



Americas Africa Lightpaths *Express & Protect*

South American – African Astronomy Coordination
Committee (SA3CC) Meeting 2024



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**



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.

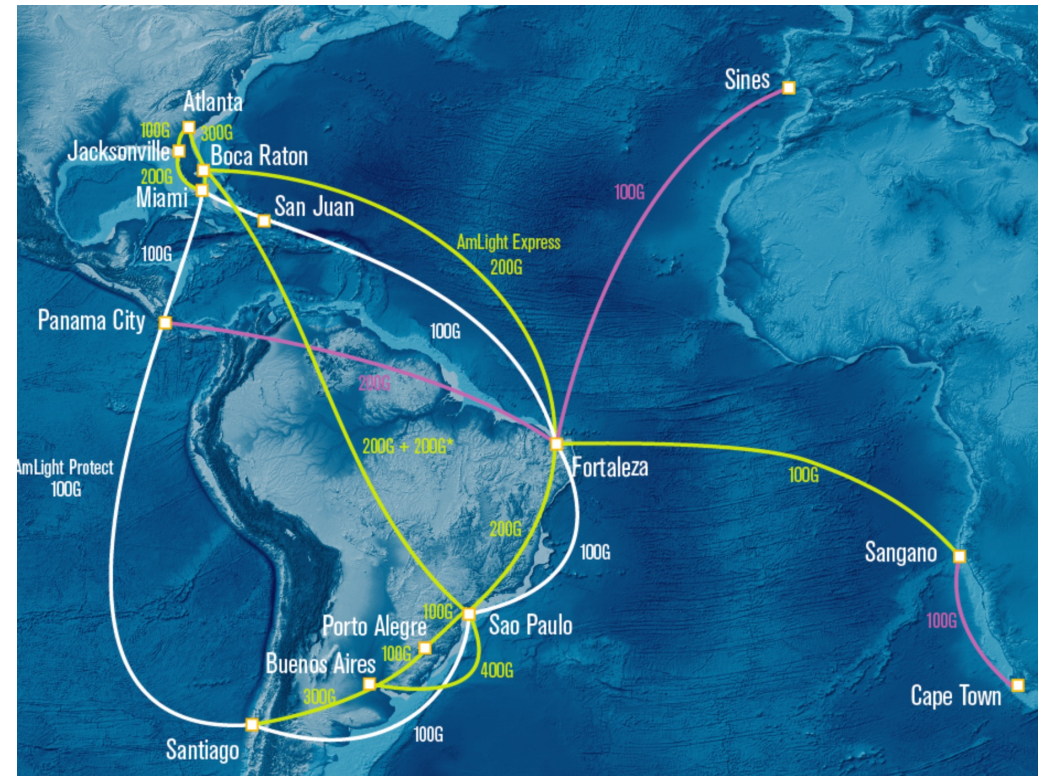
- Focus:

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

Network Connectivity

Kytos-ng

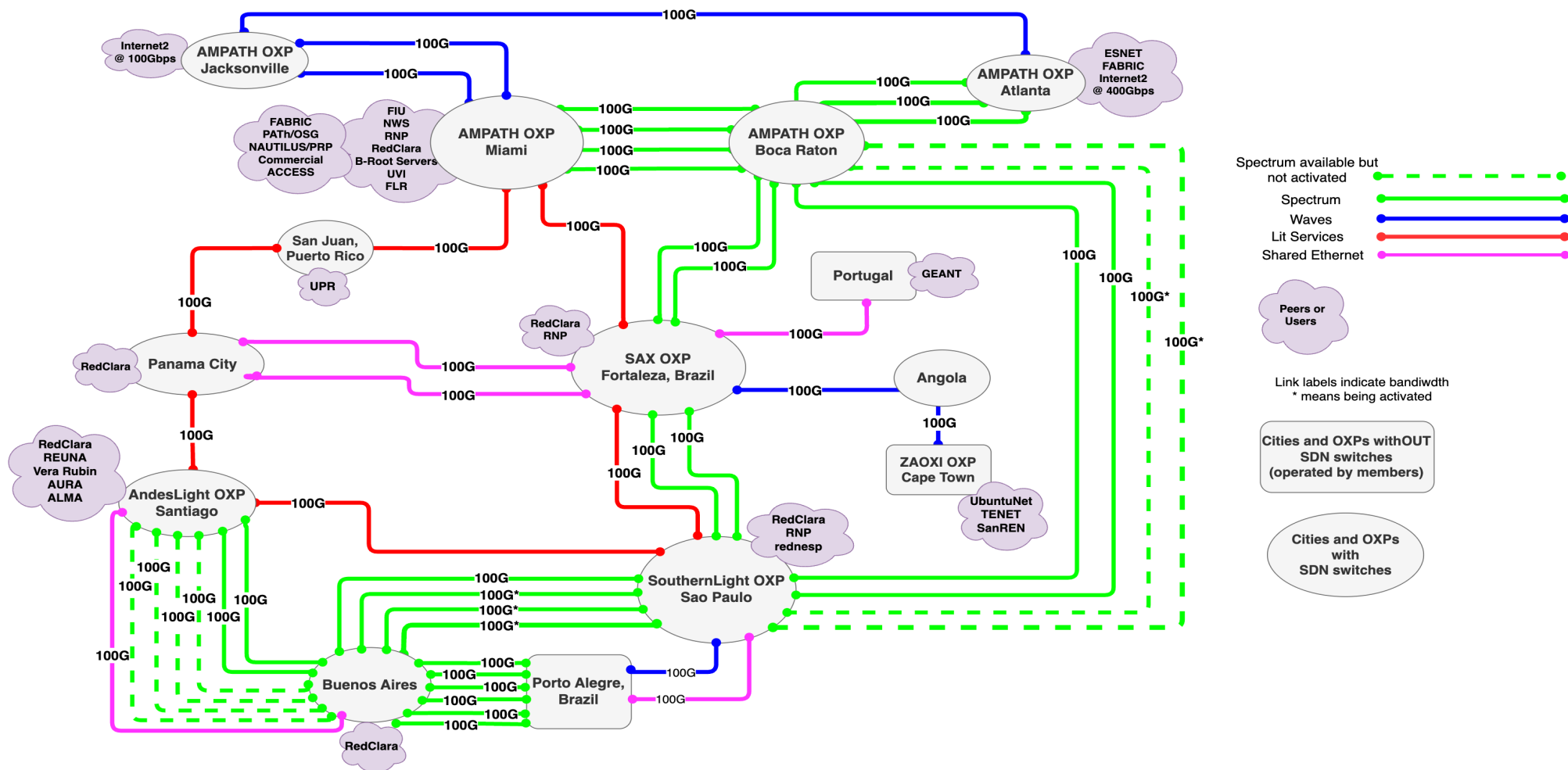
- 6x100Gbps of upstream capacity between the U.S. and Latin America, and 1x100Gbps to Africa
- 2+ Tbps of international connectivity
 - Mix of optical spectrum, optical waves, lit capacity, and shared services
- Multiple points of presence:
 - Florida(Miami, Boca Raton, and Jacksonville), Georgia(Atlanta),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



Network Connectivity – Updates since SA3CC/2023

- Since SA3CC/23, AmLight's focus was on:
 - Replacing all legacy network devices for fully programmable P4 switches & Lowering OPEX (power consumption and rack space utilization)
 - Completed. Currently, AmLight has 19 programmable switches in production.
 - Improving network resilience by adding new links
 - Completed with new links connecting JAX to ATL, SAO to BUA, Panama to Fortaleza, and BCA to ATL.
 - Increasing the number of 100G interfaces for users and science drivers
 - Each programmable switch has 32x100G interfaces, 16 of them for connectors. Each site has two switches.
 - Improving network visibility
 - In-band Network Telemetry fully supported by the programmable switches. New INT Collector.
 - Extending spectrum on Monet from 75GHz to 112.5GHz
 - Goal was Adding 2x100Gbps between Brazil to the U.S - **NEW PLAN!**

AmLight SDN Long-haul Links - 2023/2024 - Technology



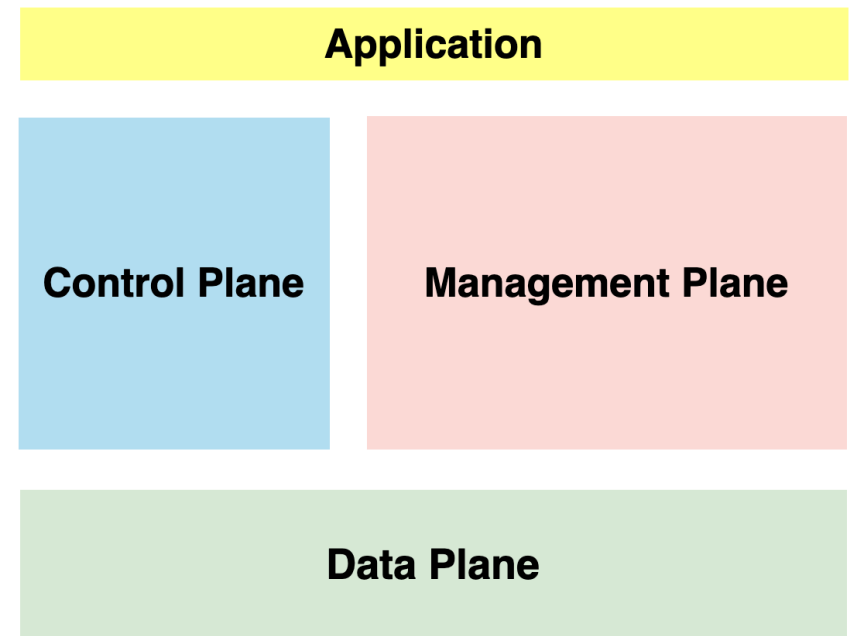
Network Connectivity – Plans for 2024/2025

- Original plan: Adding 2x100Gbps between Brazil to the U.S, summing up to 600 Gbps.
 - New Plan:
 1. Increasing the spectrum efficiency by combining channels: $75 + 75 + 37.5 = 187.5$ GHz
 2. Evaluating the Ciena Waveserver 6 Extreme transponders (variable modulation – 88 to 200 GBaud)
 3. Upgrading the US-Brazil spectrum bandwidth to **1.1 Tbps**, instead of 600Gbps
 4. Bonus: Demonstrating the new capacity during SC24.
- Activating spectrum on a new submarine cable at 112.5GHz between Argentina and Brazil
 - 4x100G activated, pending moving to a different submarine cable to increase resilience.
- Install two programmable switches in Argentina

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.

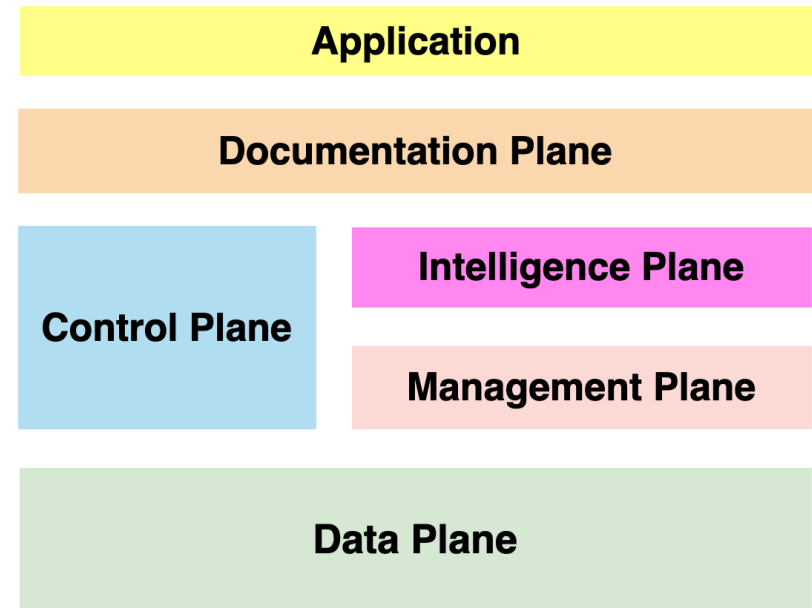


[1] IETF RFC 7626 & RFC 8597

AmLight SDN Architecture – 2021-2025

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

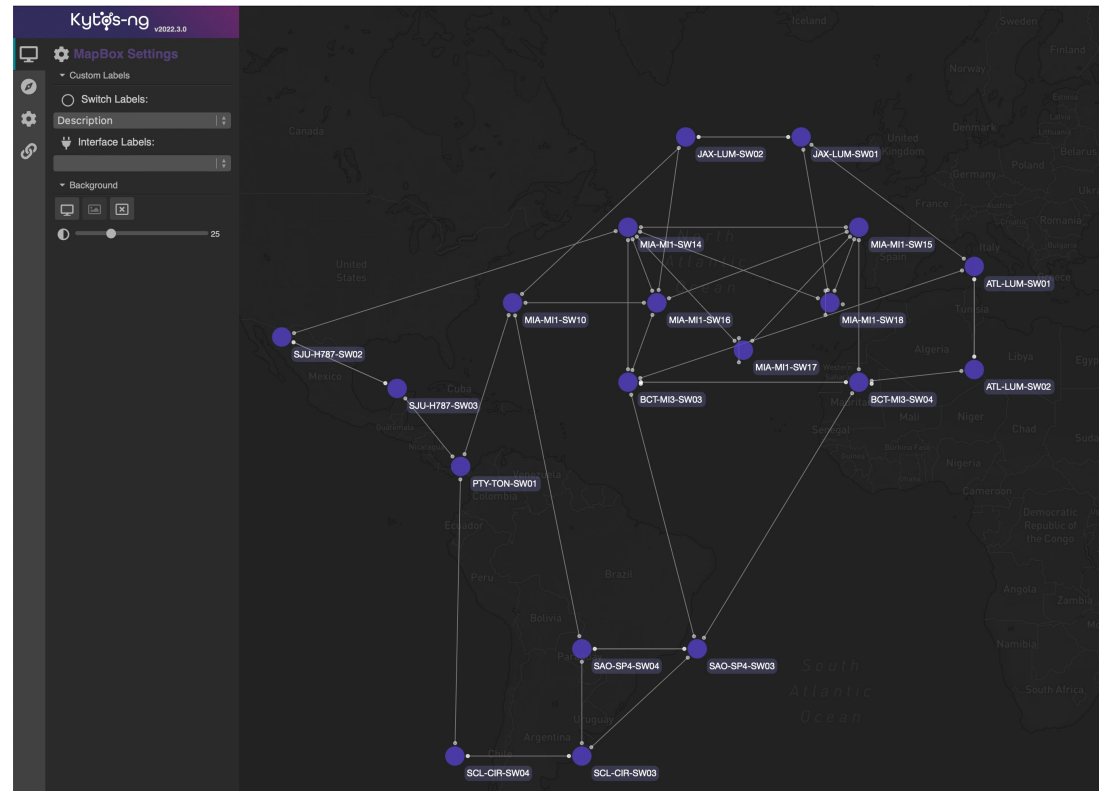
- New Data Plane based on programmable network device:
 - NoviFlow/EdgeCore P4 **programmable** switches
- New Management Plane for enhanced network visibility:
 - **P4/In-band Network Telemetry (INT)** for programmable switches
 - **Juniper JTI** for Juniper routers
- Brand-new Intelligence Plane:
 - Learns the network state and create a **sub-second** closed-loop control for traffic engineering
 - Capable of detecting microbursts as short as 10ms
- Brand-new Control Plane / Network Orchestrator:
 - Kytos-ng SDN controller



Control Plane: Kytos-ng

Kytos-ng

- Kytos-ng is an open-source network orchestrator/SDN controller customized to our needs
 - Developed by **FIU** and **rednosp**
 - Available at <https://github.com/kytos-ng>
 - Leverages Python, Docker, MongoDB, and Elastic.
- 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
 - **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



Next Step: Intelligence Plane

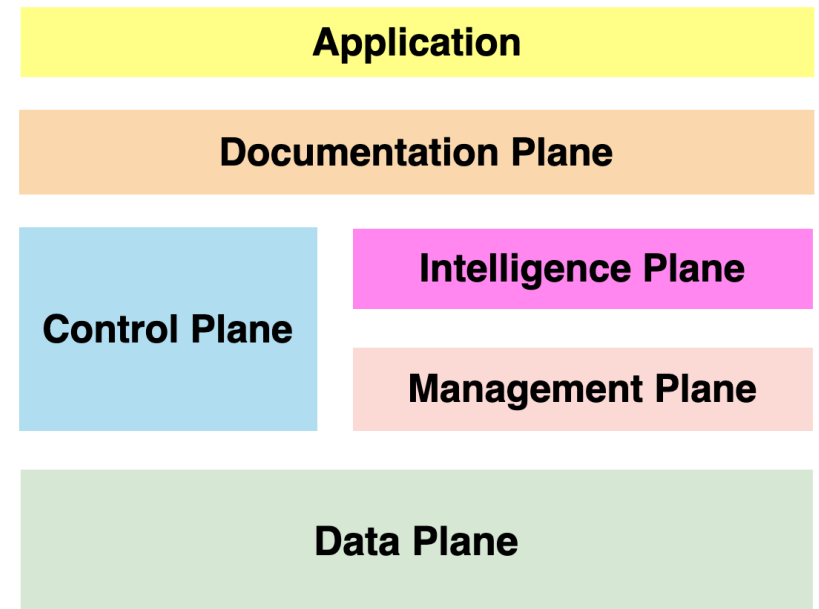
1. Gets inventory, policies, and services from the Documentation Plane
2. Gets telemetry reports from the Management Plane
3. Profiles AmLight's traffic every 100-500ms
 - Discovers performance issues and traffic anomalies
4. Makes suggestions to the Control Plane
 - Steer traffic, Load balance services, 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 \geq 2s), then load-balance
- If (50+% [Queue Occupancy] \geq 2s), then steer traffic
- If (Number of path changes \geq 5 in 2h), then set *maintenance_mode*



How is AmLight supporting SA3CC?

- AmLight has a complex topology with plenty of paths and bandwidth:
 - From Chile to Jacksonville, 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 will be performed without human intervention



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Thank You! Questions?

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AmLight: International Connectivity