Global Lambda Integrated Facility (GLIF)

Seattle, Washington

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Outline

- Introduction and Background
- Design and Implementation
- Services
- Users, Events and Activities
- Summary and Conclusions

AtlanticWave Project

- AtlanticWave has established a 10GigE wave along the Atlantic rim, from NYC to Miami
- AtlanticWave connects 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
- AtlanticWave is an integral component of the NSF IRNC WHREN-LILA project, extending open distributed exchange and transport services to Sao Paulo
- AtlanticWave partners include SURA, FIU-AMPATH, IEEAF, FLR, MAX, SLR/SoX, Internet2/MANLAN

AtlanticWave Concept

- Collaborating exchange points with a common set of goals
- Each exchange point operates independently and manages its connectors
  - Do not disrupt business and operating models
- Provide international connectors with the option to peer across a common layer2 exchange fabric

AtlanticWave Goals

- Facilitate international peering along the Atlantic rim of North and South America
- Support communities that need network resources for research between North and South America, and other countries and continents
- Enhance international science collaborations through the uptake and use of NSF IRNC links

International Research Network Connections

The NSF IRNC program provides network connections linking U.S. research networks with peer networks in other parts of the world to support science and engineering research and education applications

Awards:

- **TransPAC2** (U.S. - Japan and beyond)
- **GLORIAD** (U.S. - China, Russia, Korea)
- **Translight/PacificWave** (U.S. - Australia)
- **TransLight/StarLight** (U.S. - Europe)
- **WHREN-LILA** (U.S. - Latin America)

Western Hemisphere Research & Education Networks – Links Interconnecting Latin America (WHREN-LILA)

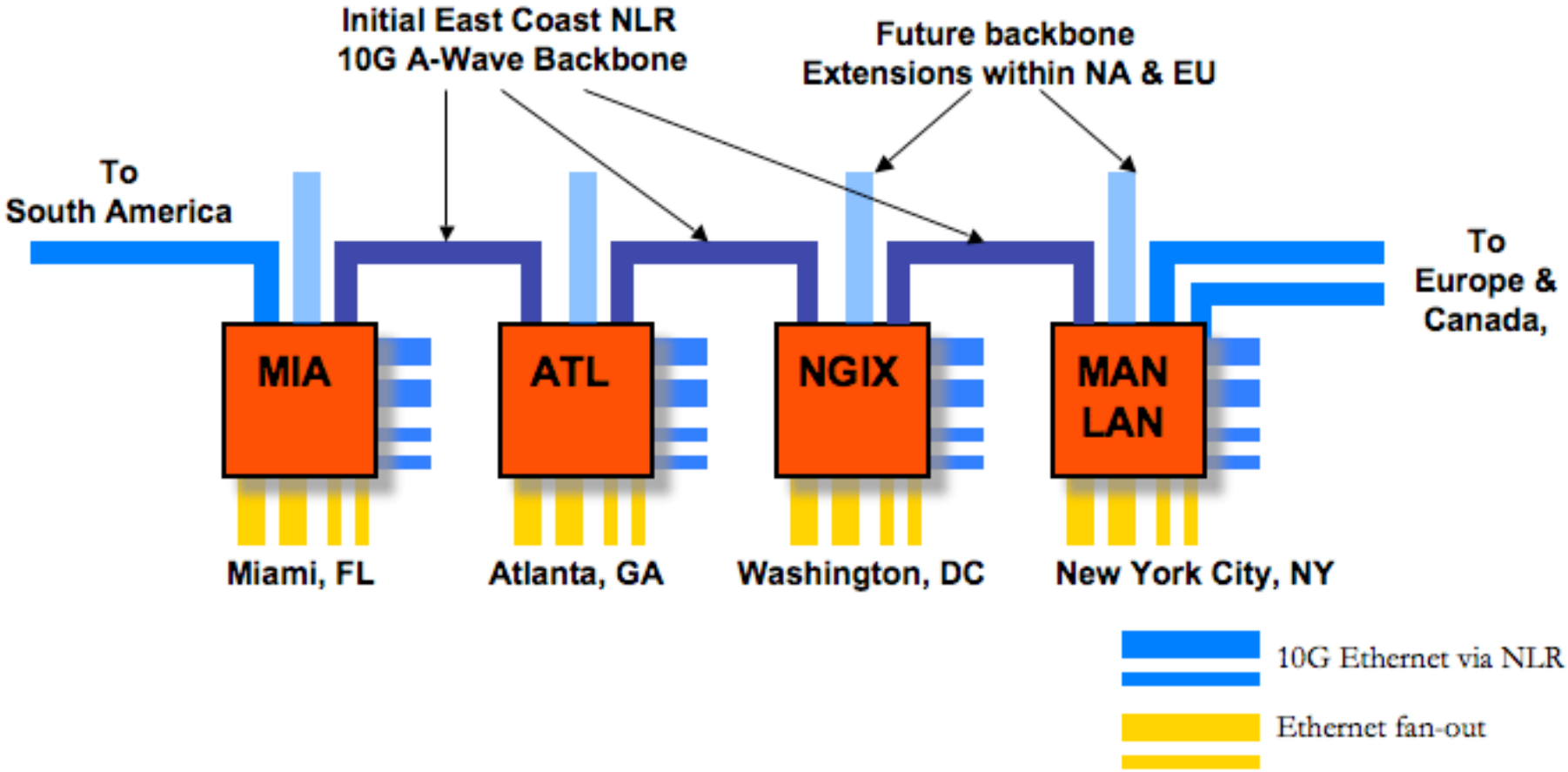
- 5-year NSF Cooperative Agreement
- Connectivity to Brazil is supported through a coalition effort through the WHREN-LILA projects
  - Florida International University (award #0441095)
  - Corporation for Education Network Initiatives in California (CENIC)
  - Project support from the Academic Network of Sao Paulo (award #2003/13708-0)
  - CLARA, Latin America
  - CUDI, Mexico
  - RNP, Brazil
  - REUNA, Chile
- Links Interconnecting Latin America (LILA)
  - Improves U.S.-Latin America connectivity
- Western-Hemisphere Research and Education Networks (WHREN)
  - Coordination among R&E network providers and users
  - Leverage participants' network resources
  - Enhance international collaborative science research and education

AtlanticWave

Governance Structure

- Governance Committee (GC)
  - Responsible for the overall strategy, finances, operations, and external relations of the Collaboration
  - Voting committee, comprised of one representative designated by each Collaborating Organization
- Engineering Committee (EC)
  - Responsible for developing recommendations to the Governance Committee for technical design and operational practices
  - MAX leads the EC by chairing the EC and coordinating with the GC
  - Non-voting committee, comprised of one or more engineers from each exchange point

AtlanticWave Architecture



By Jerry Sobieski

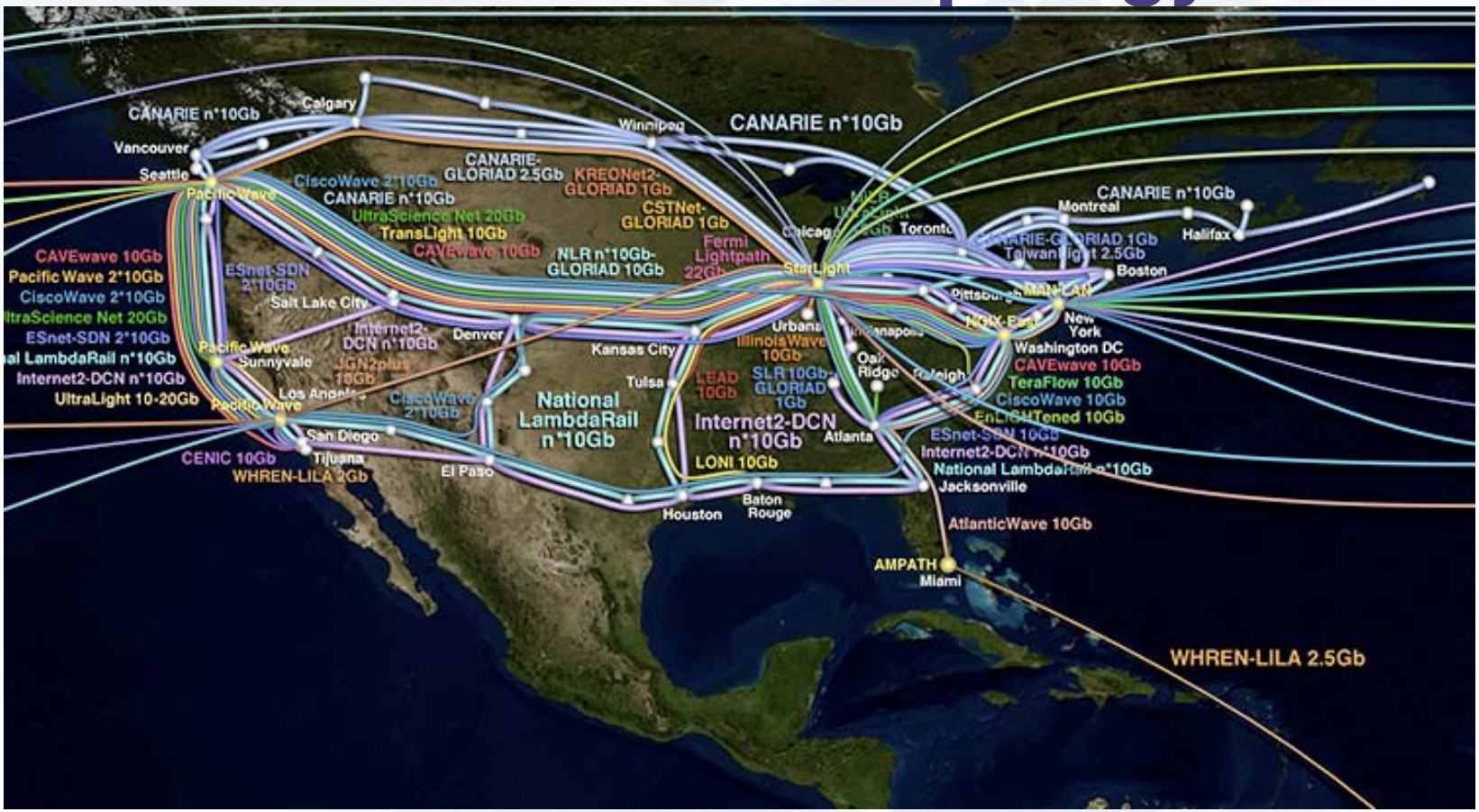
Implementation Constraints

- Heterogeneous equipment environment
- Each XP manages its own vlan domain
- Implement A-Wave with the least amount of disruption to the Exchange Points (XPs)
  - AtlanticWave AUP should not disrupt AUPs of each collaborating exchange point

Implementation and Operations

- Engineering Committee (EC) selected to use point-to-point private 802.1q vlans, after vetting pros and cons
- Allocated a full mesh of vlans across XPs
  - Not trivial to identify usable vlan blocks; found gaps in vlan ranges
- Connections are static
- Vlans are activated per request
- Activation of vlans is coordinated across XPs
- Defined MTU range from 1500 to 9000 bytes

AtlanticWave Topology



- 10GigE wave from NYC to Jacksonville over NLR
- 10GigE wave from Jacksonville to MIA over FLR
- Layer2 peering fabric extended to Sao Paulo using WHREN-LILA, and Extension to Chicago through CaveWave for interconnection with StarLight/Translight

http://www.atlanticwave.net/

AtlanticWave

AtlanticWave Services

- International Peering Service
  - R&E networks connected at one or more A-Wave exchange points can use A-Wave for primary or backup peering purposes
  - A-Wave users can initiate and establish peering agreements between themselves
  - At least one of the networks of the peering relationship must be an international network that is connected to one of the exchange points
- Special Projects
  - Short-term network transport for projects conducting experiments or research
  - Use is temporary and, if necessary, scheduled
  - Special projects must be designed to be non-disruptive with bandwidth needed by the primary peering activities

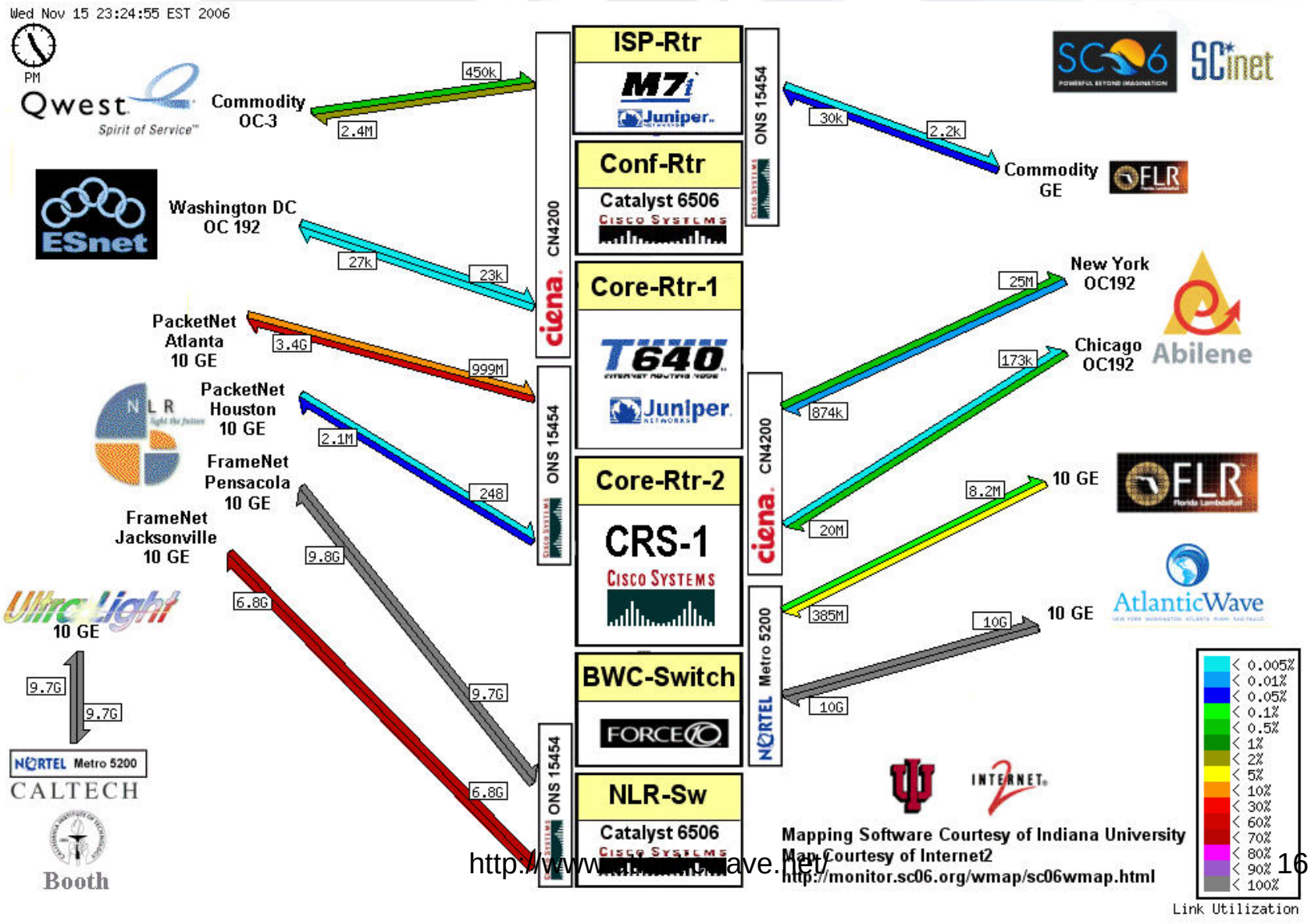
How to connect to AtlanticWave?

- Networks must first connect to one of the 4 AtlanticWave exchange points
  - Contact information for each of the XPs is available at http://www.atlanticwave.net
- To peer with another AtlanticWave user, complete the International Peering Service form
- Temporary use for projects or experiments, send send request to info@atlanticwave.net, describing requirements, estimated bandwidth, start date and duration

Events

- A-Wave supported successful demonstrations at SC06
- Contributed to the bandwidth challenge event, supporting diverse types of demonstrations

SC06 Bandwidth Challenge: Fast Data Transport



Super Computing 2008

- AtlanticWave will be available for Super Computing 2008
- Groups interested in using AtlanticWave for SC08 events should contact the AtlanticWave team with their questions and requirements
- Send an email to the following address: <request@atlanticwave.net>

Activities

- Enhancing NREN-to-NREN peering
- Enhancing LHC Compact Muon Solenoid (CMS) detector research collaborations
- Increasing participation in e-VLBI experiments

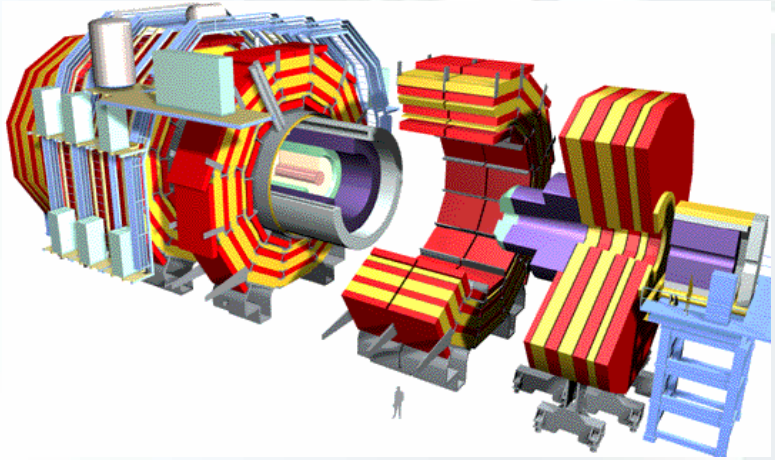
Distributed International Peering

- Enhancing nren-to-nren exchange through
  - Distributed exchange peering fabric
  - Multiple peering relationships across multiple exchange points

Peers	A Location	Z Location
RedCLARA-Internet2	Sao Paulo	Washington, DC
RedCLARA-NLR	Sao Paulo	New York
ANSP-NLR	Sao Paulo	New York
RedCLARA-Esnet (v4)	Sao Paulo	Washington, DC
RedCLARA-Esnet (v6)	Sao Paulo	Washington, DC
RNP-Internet2	Sao Paulo	Washington, DC
RedCLARA-CAnet4	Sao Paulo	New York
RedCLARA-Internet2	Miami	New York

Complete list at http://www.atlanticwave.net/network.html

Compact Muon Solenoid (CMS) detector



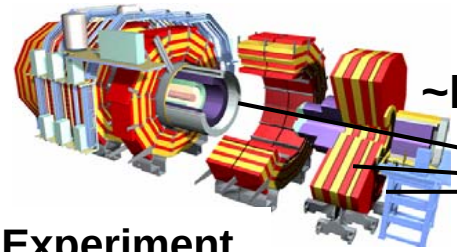
CMS is a general-purpose particle physics experiment, designed to detect a wide range of particles and phenomena

Main features of the CMS (Compact Muon Solenoid) detector:

- Its relatively small size (compact)
- Its optimization for tracking muons
- The powerful solenoid magnet

- Goals of the experiment are to:
  - Search for evidence of physics beyond the standard model, such as super symmetry, and extra dimensions
  - discover the Higgs boson
  - Answer questions of particle physics and cosmology

The LHC Data Grid Hierarchy: Developed at Caltech (1999)



Experiment

~PByte/sec

Online System

~150-1500 MBytes/sec

11 Tier1 and >140 Tier2 Centers. Transforming Data-Intensive Science

Tier 0 +1

CERN Center
PBs of Disk;
Tape Robot

Tier 1

10 - 40 Gbps

IN2P3 Center

RAL Center

INFN Center

FNAL Center

...

~10 Gbps

Tier 2

Tier2 Center

Center

nter

Center

Center

~1-10 Gbps

Tier 3

Institute

tute

stitute

Institute

Physics data cache

1 to 10 Gbps

Workstations

Tier 4

Several Petabytes in 2008
An Exabyte ~7 Years later
100 Gbps+ Data Networks

"Tier2s in the western hemisphere need to connect to Tier1s in Europe."
Harvey Newman

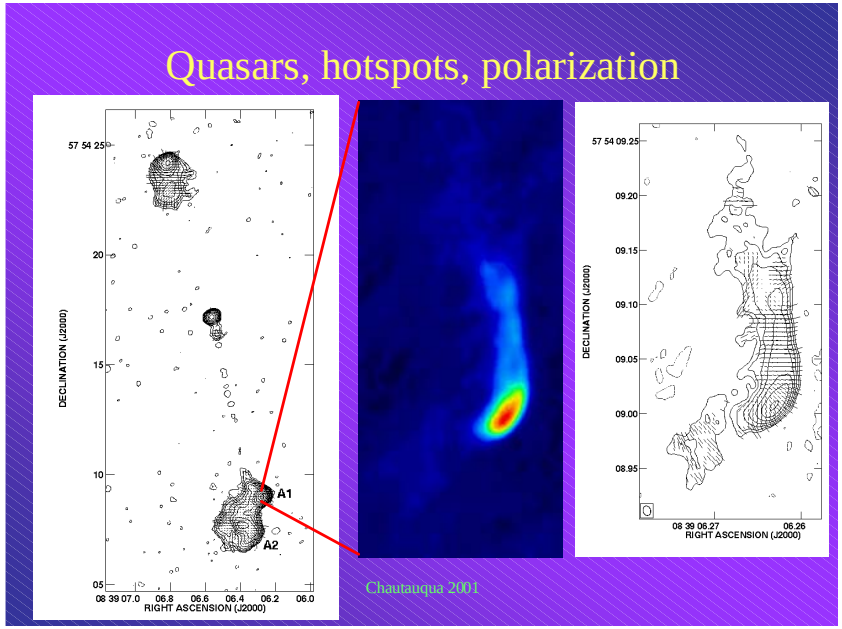
International CMS Collaborations

- AtlanticWave facilitates access to NSF IRNC links
  - U.S.-Latin America (WHREN-LILA)
  - U.S.-Europe (TransLight/StarLight)
- IRNC links enable Tier2s in the Western hemisphere to connect to Tier1s in Europe
- Access to IRNC links by Brazil's Tier2s lessens the burden on U.S. Tier1
  - IRNC links are enabling a division of labor to augment U.S. Tier1 and Tier2 capabilities by including Brazil's Tier2 facilities, providing both human and machine resources
- Two 1GigE vlans connect Brazil's Tier2s to CERN using WHREN-LILA, AtlanticWave, CaveWave and TransLight/StarLight, NetherLight, and U.S. LHCnet

VLBI Science

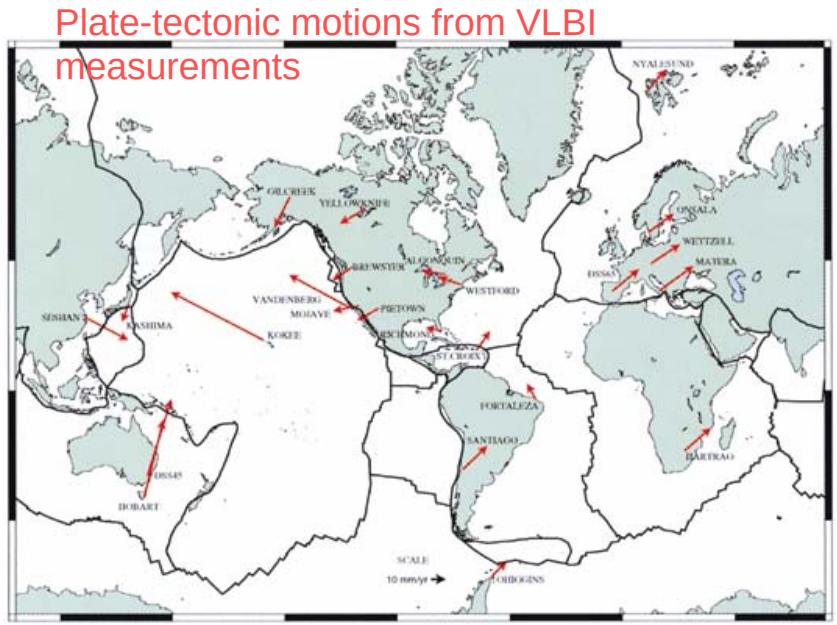
ASTRONOMY

- Highest resolution technique available to astronomers – tens of microarcseconds
- Allows detailed studies of the most distant objects – quasars, gravitational lenses, GRBs; as well as black hole at center of Milky Way



PRECISION GEODESY

- Highest precision (few mm) technique available for global tectonic measurements
- Highest spatial and time resolution of Earth's motion in space for the study of Earth's interior
  - Earth-rotation measurements important for military/civilian navigation
  - Fundamental calibration for GPS constellation within Celestial Ref Frame

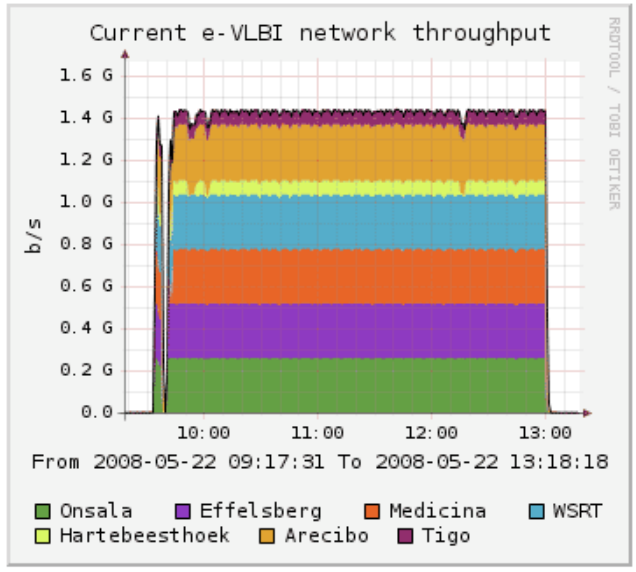


Alan Whitney

e-VLBI Radio Astronomy

- Arecibo is participating in e-VLBI experiments using AtlanticWave
- Collaboration involved Jive, SurfNet, AtlanticWave, CaveWave, Translight/StarLight, University of Puerto Rico and Arecibo
- Successful demonstration at the Terena8 conference: telescopes in Chile, Germany, Italy, the Netherlands, Puerto Rico, South Africa and Sweden streamed data to the Joint Institute for VLBI in Europe (JIVE), then correlated in real-time
- Regular use of AtlanticWave by Arecibo for e-VLBI activities

Networks create 11,000km real-time virtual telescope



Summary and Conclusions

- AtlanticWave is enhancing international peering for NRENs and international science collaborations
- Facilitating access to NSF IRNC links to Latin America and Europe
- Providing a low-cost and very simple approach by which to enhance international science collaborations
- Static vlan management scheme has worked well, since the number of active vlans remain within predefined vlan ranges

Thank You
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