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***AtlanticWave-SDX 2.0: Improving network services for Major Facilities and R&E networks using Dynamic Orchestration and Service Provisioning.***

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AtlanticWave-SDX NSF #OAC-2029278

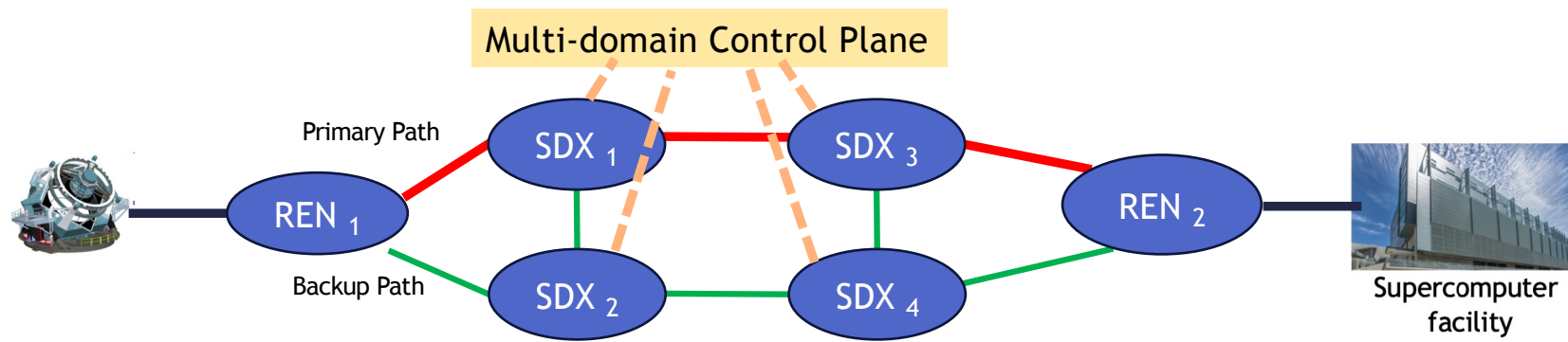
# Outline

- What is a Software-defined Exchange Point (SDX)?
- Why do we need SDXs in the R&E environment?
- Our response: AtlanticWave-SDX 2.0
  - Project Description
  - Multi-Layer Infrastructure
  - Multi-Domain Orchestration
  - Research Communities
- Current Status
  - + Quick Demo
- Future

# What is a Software-defined Exchange Point (SDX)?

- Research and Education Networks (RENs) leverage Open Exchange Points (OXPs) to create the R&E fabric across the globe
  - ANA (6), AmLight (5), PacificWave (6), GEANT (3+)
- There are no standards to define how OXPs should operate
  - Multiple service provisioning solutions
- Establishing multi-domain circuits across multiple OXPs is still a challenge:
  - AutoGOLE was created to enable inter-domain provisioning
    - No path protection
    - Network Service Interface (NSI) is 10+ years old and still not deployed by most RENs and OXPs
- **Software-defined Exchanges (SDX) was an approach to bring the power of SDN to OXPs:**
  - **Aiming to enable complex services, including multi-domain provisioning, and enhance integration between OXPs.**

# Why SDXs in R&E? Increasing Reliability and Dynamic Traffic Engineering



- Upgrading OXPs with SDXs and a Multi-domain Control Plane:
  - Upon failure in the primary path (red), for instance, connection between SDX<sub>1</sub> and SDX<sub>3</sub>, SDX<sub>1</sub> and SDX<sub>3</sub> notify the Multi-domain Control Plane of a network state change
  - Multi-domain Control Plane computes a new path, then propagates rules to all SDXs
  - Traffic is then dynamically rerouted, including L2VPNs
- No need for pre-defined static paths and support for dynamic re-provisioning for TE

# AtlanticWave-SDX 2.0

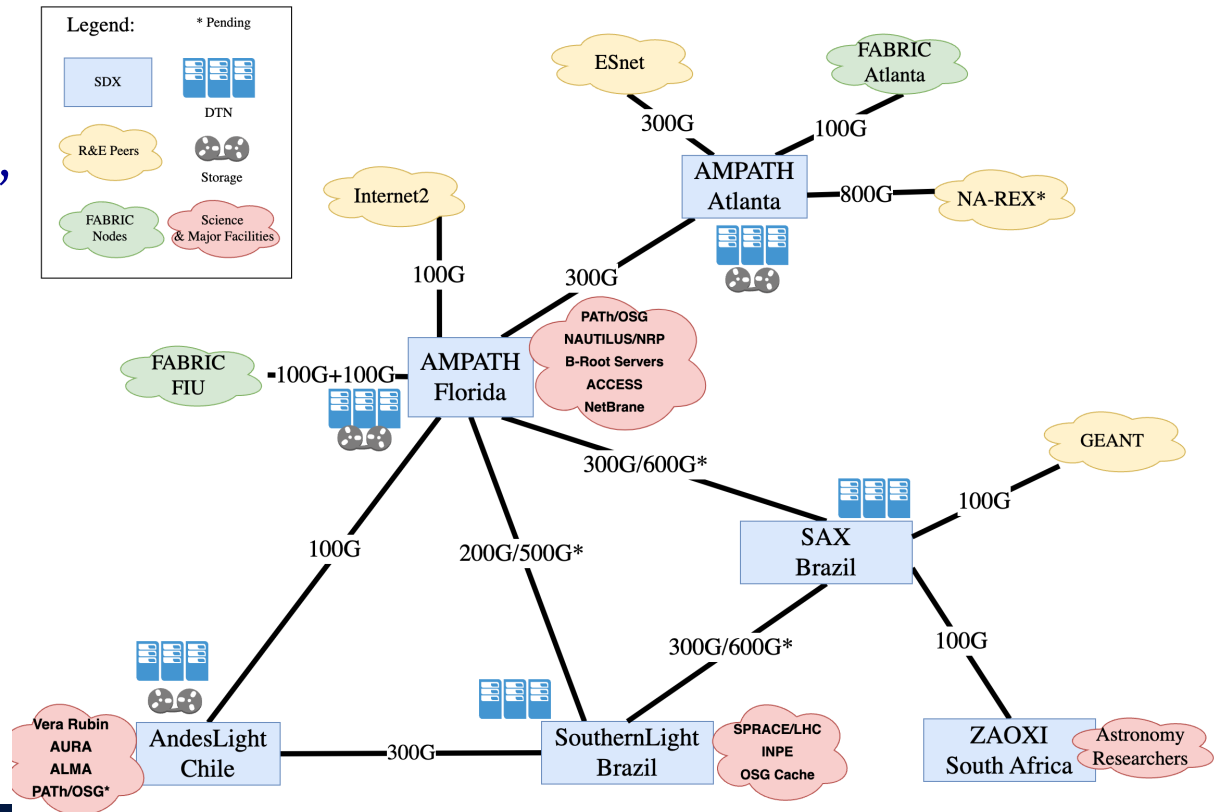
- AtlanticWave-SDX: A Distributed Production SDX, supporting research, enhancing operations, and interoperability testing at national and international scales.
  - NSF IRNC Award# OAC-2029278 (Dec 2020 to Nov 2025)
- Built upon the success of the AtlanticWave-SDX 1.0 (2015-2020)
- Goals:
  - Improving the distributed SDX between the U.S., South America, and Africa
  - Evolving the development, integration and deployment of the AtlanticWave-SDX controller
  - Coordination and engagement towards the adoption of the AtlanticWave-SDX

# AtlanticWave-SDX 2.0 [2]

- Technical target: Enhancing AtlanticWave-SDX with Autonomic Network Architecture concepts and designs
  - Self-management, resilient, scalable, and secure
- Network-driven milestones:
  - New network services (Pathfinding, L2VPN/L3VPN, and Cloud services)
  - Improving orchestration across OXPs to enhance end-to-end network services
  - Ability to analyze telemetry data to create control loops for policy-driven configurations
- User-driven milestones:
  - Enable integration with scientific workflows, including Pegasus and OSG
  - Integrate with interdomain orchestrators and testbeds: SENSE/AutoGOLE, FABRIC, and NA-REX

# AtlanticWave-SDX 2.0: Multi-Layer Infrastructure

- AMPATH, SouthernLight, AndesLight, SAX, and ZAOXI
- 100G+ to FABRIC, R&E Peers, clusters, testbeds, and scientific instruments
- Telemetry deployed per site (Optical and Packet)
- Spectrum added between FL and Brazil:
  - Final bandwidth: **1.1 Tbps**
- 100G DTNs added to each SDX/OXP

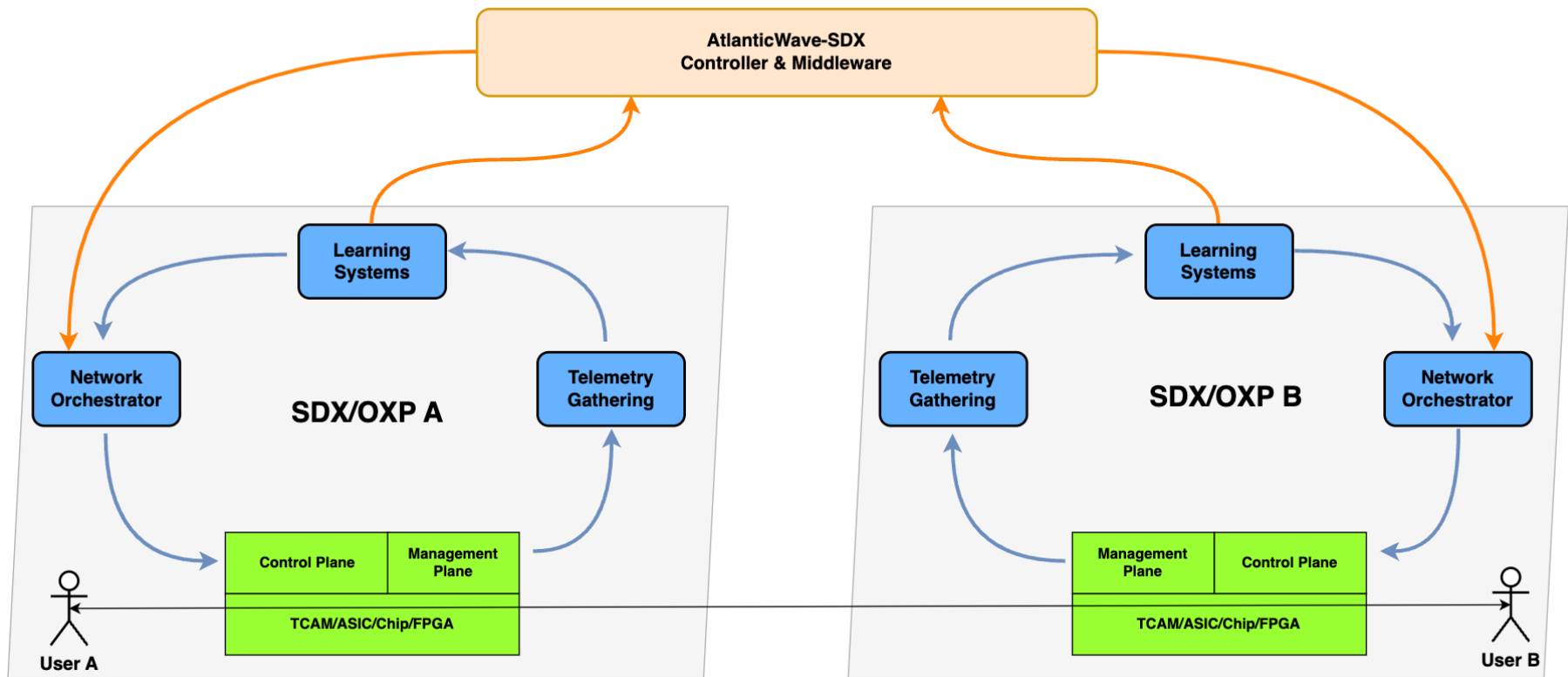


# AtlanticWave-SDX 2.0: Multi-domain Orchestration

- The SDX-Controller 2.0 has the following goals:
  - Enabling inter-domain service provisioning:
    - with multi-metric pathfinding
    - closed-loop orchestration for **service protection**, and dynamic optimization
    - by **leveraging** APIs of existing network orchestrators at the SDX/OXPs
  - Monitoring service utilization and status with **support for user notifications**
    - by integrating with existing SDX/OXP's telemetry and monitoring solutions
  - Supporting friendly user interfaces to enable **integration with science workflows** and operators:
    - MEICAN for WebUI
    - Python library for workflows and FABRIC



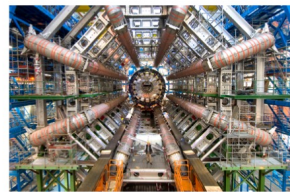
# AtlanticWave-SDX 2.0: Multi-domain Orchestration [2]



# AtlanticWave-SDX 2.0: Research Communities

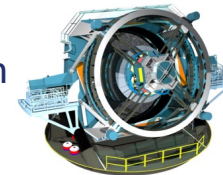
- Distributed High Throughput Computing applications

- Latency sensitive
- Open Science Grid



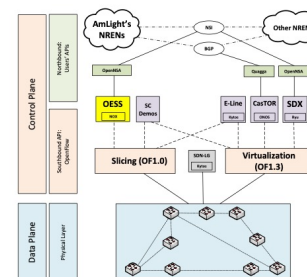
- Real-Time, high-throughput, high-resilience applications

- Strict SLA
- Vera Rubin



- International Research Testbeds

- At-scale experimentation
- FABRIC
- AmLight-Exp
- Others



# Current Status

- SDX-Controller, PCE, and middleware to support inter-domain L2VPN provisioning with path protection and webUI ready for evaluation
  - Authentication with CILogon operational for the MEICAN webUI
- Interfaces with users and OXPs published:
  - Topology Data Model Specification 2.0.0
  - Provisioning Data Model Specification 1.0
- Integration with existing OXP network orchestrators:
  - Kytos-ng and OESS 2 completed
- Integration with FABRIC
  - Python Sdplib 1.0a to be released
- Source code: <https://github.com/atlanticwave-sdx>
- Documentation: <https://sdx-docs.readthedocs.io/en/latest/index.html>
- **Currently deployed at AMPATH with integration with FABRIC and NRP! :D**

# Plans for 2024-2025

- Integrating with SENSE/Autogole
- Enabling dynamic optimization of network services by leveraging per-SDX telemetry
- Creating a Grafana portal with utilization and status of software components and network services
- Implementing authentication with support for FABRIC tokens
- Creating training material and sessions for AtlanticWave network operators
- Running proof-of-concepts with science workflows, such as OSG and Vera Rubin Observatory

# Demo

- <https://www.youtube.com/watch?v=T5unvIKnCS0&list=PLqEq6vGwylN8skpMECp1qSpEdGPo910CL>
- <https://www.atlanticwave-sdx.net/>

# Acknowledgment

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- PI Team
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**Thank You!**  
*Questions?*

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