



# HEPDG 2005

May 24, 2005

## WHREN/LILA & CHEPREO

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# Outline



- **The WHREN-LILA project**
- **US - Latin America Connectivity**
- **Links Interconnecting Latin America (LILA) year 1**
- **The AtlanticWave Project**
- **WHREN-LILA Year 1 Milestones**
- **E-Science and Engineering Collaborations**

# The WHREN-LILA Project



- **Proposal submitted by Florida International University (FIU) and the Corporation for Education Network Initiatives in California (CENIC) - Award# 0441095**
- **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) is a coordinating body of organizations from across North and South America that aims to leverage the network resources of participating members to foster collaborative research and advance education throughout the Western Hemisphere**



# Project Goals



- **Improve network connectivity between North and South America through the deployment, operation and evolution of LILA links**
- **Evolve the LILA links to their fullest capacities as resources and economies permit**
- **Foster collaborative research and advance education throughout the Western Hemisphere and other world regions**
- **Support the evolving needs of US science and engineering researchers**
- **Foster new inter-regional and inter-disciplinary communities of researchers and learners**



# WHREN - Coordination in the Western Hemisphere



- **WHREN will establish a consortium of participating western-hemisphere organizations that will collectively oversee the assignment of lightpaths across administrative domains**
- **A Governance Committee (GC) will collectively oversee the assignment and management of lightpaths and provide coordination between member organizations**
- **A Research Advisory Committee will be formed to advise the GC on program and network needs for the broad research and education community**
- **An Engineering Committee (EC) will be comprised of engineering managers from the various networks participating in WHREN**



# LILA Project Coordination



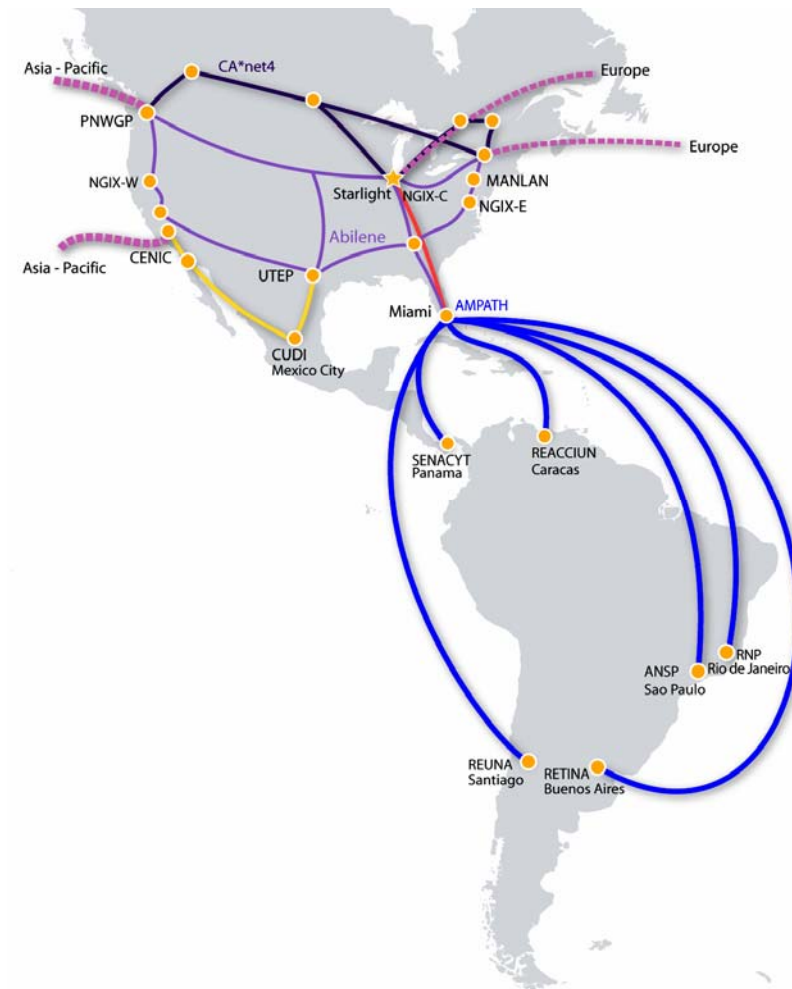
- **Participating Organizations**
  - ❑ **FIU (Awardee)**
  - ❑ **CENIC (Awardee)**
  - ❑ **ANSP (Sao Paulo)**
  - ❑ **CLARA (Latin America)**
  - ❑ **CUDI (Mexico)**
  - ❑ **RNP (Brazil)**
  - ❑ **REUNA (Chile)**
- **Project Steering Committee formed, with one member from each participating organization, for project implementation and operational decisions**
- **Engineering Committee, comprised of network engineers from each participation organization, to make network engineering and operational recommendations to the Steering Committee**



# US - Latin America Connectivity before IRNC



- Argentina, Brazil (national and the State of Sao Paulo), Chile, Panama and Venezuela connections through Miami
- Mexico connections through San Diego and El Paso
- Peerings with Internet2 and other US R&E networks through AMPATH, CaREN and UTEP
- International and FedNet peerings at STARTAP/Starlight from Miami provided by AMPATH



# Regional Development



- Cooperation of Latin American research networks (CLARA)
- @LIS Alliance of the Internet Society funded program, providing 10 Million Euros for interconnecting R&D communities of Latin America and Europe
- Creates a regional backbone in Latin America
- Direct connectivity to Europe from Sao Paulo, Brazil
- Intraregional connectivity between connected countries in Latin America
- 3 DS3s from AMPATH to support CLARA initiative

Argentina (RETINA)	Ecuador (CEDIA)	Panama (REDCYT)
Brazil (RNP)	El Salvador (RAICES)	Paraguay (ARANDU)
Chile (REUNA)	Guatemala (RAGIE)	Peru (RAAP)
Costa Rica (CRNET)	Mexico (CUDI)	Uruguay (RAU)
	Nicaragua (RENIE)	Venezuela (REACCIUN)

(NRENs in formation indicated in RED)





# Expected CLARA network topology



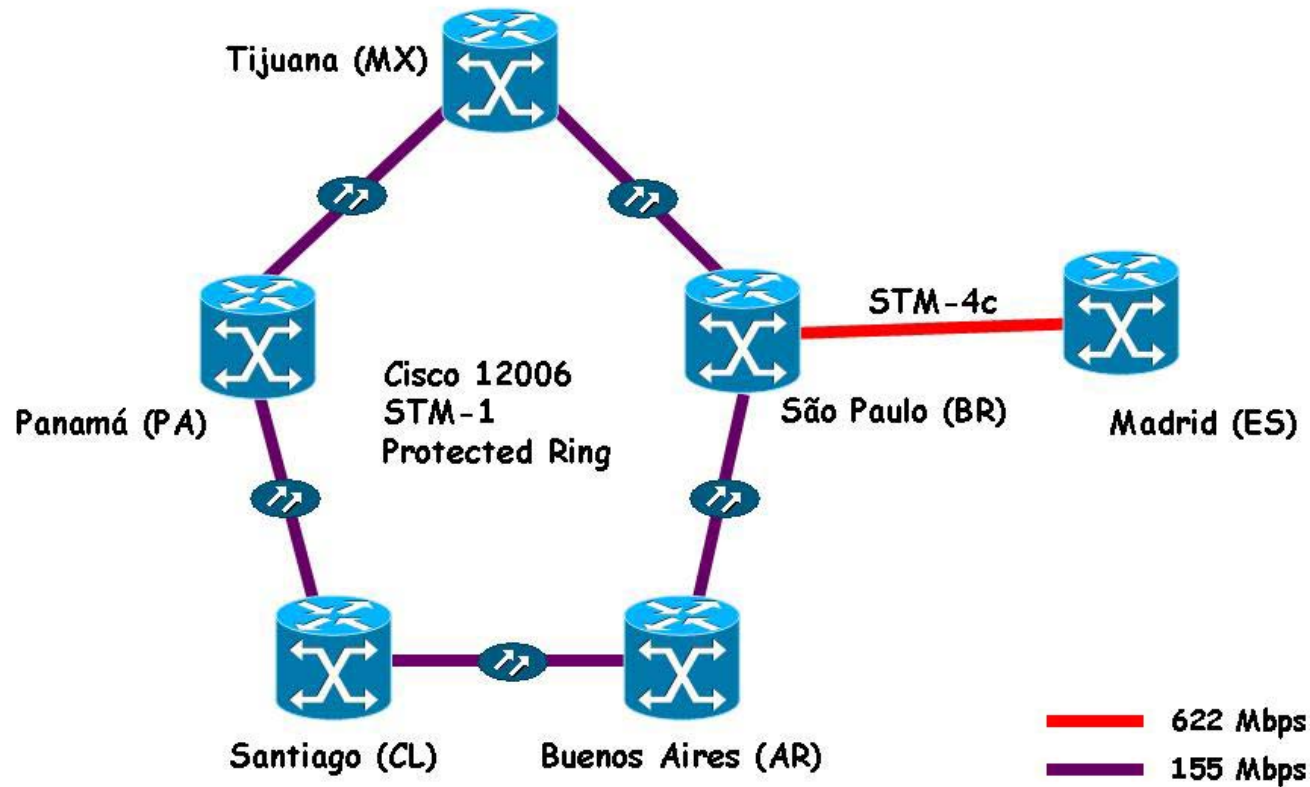
## Network Characteristics:

- 155 Mbps backbone ring
- 622 Mbps connection to Europe
- local traffic remains within the region
- 10 to 45 Mbps spur links
- 4Mbps satellite link to Cuba
- Network to be operated by CLARA (through CUDI and RNP)





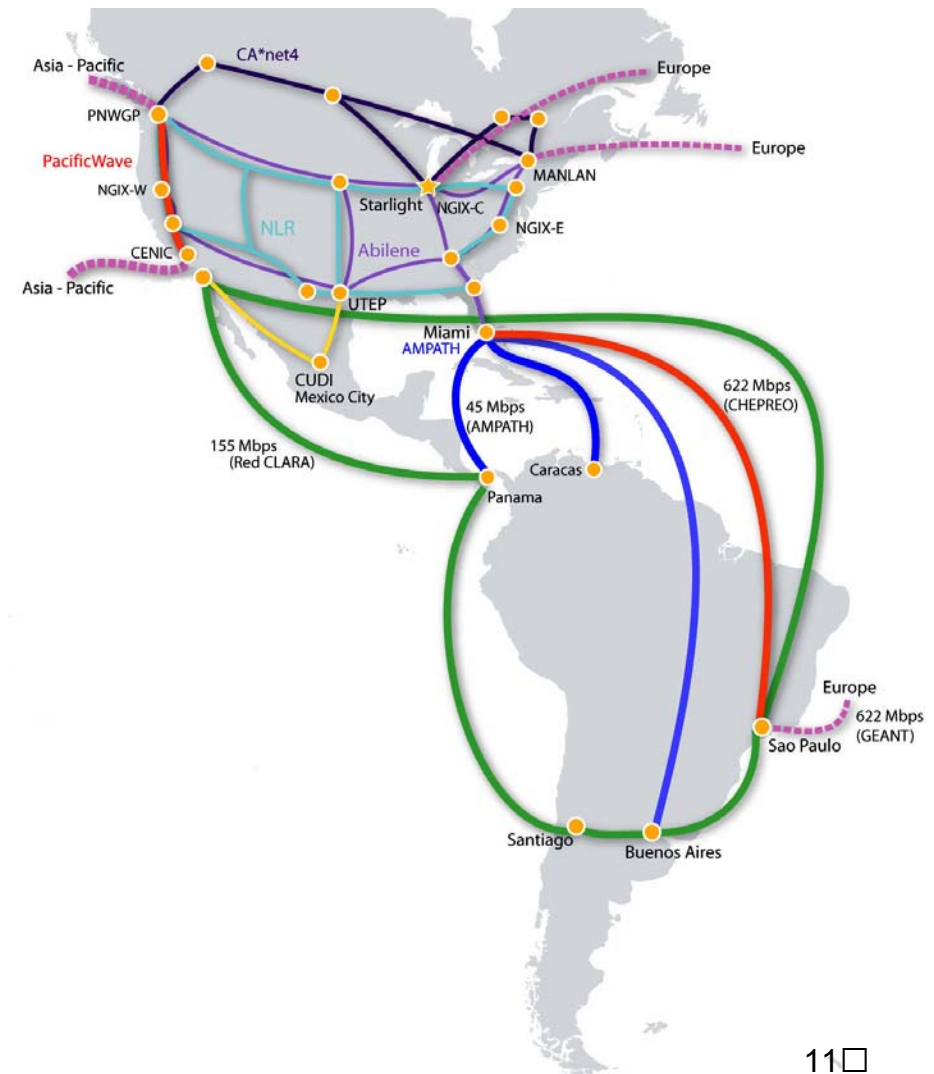
# RedCLARA Routed Network



# Current US - Latin America Topology



- RedCLARA network starts operating in August 2004
- Brazil/RNP and Chile/REUNA today transit CLARA, then GEANT to reach US R&E networks
- NSF CHEPREO project and collaboration with Sao Paulo R&E community establishes STM-4 link between US and Brazil
- ITN services and transit to FedNets through Abilene
- Argentina, Panama and Venezuela maintaining direct connections to US through AMPATH
- Mexico has direct connection to US through UTEP



# Links Interconnecting Latin America (LILA) Year 1



- **Increases Miami - Sao Paulo link from 622Mbps to 1.2Gbps**

- Q2 2005
- Evolving to 2.5Gbps

- **Establishes a dark fiber segment between San Diego and Tijuana for a 1Gbps link**

- May 2005

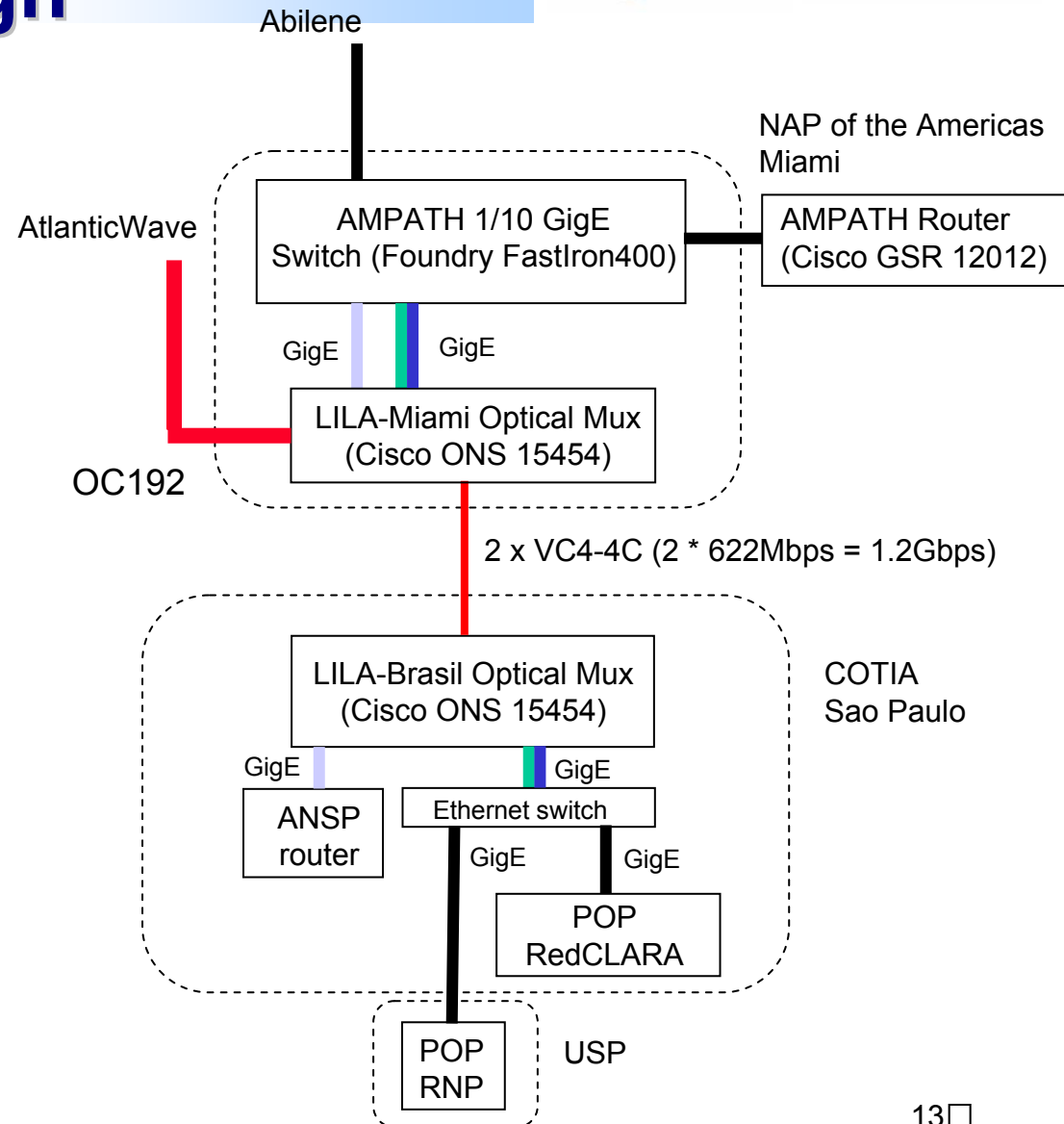
- **Enables interregional peerings through east and west coasts**



# LILA Miami - Sao Paulo link design



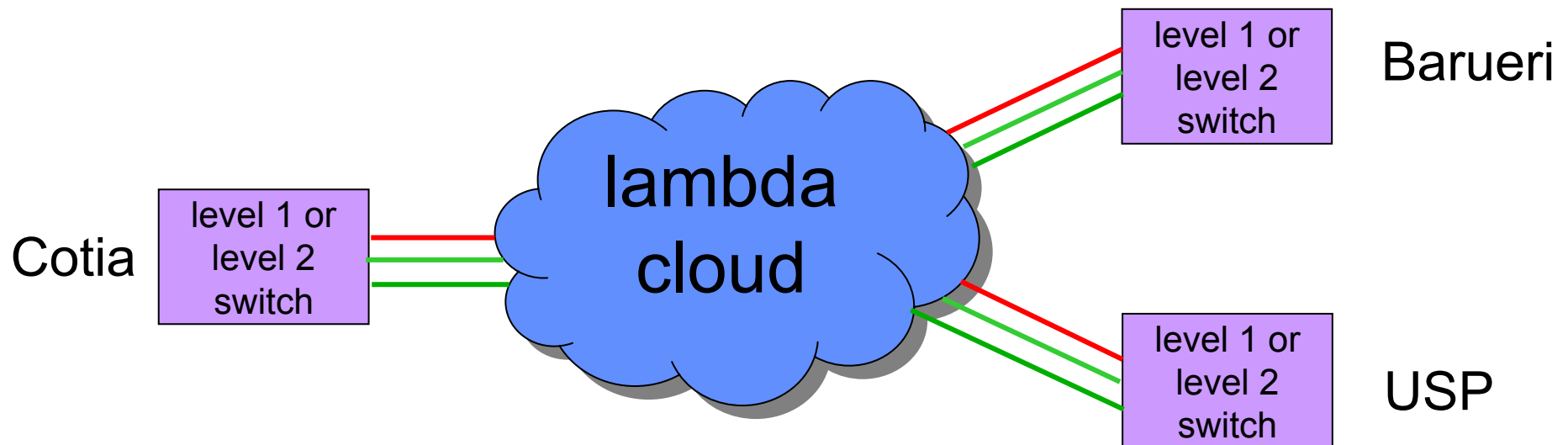
- Provides dedicated Gig-E interface to ANSP
- Provides shared Gig-E interface to CLARA and RNP
- Support planned for lightpath provisioning and deterministic transport services through AtlanticWave
- Peering with Internet2's Abilene and other R&E networks through AMPATH



# Sao Paulo Distributed exchange point



- The lambda cloud created by the WDM infrastructure permits the arbitrary interconnection of pairs of level 1 or 2 devices in different PoPs attached to the cloud
- Lambdas will usually use n-Gbps Ethernet framing
  - ❑ exceptionally SDH/Sonet framing could be used



# LILA San Diego - Tijuana Link



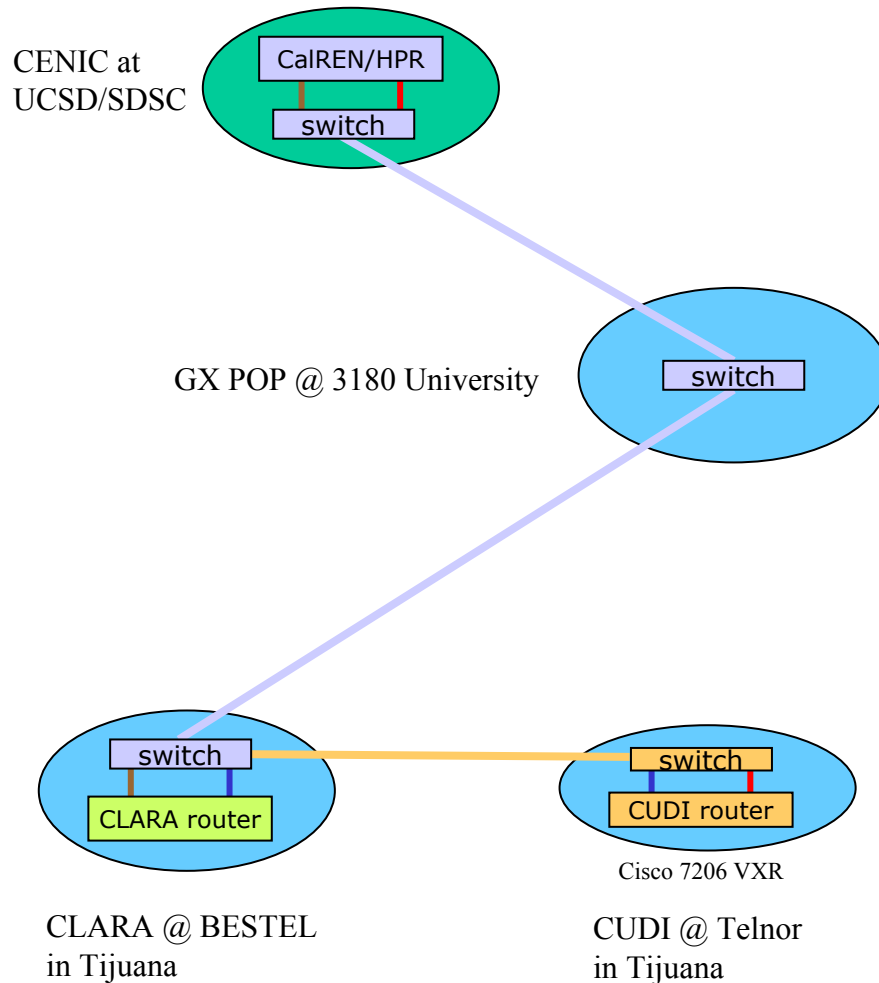
- Provides dedicated Gig-E interface to CLARA
- Provides dedicated Gig-E interface to CUDI
- Growth across border possible through purchase of additional Gig-Es up to maximum of 6
- Connections are to CENIC's CalREN/HPR routed network
- Peering through CalREN to Internet2 and other R&E networks



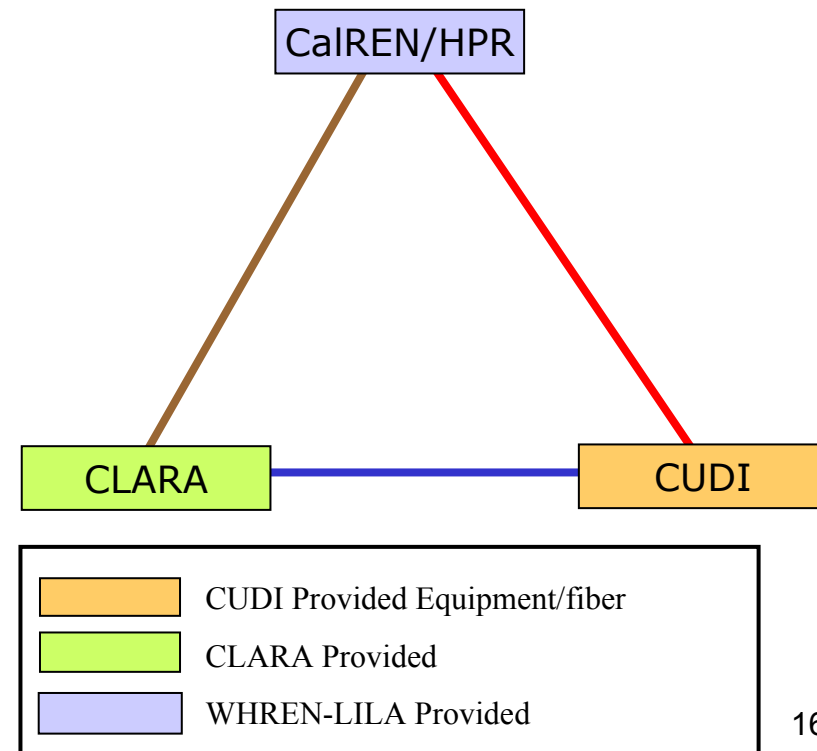
# LILA San Diego - Tijuana link design



## Physical Diagram



## Logical Diagram

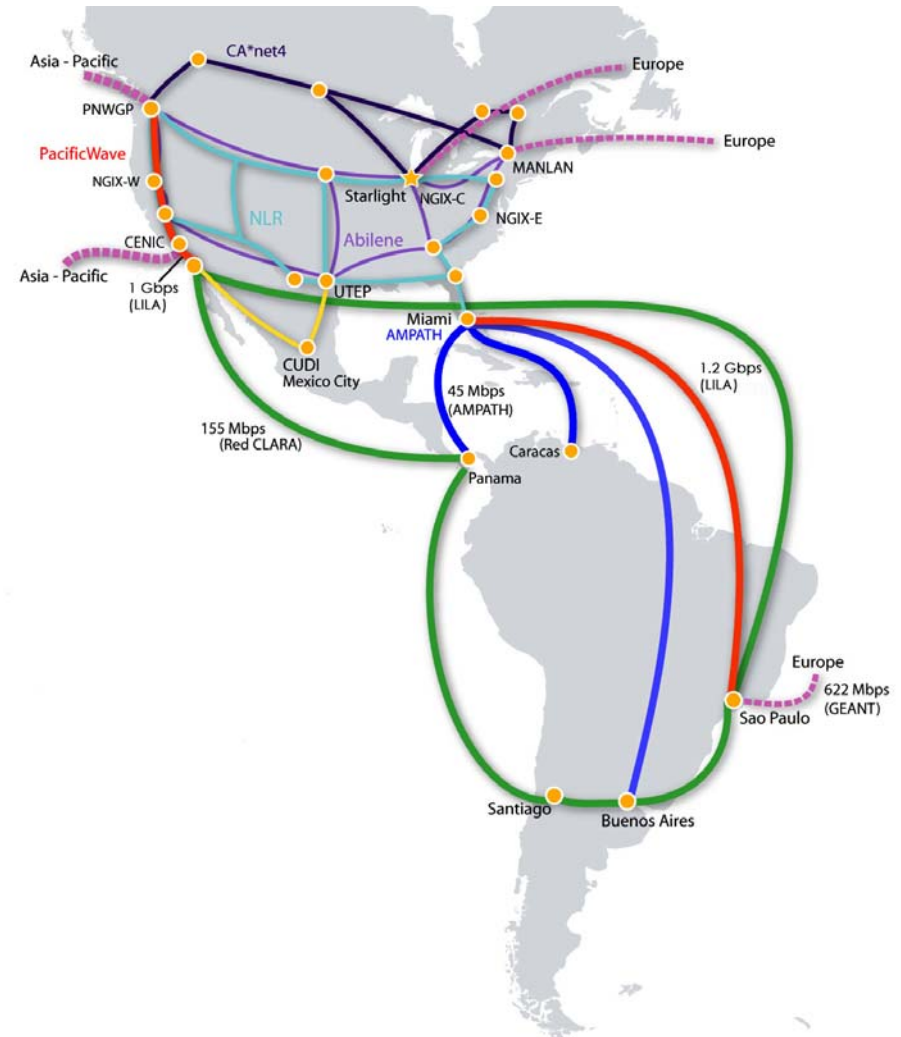




# US - Latin America Year 1 Topology



- LILA links reestablish direct connectivity to South America from east and west coasts
- Reduces delay reaching sites in Chile and Brazil from the US and Asia-Pacific
- Introduces an infrastructure to develop a distributed international exchange and peering
- Leverages network resources to provide route diversity and high-availability production services



# AtlanticWave



- **AtlanticWave is an International Peering Fabric**
  - **US, Canada, Europe, South America**
  - **Distributed IP peering points:**
    - **NYC, WDC, ATL, MIA, SPB**
- **SURA, FIU-AMPATH-CHEPREO, the IEEAF, MAX, SoX/SLR, MANLAN, and in partnership with the Academic Network of Sao Paulo (ANSP) are combining efforts to establish AtlanticWave**
- **Described as an integral component of the WHREN-LILA proposal to extend LILA on the Atlantic side to MANLAN in NYC**
- **Complements the PacificWave distributed peering facility on the west coast**



# AtlanticWave Topology

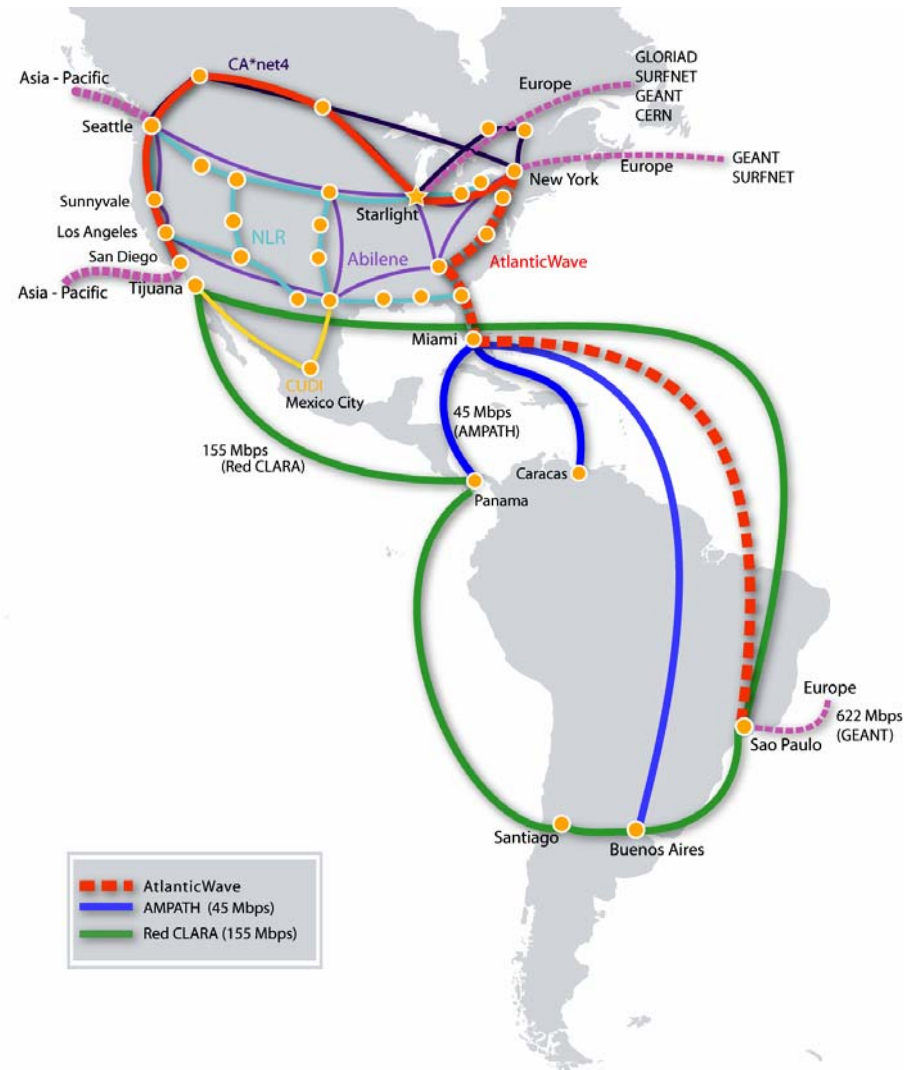


- **A-Wave provides multi-layer/multi-protocol services between participating networks**

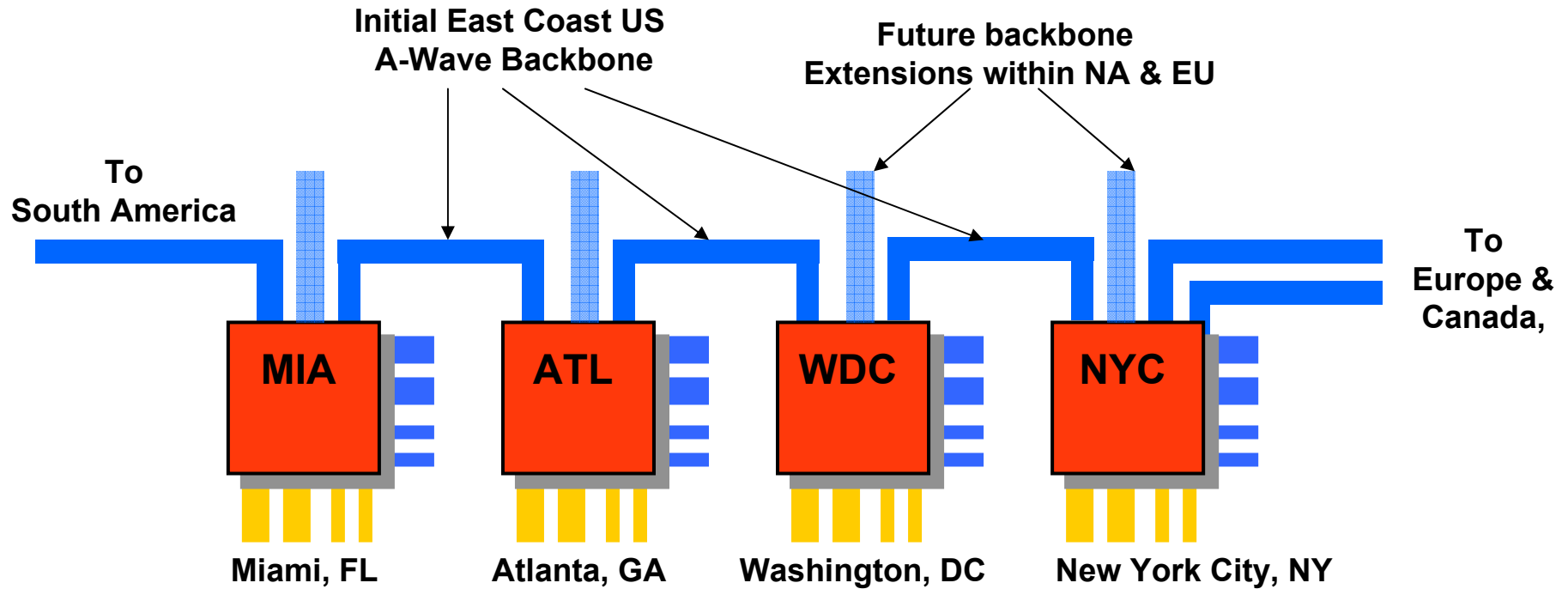
- Layer 3 peering services over ethernet
- GLIF “light path” services
- Others TBD

- **A-Wave will to provide a Layer 3 distributed exchange capability**

- Ethernet based
- Best effort packet exchange
- Linear topology – unprotected (NLR based)
- 1 GE, 10GE LAN, 10GE WAN client access
- Jumbo frame support



# AtlanticWave Design



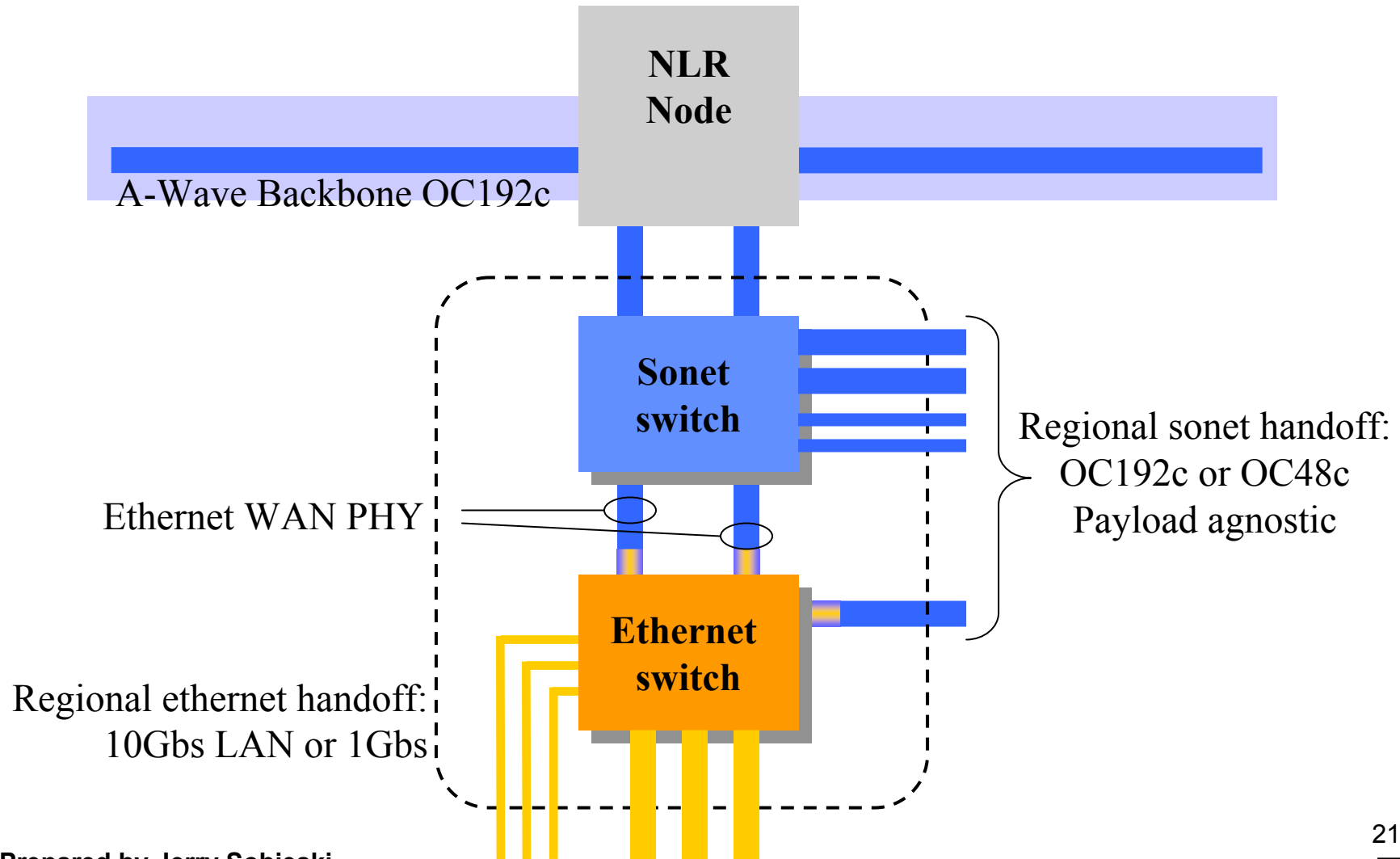
Prepared by Jerry Sobieski

 Sonet services

 Ethernet services

# Generic A-Wave Node Architecture

(using separate switching fabrics)



# Deployment Plans & Timeline



- **Phase 1: Deploy backbone OC192c** **Sept 05**
  - ❑ Between MIA-ATL, ATL-WDC, WDC-NYC
  - ❑ 10Gbs WAN PHY ethernet over NLR wave initially.
  - ❑ Migration of existing exchange switches/networks
    - Regional backhaul
    - Reconfiguration of existing exchange services and networks
- **Phase 2: Sonet switch deployment** **Dec 05**
  - ❑ Map IP/Ethernet Peering Fabric across “appropriate” sized VCG (GFP-F & VCAT)
  - ❑ Engineer and deploy GLIF Common Services in conjunction with other GLIF domains
- **Phase 3: Deploy *dynamic* light path services** **Mar 06**
- **Phase 4: Expansion** **Aug 06 ->**
  - ❑ Integrate links between A-Wave, P-Wave, Northern Tier, etc

# Year 1 Milestones

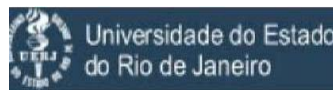
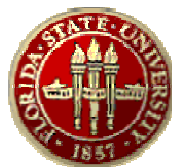
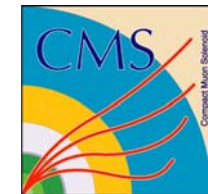


- **Implement LILA links** **May 05**
- **Implement interregional peering through CalREN and AMPATH** **June 05**
- **Establish Coordination and Control mechanisms for service management** **Sept. 05**
- **Deploy AtlanticWave OC192c backbone** **Sept. 05**
- **Deploy Next-Gen SONET switches** **Dec. 05**

# Grand Challenge Research:CHEPREO



- **An interregional grid-enabled Center for High-Energy Physics Research and Educational Outreach (CHEPREO)**
- **Fosters an integrated program of research, network infrastructure development, and education and outreach**
  - ❑ **Collaboration with FIU, Caltech, University of Florida, Florida State University, the State University of Rio de Janeiro, University of Sao Paulo**
  - ❑ **Augments bandwidth capacity to Brazil**
- **Joint funding by U.S. NSF (MPS-0312038) and State of Sao Paulo Research Foundation (FAPESP)**

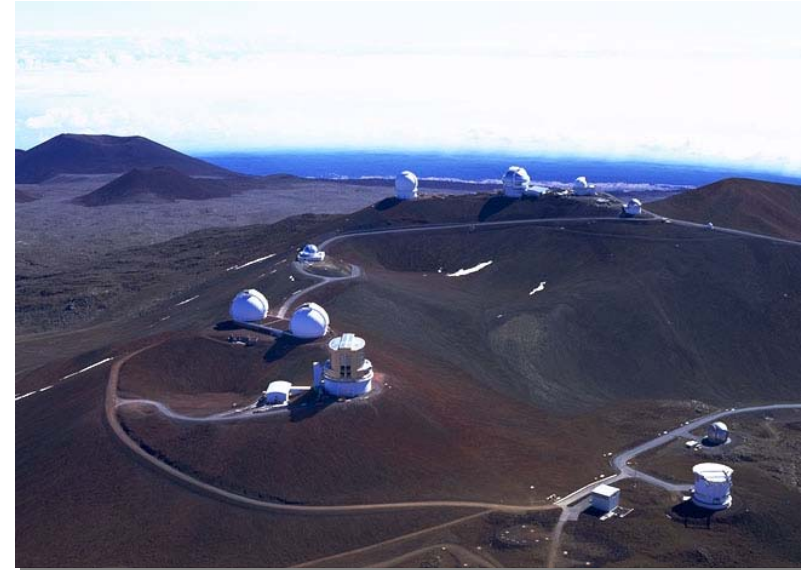




# Grand Challenge Science Instruments

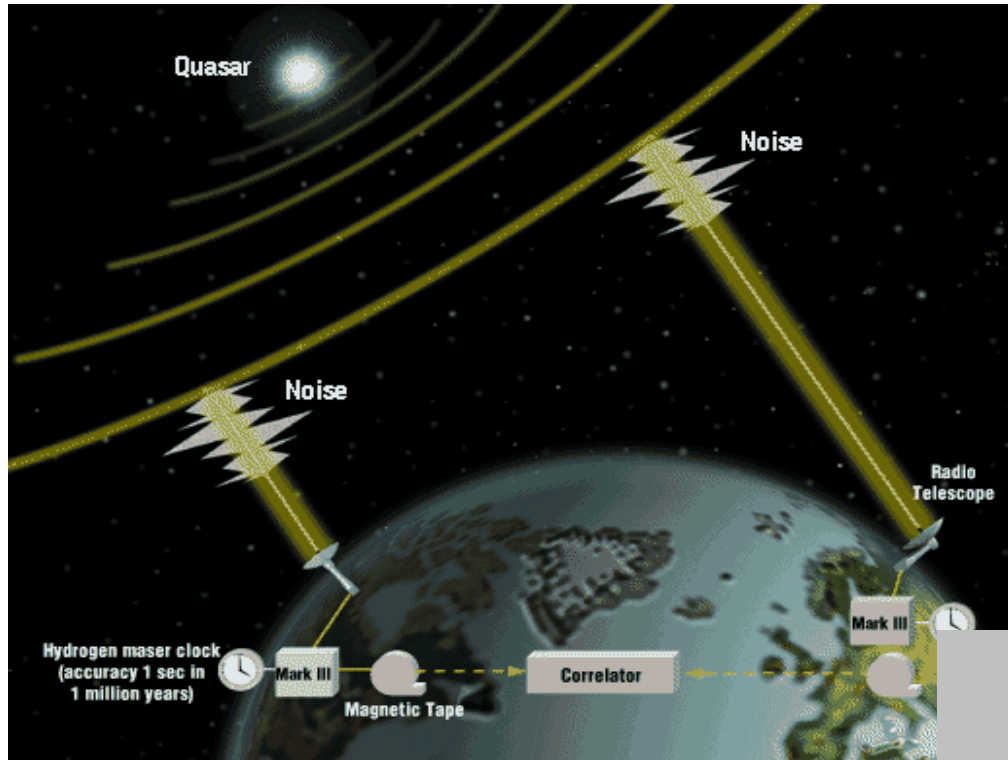


**Gemini-South Optical  
Observatory  
NRAO telescopes  
*La Serrena, Chile***



**Atacama Large  
Millimeter Array  
(ALMA)**

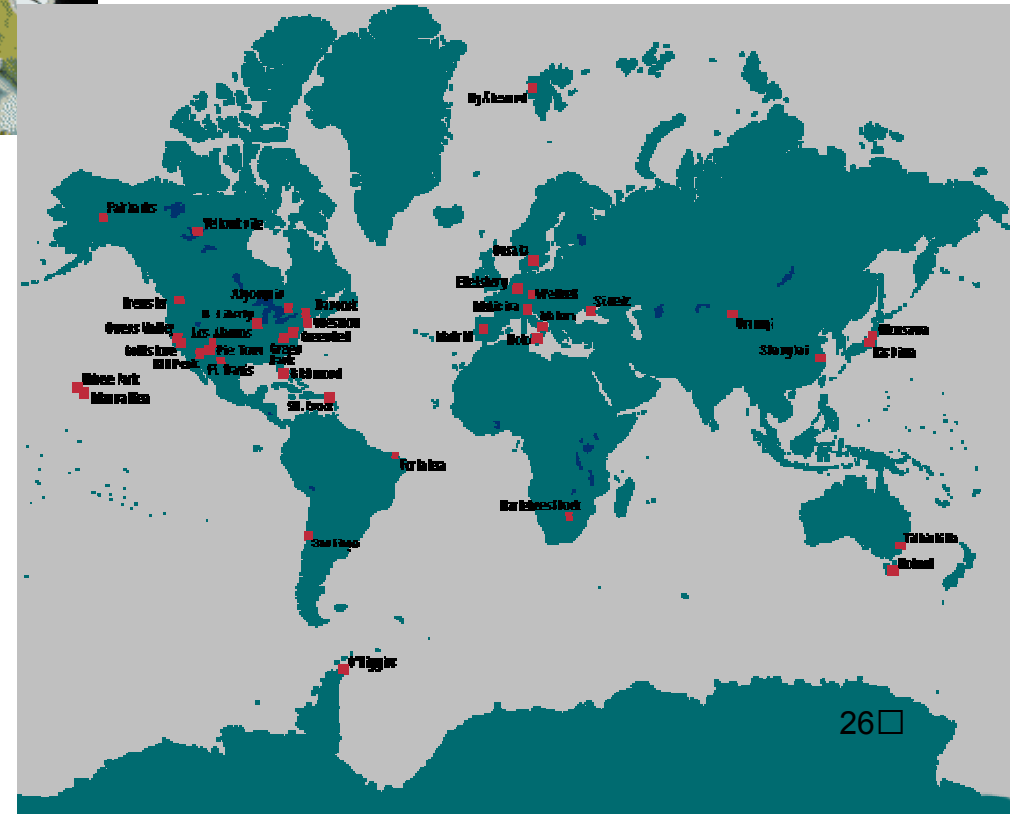
***Atacama plains***



# The Very-Long Baseline Interferometry (VLBI) Technique (with traditional data recording)



## The Global VLBI Array (up to ~20 stations can be used simultaneously)



## Pan-American Advanced Studies Institute



- NSF sponsored program to offer a series of lectures at the advanced graduate and postgraduate level involving domain researchers, students and practitioners. Award# 0418366, OISE Americas Program
- Aims to disseminate advanced scientific and engineering knowledge, stimulate collaborative learning and cooperation among the research communities of the Americas
- CIARA, along with collaborators from the U.S., Argentina and Brazil, is organizing a PASI to offer a series of lectures on the role of Grid Computing and Advanced Networking for High-Energy Physics and Astronomy
- Our PASI is planned for May 15-20, 2005 in Mendoza, Argentina
- Approximately 40 students from the Americas will learn of the major experiments, Grid and advanced networking technologies and how the growing interdependence between the science and the technologies are forming global collaborations



# Thank You!



- **WHREN-LILA, AMPATH infrastructure, CHEPREO, science application support, education, outreach and community building efforts are made possible by funding and support from:**
  - ❑ **National Science Foundation (NSF) awards STI-0231844, MPS-0312038, OISE-0418366 and SCI-0441095**
  - ❑ **Florida International University**
  - ❑ **Latin American Research and Education community**
  - ❑ **The many national and international collaborators who support our efforts**