IRNC:ProNet: TransLight/StarLight

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20 years of NSF-Funded High-Performance International Networking for Advanced Applications

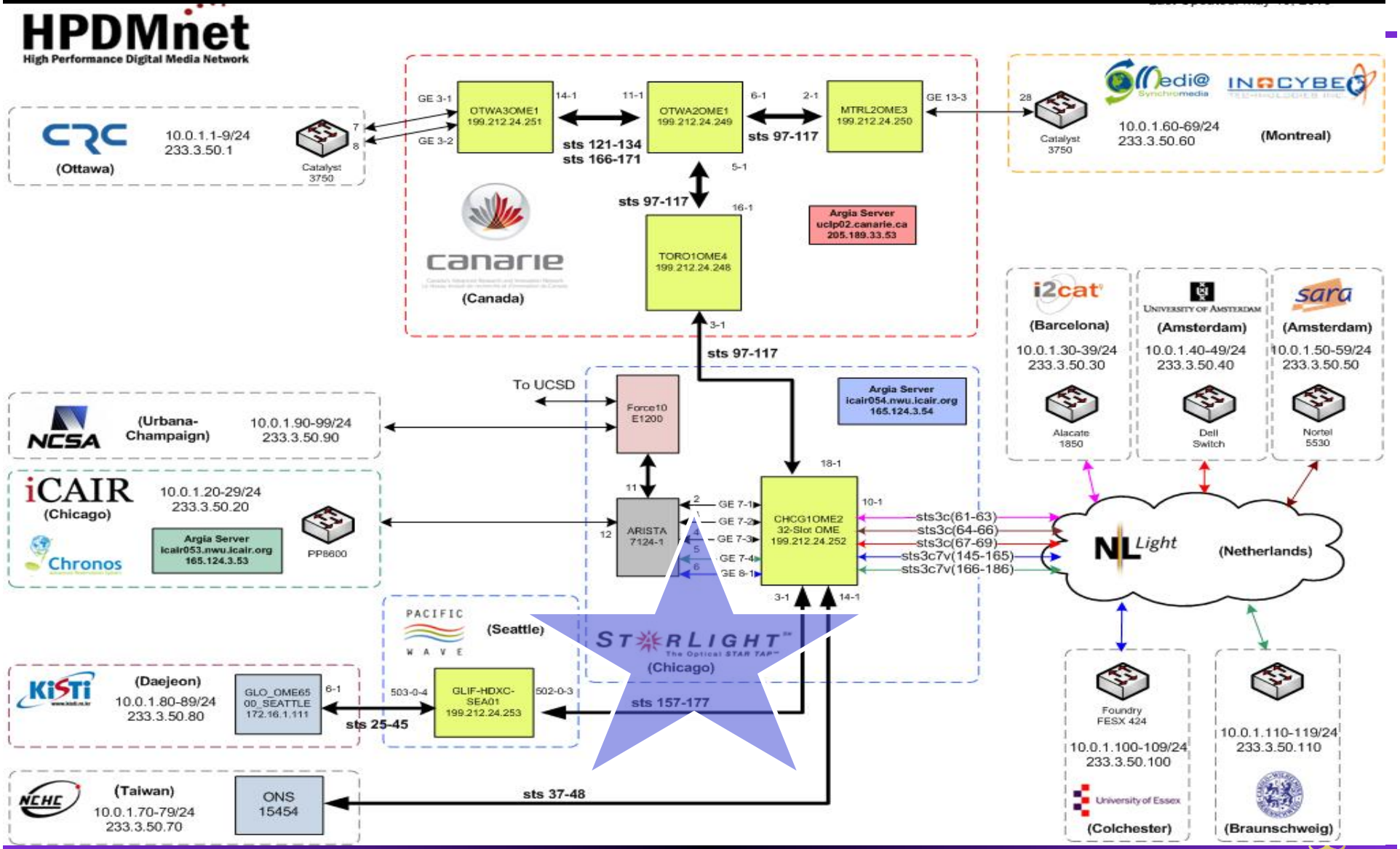
(1995-2014)

IRNC TL/SL 3-Year Deliverables

- Continue enabling multi-national application and middleware experiments on international networks
  - High-Performance Digital Media Network (HPDMnet)
  - iGENI: the GENI-funded international GENI project*
  - SAGE: connecting people and their data at high-res*
  - CineGrid: it's all about visual communications
  - GreenLight International: less watts/terabyte*
  - Science Cloud Communication Services Network (SCCSnet)*: the impending disruption
- Build cooperative partnerships (e.g. MSC-CIEC*)
- Serve GLIF, NLR, and I2 as senior leaders, reviewers
- New services, including many with industrial partners
- Create opportunities for all the REUs we can get*

*Currently also funded by various NSF awards to UCSD/UIC/NU

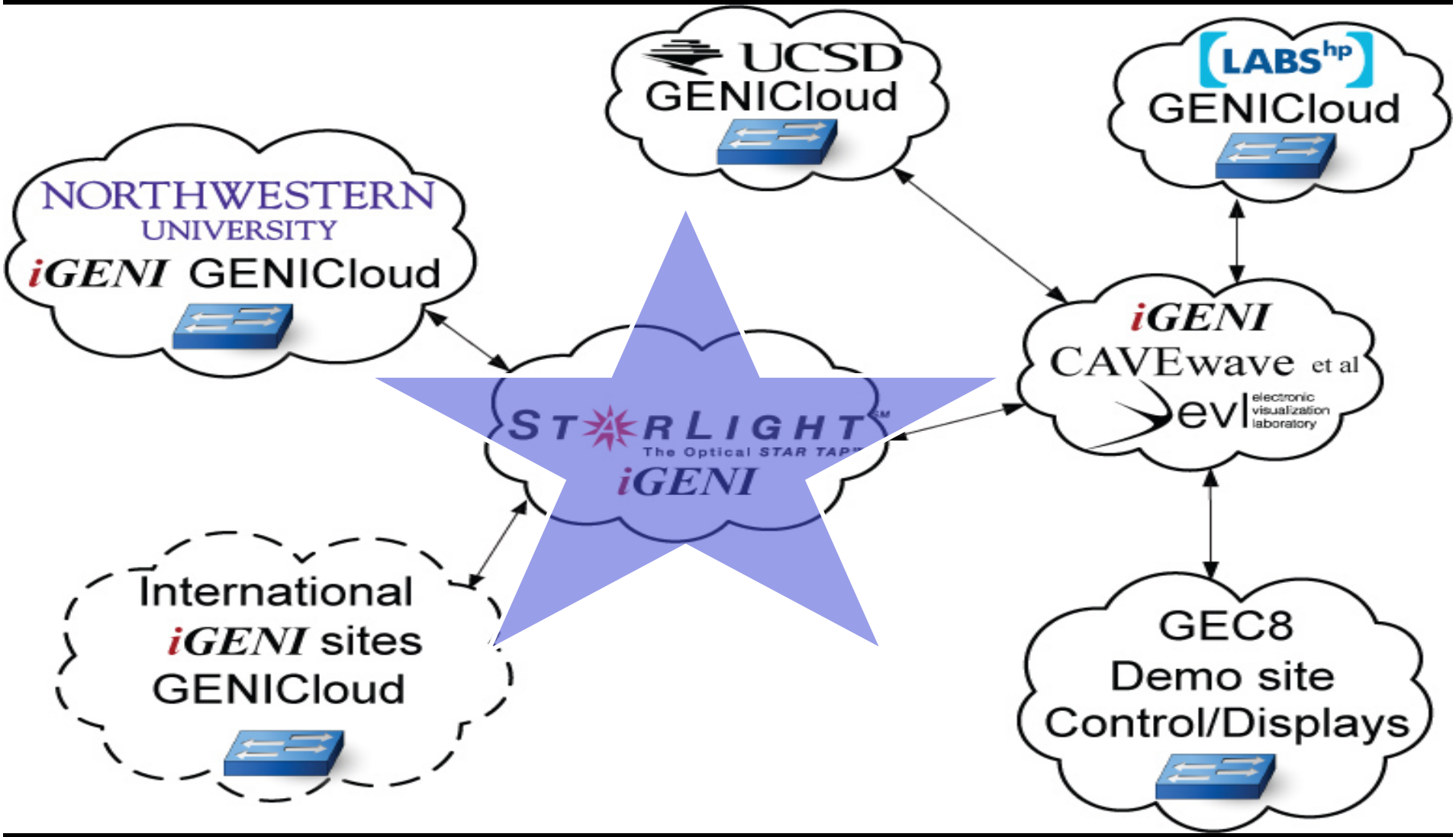
High Performance Digital Media Network



Joe Mambretti leads HPDMnet for TL/SL international trials

TRANS LIGHT STARLIGHT glif NSF

iGENI Demonstration Next Week at GENI



NU/EVL/UCSD is leading this trial

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EVL SAGE Applications

Moving from 10Gbps to 40-100G

Bitplayer
Streaming animation of tornado simulation using UDP.
516 Mbps

MagicCarpet
Streaming Blue Marble dataset from San Diego to EVL using UDP.
6.7Gbps

About 9 Gbps in total.
SAGE can simultaneously support these applications without decreasing their performance

SVC
Locally streaming HD camera live video using UDP.
538 Mbps

JuxtaView
Locally streaming the aerial photography of downtown Chicago using TCP.
850 Mbps

SAGE www.sagecommons.org

53 SAGE Collaborators Connect US Scientists to the World

Maxine Brown and Alan Verlo support SAGE for TL/SL

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Science Cloud Communication Services Network (SCCSnet)

- **The** Science Cloud Communication Services Network assists projects that are developing high-performance communication services tailored for computational clouds used by data-intensive scientific applications.
- These projects are addressing the high-volume, high-performance national and international communication requirements of scientific computational clouds versus general consumer and enterprise clouds, which use the commodity Internet.

Joe Mambretti leads SCCSnet for TL/SL international trials

CineGrid Network Partners—Worldwide

AMPATH

CANARIE

CENIC

CESNET

CzechLight

Internet2

JANET (UK)

Japan Gigabit Network 2

National LambdaRail

NetherLight

NORDUnet

PacificWave

Pacific North West GigaPOP

RNP

SOL

StarLight

SURFnet

WIDE

CineGrid Network Partners provide bandwidth and open exchanges for computer science and engineering pre-commercial trials and experiments in labs, at conferences, and large-scale, multi-national demonstrations

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CineGrid Founding Members Worldwide

More CineGrid Members—Worldwide

University of Southern California
School of Cinematic Arts

University of Washington
Research Channel

CineGrid Exchange Global Archiving with iRods

Academy of Motion Picture

California Academy of Sciences

CPqD

CINEPOST, ACE Prague

Dark Strand

i2CAT Foundation

JVC America

KAIST Graduate School of Culture Technology

Louisiana State University/Center for Computation & Technology

Universidade Presbiteriana Mackenzie

Mechdyne Corporation

Meyer Sound Laboratories

Nortel Networks

Northwestern University

NPS

Poznan

Renaissance Center North Carolina

KTH - Royal Institute of Technology

SARA

Sharp Corporation Japan

Sharp Labs USA

Tulane University

Tohoku University

University of Manitoba

Waag Society

Tom DeFanti leads CineGrid for TL/SL international trials

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Digital media needs High Bandwidth: 30 fps UDP Pixel Streams with Known Latency

Streaming Video Type	Format	Bandwidth @30FPS
HDV uncompressed 4K JPEG compressed	720p RGB16 JPEG2000	~700 Mbps
HD video	1080p RGB16	~1 Gbps
HD animation	1080p RGB24	~1.5 Gbps
HD animation stereo	1080p RGB24	~3.0 Gbps
4K video & animation 4K with full meta data	2160p RGB24	~6.0 Gbps ~13-15Gbps

Can't prototype these trials with carriers; need short-term VLANs

GreenLight's Prof. Amin Vahdat Says:

- Computing and storage will be delivered by a relatively small number of international mega-scale data centers
- Much of the activity will be around networking within and between data centers
- Storage will be redesigned from the ground up
- Network fabric must keep up with end hosts *and* reduce energy consumption
  - Scheduling algorithms to leverage path diversity
  - Dynamic energy management; optics for energy-efficient networks
- How do we find out what we need to know, as scientists and citizens, about energy consumption in networks?

GreenLight Extended to Networks: Watts/TB

- Current GreenLight/SDSC/Calit2 switches: accurate measurement of energy cost of networks between servers
  - Ethernet PDUs supply energy measurements
  - Combine with bandwidth statistics on per link basis
  - 100G switches will be instrumented with installation
- WAN terrestrial/undersea costs in long-distance watts/TB
  - More complex: measuring off-campus involves access to production equipment administered by many entities
  - For undersea circuits, the NSF/UCSD OOI initiative will calibrate and measure the energy costs for underwater equipment in our labs
- GreenGLIF members have software and hardware access to long-distance transmission equipment

Tajana Rosing, Co-PI, leads with much other funding

Networks Will Reduce Green House Gases

- TL/SL's green and transformative initiatives use high-definition and 4K videoconferencing, reducing air travel*
- Cloud computing may offer 10-20x work/watt efficiency
  - Virtualization and software optimizations
  - Much better total life-cycle cost management than universities
  - Powering of servers in more carbon-neutral facilities
  - Amazon EC2 data & compute (now in service for OOI, connected to CENIC/PNWGP and beyond)
  - Enhances University ICR; reduces carbon offset payments
- Of course, the best GHG-reducing applications are yet to be conceived and tested! Stay tuned!
- We would like to discuss ideas with people here the IRNC kickoff and at GLIF in October at CERN

*Tom's air travel here: ~1/2kW for a year

TransLight/StarLight Collaborates with All IRNC/GLIF Initiatives

Connect to TransLight/PacificWave in Seattle via TransLight (Cisco Research Wave deployed on NLR)

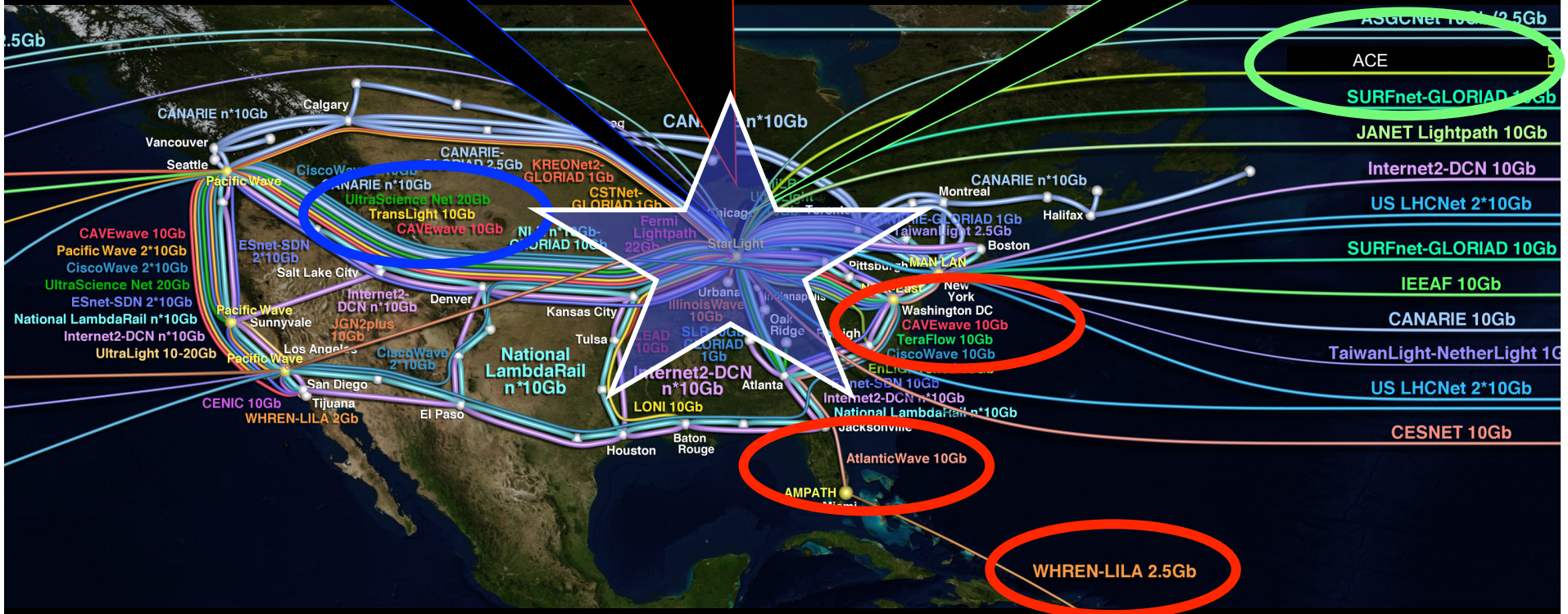
PACIFIC WAVE TRANS LIGHT

With US HEP/LHC researchers, do trials to move multi-gigabit traffic between CERN and Brazil (Geneva to Amsterdam; via LHCnet to Chicago; via CAVEwave to DC; via AtlanticWave to Miami; via AmLight-East to Brazil

WHREN

Provide GLORIAD via StarLight with services to support multi-gigabit US traffic to partners in Russia, Netherlands, Nordic countries, Asia

GLORIAD



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TL/SL Needs Help from ProNet Awardees

- Connect to open exchanges with colocation space
- Support TL/SL project deliverables with persistent bandwidth at all layers to reach international partners
- Focus on end-to-end performance and advanced services at leading-edge sites and facilities
- Train the next generation of network engineers and application scientists

Thanks, NSF/IRNC!

- TL/SL and its huge constituency look forward to years of collaboration and cooperation with IRNC ProNet/ Exp/SP awardees and their partners
- The future's so bright we'll have to wear (3D) shades!