AmLight ExP & AtlanticWave-SDX: new projects supporting Future Internet Research between U.S. & South America

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Outline

- NSF IRNC Backbone Projects
- Backbone: AmLight Express and Protect (ExP)
- RXP: AtlanticWave-SDX

NSF IRNC Backbone Projects

- The NSF International Research Network Connections (IRNC) program
  - links U.S. research networks with peer networks in other parts of the world, and
  - leverages existing international network connectivity
- 3 new backbone projects:
  - **Indiana University**: TransPAC4 - Pragmatic Application-Driven International Networking
    - U.S. - Asia Backbone Network Connectivity
    - Jennifer Schopf (Principal Investigator)
  - **University of Hawaii**: SXTransPORT Pacific Islands Research and Education Network
    - U.S. – Pacific and Oceania Backbone Network Connectivity
    - David Lassner (Principal Investigator)
  - **Florida International University**: AmLight Express and Protect
    - U.S. – South America Backbone Network Connectivity
    - Julio Ibarra (Principal Investigator)

AmLight Express and Protect (ExP)

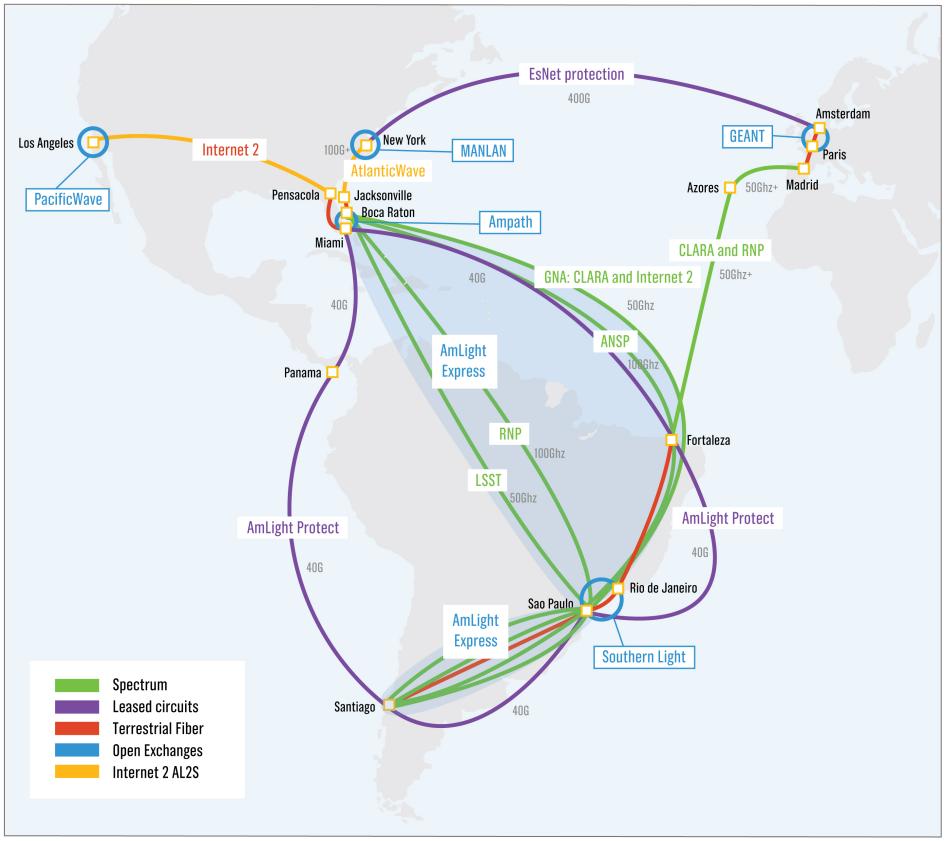
- U.S.-South America backbone network connections, NSF ACI Award# 1451018
- 5-year $5M Cooperative agreement
- AmLight ExP implements a hybrid network strategy that combines optical spectrum (Express) and leased capacity (Protect)
- Builds a reliable, leading-edge diverse network infrastructure for research and education
- Researchers will be able to leverage resources of AmLight ExP to foster network innovation

AmLight ExP Network Evolution

140G

2015-2017

680G+



2018-2031

AtlanticWave-SDX

- NSF ACI Award# 1451024
- 5-year $3.5M Cooperative Agreement
- Florida International University (FIU) and Georgia Institute of Technology (GT) are implementing AtlanticWave-SDX
- Collaboration with ANSP and RNP for SouthernLight international exchange point
- Other exchange points supporting SDN

AtlanticWave-SDX Project

- AtlanticWave-SDX (Awave-SDX) is building a distributed intercontinental experimental SDX in response to a growing demand to:
  - Support end-to-end services
    - Capable of spanning multiple SDN domains
    - Traffic engineering of end-to-end L2 circuits
    - Network programmability
  - Interconnection of international testbeds:
    - Future Internet Research
    - Prototyping and experimentation

Conceptual Design

- AtlanticWave-SDX conceptual design is comprised of two components:
  - A Network Infrastructure Development Component
    - Bridges 100G of network capacity between the R&E backbone networks in the U.S. and S. America
  - An Innovation Component
    - Builds a distributed intercontinental experimental SDX between the U.S. and South America
    - Leverages open exchange point resources at SoX (Atlanta), AMPATH (Miami), and Southern Light (São Paulo, Brazil)

Science Drivers

- Large Synoptic Survey Telescope (LSST)
  - Image transfer south-to-north for transient alert processing
  - Data Release Catalog
  - Control Information
  - Calibration Information
  - User access of scientific data in the Data Access Centers
- Atacama Large Millimeter Array (ALMA)
- U.S. Astronomy Observatories in Chile
  - CTIO, Gemini-South, SOAR, others
  - Dark Energy Camera (DECam)
- LHC Open Network Environment (LHCONE)
  - HEP experiments are moving towards more dynamic workflows and data management,
  - Significant increases in utilization of network resources in an active way
- Ultra-High Definition (UHD) Video
  - 4K UHD (8.3M pixels) and 8K UHD (33.2 Mpixels)
  - Minimum bandwidth requirement of 300Mbps with low packet loss and low jitter rates
- Capacity for large-scale testbed networks, especially SDN and Future Internet
  - FIA applications request a wide-range of network services provided by a hybrid network services environment

Testbeds in Place

FIBRE

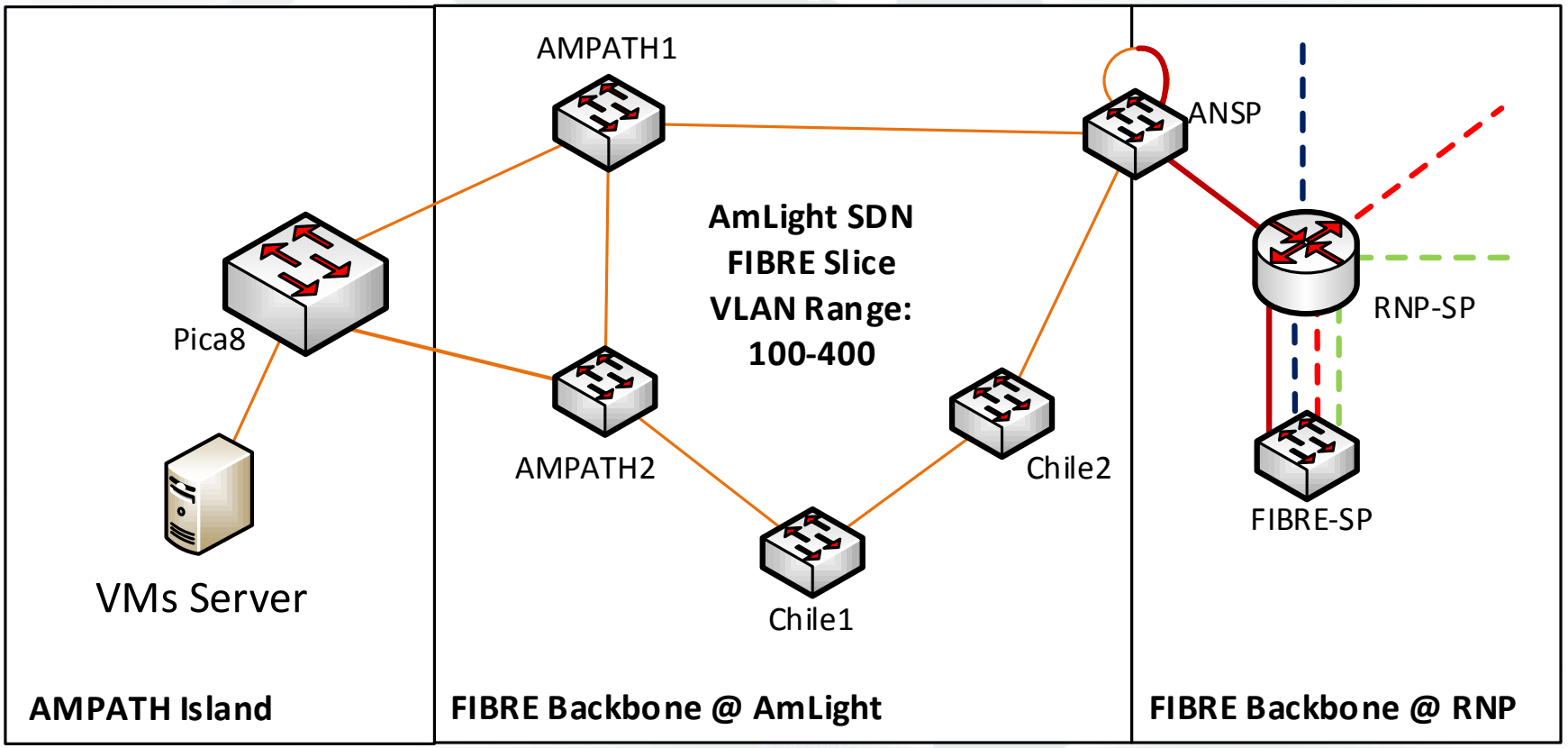
AtlanticWave-SDX

ONOS/SDN-IP

FIBRE Testbed @ AmLight

- In partnership with RNP, a FIBRE testbed island was installed at AMPATH
- More than 300 VLANs required between islands (*hard to provision*)
- AmLight SDN slicing capability is being used to interconnect islands
  - Native OpenFlow network
- Great use case to understand how complex applications could be benefit of AmLight SDN:
  - Also great opportunity for RNP to manage and operate an OF backbone

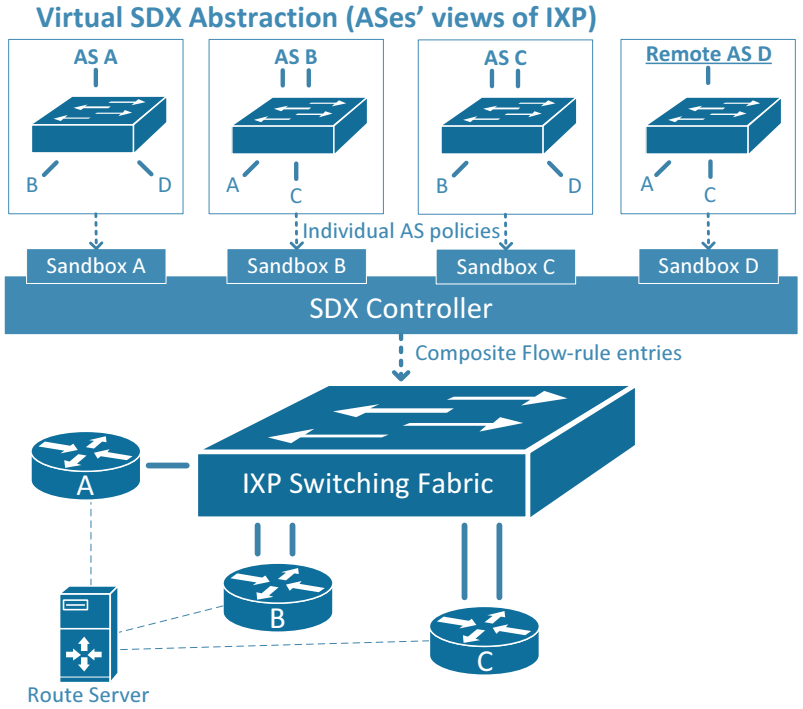
FIBRE Testbed @ AmLight



SDX & AtlanticWave-SDX

Virtual SDX Abstraction

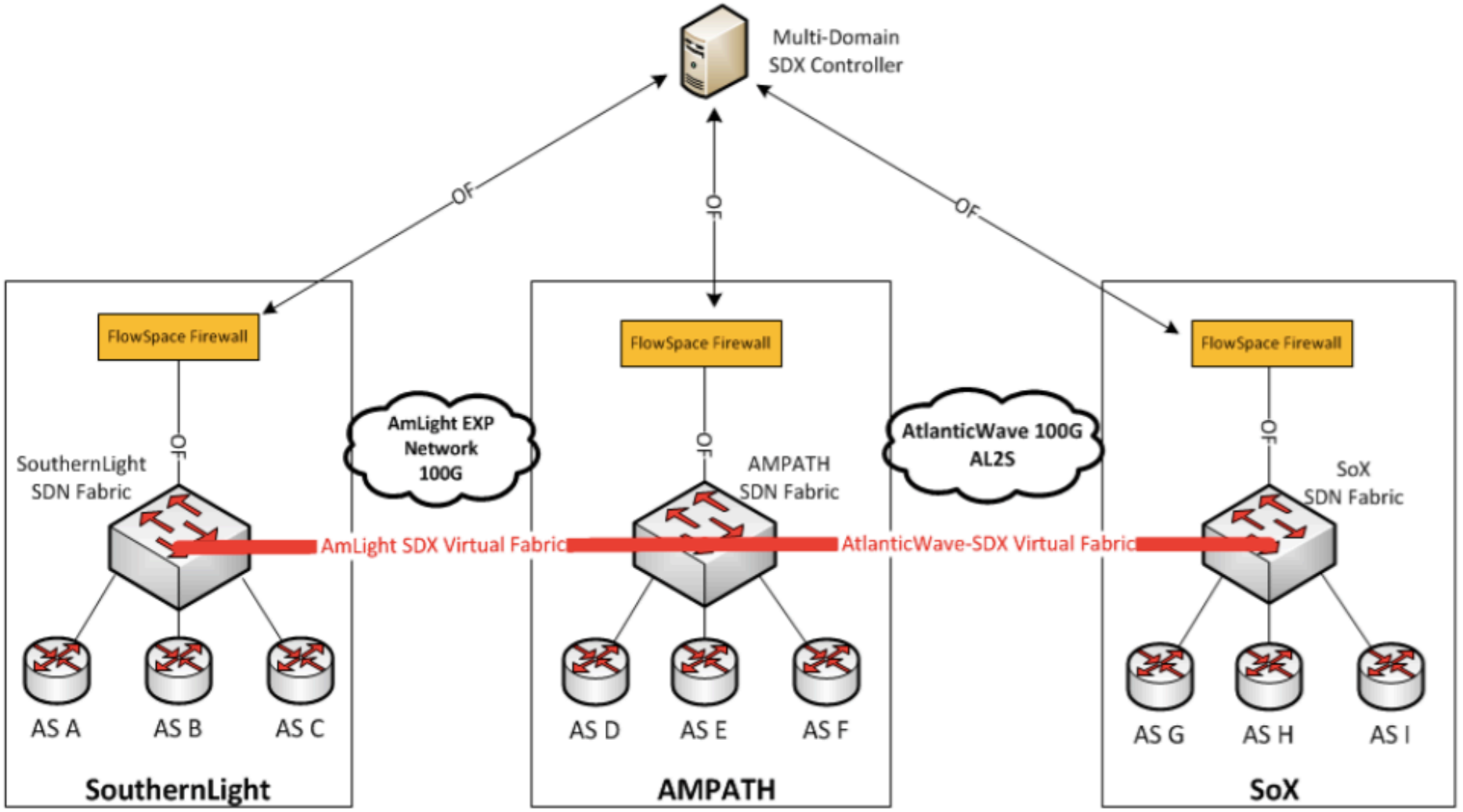
- In a traditional IXP
  - Each participating AS connects a BGP speaking border router to a shared layer2 network, and
  - A BGP route server
- In an SDX
  - Each AS can run SDN applications that specify policies
  - The SDX combines the policies of multiple ASes into a single coherent policy for the physical switches
  - The SDX controller gives each AS the illusion of its own virtual SDN switch connecting its border router to each of its peer ASes
- The Virtual SDX concept is important for both:
  - Scaling the SDX architecture, and
  - Providing end users (or their application developers) with direct control over their own traffic throughout the network



AtlanticWave-SDX - Goals

- Multi-Domain Experimental Software-Defined Exchange
  - Works as a Virtualized Service/Slice
- Environment for researchers & practitioners to collaborate at-scale
  - Prototyping of SDN applications & services
  - Scientific instruments on demand
  - Application specific infrastructure on demand
  - Interconnect international testbeds: GENI, FIBRE, GEÁNT, etc.
- Create a multi-domain high capacity distributed exchange point interconnecting these RXPs:
  - MANLAN – NY
  - MAX GIGAPOP – DC
  - SOX – Atlanta
  - AMPATH – Miami
  - SouthernLight – Sao Paulo

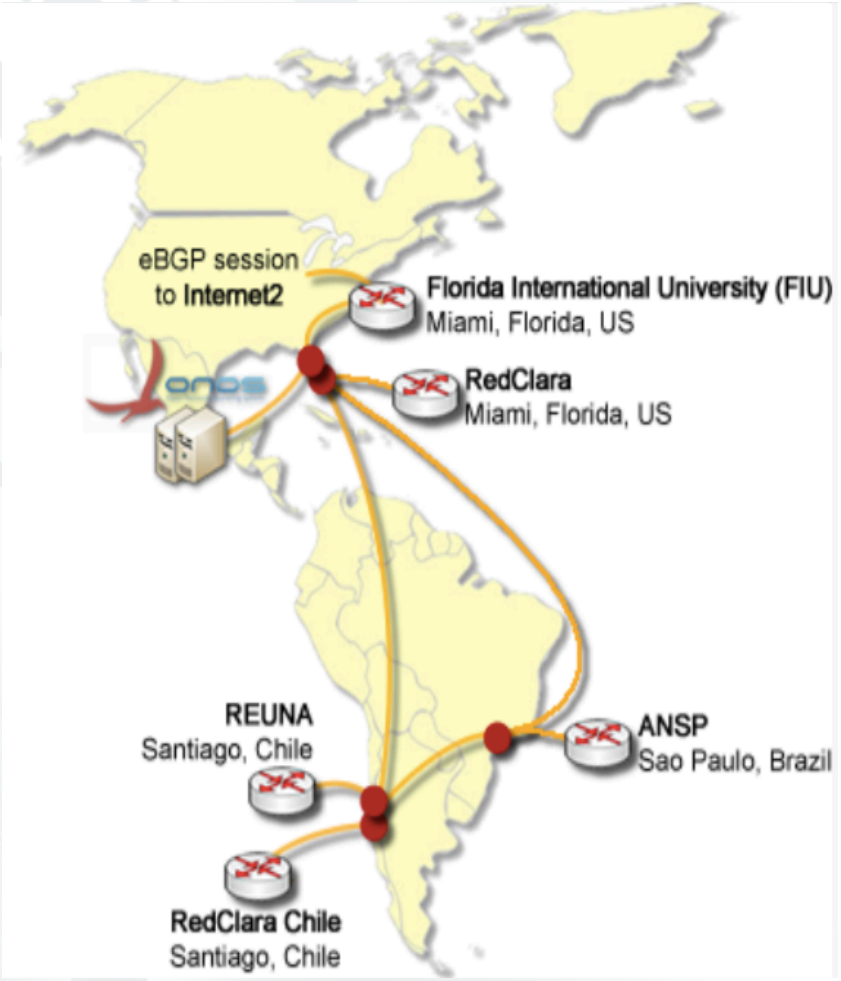
Multi-Domain SDX - Topology



ONOS/SDN-IP

ONOS/SDN-IP:

- Openflow controller developed by On.LAB
- Four main apps (NFV, NFaaS, Multi-Layer SDN Control and SDN-IP)
- SDN-IP application on ONOS enables SDN islands to seamlessly peer with the rest of the Internet.
- No need for dedicated routers



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