Use of SDN in the AmLight intercontinental research and education network

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Who we are

AMPATH:

- Academic International Exchange Point (IXP) in Miami, Florida
- Interconnects Latin America and Caribbean RENs to other RENs in the world

SouthernLight:

- Academic IXP in São Paulo, Brazil
- Interconnects all Brazilian RENs and RedCLARA

AmLight:

- International network links that connect the U.S. to Latin America

Partners: FIU, NSF, ANSP, RNP, RedCLARA, REUNA and AURA

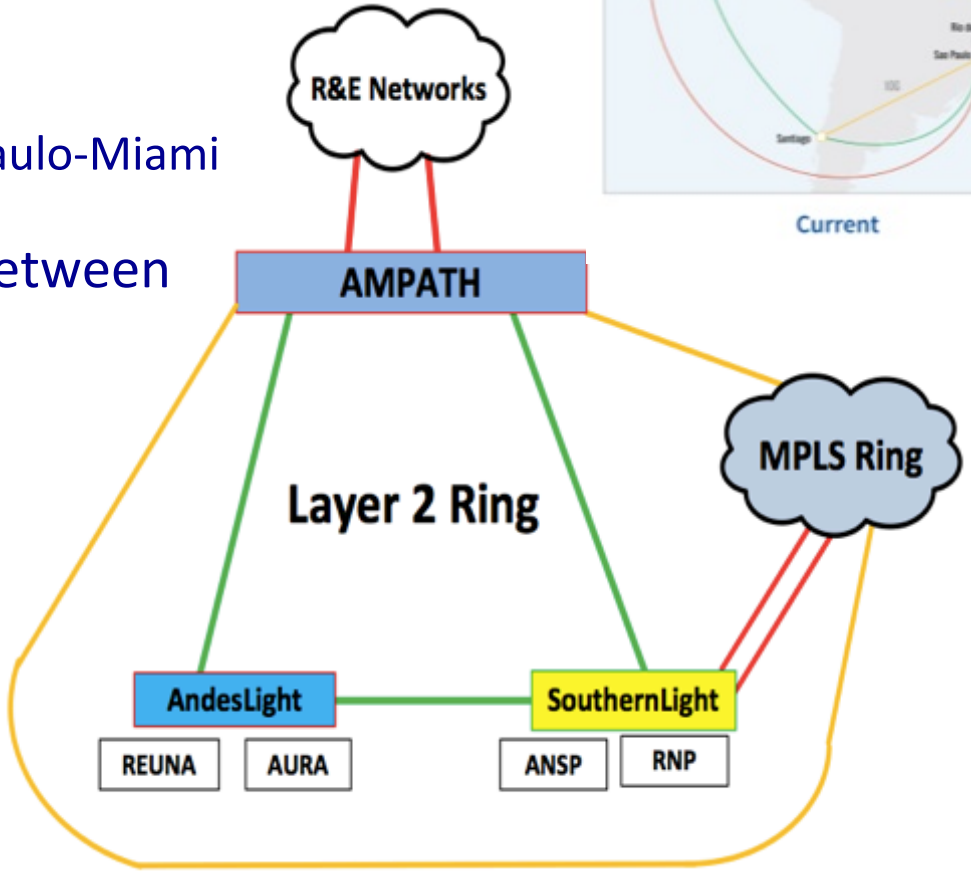
AmLight Today

A set of 4 x 10G links with two topologies:

- SDN (Layer 2) Ring:
  - Miami-São Paulo-Santiago-Miami (green)
- MPLS (Layer 3) Ring:
  - Miami-Fortaleza-Rio-São Paulo-Miami (yellow)
- Later this year: 100G link between São Paulo and Miami
- Mutual Redundancy

Connections:

- 13 RENs
- > 1000 Universities and Research Centers



AmLight Before SDN

- Configuration of circuits was based on static VLANs
  - High degree of coordination between multiple network teams
- Multiple instances of per-VLAN RSTP were used
  - Interoperability issues
  - Constrained redundancy with network operators
- Redundancy between rings was created with:
  - IEEE 802.1ad (QinQ) + L2VPNs
  - Additional ports to implement redundancy across rings

Why then move towards SDN?

Key motivations:

Improving operations efficiency

Introducing network programmability

Motivation 01: *Improving Operations Efficiency*

Requests for Layer2 circuits was increasing

- Provisioning process was complex
- Some circuits involved up to seven different networks
  - Requiring a high level of coordination
  - Engaging diverse network teams

- Multiple technologies were involved
  - From Layer 1 to MPLS

- Some circuits took weeks or even months to be provisioned

Motivation 02: Introducing Network Programmability

- Lack of support for network programmability limited applications
  - Little to no support for network-aware applications
- Researchers could only view the network status (SNMP)

Scenario Deployed (1/2)

Activated OpenFlow 1.0 + Hybrid Ports

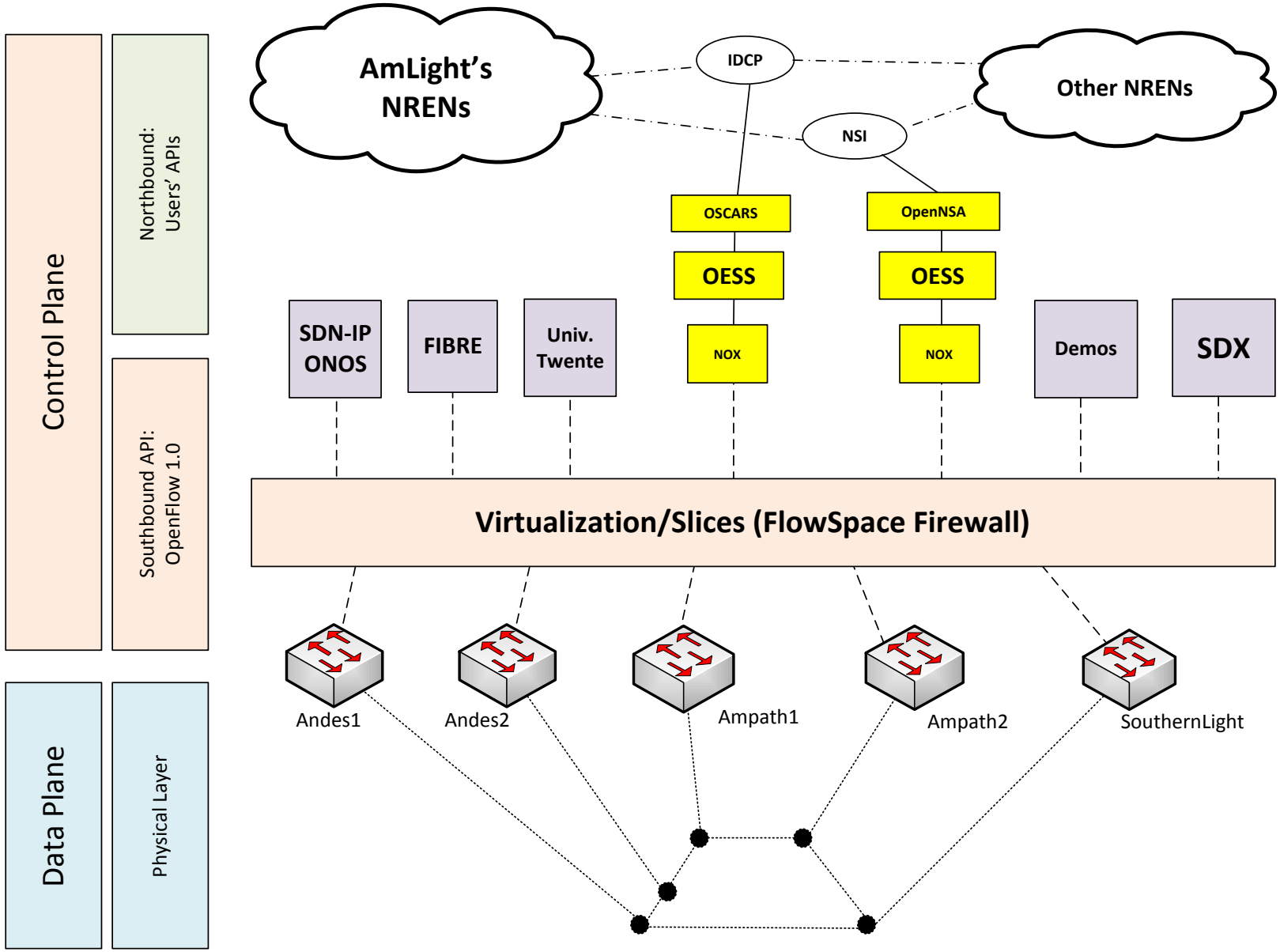
A. Improving operations efficiency:

- Internet2's OESS
- OSCARS - IDCP
- OpenNSA - NSI

B. Introducing network programmability

- Internet2's Flow Space Firewall

Scenario Deployed (2/2)



Findings (1/2)

A. Improving operations efficiency

	Average time to provision a new circuit		Avg. number of e-mails exchanged	
Domains Involved in the path	**before SDN**	**with SDN**	**before SDN**	**with SDN**
RNP, ANSP, RedClara, AmLight, Internet2, ESNET	5 days	< 5 minutes	10	0
Other networks (if IDCP or NSI supported)	12 days	< 5 minutes	65	0
Other networks with NO IDCP or NSI - < 3 networks in the path	5 days	-	10	-
Other networks with NO IDCP or NSI - > 3 networks in the path (Americas)	12 days	-	65	-
Other networks in other continents not using IDCP or NSI	45 days	-	100	-

Findings (2/2)

B. Introducing network programmability

	Network Access and Programmability	
	Before SDN	After SDN
Network View	SNMP	SNMP and Openflow
Provisioning Defined by the User	-	Full Openflow access through a dedicated slice
Multipath experiments	Static paths offered	
Flow controlled hop-by-hop	-	

Network programmability is the main achievement of this project:

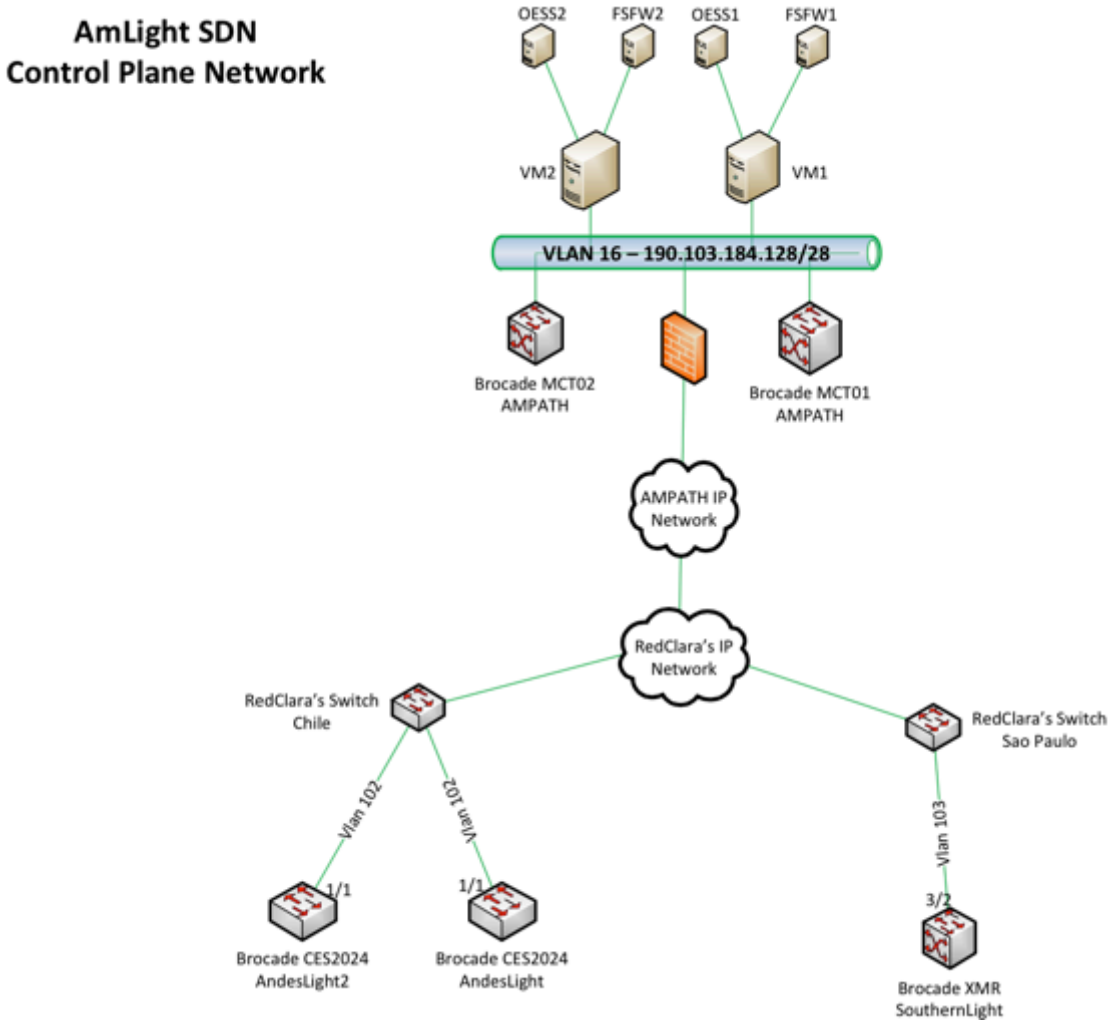
- *Network-aware applications will have AmLight as a real platform for innovation*

Some Lessons Learned

- Legacy protocols and old switching line cards have limitations
  - LACP, Counters, Ethertypes
  - Increased complexity of the deployment
    - Dedicated additional ports to work around these limitations
- Out-of-band/Control Plane network could be challenging
- Convergence methodology has to be improved
  - Specially in long-haul links

Out-of-band Control Plane Network

- Out-of-band network built for transmission of OpenFlow control messages between Controller and OpenFlow devices
- RedCLARA IP backbone was used for this solution



Future

- Explore and add new features related to troubleshooting and security
- Create a *Software-Defined Internet Exchange* (SDX)
  - involving AmLight, and
  - inter-connecting the U.S. and Brazil
- Migrate to Openflow 1.3
  - Metering and improve the network convergence

Thank You!

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  - Florida International University
  - Latin American Research and Education community
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