AmLight ExP- Network Connectivity for Open Science between South Africa, the US, and South America

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Outline

- What is AmLight-ExP?
- SC23 & BEAA Collaboration
- Open Science Grid
- Astronomy
- Cryogenic Electron Microscopy
- Other Science Drivers
- Conclusion

AmLight ExP
Americas Africa Lightpaths Express & Protect

Americas-Africa Lightpaths Express and Protect (ExP)

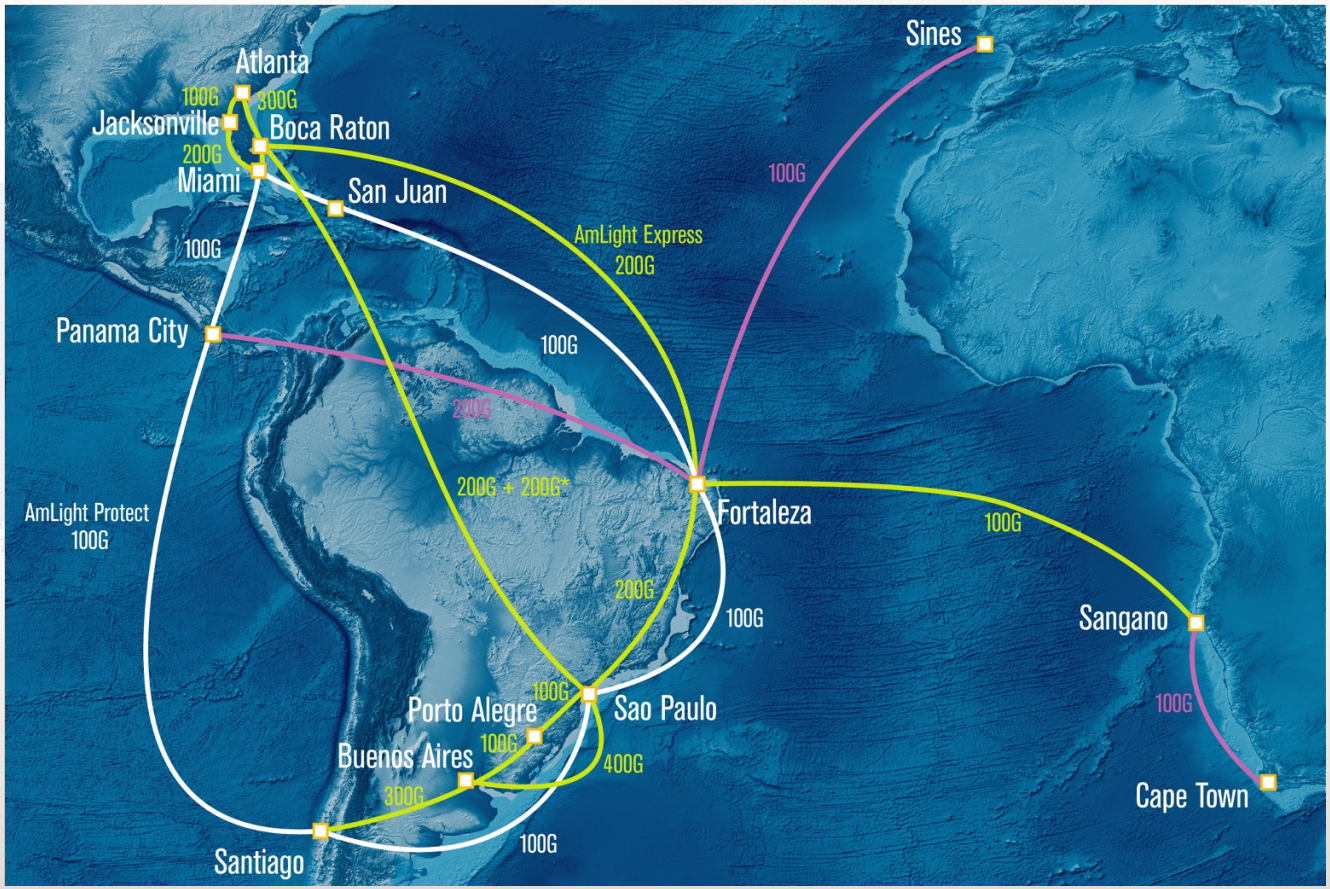
AmLight ExP is a hybrid network that uses Optical spectrum (Express) and Leased capacity (Protect) to build a reliable cutting-edge network infrastructure for research and education

AmLight ExP Network currently consists of:

- 600G of upstream bandwidth between the U.S., Latin America, Caribbean, and 100G to South Africa in Cape Town.
- Open Exchange Points (OXPs) with Points of Presence (PoPs) in: Florida (3), Brazil(2), Chile, Puerto Rico, Panama, and South Africa, New: Georgia (Atlanta), Argentina (Buenos Aires)
- Production Software-defined networking (SDN) Infrastructure since 2014
- Deeply Programmable R&E Network Infrastructure
- Highly instrumented: PerfSONAR, sFlow, Juniper Telemetry Interface (JTI), In-band Network Telemetry (INT)

(AmLight ExP project is supported by NSF Award #1451018 and #2029283.)

Americas-Africa Lightpaths Express and Protect (ExP)



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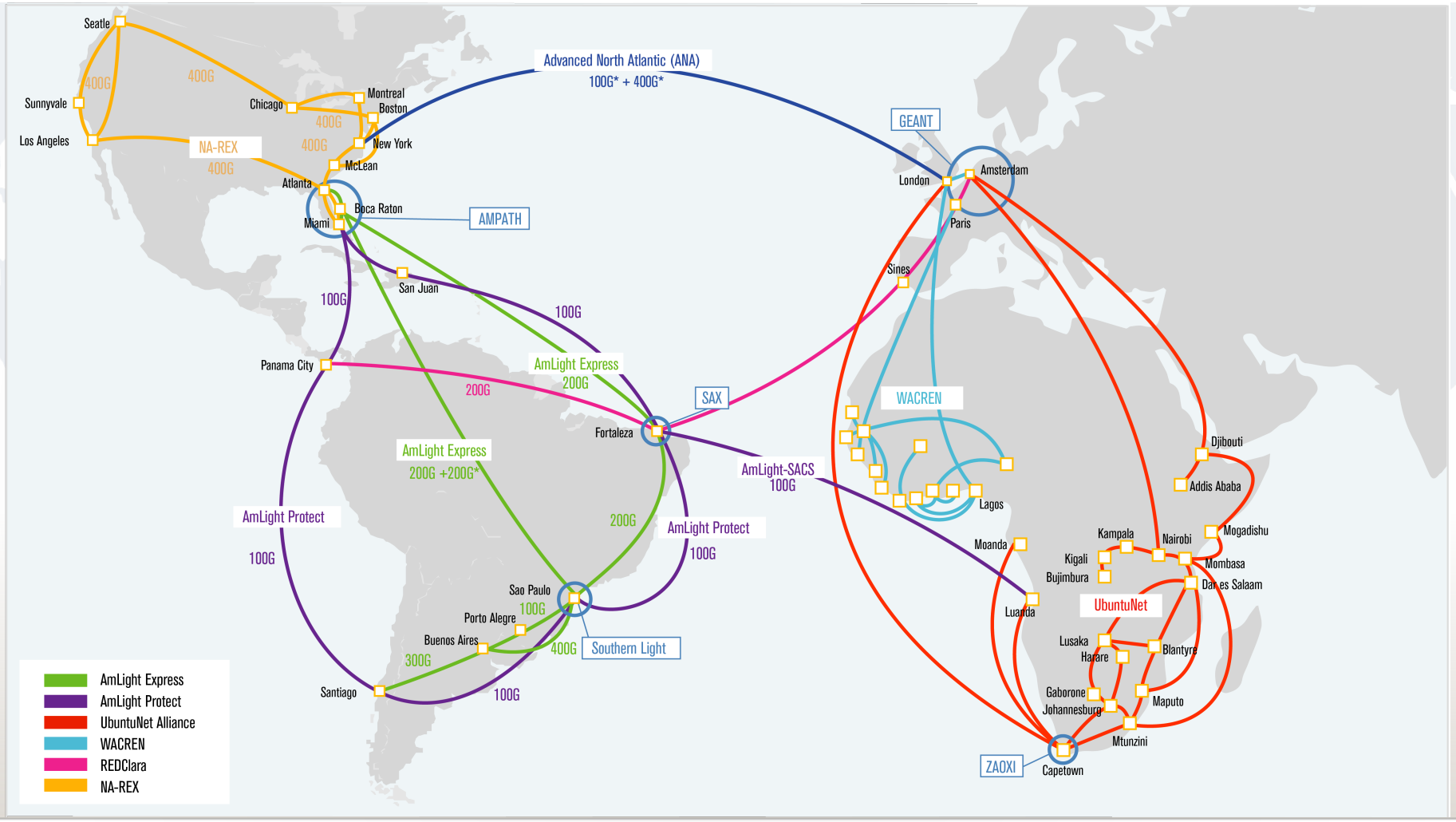
Americas Lightpaths Express & Protect
(NSF Award # OAC-2029283)


Seatle
Sunnyvale
Los Angeles
Chicago
Montreal
Boston
New York
McLean
Atlanta
Boca Raton
Miami
San Juan
Panama City
Fortaleza
Sao Paulo
Porto Alegre
Buenos Aires
Santiago
Advanced North Atlantic (ANA)
100G* + 400G*
NA-REX
AMPATH
SAX
Southern Light
AmLight Express
200G
AmLight Express
200G +200G*
AmLight Protect
100G
AmLight Protect
100G
AmLight-SACS
100G
GEANT
London
Amsterdam
Paris
Sines
WACREN
Lagos
Djibouti
Addis Ababa
Mogadishu
Kampala
Nairobi
Mombasa
Kigali
Bujimbura
Dar es Salaam
Moanda
Luanda
UbuntuNet
Lusaka
Harare
Blantyre
Gaborone
Johannesburg
Maputo
Mtunzini
ZAOXI
Capetown
400G
100G
200G
300G
AmLight Express
AmLight Protect
UbuntuNet Alliance
WACREN
REDClara
NA-REX

The South Africa NREN = TENET & SANReN

TENET

- Created in 2000 as a non-profit company. Membership is primarily universities (all 26) and research institutions, but serves a much wider constituency
- Funded through cost recovery from beneficiaries
- Operates network deployed by SANReN, but also deploys some network components
- Delivers services

SANReN

- Created in 2006 as a business unit in the Council for Scientific and Industrial Research
- Funded through a State grant (Department of Science and Technology)
- Designs, acquires and implements networks and network components, from metro to international level
- Develops and incubates services

Network performance during Supercomputing (SC23)

- Leveraged AmLight-ExP's 100Gbps infrastructure via South Atlantic Cable System (SACS)
- Demonstrated SANReN Data Transfer Nodes (DTNs)
- Achieved **2.5 Tbps data transmission** across the US, Brazil, and South Africa

Test Path: Miami to Cape Town

- Used 100Gbps SACS link (Miami - Fortaleza - Cape Town) - filled to +/- 98%.
- Achieved **70Gbps** throughput using iperf3, running 4 parallel 20Gbps streams with a 400MB TCP window

Collaboration Impact

- Highlighted **African NREN involvement** in global data transfer experiments
- Strengthened partnership between AmLight-ExP and SANReN

Bridging Europe, Africa, and the Americas (BEAA) – New Collaboration for shared transoceanic R&E networking resilience

- Partnership between **seven regional/national R&E networks** across Europe, Africa, and Latin America
- Aimed at enhancing network resilience via **shared transoceanic links**

Memorandum of Understanding (MoU)

- Signed by AmLight/FIU, GÉANT, RedCLARA, RNP, CSIR, TENET, and the UbuntuNet Alliance
- **Initial 3-year agreement** for mutual backup and high-capacity resource sharing
- Ensures **back-up connectivity** for uninterrupted R&E collaborations

Impact

- Critical during outages, e.g., **March 2024 cable disruptions** off West Africa
- Enabled traffic migration to backup systems like **Google's Equiano** and **AmLight SACS academic link**

Open Science Grid (OSG)

OSG's Role

- Provides **software and services** to enable **opportunistic usage** of distributed computational resources
- Supports **35 institutions** across five continents through the **Open Science Data Federation (OSDF)**

Infrastructure

- **17 Origins** and **34 caches** globally contributing to the resource-sharing network

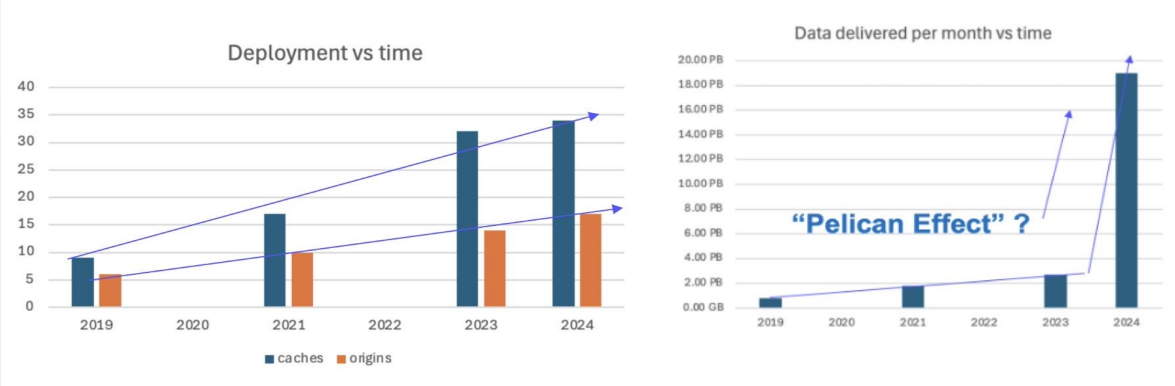
Challenges

- **Cache population delays** due to lack of data on **latency** and **geographical distance** between Caches and Origins
- Requires better insights into **round-trip time (RTT)** to improve efficiency

Open Science Data Federation (OSDF): Expanding Impact and Global Collaboration

7x Increase in OSDF Usage

- Caching system saves **75% of 100G transnational network capacity**
- Now utilized by **one-third of OSPool users**, accounting for **10% of total reads**



Top Fields Using OSDF

- Biology, Physics, Math, Chemistry, Geological & Earth Sciences

Global Expansion

- Discussions underway to deploy OSG caches in **South America** and **Africa**
- **SPRACE data center** (Sao Paulo) already serves over **1.2PB of jobs** from major projects like Ligo, Fermilab, and OSPool

Enhanced Flexibility

- OXP Orchestrators and telemetry provide better service definition, **network visualization**, and **utilization reports**

Astronomy Initiatives: South Africa's Role in Global Research

South African Astronomical Observatory (SAAO)

- Manages the **Southern African Large Telescope (SALT)** – the largest optical telescope in the Southern Hemisphere
- Hosts multiple international research telescopes connected via the **SANReN** network

MeerKAT & Square Kilometre Array (SKA)

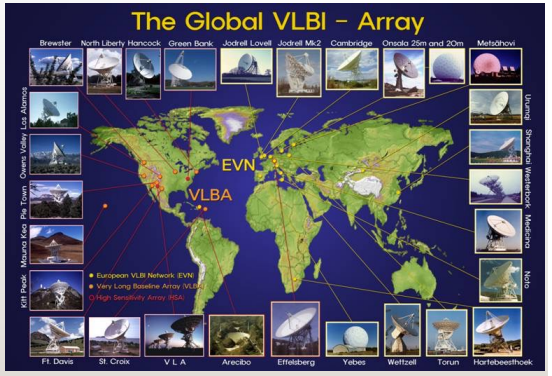
- **MeerKAT**: 64-antenna radio telescope incorporated into SKA
- SKA to include **197 dishes in South Africa** & **131,000 antennas** in Australia
- **First observations in 2024**, construction complete by 2030

Very-long-baseline Interferometry (VLBI)

- **HartRAO** in South Africa part of global collaboration for radio astronomy
- Connected to **European VLBI Network (EVN)** for data processing via **SANReN network**
- Collaboration with **AmLight** & **TENET** to facilitate data transfers to US collaborators at the **NRAO VLBA**

https://www.ska.ac.za/science-engineering/meerkat/about-meerkat/

https://www.skatelescope.org



https://geodesy.hartrao.ac.za/site/en/geodesy-equipment/radio-telescope-vlbi.html

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Cryogenic Electron Microscopy (cryo-EM): Opportunities for Global Collaboration

Cryo-EM in Biomolecular Research

- Revolutionizing studies on viruses (HIV, Tuberculosis), cancer, and bacteria
- Generates **1-10 TB of data** per session, enabling high-resolution movies of specimens

US Involvement in cryo-EM

- Over **100 cryo-EM instruments** located in the US
- Significant potential for remote collaboration

Untapped Potential in Africa

- No cryo-EMs in Africa, but African researchers are learning to use them
- **AmLight ExP, SANReN, and TENET** can facilitate collaboration with **University of Cape Town (UCT)** and US researchers

Future Collaboration

- Opportunity to pilot **remote observation programs** with US NIH/NSF-supported researchers
- Expanding access to cutting-edge research tools for African scientists

Collaborative Research Driving Science Across the South Atlantic

Medical & Agricultural Collaborations

- **Army worm pest control**: Brazil, US, South Africa & 9 African countries collaborating on maize/sorghum pest control
- **Clinical research**: FIOCRUZ (Brazil) & Mozambique focusing on infectious diseases (Malaria, AIDS, TB)

Atlantic International Research Centre (AIR-Centre)

- A platform for global collaboration on **space, oceans, climate change**, and more
- EU-BR-ZA agreements promote **South Atlantic & Southern Ocean research**

National Institutes of Health (NIH) in Africa

- $74.5M invested in **DS-I Africa** to catalyze **data science, AI**, and **health discoveries**
- Projects addressing **pandemic preparedness**, **AI for pregnancy outcomes**, **antimicrobial resistance**, and more

Conclusion & Next Steps: Advancing Global Research and Education with AmLight-ExP

AmLight-ExP: A transformative network connecting the **US, Latin America, and Africa** through advanced optical spectrum and leased capacity.

Successful Demonstrations:

- **SC24: 100Gbps throughput** tests between **US and South Africa**
- **WACS/SACS/AmLight link** boosted during SC23
- Support for **data-intensive research** in fields like **astronomy, medical research, agriculture**, and **genomics**.

BEAA Collaboration:

- Enhances **network resilience** for continuous connectivity across continents
- Regional RENs (**WACREN**, **UbuntuNet Alliance**) empower higher education institutions in Africa.

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THANK YOU!

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