South American Astronomy Coordination Committee (SAACC)

AmLight SAACC Spring Meeting Report

January 10-11, 2017, Miami, FL

Report

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1. Executive Summary

This report attempts to capture the main updates from the AmLight SAACC Spring Meeting 2017. The meeting gathered participants from several university, organizations and research institutions from USA, Latin America and Europe. The SAACC Meeting was comprised of two sessions: Science Requirements & Activities Updates and Providers updates.

Science Requirements & Activity Updates session started with welcome remarks and introduction followed by presentations from AURA, NRAO, ALMA, LSST and ended with Open Discussion/Coordination. Providers Updates session started with presentations on AmLight updates and continued with presentations from REUNA, ANSP, RedCLARA, RNP, and ended with Open Discussion/Coordination.

The SAACC Engineering Meeting was held on Wednesday January 11th to discuss the end-to-end network connectivity to support the Large Synoptic Survey Telescope (LSST) project. The main goal of this meeting was to define the next steps to interconnect all efforts towards a manageable, cost-effective, secure and scalable end-to-end network infrastructure.

2. Introduction

The South American Astronomy Coordination Committee (SAACC) is comprised of representatives from the various astronomy projects who are conducting projects or operating observatories in South America. The initial chair of the SAACC, Dr. R. Chris Smith, director of the Cerro Tololo Inter-American Observatory and head of mission for AURA Observatory in Chile, provides oversight of the Chilean activities of CTIO, Gemini, SOAR, and LSST.

The SAACC is now in its 7th year and serves not only to provide input and advice to the AmLight PI, Dr. Julio Ibarra, Assistant Vice-President of the Center for Internet Augmented Research and Assessment (CIARA) at Florida International University (FIU), and the Steering Committee on program and network needs, but also as a venue for coordinating the needs of these astronomical projects and institutions to improve their resource planning and implementation of operational connections between these distant facilities and users in the continental US and Latin-American Countries.

3. Goals and Objectives of the AmLight SAACC Meeting

Americas Lightpaths Express and Protect (AmLight ExP) enables research and education amongst the people of the Americas through the operation of production infrastructure for communication and collaboration between the U.S. and Western Hemisphere science and engineering research and education communities.

AmLight ExP builds upon the results of the WHREN-LILA project, Award# OCI-0441095, and the AmLight IRNC project, Award# ACI-0963053. Over the last 10 years these projects successfully supported a cooperative and collaborate consortium among R&E network providers and users in the Western Hemisphere.

The success of previous U.S. - Latin American networking has led to a ground swell of change for research instruments. Data intensive instruments and data *dependent* instruments are being located in South America. The Large Synoptic Survey Telescope (LSST) is a significant example of a data dependent instrument and has from the beginning been part of the planning for AmLight ExP. The decision to locate the instrument in Chile was enabled by the promise of collaborative network infrastructure. Because of bandwidth and growth requirements for LSST the consortium needed to break away from the model of leasing telecom capacity, and gain access to unlit

spectrum to be able to drive the technology, not be dictated to by carriers. This vision resulted in the IRNC ProNet: AmLight OPENWAVE supplement that allowed AmLight to experiment with the installation of a 100G alien wave on a submarine system, end-to-end under our control. With significant investment from LSST, ANSP, and RNP, AmLight will have at least 600ghz of optical spectrum by 2018 to provision and operate to meet the needs of the community. This AmLight ExP NSF support (award # 1451018) will allow the transition to this new enabling long-term infrastructure.

The focus of AmLight ExP is to be an open instrument for collaboration, interconnecting open exchange points, and providing a means to leverage collaborative purchasing and network operation in order to effectively maximize the benefits to all investors, and manage the NSF investment in the context of international partnerships. See Appendix A for the agenda.

4. Activities of the SAACC Meeting Miami

The AmLight SAACC Spring meeting took place in January 10-11, 2017 at the Kovens Conference Center at the Florida International University, Biscayne Bay Campus (*3000 Northeast 151st Street, North Miami, FL 33181).* The two-day meeting, which was organized in 2 parts:

1. SAACC Meeting on Tuesday, January 10th, 2017, from 8:45 am-5:00 pm EDT
2. SAACC Engineering Meeting on Wednesday, January 11th, 2017, from 8:45 am-5: 30 pm EDT

Approximately 41 attendees participated (23 in person and 18 remotely). See Appendix B.
The meeting gathered participants from several university, organizations and research institutions from USA, Latin America and Europe:

- National Center for Supercomputing Applications (NSCA)
- Center for Internet Augmented Research and Assessment (CIARA) at Florida International University (FIU)
- Cerro Chajnantor Atacama Telescope (CCAT)
- Brazilian National Research and Educational Network (Rede Nacional de Ensino e Pesquisa -RNP)
- Brazilian e-science/astronomy virtual institute LINEA
- Pathway of the Americas (AMPATH)
- European Southern Observatory (ESO)
- Florida LambdaRail – Florida's Research and Education Network
- National Radio Astronomy Observatory (NRAO)
- Internet2
- National University Network Chile (Red Universitaria Nacional -REUNA)
- Large Synoptic Survey Telescope (LSST)
- Cerro Tololo Inter-American Observatory (CTIO), National Optical Astronomy Observatory (NOAO)
- Ellalink Cabos Submarinos
- Academic Network at São Paulo (ANSP), Brazil
- Information Science Institute (ISI) at University of Southern California (USC)
- Cornell University
- Federico Santa María Technical University (UTFSM), Chile
- Vanderbilt University
- National Science Foundation (NSF)
- Latin American Advanced Networks Cooperation (Cooperación Latino Americana de Redes Avanzadas-RedCLARA)

- School of Integrated Science and Humanity (SISH) at Florida International University
- Energy Sciences Network (ESnet)

Video Conference connection via Bluejeans was offered for all invited participants, which were not able to travel to Miami.

4.1 SAACC Participants Updates

The SAACC Meeting was comprised of two sessions: Science Requirements & Activities Updates and Providers updates. See Appendix A for agenda details.

Science Requirements & Activity Updates session started with welcome remarks and introduction from Chris Smith, (SAACC Chair) and Julio Ibarra (AmLight PI) followed by presentations from AURA (Chris Smith, Ronald Lambert), NRAO (David Halstead, Mark Lacy)
ALMA (Giorgio Filippi –ESO, C.Saldias, N.Ovando –JAO/ADC), LSST (Jeffrey Kantor), and ended with Open Discussion/Coordination.
Providers Updates session started with presentations on AmLight updates AmLight1: International links (Julio Ibarra) and AmLight2: Connections/Protocols/Developments (Jeronimo Bezerra), continued with presentations from REUNA (Sandra Jaque), ANSP (Luis Lopez), RedCLARA (Floriencio Utreras), RNP (Michael Stanton, Eduardo Grizendi) and ended with Open Discussion/Coordination.

Questions and comments were discussed in person and from the remote participants. At the end of the SAACC Meeting, CIARA staff organized a group social event.

4.1.1 Association of Universities for Research in Astronomy (AURA)

- What is AURA?

  The Association of Universities for Research in Astronomy (AURA) is a consortium of 42 US institutions and 5 international affiliates that operates world-class astronomical observatories. AURA's role is to establish, nurture, and promote public observatories and facilities that advance innovative astronomical research.

- Challenges
  - Data Transfer – Todays Big Cameras are producing Big Data. For Ex. DECam producing ~500GB to 1TB/night, and a small telescopes like the 1.6m, Korea Microlensing Telescopes Network (KMTNet)[1] managed by the Korea Astronomy and Space Science Institute's (KASI), is equipped with camera capacity for 85 Million-pixel (9Kx9K) Charge Coupled Devices (CCDs).
  - Remote Observing becoming more common- The Southern Astrophysical Research (SOAR) telescopes are always remote for Michigan State University, the University of North Carolina; The Southeastern Association for Research in Astronomy (SARA) consortium operates two telescopes fully remote: SARA-North at Kitt Peak in Arizona, and SARA-South at Cerro Tololo in Chile. Brazilian and NOAO are becoming too. Over the shoulder observing is offered for GEMINI because no one is present in the dome at night.
  - Robotic Telescopes are likely to become more common with LSST follow-up opportunities. This makes the network connection critical.

[1] In 2015, KASI has finished building a network of wide-field photometric survey systems called the Korea Microlensing Telescopes Network (KMTNet), which installed at three sites in the southern hemisphere (Chile, South Africa, and Australia). https://www.kasi.re.kr/eng/pageView/88

- Coordination- Real-time communication and coordination is critical n transient follow-up. For example, GEMINI can get on target within minutes, and data is available in archive within minutes of boing taken. Coordination has a growing scientific importance for all observatories.
- Data Access – Archives are the starting points for a growing fraction astronomical research. Key assets in Chile are ALMA archives (under construction) and LSST Data Access Center (to host data products in La Serena.

- Network Services required:
  - Current AURA network backbone is comprised of three segments: Summit (Tololo + Pachon) to Base (La Serena), La Serena to Santiago with capacity 4Gbps through REUNA, and Santiago to US RENs with capacity up to 10Gbps through AmLight + LAUREN
  - New links for AURA and LSST
    - "Segment 1" = Mountain-La Serena: LSST>200Gbps, Others>10Gbps
    - "Segment 2" = La Serena-Santiago: LSST>100Gbps, Others>10Gbps
    - "Segment 3" = Santiago-U.S.A.: LSST>200Gbps, Others>10Gbps
  - Projected bandwidth (current to 5 years in the future)
- Solutions:
  - Key features of solutions- (1) Meets demanding requirements for LSST Operations (2) Meets AURA facilities current needs, with significant room for expansion (including those of affiliates like Carnegie, GMT, etc.) (3) Meets AURA's commitment to Chileans to make best effort to invest in bandwidth through Chilean research and educational network infrastructure and (4) Work with REUNA to create an important segment in its national high-speed network strategy, including possible links to northern international observatories

4.1.2 National Radio Astronomy Observatory (NRAO)

- What is NRAO?

Founded in 1956, the National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for use by the international scientific community. NRAO telescopes are open to all astronomers regardless of institutional or national affiliation.

- Challenges
  - Data Transfer for ALMA telescope is the largest /mm/submm telescope ever built.
    - Data transfer within Chile (ALMA Array Operations Site (AOS) to Santiago 2.5Gb/s): Data processing to produce Level 2/3 products shared between Santiago and the ALMA regional centers. Pipeline is run at 4 locations worldwide, including Santiago. Data packages are ingested into the archive in Santiago. Pipeline products are same size as raw data. The long-term plan is that all data processing and some of the archiving will take place in Santiago.
    - From ALMA (Chile) to North America: AURA is using 622Mb/s link to Chile through Sao Paolo and Miami (FIU/AmLight) to the US research network backbone (NREN).
  - For the current cycle of development the data volume artificially high as two data streams are kept with different corrections. Despite the increased efficiency about the same amount of time is available for science of the array. In addition to that more antennas will be added, which lead to larger product. Total volume could reach approximately 190TB including products.
  - For the future cycles the raw data rates will increase. "Duty cycle" of observations will also increase (by about a factor of two) as testing and maintenance procedures improve. Product data rates will increase to approximately equal raw data rates once imaging pipeline is creating full cubes for all sources. Important to note that

data rates vary through the configuration cycle. When long baseline configurations are scheduled the data rate goes up for two reasons:

– Data sampling needs to be faster to prevent beam smearing at the field edges.

– The data products, which are also mirrored from Santiago, also increase in size, to become larger than the raw data in the largest configurations.

– So far, long baseline campaigns have tended to have low observing efficiencies, however this may change.

- Network Services required:
  - Typical rate obtained during peak data transfer periods is 2-300Mb/s with bursts up to 600Mb/s. 90% is bulk data with low QoS and the remainder is database sync and telepresence.
  - Expect Full Science cycles (~2018 onwards) to have mean data rates ~100Mb/s during observations, but could be ~50% higher.
  - Increased product data rates. Best guess estimate (including product size mitigation) is around 400TB (200TB raw, 200TB products) (larger if we continue to take 2 streams).

- Solutions:
  - Redundant fiber loop via Argentina is planed
  - Joint AURA-AUI agreement for NRAO to have 100Mb/s committed (burstable to capacity) of AURA link to Chile

4.1.3 Atacama Large Millimeter/Submillimeter Array (ALMA)

- What is ALMA?

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership among Europe, North America and East Asia in cooperation with the Republic of Chile.

- Challenges
  - Provide a long term (>15 years) solution infrastructure
  - Cope with projected operations needs (>1Gbps) and scale further
  - Minimize latency between the end sites
  - Have reasonable upfront CAPEX and very low OPEX
  - Take advantage of the existing EVALSO capacity
  -

- Network Services required:
  - Due to administrative hiccups, used in “test mode”, but at full functionality. Initial expectations confirmed:
    - Delay (PING) between ALMA Operations Support Facility (OSF) and ALMA Santiago Office (SCO) around 23msec (same for both links).
    - Science Data Traffic: between 100 and 200 Mbps, and peaks up to 520Mbps.
    - Other ALMA Traffic: between 50 and 100 Mbps, and peaks up to 170Mbps.

- Solutions:
  - A dark fiber pair between AOS and CALAMA (about 150km): this comes from a newly built fiber cable
  - A dedicated LAMBDA between CALAMA and the REUNA Point of Presence (PoP) in ANTOFAGASTA (about 200 km)
  - A dedicated sub-LAMBDA between the REUNA PoP in ANTOFAGASTA and the SCO at the Vitacura Campus in Santiago: this is indeed configured on the existing EVALSO backbone
  - A dark fiber pair between AOS and the town of SAN PEDRO (2016)
  - A dedicated LAMBDA between AOS and Santiago via Argentina (2016-2018)

4.1.4 Large Synoptic Survey Telescope (LSST)

- What is LSST?

The goal of the Large Synoptic Survey Telescope (LSST) project is to conduct a 10-year survey of the sky that will deliver a 200 petabyte set of images and data products that will address some of the most pressing questions about the structure and evolution of the universe and the objects in it. The LSST survey is designed to address four science areas:

- Understanding the Mysterious Dark Matter and Dark Energy
- Hazardous Asteroids and the Remote Solar System
- The Transient Optical Sky
- The Formation and Structure of the Milky Way

- Challenges
    - Data Transfer will be done to multiple LSST Sites and Connectors:
      - Summit and Base Sites Chile: Telescope and Camera, Data Acquisition, Crosstalk Correction, Long-term storage (copy 1), Chilean Data Access Center
      - Satellite Processing Center Lyon, France: CC-IN2P3, Data Release Production (50%) French DAC
      - Headquarter (HQ) Site Arizona, US: Science Operations, Observatory Management, Education and Public Outreach
      - Archive Site Archive Center at National Center for Supercomputing Applications (NCSA) Illinois, US: Alert Production, Data Release Production (50%), Calibration Products Production, EPO Infrastructure, Long-term Storage (copy 2), Data Access Center, Data Access and User Services

    - Dedicated Long Haul Networks Two redundant 100 Gbit links from Santiago to Florida (existing fiber) Additional 100 Gbit link (spectrum on new fiber) from Santiago – Florida (US Network diverse paths not shown)

- Network Services required:
    - Leveraging joint, multi-national investments in fiber optic networks to yield10x cost reduction to LSST
      - "3T" fiber in Chile from La Serena-Santiago
      - 100 Gbps ring Santiago- Miami
      - Monet Cable Sao Paolo - Boca Raton
      - Net to LSST 140 – 200 Gbps diverse paths in Chile
      - Net to LSST 300 Gbps (100 Gbps spectrum) diverse paths Chile - US

- Solutions:
  - LSST Networks support distributed operations across 3 continents
  - LSST is employing a high degree of leverage in joint, multi-institution investments in high-speed fiber optic networks
  - LSST remains on track to achieve unparalleled level of network bandwidth and services for South American - North American astronomical research

4.1.5 Americas Lightpaths Express and Protect (AmLight ExP)

- What is AmLight?

AmLight-ExP project (2015-2020) builds upon the achievements of the AmLight[2] Project. AmLight ExP topology consists of: Atlantic 100G Miami-São Paulo; Pacific 100G Miami-São Paulo; 4x10G

[2] NSF Award # 0963053 - IRNC-ProNet: Americas Lightpaths: Increasing the Rate of Discovery and Enhancing Education across the Americas, https://nsf.gov/awardsearch/showAward?AWD_ID=0963053&HistoricalAwards=false

links landings in São Paulo, Fortaleza, Santiago; 240G of aggregate bandwidth capacity; 100G ring to include Santiago and Fortaleza in March 2017

- Challenges
    - Introducing spectrum capacity between the U.S. and Brazil
    - Continues evolving a rational network infrastructure, using both spectrum and leased capacity.

- Network Services required:
    - AmLight Express: 300GHz of spectrum: Santiago-São Paulo, and São Paulo-Miami. Spectrum to be configurable by RENs to meet user/application requirements
    - AmLight Protect: 100G leased capacity ring (Miami, São Paulo, Santiago, Panama City, Miami). AMPATH, Southern Light, REUNA, and RedCLARA operated

- Solutions:
  - Implementing an infrastructure that interconnects North America to key aggregation points in South and Central America (Brazil, Chile, Panama)
  - Evolving into a reliable, flexible and efficient research and education network infrastructure
  - Facilitating at-scale experimentation through the implementation of SDN testbeds
  - Meeting the requirements of science applications
  - Access to spectrum (Monet submarine cable) planned for 12/2017

4.1.6 SDN Americas Lightpaths Express and Protect (AmLight ExP)

- What is SDN at AmLight ExP?

AmLight is a Software Defined Network (SDN) since 2014 with fully automated provisioning. The added programmability allows users can control their own traffic and provide more flexible and secured network to improve user experience when using AmLight.

- Challenges
    - Migrating to SDN was just the first step to a new AmLight. With programmability, domain scientists can control the network to handle specific applications requirements (Shortest path, traffic prioritization vs. best effort). However, there are not so many tools for network management.

- Network Services required:
    - A Software Defined eXchange (SDX) seeks to introduce Software Defined Networking (SDN) technologies into Academic Exchange Points to optimize resource sharing and allocation (Inter-domain R&E network programmability and End-to-End QoS coordination and enforcement). SDX to provide user-friendly APIs to facility policy description.

- Solutions:
    - Developing tools to handle AmLight's needs:
        - With ANSP: SDNTrace for path validation, SDN-LG for network management
        - With Georgia Tech: an SDX controller
    - Testing new approaches to increase security, visibility and deeper programmability in partnership with vendors (Bandwidth on demand, manage the optical layer, better traffic characterization, DDoS mitigation)

4.1.7 National Network for Research and Education in Chile, REUNA

- What is REUNA?

National Network for Research and Education in Chile (NREN), Red Universitaria Nacional (REUNA), is a corporation that currently consist 35 research institutions (19 universities, 10 research centers of excellence and 5 international astronomical groups). The digital platform of REUNA has coverage in twelve regions of Chile, between Arica and Osorno, and aims to add to all regions of the country. In addition, it is interconnected to its international peers: in Latin America (RedCLARA), North America (Internet2 and Canarie), Europe (GÉANT), Asia (APAN) and Oceania (AARNET). REUNA backbone connects 12 of 15 regions of the country and has move than 3000 Km of extension. The backbone capacity is form 1 to 10 Gbps

- Challenges
    - Optical national network upgrades mentioned in REUNA's Network infrastructure Strategic Plan for 2015-2018:
      - Arica - La Serena, in synergy with astronomy community and BELLA project
      - DWDM network La Serena – Santiago (in synergy with AURA/LSST)
      - Santiago - Concepcion. Short time: upgrade in capacity. Long term: fiber or lambdas
      - Synergy with public projects

- Network Services required:
    - Upgrades on the connection from Santiago to La Serena in synergy with LSST/AURA
      - Completed 700 Km Fiber (1 pair) between La Serena & Santiago; Housing: 6 along the path plus AURA in LS
      - Installed DWDM equipment along La Serena to Santiago plus the Santiago ring
      - Upgrade back up path from 10G to minimum 40G
    - Upgrades on the connection at the La Serena Observatory
      - Fiber (2 pair) entre LS y Portería AURA
      - Fiber (12 pairs) in AURA to connect Cerros Tololo & Cerro Pachón
      - DWDM equipment between La Serena and Pachón (LSST) & Tololo (AURA)

    - Building Europe Link to Latin America (BELLA) project[3] consist 2 subprojects:

    - BELLA-T: To complete the AL optical backbone for R&E.
    - BELLA-S: Capacity over a submarine cable to connect EU & AL for at least 25 years, for the R&E community

- Solutions:
    - Upgraded connection from Santiago to La Serena in synergy with LSST/AURA
    - Upgraded optical network from Santiago to South
    - BELLA-T (part of BELLA project) to provide secure & resilient AL backbone, which allow equal access from AL to Europe, support of 100Gbps wavelengths in South America.

4.1.8 Academic Network at São Paulo (ANSP)

- What is ANSP?

A The ANSP project (Academic Network at São Paulo) provides the State of São Paulo research community with state of the art computer networking connectivity. ANSP develops

[3] Tender for Telecommunications Infrastructure and Services to connect the national research and education networks (NRENs) of: Brazil, Argentina, Chile, Peru, Ecuador and Colombia, as well as infrastructure for Chile and a submarine connection between Colombia and Brazil. https://bella-tender.redclara.net

and maintains the infrastructure, Internet services and data communication in general which, in conjunction with ANSP's Technical Reserve Program, offers the education and research community in the State of São Paulo the technological means needed to access information throughout the world, to share knowledge, to develop collaborative projects and for innovation on a large scale.

- Challenges
  - Internationally, ANSP works with FIU's CIARA and with RNP, providing 240 Gbps of connectivity between São Paulo and Miami, with a stop in Santiago (Chile)
  - Connects to the rest of the world through Atlantic Wave and Internet2 (AmLight Express)
  - ANSP transports half of the research traffic of Brazil
    -
- Network Services required:
  - Ongoing work: AmLight Express, SDX, State of São Paulo Academic Cyber-security Center, Brazilian Army Collaboration

- Solutions:

- Since 2004 ANSP runs only BGP (SDN) so that it is completely transparent to its users, who may have whichever peering/transit policies they want.
- ANSP accepts connections of 10 and 100 Mbps and 1, 10 and 100 Gbps.
- Currently, ANSP connects to Brazilian commercial networks and to the Brazilian NREN (RNP- Rede Nacional de Educação e Pesquisa) with a total capacity of 40 Gbps.
- Most of our bigger users connect also directly to RNP and Brazilian commercial internet.

4.1.9 RedCLARA

- What is RedCLARA?

RedCLARA - *Cooperación Latino Americana de Redes Avanzadas* (Latin American Cooperation of Advanced Networks) is a non-profit International Law Organization, whose legal existence is dated on 23 December 2003, when it was acknowledged as such by the legislation of Uruguay. RedCLARA develops and operates the only Latin American advanced Internet network and provides regional interconnection and connection to the world through its international links to GÉANT2 and Internet2 (USA) and, through them, to the advanced networks of the Caribbean (C@ribnet), Africa (UbuntuNet Alliance), Asia (APAN, TEIN), among others.

- Challenges
  - Expected terrestrial network evolution:
    - Colombian 100 Gbps backbone and transit for RedCLARA ready for service in December 2016
    - Ecuador's backbone and transit for RedCLARA ready in October 2017
    - Argentina's crossing at 100 Gbps should be ready for service in October 2017
    - Brazil's 100 Gbps backbone and full transit for RedCLARA in October 2018
    - Chile´s 100 Gbps backbone and transit for RedCLARA expected in March 2018
    - Peru's crossing at 100 Gbps expected operational in March 2018 as well as Colombia-Brazil submarine backup
  - Submarine cable to Europe is currently been negotiated and expected to become operational in 2019

- Network Services required:
  - Multiple network connection upgrades to 100G to Columbia, Argentina, Brazil, Peru, and Chile
  - Back up connection

- Solutions:

- 40% of the spectrum of a fiber pair in a submarine cable linking directly South America and Europe for the exclusive use of the academic community and the not-for-profit organizations in both continents.
- A complete fibre path owned by RedCLARA and its partner NRENs going from Fortaleza in Brazil all the way to Bogota in Colombia and Cucuta at the Border with Venezuela connecting Brazil-Argentina-Chile-Perú-Ecuador and Colombia with access points at the border of Uruguay and Venezuela.
- An Optical RedCLARA Backbone synergetic with the LA NRENs to enhance capillarity inside each country.
- GEANT and RedCLARA networks fully and seamlessly interconnected at optical as well as IP level.
- Internet Commodity price gap between Latin America and Europe is reduced by a factor of 4 or more.

4.1.10 RNP

- What is RNP?

The Brazilian National Research and Educational Network (Rede Nacional de Ensino e Pesquisa - RNP) provides global integration and collaboration supported by information and communication technologies, for the generation of knowledge and excellence of education and research.

- Challenges
    - Current RNP Backbone and its limitations: Use of 1, 3 and 10 G circuits of Telecom Companies; Challenged scalability with upgrade for 100G practically impossible with current companies.
    - Upgrades on international connectivity with US and Europe

- Network Services required:
    - RNP National Backbone upgrades to 100 G southeast Route (Fortaleza - Porto Alegre) consist of 3 phases: Northeast region (NE), Southeast region (SE), Southern region (S)
    - RNP is committed to provide connectivity between São Paulo and Santiago 2 x 100 G and an additional 100 G of burst traffic by 2019
    - Connection necessary for LSST network:

        1. Boca Raton (FL) to Praia Grande (SP) using Monet Cable
        2. Praia Grande to São Paulo (SP) using terrestrial link - ½ the optical spectrum of dark Fiber (Negotiation in progress)
        3. São Paulo to Santiago Routes: São Paulo to Porto Alegre to Buenos Aires to Santiago. For this link there are two possibilities. First is the use of the BELLA-T infrastructure and second is the use of the Porto Alegre – Buenos Aires route

- Solutions:
    - RNP Backbone upgrades
    - Use of new submarine cables for international connectivity (680G+ includes LSST, GNA):

    - Use of Monet Cable in LSST Project
    - Use of Ellalink in BELLA Project
    - Use of SACS and Monet in AARCLight Project

4.2 LSST Engineering Meeting

The SAACC Engineering Meeting was held at the FIU's Kovens Conference Center at 9:00AM on Wednesday January 11th to discuss the end-to-end network connectivity to support the Large Synoptic Survey Telescope (LSST) project. Because all LSST participant network operators have

ongoing network-engineering efforts in place to support the LSST project, the main goal of this meeting was to define the next steps to interconnect all efforts towards a manageable, cost-effective, secure and scalable end-to-end network infrastructure.

The LSST Engineering Meeting had the following milestones:

- Introducing the network engineers involved from each network operator;
- Detailing the physical and logical network configurations, interconnections and activations planned for the 2017-2018 time frame;
- Discussing the status and next steps of the LSST End-to-End Test Plan;
- Presenting all ongoing efforts to support the LSST network for the 2019-2020 time frame;
- Align network deployments and dates with the LSST project plan.

Jeronimo Bezerra, CIARA Chief Network Engineer, prepared a separate summary report for this meeting, contacting details about the following sessions:

Session 1: Ongoing Efforts for 2017-2018
In this session, LSST, REUNA, AmLight, FLR and NCSA provided a status of the ongoing efforts to support the LSST project for the 2017-2018 time frame. Each network operator had 20 minutes to provide details of its technical solution.

Session 2: Discussing Interconnections, Redundancy and Monitoring
In this session, the results of previous meetings and calls were presented, including the benefits and drawbacks of a full optical end-to-end network vs. Ethernet-based network. Topics such as domain interfaces, domain interconnection, purchase responsibilities, deployments timeline, monitoring and network operation/troubleshooting were deeply addressed. Single points of failures logical configuration and inter-domain network monitoring were reviewed as a last step before moving to the next session.

Session 3: Designing the LSST network solution for 2017–2018
In this session, the group discussed the final network configuration after having some options presented in the previous session, including a full Ethernet-based, an IP/MPLS, a multi-domain SDN logical configuration and a mix of all solutions. The proposed engineering plan is provided in the Section 02 of this document and it will be used to guide all network-engineering efforts for the next two years.

Session 4: LSST End-to-End Test Plan: Next Steps
In this session, using the results of the Session 3, the group discussed the next steps for the LSST End-to-End Test Plan. The detailed result of this session is provided in the Section 03 of this document.

Session 5: Ongoing efforts for 2019-2020
In this session, ESNet, FLR, NCSA, RNP and Internet2 provided overviews of their efforts to support LSST in the 2019-2020 time frame.

5. Recommendations

The SAACC Members should confirm possible date for the next SAACC Meeting to be held before of after the TICAL2017 Conference (3-5 July 2017, in the city of San José, Costa Rica).
The actions from the Engineering meeting made great and necessary progress on the long-haul network design. The demand for synchronization of the end-to-end network efforts identified a Network Engineering Team, comprised of engineers from the institution involved with the LSST networks (AURA, FIU, REUNA, NCSA). In addition to that the access to the LSST confluence page

for network will be granted to the team for accessing the baseline copies in the LSST Document Repository of the core networking documents.
It was strongly encouraged everyone working on the LSST Networks to read all of the documents in entirety and to subscribe to the LSST-End-To-End mailing list.
As a next step, future LSST Network Engineering Team virtual meeting should be scheduled for feedbacks and discussions regularly every month.

Appendix A. Program for the SAACC Meeting, January 10-11, 2017

DAY 1 (Tuesday, January 10, 2017)

8:00 – Breakfast at Kovens Conference Center
9:00 – Welcome

Session I: Science Requirements & Activities Updates
9:20 – Remarks and Introduction: Chris Smith, SAACC Chair and Julio Ibarra, AmLight PI | Download presentation: J. Ibarra, C. Smith
9:40 – AURA (Chris Smith, Ronald Lambert)| Download presentation
10:00 – NRAO (David Halstead, Mark Lacy)| Download presentation
10:20 – *Refreshment Break*
10:40 – ALMA (Giorgio Filippi -ESO, C.Saldias, N.Ovando -JAO/ADC)| Download presentation
11:00 – LSST (Jeffrey Kantor)| Download presentation
11:20 – Open Discussion/Coordination
12:00 – *Lunch Break (1 hour)*

Session II: Providers updates
13:00 – AmLight1: International links (Julio Ibarra)| Download presentation
13:20 – AmLight2: Connections/protocols/developments (Jeronimo Bezerra)| Download presentation
13:40 -REUNA (Sandra Jaque)| Download presentation
14:00 – ANSP (Luis Lopez)| Download presentation
14:20 – RedCLARA (Floriencio Utreras)| Download presentation
14:40 – *Refreshment Break*
15:00 – RNP (Michael Stanton, Eduardo Grizendi)| Download presentation
15:20 – Open Discussion/Coordination
16:00 – Adjourn
18:00 – Dinner

DAY 1 (Wednesday, January 11, 2017)

8:00 – Breakfast at Kovens Conference Center

9:10 – Roundtable of introductions
9:20 – **Session I:** Ongoing Efforts for 2017-2018
10:20 – Questions
10:30 – *Refreshment Break*
11:00 – **Session II:** Discussing Interconnections, Redundancy and Monitoring
12:00 – **Session III:** Designing the LSST solution for 2017-2018
13:00 – *Lunch Break (1 hour)*

14:00 – **Session III:** Continuation
14:30 – **Session IV:** LSST End-to-End Test Plan: Next Steps
15:45 – *Refreshment Break*
16:15 – **Session V:** Ongoing efforts for 2018-2020
17:30 – Questions
18:00 – Adjourn

Appendix B. List of Participants

In person participants:

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