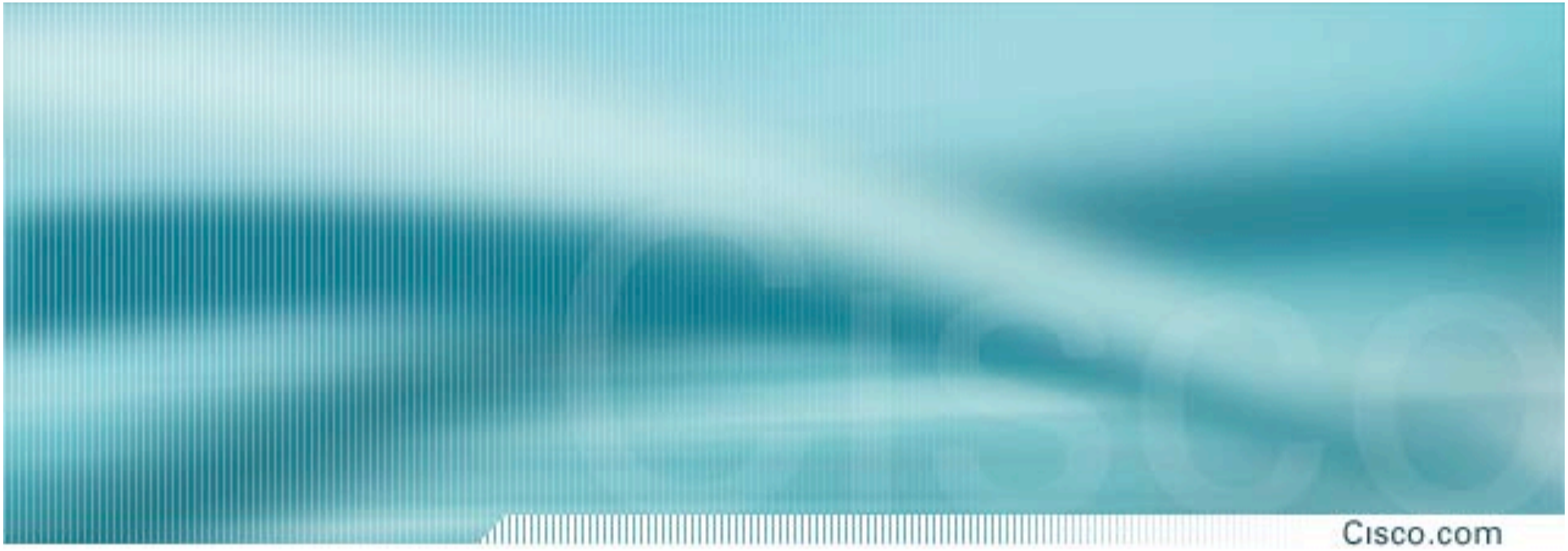

Cisco and the Internet - and innovation

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Robert J. (Bob) Aiken

(raiken@cisco.com)

Why am I a here ?

- I'm not a father of the Internet
- I'm not a grandfather of the Internet
- I am not even a young upcoming next generation researcher
- I guess that makes me an aging 2nd cousin on my Uncle's side of the Internet lineage

Evolution of the Internet

- 1st the Earth cooled
- then we had Dinosaurs
- then we had oil
- then we had Mercedes Benz
- then we had ARPAnet
- then we had research networks (NSFNET, ESnet,…)
- then we had the Internet and Porsches and IPOs
- then we had the technology bubble burst
- then the earth cooled again - OR DID IT?

What is the Internet

- A network of networks
- A community of communities
- Actually : It’s a state of mind

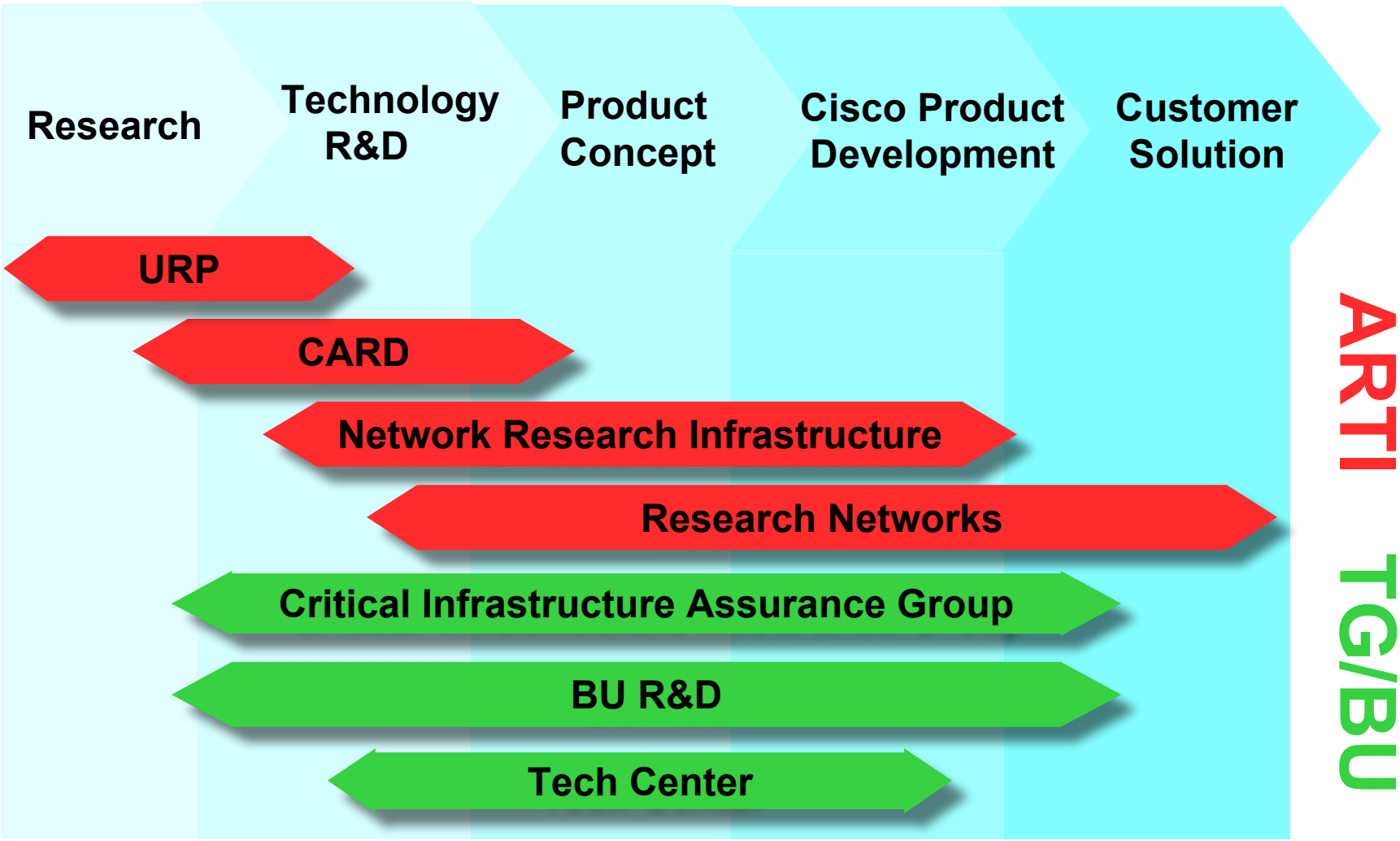
Cisco's Role in contributing to Current Internet

- **Next generation routers, switches, security, storage,…**
- **Standards Bodies (IETF, OIF, DTMF, IEEE,GGF,…)**

  Baker, Halvestrand : IETF Chairs; IESG, WG chairs, etc.
- **Partner with and support research networks on an international basis**

  Continued challenge: Network and system researchers VS production networks
- **Workshops for underdeveloped countries (eg. NATO)**
- **Support NANOG, APAN, APRICOT, TERENA, Joint Techs, and NRN conferences & Internet Organizations**
- **Internet Protocol Journal (IPJ)**

Cisco Research & Development
(covers the full life cycle of research)



Cisco's Role in contributing to Current Internet: Research Programs

- **Research programs (support continued innovation)**

  University Research Program (URP) - NSF/DARPA like program and awards (worldwide)

  Cisco Applied Research & Development (CARD) - directed shorter term research - IPR negotiated & SOW

  Research on large scale networks & protocols (TCP, BGP, Control planes, WEB100, EMULAB, …)

  Joint Cisco & University/research networks (RN) R&D – hybrid R&D (Twaren, CENIC, OARNET, NLR, AIST,…)

  Joint University-Cisco DARPA and NSF projects (LASOR, FAST, FIU, CalTech, UCB)

Cisco's Role in contributing to Current Internet : national, regional, state, affinity Research Networks

- **Helped create I2 & Abilene & Gigapops in 1998**
- **NOW (ie. 21st century)**

International networks

IEEAF, ALICE, GLORIAD, ULTRALIGHT, FIU-Cal Tech

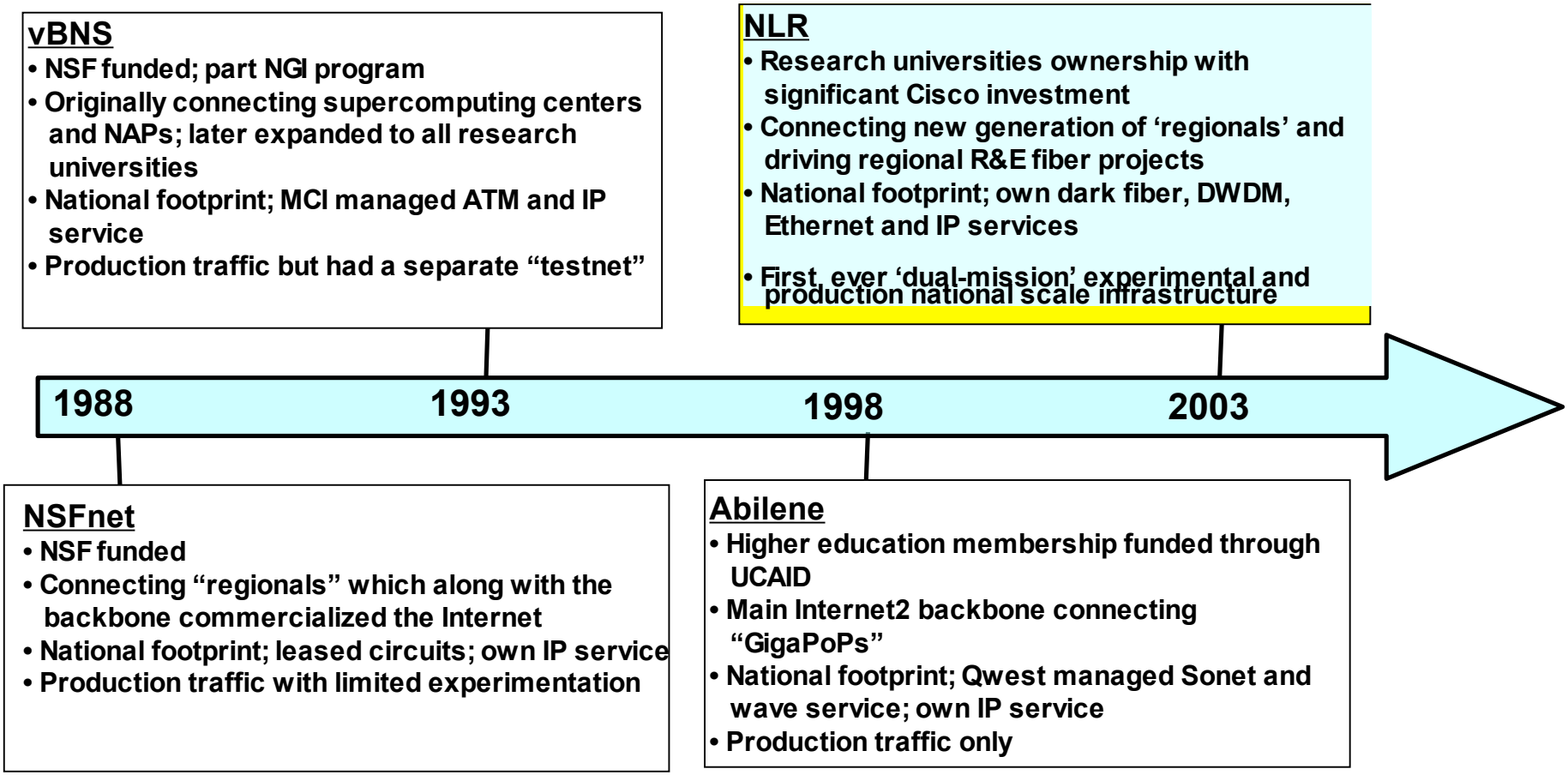
National Lambda Rail (NLR) - Cisco is partner/contributor

- full circle – ARPANET like environment ("back to the future")

- concurrently supports production and network research at all layers concurrently (ie. layer 1-9) & is AUP free

- provides primordial environment to develop next generation applications, Network, and Systems R&D

Historical Perspective: NLR is the next big US Research and Education community initiative



Every 5 years the US national research networking infrastructure evolves to the next level

NLR "Morphnet" Concept: Infrastructure Supporting Both Production and Experimental Networks

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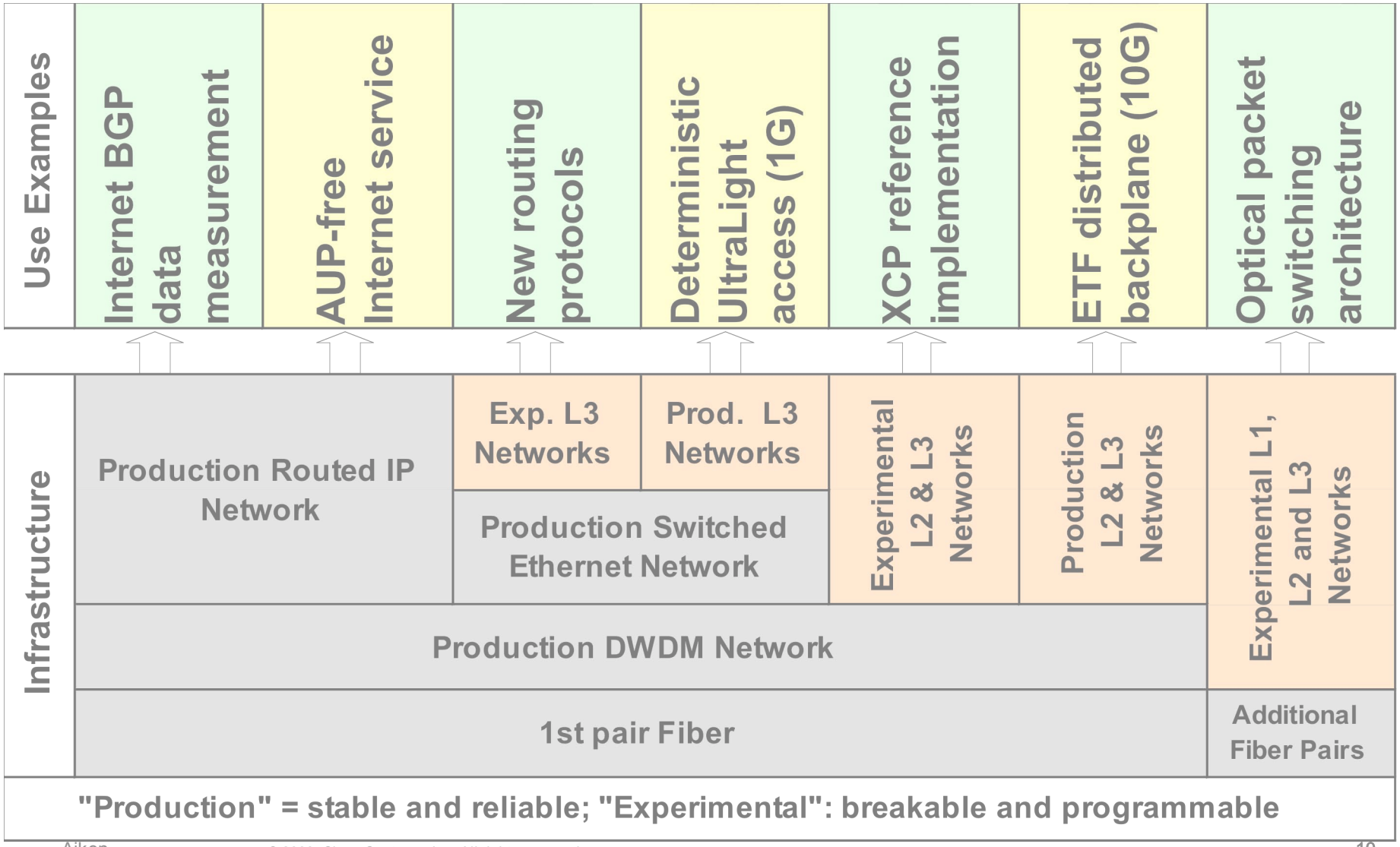
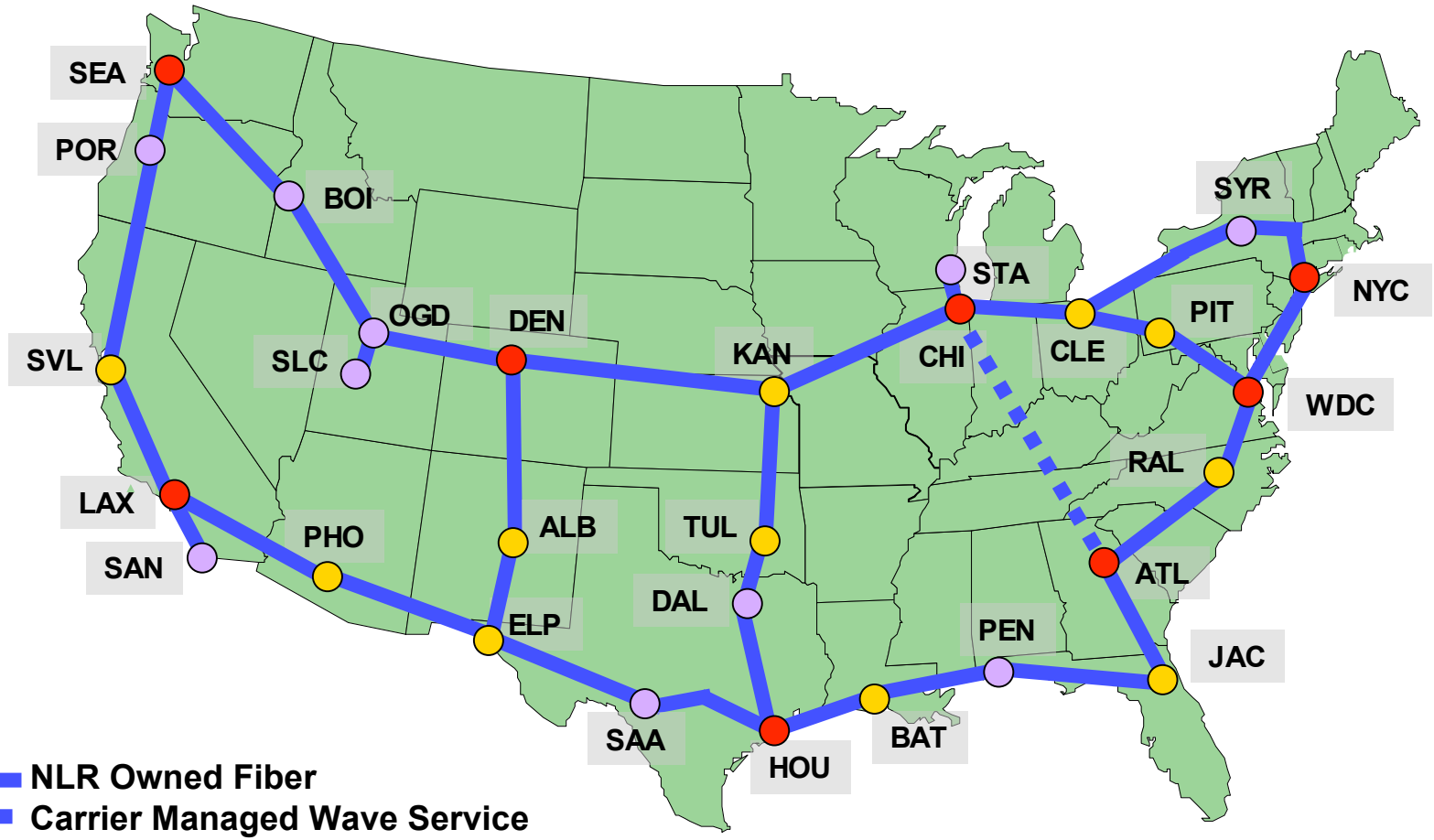


NLR Map – Phase 1 and Planned Phase 2 Footprint



NLR Owned Fiber

Carrier Managed Wave Service

NLR Layer 1, 2 and 3 PoP

NLR Layer 1 and 2 PoP

NLR Layer 1 PoP

Layer 1: Cisco 15000 series muxes

Layer 2: Cisco 6500 series switches

Layer 3: Cisco CRS-1 series routers

Future Growth of Internet

- Intelligent, self managing, self healing, self tuning networks
- Secure, highly available, fault tolerant networks
- Media convergence (data, voice, video)
- Evolution and scaling of TCP/IP (like Fortran) and experimentation of alternative transports
- Continued discussion of packet vs circuit (lambdas)
- Router & switch architectures evolve (like supercomputers)
- The edge evolves

  Mobile, wireless, ubiquitous computing, sensor nets, persistent presence, nomadic, , nano-technologies
- Multi-dimensional GRIDs (grid of grids) and peering at all layers
- Network and Grid aware applications (virtualization)
- Next Generation applications (p2p, multi-media, collaborative, …)

References

- **Communications of ACM, January ,2004, Volume 47, Number 1, pps 93-98**

  “Network and Computing Research Infrastructure : The Need to go Back to the Future” by Aiken, Boroumand, Wolff

- **Morphnet (1997)**

  http://www.anl.gov/ECT/Public/research/morphnet.html

External URLs for Academic Research and Programs

- http://www.cisco.com/go/arti
- http://www.cisco.com/go/research

- **Email: research@cisco.com**