AmLight ExP

2016 GLIF Meeting

Miami, Sep 29th 2016

AmLight backbone transition to SDN: Celebrating the second anniversary

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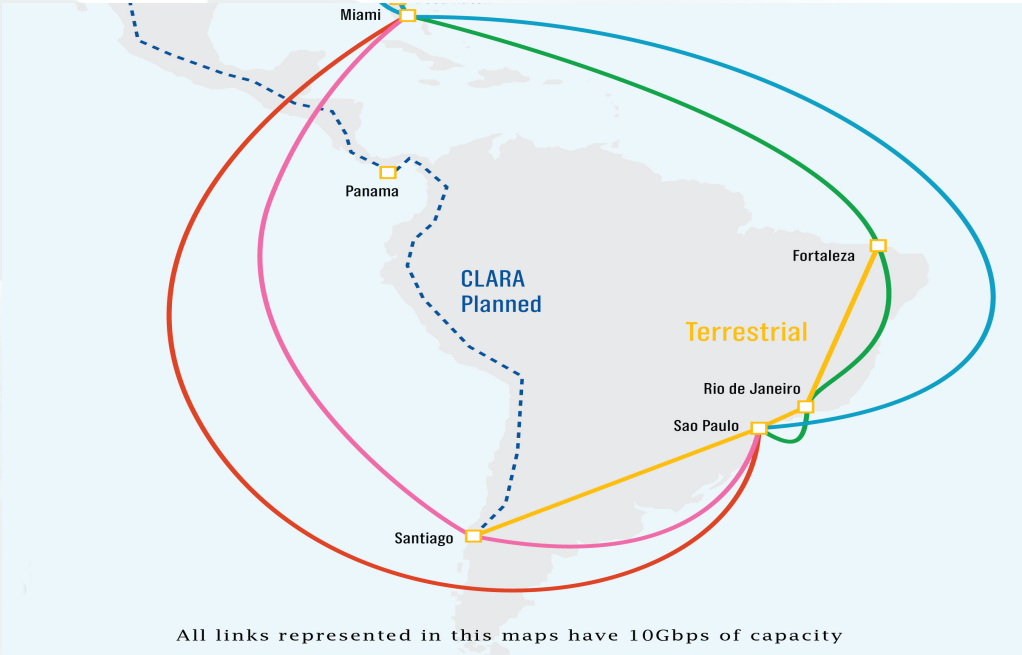
Outline

- What is AmLight?
- AmLight SDN launch
- Motivations

AmLight

- AmLight is a project of the National Science Foundation at FIU
  - Award# ACI-0963053
- Started in 2010
- It's goal is to support the needs of U.S.-Latin America research and education communities to advance discovery and scholarship

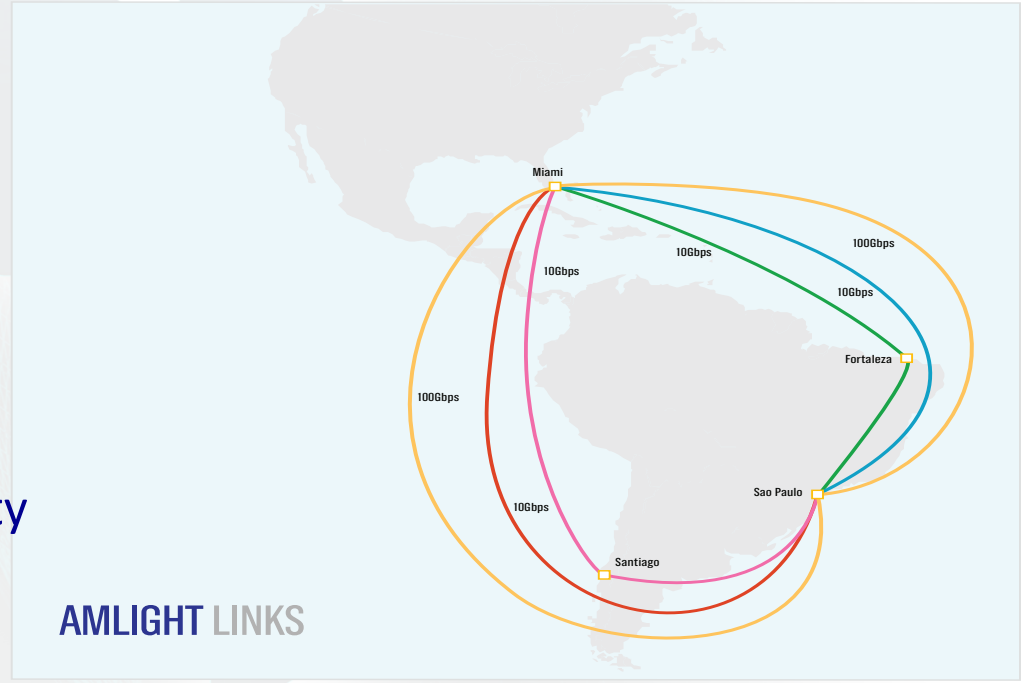


AmLight Express and Protect (AmLight-ExP)

- AmLight-ExP is a project (2015-2020) of the National Science Foundation
  - Award# ACI-1451018
- Introduces spectrum capacity between the U.S. and Brazil
- Continues evolving a rational network infrastructure, using both spectrum and leased capacity

AmLight-ExP - Today

- 100G Miami-São Paulo, Atlantic
- 100G Miami-São Paulo, Pacific
- 4x10G links, landings in São Paulo, Fortaleza, Santiago
- 240G of aggregate bandwidth capacity
- 100G ring to include Santiago and Fortaleza in November 2016



AmLight SDN Launch – 2 years ago

Key motivations to move to SDN

1. **Improving operations efficiency**
   - *How to handoff to the user the layer 2 provisioning inside AmLight?*
   - *How to improve layer 2 multi-domain provisioning?*
     - *IDCP/OSCARS, NSI/OpenNSA*

2. **Introducing network programmability**
   - *How to support network testbeds managing the network infrastructure in a secure way?*
   - *How to add and evaluate new control planes in parallel?*

Direct Achievements from the SDN deployment

1 - Improving operations efficiency:

	Average time to provision a new circuit		Avg. number of e-mails exchanged	
Domains involved in the path	***before SDN***	***after SDN***	***before SDN***	***after SDN***
RNP, ANSP, RedCLARA, AmLight, Internet2, ESnet	5 days	< 5 minutes	10	0
Other domains using OSCARS or NSI support	12 days	< 5 minutes	65	0

Julio Ibarra, Jeronimo Bezerra, Heidi Alvarez, Donald A. Cox, III, Michael Stanton, Iara Machado, and Eduardo Grizendi: "Benefits brought by the use of OpenFlow/SDN in the AmLight intercontinental research and education network", IM 2015 - 14th IFIP/IEEE Symposium on Integrated Network and Service Management, Ottawa, Canada, 11-15 May, 2015

Direct Achievements from the SDN deployment

2. 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	-	

Lessons Learned

1. SDN and OpenFlow have the potential of helping in many ISP activities
   - Especially multi-domain provisioning

2. Caution before deploying SDN applications into production
   - Gaps in troubleshooting, implementation of OpenFlow protocol, etc.
   - Many opportunities to those interested in new technologies
   - Most of the OpenFlow switches tested had immature code
   - Many features missing, poor code development, lack of tests before releasing code, etc.

Lessons Learned [2]

1. Troubleshooting is very time-consuming and frustrating
   - In most of the cases, vendors lacked proper tools for troubleshooting
   - New tools are needed urgently

2. Immature OpenFlow code = risks to production network services
   - Devices crashed due to unsupported OpenFlow messages
   - Validating OpenFlow software is very important

3. Slicing proved to be very useful for testing different control planes
   - Useful in revealing potential risks before deploying into production
   - Encourage researchers to use slicing as a testing methodology

Change of Culture @ AmLight

- From Network Engineering to SDN/Research Engineering?
  - Agile/SCRUM, Python, Java, *unittest* are part of daily discussions of the network engineering group
- Training on Software Development (programming languages, processes, etc.)
  - Python for Network Engineers was just the beginning
- Strong focus on software instead of hardware
  - Team was trained to follow the Agile/Scrum methodology
  - AmLight started to collaborate with the ONOS development (ONOS Brigade)

Network Engineer 2.0 (?)

- Main challenge was (and still is):
  - How to convince some network engineers (not managers!) that SDN "might" be useful
  - It is difficult to learn a new paradigm
- Once convinced, training, training, training!
  - Going back to school was pretty hard for some of them
  - FIU has full access to Lynda.com – easy access to great courses!
- Identity "crisis": *what am I now: a network engineer, DevOps, SDN/Research engineer?*
  - *Maybe Network Engineer 2.0?*
  - Recruiting *Network Engineer 2.0* people is challenging

New opportunities for collaboration

- With the experience acquired from the SDN deployment, new projects were created:
  - IRNC AtlanticWave-SDX: development of an intercontinental multi-domain Software-Defined Exchange (SDX)
  - IRNC AmLight Express and Protect (AmLight-ExP): expand the current SDN deployment to manage both leased and optical networks
  - NSF REU, SwitchOn, LSST are projects that will leverage the SDN deployment

- Some partnerships have evolved to a whole new level:
  - FIU and ANSP have merged their IT teams to guarantee an unified approach to the U.S.-South America connectivity
  - AmLight and Open Laboratory: AmLight is engaging with ONOS development

Outreach

- Presentations: 41, from OpenFlow to optical and SDX
- Papers: 5, from experience to academic research (1 best experience paper award)
- Tools: 3, focused on troubleshooting
- Network testbeds: 6, including ONOS, FIBRE and demos
- More info: www.sdn.amlight.net

Tools Developed @ AmLight

- Three troubleshooting tools developed so far:
  - Testbed Sanitizer (presented at the 2015 GLIF Meeting)
    - Creates a security layer between the OpenFlow switch and OpenFlow applications
    - Filters improper OpenFlow messages sent to the switches
    - Proof of concept only
  - OpenFlow Sniffer (presented at the TechEx 2015)
    - Used to monitor the control plane communication between switches and OpenFlow applications
    - Helps to identify both sides of the communication when proxies/slicers are present
    - Available: http://github.com/amlight/ofp_sniffer

Tools Developed [2]

- SDNTrace (briefly mentioned at TechEx 2016)
  - Tool to help trace the data path in OpenFlow networks
    - Validates the data path
  - Useful when troubleshooting flow issues when the network has multiple flows and devices
  - Available: http://github.com/amlight/sdntrace
- OpenNSA (NSI Agent) backend to OESS
  - OpenNSA backend to send circuit creation requests to OESS
  - AMPATH has been using OpenNSA since 2014
    - one of the first IXP to support NSI in production (no side device)
  - Available: http://github.com/jab1982/opennsa

Goals for the future

- Install and manage Spectrum using SDN
  - Integrate packet and optical layers
- Deploy the SDX controller in production
  - Prototype will be available by the end of 2016
  - Demo of our SDX prototype tonight

Goals for the future

- Migrate to OpenFlow 1.3
  - Running some experiments with Corsa and other vendors
- New tools: SDN Looking Glass
  - Unified GUI interface to operate OpenFlow networks
  - Independent of slicers/virtualization: full network visualization
    - Statistics
    - Passive and Active tests
    - Real time monitoring
  - Independent of OpenFlow controller: Ryu, ODL and ONOS supported
  - ETD: February 2017

Conclusion

- Deploying SDN pushed AmLight to *reinvent* itself
  - We continue learning how to operate SDN in a production environment
  - In some cases, CAPEX increased, while OPEX kept the same or decreased
  - Troubleshooting is still complex and time-consuming, but it is part of the game
- Facilitating development of SDN applications
  - Validation methodology for the controller
  - Bring us your Testbeds
- After two years, we consider the investment in SDN a success
  - Looking forward to enhance collaboration with other R&E networks

Thank You!

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  - Florida International University
  - Internet2 and GRNOC
  - Latin American Research and Education community
  - The many national and international collaborators who support our efforts

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