AmLight ExP
Americas Lightpaths Express & Protect

South American – African Astronomy Coordination Committee (SA3CC) Meeting 2025

Network Connectivity @ AmLight

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Outline

- **What is AmLight?**
- **Network Connectivity**
- **Network Provisioning**
- **How AmLight supports the SA3CC community**

What is AmLight?

- A distributed academic exchange point built to enable collaboration among Latin America, Africa, and the U.S.
- Supported by NSF, OAC, and the IRNC program under award # OAC-2029283 for 2021-2025
- Partnerships with R&E networks in the U.S., Latin America, Caribbean and Africa, built upon layers of trust and openness by sharing infrastructure and human resources

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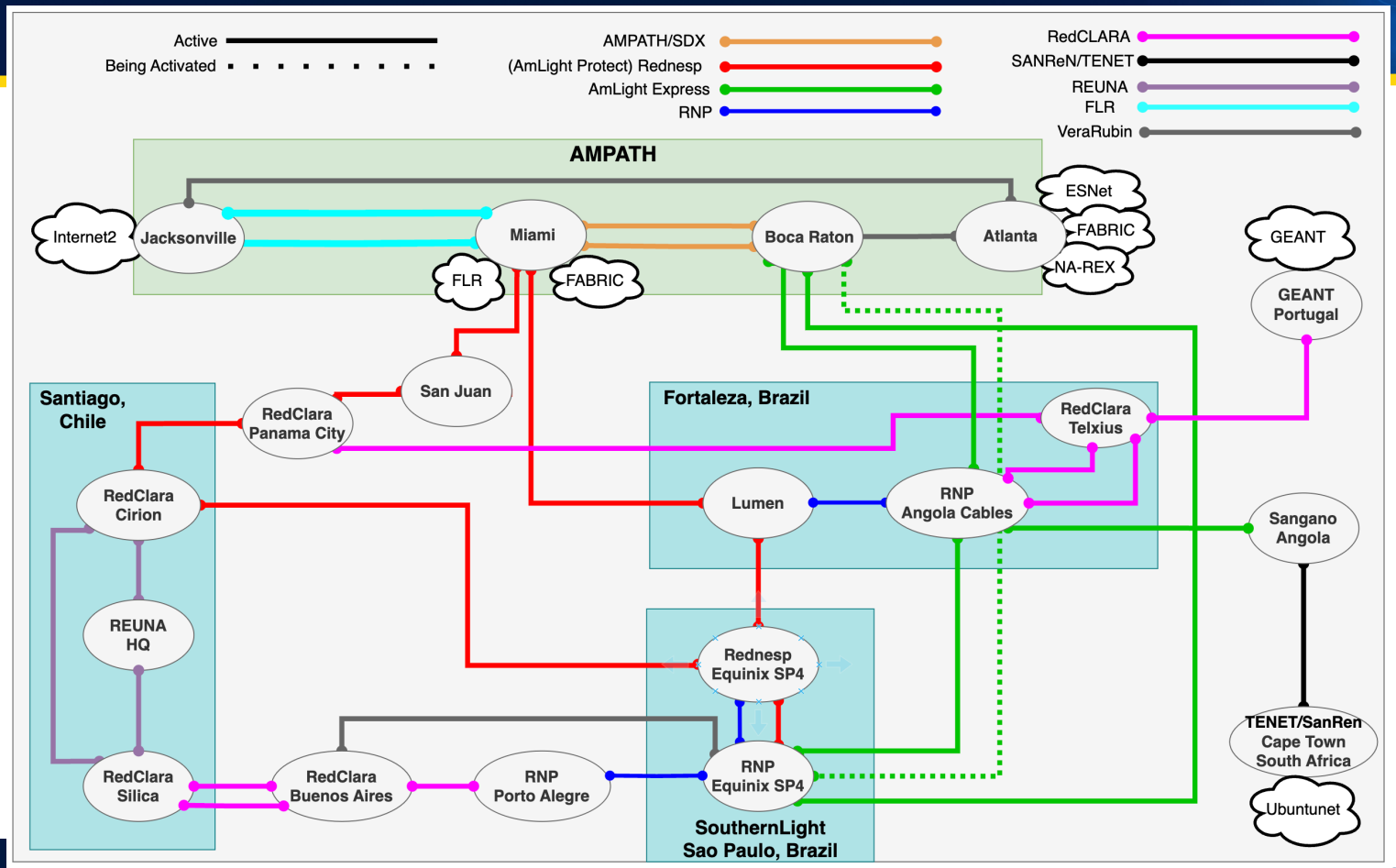
(NSF Award # OAC-2029283)

It’s all about collaboration!



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NSF 2021-2025 AmLight-ExP Project

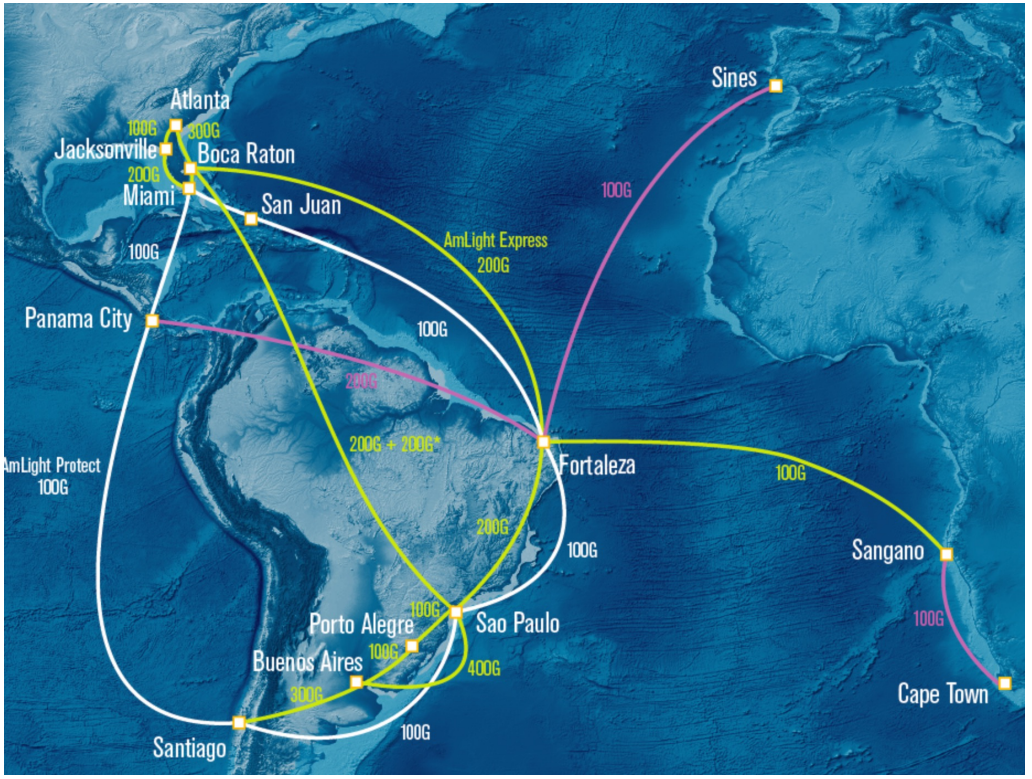
- Vision:
  - Continue enabling collaboration among researchers and network operators in Latin America, Africa, and the U.S. by providing reliable, sustainable, scalable, and high-performance network connectivity and services.

- Focus:
  - Supporting Service Level Agreement (SLA)-driven science applications
  - Improving network visibility and management
  - Enabling integration between AmLight and network-aware science drivers
  - Minimizing the human role in network operation

Network Connectivity

- 6x100Gbps of upstream capacity between the U.S. and Latin America, and 1x100Gbps to Africa
  - **700Gbps to be added in 2025**
- 2+ Tbps of international connectivity
  - Mix of optical spectrum, optical waves, lit capacity, and shared services
  - **AmLight will reach 4.9 Tbps of total capacity**[2025]
- Multiple points of presence:
  - Florida(Miami, Boca Raton, and Jacksonville), Georgia(Atlanta), Brazil(Sao Paulo and Fortaleza), Chile, Puerto Rico, Panama, and South Africa
- SDN-based with homemade orchestration and telemetry solutions!

Kytos-ng



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Updates since SA3CC/2024

- Since SA3CC/24, AmLight's focus has been on:
  - **Improving its network performance measurement capabilities** (next talk)**:**
    - BERToD: Leveraging traffic generators to isolate packet loss every 30 minutes with granular visibility ($1x10^{-9}$)
      - *BERToD being integrated with the SDN Controller to test links after recovering from faults*
    - New perfSonar node and Maddash
  - Enhancing our SDN Control Plane (Kytos-ng SDN Controller):
    - New SDN pathfinder capable of computing paths that separate routes over shared infrastructure
    - New traffic engineering/traffic prioritization policies, isolating experiments from production and monitoring
  - **Improving network visibility:**
    - New INT Collector capable of detecting microbursts as short as 20ms
    - Optical telemetry: leveraging optical metrics to correlate events across layers and anticipate link faults

Updates since SA3CC/2024 [2]

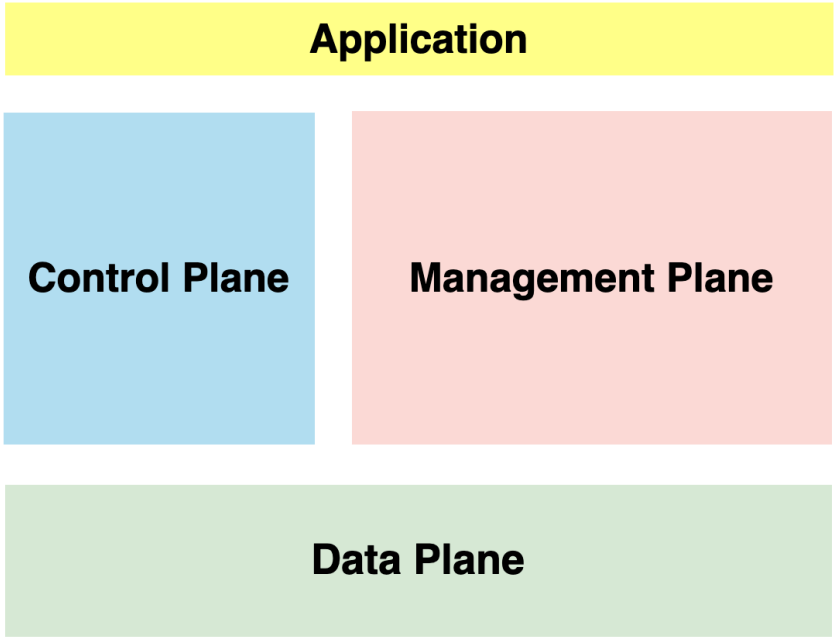
- Since SA3CC/24, AmLight's focus has been on (continuation):
  - Adding bandwidth and improving network resilience:
    - Extending optical spectrum on Monet to 187.5GHz
      - From 400Gbps to 1.1 Tbps total capacity on Monet
    - NA-REX: enhancing AmLight's connections to other Open eXchange Points in the U.S.
      - 400Gbps link to StarLight/Chicago activated last week
      - 400Gbps link to WIX/McLean under activation
      - 400Gbps link to PacificWave/Los Angeles schedule for next weeks
    - 2x 100G switches installed and connected in Buenos Aires *this week*
    - 400G switches installed in Miami, Jacksonville, and Atlanta

Network Provisioning…

AmLight SDN Architecture – 2014 - 2020

- From 2014-2020, we followed the "basic" SDN layers as in [1]
  - Application, Management, and Control Planes were very coupled under the same controller/orchestrator:
    - Each SDN Plane was operated as modules of the SDN controllers' software stack
  - Data Plane was a blend of vendors with mixed support

- The AmLight SDN Controller was responsible:
  - Provisioning L2VPN services
  - Handling fiber cuts and device outages by finding backup paths.
  - Load balance had to be performed manually.
  - Visibility based on packet samples only.

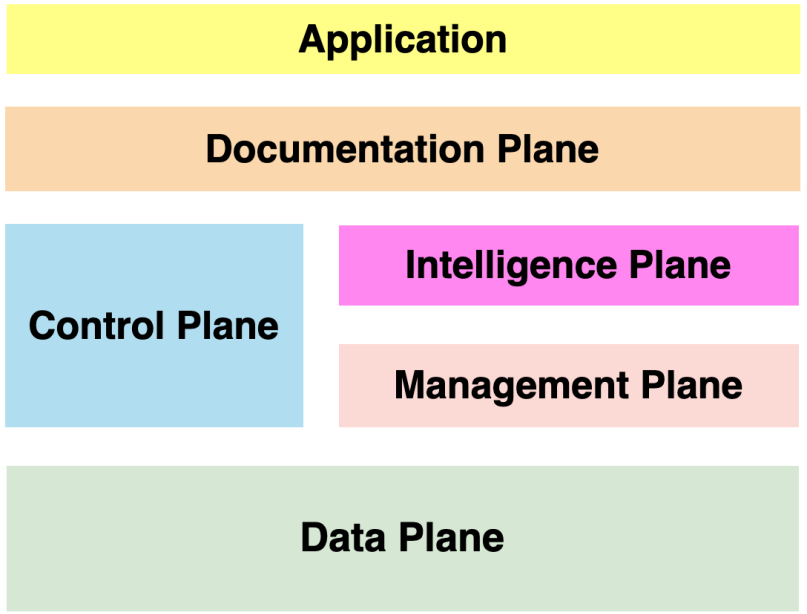


[1] IETF RFC 7626 & RFC 8597

AmLight SDN Architecture – 2021-2025

For 2021-2025, AmLight is enhancing its Software-Defined Networking (SDN) framework:

- (Done) New Data Plane based on programmable network device:
  - NoviFlow/EdgeCore P4 programmable switches
- (Done) New Management Plane for enhanced network visibility:
  - P4/In-band Network Telemetry (INT) for programmable switches
  - Juniper JTI for Juniper routers, REST for Ciena transponders
- (Done) Brand-new Control Plane / Network Orchestrator:
  - Kytos-ng SDN controller
- (Ongoing) Brand-new Intelligence Plane:
  - Learns the network state and create a sub-second closed-loop control for traffic engineering
  - Profiles AmLight every 500 ms



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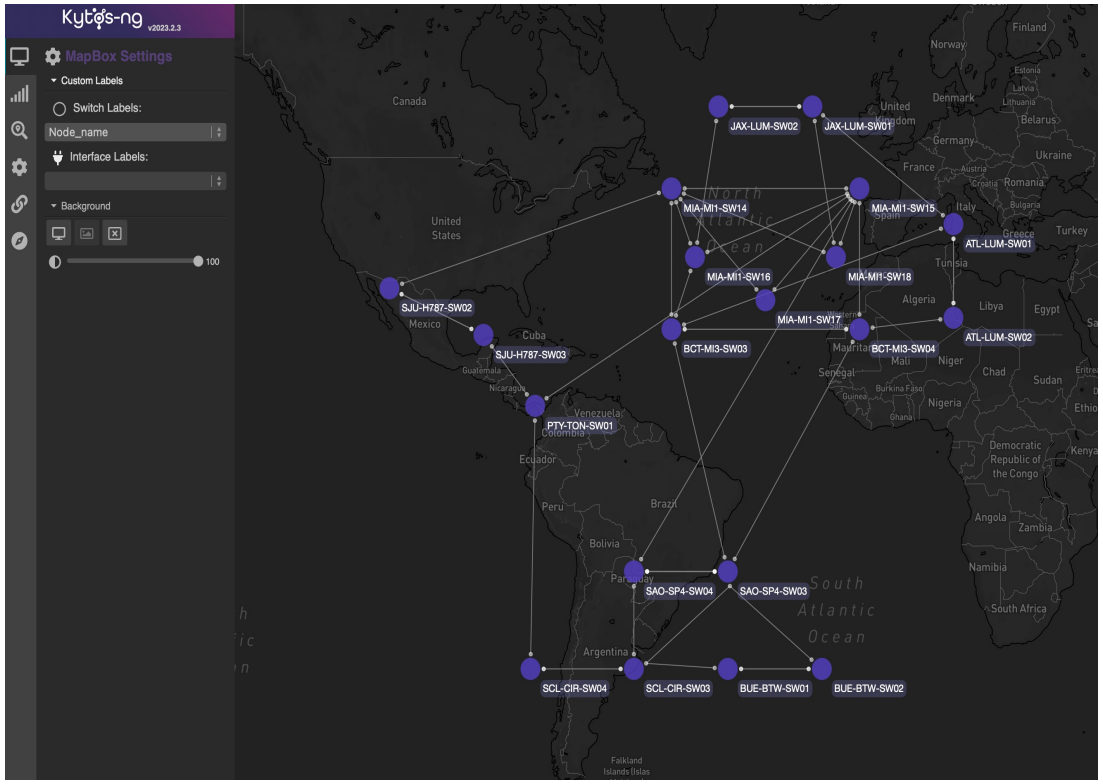
Control Plane: Kytos-ng

- Kytos-ng is an open-source network orchestrator/SDN controller customized to our needs
  - Developed by **FIU** and **rednesp**
  - Available at *https://github.com/kytos-ng*
  - Version 2025.1 released last week.

- Development focused on the AmLight operation requirements:
  - Pathfinder with support for multiple metrics and restrictions:
    - # of hops, minimum delay, max bandwidth, ownership, reliability, priority, average bandwidth utilization, asset groups
  - Integration with In-band Network Telemetry to add per-packet telemetry
  - Supports for bandwidth reservation and prioritization
  - Supports for multiple southbound protocols OpenFlow 1.3+ and gRPC



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Under Development: Intelligence Plane

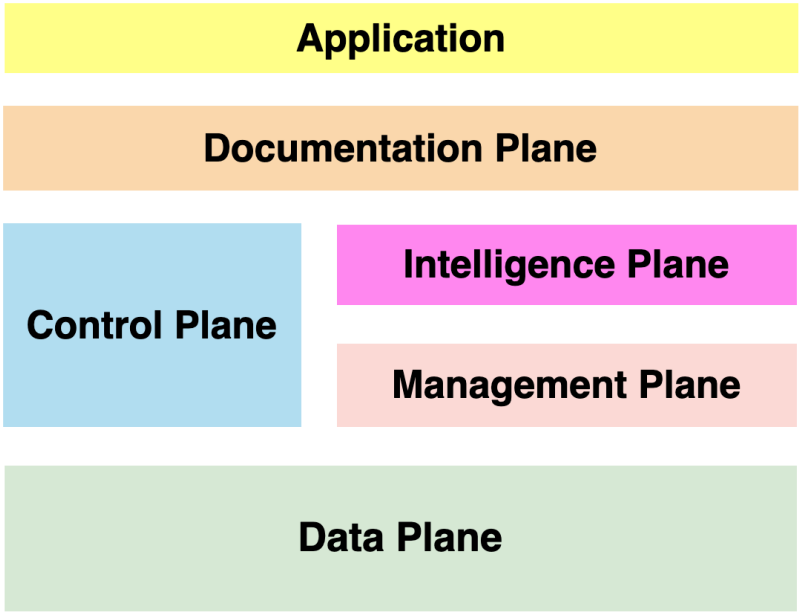
1. *Gets inventory, policies, and services from the Documentation Plane*
2. *Gets telemetry reports from the Management Plane*
3. *Profiles AmLight's traffic every 100-500ms*
   - *Discovers performance issues, traffic anomalies, and policy violation*
4. *Makes suggestions to the Control Plane*
   - *Steer traffic, Load balance services, Rate-limit anomalies*

Change of mindset compared to the previous AmLight-ExP project

- Creates the SDN closed-loop control to include policies
- Goal is to be prepared for sub-second reaction and debugging

Example of policies:

- If (80+% BW utilization >= 2s), then load-balance
- If (50+% [Queue Occupancy] >= 2s), then steer traffic
- If (Number of path changes >= 5 in 2h), then set link into *maintenance_mode*



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How is AmLight supporting SA3CC?

- AmLight has a complex topology with plenty of paths and bandwidth:
  - From Chile to Internet2 and ESnet, there are more than 25 possible paths to take
  - With the new architecture, we expect to properly load balance network services across links, while respecting user constraints and requirements

- AmLight will handle any SLA-driven packet-loss-intolerant and sub-minute-response-time-expected science application:
  - With per-packet telemetry and sub-second network profiling capacities, AmLight will be prepared to react to network conditions under 1 second
  - AmLight aims anticipate issues with the substrate and steer traffic out of the substrate before adverse events happen

- Focus on engineering and automation:
  - With the closed-loop control, several time-consuming operational activities are being performed without human intervention

AmLight: International Connectivity