

High Performance Communications Based on Dynamic Lightpaths: TransLight/GLIF

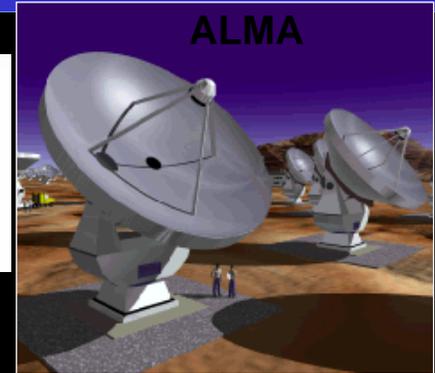
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International Center for Advanced Internet Research (www.icaair.org)
Director, Metropolitan Research and Education Network (www.mren.org)
Partner, StarLight/STAR TAP, PI-OMNINet (www.icaair.org/omninet)

JET Workshop on Optical Network Testbeds
National Science Foundation
Arlington, Va.

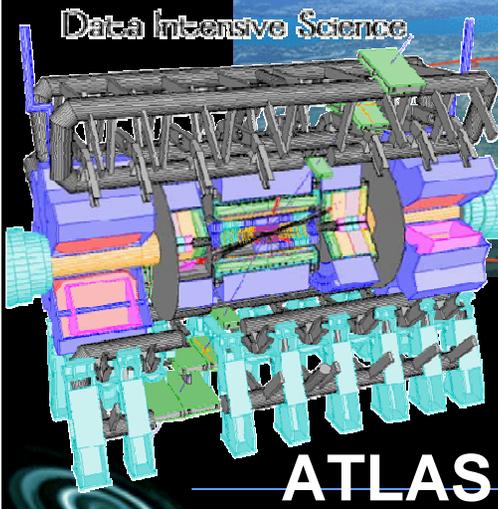
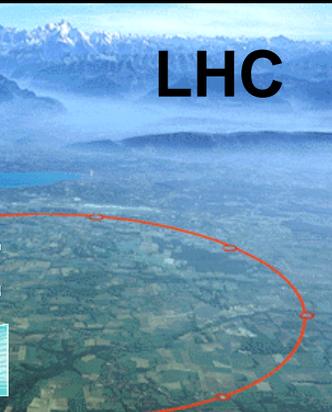
April 19, 2005



Perspective: Large Scale Science Is Global



GrPhyN



Source:
Larry Smart



Overview of Initiatives

- **Ref: Earlier Presentation on Emerging New Communications Architecture, New Technologies Migrating to Global Infrastructure**
- **Dynamic Lightpaths – Globally Implemented**
- **TransLight (First Instantiation of the GLIF)**
- **GLIF – Global Lambda Integrated Facility (www.glif.is)**
- **StarLight – An Initial GLIF Facility TransLight/StarLight IRNC (www.startap.net/starlight)**
- **TransLight/PacificWave IRNC**
- **GLORIAD and GLORIAD IRNC**
- **APATH and WHREN IRNC**
- **TransPAC IRNC**



*Lights and TransLight

- *Lights are bandwidth concentrators and exchanges (StarLight, NetherLight, UKLight, NorthernLight, T-LEX, CzechLight, HKLight, TaiwanLight etc...)
- *Lights also deliver Grid services such as computing, storage and visualization support
- *Lights disrupt old pricing structures from the traditional telcos, which kept the prices high
- *Lights goal is understanding the big data streams and how to map them economically to the least services they need
- **TransLight is the initial infrastructure part of GLIF, the Global Lambda Integrated Facility, an direct result of Euro-Link activities**

Source: Tom DeFanti



What is GLIF?

- GLIF is a consortium of institutions, organizations, consortia and country National Research & Education Networks who voluntarily share optical networking resources and expertise to develop the *Global LambdaGrid* for the advancement of scientific collaboration and discovery
- GLIF is under the leadership of SURFnet and University of Amsterdam in The Netherlands
- GLIF Is Developing Architectural Models for Global GLIF Services and Facilities, such as Open Exchange Points
- GLIF Is a Key Organizer of iGRID 2005
- www.glif.is

Source: Tom DeFanti



What is the LambdaGrid?

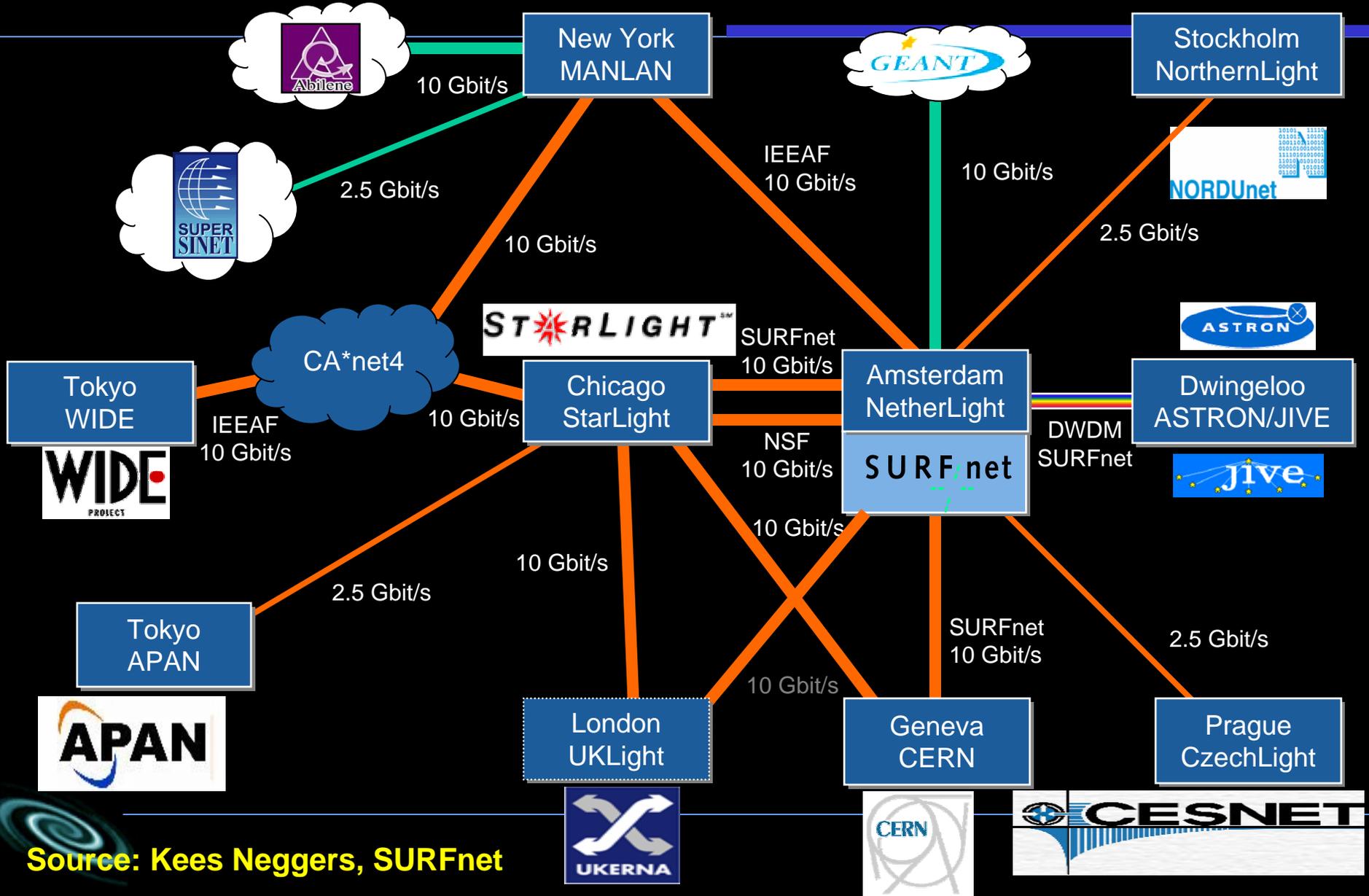
- **Today's Grids** enable scientists to schedule computer resources and remote instrumentation over today's "best effort" networks.
- **LambdaGrids** enable scientists to *also* schedule bandwidth. Wave Division Multiplexing (WDM) technology divides white light into individual wavelengths (or "lambdas") on optical fiber, creating parallel networks.
- LambdaGrids provide *deterministic networks* with known and knowable characteristics.
 - Guaranteed Bandwidth (data movement)
 - Guaranteed Latency (collaboration, visualization, data analysis)
 - Guaranteed Scheduling (remote instruments)

Source: Tom DeFanti

STARLIGHTSM



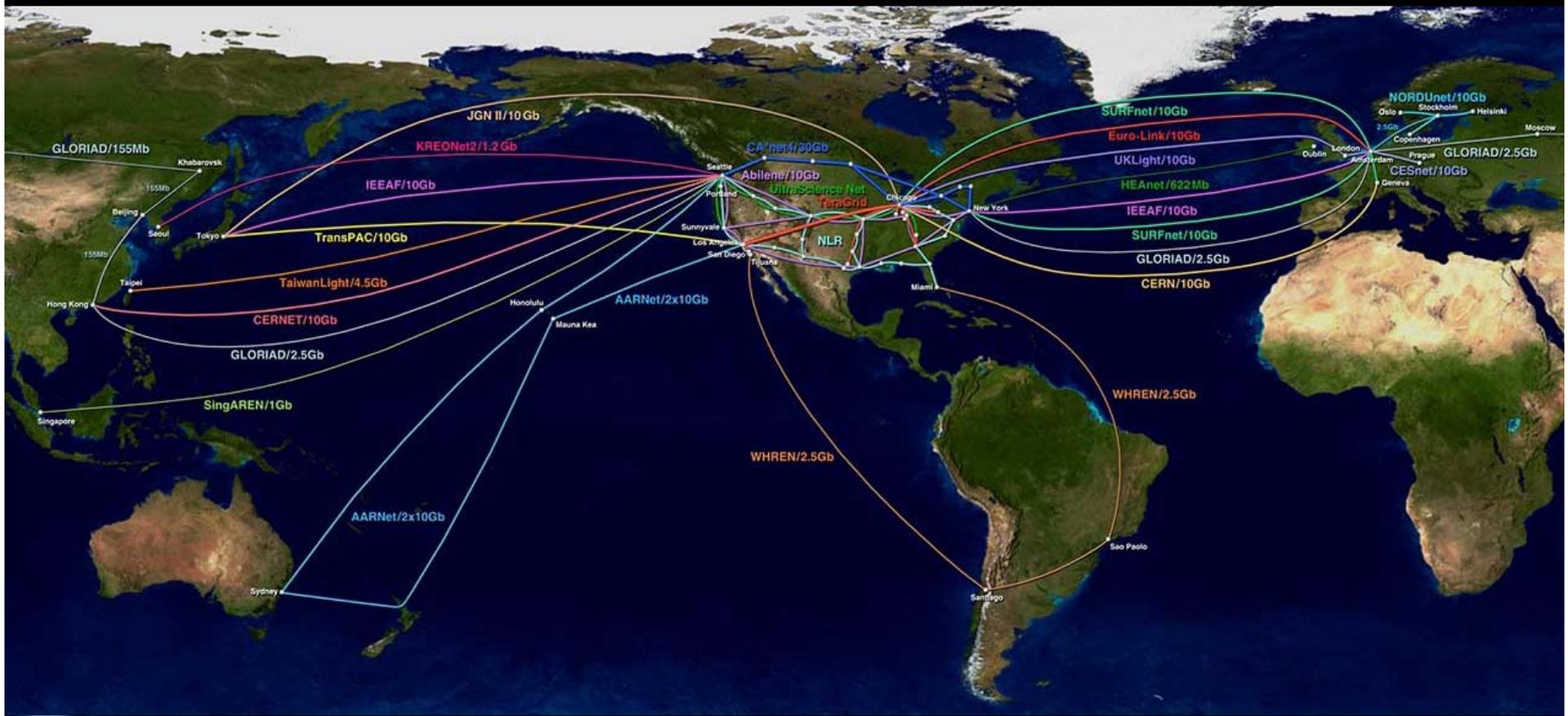
Global Participation: GLIF at StarLight



Source: Kees Neggers, SURFnet

Global Lambda Integrated Facility World Map – December 2004

Predicted international Research & Education Network bandwidth, to be made available for scheduled application and middleware research experiments by December 2004.



TransLight/StarLight IRNC Award SCI-0441094

Tom DeFanti (Principal Investigator)
Maxine Brown (Co-Principal Investigator)
Joe Mambretti (Investigator)

- **In cooperation with US and European national research and education networks, TransLight/StarLight will implement a strategy to best serve established production science**
- **TransLight/StarLight will support usage by those scientists, engineers and educators who have persistent large-flow, real-time, and/or other advanced application requirements**



Scope of Work

- **Procure and maintain (minimally) one OC-192 circuit that connects UCAID's Abilene network in New York City (NYC) to TERENA's GÉANT L3 network in Amsterdam.**
- **Evaluate feasibility of a second OC-192 for L1/L2 production services for high-flow data/collaboration-intensive applications.**
- **Ensure that appropriate traffic monitoring, measurement and analysis are accomplished through NSF-designated partners.**
- **Provide related management, documentation, engineering support and education and outreach efforts, and attend relevant networking and/or discipline science meetings and conferences.**
- **Promote and support availability to the advanced science, engineering and education communities who require ongoing transatlantic production services.**
- **Also Ref: IRNC Translight/PacificWave (TL/PW) PI John Silvester (USC), Co-PI Ron Johnson (UW), GLORIAD IRNC, Greg Cole, APATH/WHREN IRNC,**



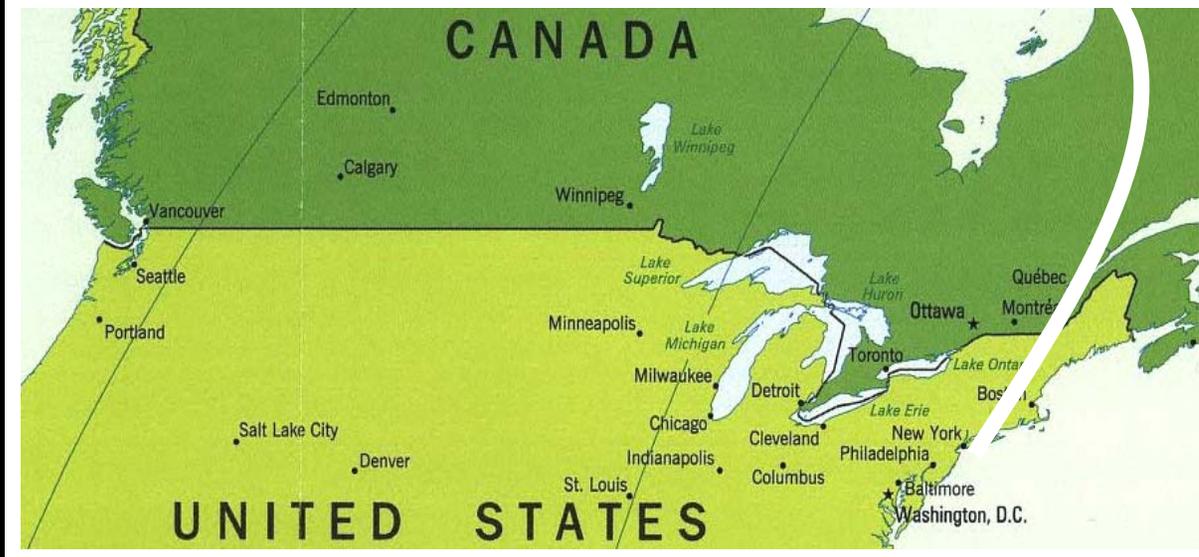
TransLight/StarLight IRNC



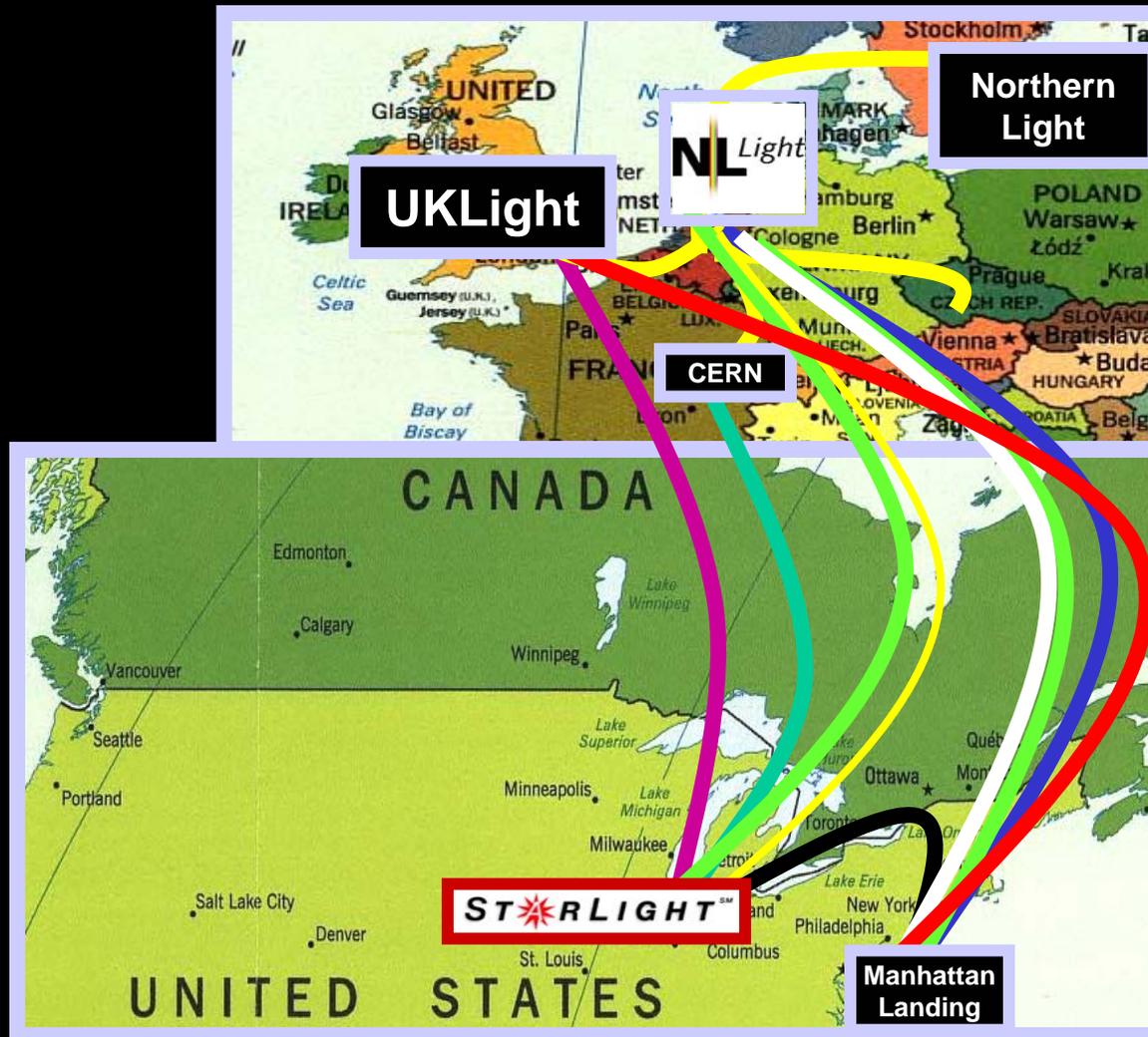
**HPIIS Euro-Link
OC-192 connection
in place until June
30, 2005**

**Tender out for new
link(s); responses
due in April**

**New link(s) to be
live on July 1, 2005**



Leveraging ~12xOC-192s Trans-Atlantic



US TransLight/StarLight (black)
10-20Gb NYC—Amsterdam

US GLORIAD IRNC (Dark Blue)
~1-10 Gb Chicago—Amsterdam

GEANT/Internet2 (red)
~30Gb London, etc.—NYC/DC?

UKLight to US (magenta)
~10Gb London—Chicago

SURFnet to US (Green)
~10Gb Amsterdam—NYC
~10Gb Amsterdam—Chicago

CERN to US (cyan)
~10Gb CERN—Chicago

IEEAF (blue)
~10Gb NYC—Amsterdam

Canadian CA*net4 to US (white)
~40Gb Chicago-Canada-NYC
~10Gb NYC—Amsterdam

European (not GEANT) (yellow)
~20Gb Amsterdam—CERN
~10Gb Prague—Amsterdam
~10Gb Stockholm—Amsterdam
~10Gb London—Amsterdam



StarLight – “By Researchers For Researchers” A Key TransLight/GLIF Facility

StarLight is an experimental optical infrastructure and **proving ground for network services** optimized for high-performance applications

GE+2.5+10GE Exchange

Soon:

Multiple 10GEs

Over Optics –

World’s “Largest”
10GE Exchange!



View from StarLight



Abbott Hall, Northwestern University's
Chicago downtown campus



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StarLight Infrastructure

StarLight is *a large research-friendly co-location facility* with space, power and fiber that is being made available to university and national/international network collaborators as a *point of presence* in Chicago



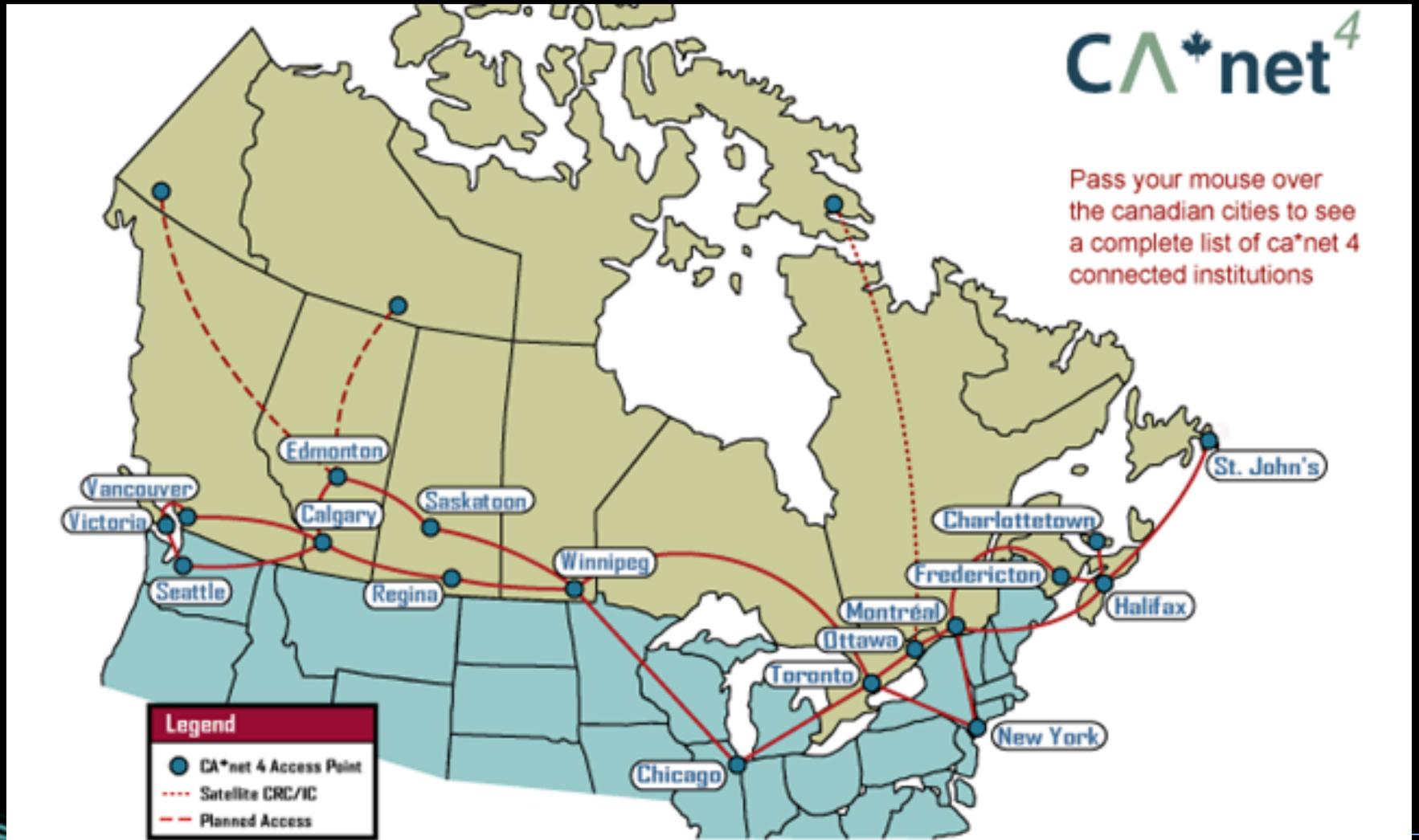
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StarLight

- **StarLight Provides Next Generation Advanced Services and Facilities in Cooperation With Multiple Regional, National, and International Networks**
- **StarLight Provides Facilities for Advanced Prototypes and Early Implementations**
- **StarLight Also Provides an Exceptional Opportunity for Leading Edge Innovation and Experimentation**
- **Future Evolution Will Implement a Range of Advanced Technologies**



CA*net4 has 2x10Gb and Equipment at StarLight



Source: CANARIE

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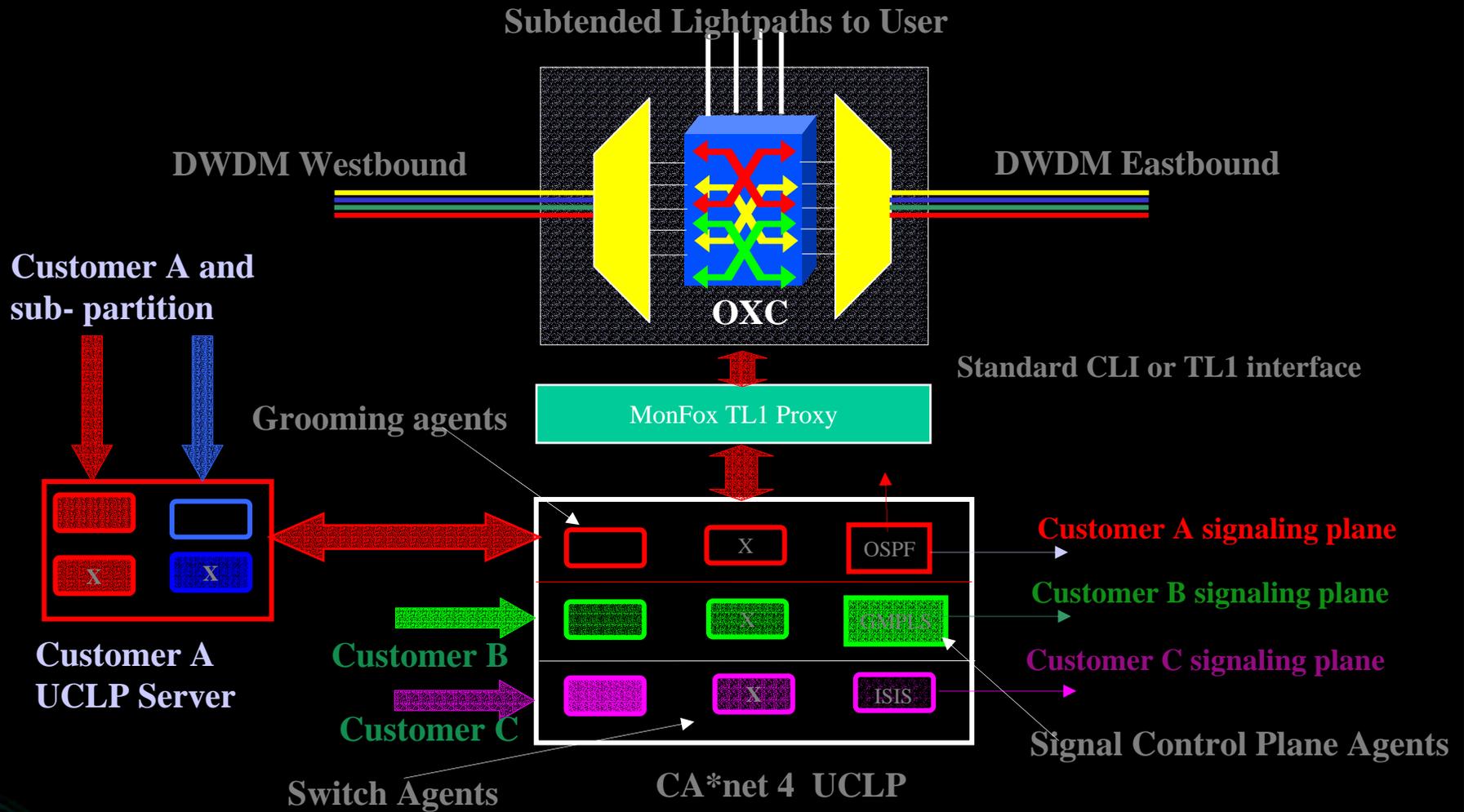
CA*net⁴

Canada's Research and Innovation Network
Réseau canadien pour la recherche et l'innovation

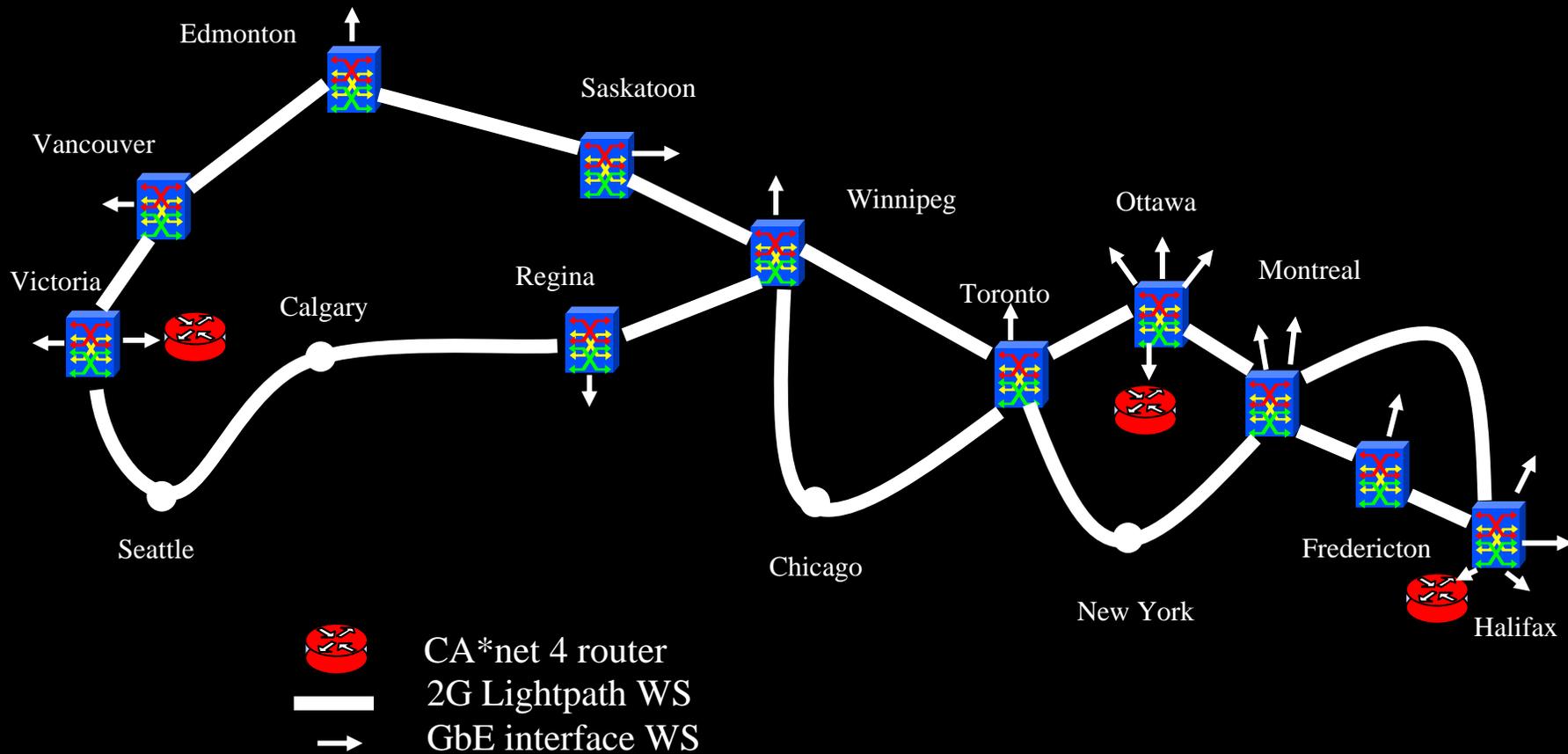


Spring/Printemps 2004

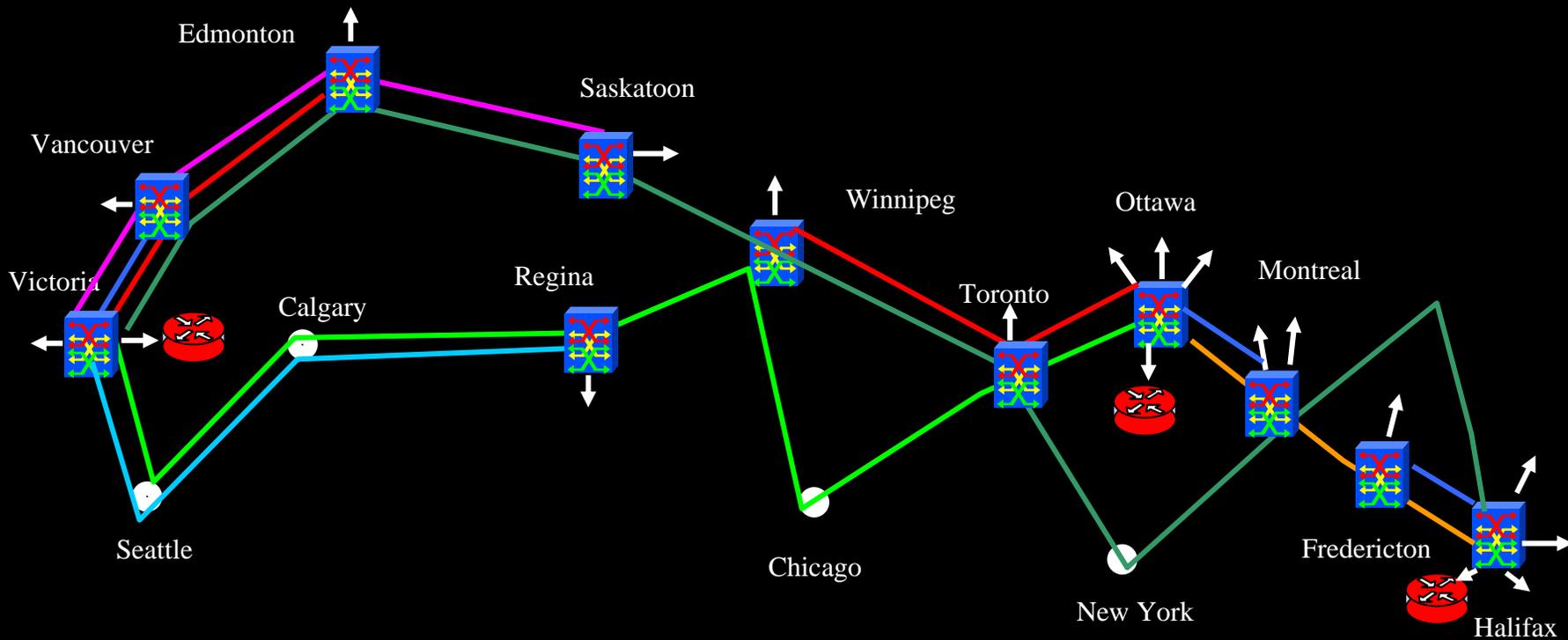
UCLP general operation



CANARIE provides APN to NRC

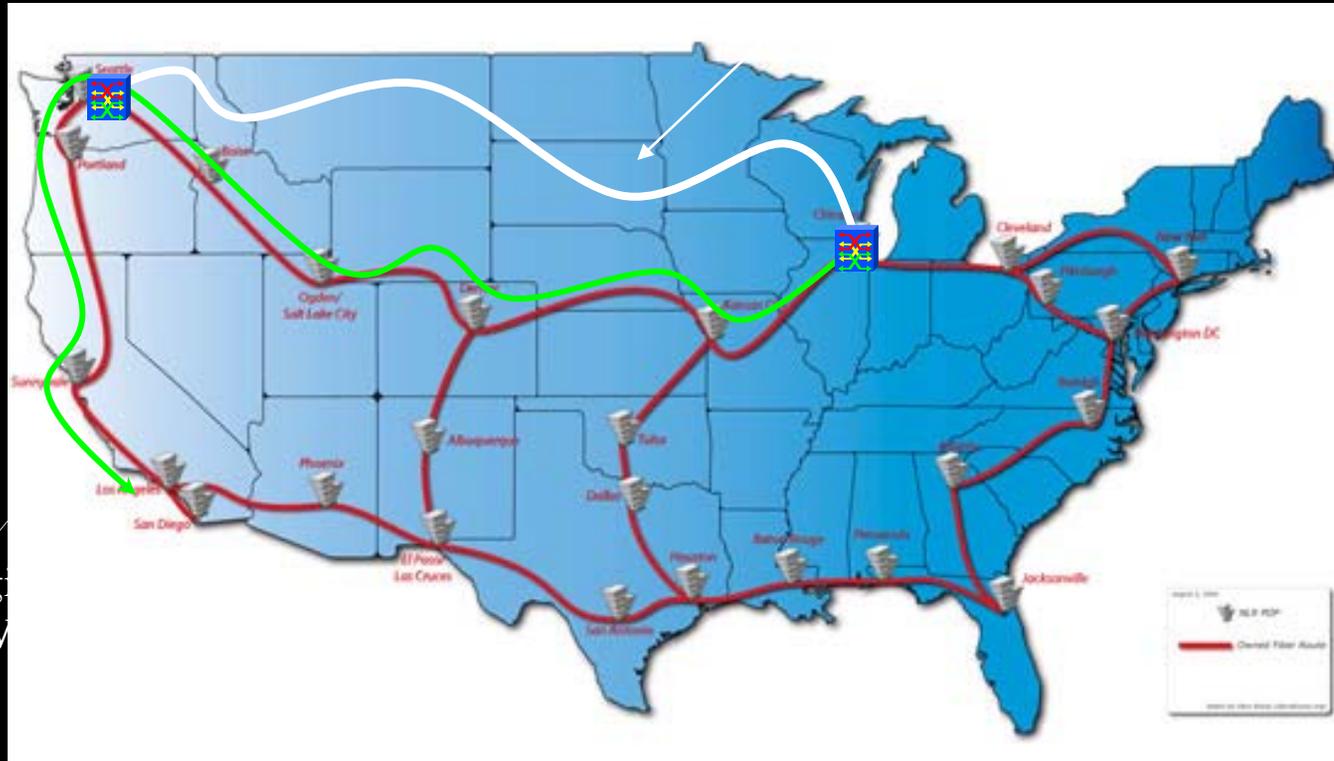


NRC partitions APN



UCLP intended for projects like National LambdaRail

CAVEwave acquires a separate wavelength between Seattle and Chicago and wants to manage it as part of its network including add/drop, routing, partition etc



NLR
Condominium
lambda network

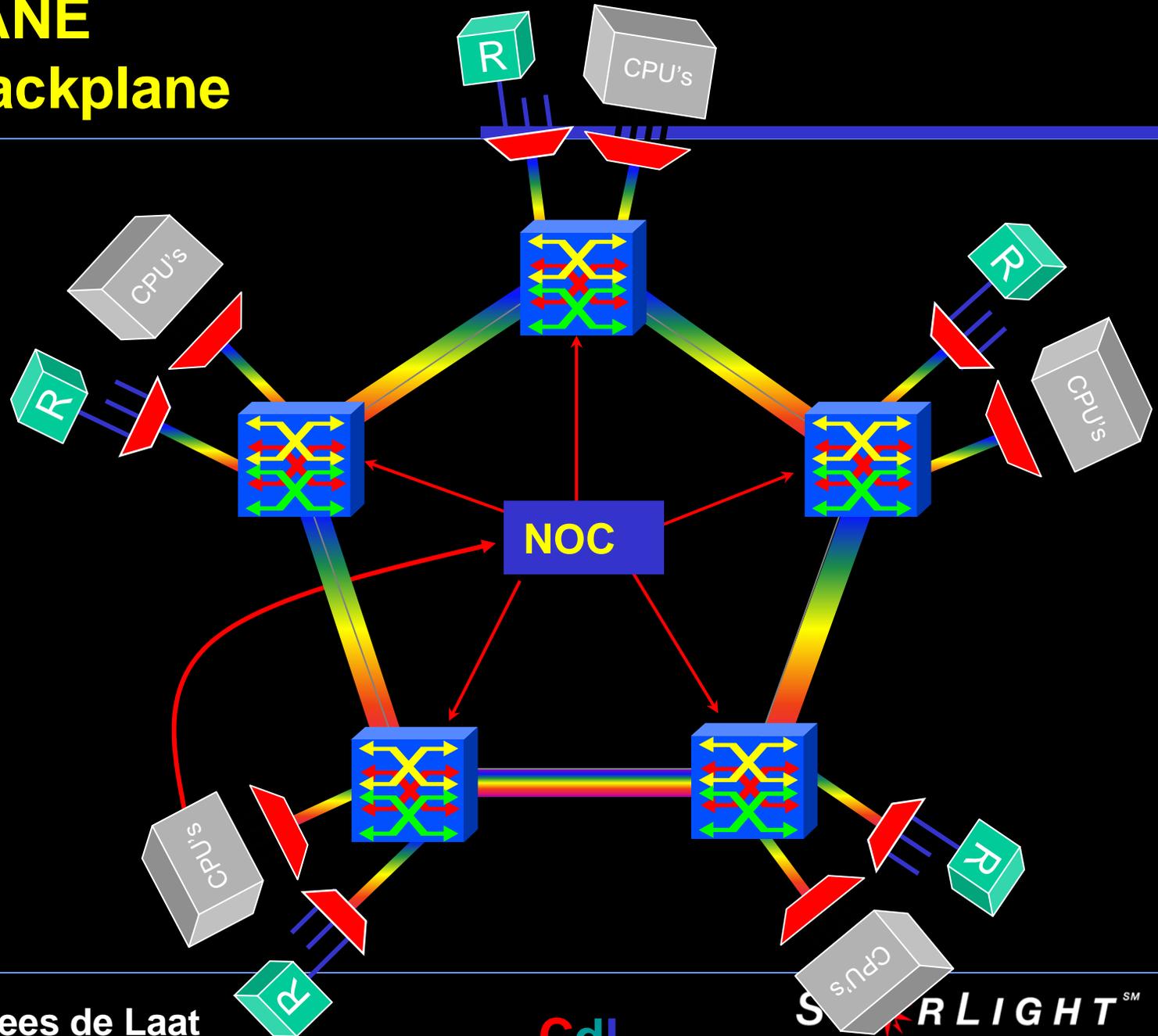
Original
CAVE

SURFnet5 – Soon “6” Connected to StarLight via Production Circuit and NetherLight Research Circuit



- Partners BT and Cisco
- 15 PoPs connected by thirty 10 Gbit/s lambdas
- Dual stack IPv4 and IPv6
- 500,000 users
- 84 institutes connected at Gbit/s level

STARPLANE DWDM Backplane

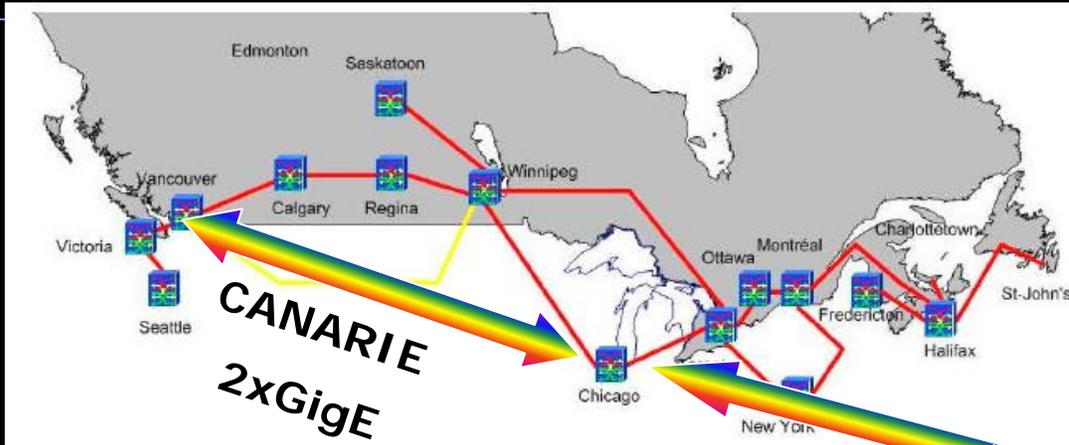


UvA-VLE
UvA-MM
VU
ULeiden
TUDelft

Source: Cees de Laat

CdL

SR LIGHTSM

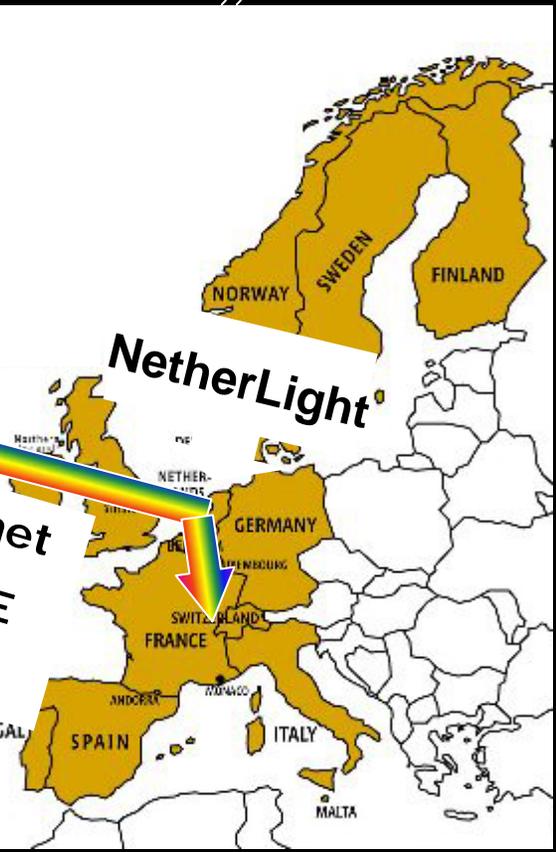


circuits

StarLight

SURFnet
2xGigE
circuits

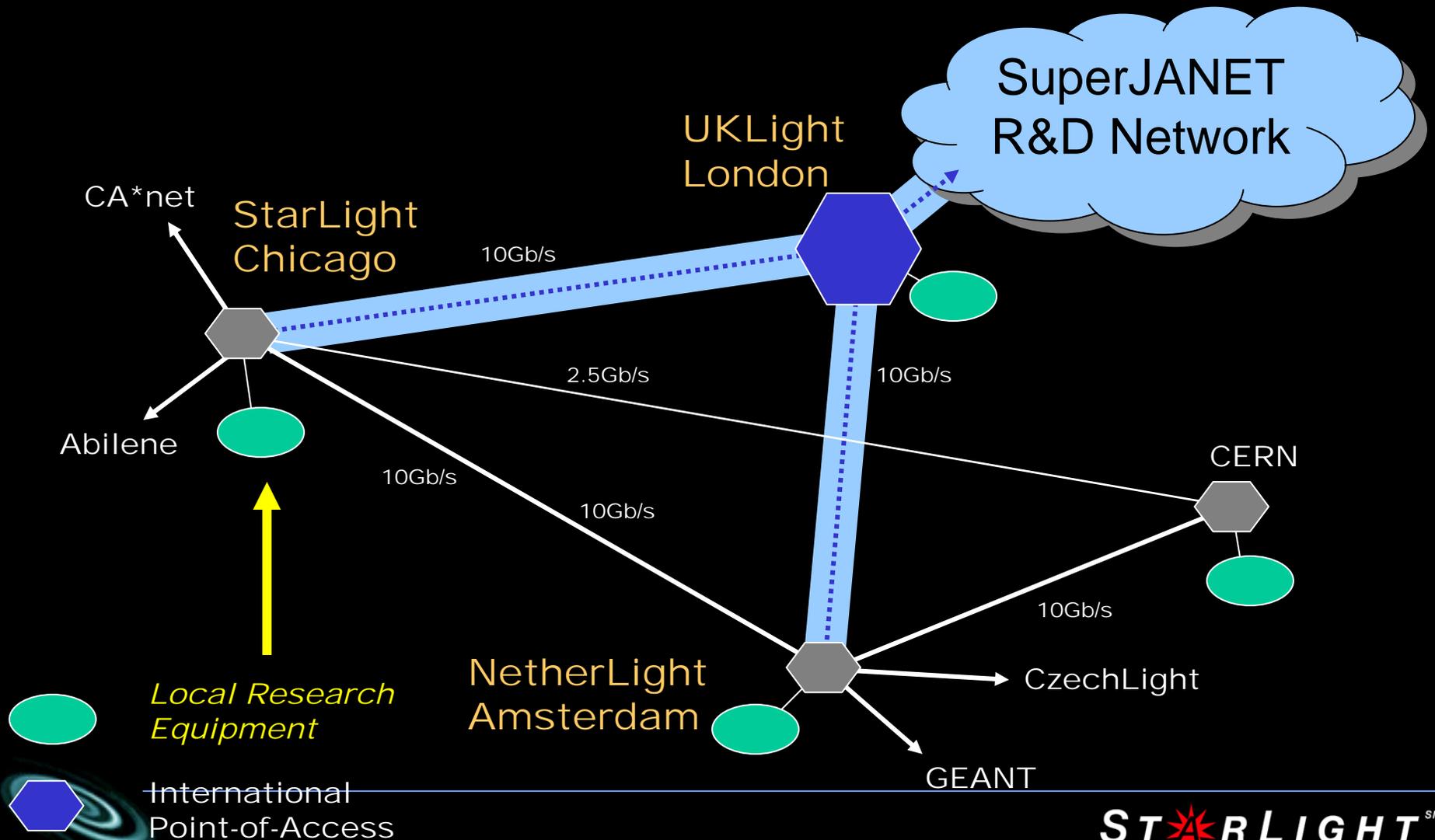
NetherLight



Source: Tom DeFanti



UKLight is Connected to StarLight with 10Gb and Equipment



Source: Peter Clarke, David Salmon, UKLight

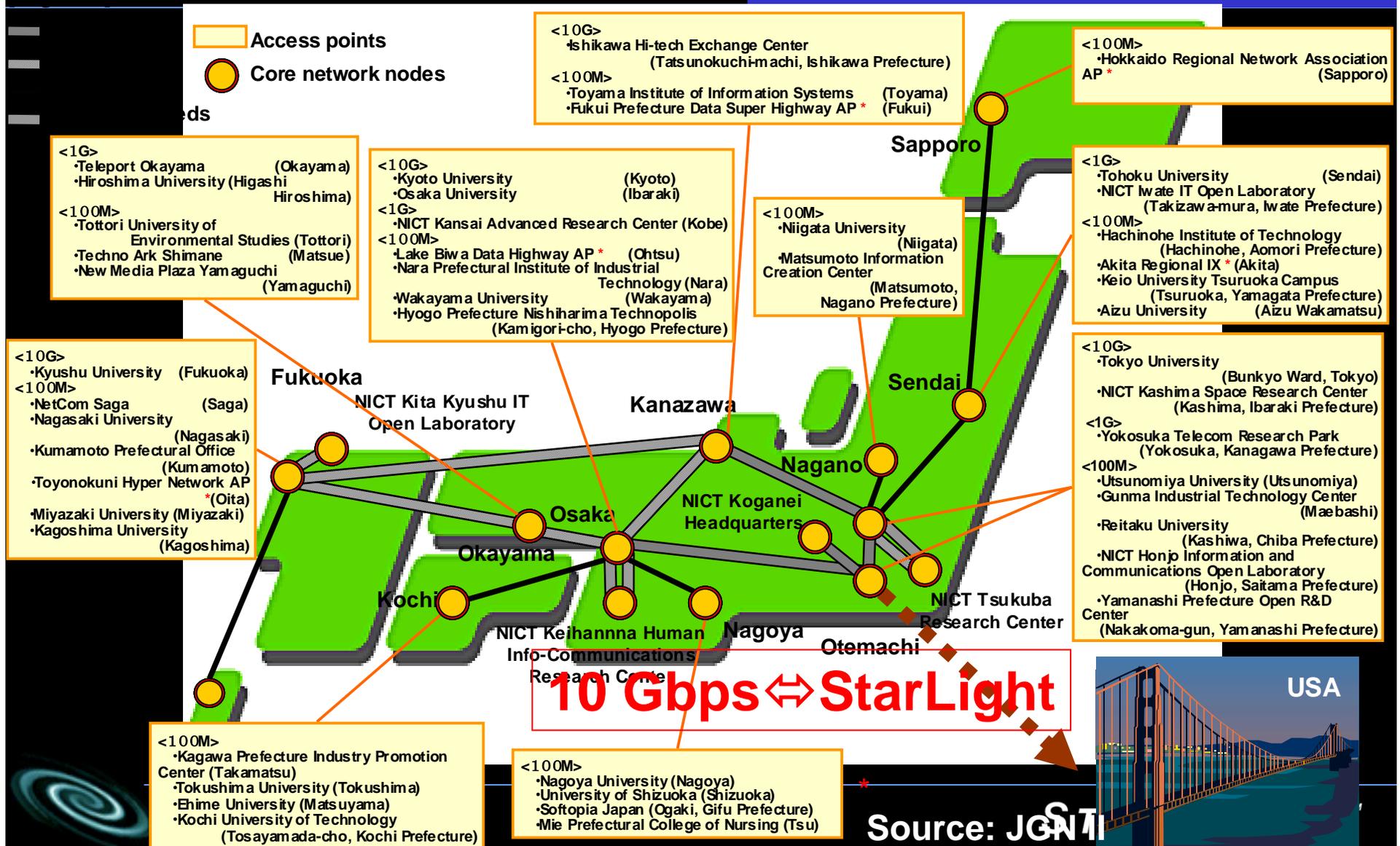
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GLORIAD: Worldwide Ring

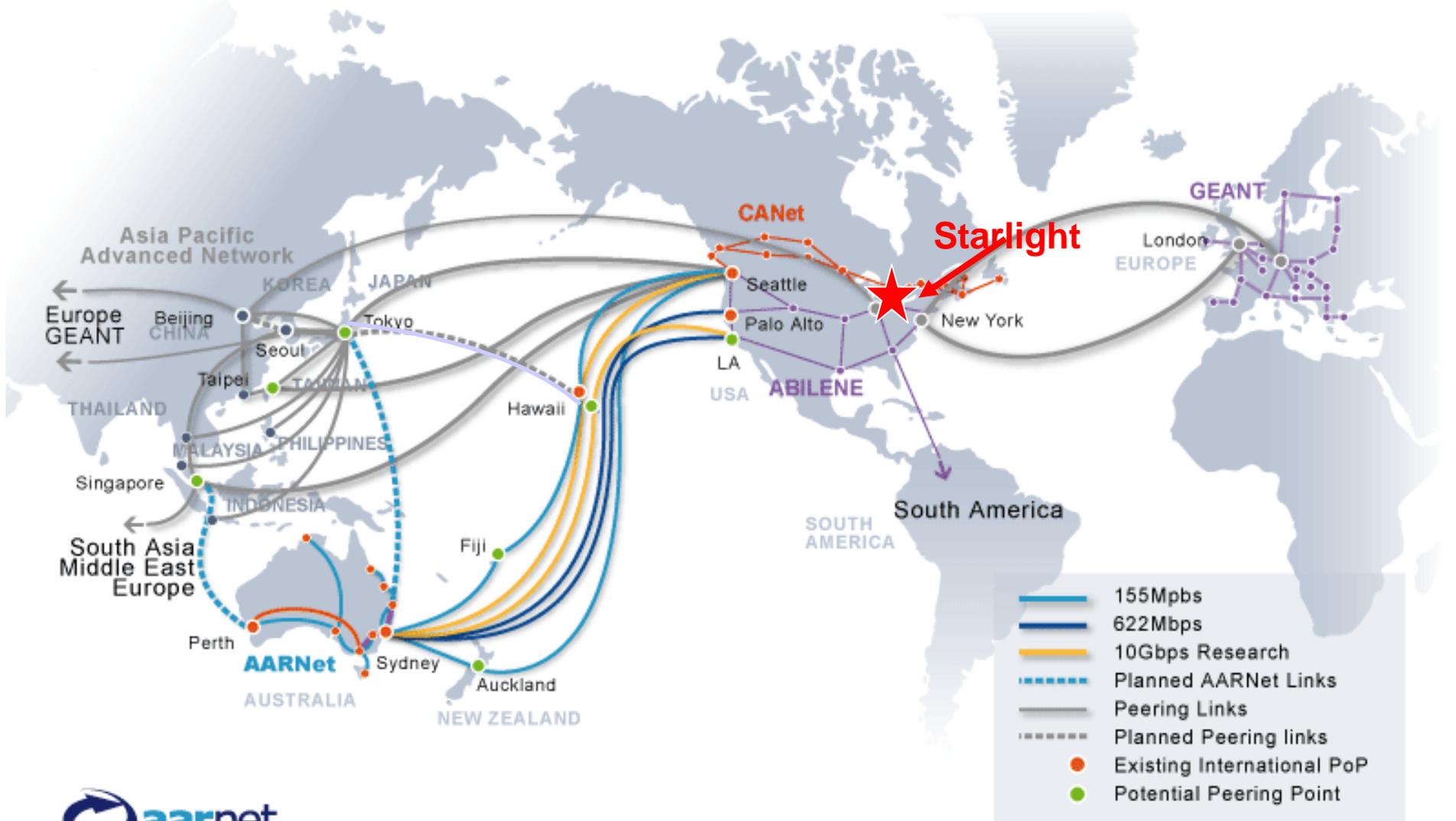
Now 622 Mb StarLight to Moscow, 10Gb Coming



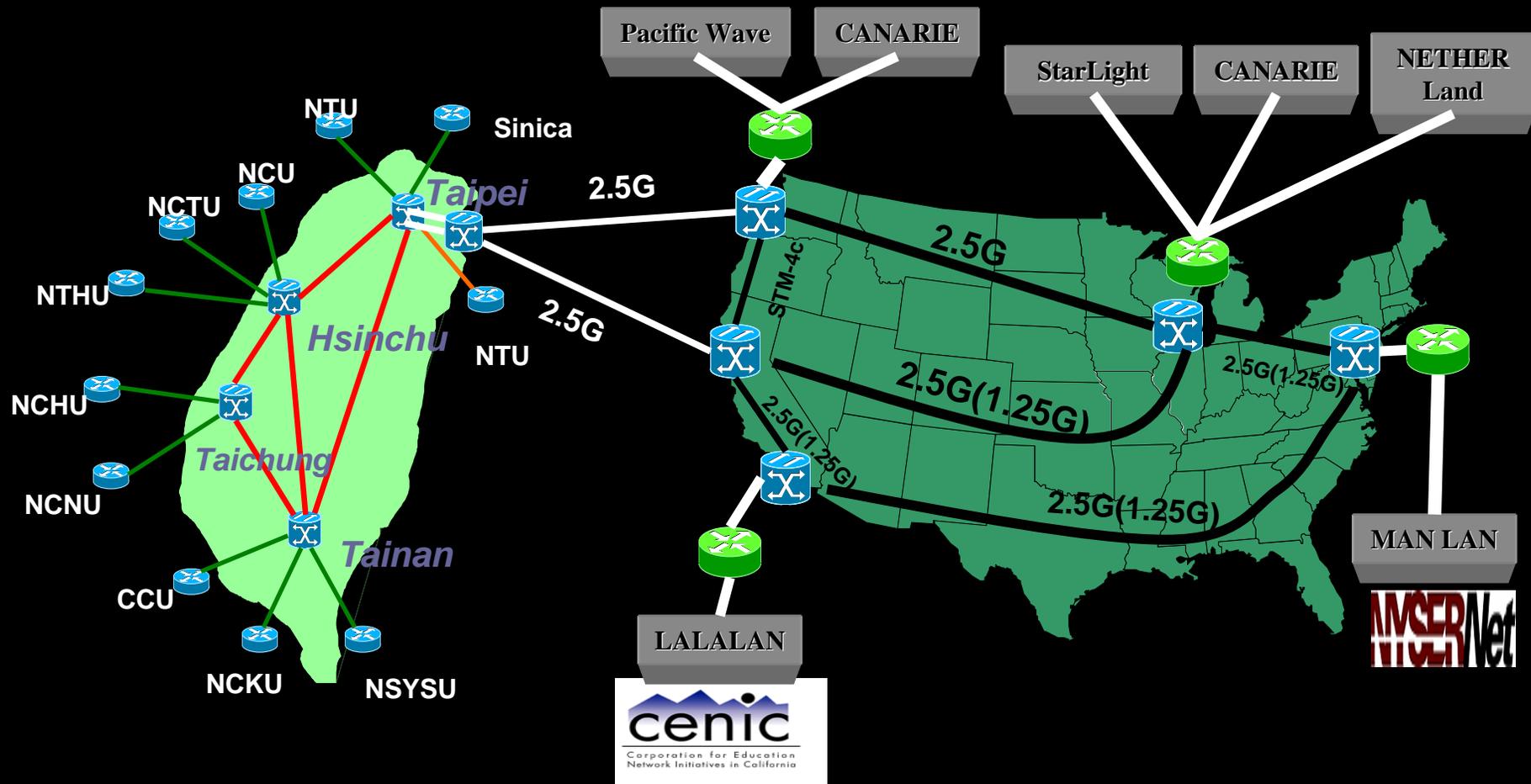
JGN II Network Topology Map



AARNET's International Connections



TWARENLight Path



Source: TWAREN

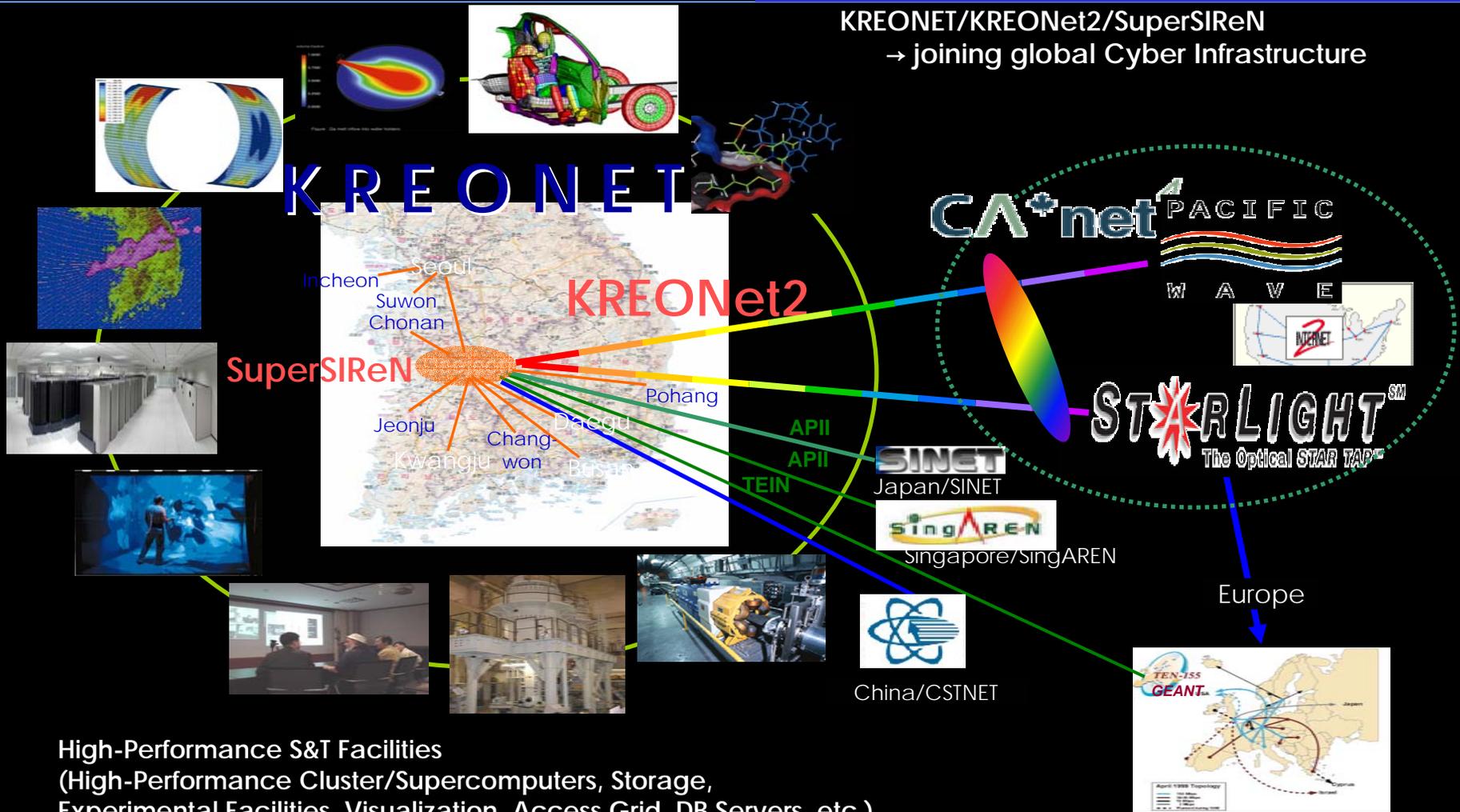
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Kreonet

e-Science based

KREONET/KREONet2/SuperSIReN

→ joining global Cyber Infrastructure



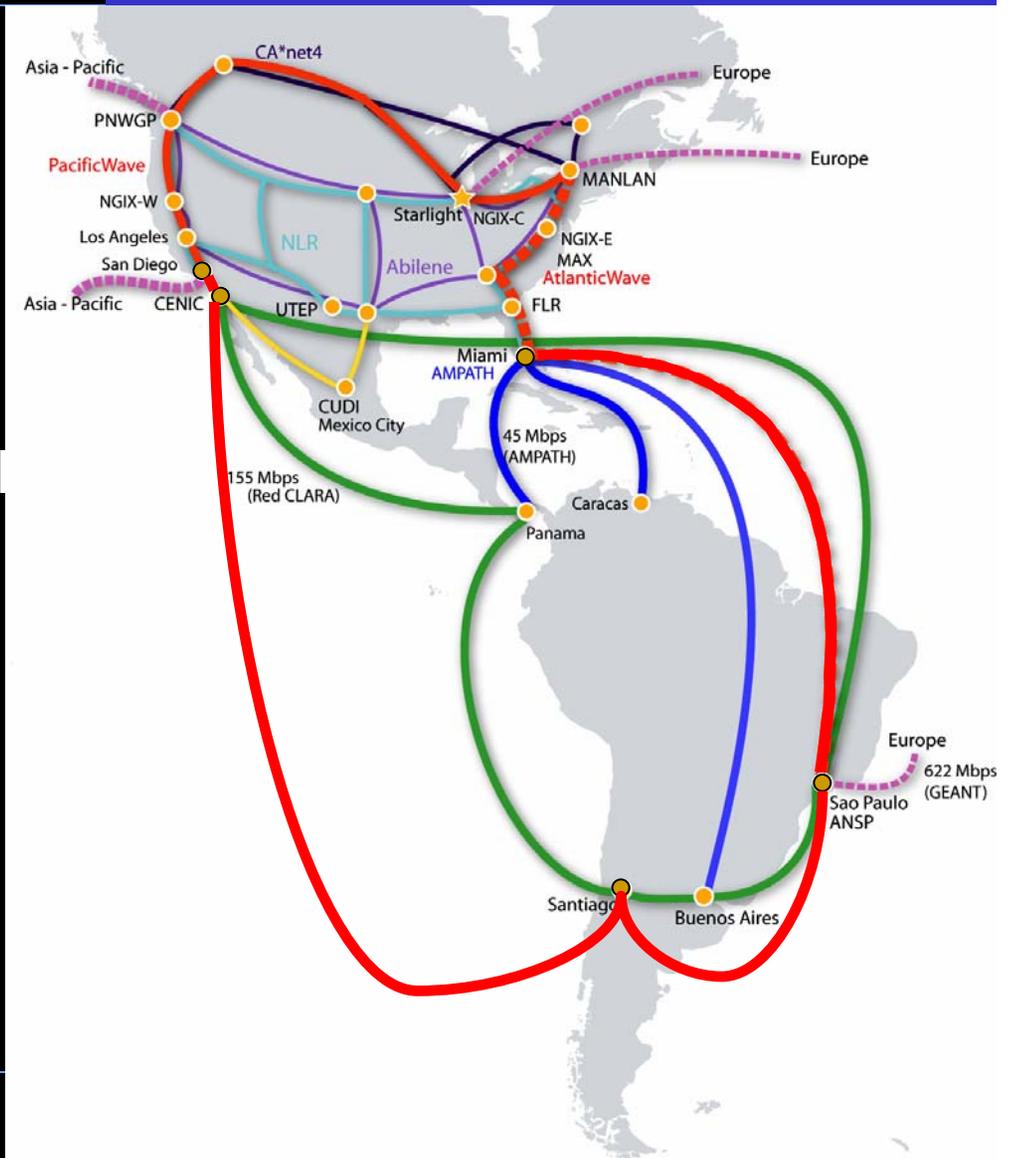
High-Performance S&T Facilities
 (High-Performance Cluster/Supercomputers, Storage,
 Experimental Facilities, Visualization, Access Grid, DB Servers, etc.)

Source: Kreonet

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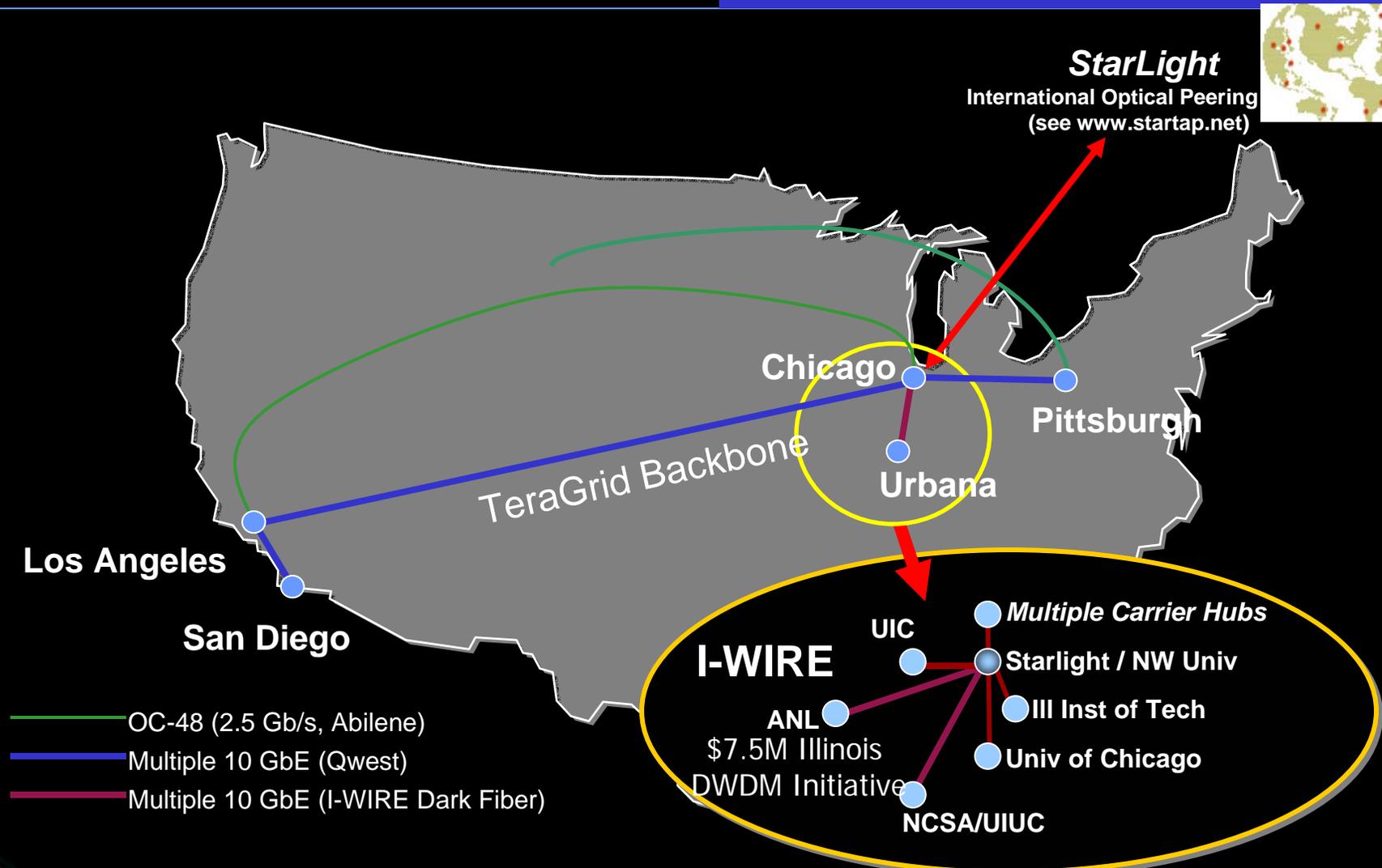
WHREN - LILA Project

- Joint response by FIU and CENIC to NSF IRNC solicitation
- 2.5Gbps persistent high-performance research network for South America to support U.S. and international science and engineering research and education communities
- Collaboration with research network operators and exchanges in the Americas
- Phased implementation over 5 years



Source: AMPATH

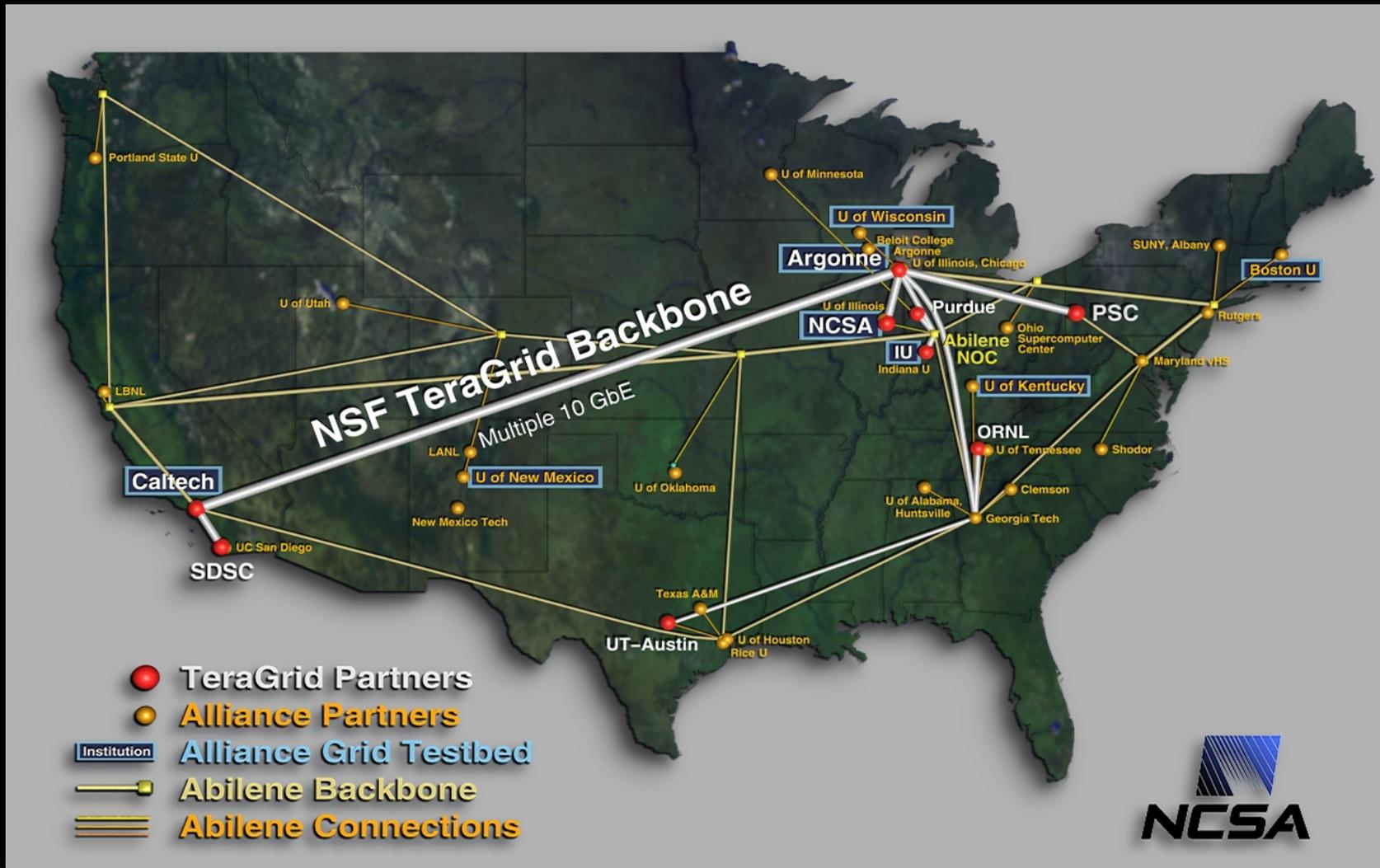
TeraGrid has 10x10Gb over I-WIRE and Equipment at StarLight



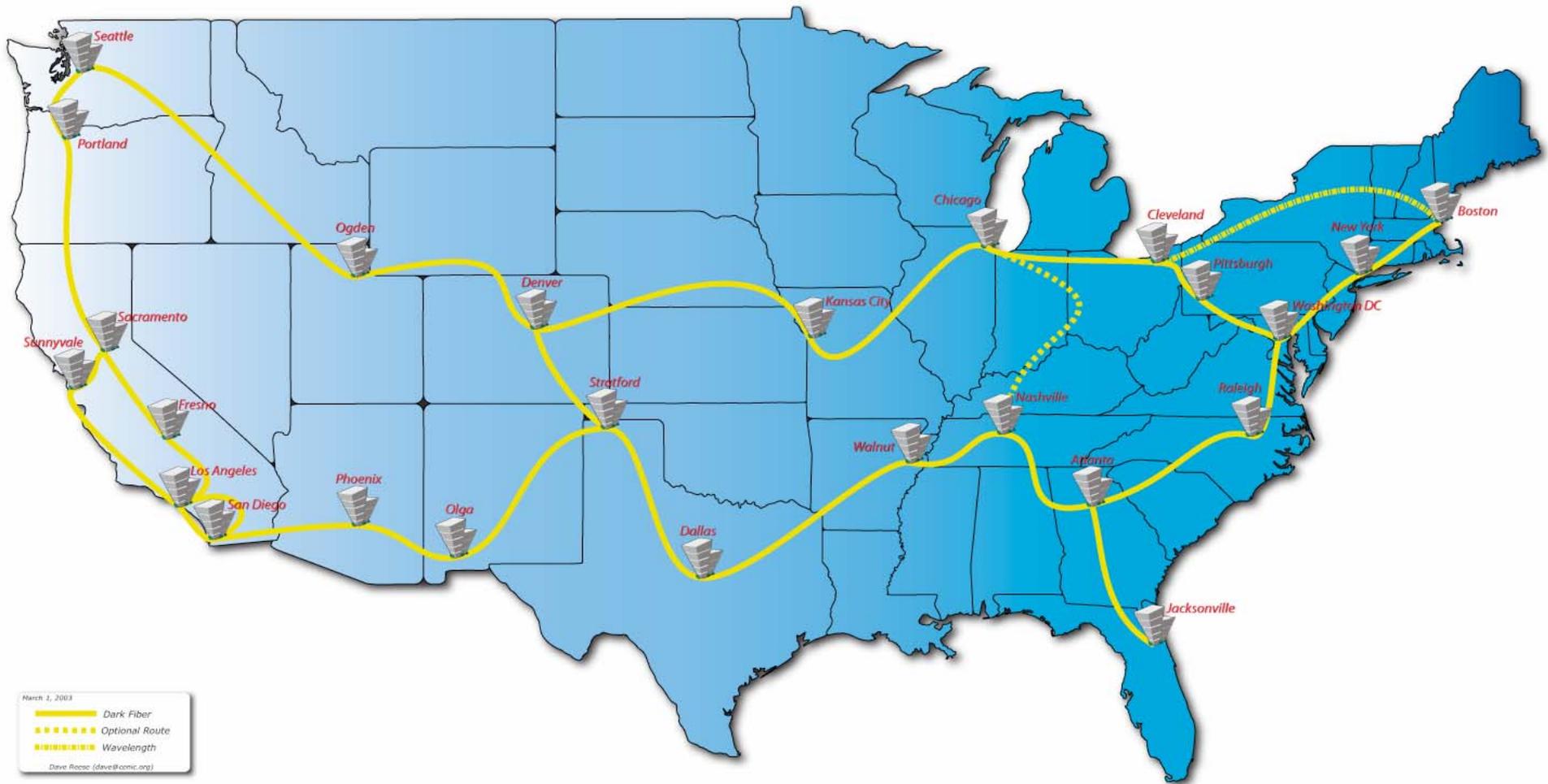
Source: Dan Reed

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ETF Connected via StarLight



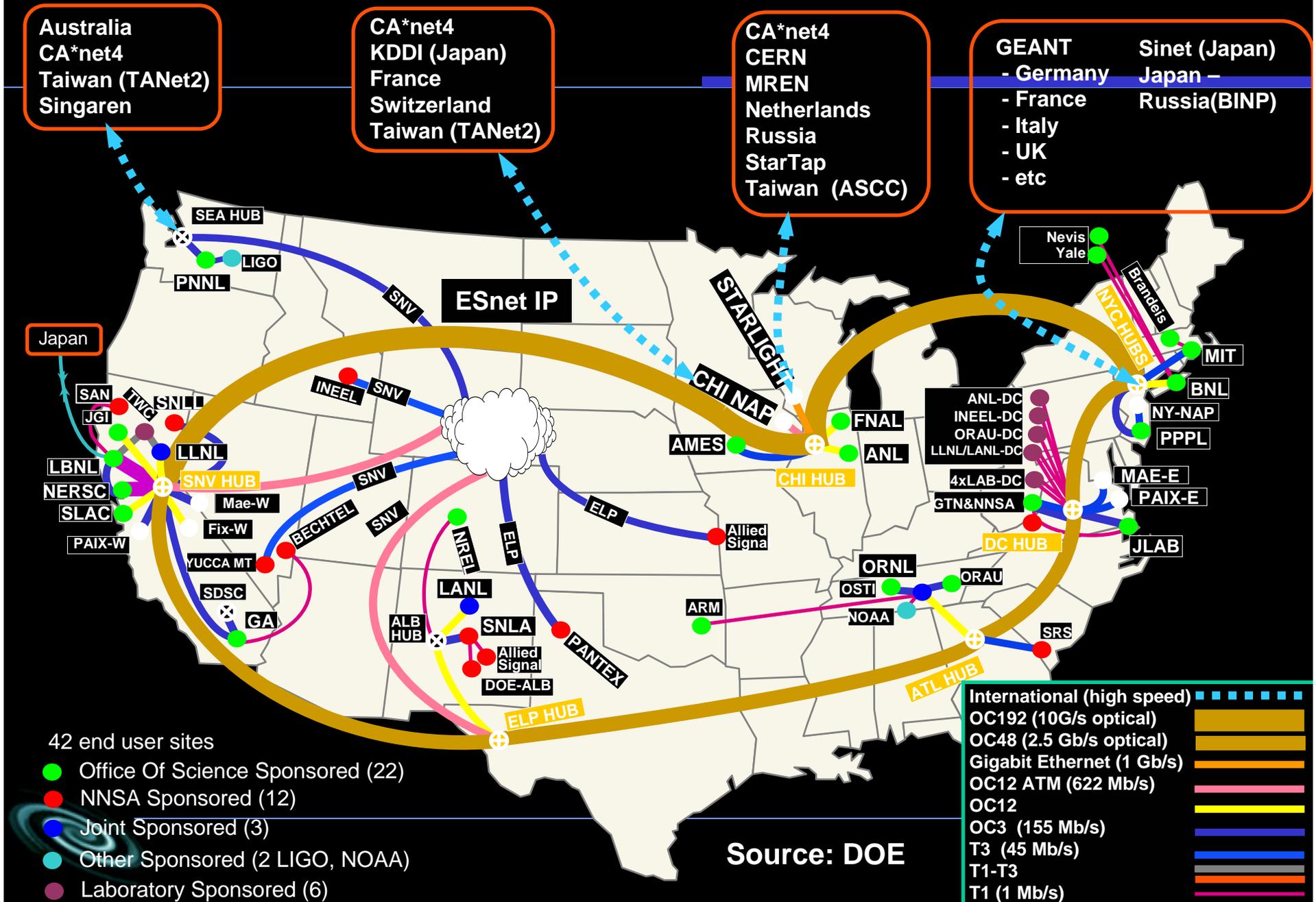
The First Link of the National Lambda Rail: StarLight \Leftrightarrow PSC for ETF



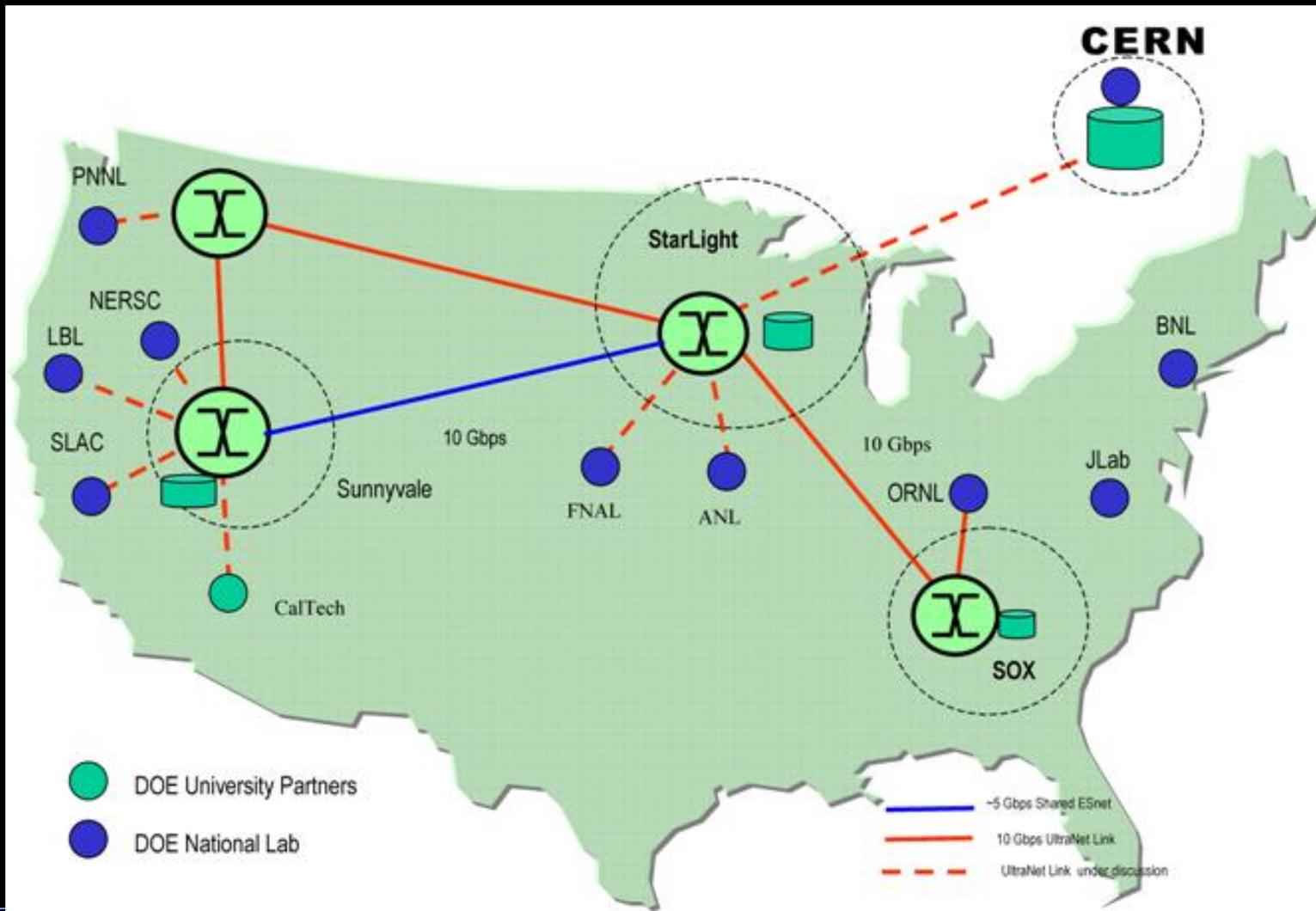
Source: John Silvester, Dave Reese, Tom West, CENIC

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DOE's ESnet Connects Facilities and Collaborators at StarLight



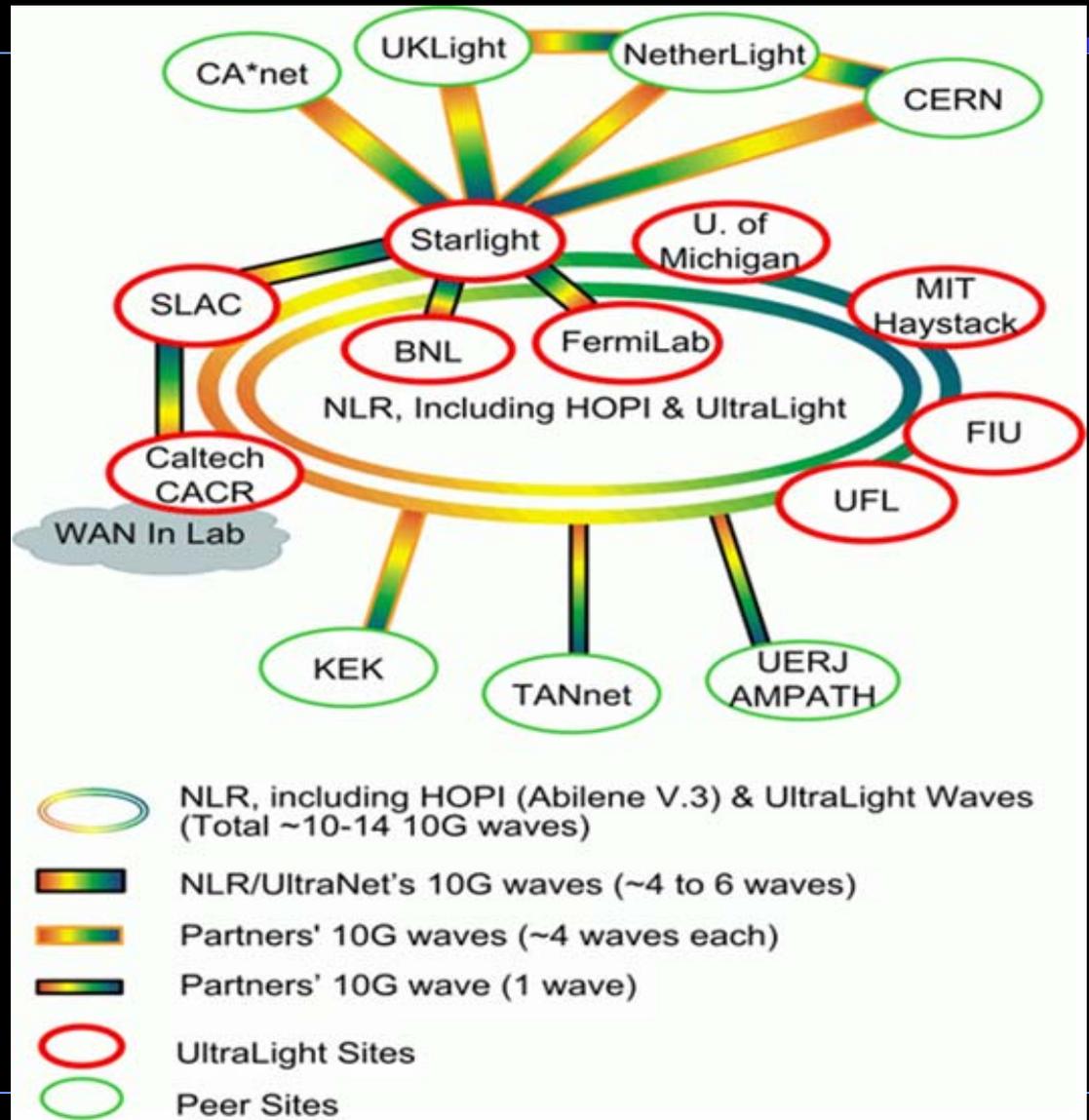
DOE's "Ultra Science Net" is at StarLight



<http://www.csm.ornl.gov/ultranet/topology.html>
Source DOE

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UltraLight Network: PHASE III



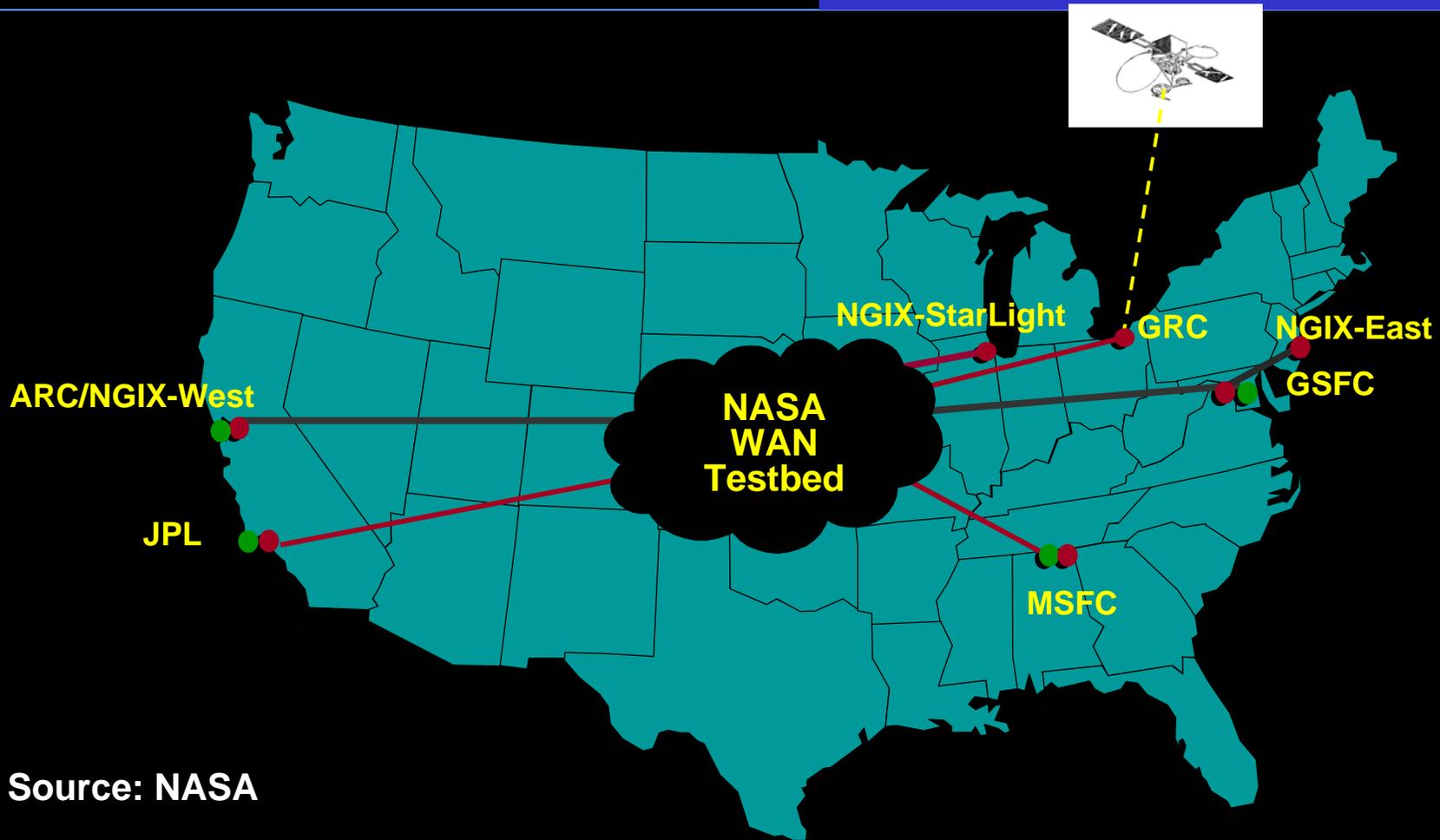
Source:

UltraLight Network



STARLIGHT™

NASA's NREN Network Testbed comes to StarLight



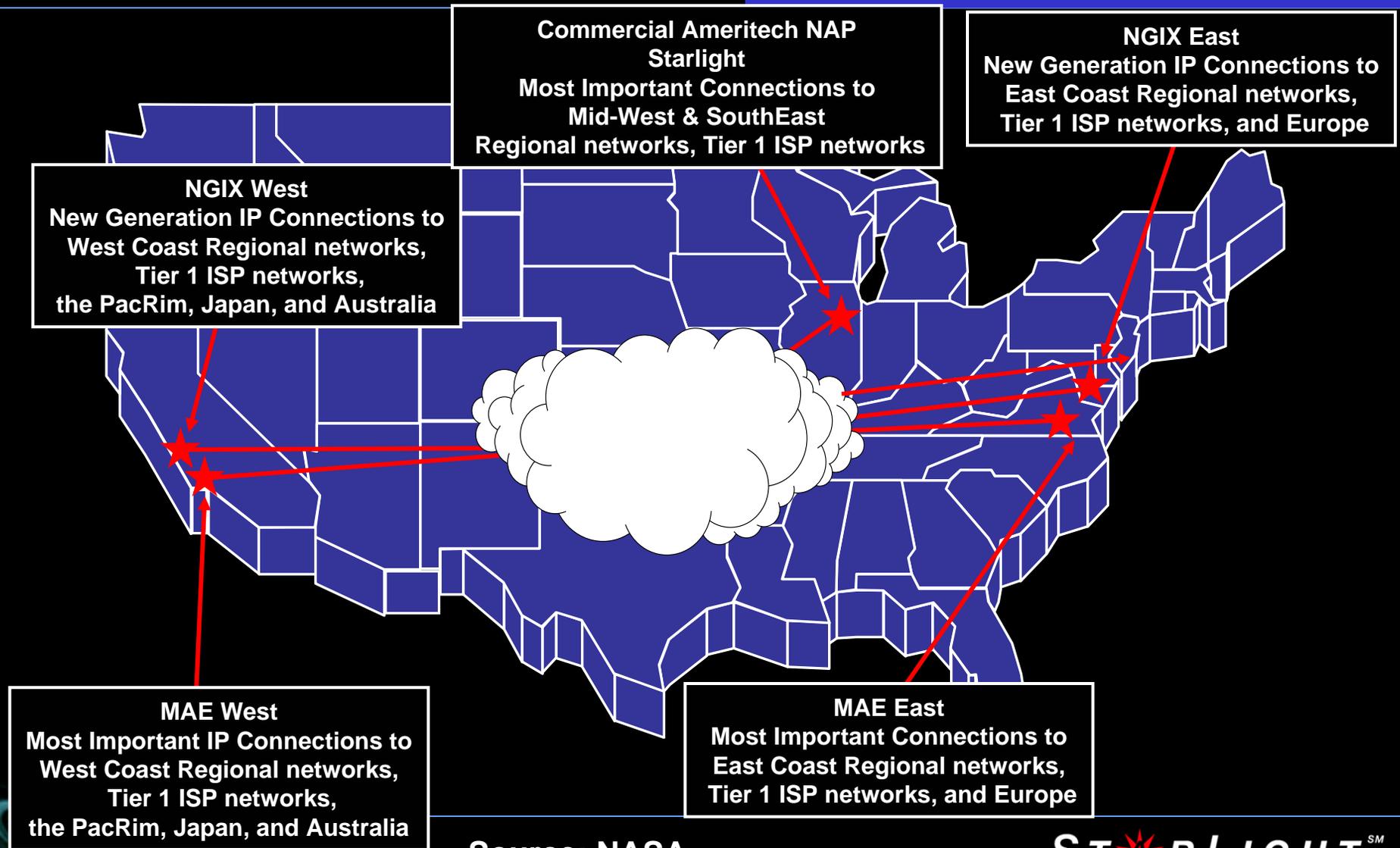
Source: NASA

NPN Sites	●	OC-3 ATM	—
NREN Sites	●	OC-12ATM	—
Hybrid Ground Station (35 Mbps)	●	

NASA WAN Testbed:

- NASA Research and Education Network (NREN)
- NASA Prototyping Network (NPN)

NASA's NISN is at StarLight



Source: NASA

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DREN Network Is At StarLight



GLIF Will Meet During “World Of Tomorrow 2005”

*i*Grid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY

September 26-30, 2005
University of California, San Diego
California Institute for Telecommunications and Information Technology [Cal-(IT)²]
United States
Co-Organizers: Tom DeFanti, Maxine Brown



STARLIGHTSM

www.startup.net/starlight

**Thanks to All Participants, NSF, and
National and International Supporters!**



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