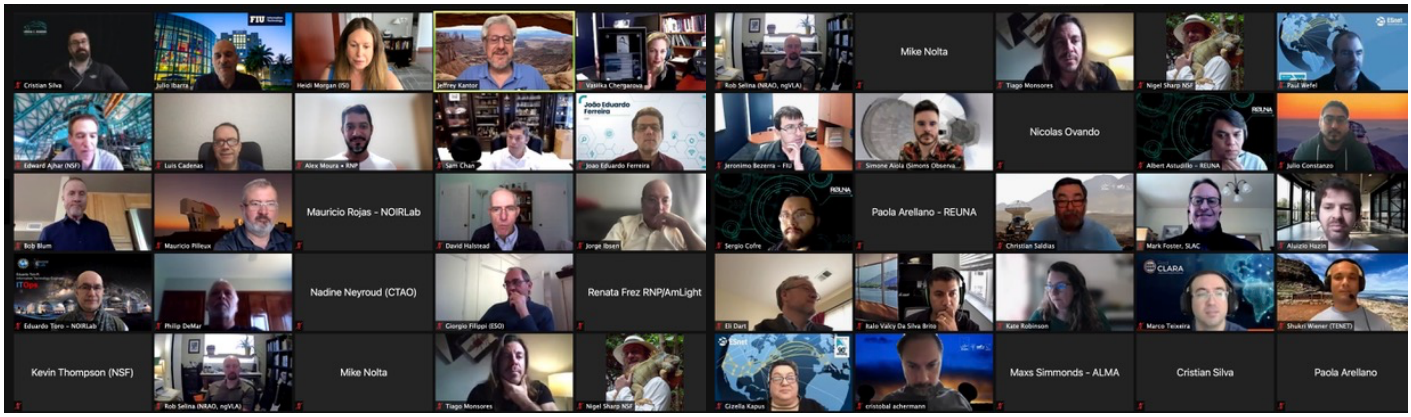

South American Astronomy Coordination Committee (SAACC) Meeting Report

April 13-14, 2021

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Executive Summary

This report documents the proceedings of the AmLight SAACC Meeting April 13-14, 2021 from the astronomy community and Research & Education Networking (REN) serving them. Participants from universities, organizations and research institutions from the USA, Latin America, Africa, and Europe participated. For the first time, the SAACC was expanded to include participation from South Africa. The SAACC Meeting was comprised of two sessions: Science Requirements & Activities Updates, and Providers updates.

The Science Requirements & Activity Updates session started with welcome remarks and introductions by the Co-Chairs (Julio Ibarra and Jeff Kantor followed by presentations from Vera C. Rubin Observatory Construction and Operations, NOIRLab, NRAO, ALMA, CCAT, GMTO, Simons Observatory, CMB-S4, ngVLA, ngEHT. A lively Open Discussion & Coordination discussion followed. The Providers Updates session included network presentation updates including AmLight-ExP, REUNA, RedCLARA, RNP, TENET/SANReN, ESnet, Internet2, SLAC and concluded with Open Discussion and Coordination.

1. Introduction

The South American Astronomy Coordination Committee (SAACC) is comprised of representatives from the various astronomy projects that conduct science and operate observatories in South America and South Africa, an addition enabled by the expansion of AmLight-ExP of the South Atlantic Cable System (SACS) 100G link in collaboration with TENET/SANReN of South Africa on the West African Cable System (WACS) to the open exchange point in Cape Town, South Africa.

The SAACC Spring meeting was hosted virtually by Florida International University from April 13-14, 2021, from 11am to 3 pm to accommodate time zones spanning Europe, North and South America, and Africa. The meeting program can be found here: https://www.amlight.net/?p=4467. A Zoom registration was used to document participation.

146 participants were invited from astronomy and National Research and Education Networks: Association of Universities for Research in Astronomy (AURA), Vera Rubin Observatory, NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab), National Radio Astronomy Observatory (NRAO), Atacama Large Millimeter/submillimeter Array (ALMA), European Southern Observatory (ESO), Giant Magellan Telescope Observatory (GTMO), Simons Observatory, Cerro Chajnantor Atacama Telescope (CCAT), Cosmic Microwave Background Stage 4 (CMB-S4), next-generation Event Horizon Telescope (ngEHT), next-generation Very Large Array (ngVLA), CIARA at Florida International University, Florida's Research and Education Network (Florida LambdaRail), Chilean Research and Educational network (REUNA), Brazilian National Research and Educational Network (RNP), Academic Network at São Paulo (REDNSP), Latin American Advanced Networks Cooperation (RedCLARA), Fermi National Accelerator Laboratory (Fermilab), National Science Foundation (NSF), National Center for Supercomputing Applications (NSCA), SLAC National Accelerator Laboratory, National Research and Education Network of South Africa (TENET/SANReN), Energy Sciences Network (ESnet), Internet2, European Research and Educational network (GEANT), University of Edinburgh, France Research and Educational network (RENATER), and Tertiary Education & Research Network of South Africa (See Appendix A & C for the agenda and participants list).

A SAACC 2021 Participant Guide was created to better accommodate the virtual meeting presentations and discussions over Zoom. The guide can be found here:

https://docs.google.com/document/d/1AK39A6wNmfwrhwtutdkxtWuBm0WhKD9CrFh_KGoYIdE/edit?usp=sharing

Spring 2021 Vera Rubin Observatory Network Engineering Team (NET) Meeting

The Network Engineering Taskforce (NET) Annual Meeting took place on April 15-16, 2021 from 11 am to 3pm following the SAACC Spring meeting. The NET was by invitation only focused on objectives of continuing the planning, development, and deployment of a collaborative network to support the needs of the Vera Rubin Observatory in Chile. Over 27 network engineers from REUNA, FIU/CIARA, SLAC, ESnet, I2, IN2P3, REDNSP, RNP, Vera Rubin Observatory, AURA, RENATER, GEANT, University of Edinburg, and technical astronomy engineers were invited to participate in this meeting (See Appendix B & D for the agenda and participants list)**.** An online guide was created to guide the participants discussions and contributions during the virtual meeting on Zoom:

https://docs.google.com/document/d/1MkGEDPzzG4qCAvRRMw2PkXw20yxmQMYdVl-XMjw95Tw/edit?usp=sharing

2. Goals and Objectives of the AmLight SAACC Meeting

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 15 years, these projects have effectively built and supported a cooperative and collaborative consortium among R&E network providers and users in the Western Hemisphere. The success of previous U.S. & Latin American networking activities has led to a groundswell of change for research instruments. Data-intensive instruments and data *dependent* instruments are being located in South America. The Vera Rubin Observatory is a significant example of a data-dependent instrument and has from the beginning been part of the planning for AmLight-ExP (NSF award # 1451018 and #2029283). The focus of AmLight-ExP is as an open instrument for collaboration that interconnects open exchange points, AmLight-ExP provides a means to leverage collaborative provisioning and network operations that effectively maximizes the benefits to all members of the consortium. AmLight-ExP manages the NSF investment in the context of leveraging international partnerships to attain the greatest benefits for all participants. See Appendix A for the agenda.

A key goal of the SAACC meeting is to gather input and collect information from participants about the activities of the astronomy projects and the R&E networks supporting them. Questions and comments posed during each presentation were recorded using Zoom.

3. Activities of the SAACC Meeting

The AmLight SAACC meeting participants hailed from the following universities, organizations, and research institutions:

- Academic Network at São Paulo (REDNSP)
- Association of Universities for Research in Astronomy (AURA)
- Atacama Large Millimeter/submillimeter Array (ALMA)
- Brazilian National Research and Educational Network (Rede Nacional de Ensino e Pesquisa - RNP)
- Cerro Chajnantor Atacama Telescope (CCAT)
- Cerro Tololo Inter-American Observatory (CTIO)
- Cosmic Microwave Background Stage 4 (CMB-S4)
- Energy Sciences Network (ESnet)
- European Research and Educational Network (GÉANT)
- European Southern Observatory (ESO)
- FermiLab (FNAL)

- Florida International University (FIU)
- Florida LambdaRail (FLR)
- French National Institute of Nuclear and Particle Physics (In2p3)
- Gemini Observatory
- Giant Magellan Telescope Observatory (GMTO)
- Information Science Institute (ISI) at University of Southern California
- Internet2
- Korea Research Environment Open NETwork (KISTI/KREONet2)
- Latin American Advanced Networks Cooperation (Cooperación Latino Americana de Redes Avanzadas - RedCLARA)
- Lawrence Berkeley National Laboratory (LBNL)
- National Radio Astronomy Observatory (NRAO)
- National Science Foundation (NSF)
- National University Network Chile (Red Universitaria Nacional -REUNA)
- Next-Generation Very Large Array (ngVLA)
- NSF's National Optical-Infrared Astronomy Research Laboratory (NSF's NOIRLab)
- Simons Observatory (SO)
- SLAC National Accelerator Laboratory
- Smithsonian Astrophysical Observatory (SAO)
- Smithsonian Astrophysics Observatory
- Tertiary Education and Research Network of South Africa (TENET)
- University of Pennsylvania
- University of Southern California Information Sciences Institute Networking & Cybersecurity Division
- US National Science Foundation
- Vera C. Rubin Observatory

61 participants attended the meeting (Appendix C) which was organized in two sessions and presentations (See appendix A) from the following institutions were included:

Science Requirements & Activities Updates

- Welcome remarks (Julio Ibarra)
- Vera C. Rubin Observatory Construction, US-ELT (Jeffrey Kantor & Cristian Silva)
- Vera C. Rubin Observatory Operations (Bob Blum)
- NOIRLab (Eduardo Toro and Mauricio Rojas)
- NRAO (David Halstead, Adele Plunkett)
- ALMA (Jorge Ibsen)
- CCAT (Mike Nolta)
- GMTO (Sam Chan)
- Simons Observatory (Simone Aiola)
- CMB-S4 (Julian Borrill)
- ngVLA (Rob Selina)
- ngEHT (Kari Haworth)

R&E Providers Updates

- AmLight1: Goals of the new AmLight-ExP project (Julio Ibarra)
- AmLight2: Evolving the AmLight-ExP SDN Framework (Jeronimo Bezerra)
- REUNA (Albert Astudillo)

- RedCLARA (Luis Eliécer Cadenas)
- RNP (Eduardo Grizendi)
- TENET/SANReN (Shukri Wiener)
- ESnet (Paul Wefel)
- Internet2 (Chris Wilkinson)
- SLAC (Mark Foster)

4. Science Requirements & Activities Updates

4.1 Vera Rubin Observatory Construction (Jeffrey Kantor, Rubin Observatory Senior Manager & Cristian Silva, Rubin Observatory IT Manager Chile)

The Vera Rubin Observatory data production includes nightly data products (alerts, difference images, and catalogs) with 60 seconds latency from the time of readout from the camera to the US Data Facility to alert publication to alert brokers. Once the data is acquired from the telescope, the summit sends the data to the base via special links that include 40x10G exclusive for science data and 2 x100G for control data. Those two links belong to Rubin Observatory and are provided by REUNA. There is also a third link, 10x 10G, that belongs to AURA, and it is shared among the other astronomy research programs in Chile. A fourth link is enabled as backup recently called Rubin Backup survival link. Once the data is at the base, there are two options for data to be transferred:

- Using the AURA border router and go over commodity internet
- Using the Rubin Border routers and go over the long-haul network (LHN) to the US Data Facility (USDF). LHN includes diverse paths, a primary link of 100G, and a backup link of 40G.

Vera Rubin Observatory is also trying to leverage Amazon and Google cloud services.

The network pre-verification review took place in June 2020. The commissioning camera and the LSST camera servers were installed at the base and the summit in 2020. Along with that, SLAC was selected as the USDF. There were several power interruptions during the pandemic. The network documentation was augmented as well.

The US Extremely Large Telescope program is a joint endeavor between the NSF's NOIRLab, Thirty Meter Telescope (TMT) in Hawaii, and the Giant Magellan Telescope (GMT) in Chile. More about this project can be seen at https://noirlab.edu/public/projects/useltp/. About 25% of the observing time will be for US astronomy researchers. NOIRLab will be providing user services, documentation, and training, to support the entire research life cycle (e.g., developing Key Science Programs (KSPs), submission of proposals, time allocation evaluation, observation planning, tracking, retrieving data and archiving long term). This program is currently in a proposal stage with NSF and has been presented to the Decadal Survey. Both telescopes will be connected to the NOIRLab headquarters in Tucson Arizona with 10 to 20G links.

4.2 Vera Rubin Observatory Operation (Bob Blum, Acting Director for Rubin Observatory Operations)

The Vera C. Rubin Observatory, previously known as the Large Synoptic Survey Telescope (LSST), was rebranded but kept the LSST acronym for the initial ten-year survey: the Legacy Survey of Space and Time. All construction activities on Cerro Pachón and at SLAC were suspended in March 2020 due to the pandemic.

Rubin's Legacy Survey of Space and Time will be observing the entire southern sky for ten years, beginning end of 2023 to 2033, with 20TB data per night, 40 Billion objects in the 15PB final catalog, and 500PB of image data. The telescope will produce 10 million transient events per night, distributed in real-time within 60 seconds to community brokers.

All optics have arrived at Cerro Pachón but still, need to be assembled and tested. The telescope mount top end was successfully assembled in March 2020. It will be followed soon by the placement of the commissioning camera.

Despite the pandemic, pre-operations have continued. A full survey proposal and detailed plan for operation will be completed this year in December. The pre-operations team currently consists of 100 people (40 FTE) from NOIRLab, SLAC, UW, Princeton, NCSA, BNL, FNAL, and more. A date preview is planned for June 2020 for the community. Up to 300 representatives of the science community will participate in an analysis of simulated LSST-like data products. The goal is to have the science community ready to ingest the data from the Vera Rubin Survey. The Baseline Survey Strategy was developed to meet the basic requirements to achieve the core science goals.

4.3 NSF's National Optical-Infrared Astronomy Research Laboratory (NSF's NOIRLab) (Mauricio Rojas, Computer Programmer CTIO NOAO)

The NOIRLab program include Cerro Tololo Interamerican Observatory (CTIO), Community Science and Data Center (CSDC), GEMINI, Kitt Peak National Observatory (KPNO), and Vera Rubin Observatory. Those facilities are operated jointly by AURA and NOIRLab under cooperative agreement. The NOIRLab IT operations (ITOps) has 23 members working in Chile, Hawaii, and Tucson, who are responsible for integrated IT services across all NOIRLab sites.

NOIRLab has two different kind of tenants: larger (GEMINI, MSO Blanco-SOAR, Rubin Observatory, Las Campanas, NRAO), and smaller (Smart group, Prompt, Gong, Alo, LCOGT, Wham, Kasi, Asas-sn, Evryscope, mEarth, and t80).

The network connectivity has 10Gbps burstable to 40Gbps on both pacific and Atlantic links, and backup link provided by REUNA via RedCLARA. From La Serena to Santiago through the valleys, a 40Gbps fiber link servs as a primary path and 4Gbps as backup through the coast. From Serro Tololo to La Serena, there is a 20x10Gbps DWDM primary link and multiple back up links.

4.4 GEMINI Observatory (Eduardo Toro, Information Technology Engineer NOIRLab)

The GEMINI observatory consists of two telescopes: Gemini North located in Mauna Kea Mountain, Hawaii, and Gemini South in Cerro Pachón, Chile. The partners include the USA, Canada, Chile, Brazil, Argentina, and Korea. There are four data centers processing the data: two at the summits and two at the bases. Remote observing is available at the bases and from Tucson, AZ. The connections have high availability and reliability due to the bandwidth capacity between Cerro Pachón and La Serena (>99%). Several improvements were implemented during 2020, such as installation of the Next Generation Firewall, implementation of network services and collaborative tools and Gemini & MSO integration. Future activity includes NOIRLab networking upgrade project, VoIP upgrade, Firewall upgrade, and integration with Rubin Observatory.

4.5 National Radio Astronomy Observatory (NRAO) and Atacama Large Millimeter/ Submillimeter Array (ALMA) (David Halstead, CIO, Assistant Director at NRAO & Adele Plunkett, Astronomer at NRAO)

The Atacama Large Millimeter/submillimeter Array (ALMA) is currently the largest astronomical project, composed of 66 high-precision antennas located on the Chajnantor Plateau. ALMA was shut down In March 2020 during the pandemic and resumed operations in March 2021. ALMA is a multinational project with many partners, and three ALMA Regional Centers (ARCs), which contain a single copy of the data:

- NA: NRAO, Charlottesville, VA, USA
- EU: ESO, Garching (Munich), Germany
- EA: NAOJ, Mitaka (Tokyo), Japan

Within Chile, the data is transported from the operations support facility to Santiago using 2.5Gb/s fiber to Calama, commercial fiber from Calama to Antofagasta, and from Antofagasta to Santiago via REUNA link. A redundant fiber loop via Argentina could be added in the future. An MOU is signed between

Associated Universities Inc. (AUI) and REUNA to provide local connectivity to Santiago. From Santiago to ARCs, there are multiple contracts with REUNA and other NRENs. There is a joint AURA-AUI agreement for 1Gbps committed (burstable to 10 Gb/s capacity) from Santiago to US NREN via Latin America's Nautilus Point of Presence. The link from NRAO to Internet2 through UVa is 10Gbps. The typical rate obtained during peak data transfer periods is 2-300Mb/s, with bursts up to 600Mb/s. The typical load is ~1TB/day. Recently most of the data processing being done in Santiago then archived at the North American ALMA Science Center (NAASC). A correlator upgrade is being developed and will be implemented in ALMA2030. The expected data date will be ~1PT/year.

4.6 Atacama Large Millimeter/Submillimeter Array (ALMA) connectivity (Jorge Ibsen, Head of ALMA Department of Computing, European Southern Observatory ESO)

ALMA is currently connected to Calama with dark fiber and to Antofagasta with Lambda, and from Antofagasta to the rest or the network via multiple 1G Ethernet. The Chajnantor plateau will host number of astronomical facilities and connectivity has significantly increased for the past years. The plan includes REUNA PoPs at ALMA and Antofagasta. There are three zones in proximity to ALMA that are hosting other projects in Cero Toco, Cero Chajnantor, and Pampa La Bola that can use the ALMA PoP. The control room extension to Santiago office project began in 2019 and was completed for eight months, right before the pandemic. The goal is to use the communication infrastructure to increase operational flexibility by allowing opportunistic testing activities from Santiago.

4.7 Cerro Chajnantor Atacama Telescope (CCAT) (Mike Nolta, CCAT Software Lead)

The Fred Young Submillimeter Telescope (FYST), formerly known as CCAT-prime, will be a 6-meter diameter telescope with a surface accuracy of 10 microns, operating at submillimeter to millimeter wavelengths and sited at 5600 meters elevation on Cerro Chajnantor in the Atacama Desert of northern Chile[1]. The partnership includes Cornell University as the lead organization, a German consortium led by the University of Cologne (Cologne, Bonn, Max Planck Inst. for Astrophysics), Canadian Atacama Telescope Corp (CATC), Canadian consortium led by the University of Waterloo (Waterloo, Toronto, British Columbia, Calgary, Dalhousie, McGill, McMaster, Western Ontario), CATC "observers"/partners (St. Mary's, Manitoba, Lethbridge, Alberta, National Research Council) and Chilean Universities (U. Chile, UCSC, PUC). The expected first light is late 2023, with a data rate of ~3-8TB/day. There are two first-light instruments: CHAI (multi-pixel heterodyne receiver) and Prime-Cam (7 optic tubes, each tube with a field of view of ~1.3 deg). Because its location is at a high altitude, FYST faces different regulations (e.g., fuel companies won't make regular deliveries, so generators need to be located at a more accessible site). There is an agreement in place for CCAT generators and fiber connections to be placed close to the ALMA service area. The original plan was to ship disks, but the data can be transferred over the network if the network connection is available. During CHAI observation, the data will be sent to Cologne, Germany (~685Mbps) and Toronto, Canada (~13Mbps). During pre-Cam observation, the data will be sent to Cornell University, USA (~386Mbps) and Toronto, Canada. There has been a delay because of the pandemic, but the summit has been leveled, and manufacturing has begun in Germany.

4.8 Giant Magellan Telescope Observatory (GMT) (Sam Chan, GMT Head of Information Technology)

The GMT[2] will be the largest telescope in the world with Each Mirror is 8.4-meter (27.5 feet) mirror - about two stories high when standing on edge. The GMT's 24.5-meter primary mirror will be comprised of seven 8.4-meter diameter segments. Two of the mirrors are completed, three are in production queue, and one is casting. GMT and the 30m telescope in Hawaii are part of the US Extremely Large Telescopes (ELT)[3] program. The pandemic halted the construction of GMT, and the first light will be in 2028. The team hopes to leverage fiber links from the Summit to La Serena and RENs connections for the data transfer

[1] Fred Young Submillimeter Telescope (FYST): http://www.ccatobservatory.org/index.cfm/page/about-ccat.htm
[2] Giant Magellan Telescope Observatory https://www.gmto.org/
[3] US ELT program https://www.noao.edu/us-elt-program/

process. Data archiving facility(s) have not been selected yet. The produced data is estimated to be ~10-40 TB per night. Backup options (e.g., AWS, Pasadena data center, summit data facility) are currently discussed.

4.9 Simons Observatory (SO) (Simone Aiola, Data and Pipeline Project Lead)

The Simons Observatory (SO)[4] is a forthcoming polarization-sensitive Cosmic Microwave Background (CMB) experiment, located in the high Atacama Desert in northern Chile inside the Chajnantor Science Preserve. The survey will last five years, starting from 2023 to 2028, and will include data from the CLASS, ACT, and Polar Bear/Simons Array telescopes in Chile. Remote connectivity is expected to start by the end of 2021, initially via a radio link between SO and Sa Pedro de Atacama. The data acquisition will be handled by the observatory control system, visualizing software, and an integrated system of alarms to monitor observations and site. The testing and integration, optical validation will be done in 2021; the first light is expected by 2022, the first science observation by 2023, and full science observation by 2024. Two copies of the data will be stored at SO for a month. The data also will be sent within 24h to UCSD, SDSC, National Energy Research Scientific Computing Center (NERSC), and later to Princeton. There are no strict requirements on data getting to the USA. There is also a discussion of using shipping disks and SneakerNet just in case the fiber link is not finalized. The data rate is estimated to ~132 Mbps during the day with 40-50 TB data volume per month. The raw data for the 5-year survey will be ~3PB. The Atacama Astronomical Park (Parque Astronómico de Atacama PAA) will be providing fiber connectivity from ALMA to SO. An MoU between SO and ALMA to allow fiber connection is written and under preliminary revision. An MoU between SO and REUNA to utilize the service needs to be finalized. SO connection path follows SILICA PoP >>REUNA PoP ALMA via PAA fiber>> Calama >>Antofagasta>> Santiago>>Miami>>San Diego. Testing has been performed from ALMA PoP to NESC (>700Mbps for over a month).

4.10 Cosmic Microwave Background (CMB) -S4 (Julian Borrill, Senior Scientist in the Physics Division at Berkeley Lab)

CMB-S4 is the 4th generation ground-based CMB experiment[5]. CMB-S4 is supported by the Department of Energy Office of Science (DOE/HEP) and the National Science Foundation (NSF: Astronomy & Physics & Polar programs). The experiment will use instruments located at the South Pole and the Atacama Desert in Chile. CMB-S4 precursors include South Pole Observatory, Simons Observatory & CCAT-prime for seven years. The construction will take place from 2019 to 2027, followed by instrument deployment across both sites from 2027 to 2029, and operations will be from 2029 to 2036. The data from Chile will be transferred over the REUNA/AmLight links to NERSC and Argonne Leadership Computing Facility (ALCF). There is no physical network connection at the South Pole, and the reduced data will be shipped using disks to the USA. The current site design does not include the reuse of SO site facilities or telescopes, but this is a possible option for the future, which is discussed. The compressed data rate is ~1.2Gbps with real-time transfer to NERSC, and a few hundred transient alerts per year will be analyzed using FABRIC nodes. At the Atacama site, one-month data will be stored on-site (~400TB). The design plans are preliminary. CMB does not yet have any commitment from or agreement with any networking or computing facility resource providers.

4.11 Next Generation Very Large Array (ngVLA) (Rob Selina, ngVLA Project Engineer)

The Next Generation Very Large Array (ngVLA)[6] is a development project the National Radio Astronomy Observatory (NRAO) for thermal imaging at a milli-arcseconds resolution which aims to bridge the Square Kilometer Array (SKA) and ALMA capabilities. Currently, there are four antenna designs under review. The construction of the antennas will begin from 2025 to 2035. The first operation will start in 2028 and full operation in 2035. The Main Array (MA) locations are planned USA (New Mexico, Texas,

[4] Simons Observatory https://simonsobservatory.org/

[5] CMB-S4 project https://cmb-s4.org/

[6] Next Generation Very Large Array (ngVLA) https://ngvla.nrao.edu/system/media_files/binaries/130/original/ngVLA-Project-Summary_Jan2019.pdf?1548895473

Arizona) and Mexico. The Large Baseline Array (LBA) locations are planned for the USA (California, Washington state, Virginia, Iowa, Virgin Islands, Puerto Rico, Hawaii, and possibly Florida) and Canada (Penticton).

The data rate of 723 Gbps per antenna will aggregate to 800Gbps links on ngVLA installed fiber. For example, ~3 antenna LBA site will equal ~1Tbps link. All sites can be connected via leased fiber, spectrum, or bandwidth. The data rates are estimated to average 8GB/s to peak 128GB/s and computing ~60PFLOPS/s. The data archiving will follow ALMA-like distributed archiving and re-processing among international partners. The ngVLA will require a significant investment in new fiber-optic infrastructure in the Southwest USA, with connections across North America.

4.12 Next Generation Event Horizon Telescope (ngEHT) (Kari Haworth, Chief Technology Officer at Center for Astrophysics Harvard & Smithsonian)

The Event Horizon Telescope[7] is an international collaboration capturing an image of black holes using a virtual Earth-sized telescope. The first full EHT observation took place on April 5-14, 2017, with 8-station EHT array telescopes: APEX, SPT, ALMA, LMT, SMTO, JCMT, SMA, Pico Veleta. The ngEHT vision for the future includes using new technologies to expand with more sites, wider bandwidth, bult-in autonomy, and faster time-to-science. Currently, there are significant challenges of how to get the data fast. The desired increase of bandwidth to 256Gbps presents a new challenge in recording the data with that speed. Such a data rate will produce 1.7PB for a 5-day campaign. The EHT/ngEHT data reduction starts with raw signals data of 80PB, which is shipped from all the sites to a correlator facility and reduced to 160TB, then the data is calibrated to 160MB to produce a movie of 1MB. The challenge is how to get all the data from all sites around the globe to a central location (e.g., getting data from Antarctica takes 6-9 months), and is there a possibility for getting partial real-time data to one site. The research team is looking to possible high bandwidth-on-demand recording and playback, archrivals for few months, portable disk solutions, commodity SSD storage, ground fiber, satellites (e.g., Starlink ~1Gbps), satellites free-space optical (~100Gbps), and cloud computing. The estimated cost for construction will be $140M with an anticipated international contribution of 50% and operation of $13M/year.

4.13 Summary Science Instruments

Instrument	Location	Data archive	Stage	Start - End date	Data flow characteristics
Vera Rubin Observatory	La Serena, Chile	US: SLAC, EU: In2p3	construction	Oct 2023-2033	20TB per night, Image must be transferred within 6 seconds from the Base to the USDF. The telescope will produce 10 million transient events per night, which will be distributed in real time within 60 seconds to community brokers. Data flow from Chile to USA and EU. US partners: NSF, DOE, IN2P3; Managed by AURA
Las Campanas Observatory (LCO)	Cerro Las Campanas, Chile	LCO do not use data archive, only use own servers	operation	1971-present	Data comes from multiple telescopes: Swope Telescope, Warsaw Telescope, Giant Magellan Telescope (GMT), Magellan Telescopes, and other partners. US partners: Carnegie Institution for Science (CIS); Managed by AURA & NOIRLab

[7] ngEHT: https://eventhorizontelescope.org/

Small and Moderate Aperture Research Telescope System	Cerro Tololo, Chile	NOIRLab Astro Data Archive Tucson, AZ	operation	2003-present	US partners: SMARTS Consortium operates four small telescopes. Managed by NOIRLab & AURA as tenant
Wisconsin H-Alpha Mapper (WHAM)	Cerro Tololo, Chile	TBD	operation	2009-present	US partners: University of Wisconsin; Managed by NOIRLab & AURA as tenant
Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes (PROMPT)	Cerro Tololo, Chile	Transferred over the internet back to a 100 TB RAID on the UNC campus	operation	2004-present	US partners: University of North Carolina at Chapel Hill; Managed by NOIRLab & AURA as tenant
Southeastern Association for Research in Astronomy (SARA)	Arizona, Cerro Tololo in Chile, and Canary Islands	There is no centralized archive; Personal Dropbox account	operation	1990-present	US partners: Florida Tech, ETSU, UGA, VSU, FIU, Clemson U; Managed by NOIRLab & AURA as tenant
Las Cumbres Observatory Global Telescope Network (LCOGT)	California, Texas, Hawaii, Cerro Tololo Chile, South Africa, Canari Islands, South District Israel, United Kingdom, China, Australia	From the site's computers to the Amazon cloud	operation	2005-present	Fully robotic operations. The network operates around-the-clock. Calibration observations are made during daytime; science observations are acquired at night. Observing schedules are stored at site, so telescopes can continue observing even when an external link is interrupted. US partners: University of California, Santa Barbara; Managed by NOIRLab & AURA as tenant
mEarth	Tucson, Arizona and Cerro Tololo, Chile	ExoFop-TESS at Caltech, CA, USA	commissioning	2008-present	US partners: Harvard; Managed by NOIRLab & AURA as tenant
Korea Microlensing Telescope Network (KMTnet)	Korea, Australia, South Africa, Chile	KMTNet data center at Daejeon in Korea	commissioning	2009-present	Managed by NOIRLab & AURA as tenant
T80-South supporting the Southern Massive Astrophysical Panchromatic Survey (S-MAPS) project	Cerro Tololo, Chile	Through the internet and using tapes stored at the University of São Paulo	operation		The system averages 5000 images per night with ~300,000 sources per image, and to date has taken over 3 million images, totaling 250TB of raw data. Managed by NOIRLab & AURA as tenant
Evryscope-South Telescopes	California and Cerro Tololo, Chile	Data is stored on the mountain. Data rate is too high to take back to the US	operation	2015-present	US partners: NSF; U of North Carolina; NOIRLab & AURA as tenant
All-Sky Automated Survey for Supernovae project (ASAS-SN)	2 telescopes in Cerro Tololo, Chile; 24 telescopes, distributed	First to Las Cumbres Observatory (LCOGT) then to Ohio State	operation	2012-present	US partners: Ohio State University; NOIRLab & AURA as tenant

	around the globe	University via network			
Andes Lidar Observatory (ALO)	Cerro Pachón, Chile	TBD	operation	2009-present	This observatory houses several passive optical instruments, including a Mesosphere Temperature Mapper, an Infrared Imager, a near-infrared All Sky Imager, and a meteor radar; NOIRLab & AURA as tenant
Scientific Solutions, Inc. (SSI) triple-etalon Fabry-Perot interferometer (FPI)	Cerro Tololo, Chile and Peru	presently not operational	operation	2006-presently not operational	Support of the Comm/Nav Outage Forecast System (C/NOFS) project. US partners: Air Force Research Laboratory & NSF; NOIRLab & AURA as tenant
Gemini Observatory	Cerro Pachon in Chile, and Mauna Kea, Hawaii	Amazon Cloud	operation	1994-present	Base Facility Operations: Remote Observing - VPN access. Summit Base Data Transfer: High Bandwidth; High Availability: World-Class availability (>99%); High Reliability: Maximum MTBF (>10 years); Cross-site Coordination: Low Latency between: Hilo - La Serena & La Serena - Tucson. Cloud Data Archiving: Upload/Download from AWS. NOIRLab & AURA as tenant
Atacama Large Millimeter/submillimeter Array (ALMA)	San Pedro de Atacama	NRAO, Charlottesville, VA, USA; EU: ESO, Garching (Munich), Germany; NAOJ, Mitaka (Tokyo), Japan	operation	2011-present	1TB per day, total volume will be ~220TB; Typical rate obtained during peak data transfer periods is 2-300Mb/s, with bursts up to 600Mb/s. A new correlator will increase the data to 1PT/year in 2030. Data come from Chile to USA, EU, and Japan. US partners: NRAO; Managed by Associated Universities, Inc. (AUI)/NRAO
CCAT	Cerro Chajnantor Chile	Cologne, Germany Toronto, Canada Cornell University, Ithaca, NY, USA	planning	2023	~3-8 TB/day; connecting to dark fiber at ALMA Pad 409 Dark Fibers; During CHAI observation, the data will be sent to Cologne, Germany (~685Mbps) and Toronto, Canada (~13Mbps). During pre-Cam observation, the data will be sent to Cornell University, USA (~386Mbps) and Toronto, Canada. Data flow from Chile to Germany, Canada, and USA.
US ELT: GMT & 30m Hawaii telescope	Chile and Hawaii	TBD	construction	2028	Projected 10-40 TB per night. Data flow from Chile and Hawaii; Managed by NSF & NOIRLab
Simons Observatory	Atacama Desert in Northern Chile	Princeton USA	planning	2023-2028 (ish)	The data rate is estimated to ~132 Mbps during the day with 40-50 TB data volume per month. The raw data for the 5-year survey will be ~3PB. There is NO strict requirement on data getting to the US. Data flow from Chile to Princeton USA

Cosmic Microwave Background (CMB-S4)	Chile and at the South Pole	NERSC	planning	2029-2036 (ish)	The compressed data rate is ~1.2Gbps with real time transfer to NERSC and few hundred transient alerts per year will be analyzed using FABRIC nodes; Managed by DOE & NSF
Next Generation Very Large Array (ngVLA)	New Mexico, Texas, Arizona, Mexico, California, Washington state, Virginia, Iowa, Virgin Islands, Puerto Rico, Hawaii and Florida	TBD	planning	2025-2035	The data rate of 723 Gbps per antenna will aggregate to 800Gbps links on ngVLA installed fiber. For example, ~3 antenna LBA site will equal ~1Tbps link. The LBA sites (UPR, U Central Florida, Arecibo Observatpry) proposed to NSF a 100Gbps link to I2. US partners: NSF; Managed by NRAO, NSF, and AUI
ngEHTNext Generation Event Horizon Telescope (ngEHT)	South Pole, Chile, Hawaii, Mexico, USA, Greenland, France, Spain	TBD	planning	2019-2024 design; 2024-2030 build and commission	The EHT/ngEHT data reduction starts with raw signals data of 80PB which is shipped from all the sites to a correlator facility and reduced to 160TB, then the data is calibrated to 160MB to produce a movie of 1MB. US partners: NSF

5. R&E Provider Updates

5.1 Goals of the new AmLight-ExP project (Julio Ibarra, Assistant Vice President of Technology Augmented Research at FIU)

AmLight ExP project (Award #2029283) and AtlanticWave-SDX (Award #2029278) project are supported by NSF. The primary goals of those projects are to improve resiliency and increase self-management of the network. To achieve those goals, the team plans to improve the AmLight-ExP physical network by increasing the capacity and adding network paths to increase resiliency and replace some legacy network devices. The performance measurement environment will be improved by adding 10G perfSonar nodes across the AmLight topology and adding In-band Network Telemetry for fine-grained real-time network monitoring. The self-management of the AmLight-ExP network will be increased by improving the Software-Defined Networking (SDN) infrastructure and adding autonomic network capabilities at Open Exchange Points (OXP). This effort will be achieved in coordination will all the collaborating partners.

Currently, the AmLight Express network has 600Gbps in service and a 100G AmLight Protect ring. There are OXPs in Miami, Fortaleza, Sao Paulo, Santiago, and Cape Town.

The network expansion from 2021 to 2026 includes adding 100G path from Santiago, Chile to Porto Alegre, Brazil, and 2x100G from Fortaleza to Sines by RedCLARA in 2021, increasing the spectrum on the Express path from Sao Paulo to Boca Raton, and extending the path to Atlanta by FIU from 2022 to 2023, and adding capacity and resiliency from Sao Paulo to Fortaleza by RNP in 2022.

The self-management (autonomic) OXP architecture envisioned with the AtlanticWave-SDX project includes implementation of closed-loop orchestration, dynamic provisioning of L3 services, integration with SENSE, AutoGOLE, and FABRIC orchestrators, additional compute and storage, integration with science applications, adding network management tools, and deploying at OXPs in MIA, JAX, ATL, FLZ, SAO, SCL, CTN.

5.2 Evolving the AmLight-ExP SDN framework (Jeronimo Bezerra, IT Associate Director, Chief Network Engineer at FIU)

The motivation for enhancing the AmLight network is to enable support for the upcoming science applications and their requirement, complex Service Level Agreements (SLAs), supporting new paradigms, more bandwidth, network experimentation, and lowering expenses. The legacy network presents several challenges: lack of real-time network telemetry, lack of flexibility for finding paths based on user-specific metrics, lack of ability for complex network and traffic engineering policies, lack of flexibility for dynamic network tuning, which results in constraining innovation.

A major goal for 2021-2026 includes creating an autonomic networking architecture for a self-managed network (e.g., self-configuration, self-healing, self-optimization, self-protection). This plan can be achieved by using highly programable network devices, gathering network telemetry to profile the network in real-time, developing a central repository for users' requirements and network policies, building a learning framework to learn from the network behavior from telemetry and policies, and deploying a new SDN orchestrator. The AmLight SDN Orchestrator is being built over the Kytos[8] SDN platform supported by the Academic Network of Sao Paulo (REDNESP).

5.3 Chilean Academic Network (REUNA) (Albert Astudillo, Chief Technology Officer at REUNA)

Approximately 80% of the research done in Chile is carried out by REUNA's network, including 17 PoPs (11 with 100G capacity). The northern backbone network includes 2x100G paths from Santiago to La Serena and Antofagasta, and multiple 10G paths and resilient backup. REUNA partners with important international initiatives such as the RedCLARA expansion, the BELLA project, and AmLight ExP. One of the new projects with the astronomical community includes creating the PoP in Chanjantor Valley, which will be able to provide connectivity to multiple projects in the area. Another project includes providing an alternative secondary path for scientific data flow from instruments located in Las Campanas using existing infrastructure. The Lyra project consists of a new path over an existing infrastructure from Santiago to La Serena, which further extends to Las Campanas, GMT, Tololo, and La Silla. The link from Tololo to La Silla uses a microwave link and has been tested in 2020. REUNA is also planning to increase the capacity to 200Gbps in the metropolitan ring in Santiago to handle the traffic from Vera Rubin Observatory, AURA, Evalso[9], NAOJ, ESO, ALMA, and RedCLARA. The Patagonia project over FOA (Fibra Óptica Austral) is planning to integrate the rest of Chile to the REUNA backbone infrastructure with multiple PoPs connected with 10G.

5.4 Latin American Cooperation of Advanced Networks (RedCLARA) (Luis Eliécer Cadenas, Executive Director RedCLARA)

Today's RedCLARA infrastructure consists of multiple 100Gbps links in South America extending to Central and North America, Europe, and Africa. The Bella Cable was successfully deployed in March, and its activation is expected in June 2021. There will be an initial capacity of 100 Gbps and an additional 100 Gbps dedicated to transport Copernicus data. The maximum capacity is 4.5Tbps, and RedCLARA will acquire 45 optical channels for 25 years. The bandwidth required within less than one year over the path Fortaleza-Porto Alegre-Buenos Aires-Santiago will be 50Gbps. The Copernicus mirror data center located in the University of Chile will be implemented in the following 24 months. Other data centers probably will be located in Brazil and Colombia. The end of the first phase will be December 2021.

Bella-T phase two also includes strengthening and expanding the Lain American digital ecosystem to multiple carriers in Latin & Central America and the Caribbean. The total investment in REN infrastructure from RedCLARA since its inception in 2003 is accumulated to over $100M. For the next two years, the investment for supporting the REN infrastructure is estimated to $60M.

[8] Kytos SDN platform: https://kytos.io/
[9] EVALSO project http://www.evalso.eu/evalso/

5.5 Brazil's academic network - Rede Nacional de Ensino e Pesquisa (RNP) (Eduardo Grizendi, Engineering and Operations Director of RNP)

RNP is currently upgrading its national backbone network to 100G, and jointly with REDNESP is participating in international projects, such as the AmLight ExP, the Bella project, and RedCLARA. RNP also operates two GXP, one in Fortaleza (SAX) and one in Sao Paulo (SOL). RNP has over 1500 PoP sites connected in over 40 cities in Brazil. To support the multiple international connections in Fortaleza, a metropolitan underground fiber is being optimized to provide a more robust infrastructure. The same optimization is planned to take place in Sao Paulo as well. These initiatives will be completed by the end of 2021. RNP is acquiring a Right of Use of optical fiber for 20 years on the path Porto Alegre-Florianopolis-Curitiba- Sao Paulo-Rio de Janeiro and Fortaleza-Salvador- Rio de Janeiro.

5.6 South Africa National Research and Educational Network (SA NREN) (Shukri Wiener, Executive Officer Technical and Operations)

SA NREN is comprised of TENET and SANReN. The roles and responsibilities of the South African NREN (SA NREN) are distributed between the South African National Research Network (SANReN) group at the Council for Scientific and Industrial Research (CSIR) and the Tertiary Education and Research Network of South Africa (TENET)[10]. The international connectivity of SA NREN includes capacity on several submarine cable systems: SACS 100G, WACS 60G (100G), SAT3 20G, EASSy 20G, and SEACOM 60G (100G); and connect to four International R&E Exchange points: ZAOXI Cape Town, AMPATH Miami, GEANT London, and Netherlight Amsterdam. SA NREN interconnects with the three regional African networks UbuntuNet Alliance, WACREN, and ASREN. The SA NREN backbone includes multiple 10G links, which are being gradually upgraded to 100G or 200G.

Several astronomy instruments are located in the South African regions. The Southern African Large Telescope (SALT) is managed by the South African Astronomical Observatory (SAAO) field station near the small town of Sutherland, approximately 400km from Cape Town. It is connected with a 10Gbps link. The South African Radio Astronomy Observatory (SARAO) manages the MeerKAT (pathfinder to SKA) in the Karoo desert, approximately 700km from Cape Town. This site currently is connected with 10Gbps, and it will be updated to 100Gbps by the end of 2021. The use of DWDM technology is planned in the future. SARAO also manages the Hartebeesthoek Radio Astronomy Observatory (HartRAO) facility, which is approximately 70km from Johannesburg and has a 50Gbps link.

There are several astronomy collaborations between South Africa and Latin America. The Geodetic VLBI, under the auspices of the International VLBI Service (IVS), is co-observing with the HartRAO in Hartebeesthoek, South Africa, the Rádio Observatório Espacial do Nordeste (ROEN) in Fortaleza, Brazil, and the Argentine-German Observatory (AGGO) in Pereyra, Argentina. Those instruments are sending the data to a correlator to New Mexico (possibly shipping disks). HartRAO Astronomical VLBI also collaborates with the European VLBI Network (EVN)[11] in real-time and recorded modes by using L2 1Gbps MPLS REN link to Joint Institute for VLBI ERIC (JIVE)[12].

5.7 Energy Science Network (ESnet) (Paul Wefel, Network Engineer)

ESnet is the US Department of Energy High-Performance Network. ESnet connects all of the DOE national labs, many DOE sites, and hundreds of research and commercial networks internationally. ESnet experienced a drop in traffic due to all national labs been closed during the pandemic for the year 2020. ESnet 6 includes upgrades in all components (Optical Core, Low Touch Service Edge Packet Core, and High Touch Service Edge) while the network has been operational. Currently, ESnet 5.5 has been completed, and the rest of the upgrades will be completed by 2023. The ‘High-Touch’ hardware can provide a programmable data-plane where the ‘Low-Touch’ (and ‘No-Touch’) is an Application-Specific Integrated

[10] SA NREN https://sanren.ac.za/south-african-nren/
[11] European VLBI Network (EVN) https://www.evlbi.org/
[12] JIVE http://www.jive.eu/

Circuits (ASIC) based data-plane. The High Touch system will provide a programmable data plane for developing and deploying innovative science data services and the first High Touch service, such as precision network telemetry.

For the Vera Rubin Observatory data transfer, ESnet has provisioned two paths from Atlanta to SLAC. The Northern path includes Atlanta- Houston- El Paso- Sunnyvale- SLAC, and the southern path includes Atlanta- Nashville- Chicago-Kansas City-Denver-Sacramento-SLAC. An additional path to Europe includes SLAC-ESnet backbone-GEANT (Amsterdam, London, Geneva)-RENATER-IN2P3. ESnet is also planning to purchase spectrum for the transatlantic link by 2023.

5.8 Internet2 (I2) (Chris Wilkinson, I2 Director of Network Engineering & Planning)

The I2 Next Generation Infrastructure services include data-intensive transport (L3, AL2S, AP-REX, Waves), cloud access, and security and connectivity (Spectrum, rlPcord, DDoS protection). Similar to ESnet, I2 is seeing an exponential growth in traffic carried by year. The Next Generation Infrastructure Program includes the services and service models through which the community adopts Internet2 infrastructure services. It includes new features, primarily driven by software, automation, and systems virtualization to allow the infrastructure to be more readily integrated into the broader campus, regional, and cloud environment around us. The current aggregated capacity of the I2 backbone is 800Gbps. Performance assurance nodes also have been deployed at every location to ensure that the network is functioning correctly. The new software architecture provides supervision, orchestration, provisioning, and assurance. The fiber upgrades were completed by February 2021, the packet platform was completed by March 2021, and most of the legacy equipment will be removed by the end of 2021. The Next Generation Infrastructure will provide members with packet capability (e.g., access to 400G connections, 100G performance assurance mesh, etc.), optical capability (e.g., 10G, 100G, and 400G wave services, better visibility of system and service performance, etc.), and interconnection capability (e.g., consistent load-balancing at all interconnect sites, large peer-facing port counts, etc.).

5.9 SLAC National Accelerator Laboratory (Mark Foster, Director IT Infrastructure at SLAC)

SLAC National Accelerator Laboratory is a US Department of Energy (DOE) Office of Science laboratory operated by Stanford University[13]. In 2020, SLAC was selected as the US Data facility designated for Rubin Observatory data processing, archiving, and data access. The goal is for the Vera Rubin Observatory data to be transferred to SLAC in 6 secs and the alerts generated in 1-2 mins (60s goal). The SLAC Shared Data Facility is currently expanding storage and achieving capacity to accommodate the future incoming data from the Rubin Observatory. Currently, SLAC can support 200Gbps aggregate capability between SLAC and other sites with multiple ESnet 100Gbps links (ability to scale Nx100Gbps now, Nx400Gbps future). ESnet6 is installing two optical nodes on SLAC premises: part of Bay Area optical ring (multi-Tbps optical capacity) to accommodate the Vera Rubin Observatory traffic.

6. Meeting Survey

A short survey was sent to 61 participants to assess the outcome of the meeting. The goal was to determine if the participants found the presentations informative (astronomy and technical), and if more technical content is desired, if there was sufficient information about the science requirements, and how RENs can support the astronomy science requirements.

We received 17 responses which represent about 28% of the participants. All surveyed found the meeting useful and informative. Having one day for the astronomy project and a second day for network providers worked well for all. All participants found the content about the astronomy projects and network support to be sufficient. See Appendix E for more details.

[13] SLAC https://www6.slac.stanford.edu/

Appendix A. Program for the SAACC Meeting

Tuesday, April 13, 2021

11:00 – Welcome | Download presentation

Session I: Science Requirements & Activities Updates
11:10 – Vera C. Rubin Observatory Construction, US-ELT (Jeffrey Kantor & Cristian Silva) | Download presentation
11:30 – Vera C. Rubin Observatory Operations (Bob Blum)| Download presentation
11:50 – NOIRLab (Eduardo Toro and Mauricio Rojas)| Download presentation
12:15 – NRAO (David Halstead, Adele Plunkett)| Download presentation
12:35 – ALMA (Jorge Ibsen)| Download presentation
12:55 – CCAT (Mike Nolta)| Download presentation
13:05 – *Refreshment Break*
13:35 – GMTO (Sam Chan)| Download presentation
14:55 – Simons Observatory (Simone Aiola)| Download presentation
15:15 – CMB-S4 (Julian Borrill)| Download presentation
15:35 – ngVLA (Rob Selina)| Download presentation
15:55 – ngEHT (Kari Haworth)| Download presentation
16:05 – Open Discussion/Coordination

Wednesday, April 14, 2021
11:00 – Welcome

Session II: Providers updates
11:10 – AmLight1: Goals of the new AmLight-ExP project (Julio Ibarra) | Download presentation
11:30 – AmLight2: Evolving the AmLight-ExP SDN Framework (Jeronimo Bezerra) | Download presentation
11:50 – REUNA (Albert Astudillo) | Download presentation
12:10 – RedCLARA (Luis Eliécer Cadenas) | Download presentation
12:30 – RNP (Eduardo Grizendi) | Download presentation
12:50 – *Refreshment Break*
13:20 – TENET/SANReN (Shukri Wiener) | Download presentation
13:40 – ESnet (Paul Wefel) | Download presentation
14:00 – Internet2 (Chris Wilkinson) | Download presentation
14:20 – SLAC (Mark Foster) | Download presentation
14:40 – Open Discussion/Coordination
15:00 – Adjourn

Appendix B. Program for the Vera Rubin Observatory NET Meeting

Thursday, April 15, 2020

11:00 - Welcome and Introductions

- Goals and Objectives
- Planned Outcome
    - 2021 Vera Rubin NET Meeting Report
- Rubin Observatory Network Status Overview - Jeff

11:20 - *Session 1*: LHN Specifications and Design Documents Catalog - Julio Ibarra and Jeff Kantor

Objective: Catalog for documents to transition from Construction to Operations.

Outcome: Identify documents that will guide NET activities on to Operations. Consolidate catalog on to single website/Dropbox. Identify document owners.

11:40 - *Session 2a*: Updates about the physical networks in Chile and Brazil - Julio Ibarra moderator

Report on the physical networks since the 2020 Rubin Observatory NET meeting. A representation of the portion of your physical network that supports the Rubin Observatory is requested; anything else is outside the scope.

The outcome of Session 2 is to document what the Rubin Observatory NET has deployed at the physical layer since the 2020 Rubin Observatory NET meeting. Each physical network representative will present 1 - 2 slides and take questions.

- Rubin Observatory Network - Cristian Silva (10min)
- REUNA - Albert Astudillo (10min)
- RedCLARA - Marco Teixeira (10min)
- RNP - Aluizio Hazin (10min)

Outcome: Diagrams and description to be made available for LSE-78 and LSE-479.

12:20 - *Session 2b*: Updates about the physical networks International and CONUS - Phil DeMar moderator

- UK - (Peter Clarke) (10 min)
- GEANT - Richard Hughes Jones (10 min)
- RENATER - Stewart McLellan (10 min)
- FIU-AmLight - Jeronimo Bezerra (10min)
- SLAC - Mark Foster (10min)
- ESnet - Paul Wefel (10 min)

Outcome: Diagrams and descriptions to be made available for LSE-78 and LSE-479.

13:30 - *Scheduled Break (30 minutes)*

14:00 - *Session 3*: Updates to LSE-78 Rubin Observatory Network Design Document - Jeff Kantor moderator

Review the significant changes to LSE-78, with emphasis on CONUS and transatlantic networks due to the selection of SLAC as the US Data Facility for Operations, and the addition of a UK processing site and Data Access Center(s).

Outcome: Session 3 is to confirm the updated document as ready to submit to the Rubin Observatory Change Control Board (CCB). Identify gaps in the updated document and to assign for updates.

14:30 - *Session 4*: Updates to LSE-479 Rubin Observatory Network Technical Document – Julio Ibarra moderator

Review the significant changes to LSE-479, with emphasis on CONUS and transatlantic networks due to the selection of SLAC as the US Data Facility for Operations, and the addition of a UK processing site and Data Access Center(s). Also, cover Huawei Avoidance new path in Brazil.

Outcome: Session 4 is to confirm the updated document as ready to submit to the Rubin Observatory Change Control Board (CCB). Identify gaps in the updated document and to assign for updates.

15:00 - Wrap up and Actions

15:10 - Adjourn

Friday, April 16, 2021

11:00 - Welcome – Julio Ibarra and Jeff Kantor

- Overview of Day 1 meeting and Roadmap for Day 2

11:10 - *Session 5*: End-to-end Test Plan and Performance: measurement and QoS- Julio Ibarra moderator

Purpose: To understand what the Rubin Observatory NET must accomplish to satisfy ourselves that we can demonstrate that the networks are ready for Verification and acceptance, and can be measured and monitored.

Context:

- Primaries are dedicated by end of FY22 (except Boca - Atlanta in FY23). By definition, no need for QoS on the dedicated primary (only Vera Rubin traffic)
- Secondary: SLA Expectation: By the end of FY22, there is a 40G minimum (during observing 10 hours per night) required on your secondary.
    - How to achieve that?
    - Shared minimum guaranteed vs dedicated, QoS or other mechanism?
    - Update
    - What bandwidth guarantees are required from USDF to IN2P3? and UK facility?
- Update overall End-to-End Test Plan to include: (Jeronimo and Renata)
    - End-to-end Measurement Infrastructure (Renata Frez)

- QoS Test Plan (Jeronimo Bezerra)
    - Intra-domain QoS Test plan
    - Inter-domain QoS Test plan

The outcome of session 5 is to:

- Identify what needs to be done to be ready for QoS test plan to be merged completely into the LSE-479.
- Identify what needs to be done to the End-to-End Test plan document for submission to the Rubin Observatory CCB for baseline.
- Identify gaps and make assignments to authors of documents.

12:10 - *Session 6*: Rubin Observatory Networks Verification - Phil Demar moderator

Purpose: To understand what must be accomplished to demonstrate to funding agencies and to Rubin Observatory management that by FY2022 the Rubin Observatory Network has met its requirements.

Review the Vera Rubin Observatory Network Verification plans and schedule.

- Rubin Observatory Network Verification (planning for formal tests/demonstrations) – Cristian Silva
    - Responses to the 2020 Pre-Verification Review.
    - LDM-732 Rubin Observatory Networks Verification Baseline (Cristian Silva)
        - LDM-732 describes the methodology used (how) the Rubin Observatory NET demonstrated that requirements were met.

Outcome: Review is to provide comments that will be useful for the improvement of the Network Verification plan.

13:10 - *Scheduled Break (30 minutes)*

13:40 - *Session 7*: Operations Contracts, SLOAs, MOAs, baselining the O&M plan, and establishing the Virtual NOC - Phil DeMar moderator

- An update on the plans, budgets, requests for FY22 and FY23 (including VNOC) - Jeff Kantor
- An update on Operations Contracts, SLOAs, and MOAs, including comments on SLOA template - Jeff Kantor
- Discussion and comments on O&M plan - Jeff Kantor

Outcome: Collect comments to the drafts of SLOAs and O&M plan provided to Jeff.

14:10 - Closure and Next Steps

14:30 - Adjourn

Appendix C. List of Participants SAACC Meeting April 13-14, 2021

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Appendix D. List of Participants Vera Rubin Observatory NET Meeting April 15-16, 2021

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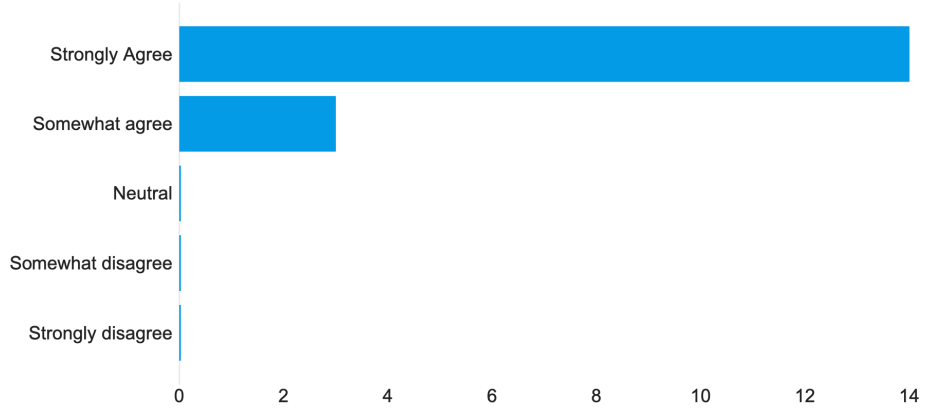
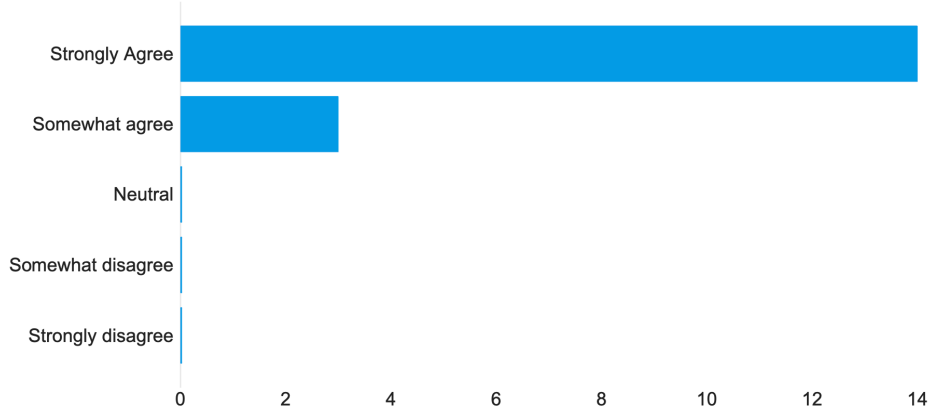
Appendix E. Survey results

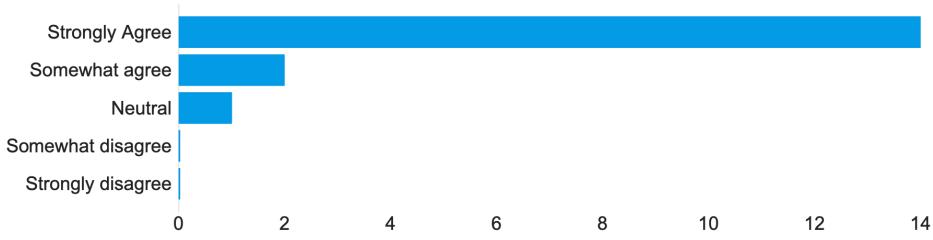
Q1 - I found the meeting informative and useful



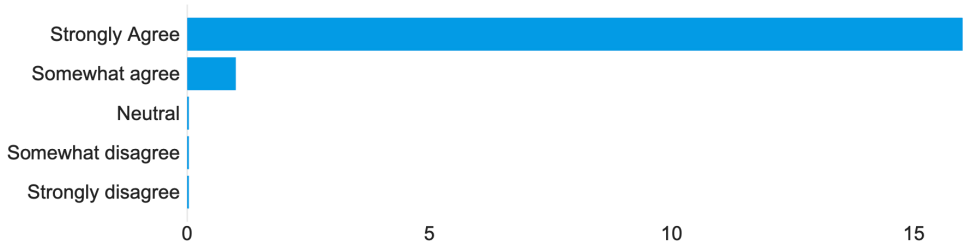
Q2 - The 2-day format of the first day for the science projects, and the second day for the RENs works for me



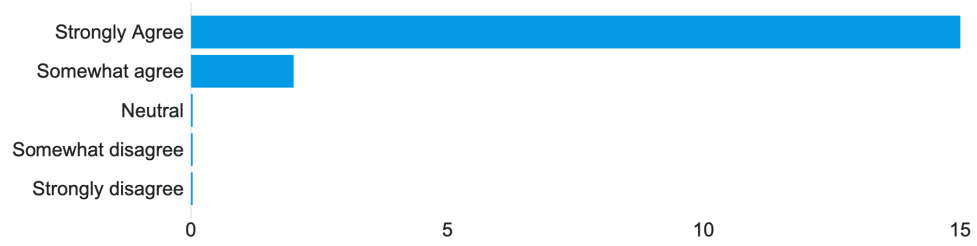
Q3 - The content about astronomy projects was sufficient



Q4 - The content about the network support was sufficient



Q5 - I have a better understanding of the role of RENs and how they can benefit my science project



Q6 - Is there anything else you would like to share with us?

Is there anything else you would like to share with us?
Great meeting - first time I attended. Nice to get some good background on the astronomy projects and interact with NREN colleagues/collaborators.
Thanks!
I would suggest to mix the providers and science talks, perhaps not a random shuffle, but something like: - First day: first half science, second half provider - second day: first half provider, second half science
The addition of the Event Horizon Telescope presentation was a very good idea. Next time I'd like to also get a presentation on one of the telescopes in South Africa that has collaborative relationships in the US or South America. SAACC should continue to extend invitations that bring diverse representation to the meetings.