International Extensions to NRP

6NRP Workshop
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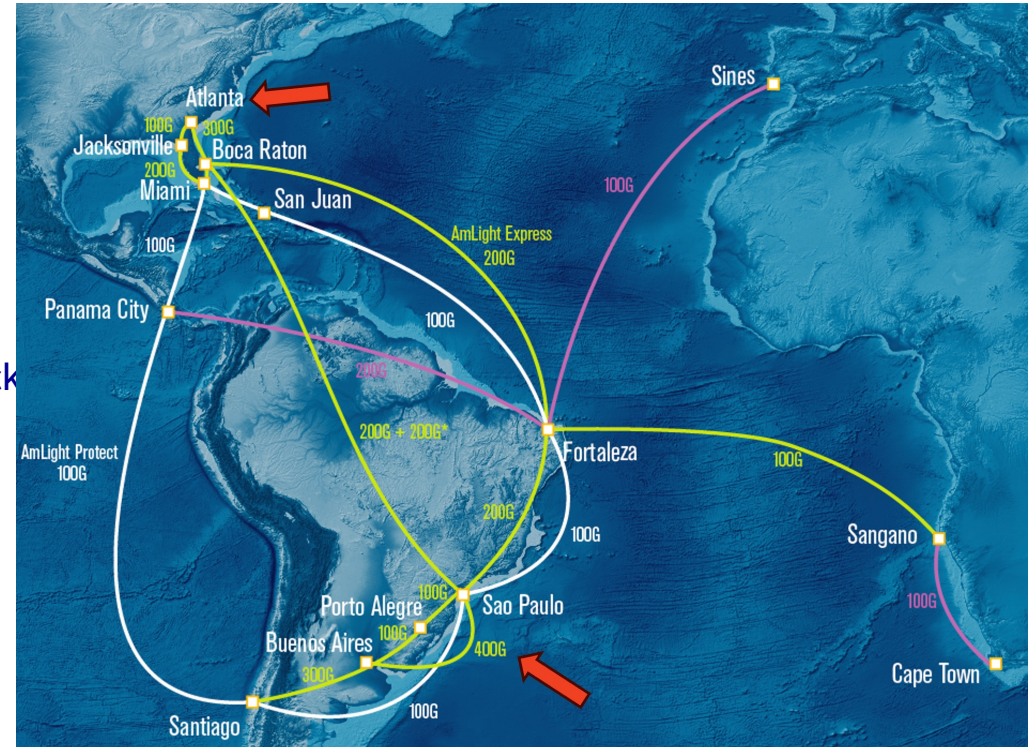
AmLight-ExP Network Infrastructure (Physical)

- 2.1+ Tbps of international connectivity
  - 600G of upstream capacity between the U.S., Latin America, Caribbean and 100G to Africa
- OXPs: Florida(3), Georgia, Brazil(2), Chile, Argentina, Puerto Rico, Panama, and South Africa
- Production SDN Infrastructure since 2014
- Deeply programmable across the network stack
  - Programmable P4 Data Plane
  - 21 P4 Switches
  - Open Source SDN Controller (kytos-ng)
- Highly instrumented
  - PerfSonar, sFlow, Juniper Telemetry Interface (JTI), In-band Network Telemetry (INT)



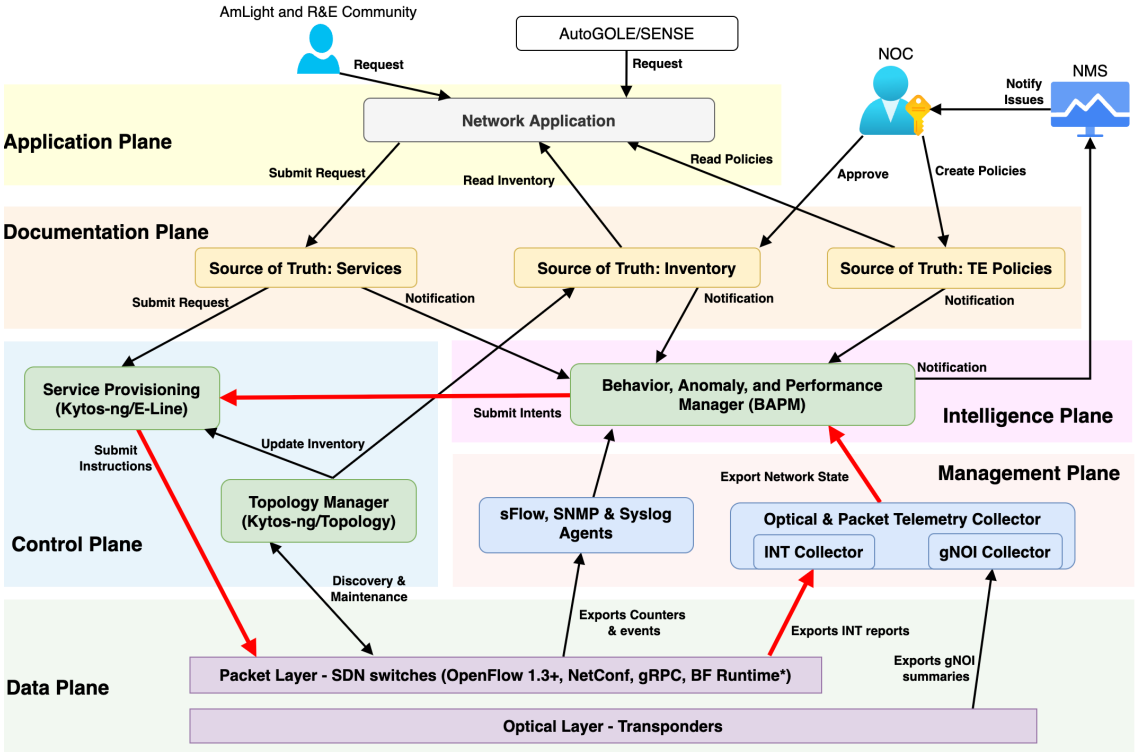
AmLight ExP
Americas Lightpaths Express & Protect

2025 Roadmap for the AmLight-ExP network infrastructure

- Increasing the spectrum from Florida to Sao Paulo/Brazil from 75 GHz to 112.5 GHz by
  - Deploying a Ciena WaveServer 6E
    - Total bandwidth to scale up to 1.1Tbps (800Gbps then 1.1Tbps)
  - Status: Waiting for the WaveServer 6E transponder to be delivered.
- Deploying a PATh node in Santiago, Chile
  - Status: Preparing for procurement.
- Connecting to NA-REX at 2x400G in Atlanta
  - Status: Connections made, working with Internet2 on the activation.

Evolving the AmLight-ExP SDN framework

- Evolving the SDN framework to regulate AmLight-ExP network, with autonomic network functions:
- **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 compute the network state
  - Creates a closed-loop control for self-management
  - 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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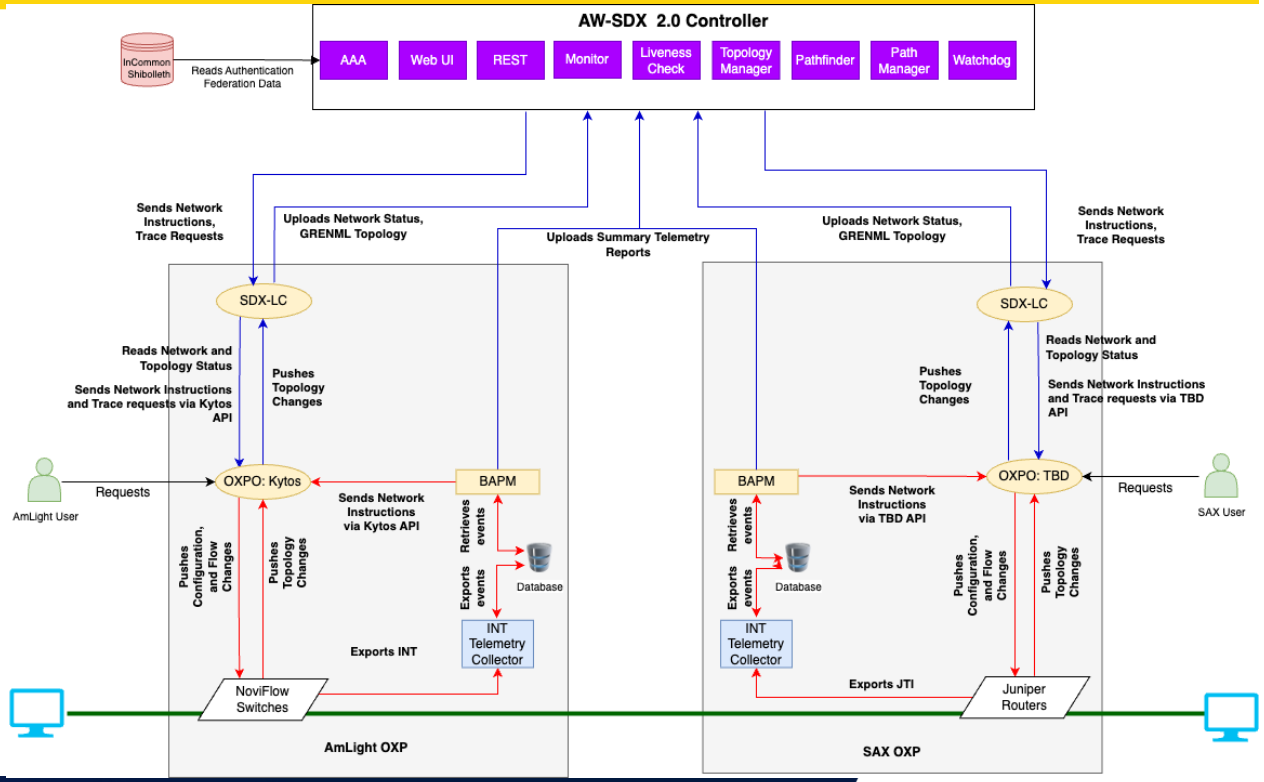
2025 Roadmap for the AmLight SDN network

- Customize the AmLight forwarding logic/pipeline to support new telemetry features and new customized protocols:
  - The objectives are:
    - To expand the telemetry metadata collected from switches and
    - To enable stateful network functions at line rate
  - First prototype is ready to test on the AmLight production network

- Development of a bit error rate testing solution using packet generators to detect and isolate packet loss and confirm Vera Rubin's SLA:
  - *AmLight Network Monitoring Framework* at the ESnet CI Lunch and Learn, by Jeronimo Bezerra, February 28th

AtlanticWave-SDX: Closed-loop Orchestration

- Goal:
  - Enable inter-domain visibility and path protection across OXPs
  - Give users full visibility of their services
  - Multi-domain SDX Controller
- 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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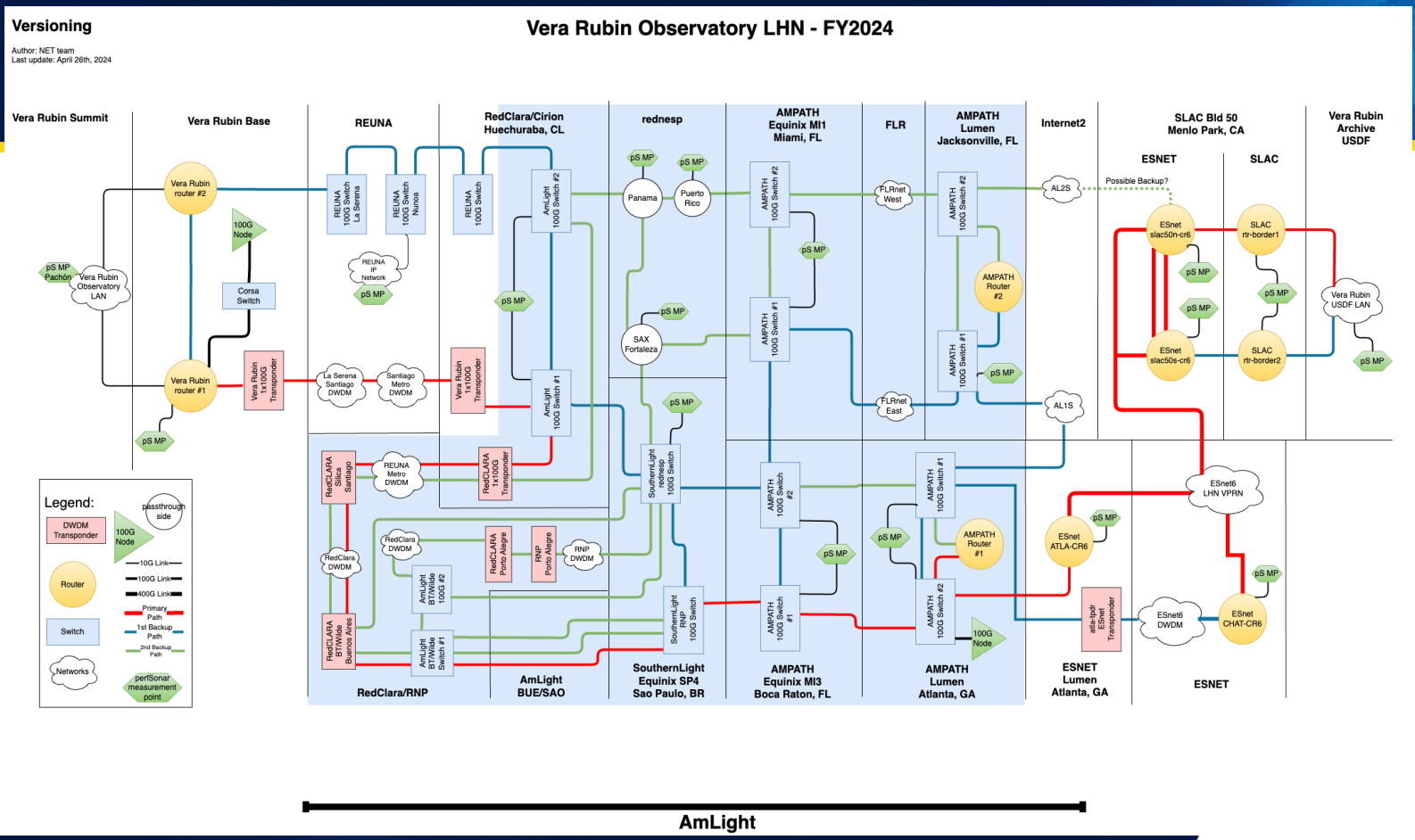

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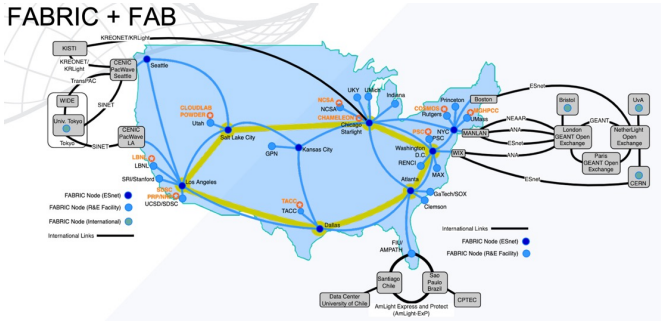
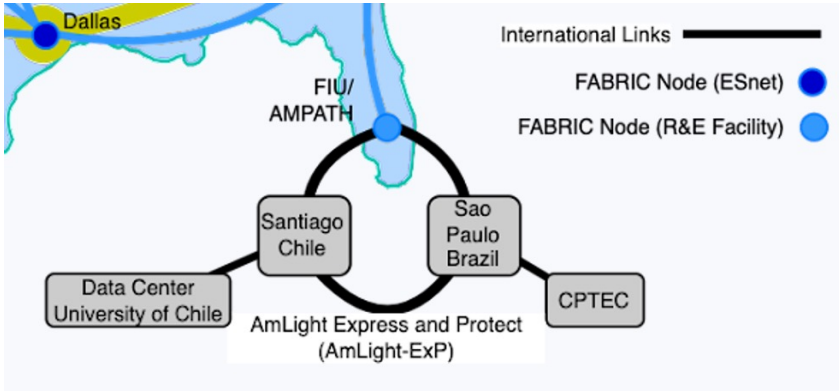
AtlanticWave-SDX is Integrated with FABRIC

- AmLight is connected to FABRIC via a dedicated 100G facility port
- SDXlib was developed to integrate AtlanticWave-SDX with FABRIC
- Launched at SC24, SDXlib demonstrated how
  - Optical telemetry was captured from AmLight's optical equipment and forwarded to FABRIC's facility port
  - Captured optical telemetry was forwarded to a FABRIC node with disk and GPU
  - Processing leveraged FABRIC and Chameleon resources
  - Resulting datasets were exported to AW-SDX and hosted for the community to download, all instantiated by SDXlib
  - All of it from just ONE FABRIC notebook and no NOC interaction
- *Experimenters on FABRIC and network operators can now use SDXlib to automate network provisioning over multiple network domains*





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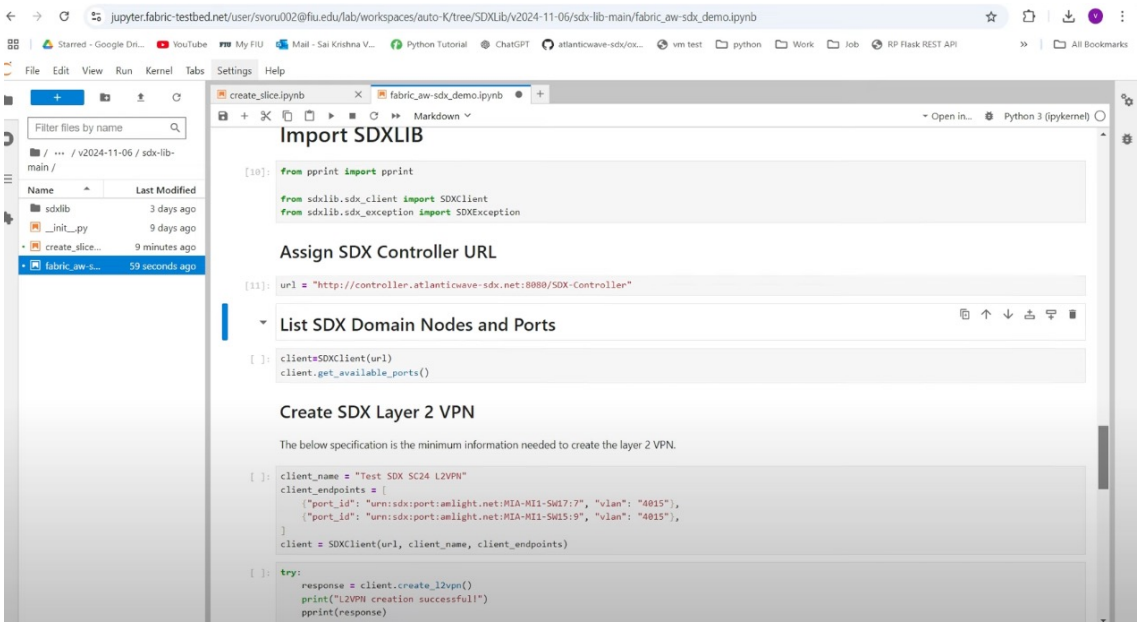
About SDXlib

- SDXlib is a Python library to allow FABRIC experimenters to create services directly from Jupyter Notebooks
- Similar methods as FABlib
- Abstracts manual complexity to enable quick deployment
- Leverages the functionality of the AtlanticWave-SDX
- Experimenters can create L2VPNs from FABRIC facility port to an endpoint on AmLight



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2025 Roadmap for the AtlanticWave-SDX

- Inter-domain provisioning:
  - Integrate with FABRIC
  - Status: Completed with demo at SC24. The SDX Python library was uploaded as a FABRIC artifact and a Jupyter notebook was created as a template.
- Rollout AtlanticWave-SDX software to production to get feedback from OXP operators
  - Status: On going. The SDX controller was deployed for SC24, and it's being used by operators and FABRIC experimenters (PATH being the first)
- SDX Controller:
  - Add support for consuming FABRIC tokens for seamless integration of Jupyter Notebooks
  - Status: Multiple authentication mechanisms are under development.
- Integration with AutoGOLE/SENSE:
  - Develop an OpenNSA backend to integrate AtlanticWave-SDX into the AutoGOLE/SENSE network
  - Status: Under development

THANK YOU

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AtlanticWave SDX
INTERNATIONAL DISTRIBUTED SOFTWARE-DEFINED EXCHANGE

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