

# PRESS RELEASE

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## AmLight supports wide-area network demonstrations in Super Computing 2013 (SC13)

Miami, Florida, February 3, 2014 – Florida International University FIU’s AmLight project supported two long-haul network experiments that spanned the continents of South and North America. AmLight allocated up to 20Gbps of bandwidth capacity between Miami and São Paulo. With support from Florida LambdaRail (FLR), National LambdaRail (NLR) and Internet2, the 20Gbps of bandwidth capacity was extended from Miami to the SC13 show floor in Denver, Colorado. Layer2 lightpaths were provisioned from São Paulo to the show floor in Denver, overlaid on the AmLight, FLR, NLR and Internet2 AL2S backbone networks. The network diagram in Figure 1 illustrates the wide area and local area networks for High-Energy Physics (HEP) deployed by the Caltech team and partners, including the connections for the LHC CMS Tier2 Computing Centers in Rio de Janeiro (HEPGRID) and São Paulo (SPRACE), provided respectively by RNP and ANSP through the International Exchange Points in São Paulo (SouthernLight) and Miami (AMPATH), FLR, NLR and Internet2 AL2S.

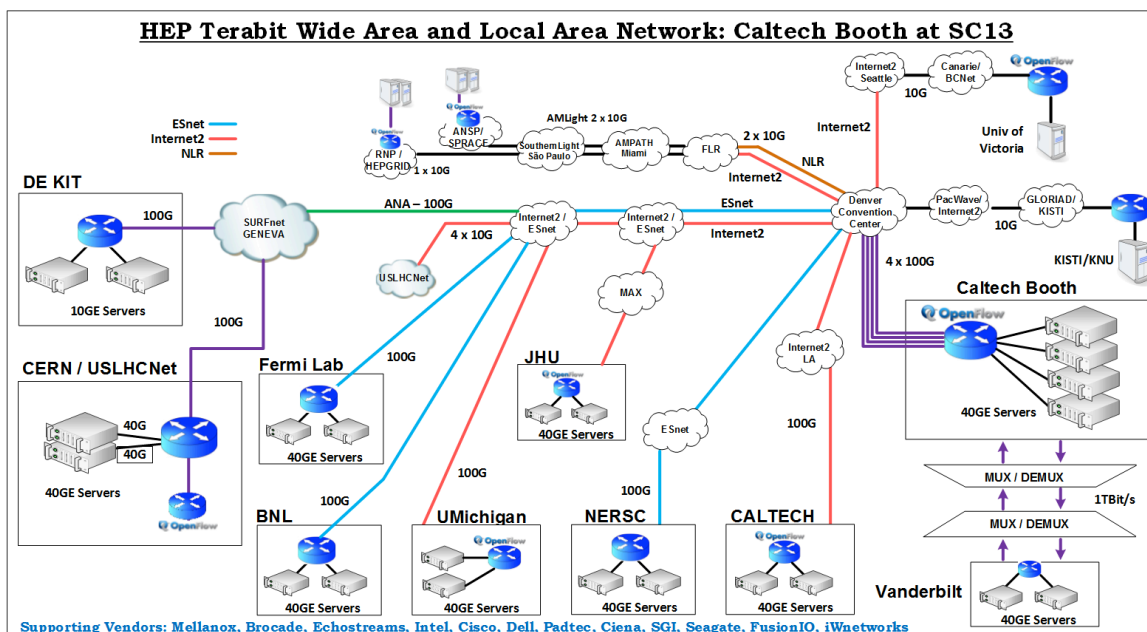


Figure 1 - HEP Terabit WAN and LAN for the Caltech Booth at SC13

The wide area network shown in Figure 1 represents the collaboration of many geographically distributed research and education networks, and computation and storage facilities, to form a global testbed environment, in order to conduct at-scale network experiments. The two experiments AmLight supported were (a) the GLIF Automated GOLE Network Services Interface (NSI) version 2.0 protocol; and (b) Openflow-based Multipath Networks in the WAN. The following is a description of these experiments and their results.

## **GLIF Automated GOLE NSI version 2.0 protocol demonstration**

Both, the Americas Pathway (AMPATH) International Exchange Point in Miami, Florida, and the Southern Light International Exchange Point in São Paulo, each participated in the Automated GLIF Optical Lightpath Exchanges (AutoGOLE) trial at SC13.

The Global Lambda Integrated Facility (GLIF) Automated GOLE pilot dynamically connects GLIF Open Lightpath Exchanges (GOLEs) and networks across the globe. The demonstration at SC13 was an inquiry-based experiment that aimed to observe how the Network Service Interface Connection Service (NSI CS 2.0) behaved in a global multi-domain environment. NSI is an architectural standard being developed as a cooperative project between the GLIF community and the Open Grid Forum (OGF), a standards development organization. This experiment involved the set up of dynamic Layer2 services between 20 network domains on 4 continents to demonstrate real-world compatibility of version 2.0 of the NSI.

Pre-staging of the SC13 Denver demonstration took place during the Annual GLIF meeting in October, in Singapore. Participating GOLEs, networks and partners during the GLIF and SC13 demonstrations were AIST (JP), SINET (JP), KDDI R&D Labs (JP), JGN-X (JP), KISTI (KR), SingAREN (SG), SouthernLight (BR), RNP (BR), AMPATH (US), ESnet (US), Internet2 (US), StarLight (US), PSNC (PL), NORDUnet (Scandinavia), GEANT (EU), GRnet (GR), CESNET (CZ), University of Amsterdam (NL), SURFnet (NL) and NetherLight (NL).

Each GOLE ran the NSI version 2 protocol, and replied to requests to establish Layer2 circuits dynamically. Three data plane demonstrations were successfully performed, with one demonstration involving AMPATH and SouthernLight. An NSI aggregator was created to request the creation of dynamic circuits to all participating GOLEs, including AMPATH and SouthernLight.

The experiment installed a large video display in the SC13 exhibit show floor. Video sources worldwide used the Layer2 lightpaths created to each GOLE to stream video to a receiver at SC13 (Figure 2). Multiple domains installed a VideoLAN Client (VLC) video-streaming source that were used to stream videos to various booths at the SC13 show floor. RNP participated by installing a video player in Rio de Janeiro, Brazil, in its own facilities. Building the experiment, coordinating a global deployment of the new NSI v2.0 protocol, then testing its stability and scalability were challenges of this demonstration at SC13.

## AutoGOLE 2013 Demo – SC13

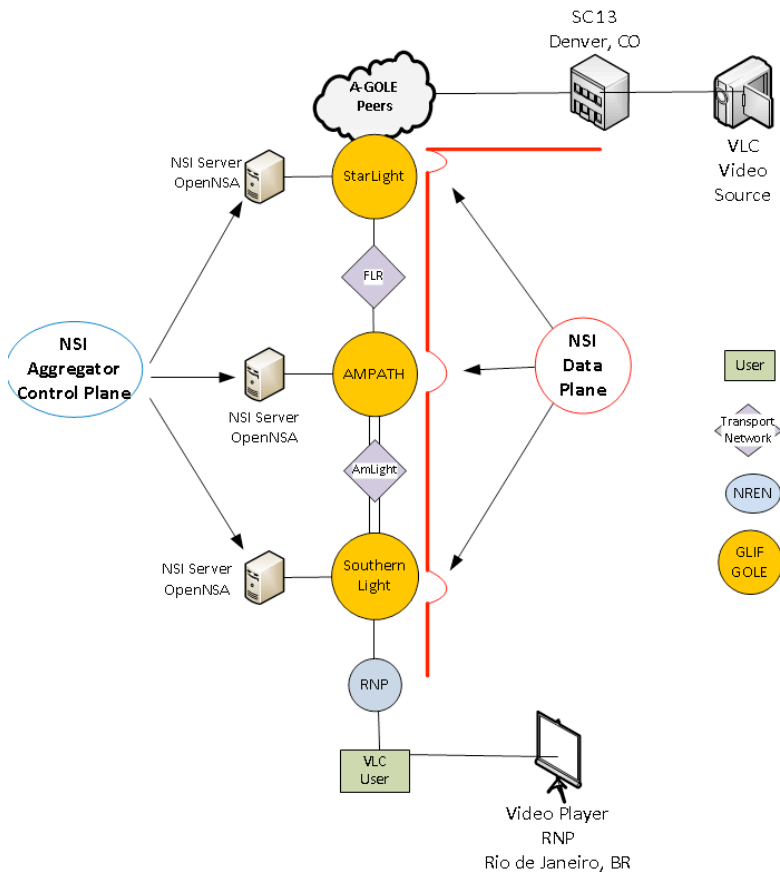
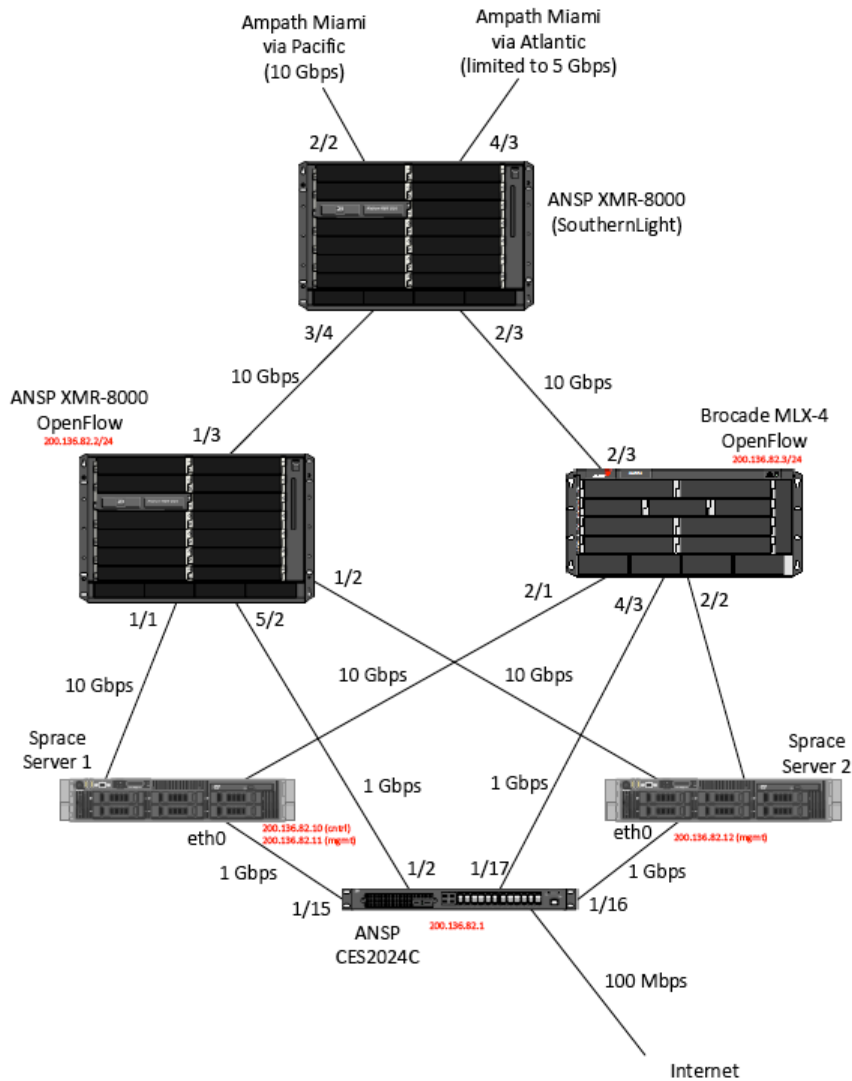


Figure 2 - AutoGOLE Demo at SC13

### Bandwidth tests and OpenFlow-based Multipath Networks in the WAN

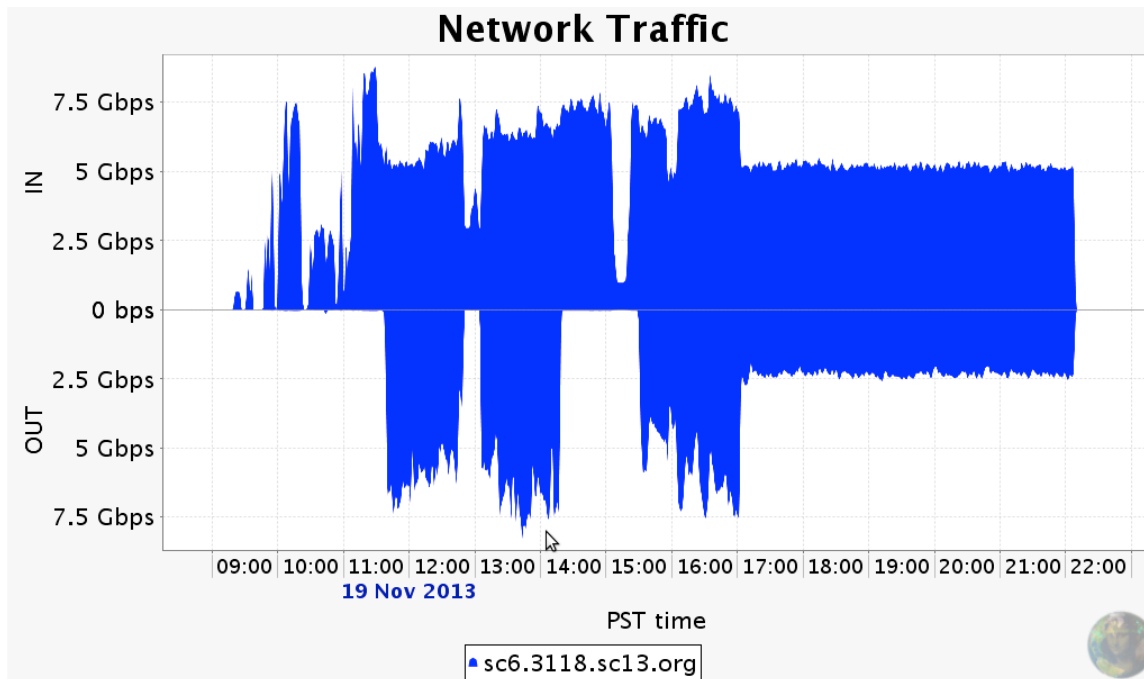
The SPRACE/UNESP team in São Paulo, together with the HEPGRID/UERJ team in Rio de Janeiro, conducted a series of bandwidth tests to stress the network links between Brazil and Denver established during SC13. Two high-end Intel Xeon servers with two-port 10GbE network cards, installed at the ANSP POP in the NAP of Brazil (<http://www.terremark.com/data-centers/americas/nap-brazil.aspx>), were connected to two Brocade OpenFlow-enabled switches – MLXe-4 and XMR-8K. These servers were used to generate traffic between Brazil and the Colorado Convention Center in Denver, through AmLight links (connections between SouthernLight and AMPATH in Figure 3), with traffic generated using Caltech’s Fast Data Transfer tool (<http://monalisa.cern.ch/FDT/>). A server installed at the SC13 show floor with two 40G Ethernet NIC was configured as an FDT server, and the two servers showed in Figure 3, together with a set of servers installed at HEPGRID in Rio de Janeiro State University, were configured as FDT clients.



**Figure 3 – SPRACE / ANSP / AMPATH setup for OpenFlow tests at SC13**

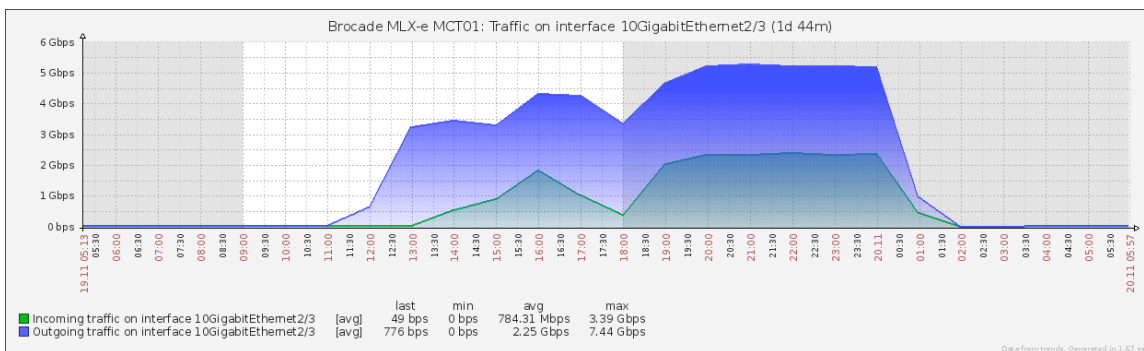
The SPRACE team also participated in the OpenFlow-based multipath experiment conducted by Caltech, which uses the SDN paradigm to investigate the use of multipath connectivity in wide-area networks. To this end, physics data was transferred over the network using OpenFlow link layer multipath switching to efficiently utilize the multiple network paths to form a loop free topology. The multipath utilization is completely transparent to the end hosts of the network and accomplished using the Caltech developed OLiMPS OpenFlow controller that resided at CERN in Switzerland. This methodology allows an automated in-network load balancing of various flows to raise the network utilization and efficiency. Moreover, multiple network links can be arbitrarily added to a network to increase capacity and redundancy without the traditional challenges of Layer-2 link aggregation using LACP. During the demonstration we were able to establish perfectly balanced network traffic across the multiple links of the testbed in a configuration that would normally cause a network loop. A similar experiment was first conducted at the TERENA 2013 meeting, in Maastricht, Netherlands – [“Openflow-based Multipath in Wide Area Networks”](#). The two Intel servers, installed at the NAP of Brazil, connected to the Brocade switches, were extensively exercised during these experiments. The SPRACE team also had the opportunity to make some extra experiments using different OpenFlow controllers (POX, RYU, as well as FloodLight, the one used as a basis for Caltech’s OLiMPS controller).

In order to support the experiments’ bandwidth requirements, two 10G circuits over diverse paths were made available from São Paulo to the Denver SC13 show floor, supported by AmLight, AMPATH, FLR, NLR and Internet2. The experiment was organized to use two VLAN ranges: one range used a dedicated NLR 10G wave and another used AtlanticWave. Figure 4 shows the network traffic as captured by Caltech’s monitoring tool known as MonALISA (<http://monalisa.cern.ch/monalisa.html>) during the bandwidth tests.



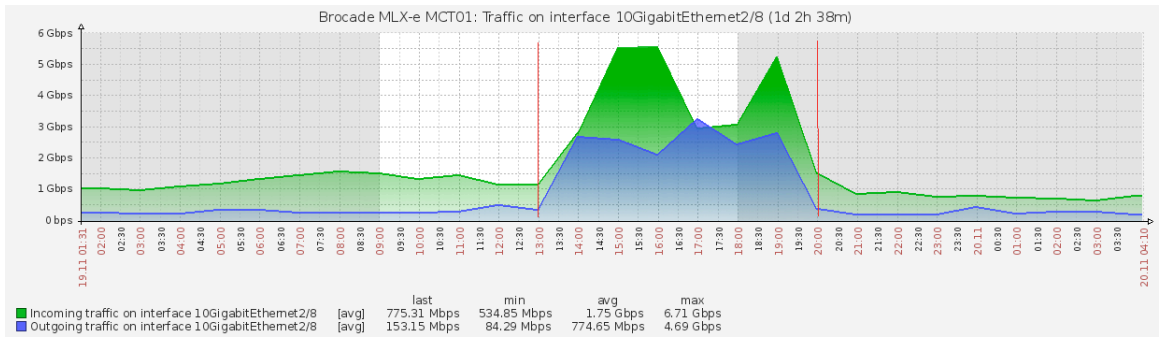
**Figure 4 - Bandwidth tests from Rio de Janeiro and São Paulo to Denver during SC13**

On the international links that connect São Paulo to Miami, one VLAN range was configured in the AmLight Atlantic link, the other one in the AmLight Pacific link. The total available bandwidth was set to 20 Gbps. Using these two ranges, it was possible to perform the tests described above. The graphs and descriptions below characterize the traffic generated by the experiments.



**Figure 5 - Dedicated Wave to SC13**

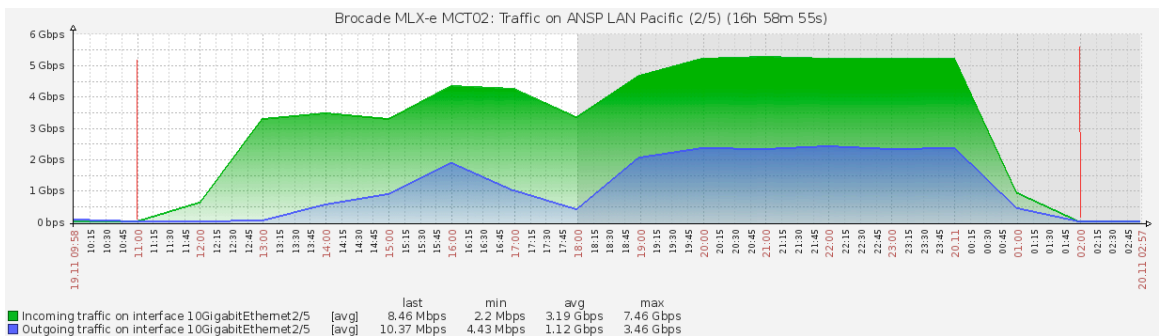
As explained, the experiment was defined to use two VLAN ranges. The first range was configured to use the dedicated SC13 10G wave. Along this path, a set of experiments was conducted, starting at November 19th 11 AM EDT and ending at November 20th 02 AM EDT. As this wave was allocated for exclusive use for SC13, all traffic in Figure 5 represents the bandwidth utilization for the Openflow Multipath experiments. It is possible to see up to 5.5 Gbps of Incoming Traffic (Download traffic from Brazil's point of view) and up to 2.5 Gbps of Outgoing traffic (Traffic sent from Brazil to the SC13 show flow).



**Figure 6 - Secondary VLAN range through AtlanticWave**

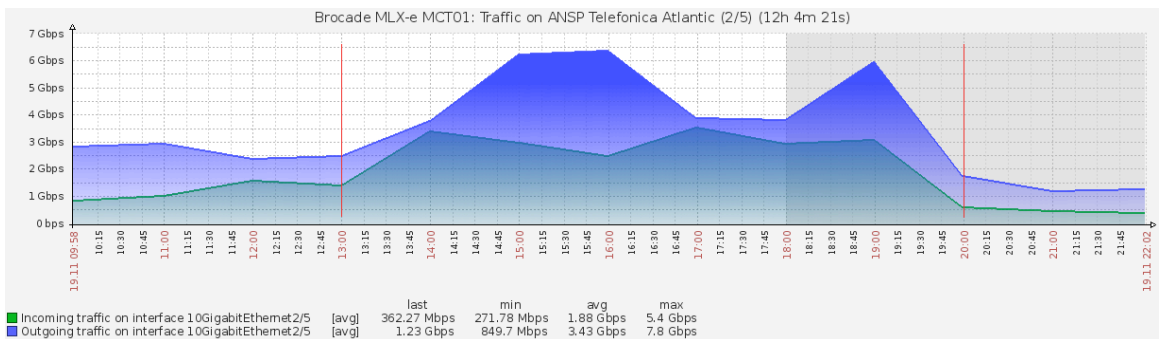
The second VLAN range was configured to use the AtlanticWave link. This link was not a dedicated circuit to the SC13 experiment, but it was possible to see the network utilization in Figure 6 (November 19<sup>th</sup>, from 13:00 to 20:00), using up to 5.5 Gbps for Incoming Traffic (traffic flowing from the SC13 show flow to Brazil) and around 3 Gbps for Outgoing Traffic (traffic flowing from Brazil to the SC13 show floor).

In Figures 7 and 8, it is possible to see all traffic flowing from and to Brazil using the international AmLight links, from Miami to Brazil: Figure 7 as the first VLAN range and Figure 8 as the second VLAN Range. Start and end times are indicated in the graphs to ease visualization.



**Figure 7 - AMLIGHT Pacific Link – First VLAN range**

It is possible to see in Figure 7 the same 5.5 Gbps of Incoming traffic and 2.5Gbps of Outgoing Traffic of the SC13 dedicated wave (Figure 5).



**Figure 8 - AMLIGHT Atlantic Link – Second VLAN range**

Figure 8 shows not only the SC13 traffic, it also shows production traffic for AmLight. But it is possible to see that between 13:00 and 20:00 the traffic pattern changed with all traffic generated by the FDT peers. It is possible to visualize that the traffic flowed from the AtlanticWave link (Figure 6) to the AMLIGHT Atlantic Link, shown here in Figure 8.

About CIARA: Florida International University's Center for Internet Augmented Research and Assessment (CIARA), in the Division of IT, has developed an international, high-performance research connection point in Miami, Florida, called AMPATH (AMericasPATH; [www.ampath.fiu.edu](http://www.ampath.fiu.edu)). AMPATH extends participation to underrepresented groups in Latin America and the Caribbean, in science and engineering research and education through the use of high-performance network connections. AMPATH is home to the Americas Lightpaths (AmLight) high-performance network links connecting Latin America to the U.S., funded by the National Science Foundation (NSF), award #ACI-0963053 and the Academic Network of São Paulo (award #2003/13708-0). AmLight aims to enhance science research and education in the Americas by interconnecting key points of aggregation, providing operation of production infrastructure, engaging U.S. and western hemisphere science and engineering research and education communities, creating an open instrument for collaboration, and maximizing benefits of all investors.

About ANSP: The Academic Network of São Paulo (ANSP) provides connectivity to the top R&E institutions, facilities and researchers in the State of São Paulo, Brazil, including the University of São Paulo, the largest research university in South America. ANSP directly connects to AmLight in Miami at 20G. ANSP also provides connectivity to Kyatera, a 9-city dark-fiber-based optical network infrastructure linking 20 research institutions in the state and a number of special infrastructure projects like GridUNESP, one of the largest computational clusters in Latin America, supporting interdisciplinary grid-based science.

About RNP: The Brazilian Education and Research Network (RNP), qualified as a Social Organization (OS) by the Brazilian government, is supervised by the Ministry of Science, Technology and Innovation (MCTI), through the inter-ministerial RNP program, which also includes the Ministries of Education (MEC), Health (MS) and Culture (MinC). The first Internet provider in Brazil with national coverage, RNP operates a high-performance nationwide network, with points of presence in all 26 states and the national capital, providing service to over 800 distinct locations. RNP's more than two million users are making use of an advanced network infrastructure for communication, computation and experimentation, which contributes to the integration of the system of Science and Technology, Higher Education, Health and Culture.