Novel Network Services for Supporting Big Data Science Research

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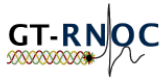
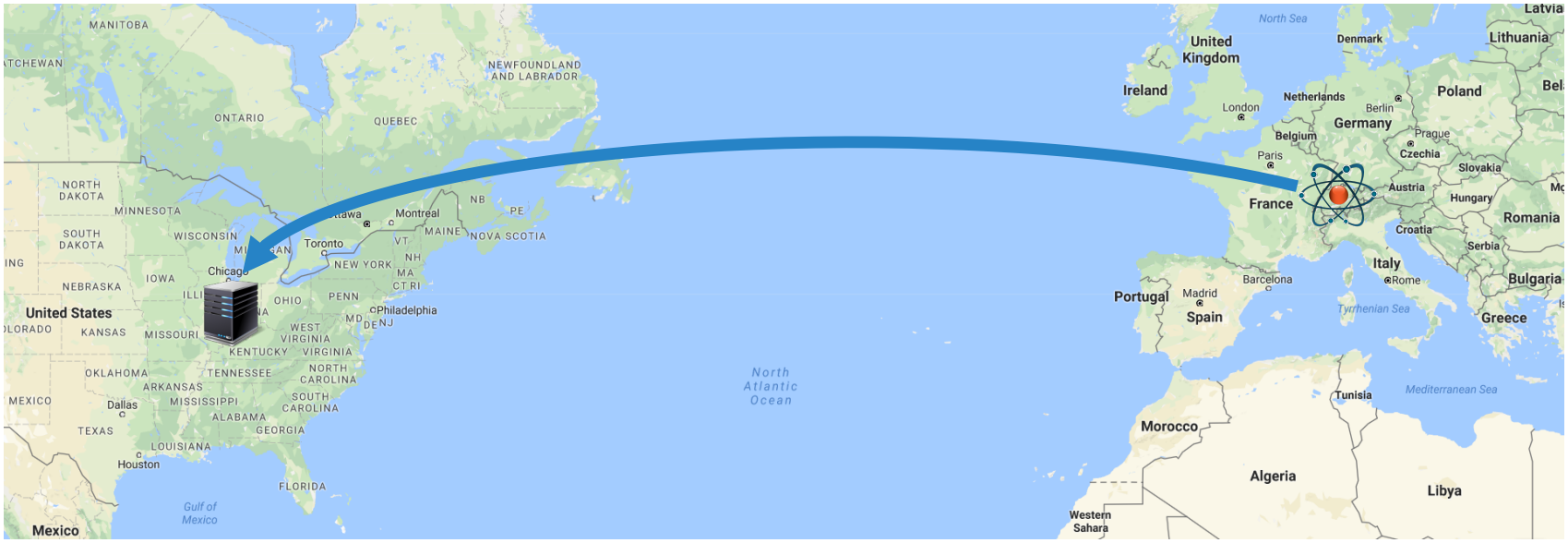


Motivation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Serbia
Bulgaria
Italy
Rome
Barcelona
Portugal
Madrid
Spain
Tyrrhenian Sea
Greece
Mediterranean Sea
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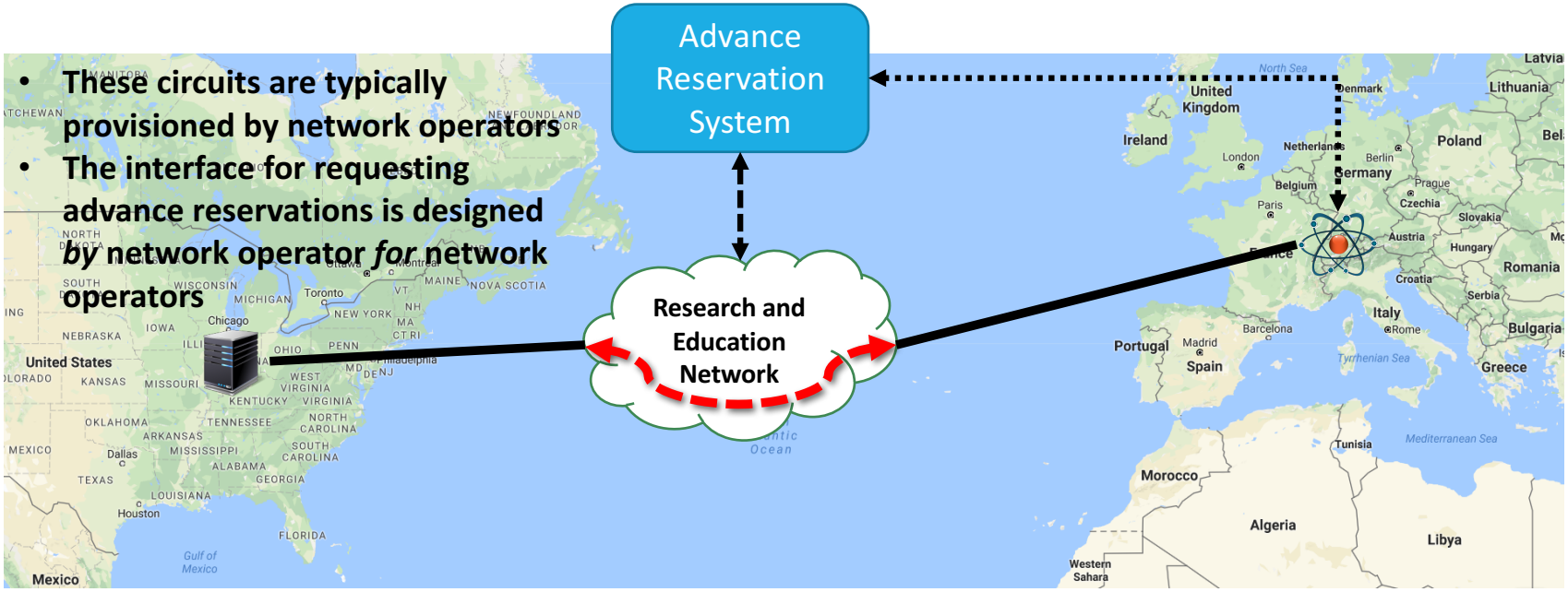
Motivation

- These circuits are typically provisioned by network operators
- The interface for requesting advance reservations is designed *by* network operator *for* network operators



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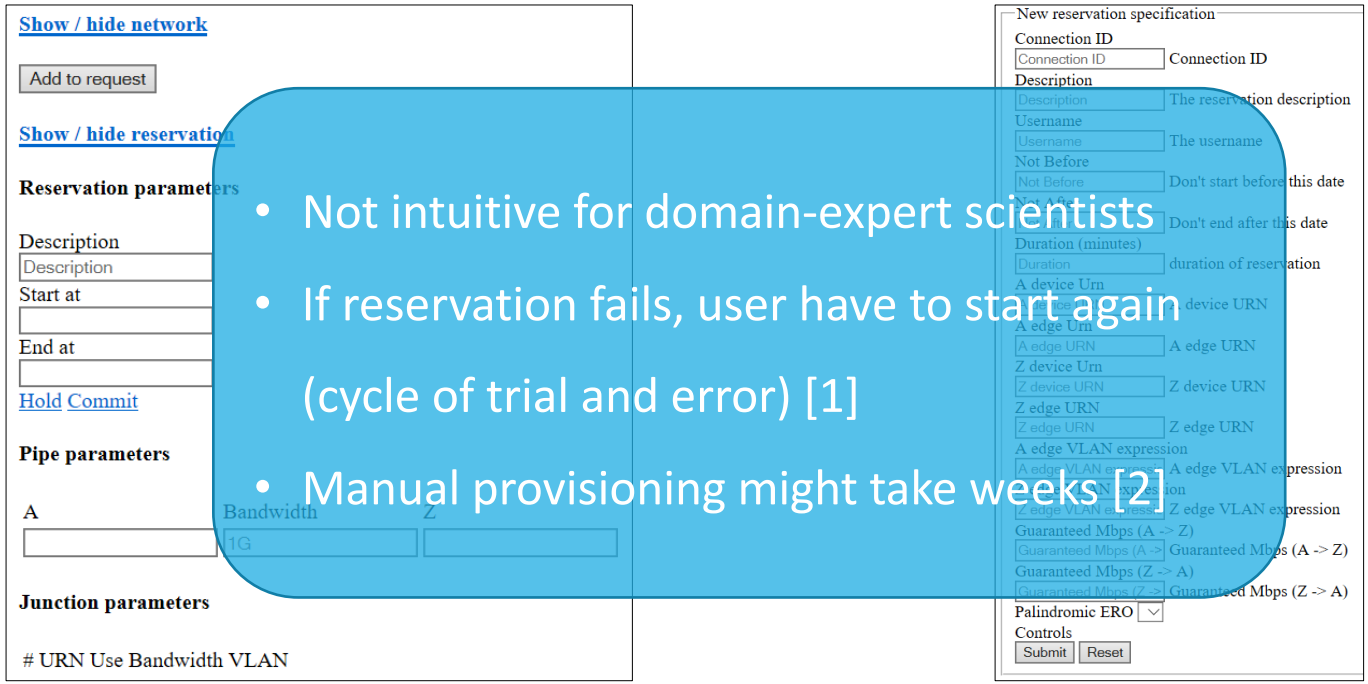

- Not intuitive for domain-expert scientists
- If reservation fails, user have to start again (cycle of trial and error) [1]
- Manual provisioning might take weeks [2]

Outline

- Background
- AtlanticWave/SDX Architecture
- Future Generation Science Network Services
- Related Work
- Conclusions

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- Background
  - Software-Defined Exchange (SDX)
  - Software-Defined Networking (SDN)
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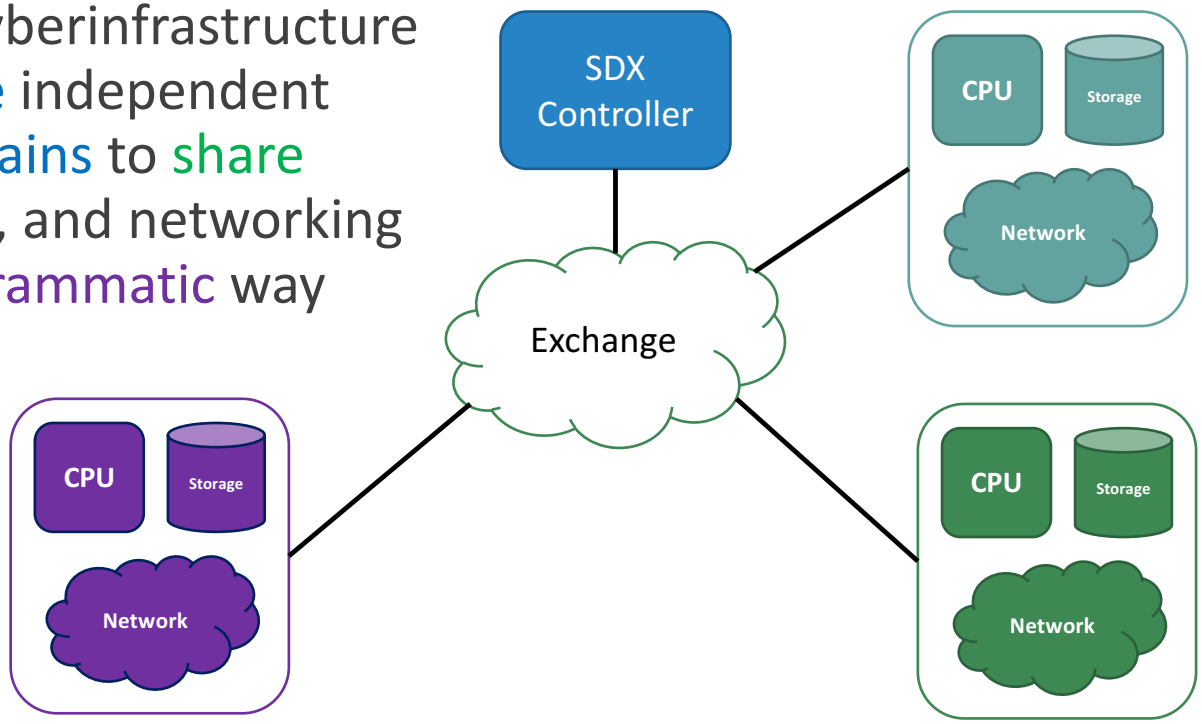
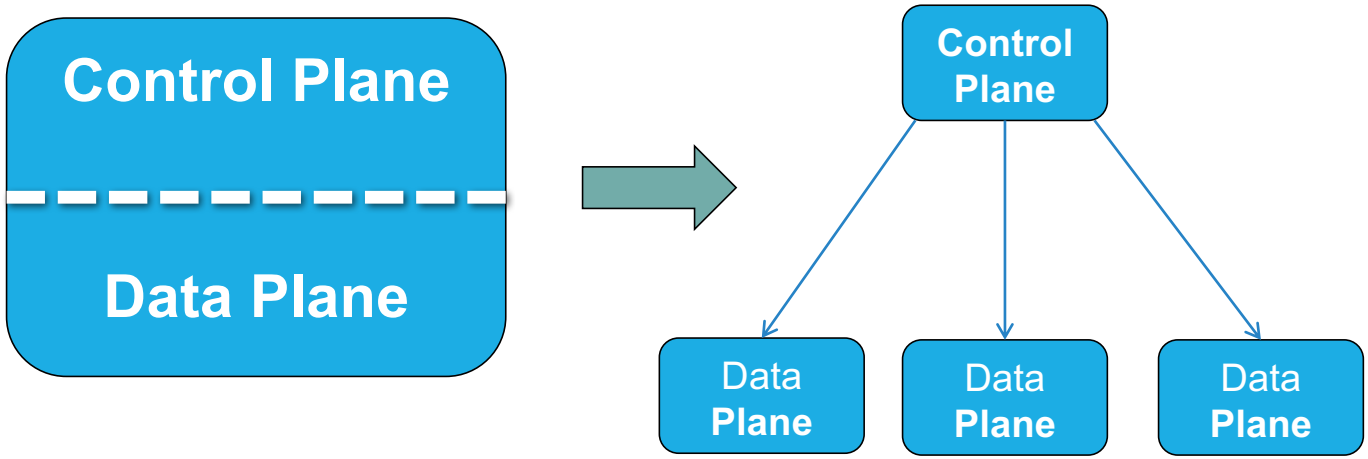
Software-Defined Exchange (SDX)

An SDX is a novel cyberinfrastructure that allows multiple independent administrative domains to share computing, storage, and networking resources in a programmatic way



What is SDN?

Software Defined Networking (SDN) separates the control plane from the data plane



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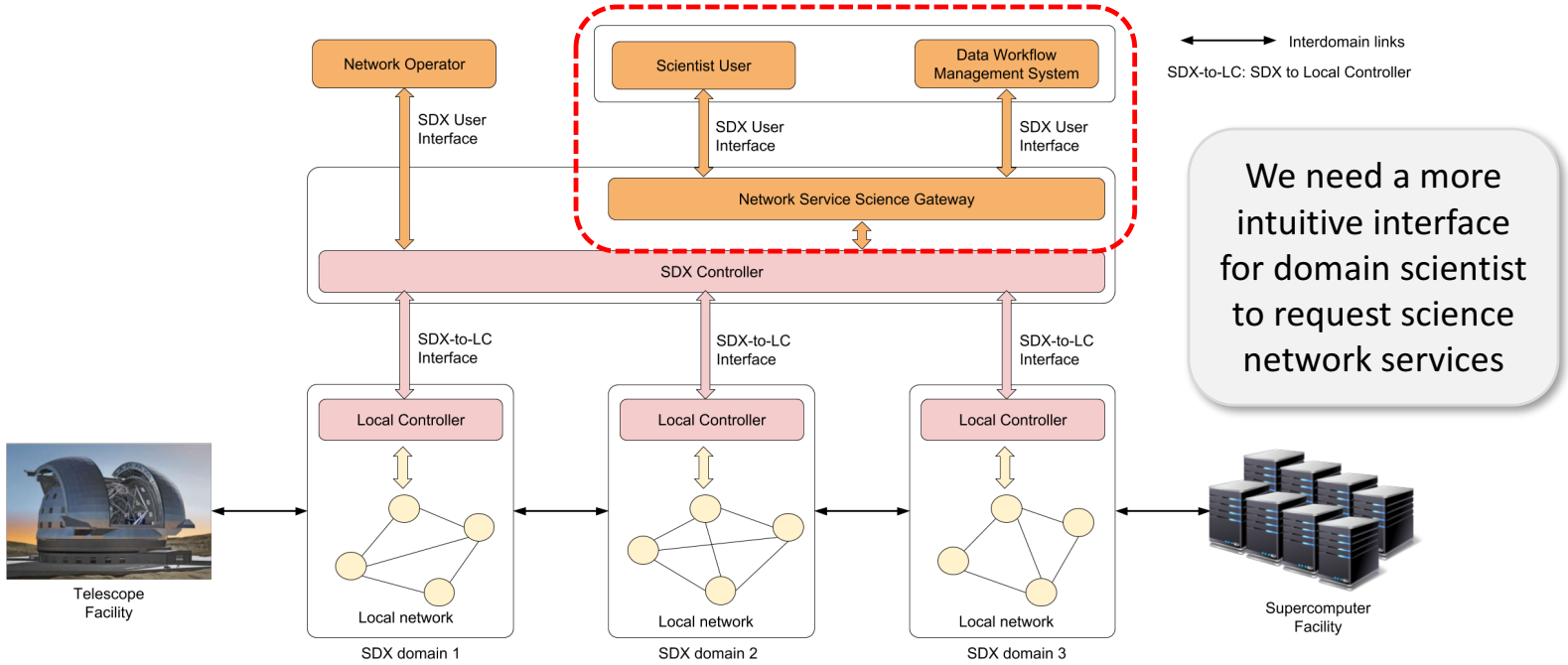
AtlanticWave/SDX Architecture



[3] J. Chung, J. Cox, J. Ibarra, J. Bezerra, H. Morgan, R. Clark, and H. Owen, "AtlanticWave-SDX: An international SDX to support science data applications," Software Defined Networking (SDN) for Scientific Networking Workshop, SC'15, pp. 1–7, Nov 2015.

The Stack

Front-end → Python Flask

- Web interface
- REST API

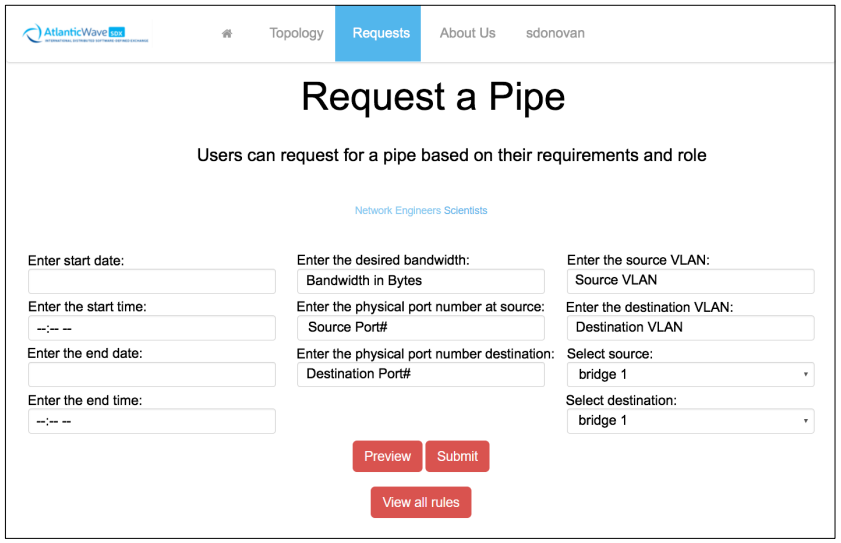
SDX and Local Controllers

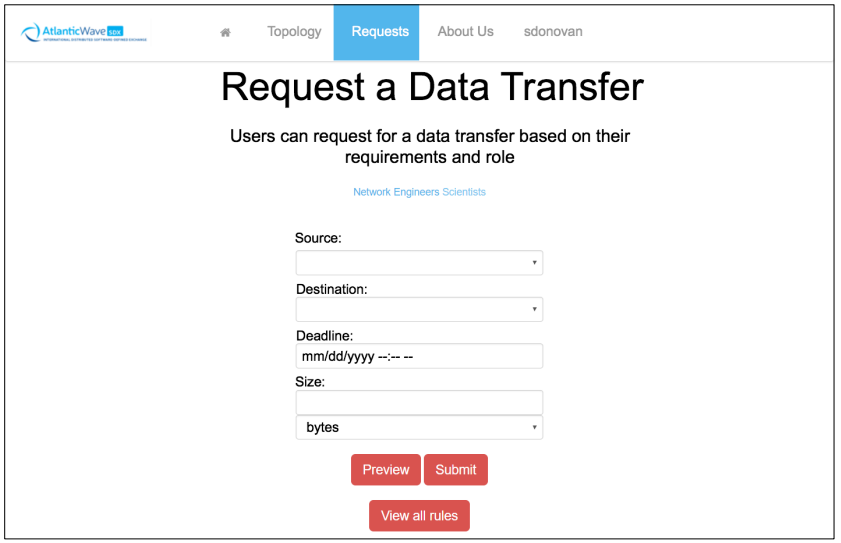
- Ryu SDN framework → Written in Python

SDN switch configuration

- OpenFlow v1.3
- Corsa switches

SDX User Interface





SDX User Interface Demo

Network Operator: https://youtu.be/EczfnoeHbgQ

Scientist: https://youtu.be/tjoKZNM41Qk

REST API

GET /api/v1/policies/

List all visible policies. Administrators are able to view all policies, while regular users are only able to see their own policies.

GET /api/v1/policies/number/<policynumber>

Get details of a given policy specified by *policynumber*. Each policy type will return different style of information, so we've sequestered the details into a sub-piece

REST API

POST /api/v1/policies/type/scitunnel/

- Create a new L2 Tunnel Policy from a scientist request.

Request JSON Object

- size (int) - Dataset size in bytes
- deadline (*string*) - Deadline for the data transfer. String should be in RFC3339 format: "2017-04-12T23:20:50“
- srcdtn (*string*) - Name of source data transfer node.
- dstdn (*string*) - Name of destination data transfer node.

Response JSON Object

- policy (*dict*) - Link to the newly created policy.

REST API

POST /api/v1/policies/type/l2tunnel

Create a new L2 Tunnel Policy.

Request JSON Object

- starttime (*string*) - Start time of the L2 Tunnel. String should be in RFC3339 format: `"2017-04-12T23:20:50"`
- endtime (*string*) - End time of the L2 Tunnel. String should be in RFC3339 format: `"2017-04-12T23:20:50"`
- srcswitch (*string*) - Name of source switch. See the */api/v1/localcontrollers/<lcname>/switches/* endpoint for switch names.
- dstswitch (*string*) - Name of destination switch. See the */api/v1/localcontrollers/<lcname>/switches/* endpoint for switch names.
- srcport (*int*) - Port number on source switch. See the */api/v1/localcontrollers/<lcname>/switches/<switchname>/ports* endpoint for switch port information
- dstport (*int*) - Port number on source switch. See the */api/v1/localcontrollers/<lcname>/switches/<switchname>/ports* endpoint for switch port information
- srcvlan (*int*) - VLAN at source port.
- dstvlan (*int*) - VLAN at destination port.
- bandwidth (*int*) - Bandwidth in kbit/sec.

Response JSON Object

- policy (*dict*) - Link to the newly created policy

REST API

Example Response

```
HTTP/1.1 200 OK
Content-Type: application/json
{
  "policy": {
    "href": "http://awavesdx/api/v1/policy/number/3",
    "policynumber": 3,
    "user":"sdonovan",
    "type":"l2tunnel",
    "json":"{
      "l2tunnel":{
        "starttime":"1985-04-12T23:20:50",
        "endtime":"1985-04-12T23:20:50+0400",
        "srcswitch":"atl-switch",
        "dstswitch":"mia-switch",
        "srcport":5,
        "dstport":7,
        "srcvlan":1492,
        "dstvlan":1789,
        "bandwidth":1}
      }
    }
  }
```

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Future Generation Science Network Services

Simplify current science network services

Bandwidth calendaring

- Augmented by external sources (e.g. weather data)
- Predictive

Fetch the nearest dataset

- Physical proximity
- Network congestion
- Green paths

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Related Work

Software-Defined Networking (SDN) bandwidth reservation

- Lark Project [4] → OpenFlow for HTC
- Developing applications with networking capabilities via end-to-end SDN (DANCES) [5] → BW management (SLASH2 and GridFTP)

Intent-based Networking

- Intelligent Network Deployment Intent Renderer Application (iNDIRA) [6]

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Conclusion

We presented AtlanticWave/SDX, an architecture for novel network services, that leverages SDX

We proposed interfaces that allow domain-expert scientists and data workflow management systems to reserve resources of the scientific network.

We proposed future generation science network service such as augmented, predictive bandwidth calendaring, and fetch the closest dataset.

References

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[5] V. Hazlewood, K. Benninger, G. Peterson, J. Charcalla, B. Sparks, J. Hanley, A. Adams, B. Learn, R. Budden, D. Simmel, J. Lappa, and J. Yanovich, "Developing applications with networking capabilities via end-to-end SDN (DANCES)," XSEDE16, pp. 1–7, July 2016.

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Questions/Comments

HTTP://WWW.ATLANTICWAVE-SDX.NET/

HTTPS://GITHUB.COM/ATLANTICWAVE-SDX/ATLANTICWAVE-PROTO

Backup Slides

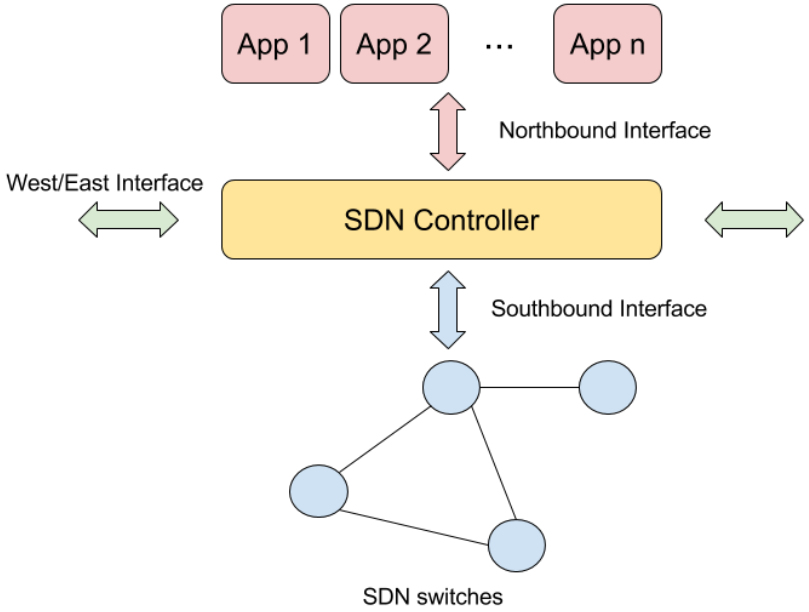
Software-defined Networking

Decoupling of control and data planes

- The control plane is physically distributed, yet logically centralized (**SDN controller**)
- The data plane is distributed on the network devices (**SDN switches**)
- Agile programmability, rapid innovation, and independent evolution

Interfaces:

- Applications to controller (e.g., IDS, load balancer, and traffic eng.) → **Northbound**
- Controller to SDN switches (e.g., OpenFlow) → **Southbound**
- Between controllers → **West/East**



Centralized SDX Architecture Interconnecting Independent SDN Domains

SDX controller interfaces:

- Applications to SDX controller (e.g., science workflow manager or resource scheduler) → **Northbound**
- Controller to SDN participant domains (match SDN northbound interface) → **Southbound**
- Between SDX controllers → **West/East**

SDX controller functions:

- Resource management
- Path computation
- Resource provisioning