Open Science Data Cloud

Partnership for Int'l Research & Education

Amsterdam Workshop

June 11th , 2015

AmLight SDN Testbeds; The Future of Collaboration

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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

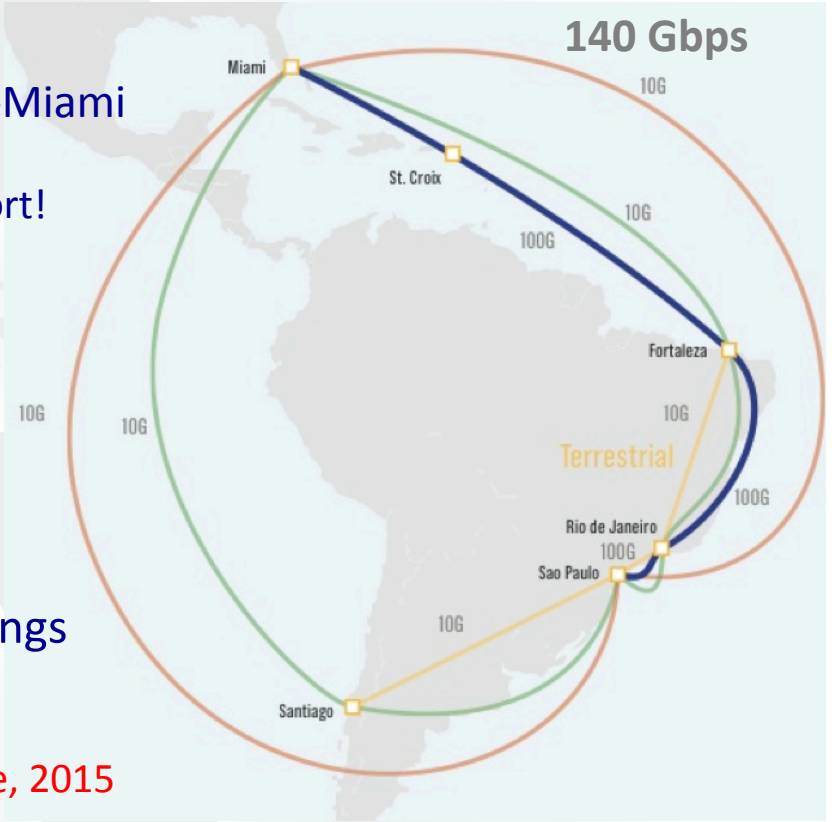
Describing AmLight

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

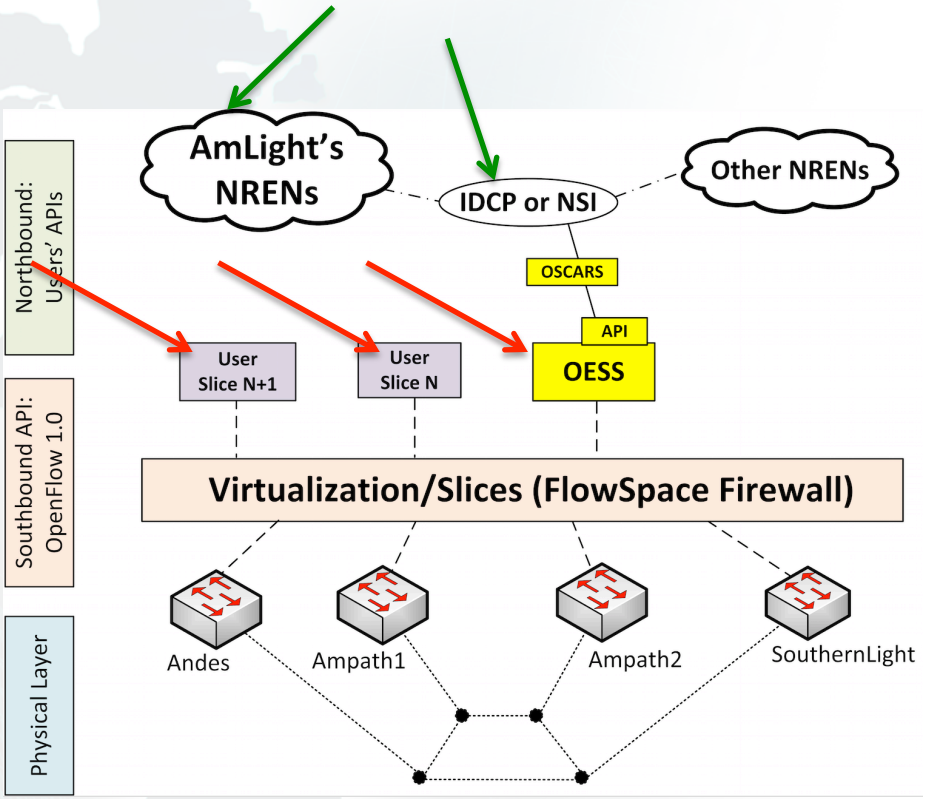
Two possible interfaces to use AmLight SDN offered to users and researchers:

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



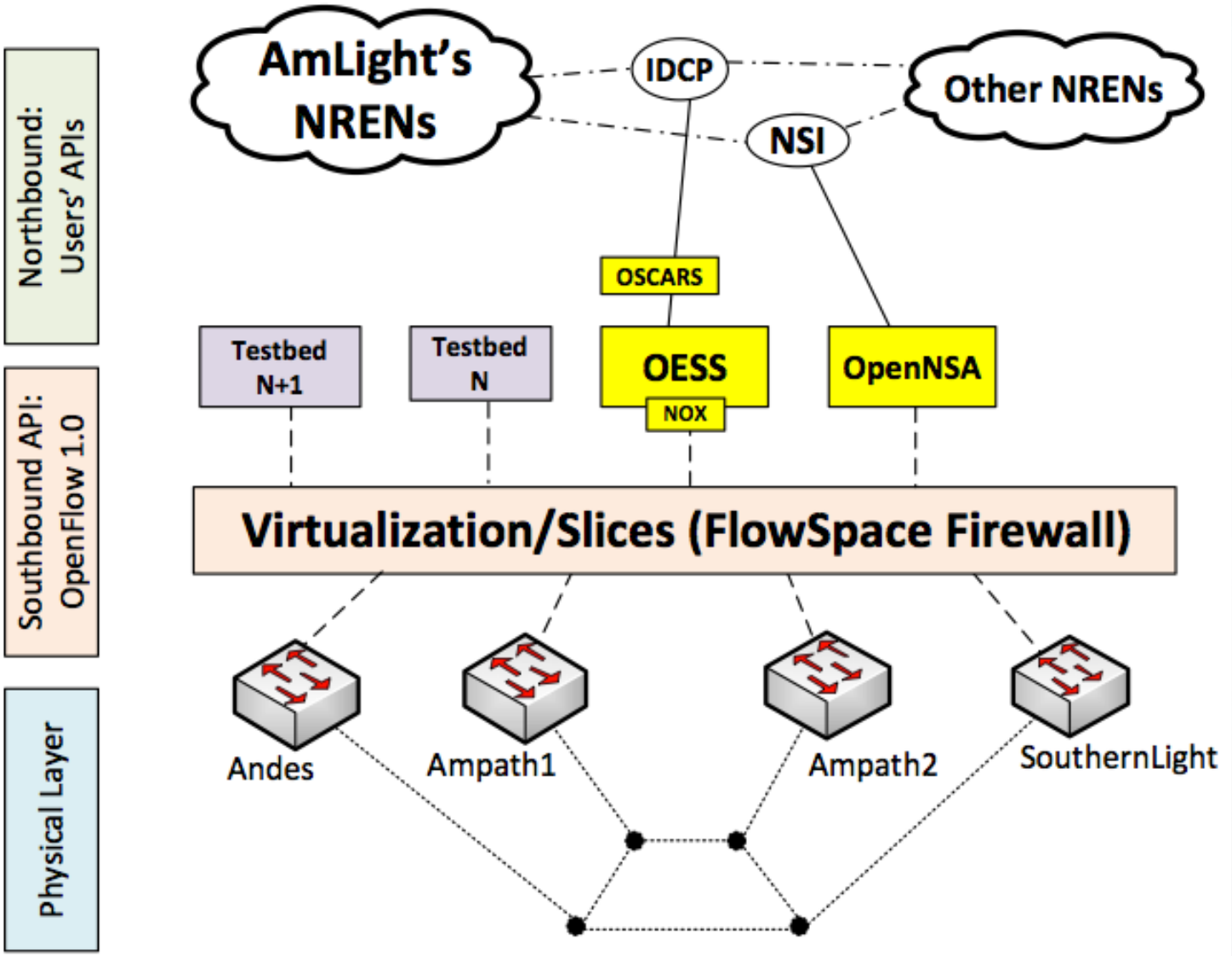
Describing AmLight SDN – Using OpenFlow (1)

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

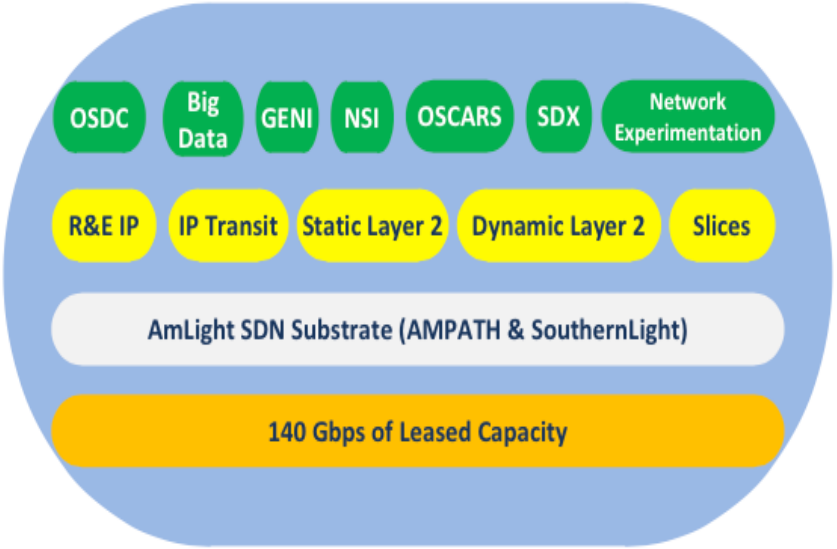
Describing AmLight SDN – Using OpenFlow (2)



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 same 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

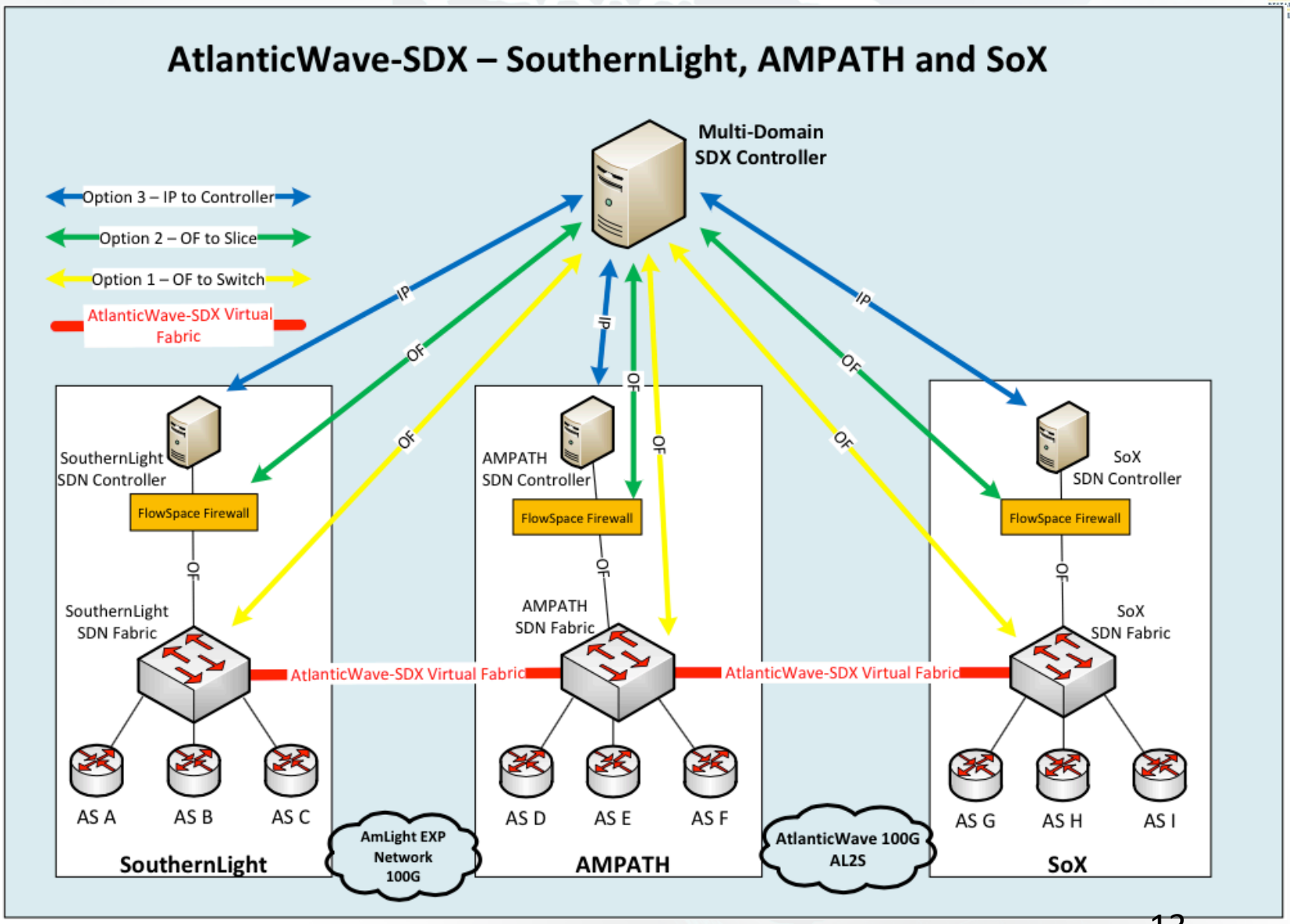
- Quality of Service
  - Bandwidth Guarantee in an OpenFlow/SDN network
  - Dynamic application load-balancing
- Security
  - Secure access with network virtualization
  - Isolation between applications
- Networking
  - Multipath TCP
  - Scalability
  - IP/IPv6/Multicast Routing
  - Inter-SDN domain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



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/

Award# CNS- 1443285, $200,000.00, 2014-2016, EAGER: **SwitchOn - Exploring and Strengthening US-Brazil Collaborations in Future Internet Research,**

SwitchOn Workshop on US-Brazil Collaborations for Future Network Research

Miami, Florida, January 8-9, 2015

Next workshop USP Sao Paolo Oct 15-16, 2015

Thank You!

AmLight SDN Testbeds;
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Questions ???

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