



South American – African Astronomy Coordination  
Committee (SA3CC) Meeting 2022



# AmLight: International Links

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# Outline

- What is AmLight?
- Network Connectivity
- Network Provisioning & Operation
- How the 2021-2025 AmLight-Exp project will benefit the SA3CC community.
- Conclusion

# 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 resources
  - Human resources



# The NSF 2021-2025 AmLight-ExP Project Goals

- 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:

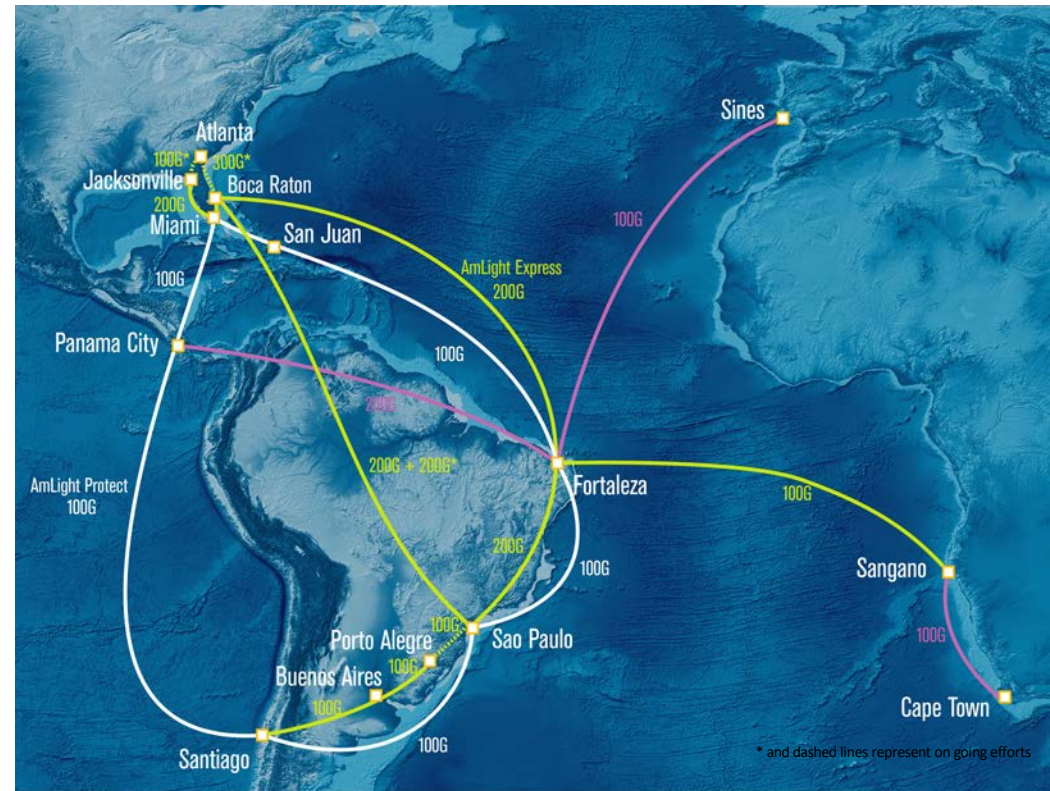
- Supporting Service Level Agreement (SLA)-driven science applications
- Improving network visibility and management
- Enabling integration between AmLight and network-aware science drivers
- Adding new network and cloud services
- **Minimizing the human role in network operation**

Network Connectivity...

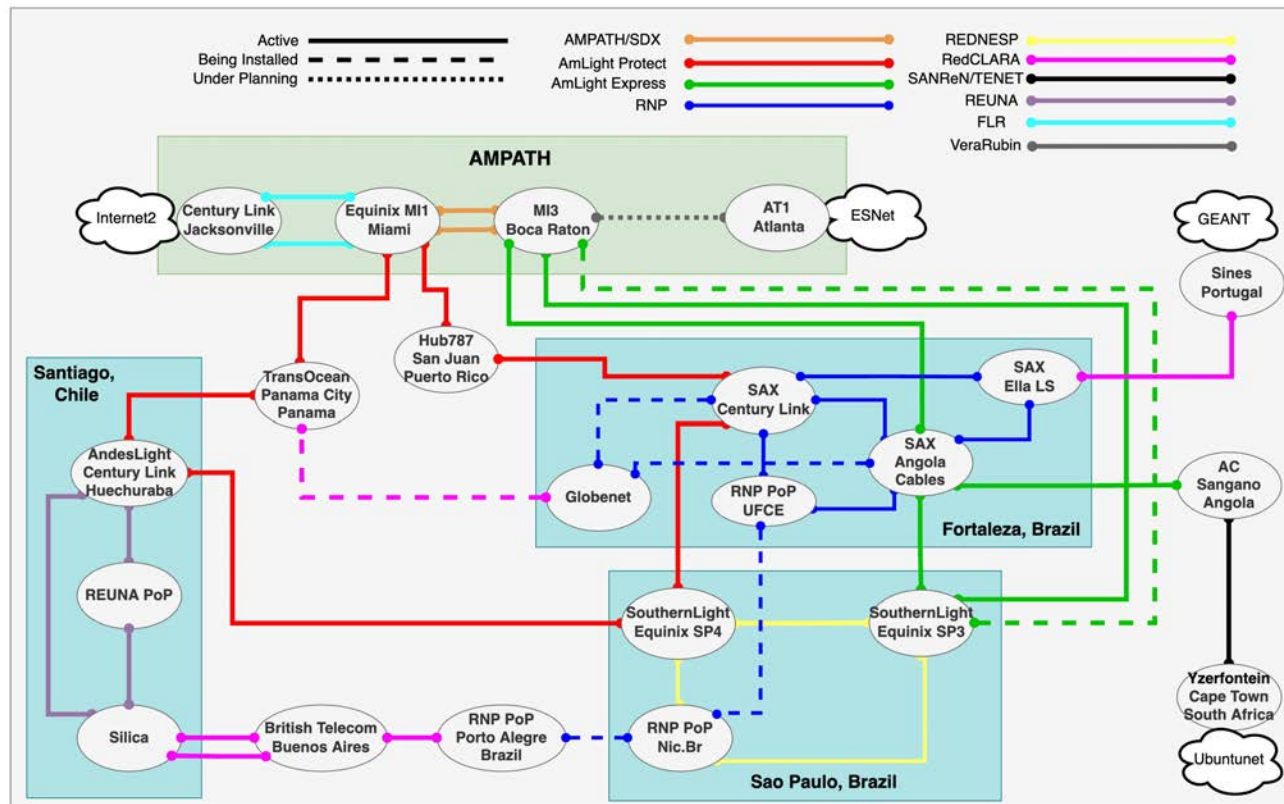


# Network Connectivity

- 600Gbps of upstream capacity between the U.S. and Latin America, and 100Gbps to Africa
  - 2023: Add 200Gbps from Brazil to the U.S.
- 2+ Tbps of international connectivity
  - AmLight Express (green), AmLight Protected (white), plus waves provided by RedClara and SANReN/TENET (pink)
  - 2022: RedClara is adding 100G from Panama City to Fortaleza
- NAPs: Florida(3), Brazil(2), Chile, Puerto Rico, Panama, and South Africa
  - 2022: AmLight is expanding to Atlanta, Georgia with 400Gbps of total capacity:
    - 300Gbps from Boca Raton to Atlanta
    - 100Gbps from Jacksonville to Atlanta
    - Dedicated connections to ESnet and FABRIC



# AmLight: Collaboration at its finest!



# AmLight: Country-to-Country Connectivity

	Florida/US	Georgia/US	Brazil	Chile	Panama	Puerto Rico	South Africa
Florida/US		400 Gbps	600 Gbps		100 Gbps	100 Gbps	
Georgia/US	400 Gbps						
Brazil	600 Gbps			300 Gbps	100 Gbps	100 Gbps	100 Gbps
Chile			300 Gbps		100 Gbps		
Panama	100 Gbps		100 Gbps	100 Gbps			
Puerto Rico	100 Gbps		100 Gbps				
South Africa			100 Gbps				

Green: New Installation

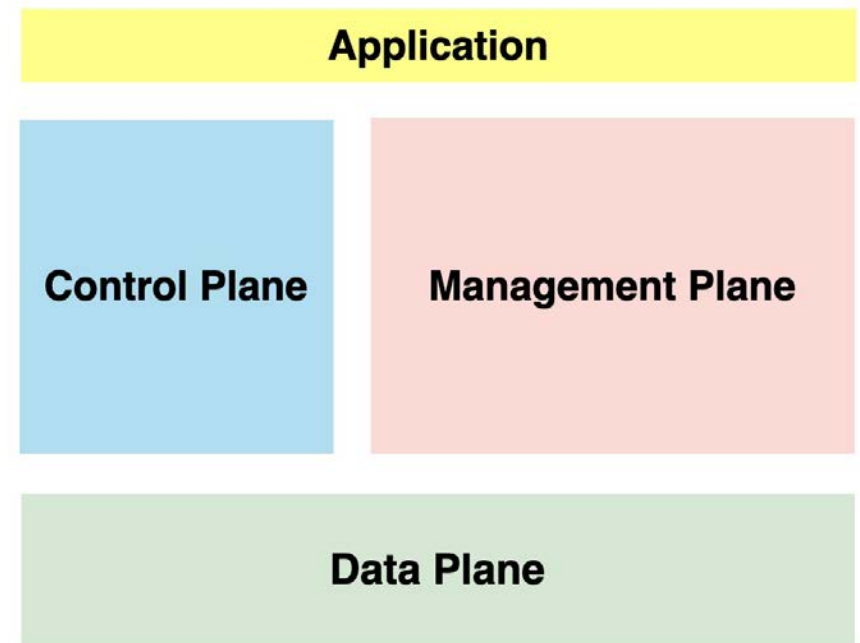
Blue: Upgrades Planned/In Motion



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 (Dell, Corsa, Brocade) with mixed support
  - Southbound Interface was OpenFlow 1.0 and OpenFlow 1.3
- 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.*

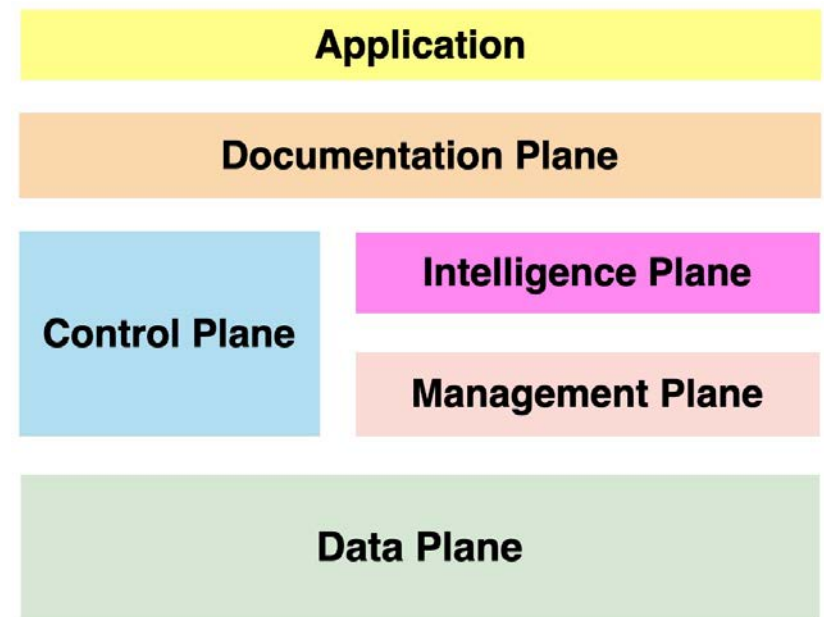


[1] IETF RFC 7626 & RFC 8597

# AmLight SDN Architecture – 2021-2025

For 2021-2025, we will add specialized components per SDN Plane:

- New Management Plane:
  - AmLight will use **In-band Network Telemetry (INT)** for counters and network state
    - (next presentation)
- Brand-new Intelligence Plane:
  - Focused on learning the network state and creating a **sub-second** closed-loop control
  - Intelligence Plane will use In-band Network Telemetry to audit how the Control Plane implements the user requests
- Brand-new Control Plane:
  - Kytos-ng (next slide)
- New Data Plane based on programmable network device
  - NoviFlow P4 switches



# Control Plane: Kytos-ng

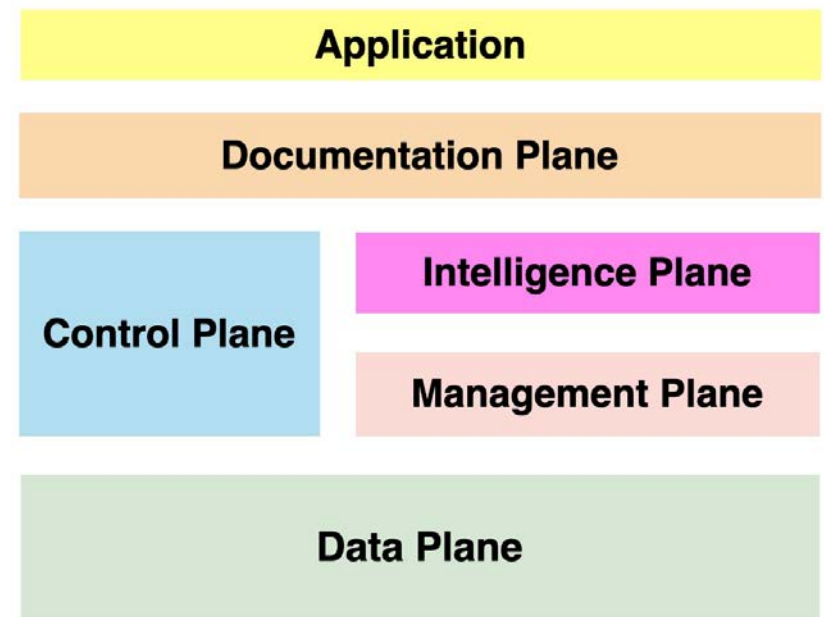
- Kytos-ng is the next generation of the Kytos SDN Platform.
  - Maintained by **FIU** and **Rednesp** since May 2021
  - Remains open-source code
  - First Kytos-ng release was launched on Feb 15<sup>th</sup>.
- Development focused on the AmLight operation requirements:
  - **Pathfinder with support 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**
  - Supports for multiple southbound protocols OpenFlow 1.3+ and gRPC (P4Runtime)

kytos

<https://github.com/kytos-ng>

# Data Plane

- Packet Layer:
  - Legacy switches replaced by NoviFlow switches (Tofino ASIC)
  - 32x100G ports per switch
  - Virtual Machine embedded
  - OpenFlow 1.3+1.4 & P4Runtime for southbound
  - INT for per-packet telemetry
- Optical Layer:
  - Ciena Waveserver Ai transponders
  - Point-to-point circuits with API license
  - Streaming telemetry-capable devices
  - REST API being used for monitoring
- \$\$\$ saved w/ colocation, power, and maintenance





# Intelligence Plane

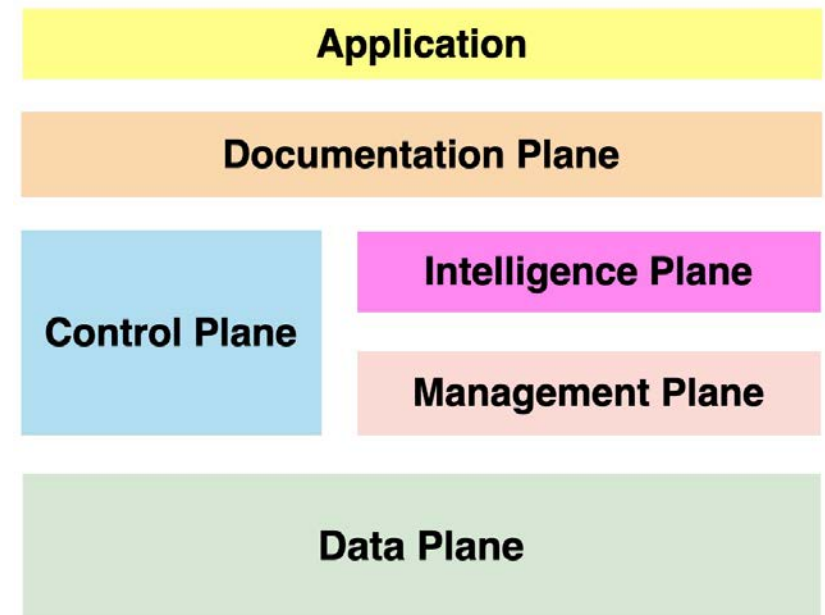
1. Gets inventory, policies, and services from the Documentation Plane
2. Gets telemetry reports from the Management Plane
3. Profiles AmLight's traffic every 100-500ms
  - Discovers performance issues and traffic anomalies
4. Makes suggestions to the Control Plane
  - Steer traffic, Load balance services,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

- 80+% BW utilization  $\geq 2s$
- 50+% [Queue Occupancy]  $\geq 2s$
- Number of path changes  $\geq 5$  in 2h



# How will 2021-2025 AmLight-ExP support SA3CC?

- AmLight has many links and multiple paths connecting its sites:
  - 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
  - With optical telemetry, AmLight will anticipate issues with the substrate and steer traffic out of the substrate before adverse events happen
- AmLight engineering team prefers to focus on engineering and new services than manual activities:
  - With the closed loop control, some time-consuming operational activities will be performed without human intervention
  - In the end, we will have more hands developing and automating routines



**Thank You! Questions?**

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