



Open Science Data Cloud
Partnership for Int'l Research & Education
Amsterdam Workshop
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AmLight SDN Testbeds; The Future of Collaboration

Heidi L. Morgan
Florida International University
<heidi@fiu.edu>



Outline

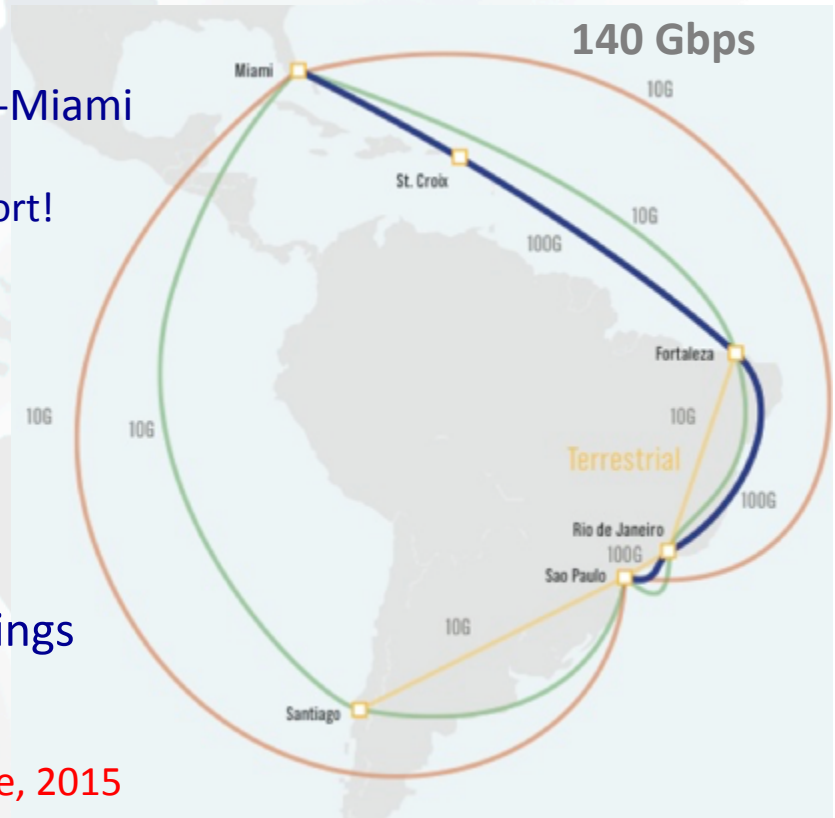


- The AmLight Consortium network overview
- Creating Testbeds; Programmability @ AmLight SDN for Users
- Using Testbeds to Facilitate Research
- Current Testbeds
- The Future of AmLight SDN – AtlanticWave SDX

Describing AmLight

4 x 10G links and two topologies to increase resilience and support for experimentation:

- **SDN ring:** Miami-Sao Paulo, Brazil-Santiago, Chile-Miami
 - 20 Gbps of total capacity
 - Full Openflow 1.0 and network virtualization support!
 - Uses Brocade devices
- **MPLS ring:** Miami-Brazil-Miami
 - 20 Gbps of total capacity
 - Layer 2 support
 - Uses Juniper devices
- Mutual redundancy between SDN and MPLS rings



OpenWave Supplement to AmLight:

- New 100 Gbps between Sao Paulo and Miami- June, 2015
- Part of the SDN domain
- Focused on experimentation

Total capacity in place for the next 2 year: 140 Gbps

Programmability @ AmLight SDN for Users



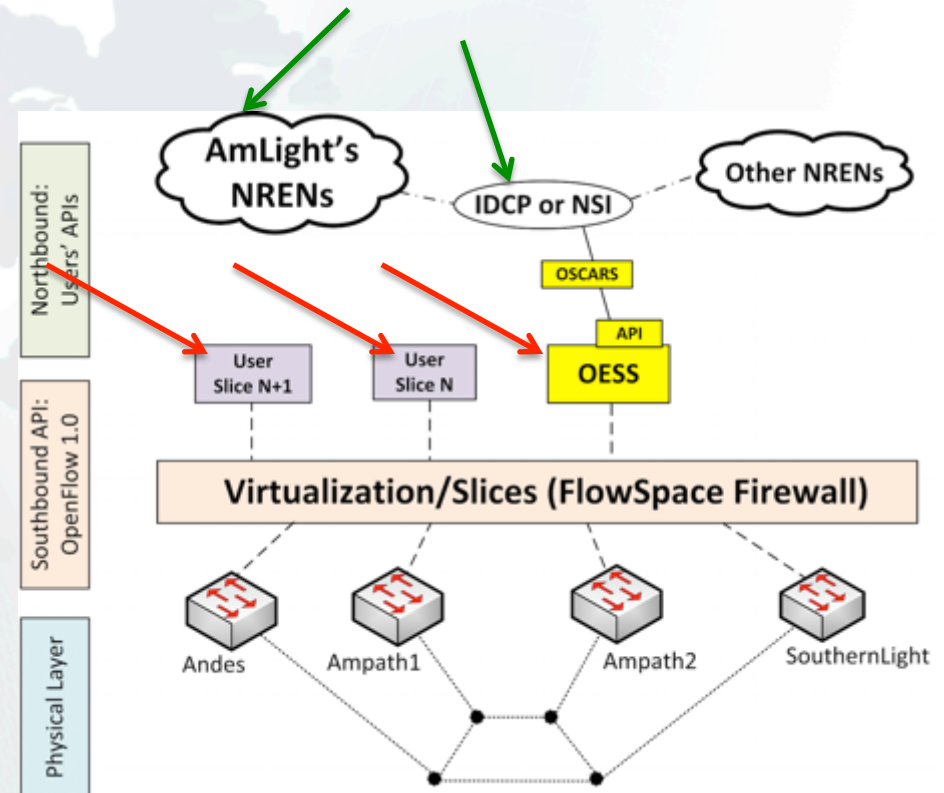
Two possible **interfaces** to use AmLight SDN offered to users and researchers:

OpenFlow (currently 1.0, 1.3 in the future)

- OpenFlow dedicated slices are created by the users
- Users will have their own VLAN ranges
- Different virtual topologies available
- Layer 2 and / or Layer 3 matches
- Low level configuration

NSI v2 – Network Service Interface

- High level abstraction for layer 2 multi-domain provisioning
- No need to know the topology and physical devices/configurations
- Layer 2 circuit provided as a service: easier to isolate from production traffic



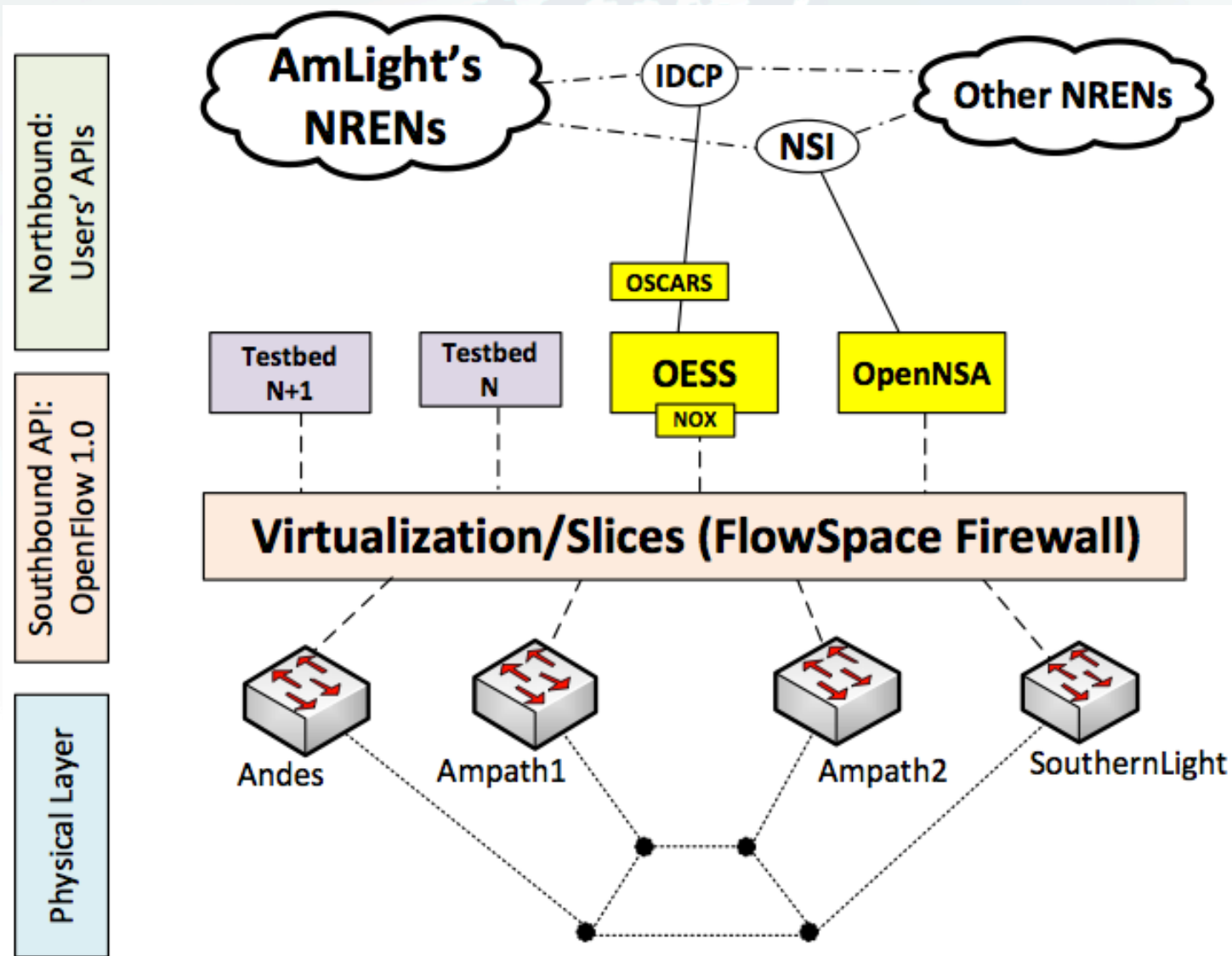
Describing AmLight SDN – Using OpenFlow (1)



How network testbeds for users are created:

- To enable testbed creation, network virtualization is used:
 - Virtual networks are based on switch ports and VLANs
 - A set of Interfaces and VLANs creates a slice
 - Slices allow users to have their own testbeds/virtual networks
- How does AmLight support slices?
 - Internet2 Flow Space Firewall (FSF) is being used to create slices
 - FSF talks OpenFlow 1.0 to controller and network devices
 - Provides strong isolation between slices
 - Filters OpenFlow messages based on Interfaces and VLANs
 - Provides filter to protect all slices: # of flows inserted and flows inserted per second.
 - Supports a high # of parallel slices

Describing AmLight SDN – Using OpenFlow (2)

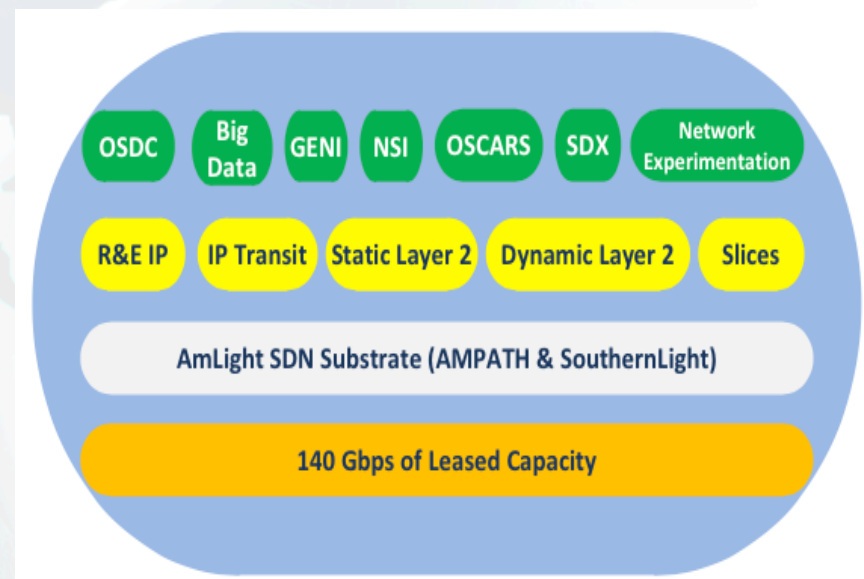


AmLight SDN – Production Slice



Currently almost all transport services provided by AmLight run on the top of a single slice called the:

- **AmLight SDN Slice**
 - Comprised of Layer 2 circuits
 - Created by a Web GUI
 - Supports IPv4/IPv6/Multicast



AmLight SDN Slice Configuration:

- OpenFlow Controller: **NOX**
- Orchestrator: **Internet2 OESS**
 - Supports Layer 2 provisioning via Web User Interface
 - Supports OSCARS (multi-domain provisioning)
- Deployed August 2014

Facilitating Research



Why use AmLight as part of your testbed instead of using simulation?

- Real time Constant and Long Network Delays
 - 106 ms (rtt) Miami-Sao Paulo through Atlantic rim
 - 140 ms (rtt) Miami-Sao Paulo through Pacific rim
- Real devices, real challenges
 - Brocade MLXe and CES switches in use
 - A testing environment is available for ratification (to test applications before going production – same models as production)
- With a network slice using OpenFlow:
 - Different virtual topologies are available
 - Ring, linear, star
 - Your own VLAN range
 - No need to contact NOC or Engineers for any provisioning activity
- 100+ Gbps of capacity for experimentation!

Who is using AmLight SDN?

Current Testbeds (1/2)

Each Testbed has it's own Slice

- **NSI testing deployment**

- AmLight uses OpenNSA for NSI inter-domain communication
- OpenNSA is a software agent of NSI protocol developed by Nordu.Net
- OpenNSA doesn't support Openflow as backend for network configuration
- AmLight has developed their own backend to integrate with the SDN network
- As this code and the NSI protocol are new, a separated slice was created to avoid impact to the production traffic
- Using the real network but in a dedicated slice with no impact for production

- **OpenFlow Statistics Validation**

- PhD study at the University of Twente, The Netherlands
- OpenFlow Statistics showed bad values coming from some OpenFlow switches
- A partnership was created to evaluate AmLight switches
- The work is all being done remotely
- Fundamental for load-balancing applications in the future (big data applications)

Who is using AmLight SDN?

Current Testbeds (2/2)

- Interconnecting Testbed's Islands with OpenFlow
 - In partnership with RNP, a FIBRE testbed island is being installed at AMPATH
 - More than 400 VLANs required between islands (hard to provision)
 - AmLight SDN slicing capability will be used to interconnect islands natively (no L2VPN required)
- Testing new controllers and applications in a separated slice
 - New controllers and applications can be easily added for tests (Ryu, ONOS, etc.)
 - Two orchestrators in place at the same time with no overlapping
- Demonstrations
 - Internet2 Multi-Domain Slices (Oct 2014 I2 Tech Exchange Meeting)
 - How multiple slices from different networks could look like one single slice?
 - We showed this was possible and easy to manage
 - Internet2 Inter-Domain IP connections (Apr 2015 I2 Global Summit)
 - How to interconnect SDN islands using IP?

AmLight Near Future Challenges



- Quality of Service
 - Bandwidth Guarantee in an OpenFlow/SDN network
 - Dynamic application load-balancing
- Security
 - Secure access with network virtualization
 - Isolation between applications
- Networking
 - Multipath TCP
 - Scalability
 - IP/IPv6/Multicast Routing
 - Inter-SDN domain forwarding (SDX)

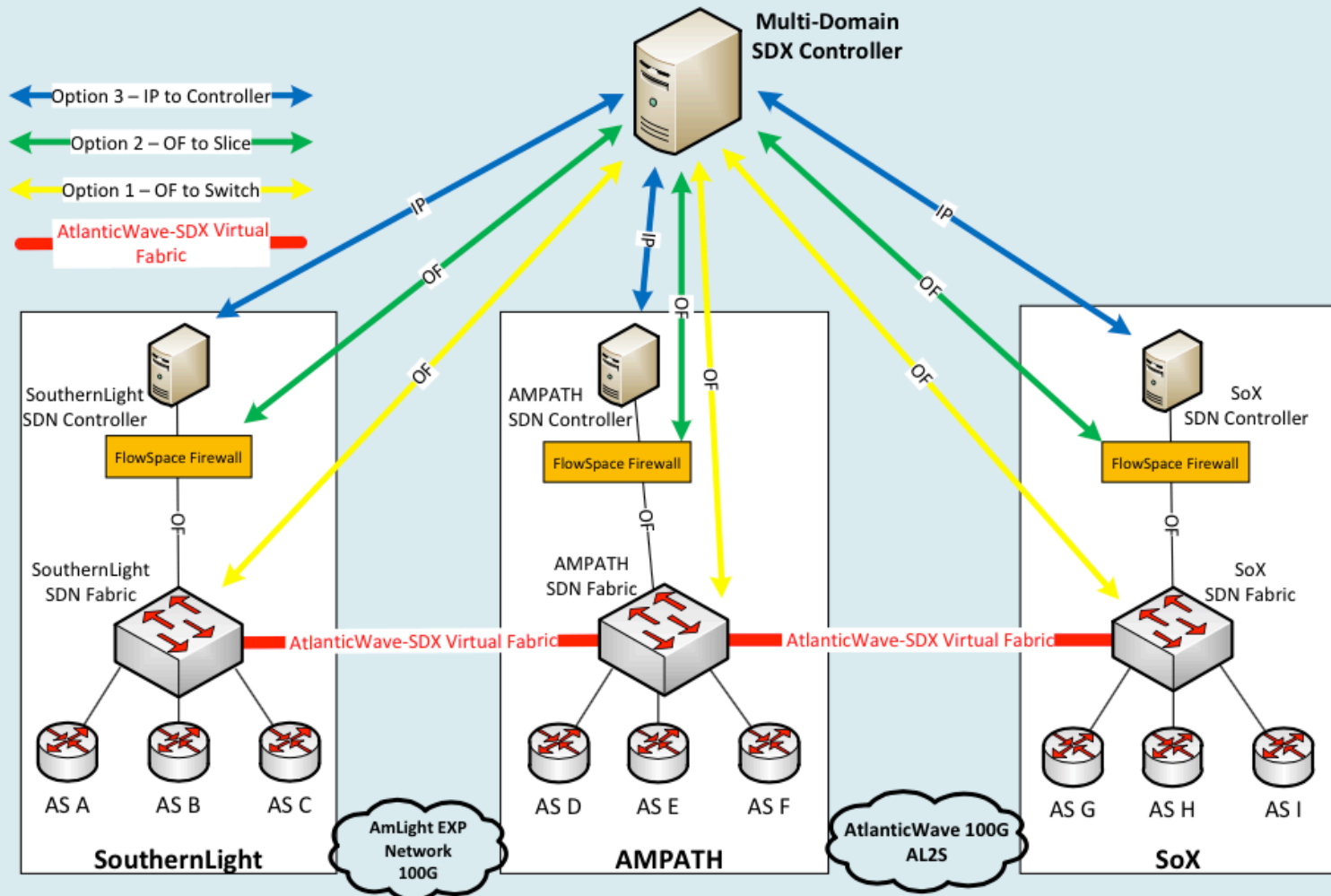
Future (1/2)

AtlanticWave-SDX Project Goals:

- Distributed Experimental Software-Defined Exchange
- Environment for researchers & practitioners to collaborate at-scale
 - Prototyping of SDN applications & services
 - Scientific instruments on demand
 - Application specific infrastructure on demand
- SDX is a Virtualized Service meaning a Dedicated Slice
 - Create a multi-domain high capacity distributed exchange point interconnecting these RXP's:
 - MANLAN – NY
 - MAX GIGAPOP – DC
 - SOX – Atlanta
 - AMPATH – Miami
 - SouthernLight – Sao Paulo
- Increase bandwidth between AmLight users and Internet2
 - From 20 to 100Gbps
- Full support for OpenFlow between AmLight and Internet2
 - Internet2 AL2S and AmLight SDN directly connected via OSCARS

Future (2/2) – Multi-Domain SDX

AtlanticWave-SDX – SouthernLight, AMPATH and SoX



Focused Technical Workshop:

International OpenFlow/SDN Testbeds

- Hosted by Florida International University and Internet2, March 31-April 2, 2015
- Objective:
 - Bring together network, software, and data management experts to discuss International OpenFlow/SDN Testbeds
- Outcome includes:
 - Developing best practices for challenge areas
 - Expanding community knowledge base
 - Providing resources for improved testbed development and operations
- <https://meetings.internet2.edu/2015-ftw-international-openflow-sdn-testbeds/>



Thank You!

AmLight SDN Testbeds; The Future of Collaboration Questions ???

PI for AmLight: julio@fiu.edu
Co-PIs: heidi@fiu.edu, chip.cox@vanderbilt.edu
Sr. Network Engineers: jbezerra@fiu.edu, jgrace@fiu.edu

