AtlanticWave-SDX: An International SDX to Support Science Data Applications

Jeronimo A. Bezerra and Joaquín Chung
<jbezerra@fiu.edu>, <joaquin.chung@gatech.edu>

Outline

- Introducing LSST as an Use Case
  - Presenting LSST requirements
- Software Defined Exchanges & Scientific Applications:
  - Motivation
  - Taxonomy
  - Architecture
  - Applications

Introducing LSST requirements

- New scientific instruments that are being designed and deployed will increase the need for large, real-time data transfers among scientists throughout the world:
  - the Large Synoptic Survey Telescope (LSST) being built in Chile will produce 2.7 GB images that must be transmitted to the U.S. in 5 seconds;
  - at the same time, the telescope will be remotely operated from Tucson, AZ.

Introducing LSST requirements (2)

- The LSST operation will consist of two Channels:
  - Control Channel
    - Requires low latency, high priority, and low bandwidth
    - Bandwidth around a few Mbps
  - Data Channel
    - Requires high bandwidth, low latency and high priority
    - 2.7GB images to be sent in 5s: up to 90 Gbps
- End-to-end path must provide high resilience, low delay, multiple paths, high bandwidth and an efficient control plane to act in all status changes

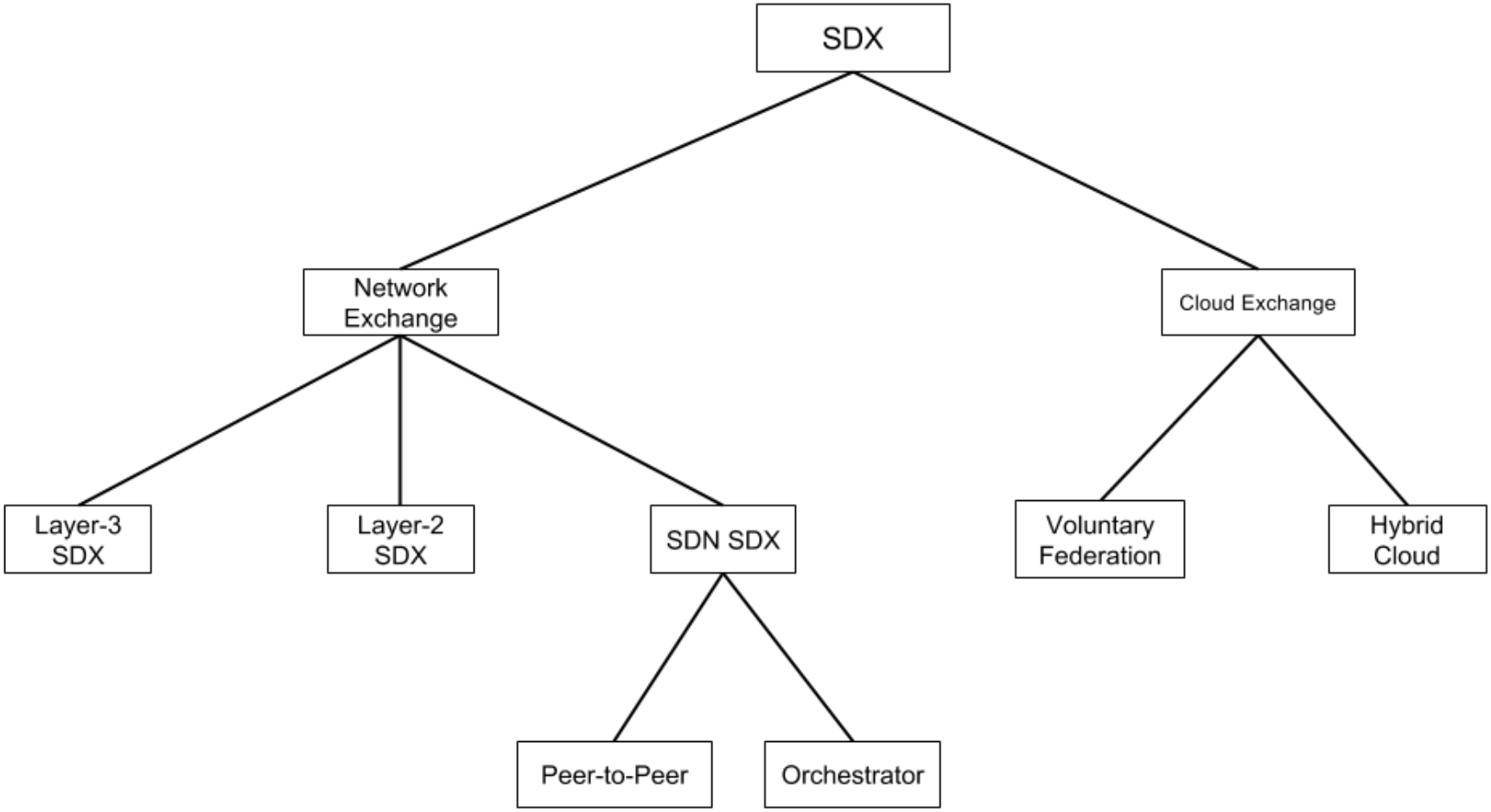
LSST: End-to-End Path

- Most of the R&E networks can accommodate some of the LSST requirements:
  - Multiple paths with multiple 100G links
  - Dynamic provisioning, bandwidth reservation, network programmability, etc.
- But R&E networks are interconnected through Academic Exchange Points:
  - Almost no support for programmability
- High demanding end-to-end applications requires that all networks in the path support QoS and Programmability
  - Including the Academic Exchange Points
- Software Defined Exchanges as a possible solution

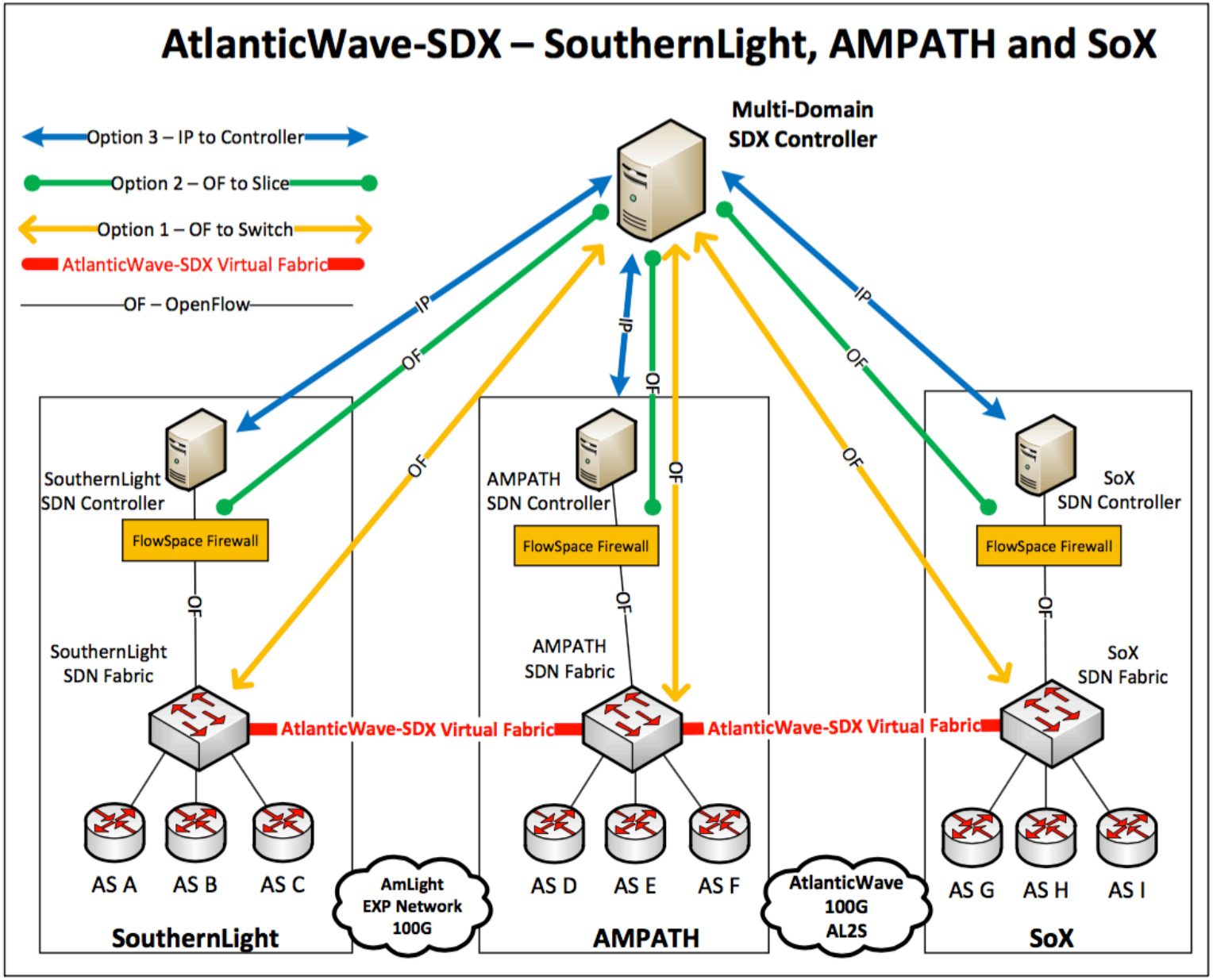
SDX Motivation

- A Software Defined eXchange (SDX) seeks to introduce Software Defined Networking (SDN) technologies into Academic Exchange Points to optimize resource sharing and allocation
  - Inter-domain R&E network programmability
  - End-to-End QoS coordination and enforcement

An SDX Taxonomy



SDX Architectures



SDX Applications

- To augment BGP policies in an IXP:
  - Application-specific peering
  - Inbound traffic engineering
  - Wide-area load balancing
  - Redirection through middle boxes

A. Gupta, E. Katz-Bassett, L. Vanbever, M. Shahbaz, S. P. Donovan, B. Schlinker, N. Feamster, J. Rexford, S. Shenker, and R. Clark, "SDX," ACM SIGCOMM Comput. Commun. Rev., vol. 44, no. 4, pp. 551–562, Aug. 2014.

SDX Applications (2)

- Data Domain:
  - Data-on-demand
  - Data preprocessing
  - High-quality media transmission over long-distance networks.
- Infrastructure Domain:
  - Data mobility for Inter-cloud use
  - Follow the sun (or moon) principles for Datacenter
  - Disaster recovery by IaaS migration.

G. Carrozzo, R. Monno, B. Belter, R. Krzywania, K. Pentikousis, M. Broadbent, T. Kudoh, A. Takefusa, A. Vieo-Oton, C. Fernandez, B. Puvpe, and J. Tanaka, "Large-scale SDN experiments in federated environments," in 2014 International Conference on Smart Communications in Network Technologies (SaCoNeT), 2014, pp. 1–6.

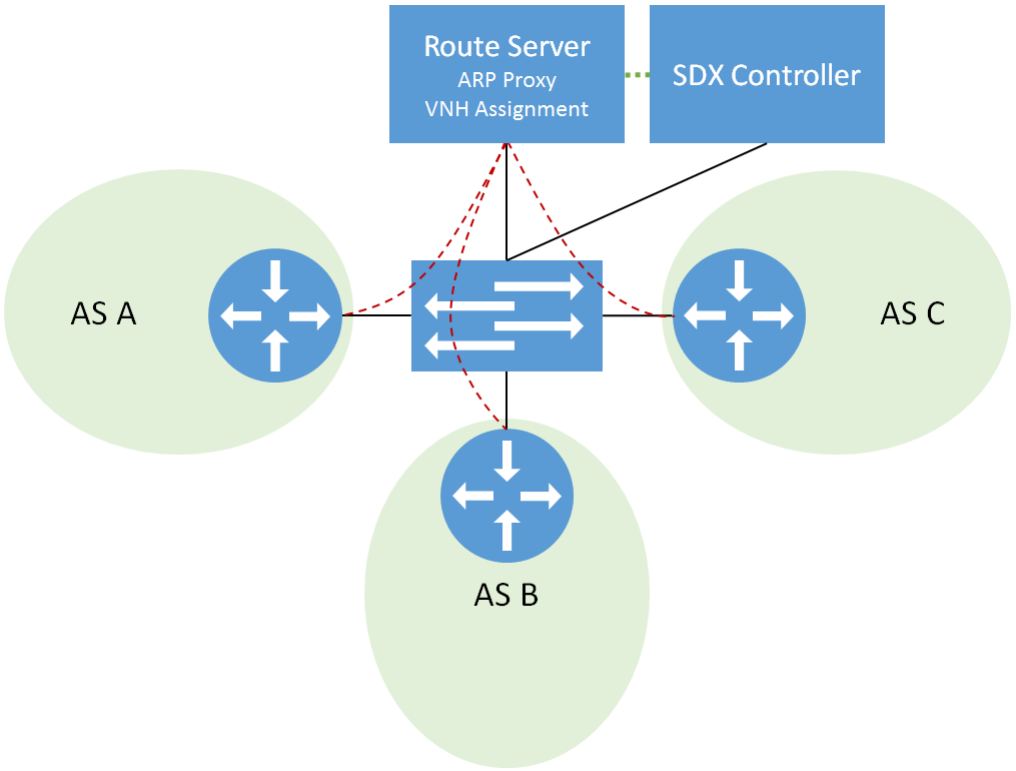
SDX Policies

- Policies based on packet header field:
  - Match TCP or UDP source and destination ports,
  - Match source and destination IP address or
  - Match source and destination MAC addresses
  - Apply actions accordingly.

- Policies based on external data:
  - Collect information from other systems such as: network monitoring systems, user databases, DNS or NTP server
  - Match parameters such as network latency, bandwidth, user name, domain name, date and time
  - Apply actions accordingly.

Application Specific Peering

```
if (dstport == 80)
    forward to B
else if (dstport == 4321 || dstport == 4322)
    forward to C
```



More Policy examples

- On-demand Virtual Circuit provisioning

```
if (current_latency > SLA_latency)
    secondary = findSecondaryPath()
while (current_latency > SLA_latency)
    LoadBalance(primary, secondary)
```

- Bandwidth Calendaring

```
scheduled_time = 21:00:00 GMT -5
if (current_time == scheduled_time) {
    BW = 90 // Bandwidth in Mbps
    t = 60 // Reservation time
    OnDemandVC(BW, t)
}
```

Security Concerns for SDX

- Inherited vulnerabilities:
  - Layer 3 SDX → BGP
    - Prefix Hijacking, TCP, attribute manipulation
  - Layer 2 SDX → Ethernet shared domain
    - MAC flooding, VLAN hopping, man-in-the-middle (via MAC address spoofing)
  - SDN SDX → Controller
    - Single point of failure
- SDX controller is a middle-man that every participant has to trust
  - Participants would declare policies that interfere with others

Security Concerns for SDX (2)

- Countermeasures
  - RPKI and S-BGP
  - Secure communication between SDX controller and participants
  - Strong isolation between participants
  - Trust relationship between SDX controller and participants

Ongoing Research

- Exploration of extended Pyretic policies
- Representation of policies as RESTful or JSON APIs
- Evaluation of new intent-based networking interfaces for SDN controllers

Conclusion

- SDX could be used to address users' requirements for compute, storage and networking resource sharing
- SDX will evolve the Academic Exchange Point
- SDX has potential to provide end-to-end inter-domain programmability and QoS
- With SDX, LSST will be able to achieve its goals of high bandwidth availability, low latency and high priority over existing R&E interconnected networks

Questions?

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Joaquín Chung*, Jacob Cox*, Julio Ibarra^, Jerônimo Bezerra^, Heidi Morgan^, Russell Clark*, Henry Owen*
* Georgia Institute of Technology, ^ Florida International University
* Atlanta, Georgia, ^ Miami, Florida
*{joaquin.chung, jcox70, russ.clark}@gatech.edu, ^{julio, jbezerra, heidi}@fiu.edu, henry.owen@ece.gatech.edu