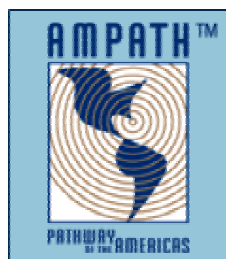


# Western-Hemisphere International Exchange Points



## *Optical Network Testbeds Workshop 3*



September 7-8, 2006

Tokyo, Japan

Heidi Alvarez, Ph.D.

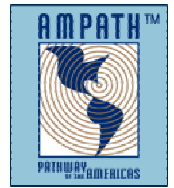
Director

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**

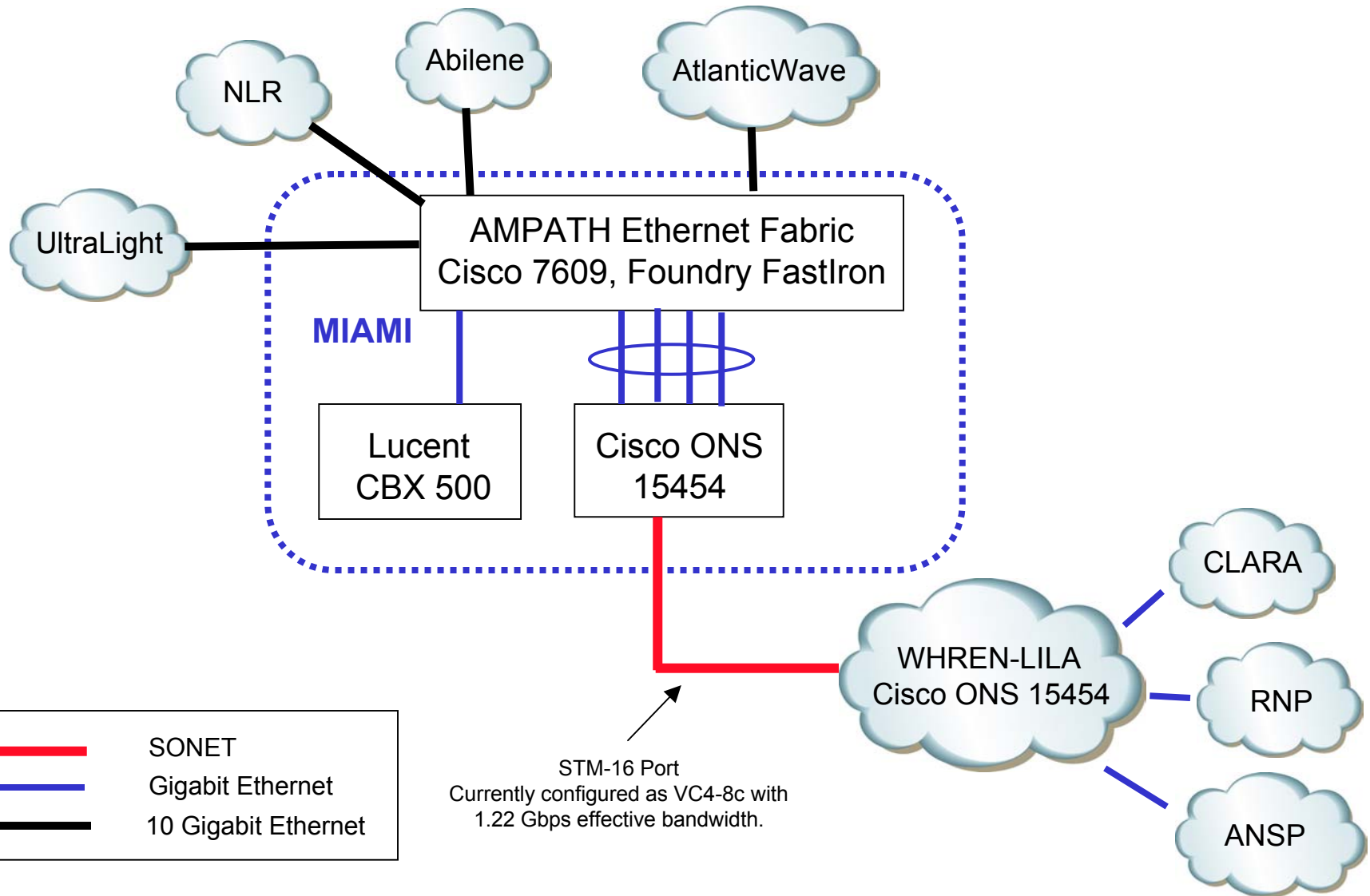
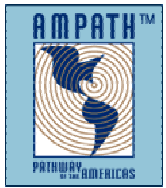


# Current RedCLARA topology



- **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**

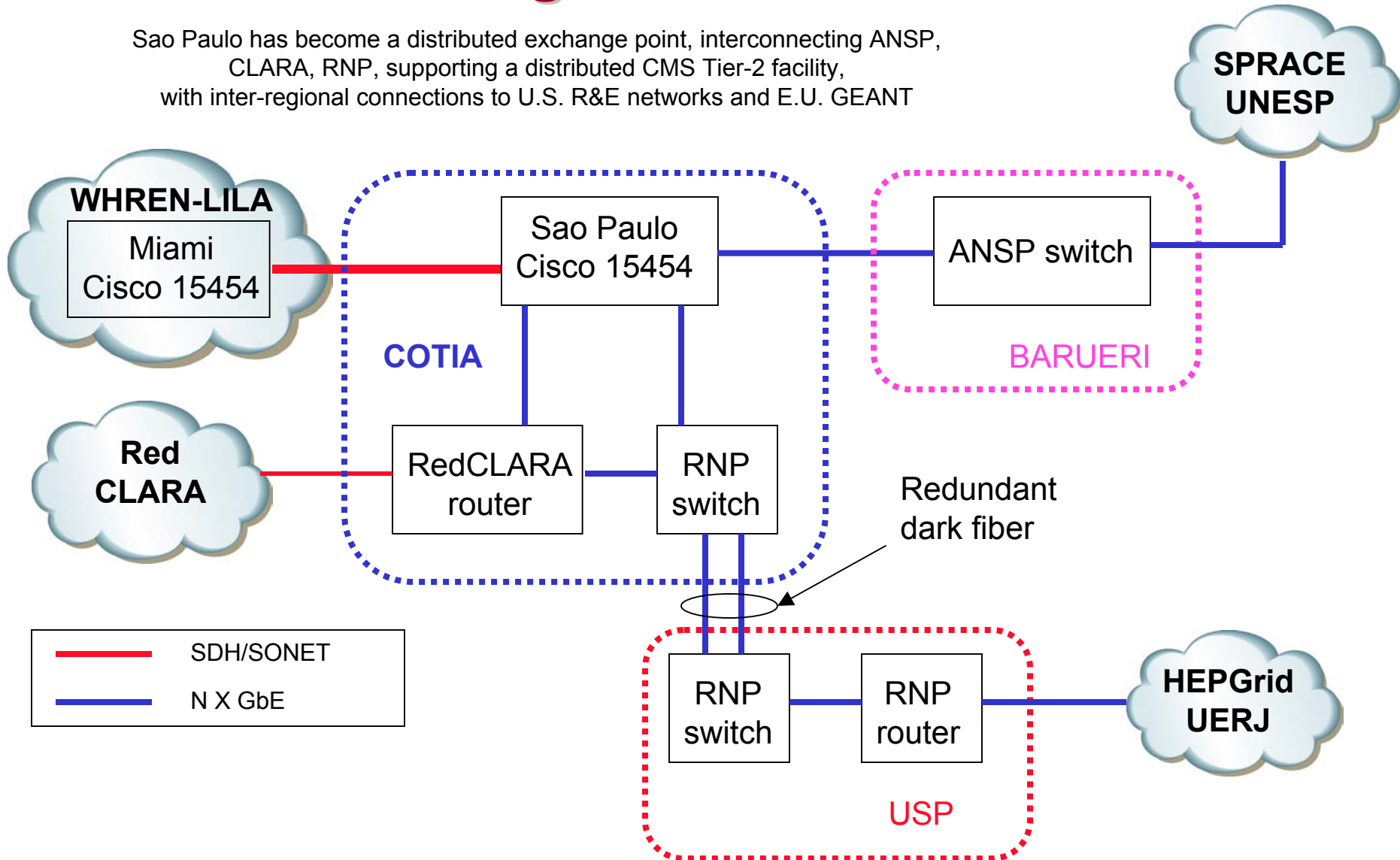
# AMPATH International Exchange Point



# 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



- **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



**AtlanticWave**  
NEW YORK WASHINGTON ATLANTA MIAMI SAO PAULO

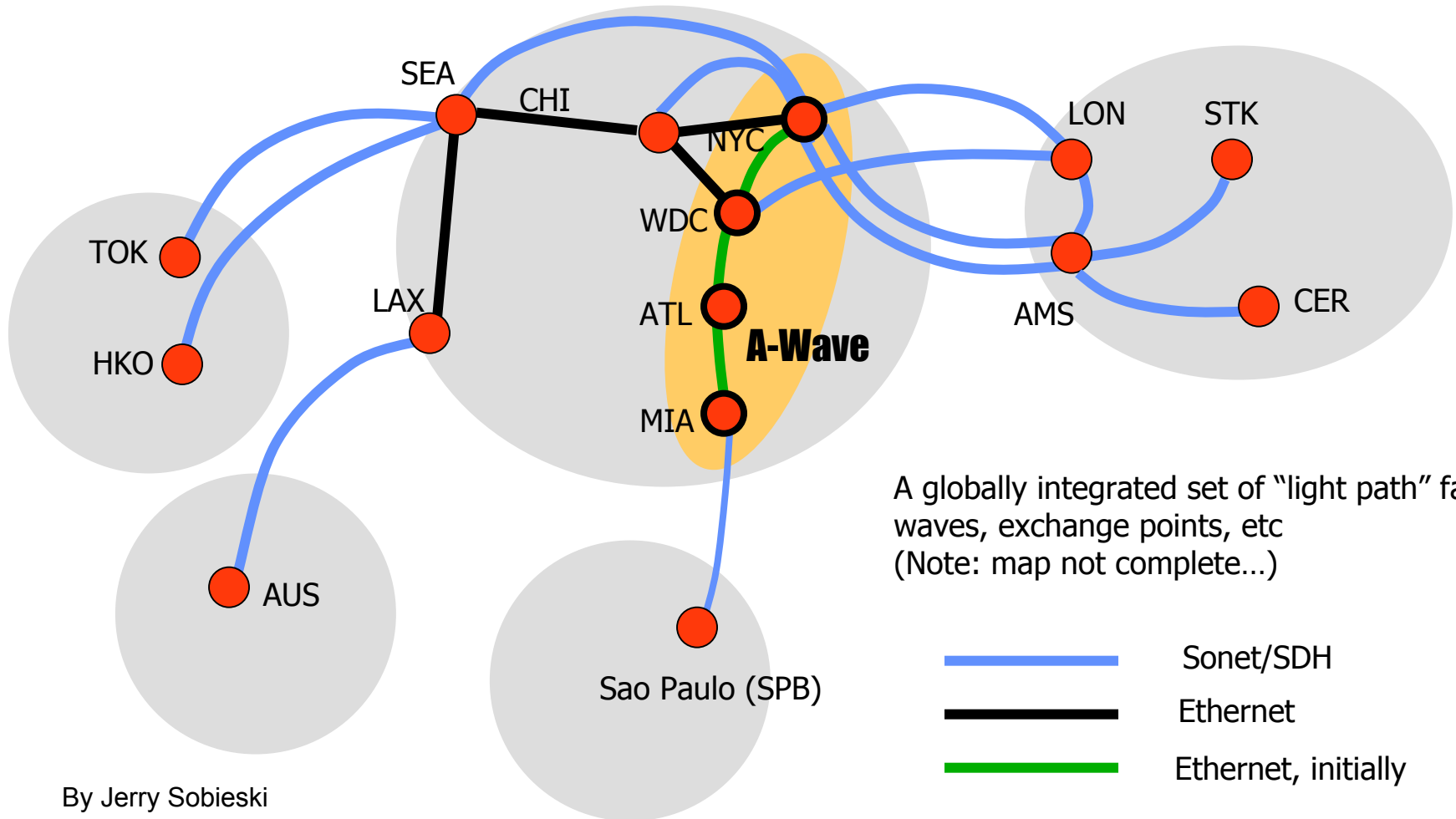
- **Atlantic Wave is a key component of international R&E networking, providing transport between these U.S. exchange points**
  - ❑ Europe, US, and Canada meet in NYC and WDC
  - ❑ US and South America in MIA
- **A-Wave needs to be part of the service fabric that is being deployed globally, with intercontinental 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)

# 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...)

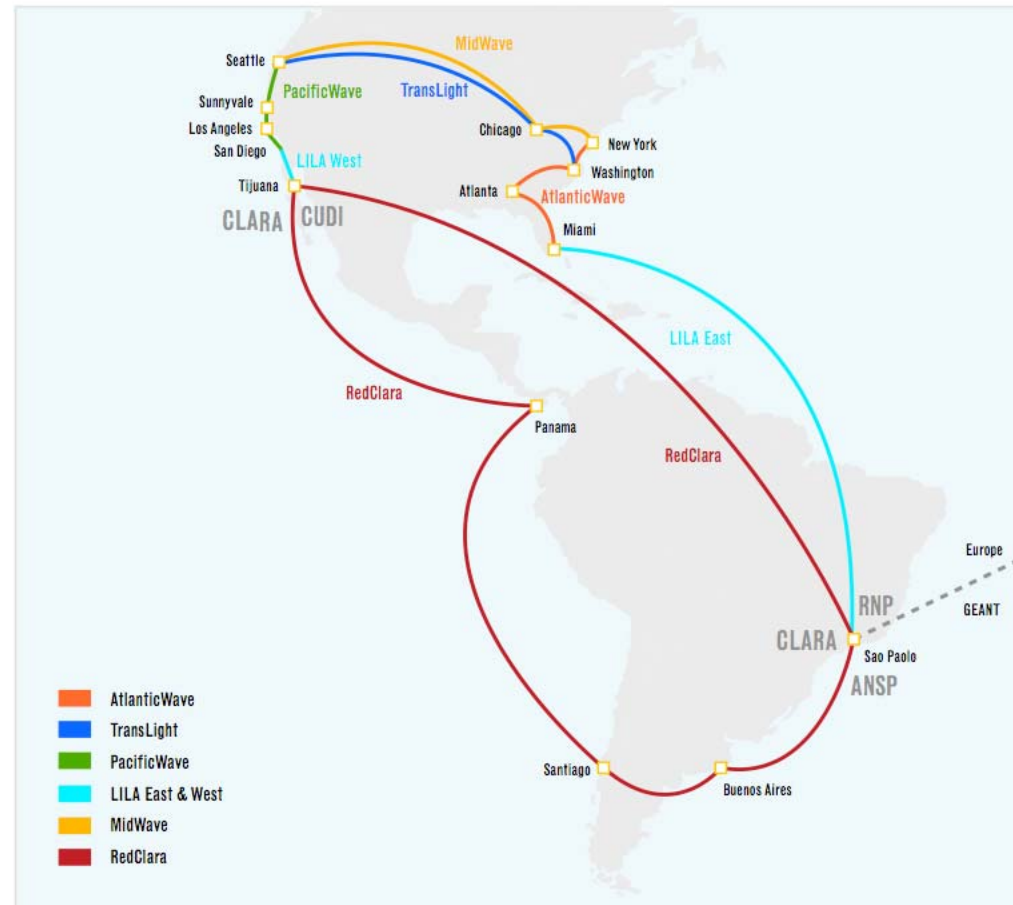
- Sonet/SDH
- Ethernet
- Ethernet, initially

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:**
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  - ❑ **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**