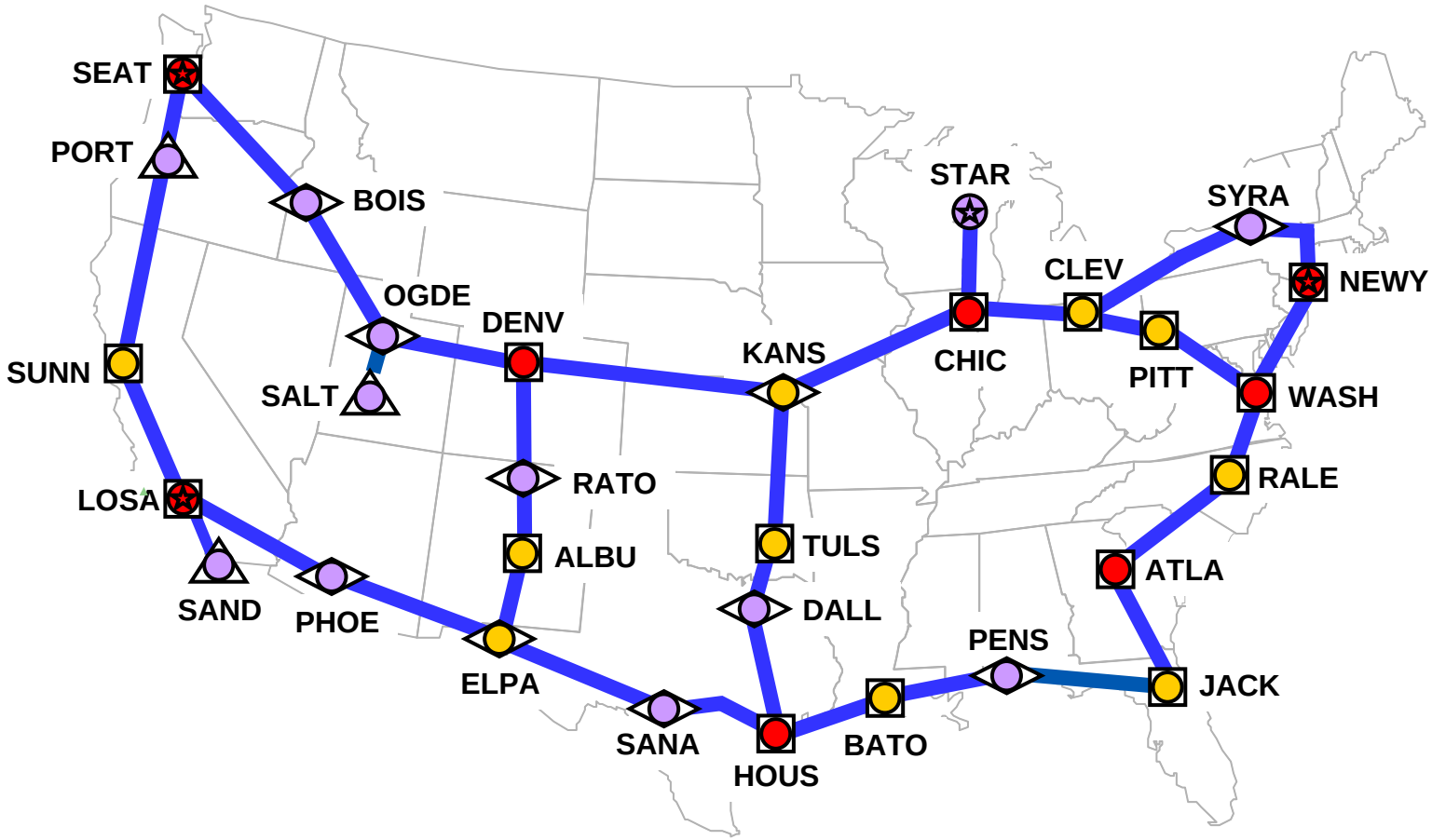
NLR - Background

- National LambdaRail is a non-profit corporation created (2003) by a consortium of major regional US R&E networks in conjunction with CISCO Systems and Internet2. Today there are 14 members.
- Identified the need for experimental and research oriented network(s)
- Research networking AND network research
- Took advantage of dark fiber price trough (minimum?) to acquire national footprint 20yr IRU's
- Partnered with CISCO to deploy 40 lambda DWDM network
- Provides a range of services and networks to its members over this infrastructure
- Parallel effort by regional networks (RONS) has developed similar capability for regional connectivity and distribution (e.g. CENIC, LEARN, FLR, …)

NLR Infrastructure

- Over 11,000 route miles of fiber
- 20-yr IRUs on dark fiber
- Layer 1 Optics: Cisco 15808s and 15454s supporting up to 40 10 Gbps lambdas LANPHY
- Layer 2: Cisco 6509 switches for Gigabit Ethernet
- Layer 3: Cisco CRS-1 routers for IP
- Wavelengths available for experimental or production networks

NLR – Footprint



Suymmary of NLR Usage

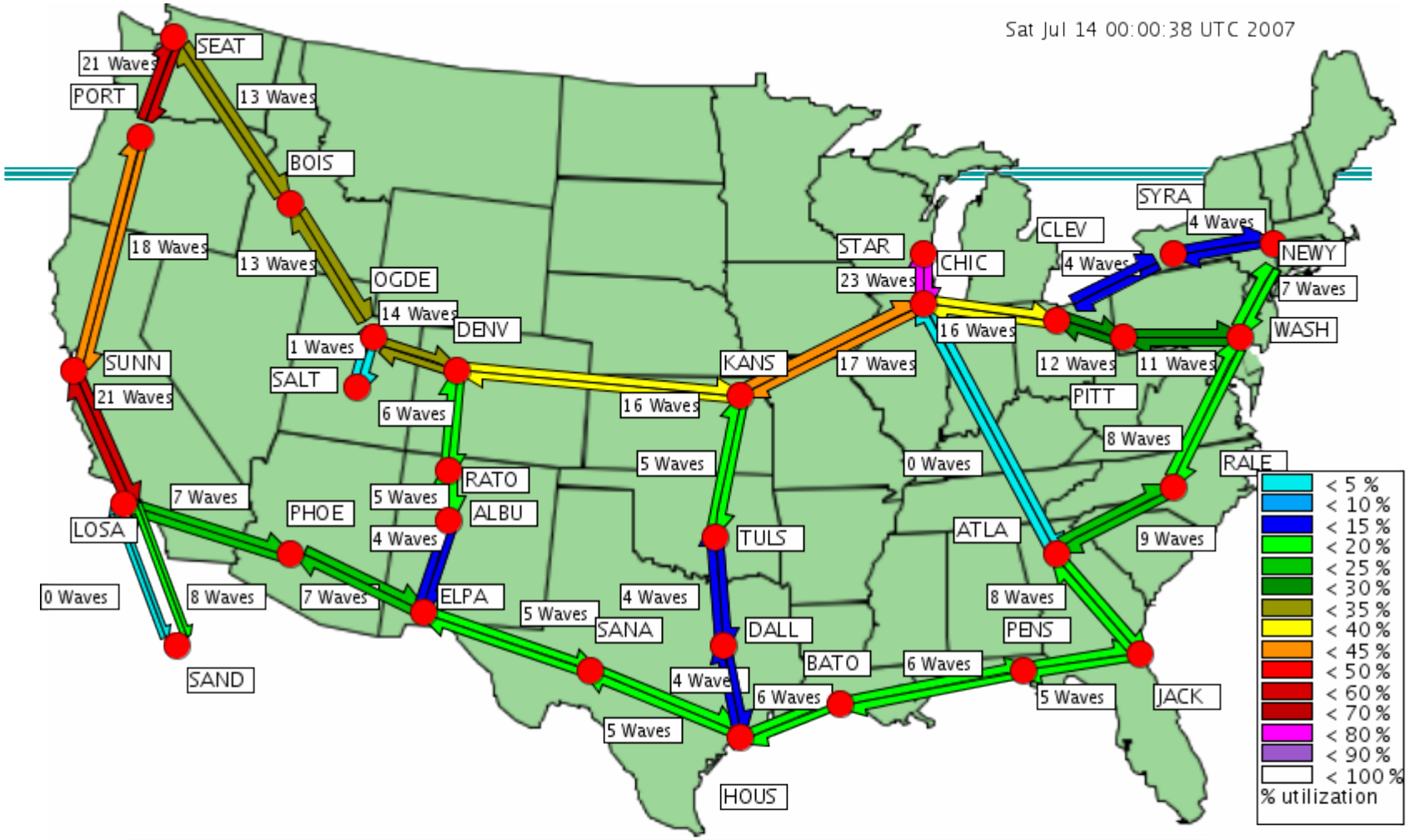
- Three main network services offered:
  - Wavenet (layer 1 or 1.5) – dedicated capacity – true Lighptaths
  - Framenet (layer 2) VLAN over Ethernet structure. Also called lightpaths. (can be with or without bandwidth management)
  - Packetnet (layer 3) Traditional IP service

WaveNet Overview

- ETE circuits consisting of wave segments
- Dedicated waves purchased by regionals or research projects
- Research waves, supported by CISCO, made available in support of approved research projects
- Quickstart waves (if available and preemptable for fail-over)

Infrastructure Update - WaveNet

- Steady demand for WaveNet services
- NLR has allocated 199 WaveNet Circuits to date
- 126 Active Circuits
  - 75 Customer Circuits
  - 51 Backbone Circuits (L2, L3, Optical Switch)
- 32 Misc Circuits - spare, unallocated, reserved, SC07
- 41 Decommissioned circuits
  - includes SC related circuits, circuits no long in use by customers, etc.



NEWY->WASH	7 Waves	WASH->RALE	8 Waves	NEWY->SYRA	4 Waves	RALE->ATLA	9 Waves
WASH->PITT	11 Waves	ATLA->JACK	8 Waves	PITT->CLEV	12 Waves	CLEV->CHIC	16 Waves
SYRA->CLEV	4 Waves	CHIC->KANS	17 Waves	KANS->TULS	5 Waves	TULS->DALL	4 Waves
DALL->HOUS	4 Waves	KANS->DENV	16 Waves	DENV->OGDE	14 Waves	OGDE->BOIS	13 Waves
BOIS->SEAT	13 Waves	SEAT->PORT	21 Waves	PORT->SUNN	18 Waves	SUNN->LOSA	21 Waves
LOSA->PHOE	7 Waves	PHOE->ELPA	7 Waves	ELPA->ALBU	4 Waves	ALBU->RATO	5 Waves
RATO->DENV	6 Waves	ELPA->SANA	5 Waves	SANA->HOUS	5 Waves	HOUS->BATO	6 Waves
BATO->PENS	6 Waves	PENS->JACK	5 Waves	CHIC->STAR	23 Waves	OGDE->SALT	1 Waves
LOSA->SAND	0 Waves	LOSA->SAND	8 Waves	CHIC->ATLA	0 Waves		

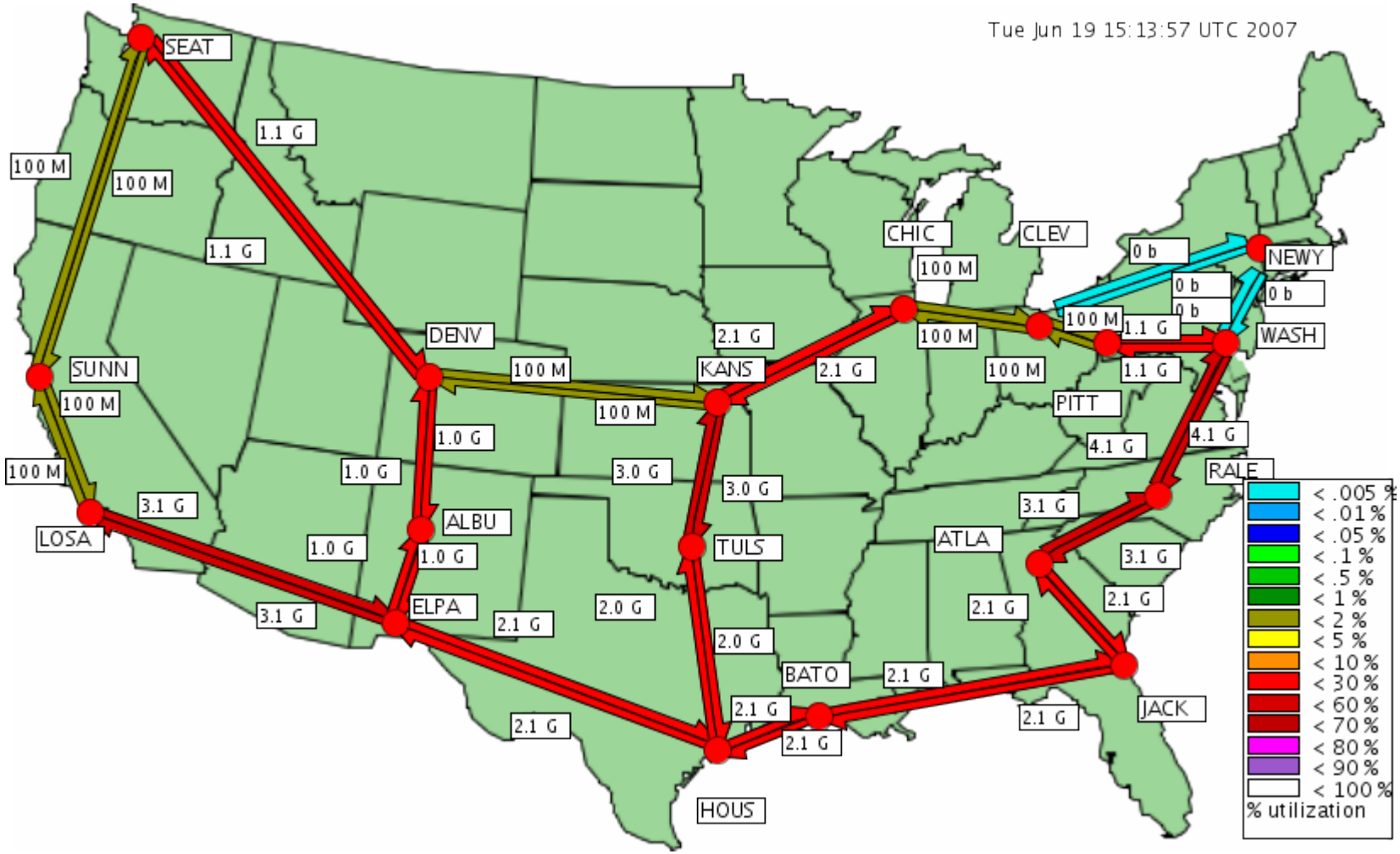
FrameNet Overview

- **National Exchange Fabric Service**
  - NEF is a single VLAN and broadcast domain that extends to every member
  - Allows members to arrange bi-lateral peerings
  - Every member gets a single 1GigE interface on their local NLR FrameNet node for use of the NEF service
- **Point-to-point, Dedicated Bandwidth Service**
  - Members may order private VLANs to connect 2 different locations together, with dedicated bandwidth, for a circuit-like service
  - Bandwidth available from 100Mbps to 10Gbps
- **Point-to-multipoint, Best Effort Service**
  - Members may order private VLANs to multiple locations for a circuit-like service
  - Traffic on these VLANs carried through the network on a best effort basis

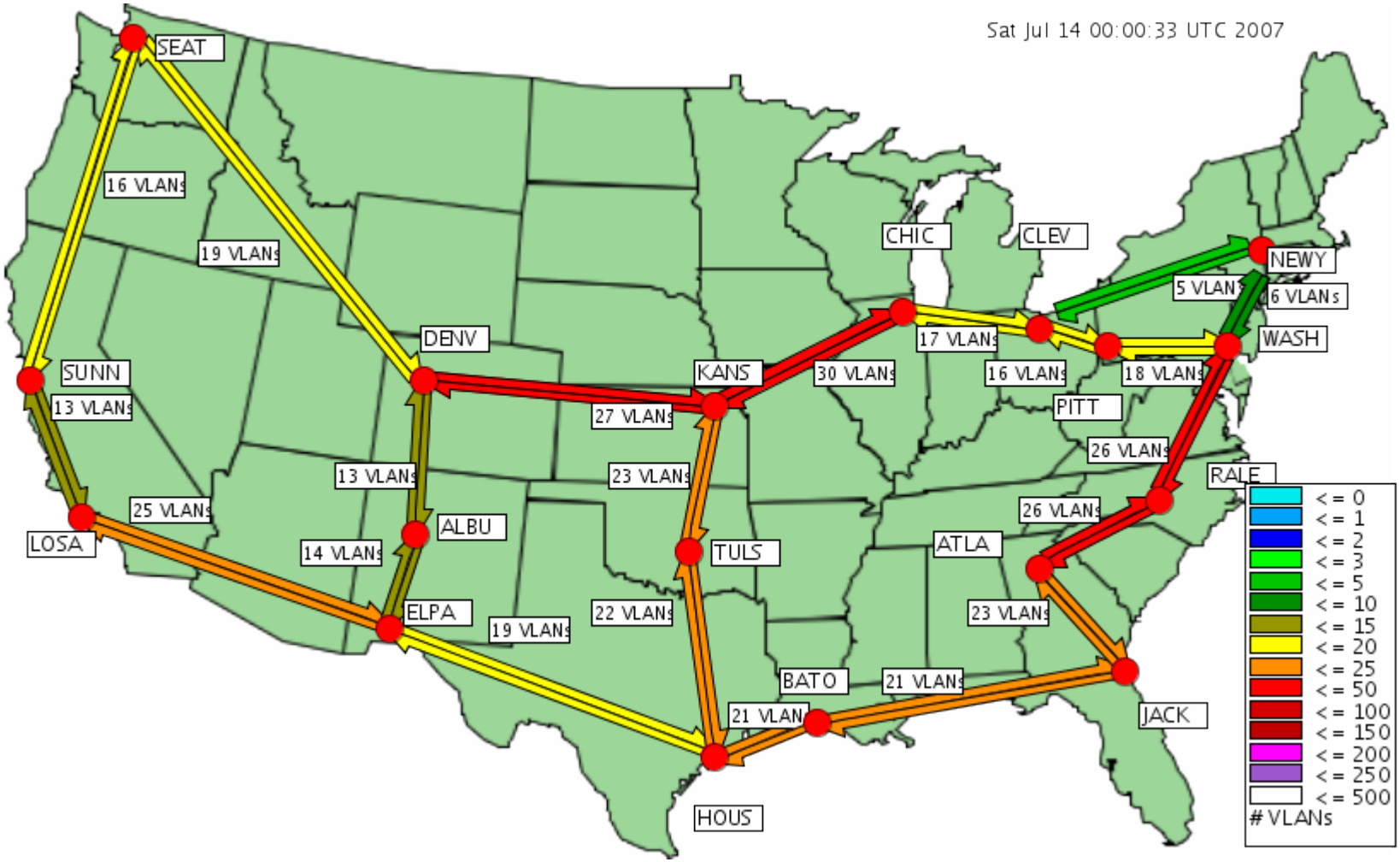
FrameNet

- Demand continues to grow, 10 GE interfaces and non-dedicated bandwidth are popular
- 86 Active VLANs, both dedicated and non-dedicated
- Currently primary use of dedicated service is for Layer 3 backup connections
- Interest by research groups
  - Collaborative multi-point projects
  - Experiment on non-dedicated service, understand utilization, then migrate to dedicated service.
- New Services being Developed, in particular **on-demand** dedicated services
- Adding FrameNet connection to MANLAN switch to support layer2 connectivity to international networks

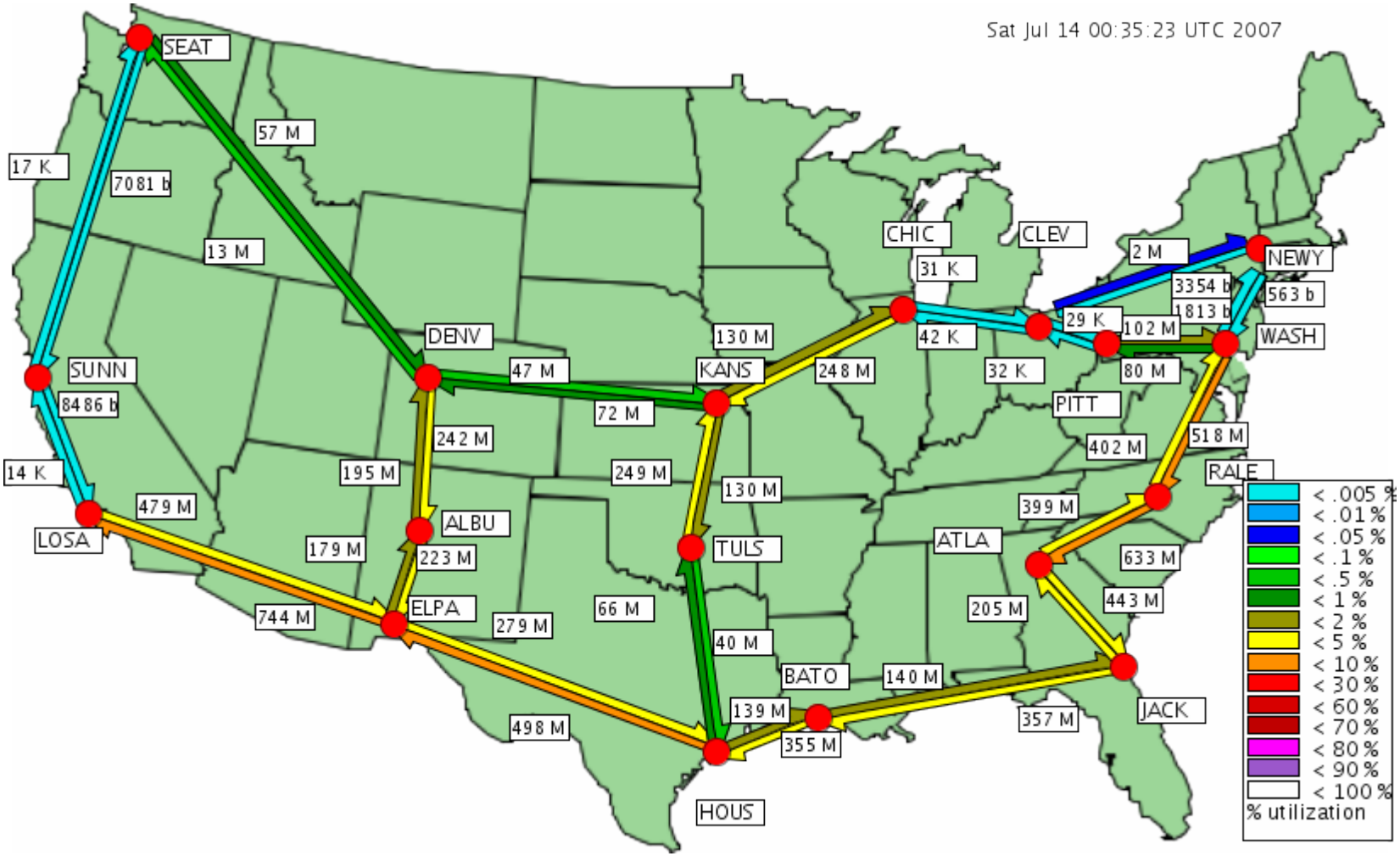
FrameNet - Dedicated Bandwidth



FrameNet - VLAN Count



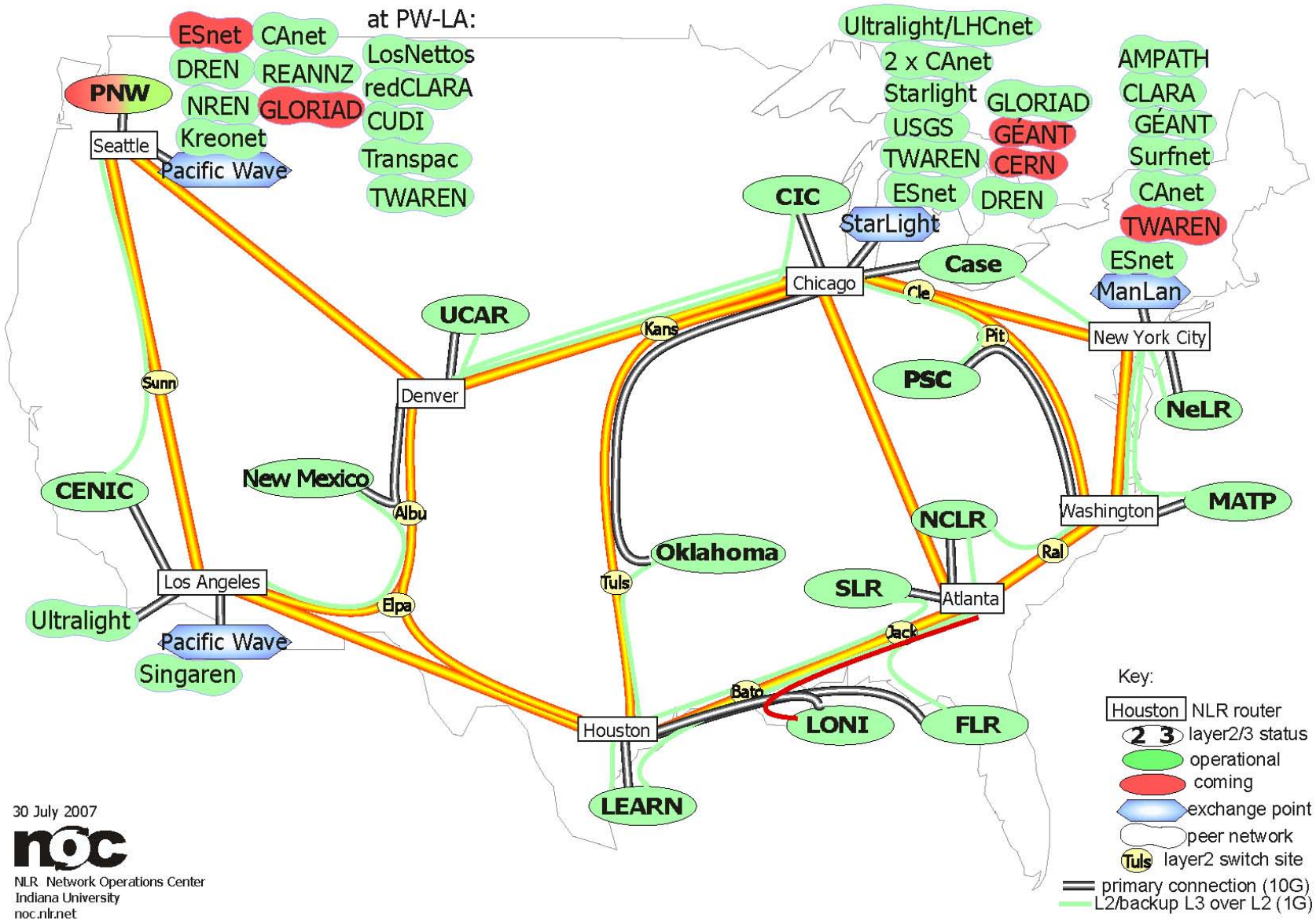
FrameNet Traffic Map



PacketNet Overview

- “Production” 10G Layer 3 IP network, fully operational
- Potential for several packet networks on different lambdas (or VLANS) can use virtual routing capability of CRS-1 or multiple router instances
- “Experimental” for research use to be made available when needed

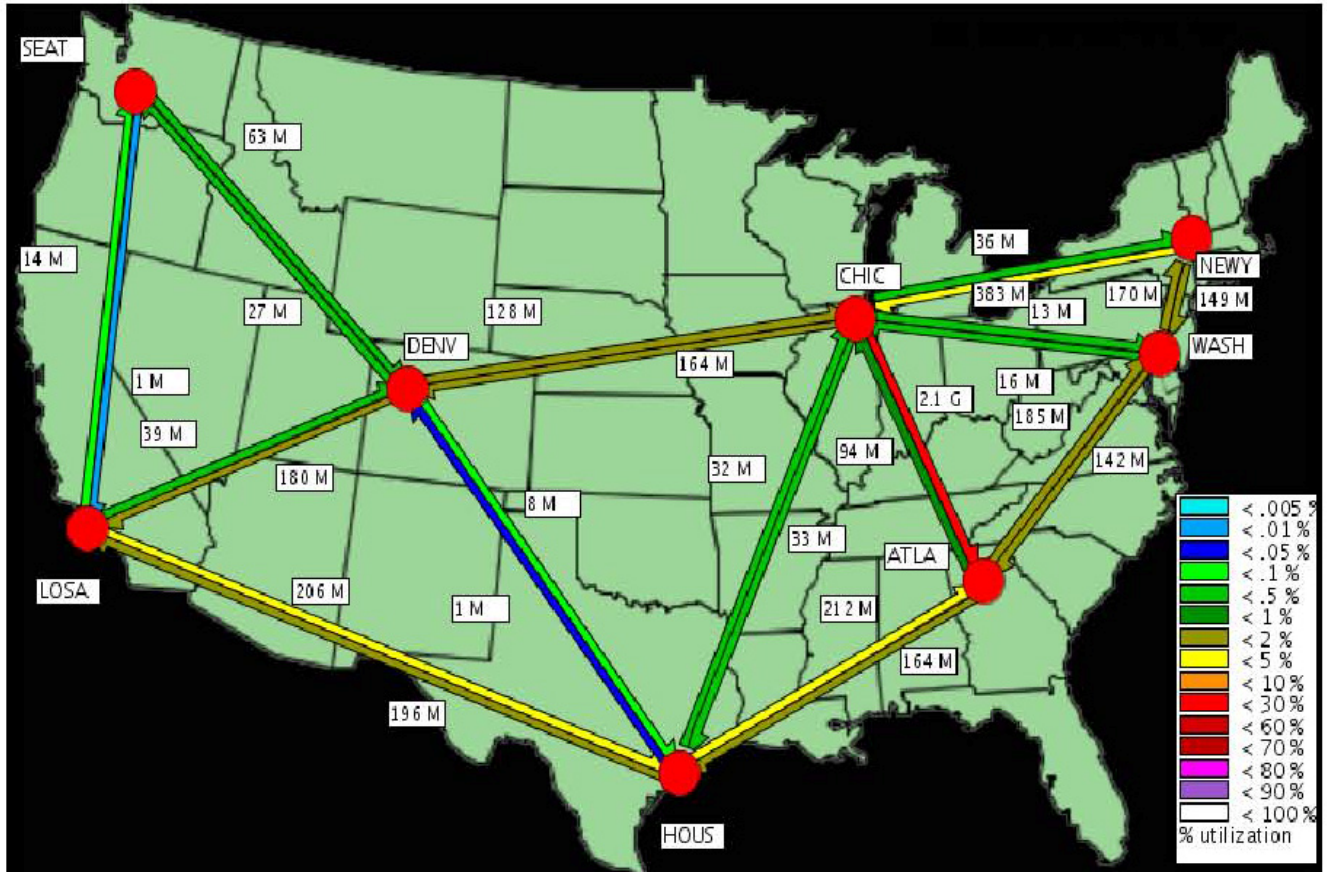
NLR Members' PacketNet Connection Status



30 July 2007

NLR Network Operations Center
Indiana University
noc.nlr.net

PacketNet Weather Map



weathermap.grnoc.iu.edu/nlrmaps/layer3.html

Summary

- Fairly extensive deployment of nationwide infrastructure in place
- Reasonable amount of experimentation with dedicated static lightpaths to date
- Some experimentation with dynamic lightpaths
- Need for extension of capabilities through the regional networks and onto campuses
- More development of dynamic lightpath capable exchange points (GOLES)
- Experimentation with Internet2 DCS services

Contact Information

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