Western-Hemisphere International Exchange Points

Optical Network Testbeds Workshop 3

September 7-8, 2006

Tokyo, Japan

Heidi Alvarez, Ph.D.
Director
Julio E. Ibarra, Executive Director
Center for Internet Augmented Research and Assessment

Outline

- The WHREN-LILA project and Distributed Exchange Points
  - AMPATH International Exchange Point
  - Sao Paulo Distributed Exchange Point
- The AtlanticWave Project
- Western Hemisphere International Exchange Points
- Next Steps

WHREN-LILA
IRNC Award 0441095

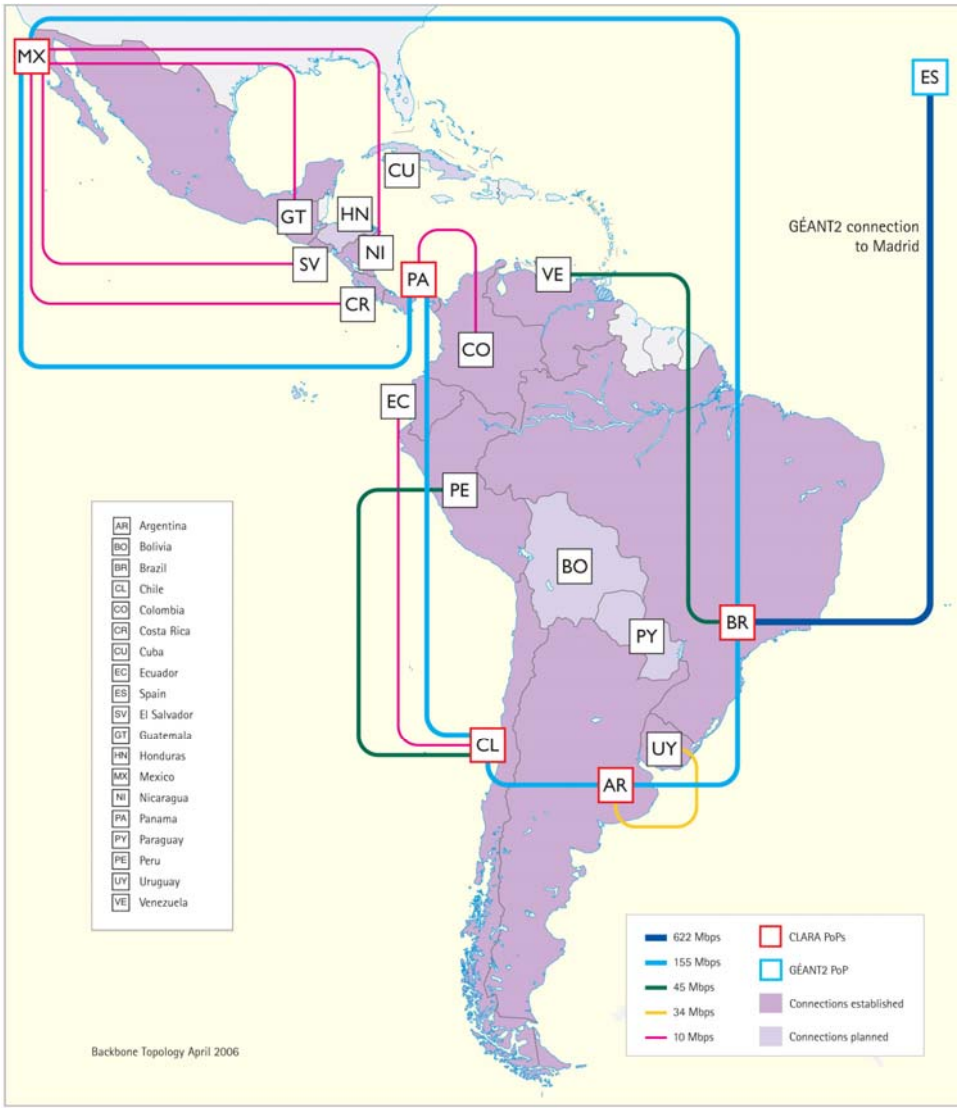
- 5-year NSF Cooperative Agreement
  - Florida International University (IRNC awardee)
  - Corporation for Education Network Initiatives in California (CENIC)
  - Project support from the Academic Network of Sao Paulo (award #2003/13708-0)
  - CLARA, Latin America
  - CUDI, Mexico
  - RNP, Brazil
  - REUNA, Chile
- Links Interconnecting Latin America (LILA) aims to Improve connectivity in the Americas through the establishment of new inter-regional links
- Western-Hemisphere Research and Education Networks (WHREN) serves as a coordinating body whose aim is to leverage participants' network resources to foster collaborative research and advance education throughout the Western Hemisphere

Links Interconnecting Latin America

- Miami - Sao Paulo link: STM-16 at 1.2Gbps. Increasing to 2.5Gbps in time for SC06
- LILA-East connects the State of Sao Paulo academic network (ANSP), Latin America's regional network (CLARA) and Brazil's NREN (RNP)
- LILA-West connects San Diego - Tijuana: operating at 2 x 1 Gbps, providing dedicated GigE links to CLARA and Mexico's NREN (CUDI)
- East and west coast connectivity to NLR, US FedNets, I2 Abilene and other US and global R&E networks are served by LILA

http://www.whren-lila.net

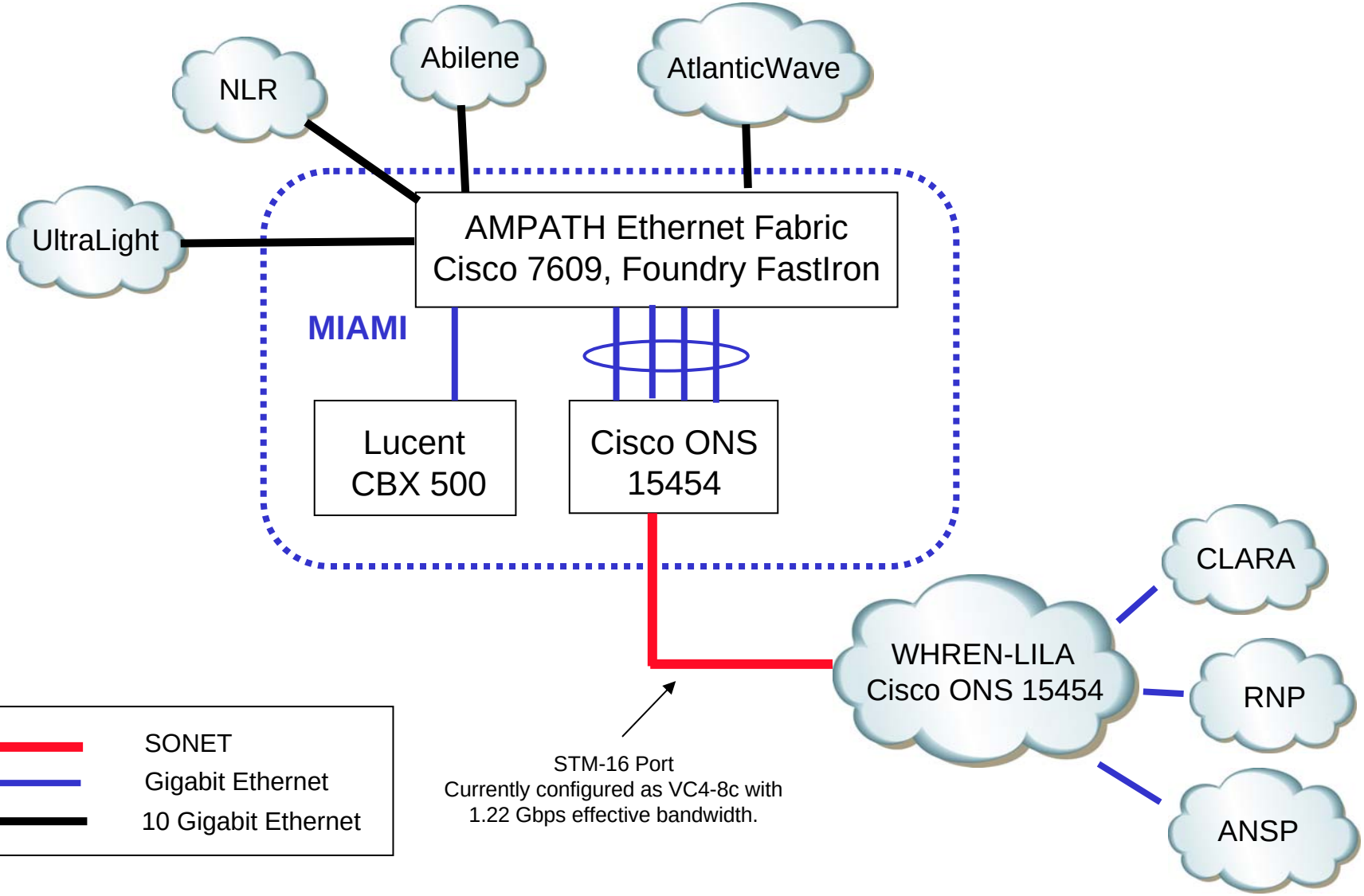
Current RedCLARA topology



- **Backbone ring: 155 Mbps (Sao Paulo, Buenos Aires, Santiago, Panama, Tijuana)**
- **Access links of 10 to 45 Mbps**
- **Connection to Europe (GÉANT) at 622 Mbps from Brazil**

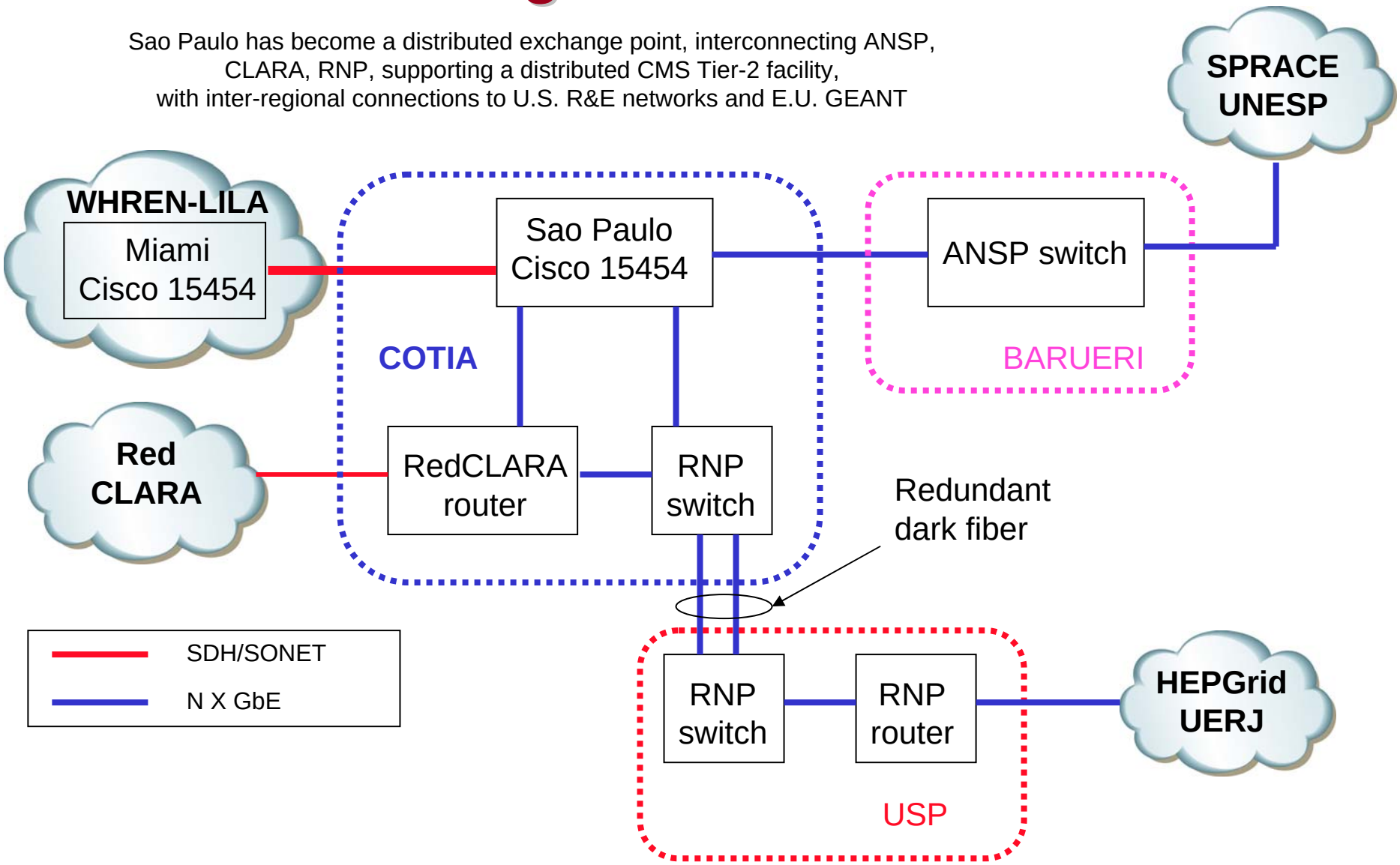
By Michael Stanton

AMPATH International Exchange Point



Sao Paulo Distributed Exchange Point

Sao Paulo has become a distributed exchange point, interconnecting ANSP, CLARA, RNP, supporting a distributed CMS Tier-2 facility, with inter-regional connections to U.S. R&E networks and E.U. GEANT



WHREN-LILA Distributed Exchange Point Characteristics

- **Built using Cisco ONS 15454 SDH Chassis**
  - STM circuit between Miami and Sao Paulo is configured currently as VC4-8c (~ 1.22 Gbps) linear circuit
  - Drawback: Static Provisioning, tear-down required if peers require additional bandwidth
  - VCAT and sw-LCAS can be used to accommodate network dynamics (SC '06)
  - STS-v (VCAT) circuits along with sw-LCAS allows network reconfiguration without service interruption and provides greater circuit granularity
- **Ethernet L2 End-to-End Service currently provided using ML-1000-2 cards installed on ONS**
  - Currently 2 ML cards provide a total of 4 GigE ports
  - GigE ports can be configured with various 802.1Q VLANs as well as transport user-defined VLANs using QinQ mapping
  - Bridge groups provide the necessary mappings via internal ONS cross-connect fabric to previously provisioned SDH circuits
  - CoS/QoS and other policing methods can be applied to ML ports to conform to requirements as well as QinQ VLAN mappings

AtlanticWave

- AtlanticWave is provisioning a 10GigE wave to support a distributed international exchange and peering fabric along the Atlantic coast of North and South America, following the GLIF GOLE model.
- AtlanticWave will connect the key exchange points on the U.S. East Coast:
  - International Exchange Points MANLAN in NYC and AMPATH in Miami
  - MAX gigapop and NGIX-East in Washington, DC
  - SoX gigapop in Atlanta
- A-Wave is an integral component of the NSF IRNC WHREN-LILA proposal to create an open distributed exchange and transport service along the Atlantic rim.
- A-Wave partners include SURA, FIU-AMPATH, IEEAF, FLR, MAX, SLR/SoX, Internet2/MANLAN, and the Academic Network of Sao Paulo (ANSP).

IP Peering/Exchange Services over A-Wave

AtlanticWave
NEW YORK WASHINGTON ATLANTA MIAMI SAO PAULO

- A-Wave will provide a Layer 3 exchange capability
  - Ethernet based
    - Best effort packet transit between peering networks
    - 1 GE, 10GE LAN, 10GE WAN client access
    - Jumbo frame support
  - VLAN based
    - A single VLAN (broadcast domain) allows each attached network to establish their peerings directly with the other attached networks
      - No requirement for a Layer 3 transit ASN
      - Requires fewer "man in the middle" cycles to establish VLANs for each peering pair
    - Multiple VLANs are provisioned in order to constrain broadcast traffic
      - Reduces the amount of extraneous traffic consuming inter-switch capacity

Thanks to Jerry Sobieski

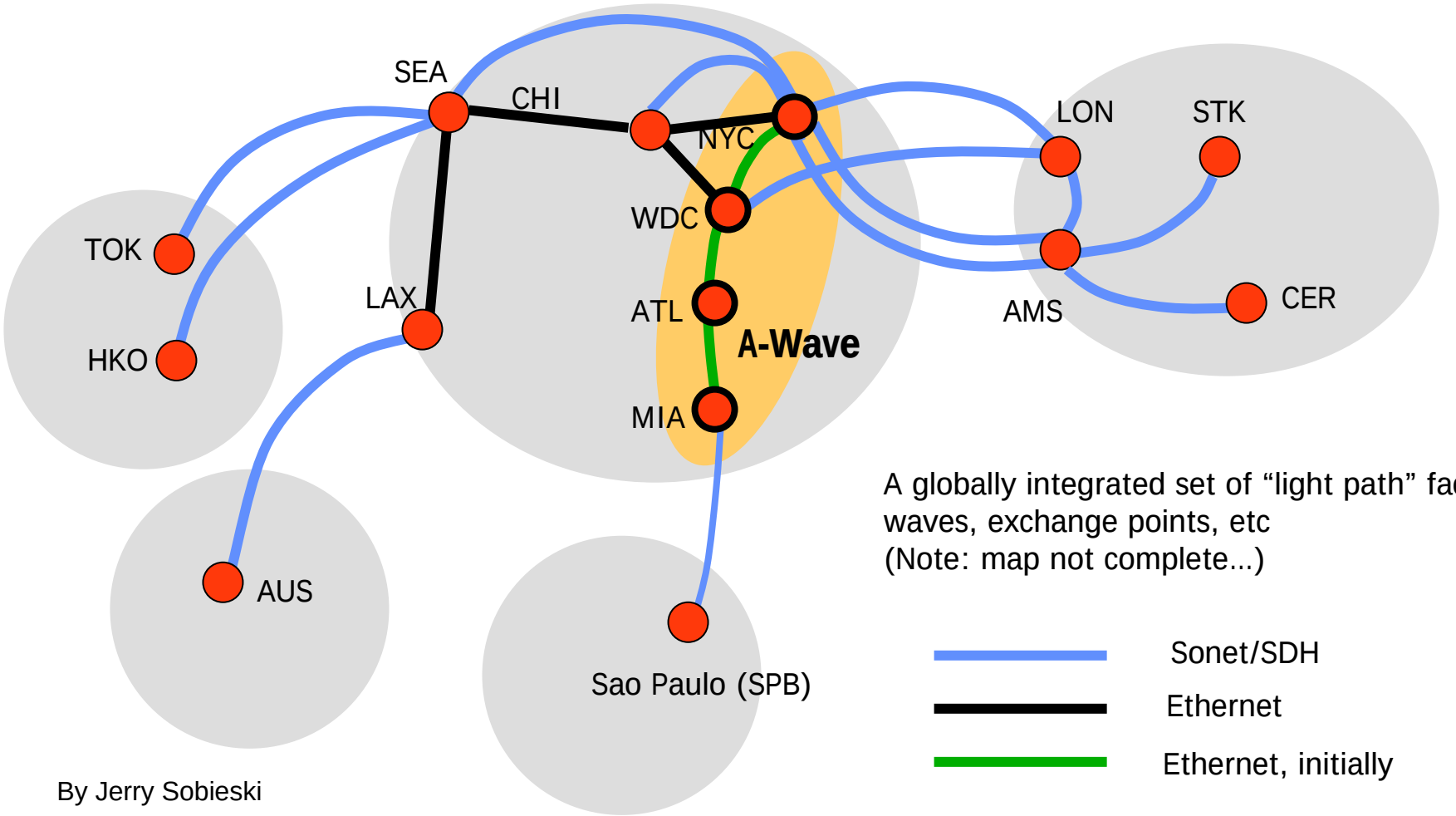
"GLIF" Services across A-Wave

- Atlantic Wave is a key component of international R&E networking, providing transport between these U.S. exchange points
  - Europe, US, and Canada meet in NYC and WDC
  - US and South America in MIA
- A-Wave needs to be part of the service fabric that is being deployed globally, with intercontinental transport (including between U.S. and Canada) based upon Sonet/SDH
  - Current or next gen Sonet/SDH
  - Generic Framing Protocol (GFP)
  - Ethernet is becoming much more common for layer3 best-effort peering between routers and for end system interfaces into "GLIF" service environments
  - Future architectures will be exploring other framing capabilities e.g. Infiniband
- A-Wave also needs to be part of U.S. distributed exchange fabric - which is mostly Ethernet based
- A-Wave Deployment Evolution:
  - Stage 1: Static Layer-3 Peering Capabilities & [Static] Point to Point VLANS (Now) over Ethernet
  - Stage 2: Layer 2 VLAN Circuit Switched Services (Spring '07)
  - Stage 3: Dynamic TDM (Sonet/SDH Layer) (~Fall '07)

Thanks to Jerry Sobieski and Don Riley

The Global Picture

AtlanticWave
NEW YORK WASHINGTON ATLANTA MIAMI SAO PAULO



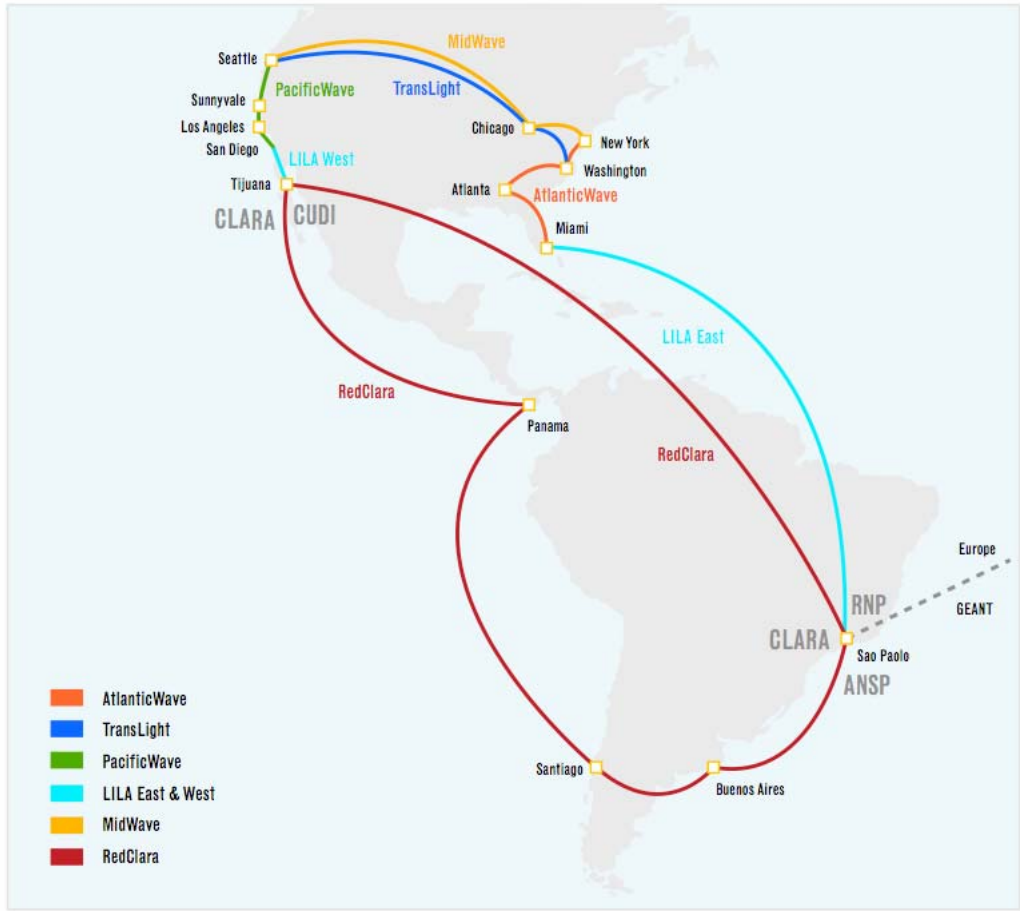
A globally integrated set of “light path” facilities: waves, exchange points, etc
(Note: map not complete...)

Sonet/SDH
Ethernet
Ethernet, initially

By Jerry Sobieski

Western-Hemisphere International Exchange Points

- Collaboration with TransLight and CANARIE to extend connectivity to StarLight and PacificWave
- International Exchange Points at Sao Paulo, Miami, Washington DC, NYC, Chicago, Seattle, LA
- Exchange and Peering capabilities with national and international networks



Next Steps for WHREN-LILA and AtlanticWave

- Extending 1Gbps End-to-End pipes to support applications in Latin America; e.g., high-energy physics community preparing for LHC experiments
- Extending GigEs for CLARA and CUDI to PacificWave in Los Angeles
- Extending GLIF services across AtlanticWave
- Harmonizing AUPs of international exchange points to support interoperation of distributed exchange and peering services
- Working with dynamic bandwidth provisioning by power users and groups

Thanks to Xun Su, CHEPREO/Caltech

Thank You!

- **WHREN-LILA, AMPATH infrastructure, CHEPREO, CyberBridges, science application support, education, outreach and community building efforts are made possible by funding and support from:**
  - **National Science Foundation (NSF) awards MPS-0312038, CNS-0335287, OISE-0418366, OISE-0549456, OCI-0537464, SCI-0441095, OISE-0617469, IIS-0646144, OCI-0636031**
  - **Academic Network of Sao Paulo, award #2003/13708-0**
  - **Southeastern University Research Association (SURA)**
  - **Florida International University**
  - **Latin American Research and Education community**
  - **The many national and international collaborators who support our efforts**