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Coexisting Production and Experimental Testbeds at AmLight: A Secure Approach

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Outline

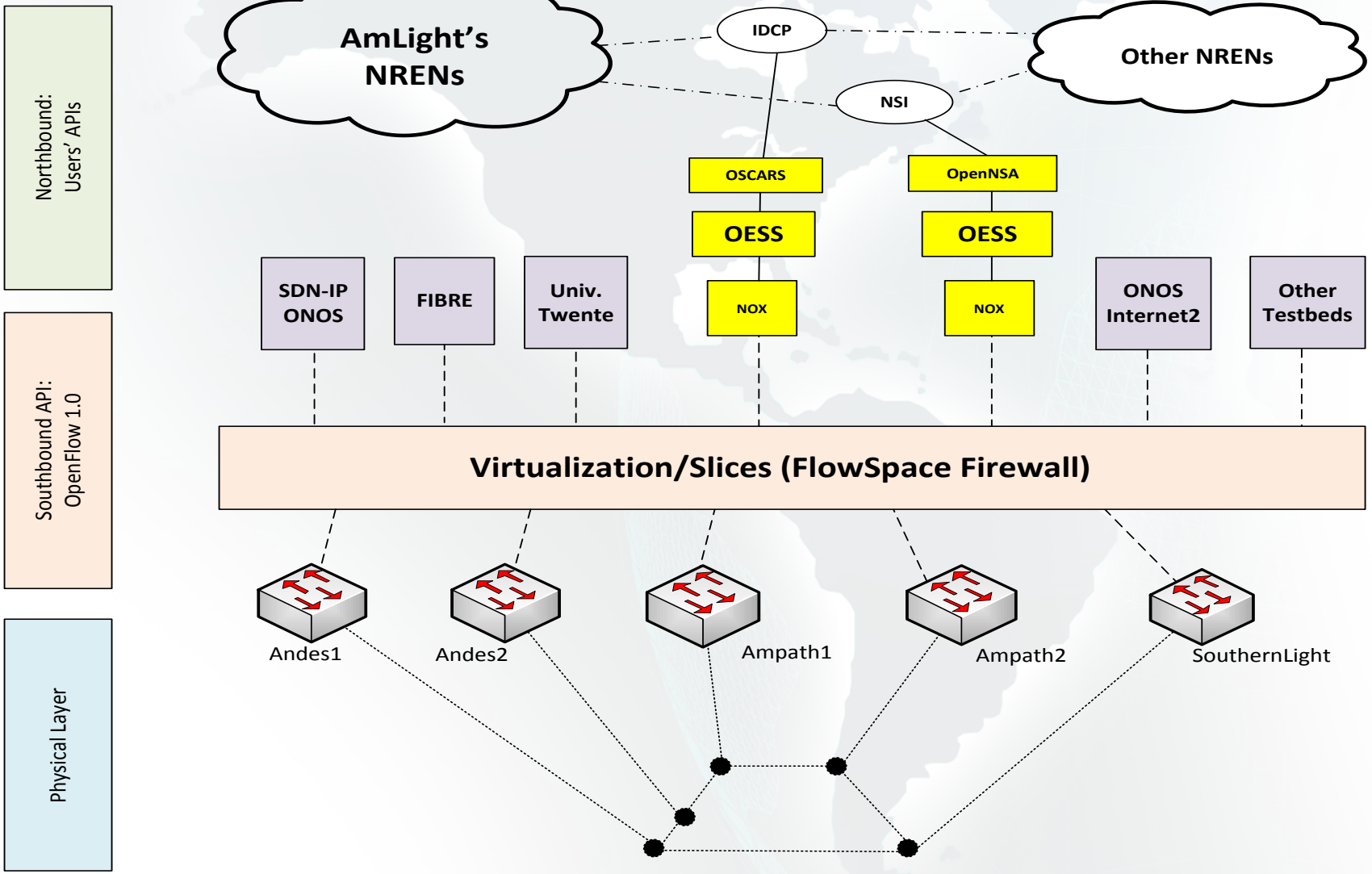
- Context
- Motivation
- Architecture
- Methodology
- Results
- Future

Context

AmLight is a Distributed Academic Exchange Point

- Production SDN Infrastructure (since Aug 2014)
- Connects AMPATH and SouthernLight GLIF GOLES
- Carries Academic and Non-Academic traffic
  - L2VPN, IPv4, IPv6, Multicast
- Supports Network Virtualization/Slicing
  - Openflow 1.0
  - Flow Space Firewall for Network Virtualization/Slicing
  - OESS for L2VPNs
  - NSI(OpenNSA+OESS) and OSCARS enabled
    - Including AMPATH and SouthernLight
  - Currently 4 slices for experimentation (including ONOS SDN-IP)

Context (2)


Northbound:
Users' APIs
Southbound API:
OpenFlow 1.0
Physical Layer
AmLight's NRENs
IDCP
NSI
Other NRENs
OSCARS
OpenNSA
OESS
OESS
NOX
NOX
SDN-IP ONOS
FIBRE
Univ. Twente
ONOS Internet2
Other Testbeds
Virtualization/Slices (FlowSpace Firewall)
Andes1
Andes2
Ampath1
Ampath2
SouthernLight

Examples – ONOS SDN-IP @ ONS

Examples (2) – ONOS SDN-IP @ ONS

Examples (3) – And more…

- In partnership with RNP:
  - FIBRE (*Future Internet testbeds / experimentation between BRazil and Europe*): how to use an OpenFlow native backbone to interconnect FIBRE islands (or racks)?
  - FIBRE island installed at AMPATH/Miami and using AmLight
- In partnership with Internet2:
  - Internet2 Technology Exchange 2014 – Multi Domain controller managing slices from different SDN domains (Internet2, AmLight, Univ. of Utah and MAX)
  - Internet2 Global Summit – ONOS SDN-IP demonstration
- In partnership with University of Twente:
  - "*Assessing the Quality of Flow Measurements from OpenFlow Devices*"
  - Authors: Luuk Hendriks, Ricardo de O. Schmidt, Ramin Sadre, Jeronimo A. Bezerra, and Aiko Pras
- All of them running on the same production infrastructure

Motivation

- *How to guarantee experimental applications won't affect my "production" slice?*

- FlowSpace Firewall *slices* based on <switch,port,vlan>:
  - No extra filters are possible at this moment

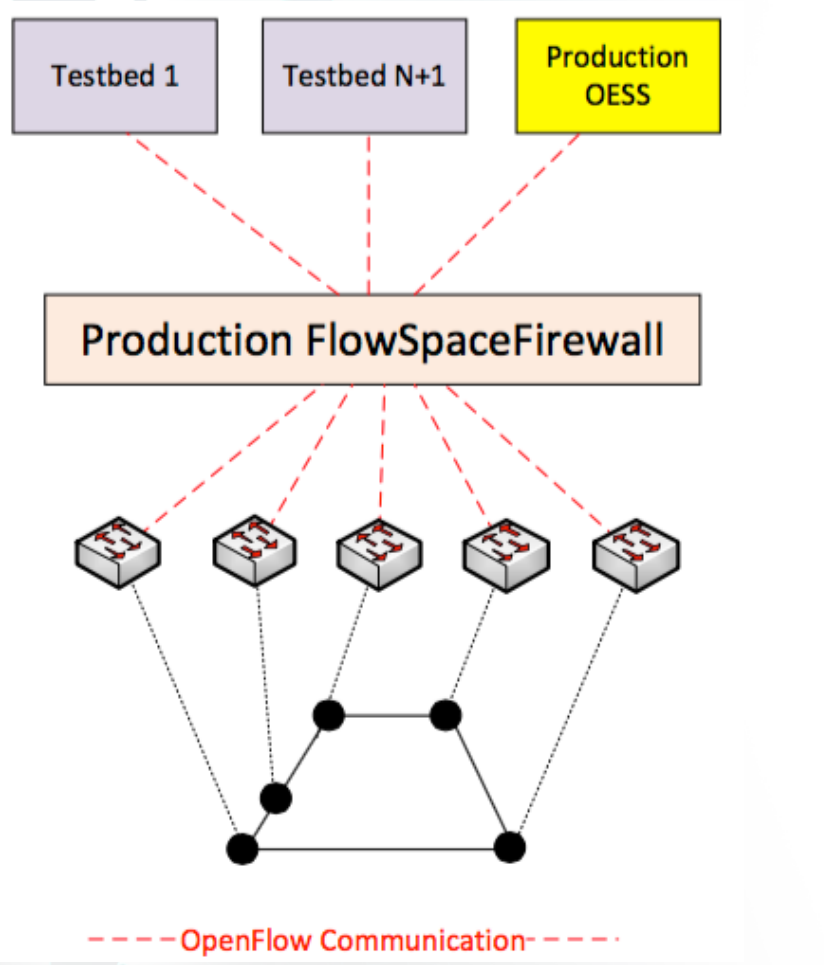
- Multiple OF controllers could manage the same OpenFlow device:
  - Complicated to isolate who is sending specific OF messages

- OpenFlow deployed by some vendors is still "experimental":
  - Unsupported messages could lead to a device crash

- Troubleshooting is still complicated:
  - Logs provided by the SDN stack is still poor

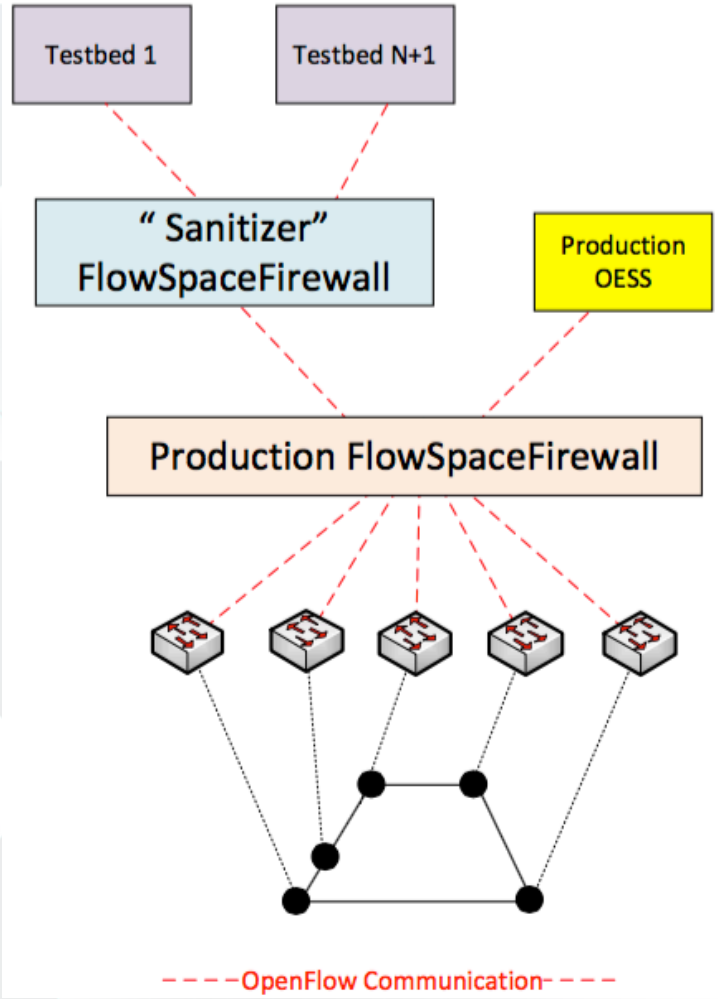
Architecture - Before

- Single FSFW interfacing all apps
- Troubleshooting done through *logs* and *tcpdump* captures
- A testing methodology in place before adding new testbeds:
  - *Understanding of the researcher's applications*
  - *Tests in lab prior adding to the production environment*
  - *AmLight and Researcher manage the SDN app together*
    - *Risky*
  - *Very time-consuming*
  - A few crashes happened, hard to understand "why"



New Architecture – Proof of Concept

- Two Layers of Virtualization
  - Main/Production Layer
  - Experimentation Layer
- Experimentation Layer had a "Sanitizer" module added:
  - Controls what OpenFlow messages can be sent to the "Physical Layer"
  - Allows filters per OpenFlow Type, per-match and per-action
  - Off-loads switches from unsupported OpenFlow messages
- Sanitizer logs transactions and filters based on dictionaries:
  - XML files created as result of OF Tests
  - Detailed logs per slice or per type of message
- OpenFlow Sniffer keeps monitoring all communication
  - To help vendors in their troubleshooting activities



Methodology

- OF Tests:
  - Each device, software version and line card type is stressed in lab
  - Unsuccessful tests are collected and processed
  - When a specific match or action is not supported, it is added to the dictionary
- XML filters
  - Defines the Dictionary to be used by Sanitizer
  - They can be created through field experience
- Filters are stateless:
  - Less powerful but easier to deploy and faster
  - Some issues require stateful filters (future work?)

Examples

- ONOS vs Brocade CES:
  - ONOS sends all flows in a single batch command
  - Brocade CES doesn't support MAC rewrite
  - ONOS logs only have "batch failed"
  - Tcpdump had to be used
  - Satinizer's dictionary has a "CES and Mac-rewrite don't mix" entry and log it
- Brocade CES NI 5.7 vs OpenFlow Vendor type:
  - Some OpenFlow messages type Vendor were forcing Brocade CES to restart the OpenFlow connection
  - Satinizer's Dictionary has a "CES 5.7 doesn't take unknown Vendor ID" filter and log it
- OESS Forwarding Verification vs Brocade MLX-4 4x10G line card:
  - Ethertype 0x88b6 not support, internal trace logs rotating too fast
  - Satinizer's Dictionary has a "LP 4x10G and Etype "A" don't mix" filter and log it

Findings

- Off-loading some filters help switches to focus on “supported” features
  - Also preserves switches internal trace logs queue
- New per-slice logging helps to identify which application sent a specific OpenFlow message
  - Helps researcher to improve his/her SDN application
- Troubleshooting logs helps vendors to reproduce the issue
- A testing methodology before adding anything to production is still required, once some issues require stateful/complex filters

Future

- Testbed Sanitizer was a proof-of-concept to understand how complex and deep the problem is
- Future is unclear: should we develop a production sanitizer? Or should we "force" vendors to create a better code?
- Stateful filters are very important, but they are very complex to deploy
- OF 1.3 will be even more complicated: meters, multi-tables, etc.

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Running production and experimentation at AmLight SDN

Thank You!

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