



2026 WRNP/SBRC

Praia do Forte, Bahia, Brazil



AI @ AmLight: Operating a 5 Tbps Research Network with AI-Driven Intelligence

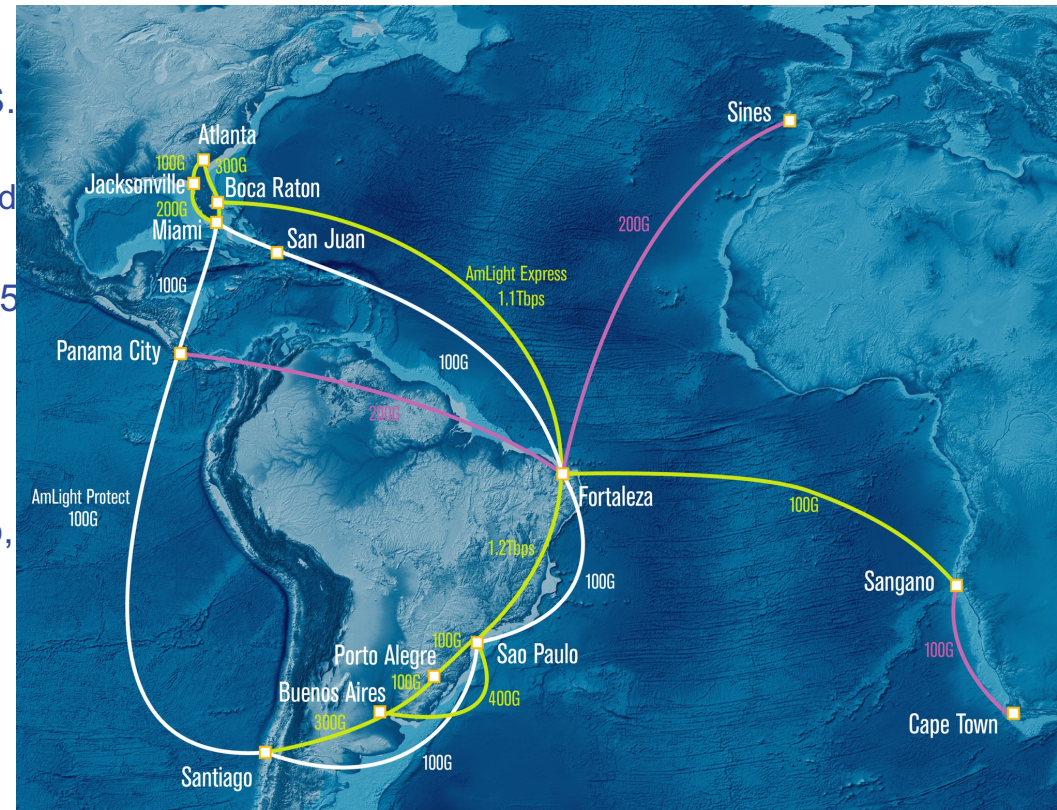
Jeronimo “Jab” Bezerra <jbezerra@fiu.edu>

Outline

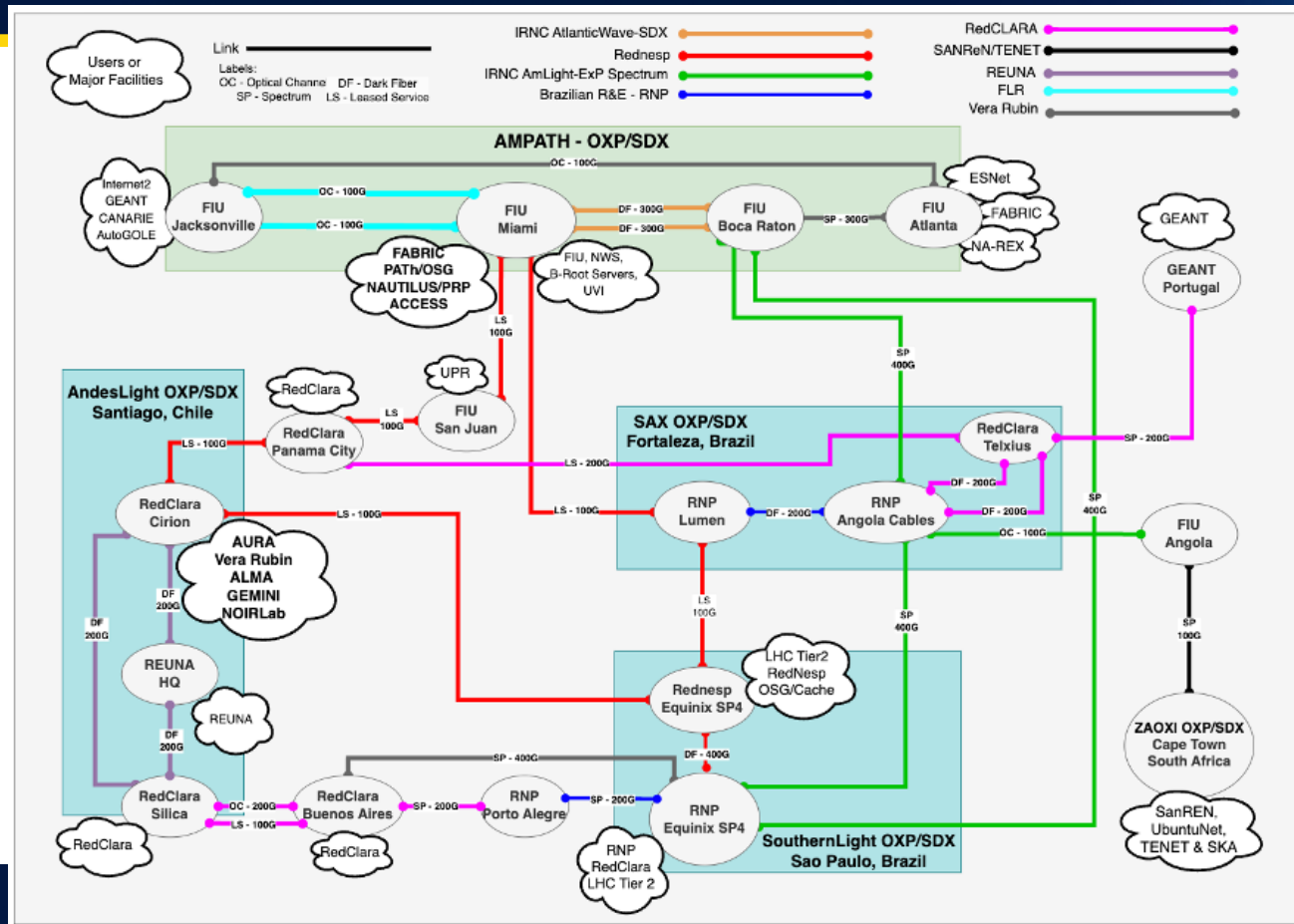
- AmLight's 5 Tbps Architecture and Operational Scale
- Programmable Infrastructure and Telemetry in Numbers
- AI-Driven Operations for SLA-Critical Scientific Workflows
- Toward an Autonomous Research and Education Network

Introducing AmLight

- A distributed academic exchange point built to enable collaboration among Latin America, Africa, and the U.S.
 - Members: FIU, AURA, Vera Rubin Observatory, **RNP**, **Rednesp**, RedClara, REUNA, FLR, SANReN, TENET, and Internet2
- Supported by NSF, and the IRNC programs since 2005
 - **AmLight: The Next Frontier in 2026-2030!**
- A blend of optical spectrum, optical waves, and leased services
- NAPs: Florida(3), Atlanta, Brazil(2), Chile, Puerto Rico, Argentina, Panama, and South Africa
- Infrastructure managed by a homemade SDN controller: Kytos-ng (github.com/kytos-ng)

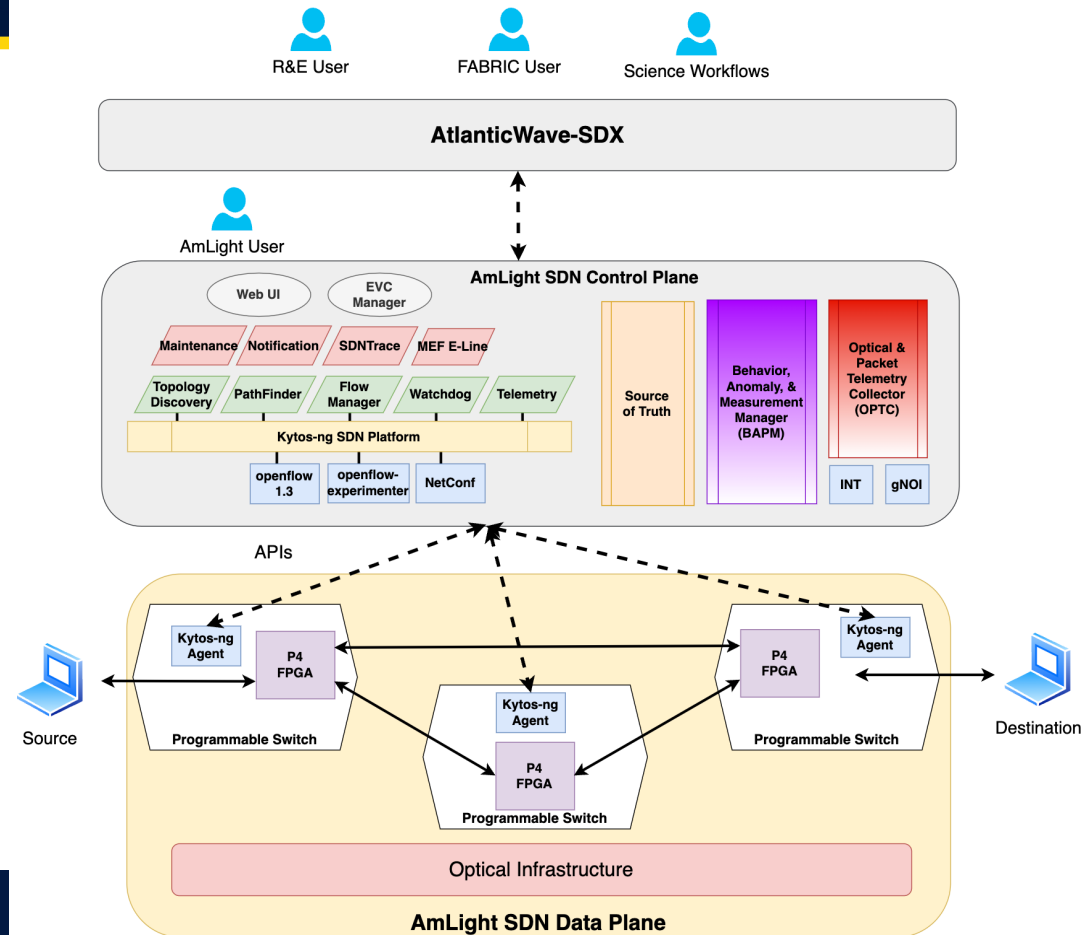


Collaboration at its finest!



AmLight SDN Infrastructure

- AmLight operates at multiple layers:
 - Inter-domain for integration with remote instruments, OXPs, testbeds, and science workflows
 - AtlanticWave-SDX
 - Intra-domain for an efficient network provisioning with sub-second service restoration
 - Packet Layer and Optical Layer
 - Kytos-ng, In-band Network Telemetry (INT), Traffic Engineering, and policies



Programmable Infrastructure and Telemetry in numbers

Network in numbers:

- Connectivity:
 - 1.2 Tbps between US and Latin America
 - 1.2 Tbps to U.S.'s IXPs
 - 41x 100G network links
 - 18 datacenters
 - 7 countries
 - ~38 P4-based programmable switches
 - 6x Routers
 - 7x DCIs
- Network measurement instrumentation
 - 11x PerfSONAR nodes
 - 1x Traffic Generator
 - 6x SmartNICs
 - Dedicated Programmable switches

Network Telemetry in numbers

- Per-packet network telemetry:
 - ~5 Mpps // 92 TB/day
- Centralized Syslog
 - 187 devices // ~977,000 entries/day
- + SNMP / sFlow / JTI / gNOI / gRPC
- 15+ Grafana dashboards, several Zabbix dashboards, customized scripts
- XDP/EBPF, Nvidia BlueField, FPGAs generating or collecting telemetry
- **1.8M lines of code to support AmLight among scripts, applications, and orchestration.**

Use Case: Vera Rubin Observatory Operation

- The camera will take a picture of the southern sky every 30 seconds, and produce a 13GB image
- Each image must be transferred to the USDF at SLAC, within 7 seconds, inside the 30 second transfer window
- Constraints
 - Distance from the Base station to the USDF is approximately 12,000 miles
 - RTT from the Base Station to the USDF is approximately 220+ ms
 - 0.00001% of packet loss will compromise the Rubin Observatory image transfer workflow
- Challenges
 - How to build the LHN to deliver a 13GB image within the 7s window?
 - How to recover from an event that impacts network service on the LHN, and continue to deliver 13GB images on time?



AmLight: 20+ Years of Innovation

- 2005-2010: Building international R&E connectivity
- 2010: Pioneer using **coherent alien waves** on legacy submarine systems
- 2013: Dynamic circuits using OSCARS / NSlv2 in production
- 2014: Migration to **Software-Defined Networking (SDN)** and network slicing
- 2018: Acquired **optical spectrum** on a submarine system (Monet)
- 2020: Programmable switches with P4 and **per-packet network telemetry** (INT)
- 2021: Deployment of a **homemade network orchestrator**: Kytos-ng SDN Platform
- 2024: Use of traffic generators to continuously evaluate link quality
- 2026: Activated a **1Tbps optical channel** between the U.S. and Latin America
- *What should we do next?*

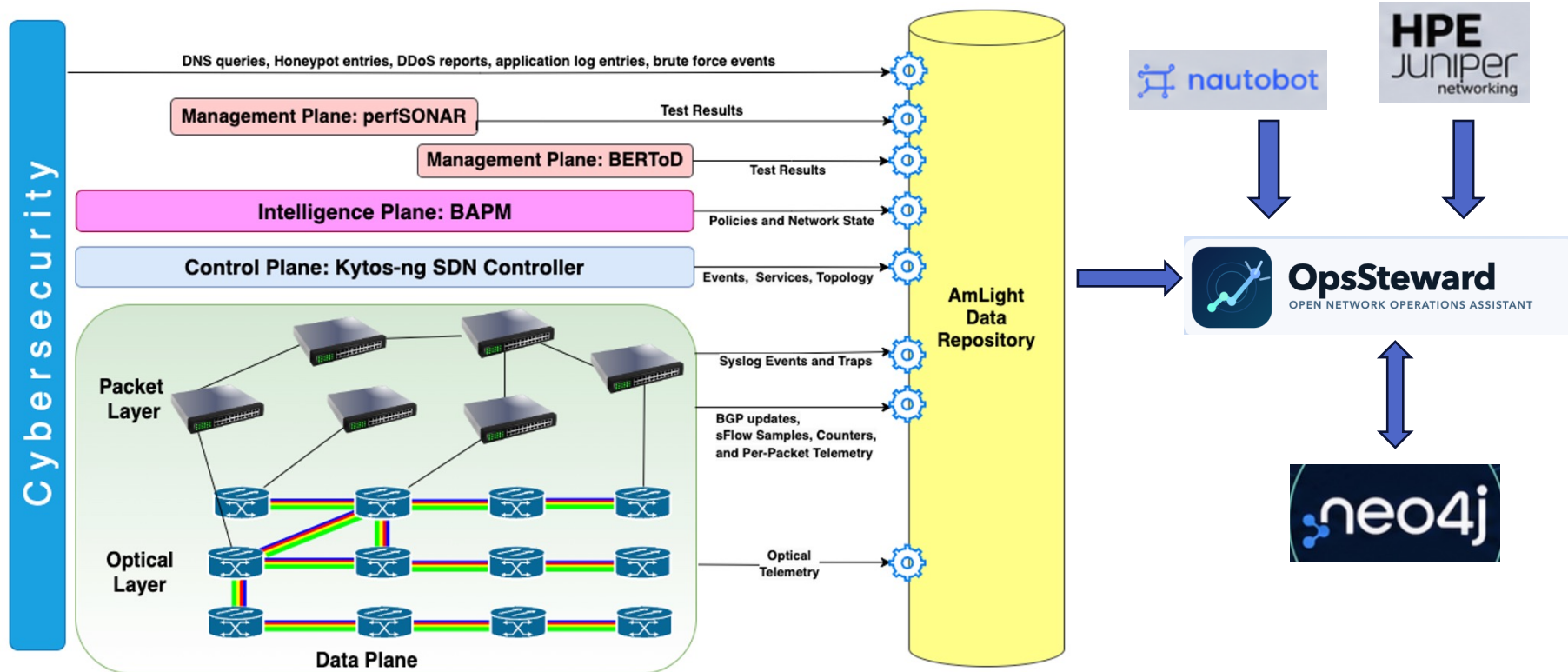
Enters...



OpsSteward: AI-Native Network Operations Platform

- AI-driven operational intelligence platform to support **SLA-based science drivers** and R&E networks
 - Transforms operational data into intelligent network operations
- Designed for large-scale SDN, optical, and multi-domain infrastructures
 - *Integrates* topology, telemetry, logs, services, and operational context into a unified knowledge graph
 - *Combines* Data, Graph intelligence (Neo4j), Retrieval-Augmented Generation (RAG), and locally-hosted LLMs (vLLM)
 - To build AI-assisted operational workflows
- Built to support:
 - Faster troubleshooting, Intelligent automation, root-cause analysis, SLA awareness, MOP writing, and autonomous operations
- Developed for environments where reliability, observability, and operational scale are critical

OpsSteward: AI-Native Network Operations Platform



OpsSteward: How it works

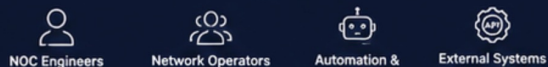
- Reports network and policies inconsistencies, Correlates events, Notify operators, Create MOPs, Supports report-writing activities
- Operational answers cite the system of record, not model memory.
- Every decision is recorded for accountability and troubleshooting purposes.
- OpsSteward is not only chat. It is an evidence layer over network operations.
- **Operational Intelligence Through Context and Reasoning**



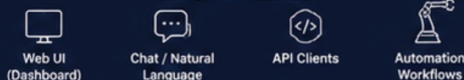
OpsSteward

AI-Powered Network Operations Platform

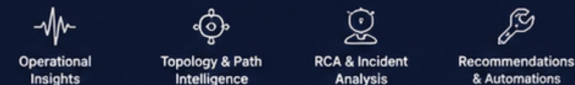
WHO USES IT



WAYS TO INTERACT



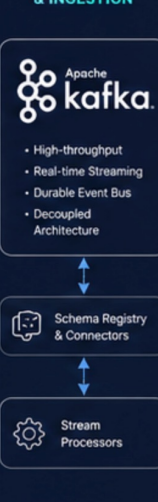
WHAT THEY GET



DATA & TELEMETRY SOURCES



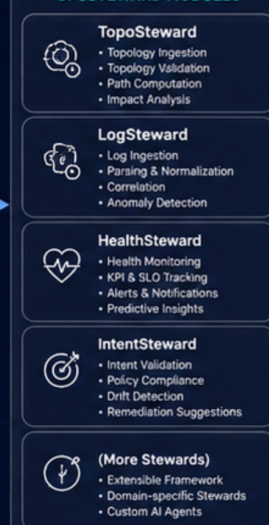
EVENT STREAMING & INGESTION



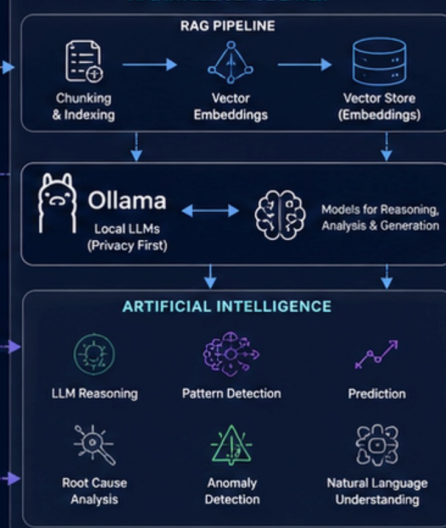
KNOWLEDGE GRAPH & OPERATIONAL INTELLIGENCE



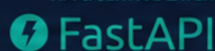
OPSTEWARD MODULES



AI & INTELLIGENCE LAYER



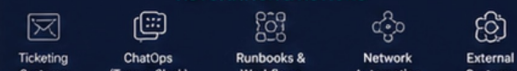
API & SERVICE LAYER



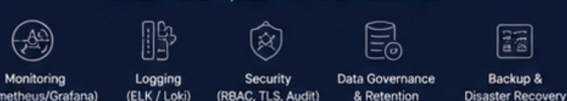
- RESTful APIs
- Authentication & Authorization
- Rate Limiting
- OpenAPI / Swagger

- Real-time APIs (WebSockets)
- Programmatic Access
- Integration Gateway
- Automation Hooks

AUTOMATION & ACTIONS



OBSERVABILITY, SECURITY & GOVERNANCE

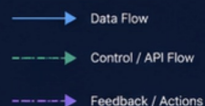


DEPLOYMENT OPTIONS



KEY BENEFITS

- ✓ Holistic Network Visibility
- ✓ AI-Powered Insights
- ✓ Faster Incident Resolution
- ✓ Proactive Operations
- ✓ Automation at Scale
- ✓ Open & Extensible
- ✓ Built for Research Networks



Some outputs

What are the most unreliable links this month?

KNOWN QUESTIONS

What are the most unreliable links this month?

Production devices

Render topology

Interface timeline

Interface impact

PDU impact

MI1 feed impact

ANSWER SOURCE

☐ Auto

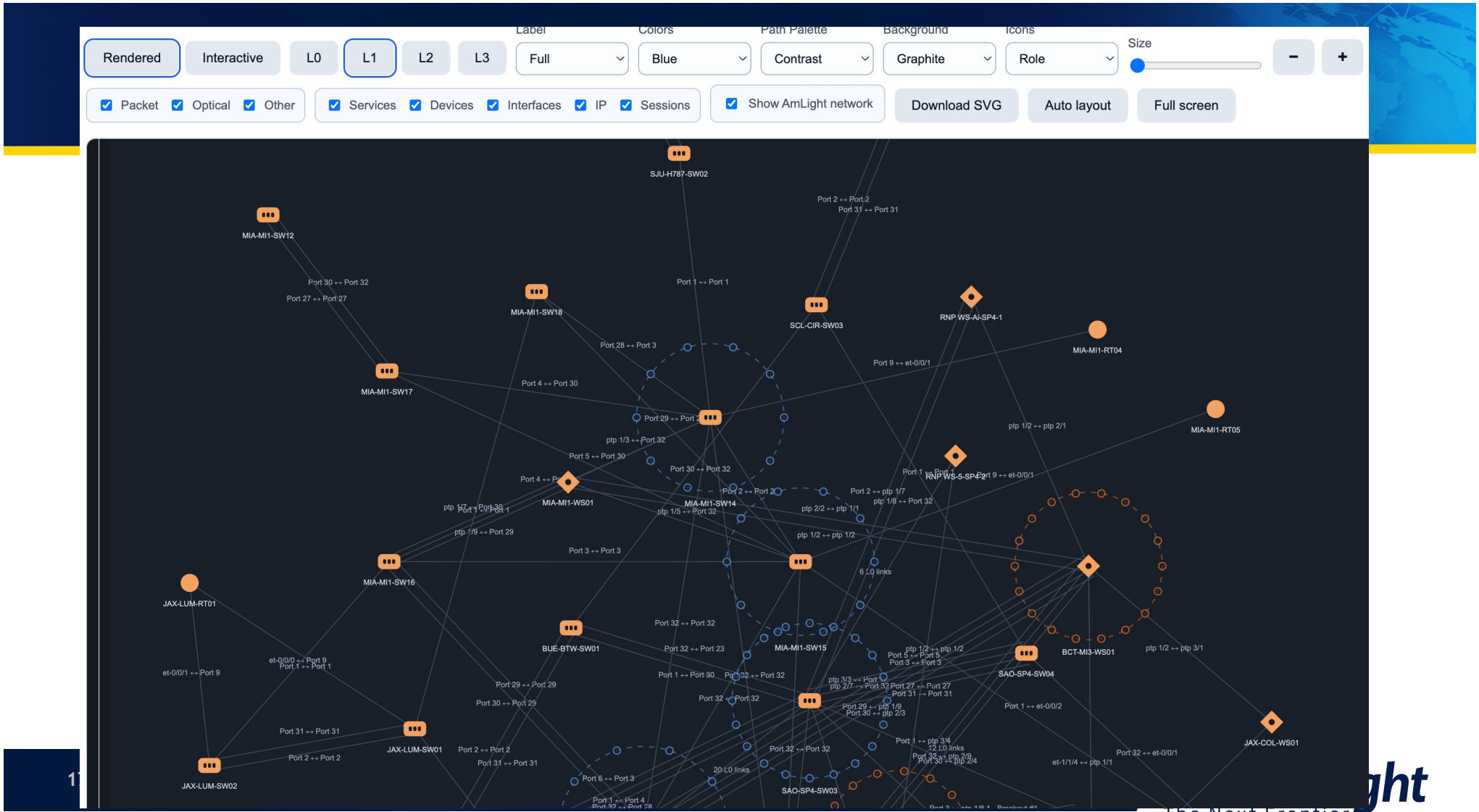
☐ Knowledge Base

☒ Graph DB

 Send

Link ▾	L2Adjacency ▾	Flaps ▾	State Changes ▾	Total Downtime ▾	Ongoing Down ▾	Open Downtime ▾	Last Down ▾	Last Up ▾
BUE-BTW-SW02 Port 1 <-> SAO-SP4-SW03 Port 4	SAO-BUE-100G-05	118	555	5d 21h 30m 46s	no		2026-05-25 13:28:25+00:00	2026-05-25 13:28:27+00:00
MIA-MI1-SW18 Port 1 <-> JAX-LUM-SW01 Port 1	MIA-JAX-100G-02	27	123	14h 50m 40s	no		2026-05-20 04:06:12+00:00	2026-05-20 05:08:49+00:00
BUE-BTW-SW01 Port 32 <-> SAO-SP4-SW03 Port 23	SAO-BUE-100G-03	25	103	1d 0h 23m 42s	no		2026-05-18 18:39:05+00:00	2026-05-18 18:39:08+00:00
SCL-CIR-SW03 Port 1 <-> SAO-SP4-SW04 Port 1	SAO-SCL-100G-01	24	102	18h 19m 39s	no		2026-05-25 16:32:32+00:00	2026-05-25 16:34:31+00:00
SAO-SP4-SW03 Port 30 <-> BUE-BTW-SW01 Port 1	SAO-BUE-100G-01	24	102	4m 29s	no		2026-05-18 18:39:05+00:00	2026-05-18 18:39:08+00:00
BUE-BTW-SW02 Port 32 <-> SAO-SP4-SW03 Port 28	SAO-BUE-100G-04	23	103	1d 0h 23m 44s	no		2026-05-18 18:39:05+00:00	2026-05-18 18:39:08+00:00







OpsSteward
OPEN NETWORK OPERATIONS ASSISTANT

AI FOR NETWORK OPERATIONS
AMLIGHT REFERENCE DEPLOYMENT

Assistant

Docs

Status

Login

Dark mode

Summarize what happened in the network last night and highlight Rubin LHN impact

KNOWN QUESTIONS

Summarize what happened in the network last night and highlight Rubin LHN impact

Production devices

Render topology

Interface timeline

Interface impact

PDU impact

MI1 feed impact

ANSWER SOURCE

☐ Auto

☐ Knowledge Base

☒ Graph DB

Send

Operational events in last night: 2 interface flaps, 4 BGP flaps, 4 BFD flaps, and 300 EVC state changes. Raw state-change records: 4 interface events, 8 BGP events, 8 BFD events, and 300 EVC events. A flap is a recovered down/up cycle; events are the individual state-change log records.

53 observed state events matched Rubin LHN using MOP Workbench desired_state.yaml. This is a v1.0 temporary service scope until Rubin LHN dependencies are modeled as graph service identity. Known routed-session downtime in the window is 38s.

deterministic route: inspect_operational_timeline · Processed in 1.45s · No LLM call



Future

- Version 1.0 - Release-grade assistant (Q2/2026)
 - Builds graph database from Nautobot and Kytos SDN controller and Syslog events via Kafka
 - Supports IP/VRF and L2 Services
 - Uses Ollama on a Nvidia DGX Spark
- Version 2.0 - Interoperable operations model (Q3/2026)
 - Adds support for Netbox and Service Counters (L2VPNs stats)
 - Adds support for vLLM over Ollama on a Nvidia DGX Spark
 - Adds support for Infrastructure Segments for Disjointness verification
- Version 3.0 - Governed closed loop (Q4/2026)
 - Agentic AI with Human **approval** in the loop for service orchestration
- Version 4.0 - Fully AI-based closed loop (Q2/2027)
 - Fully Agentic AI with human **notification** for service orchestration

Questions?

THANK YOU

Want to know more?

<https://www.es.net/science-engagement/ci-engineering-lunch-and-learn-series/>

