9th Annual TPRE Meeting

January 20, 2024

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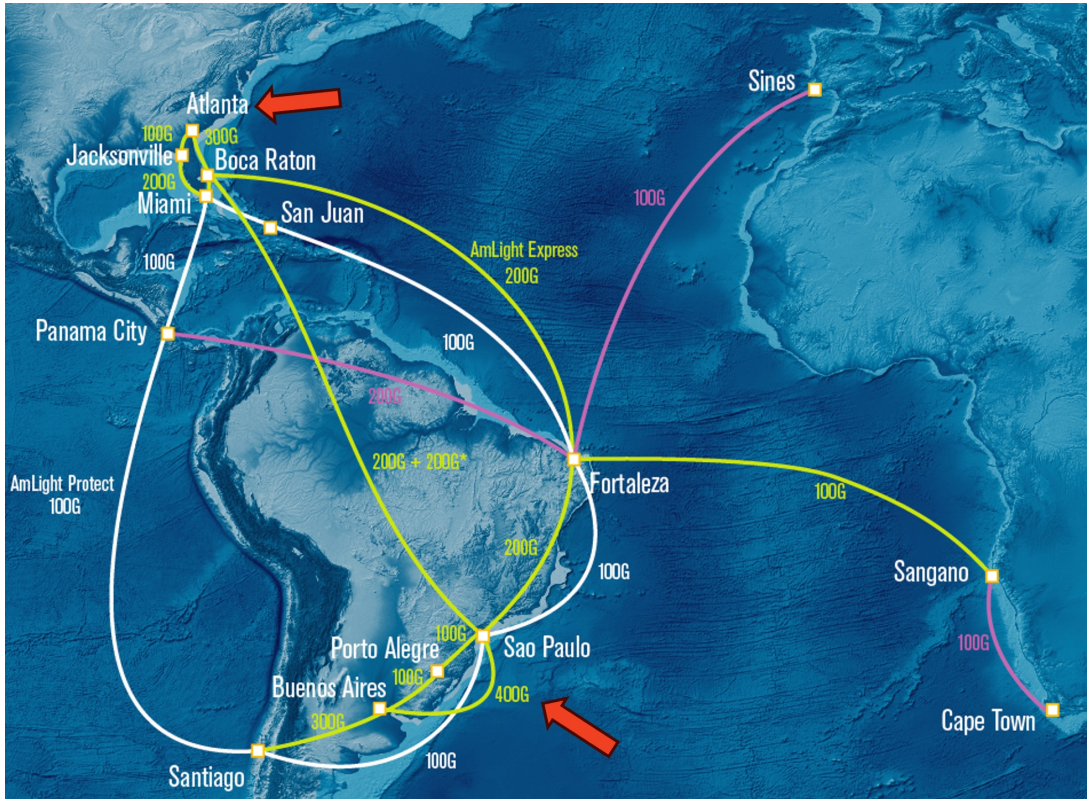
Co-PI

AmLight Express and Protect (AmLight-ExP) Network Infrastructure

- 2.1+ Tbps of international connectivity
  - 600G of upstream capacity between the U.S., Latin America, Caribbean and 100G to Africa
- OXPs: Florida(3), Brazil(2), Chile, Puerto Rico, Panama, South Africa, Georgia(Atlanta), and Argentina
- Production SDN Infrastructure since 2014:
  - Homemade SDN Kytos-ng
  - P4 -> In-band Network Telemetry (INT)
  - 21x P4 switches
- Highly instrumented for monitoring:
  - PerfSonar(11), sFlow, Juniper Telemetry Interface (JTI), INT



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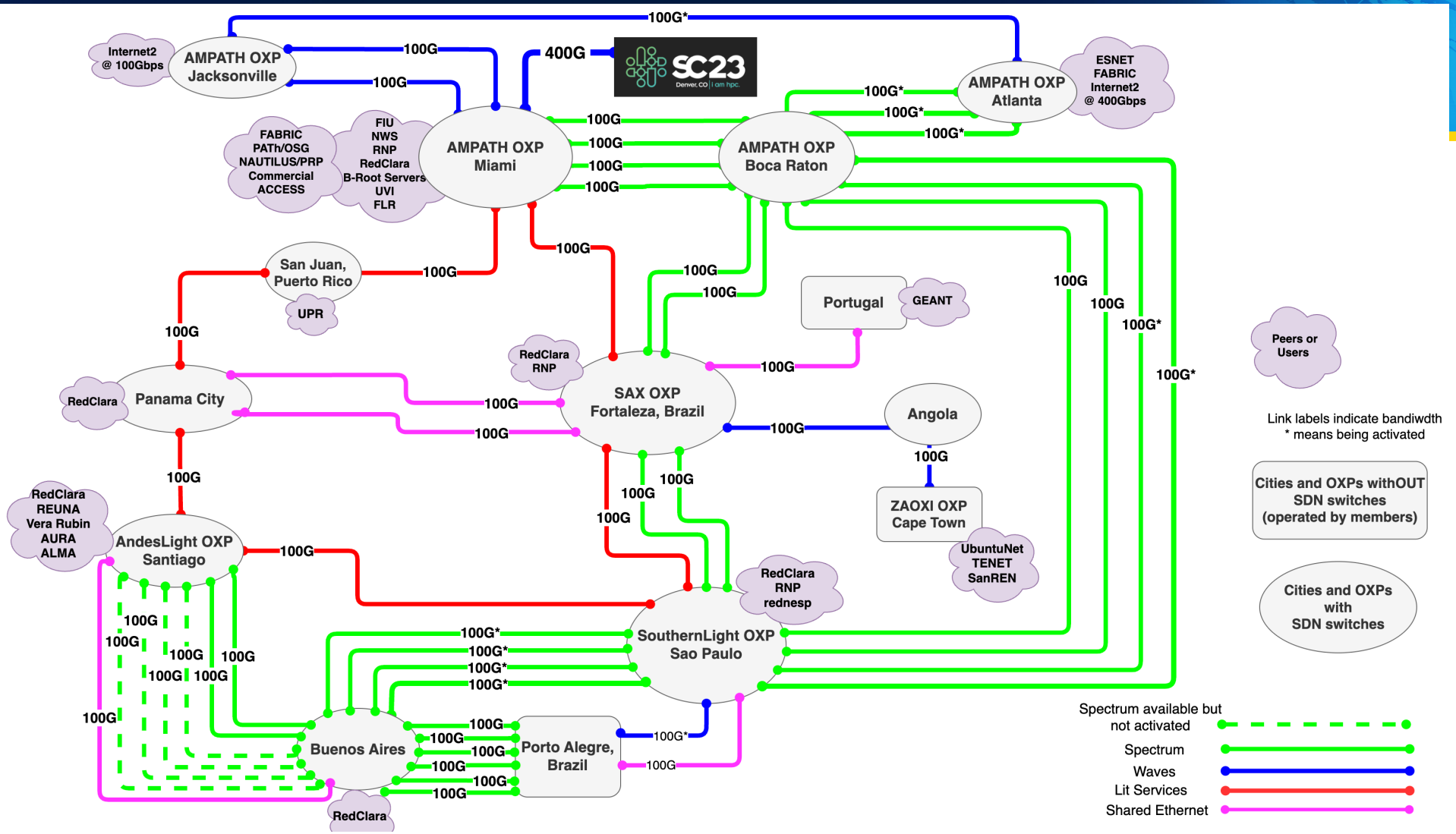
2023 Roadmap (sample) for Improving the AmLight network infrastructure

- Deploying nive NoviFlow/P4 Edgecore switches at multiple sites - Completed!
  - Decommissioning legacy switches – Completed!
- Commissioning AMPATH Atlanta OXP – Completed!
- Activating 75GHz spectrum between Boca Raton, FL, and Atlanta
  - Supports Vera Rubin, FABRIC, and LHC – Completed: 300Gbps + 100Gbps over I2 from JAX to ATL
- Activating 4x100G links between Sao Paulo and Buenos Aires
  - Provides 100G dedicated primary path for Vera Rubin – Completed!

2024 Roadmap (sample) for Improving the AmLight network infrastructure

- Increasing the spectrum from Boca Raton to Sao Paulo from 75 GHz to 112.5 GHz
  - Increases bandwidth capacity from 200G to 400G over Monet
- Deploying a PATh/OSG node in Santiago, Chile
- Connecting to NA-REX at 400G in Atlanta


Internet2
@ 100Gbps
AMPATH OXP
Jacksonville
100G*
100G
100G
400G
SC23
Denver, CO | i am hpc.
AMPATH OXP
Atlanta
ESNET
FABRIC
Internet2
@ 400Gbps
100G*
100G*
100G*
FABRIC
PATh/OSG
NAUTILUS/PRP
Commercial
ACCESS
FIU
NWS
RNP
RedClara
B-Root Servers
UVI
FLR
AMPATH OXP
Miami
AMPATH OXP
Boca Raton
100G
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Panama City
SAX OXP
Fortaleza, Brazil
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ZAOXI OXP
Cape Town
RedClara
REUNA
Vera Rubin
AURA
ALMA
AndesLight OXP
Santiago
100G
UbuntuNet
TENET
SanREN
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SouthernLight OXP
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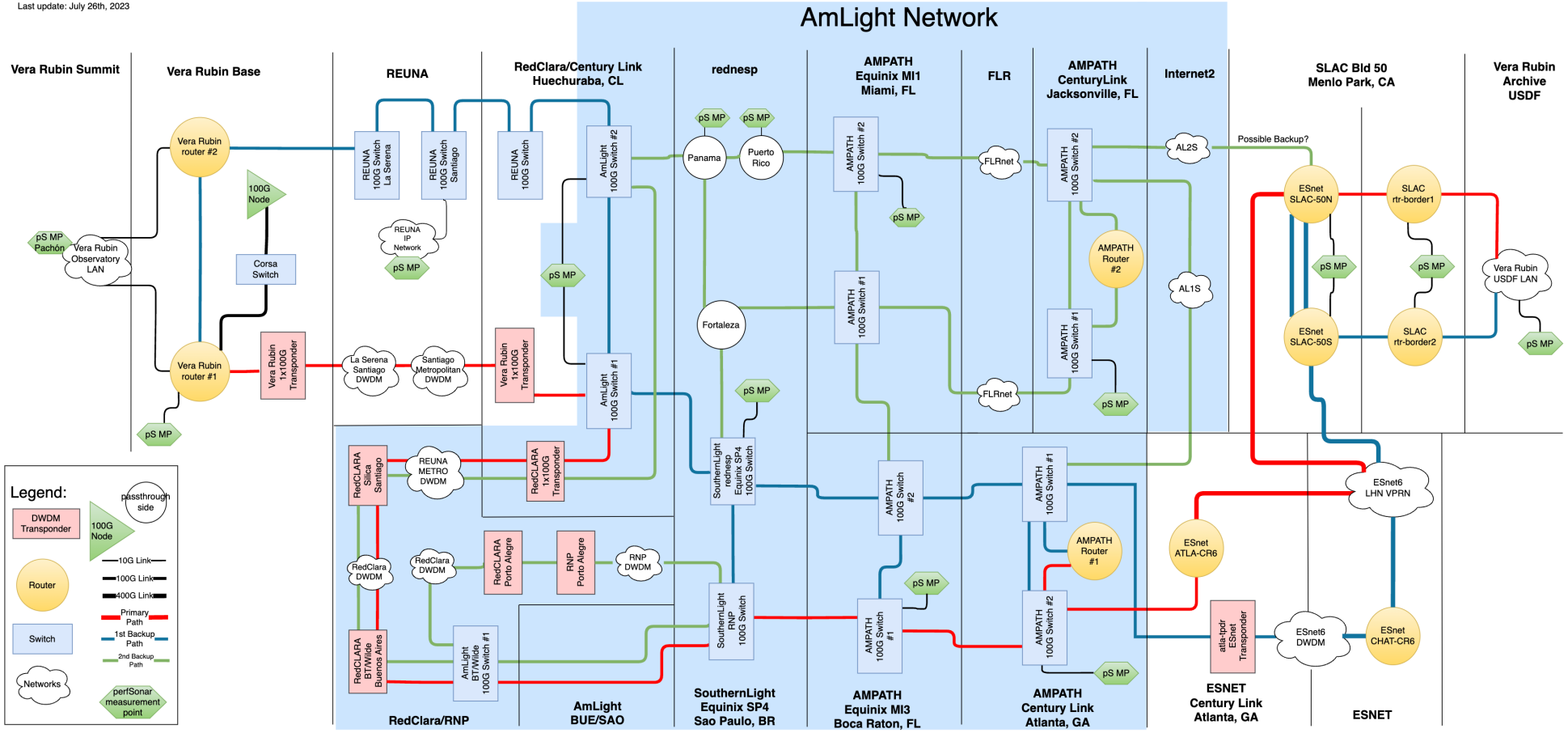
Buenos Aires
Porto Alegre,
Brazil
100G*
100G
RedClara
Peers or
Users
Link labels indicate bandiwdth
* means being activated
Cities and OXPs withOUT
SDN switches
(operated by members)
Cities and OXPs
with
SDN switches
Spectrum available but
not activated
Spectrum
Waves
Lit Services
Shared Ethernet

Versioning

Author: NET team
Last update: July 26th, 2023

Vera Rubin Observatory LHN - FY2024



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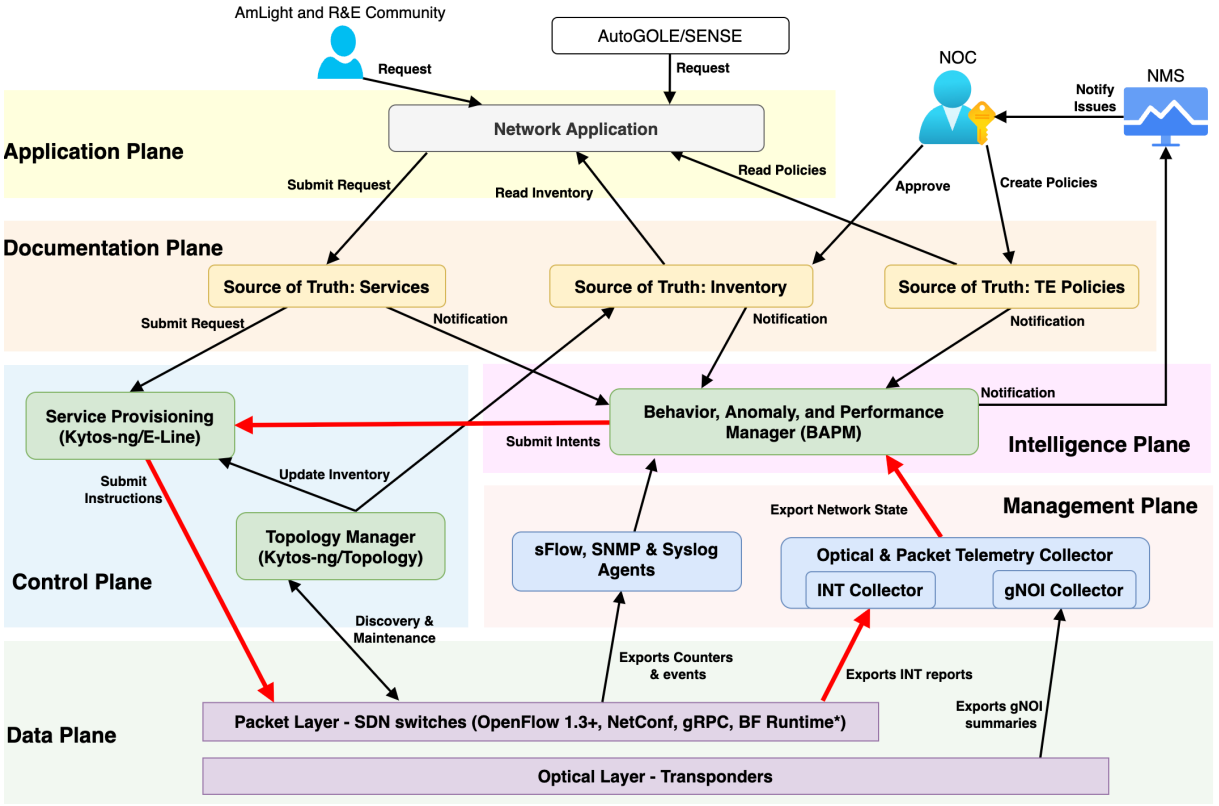
Evolving the AmLight-ExP SDN framework

- Evolving the SDN framework with six SDN planes to autonomically regulate AmLight-ExP network:
- **Data Plane:**
  - Exports counters from the Optical and Packet layers to the Management Plane
- **Control Plane (CP):**
  - Topology discovery and maintenance (Topology Manager)
  - Service Provisioning (submits instructions to Data Plane)
- **Management Plane:**
  - Exports network state to the Intelligence Plane:
    - Sampling counters; Optical and Packet telemetry
- **Intelligence Plane:**
  - Correlates events with inventory and traffic engineering policies from the Documentation Plane to learn the network state
  - Creates a closed-loop control for self-optimization
  - Submits requests to the CP if non-compliance
- The first Autonomic Function planned is to support L2VPNs fully managed by this architecture



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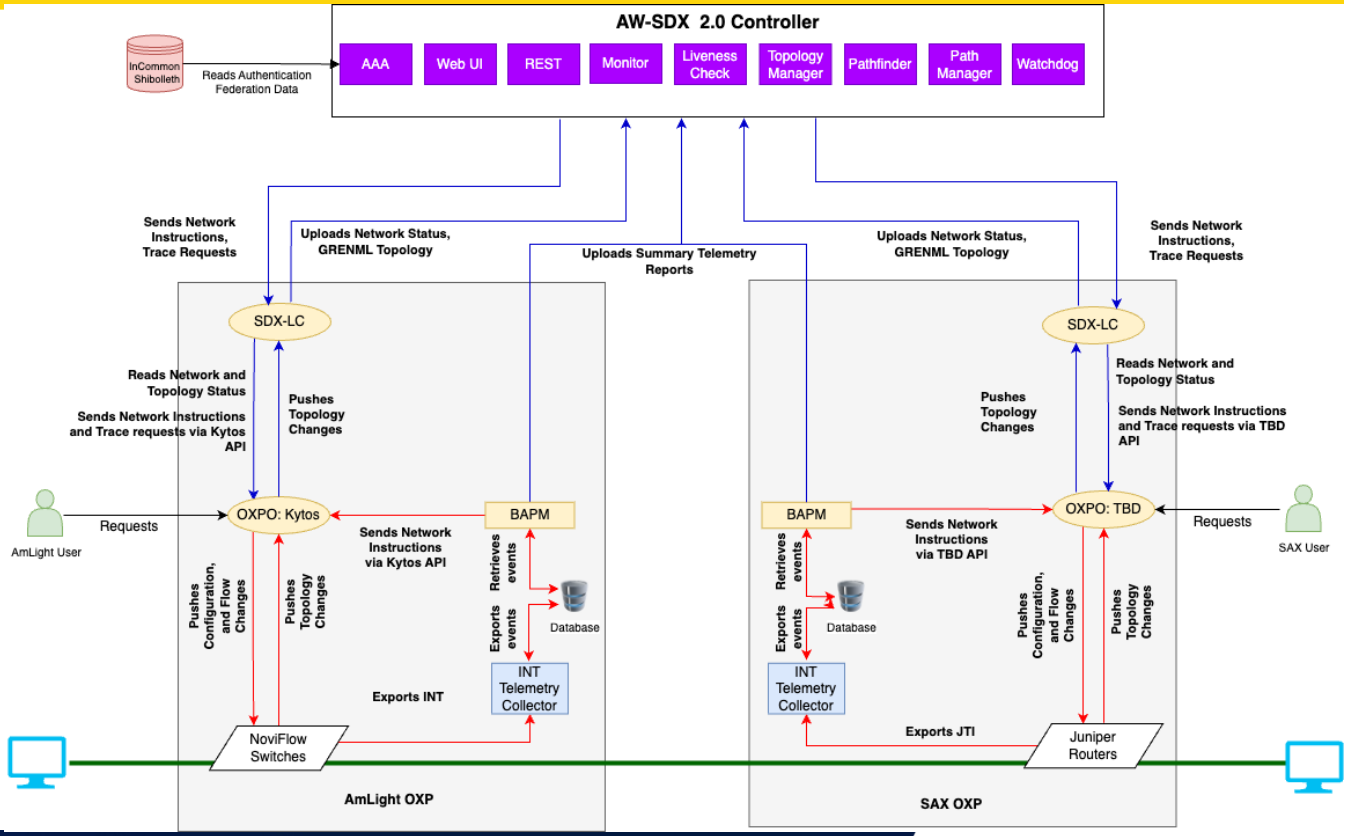
2023 Roadmap for the AmLight SDN network

- Deploy a new release of the AmLight SDN Controller:
  - Enhances support for In-band Network Telemetry (INT), Bidirectional Forwarding Detection (BFD), and for VLAN ranges for point-to-point Ethernet Virtual Circuits (EVCs)
  - Completed! Our homemade and open-source SDN controller Kytos is fully deployed
- Assess the complexity of adding Barefoot Runtime (BFRuntime) as a southbound interface for provisioning
  - Objective is to evaluate the effort needed to support P4 natively and decommission OpenFlow in the near future
    - Assessment completed. Next step is prototyping the new southbound.

AtlanticWave-SDX: Closed-loop Orchestration

- Goal:
  - Enable path protection across OXPs
  - Give users full visibility of their services
- Per-OXP Orchestration:
  - Bring your own Orchestrator
  - OXP decides what Autonomic Functions to support
- Inter-Domain Orchestration
  - SDX defines interfaces and data models for OXPs
  - OXPs produce and consume data from the SDX Controller
  - SDX creates a full topology
  - SDX supports all inter-domain network functions



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2023 Roadmap (sample) for the AtlanticWave-SDX

- Inter-domain provisioning:
  - Design and implement the SDX controller API for MEICAN data consumption – Completed!
  - Add support for CILogon to MEICAN – Completed!
- SDX Controller:
  - Implement optimal end-to-end connection protection and restoration algorithms – Completed!
  - Implement time series analysis and ML decision functions for re-optimization and self-healing actions – Pending!
- Path Computation Element (PCE):
  - Add TE optimization component to compute two or more disjoint paths between two endpoints – Completed!
  - Integrate the PCE functions with the SDX controller – Completed!
- Data Model:
  - Define the BAPM data model for the telemetry and monitoring information between the OXP BAPM and the SDX Controller middleware – Completed!
- Interfaces:
  - Enhance the message queue functions to support communications between the OXP BAPM and the SDX Controller
  - – Completed!

2024 Roadmap (sample) for the AtlanticWave-SDX

- Inter-domain provisioning:
  - Integrate with FABRIC
- SDX Controller:
  - Increase test coverage
  - Add support for consuming FABRIC tokens for seamless integration of Jupyter Notebooks
- Network Visibility and Interfaces:
  - Expand web user interface to enable each user to access a Grafana portal of its services
- Rollout to production to get feedbacks from OXP operators

THANK YOU

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FLORIDA INTERNATIONAL UNIVERSITY

AMLIGHT
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AMPATH
PATHWAY OF THE AMERICAS

AmLight ExP
International Distributed Exchange Point

AtlanticWave SDX
INTERNATIONAL DISTRIBUTED SOFTWARE-DEFINED EXCHANGE