Network Research Infrastructure: Back to the Future

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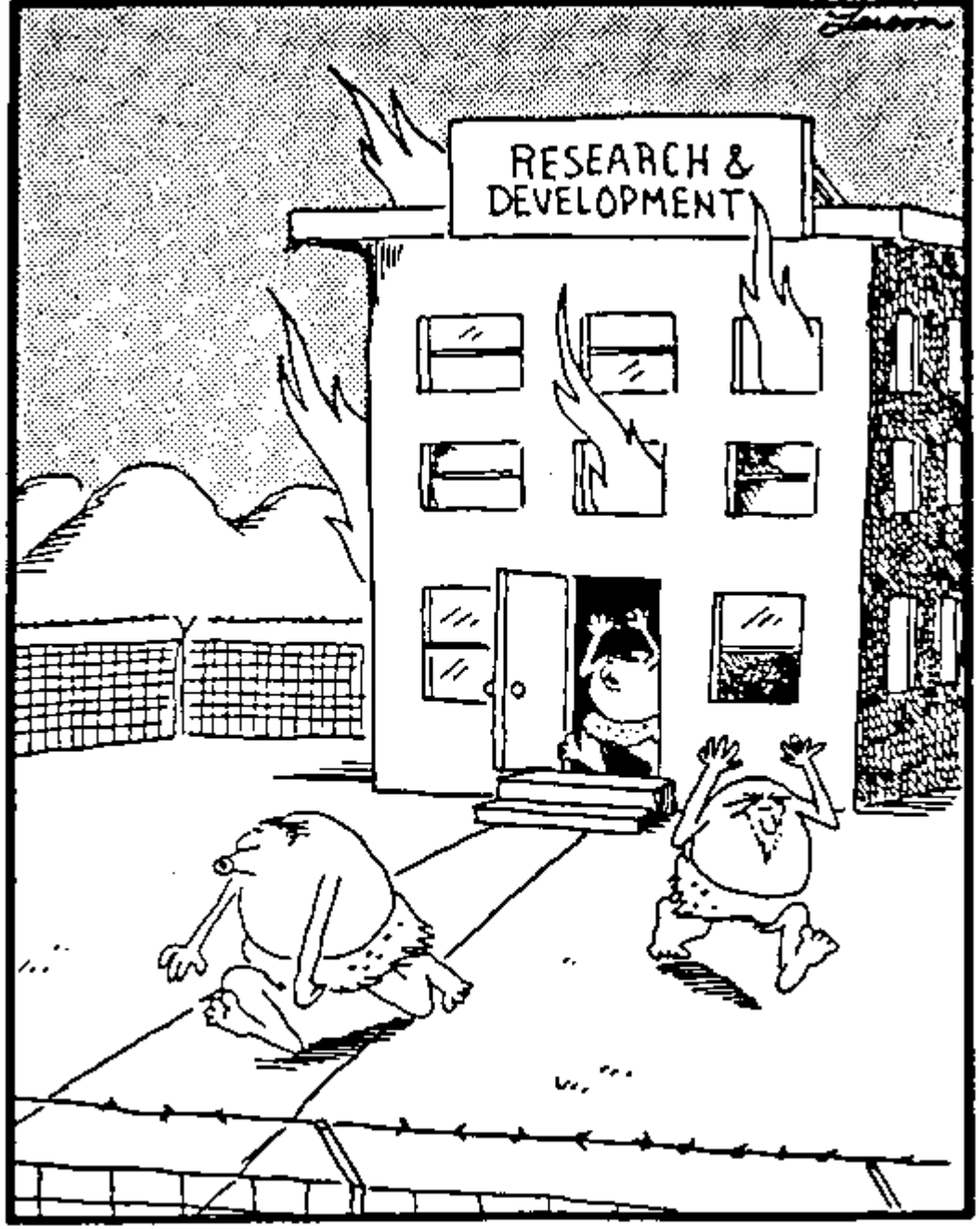
"Research is what I am doing when I don't know what I am doing"

Werhner von Braun



Fire is invented.

Evolution of Networks

- 1st the Earth cooled
- then we had Dinosaurs
- then we had oil
- then we had Mercedes Benz
- then we had ENIAC
- then we had ARPAnet
- then we had research networks (NSFNET, SURFnet, ESnet,…)
- then we had NGI
- then we had “THE Internet”, BMWs, and IPOs
- then we had the technology market bubble burst
- then the earth cooled – again - or did it?

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Evolution of Networks – really

- ARPAnet
- NSFNET/JANET/SURFNET/SINET/ESnet/etc.
- NSFNET II - NAPs, vBNS, ... (circa 1992) - peering & network mgmt R&D
  - Commercialized Internet
- Gigabit testbeds (circa 1992-95) - optics R&D and ATM
- WEB takes off (circa 1994)
- I-WAY (circa 1995) – 1st temporary "GRID"
- Internet2/NGI – Deja vu all over again ala NSFNET (circa 1996)
- Middleware / Globus / GRIDs (circa late 1990s)
- E-Presence / Ubiquitous computing / Nano technologies / PDAs / wireless - all Chaos agents changing way we work and live
- Concurrent network research & production networks (e.g. NLR, CENIC) & GRIDs – idea from 1997 MORPHNET

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Network Research Trends

- Intelligent Networks (not just Speed & Feeds)
- Dark Fiber & Waves
- VPNS & Tunneling
- Security, High availability, resiliency
- End to End Capabilities (core is least of our worries)
  - Host, Campus, PAN, LAN, MAN, WAN
- Next Generation TCP & Congestion control
  - E.g. FAST, XCP, HS-TCP, RDMA , etc.
- Convergence of Application, middleware and networks
- Network Research Infrastructures (e.g. NLR)

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Intelligent Networks

- Network management
- Dynamic provisioning
- VPNS & Tunnels
- Signaling and control
- QoS
- Policy
- Content and Path optimization
- Security
- Adaptive and agile networks

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GGF Network R&D WG

- Congestion Control & scaling of IP & TCP
- Routing : packet size vs TCP scaling
- Multicast
- OSes (end system, kernels, memory copies)
- Light vs heavy weight protocols (eg.PDA)
- Macroscopic traffic and System considerations

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Industry and Researcher Collaboration Opportunities

- All of the prior mentioned network trends provide ample opportunities for REAL Industry and R&E&D collaboration ;

- BUT

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We Need a New Model for Industry-R&E Collaboration

- Ask not what your industry partner can do for you , rather ask what you can do for your Industry Partner
- It's the relationship developed not the cheap or free HW & SW which is a value in the future

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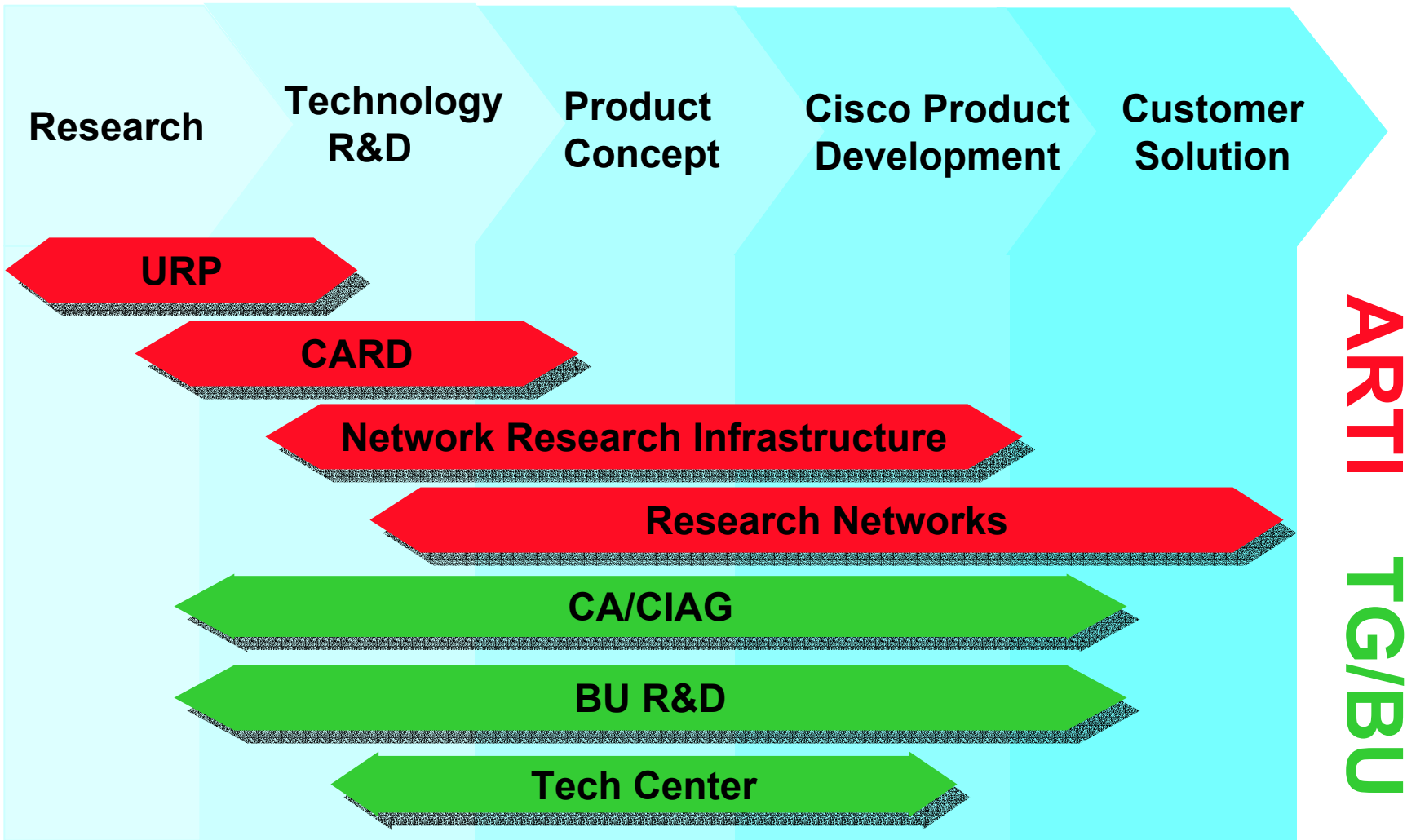
Cisco Research & Development



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Technology Transfer & Industry Collaboration MYTH

- **The Vast majority of research is never transferred to Industry or commercialized**
- **Industry collaborators should be more than names proposals**
- **"Submarine Truths"**
  - **R&D will develop niche markets which Industry won't pursue due to lack of markets**
  - **so Government and R&D community needs to belly up to the bar and pay for it – don't pass off as TECH XFER**

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Need New Model of Industry-R&E Relationship

- Quit looking to Industry as cash cows to just fund lunches, conferences, etc.
- Quit asking for free HW and SW
- Look for real partnerships
  - Put real $ on table – pay for somethings – Industry will meet you halfway
  - No AUP – get real industry involved at all layers
  - Adopt real joint research and production infrastructure
    - ✓ No Pain No Gain – ie. cannot claim its cutting research when its based on 99. 999% up time!
    - ✓ Real joint R&D will benefit both Industry and R&D

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CalREN-2 : Design Methodology

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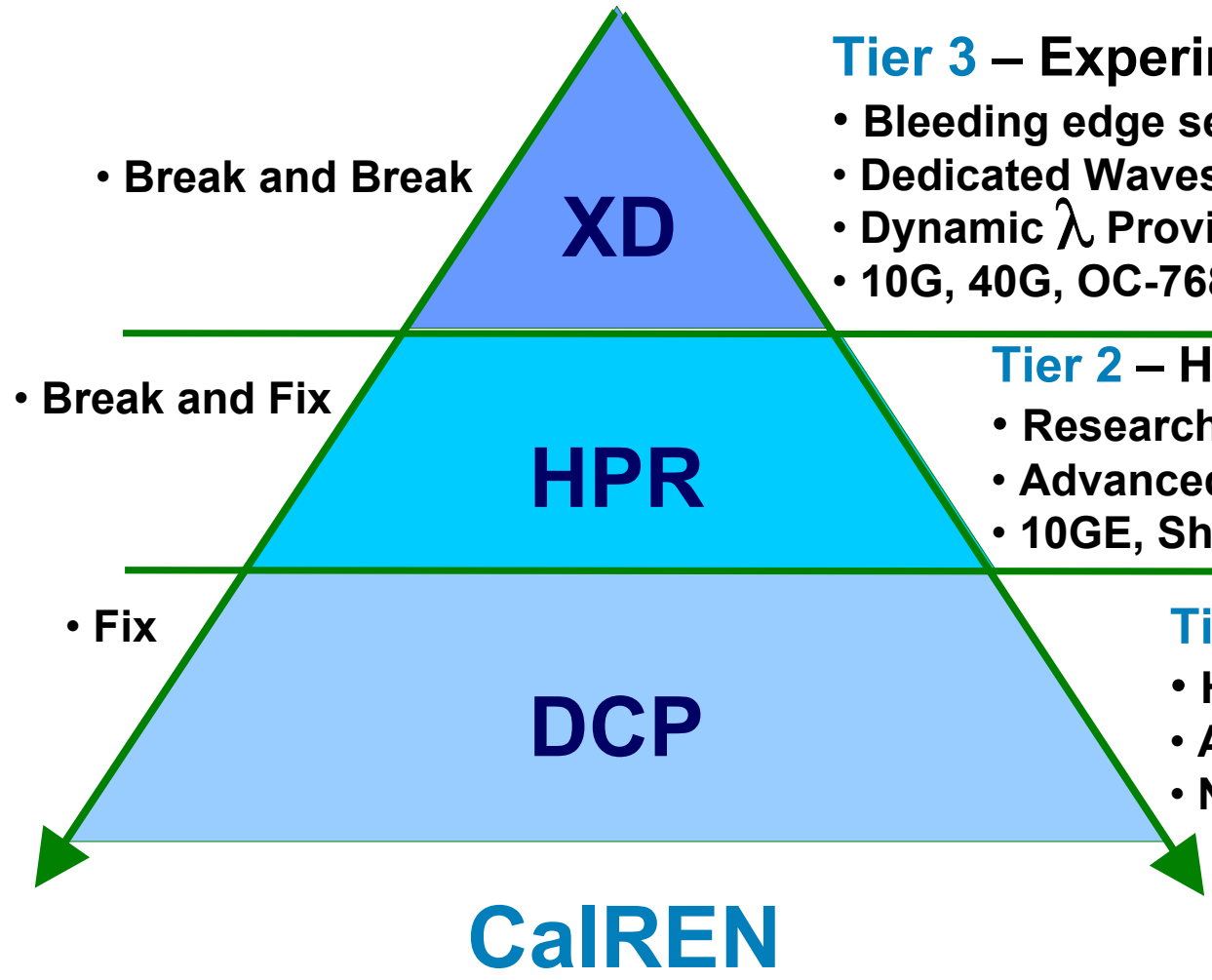

Tier 3 – Experimental/Developmental

- Bleeding edge services
- Dedicated Waves
- Dynamic λ Provisioning
- 10G, 40G, OC-768
- Network Playground
- Unknown Services

Tier 2 – High Performance Research

- Research Apps, low latency, GRID
- Advanced Services IPv6, QoS, IPMc
- 10GE, Shared Waves

Tier 1 – Commodity Internet

- High Availability
- Aggregated Connectivity
- NxGE, OC-12, OC-48

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NLR networking research use vs. production (aka MORPHNET) – NO AUP!

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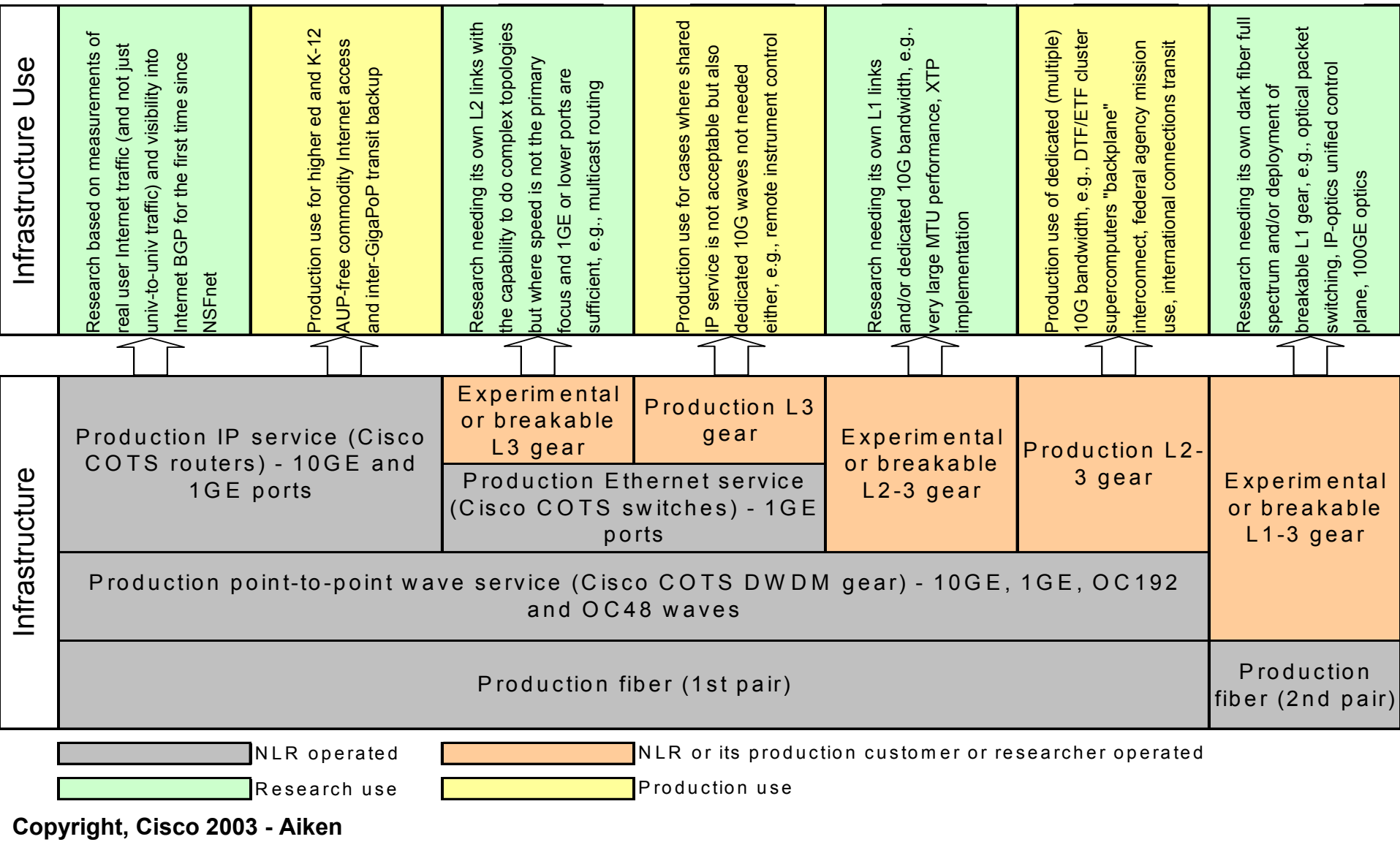

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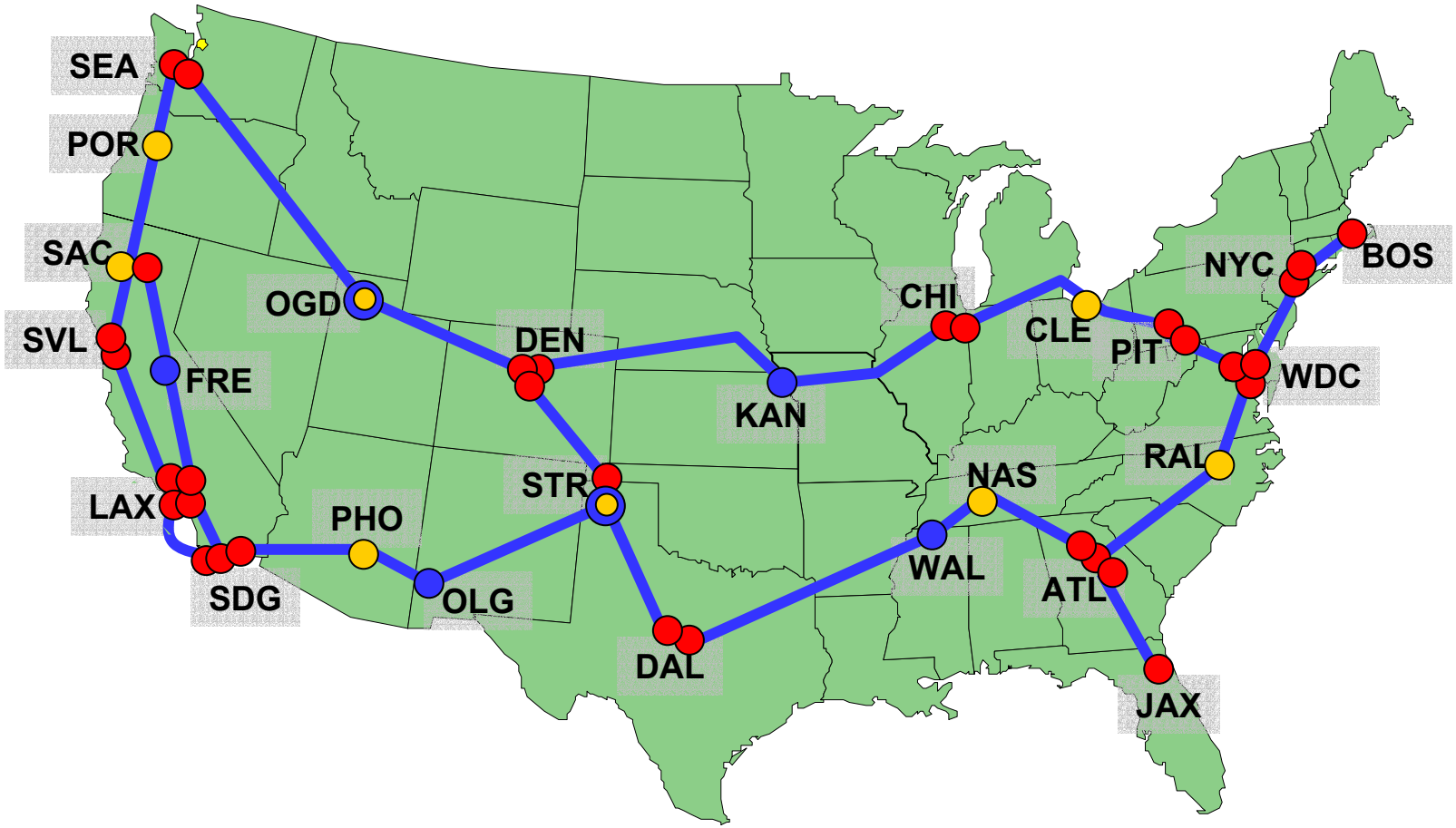
Experimental network facilities: NLR



15808 Terminal

15808 OADM

Fiber route

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Summary

- Application and Network research were coupled on the ARPANET and NSFNET
- WEB grew as result of Application requirements and the existence of a transparently connected network research infrastructure
- Need to go back to the Future and do this again
  - This will only occur when we see a real partnership between Industry and R&D community that goes beyond just getting free HW/SW
  - Programs need to budget accordingly for Networks and other infrastructure and people

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