Integrating PRAGMA-ENT and Inter-Cloud Platform using Dynamic L2VLAN Service

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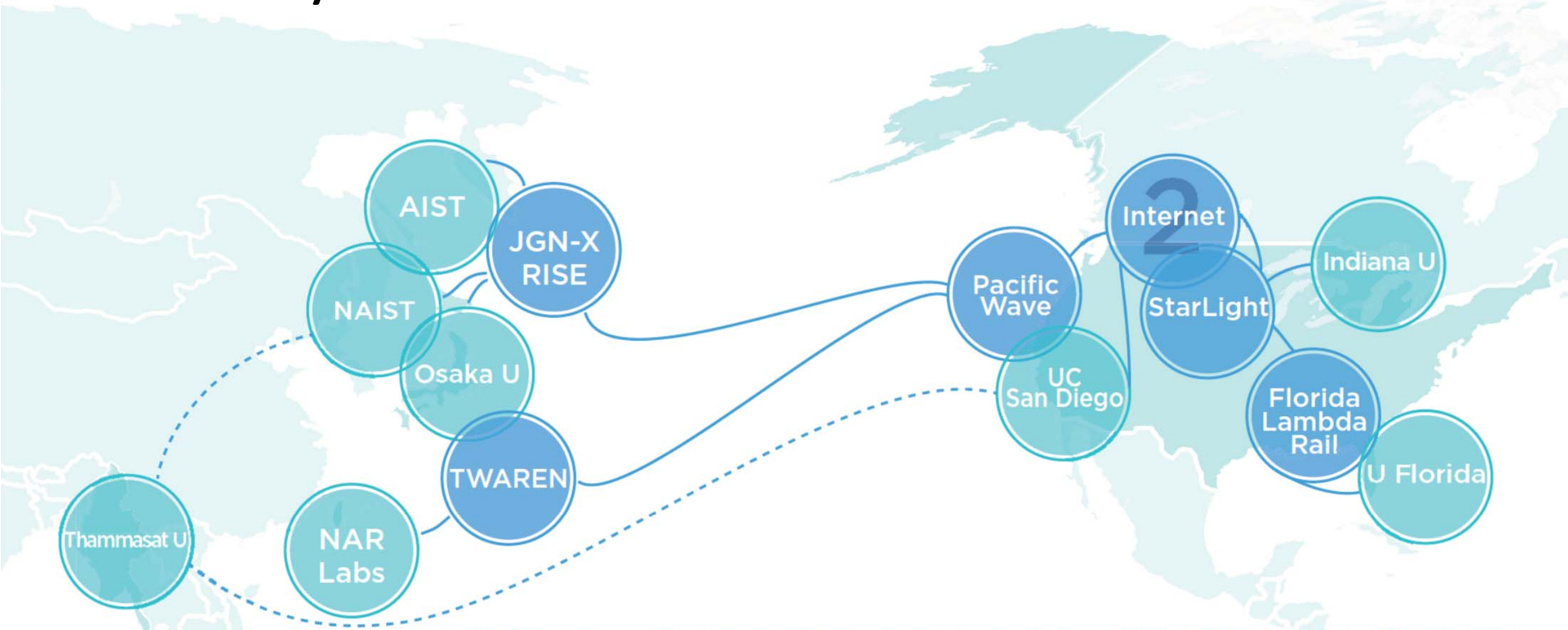
PRAGMA-ENT

(Experimental Network Testbed)

- An international SDN/OpenFlow testbed for use by PRAGMA researchers and collaborators



PRAGMA EXPERIMENTAL NETWORK TESTBED (PRAGMA-ENT)

A Resource for the PRAGMA Community

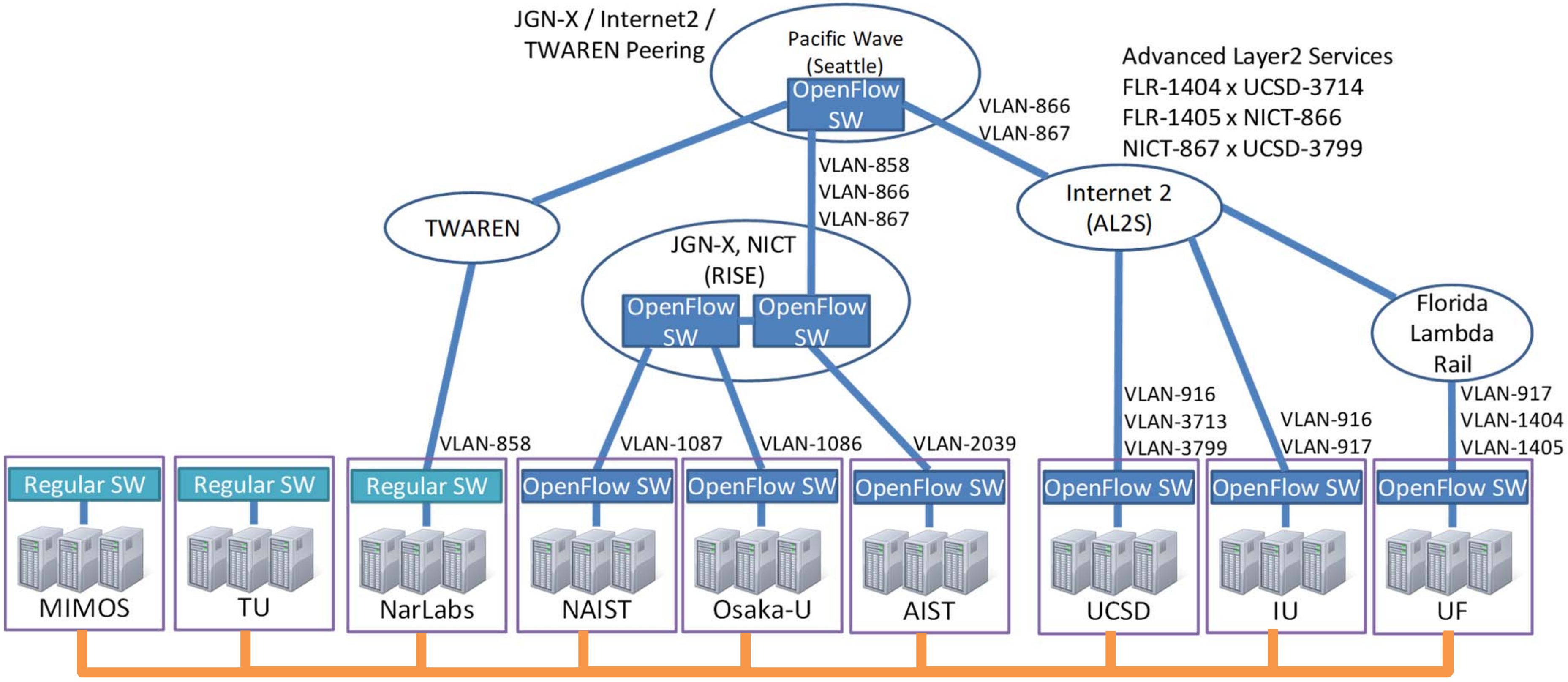
Goals of PRAGMA-ENT

- Build a breakable international SDN/OpenFlow testbed for use by researchers
  - By no means a production system
  - Complete freedom to access and configure network resources
- Provide access to SDN hardware/software to researchers
- Offer networking support for multi-cloud and user-defined trust envelopes

ENT Members

- **Nara Institute of Science and Tech**
  - Kohei Ichikawa
  - Pongsakorn U-chupala
  - Chawanat Nakasan
  - Che Huang
- **University of Florida**
  - Matthew Collins
  - Maurício Tsugawa
  - Renato Figueiredo
  - Kyuho Jeong
- **Osaka University**
  - Shinji Shimojo
  - Susumu Date
  - Yoshiyuki Kido
  - Yasuhiro Watashiba
- **University of California, San Diego**
  - Phil Papadopoulos
  - Nadya Williams
  - Shava Smallen
- **Advanced Industrial Science and Tech**
  - Yoshio Tanaka
  - Jason Haga
- **Indiana University**
  - Quan Zhou
  - Jim Williams
  - Jennifer Schopf
- **National Institute of Information and Communications Technology**
  - Jin Tanaka
  - Hiroaki Yamanaka
  - Eiji Kawai
- **National Institute of Informatics**
  - Atsuko Takefusa
- **National Center for High-performance Computing**
  - Fang-Pang Lin
  - Te-Lung Liu
  - Li-Chi Ku
- **Kasetsart University**
  - Putchong Uthayopas
- **Thammasat University**
  - Prapaporn Rattanatamrong
- **MIMOS**
  - Luke Jing Yuan

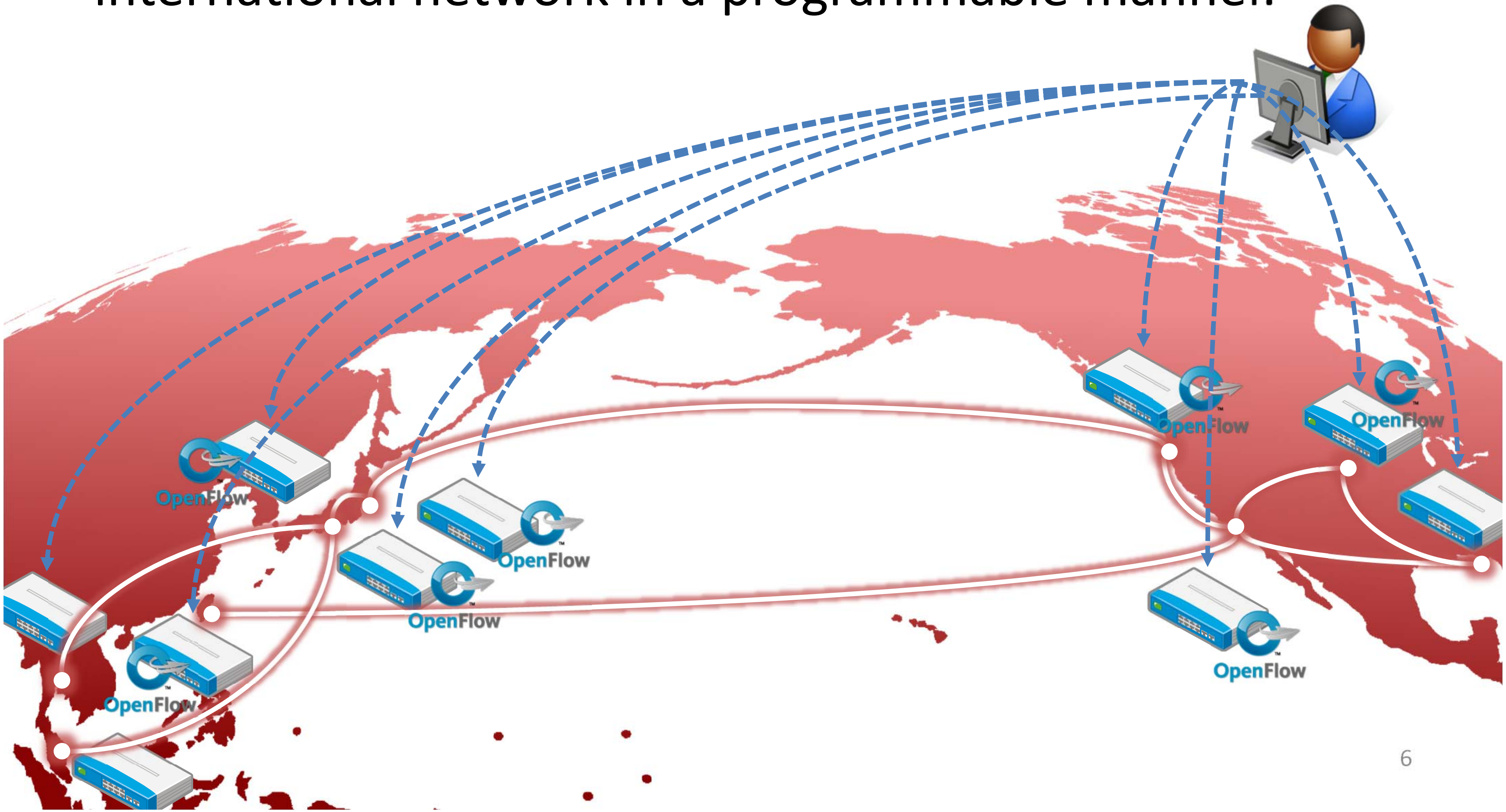
ENT Architecture:
L2 Data Plane Backbone



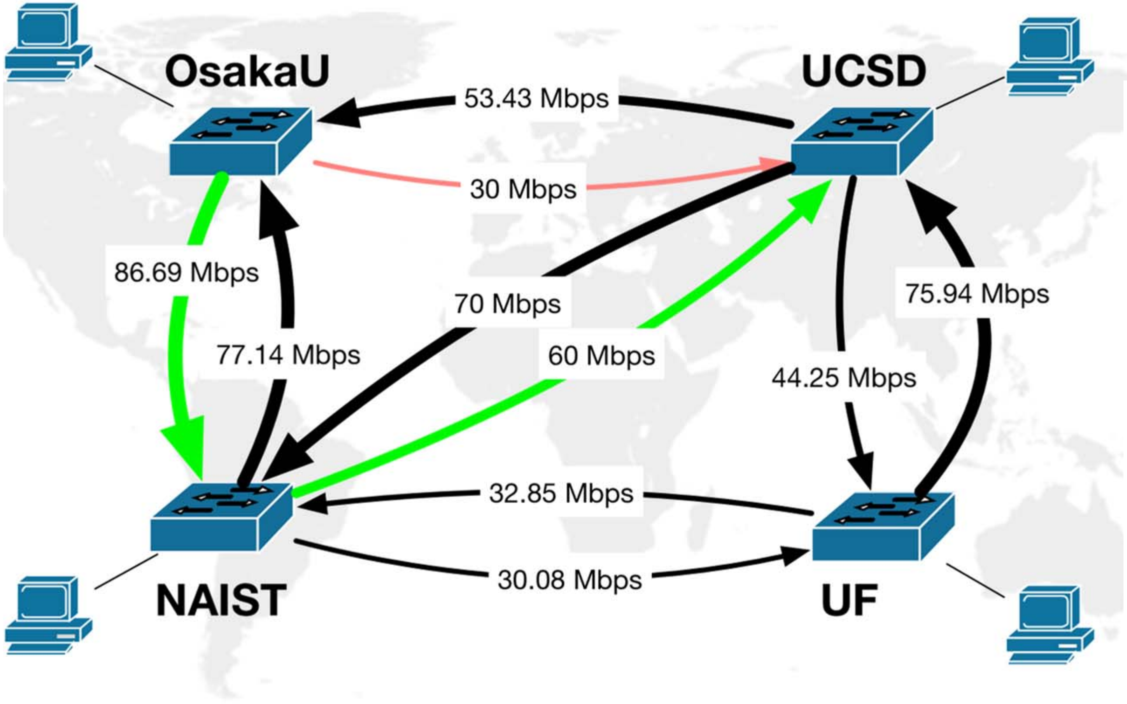
GRE tunnel links over the commercial Internet are established as alternative paths

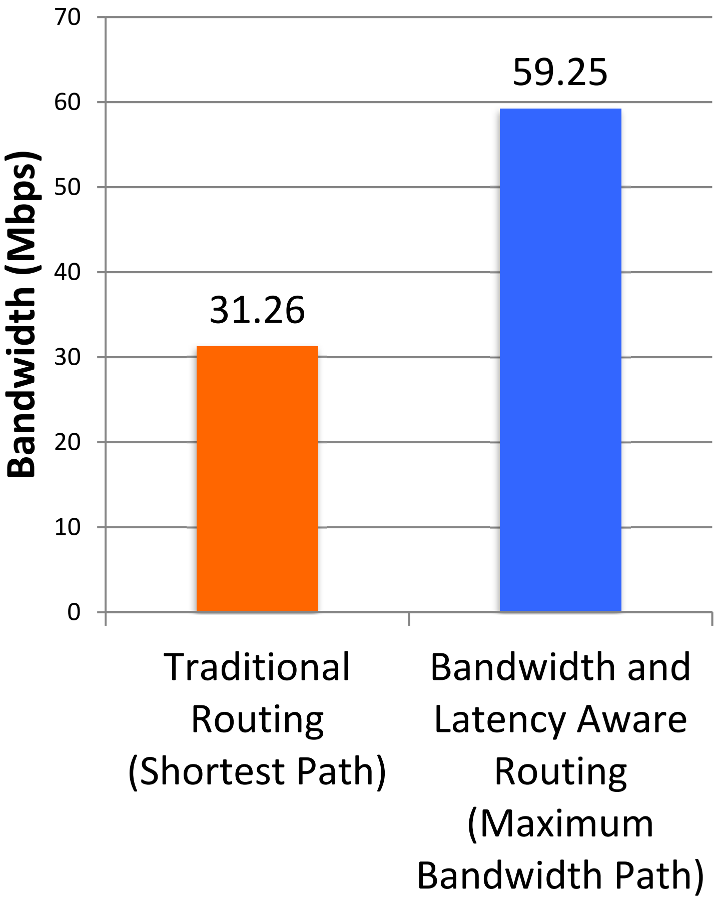
Programmable International Network Testbed

The researchers can freely control the entire international network in a programmable manner.



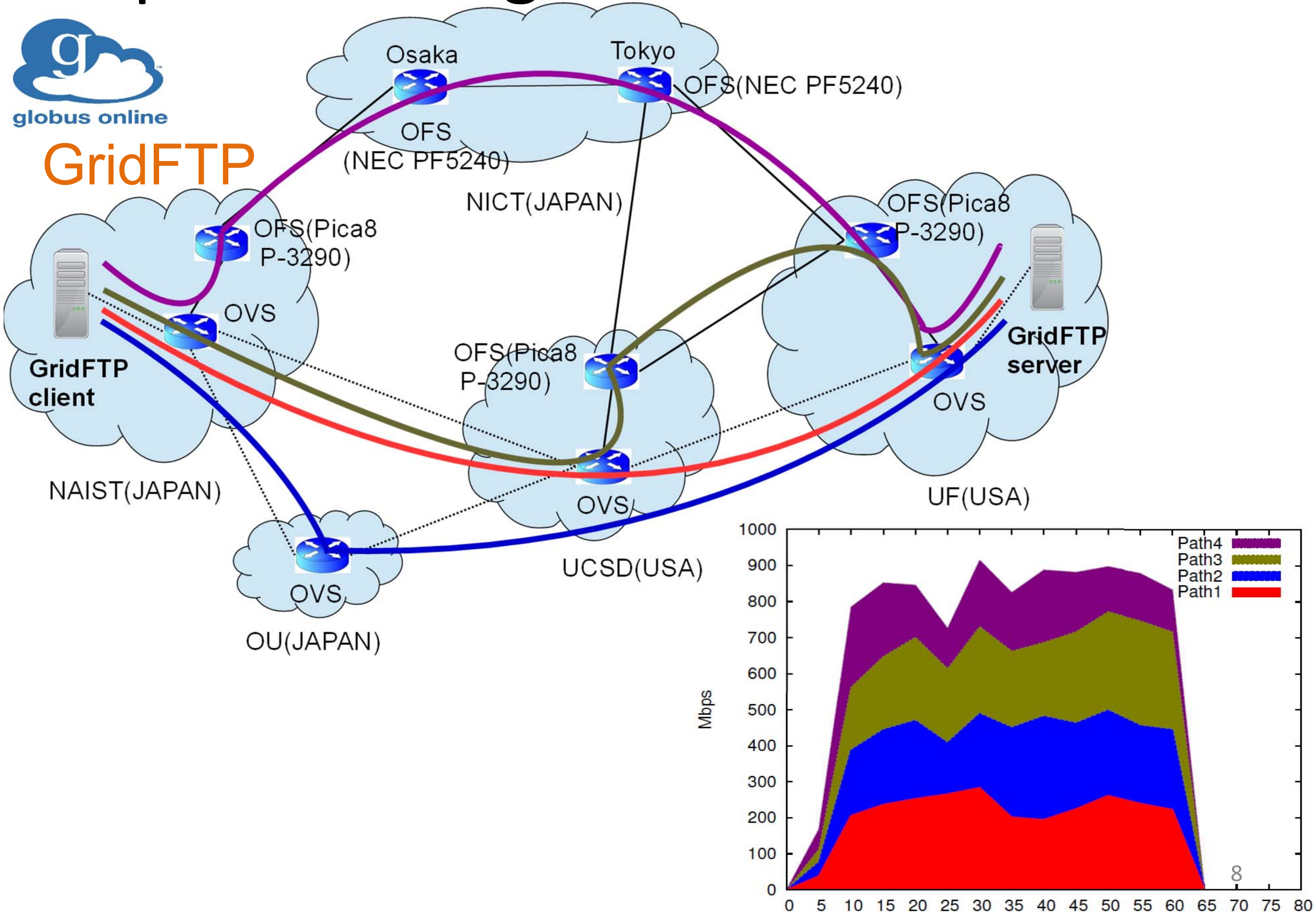
Application of ENT (1): Application-aware routing





Application of ENT (2): Multipath routing

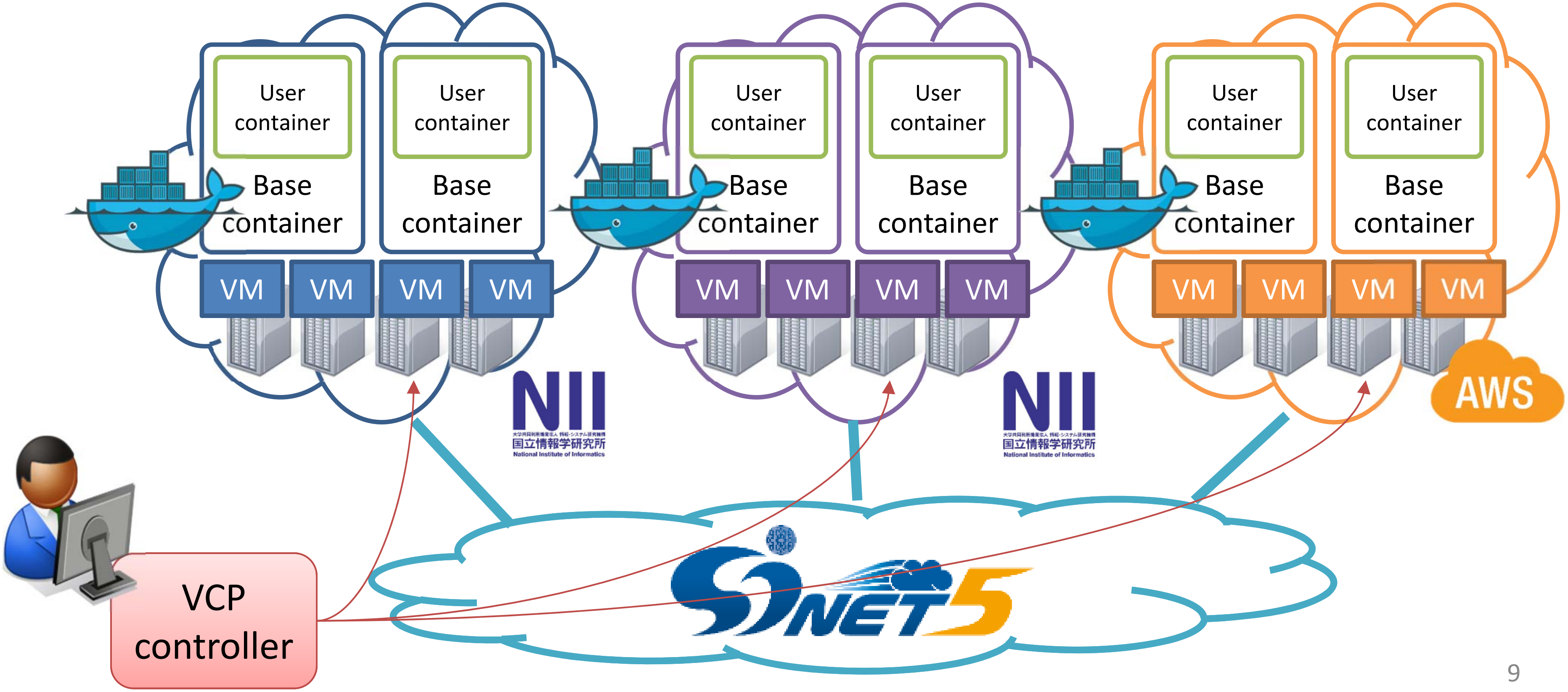
GridFTP



Extension of ENT to Inter-Cloud Services of NII/SINET

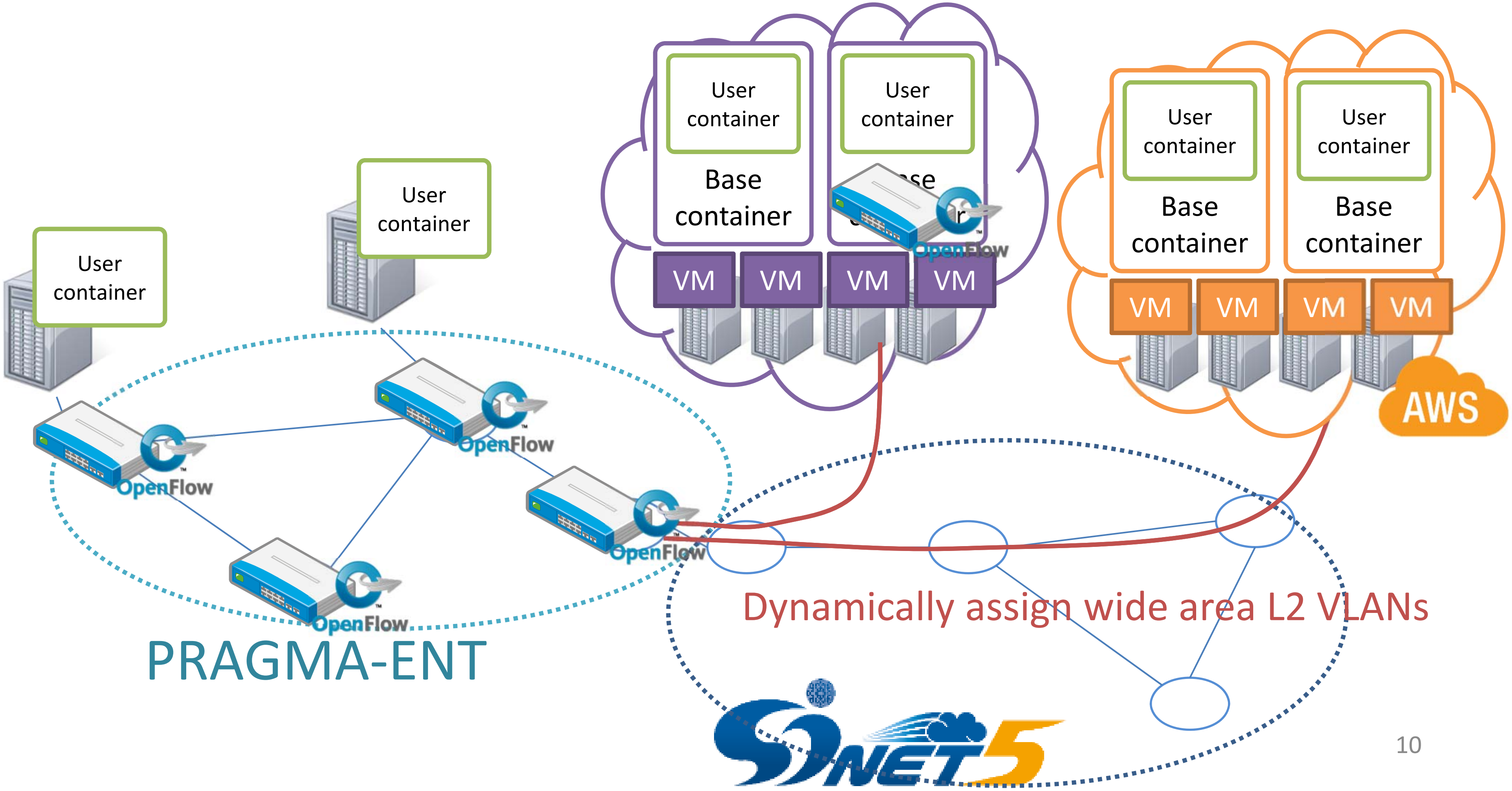
Virtual Cloud Provider (VCP) Service

- Container-based Inter-Cloud infrastructure



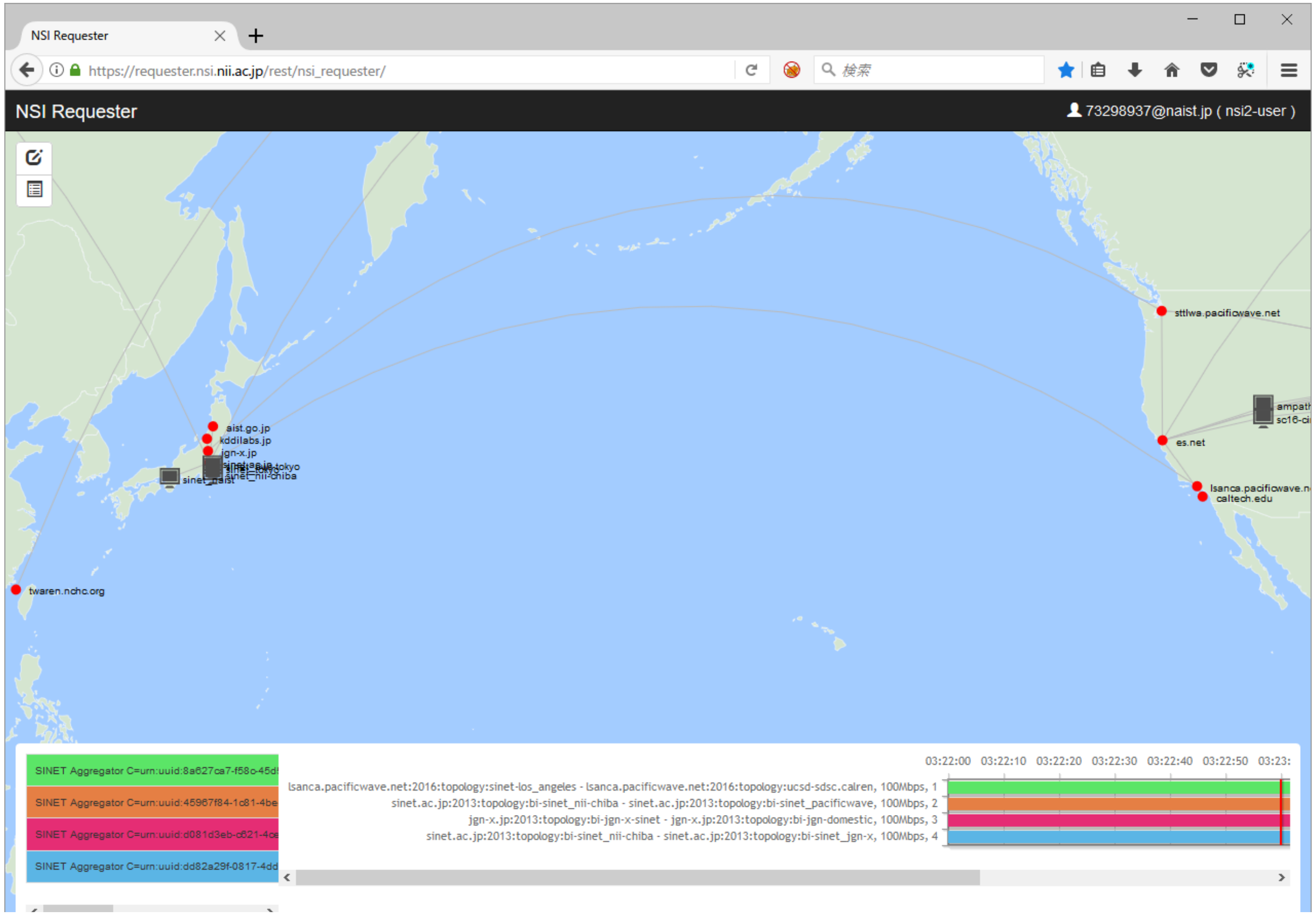
Extension of ENT to Inter-Cloud Services of NII/SINET

Interconnect between ENT and SINET with Network Service Interface (NSI)



NSI (Network Service Interface)

NSI provides an interface to deploy L2 VLAN in a on-demand manner.



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SINET Aggregator C=urn:uuid:d081d3eb-c621-4ce

SINET Aggregator C=urn:uuid:dd82a29f-0817-4dd

lsanca.pacificwave.net:2016:topology:sinet-los_angeles - lsanca.pacificwave.net:2016:topology:ucsd-sdsc.calren, 100Mbps, 1

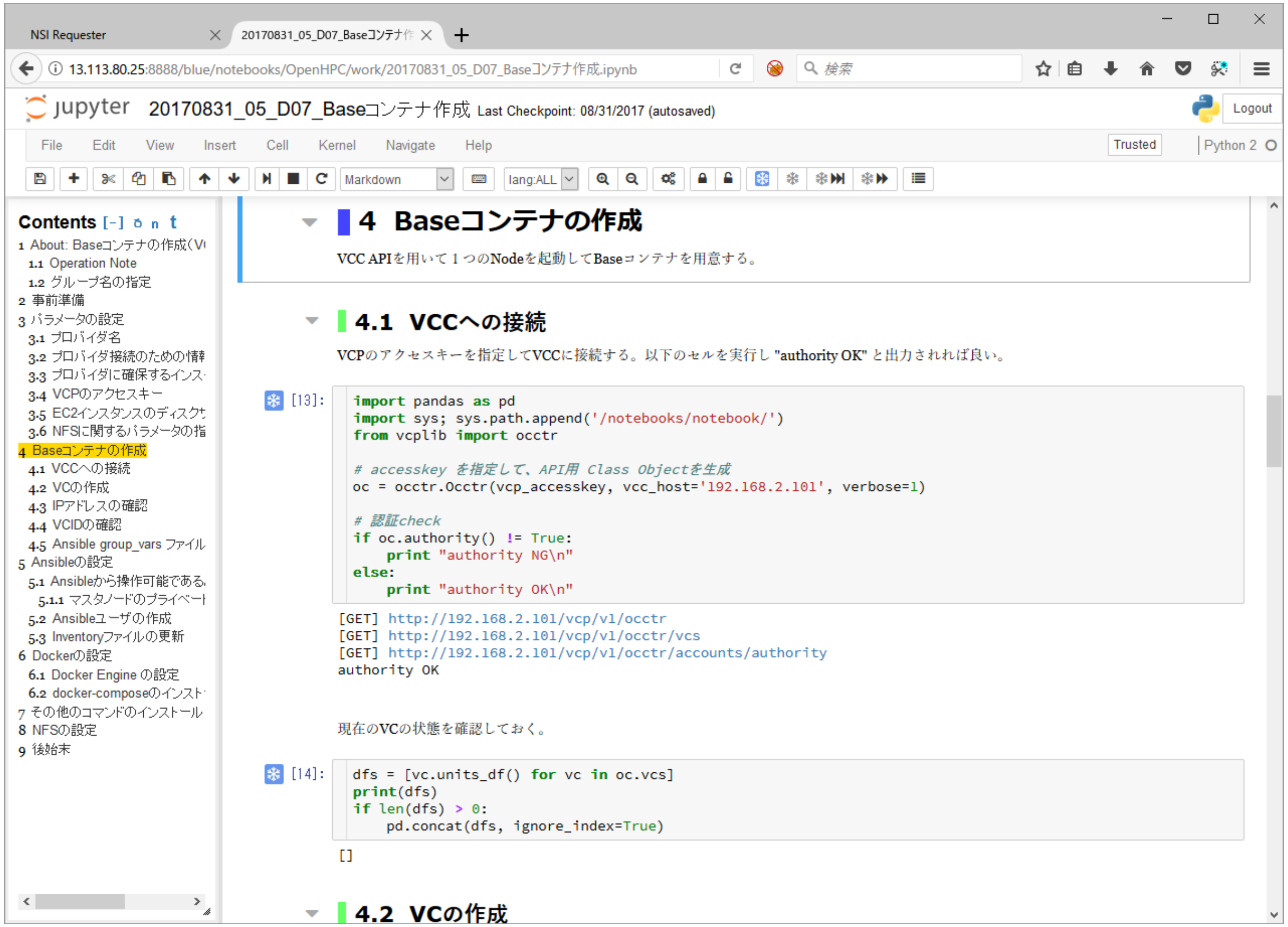
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_pacificwave, 100Mbps, 2

jgn-x.jp:2013:topology:bi-jgn-x-sinet - jgn-x.jp:2013:topology:bi-jgn-domestic, 100Mbps, 3

sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_jgn-x, 100Mbps, 4

VCP (Virtual Cloud Provider)

VCP provides a Jupyter-based interface to instantiate containers in the inter-cloud platform


NSI Requester
20170831_05_D07_Baseコンテナ作
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検索
jupyter
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View
Insert
Cell
Kernel
Navigate
Help
Trusted
Python 2
Markdown
lang:ALL

4 Baseコンテナの作成

VCC APIを用いて１つのNodeを起動してBaseコンテナを用意する。

4.1 VCCへの接続

VCPのアクセスキーを指定してVCCに接続する。以下のセルを実行し "authority OK" と出力されれば良い。

[13]:

```
import pandas as pd
import sys; sys.path.append('/notebooks/notebook/')
from vcplib import occtr

# accesskey を指定して、API用 Class Objectを生成
oc = occtr.Occtr(vcp_accesskey, vcc_host='192.168.2.101', verbose=1)

# 認証check
if oc.authority() != True:
    print "authority NG\n"
else:
    print "authority OK\n"
```

```
[GET] http://192.168.2.101/vcp/v1/occtr
[GET] http://192.168.2.101/vcp/v1/occtr/vcs
[GET] http://192.168.2.101/vcp/v1/occtr/accounts/authority
authority OK
```

現在のVCの状態を確認しておく。

[14]:

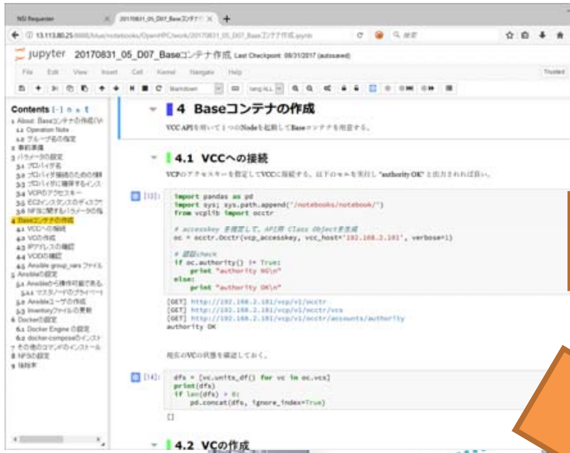
```
dfs = [vc.units_df() for vc in oc.vcs]
print(dfs)
if len(dfs) > 0:
    pd.concat(dfs, ignore_index=True)
```

```
[]
```

4.2 VCの作成

Demo: Inter-Cloud environment deployment using dynamic L2VLAN service

Jupyter-based SDK



20170831_05_D07_Baseコンテナ作成 Last Checkpoint: 08/31/2017 (autosaved)

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5.2 Ansibleユーザの作成
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8 NFSの設定
9 後始末

4 Baseコンテナの作成

VCC APIを用いて1つのNodeを起動してBaseコンテナを用意する。

4.1 VCCへの接続

VCPのアクセスキーを設定してVCCに接続する。以下のセルを実行し "authority OK" と出力されれば良い。

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```
import pandas as pd
import sys; sys.path.append('/notebooks/notebook/')
from vcplib import occtr

# accesskey を指定して、API用 Class Objectを生成
oc = occtr.Occtr(vcp_accesskey, vcc_host='192.168.2.181', verbose=1)

# 認証check
if oc.authority() != True:
    print "authority NG\n"
else:
    print "authority OK\n"
```

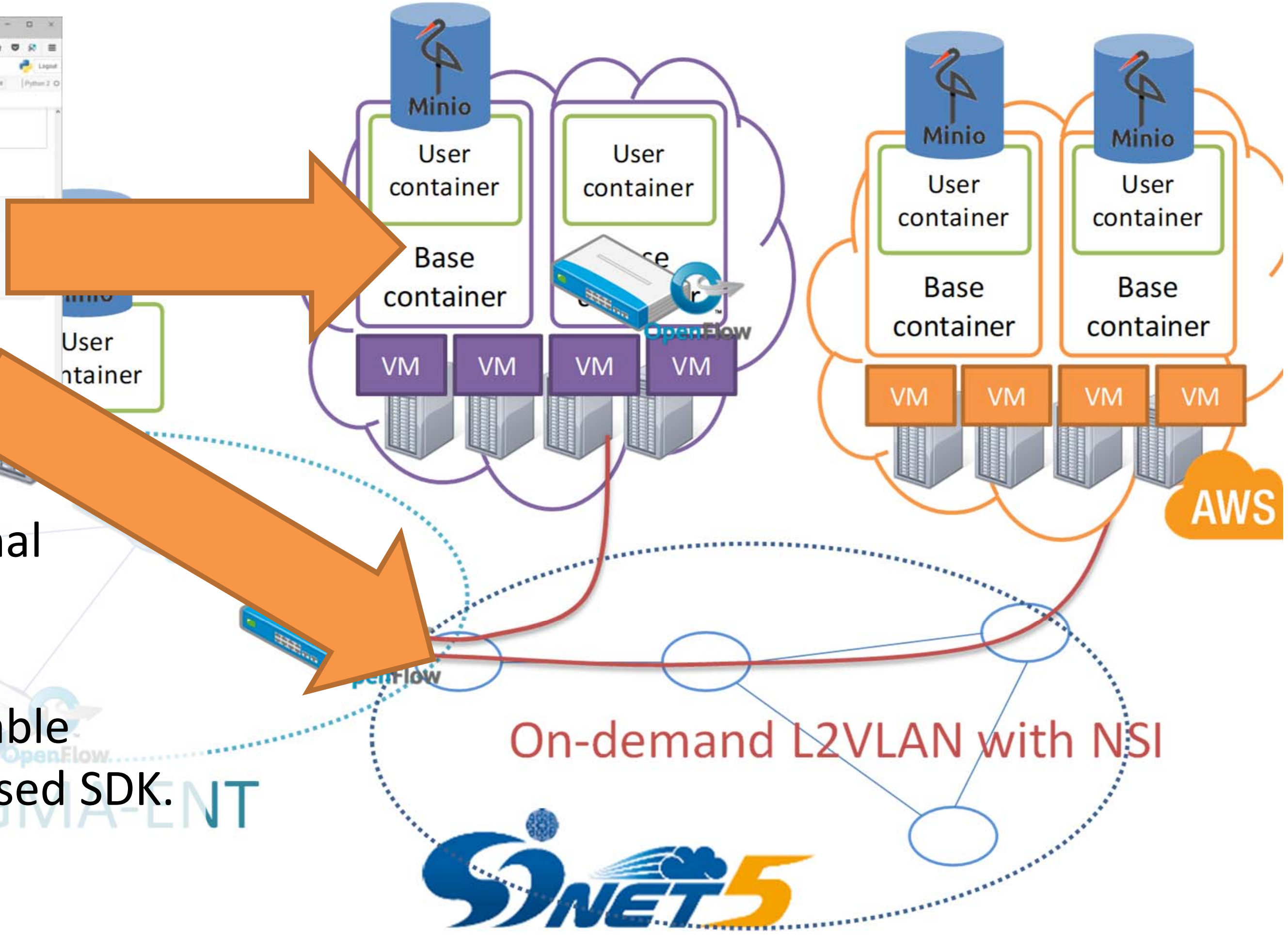
```
[GET] http://192.168.2.181/vcp/v1/occtr
[GET] http://192.168.2.181/vcp/v1/occtr/vcs
[GET] http://192.168.2.181/vcp/v1/occtr/accounts/authority
authority OK
```

現在のVCの状態を確認しておく。

[14]:
```
dfs = [vc.units_df() for vc in oc.vcs]
print(dfs)
if len(dfs) > 0:
    pd.concat(dfs, ignore_index=True)
```

```
[]
```

4.2 VCの作成

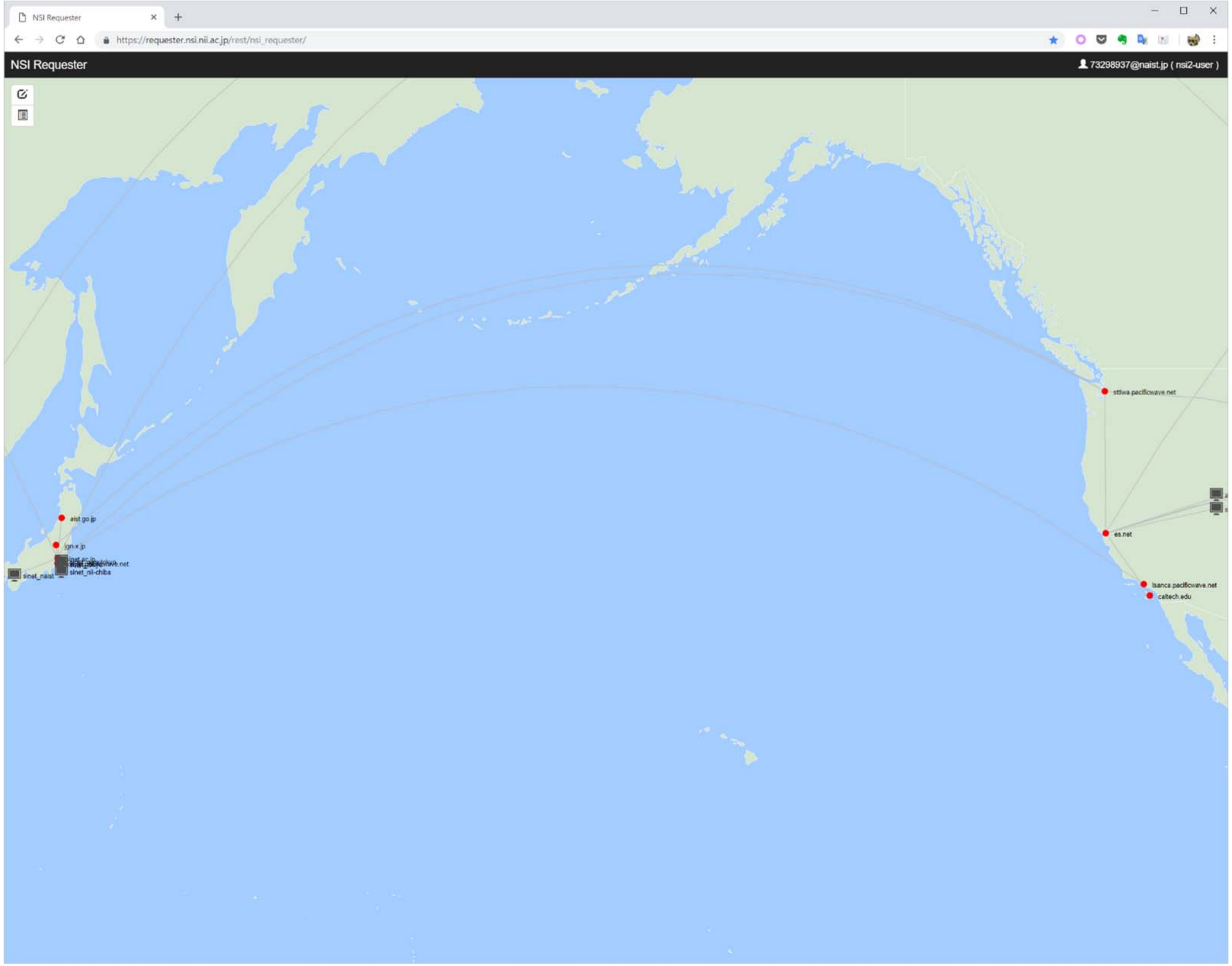


On-demand L2VLAN with NSI

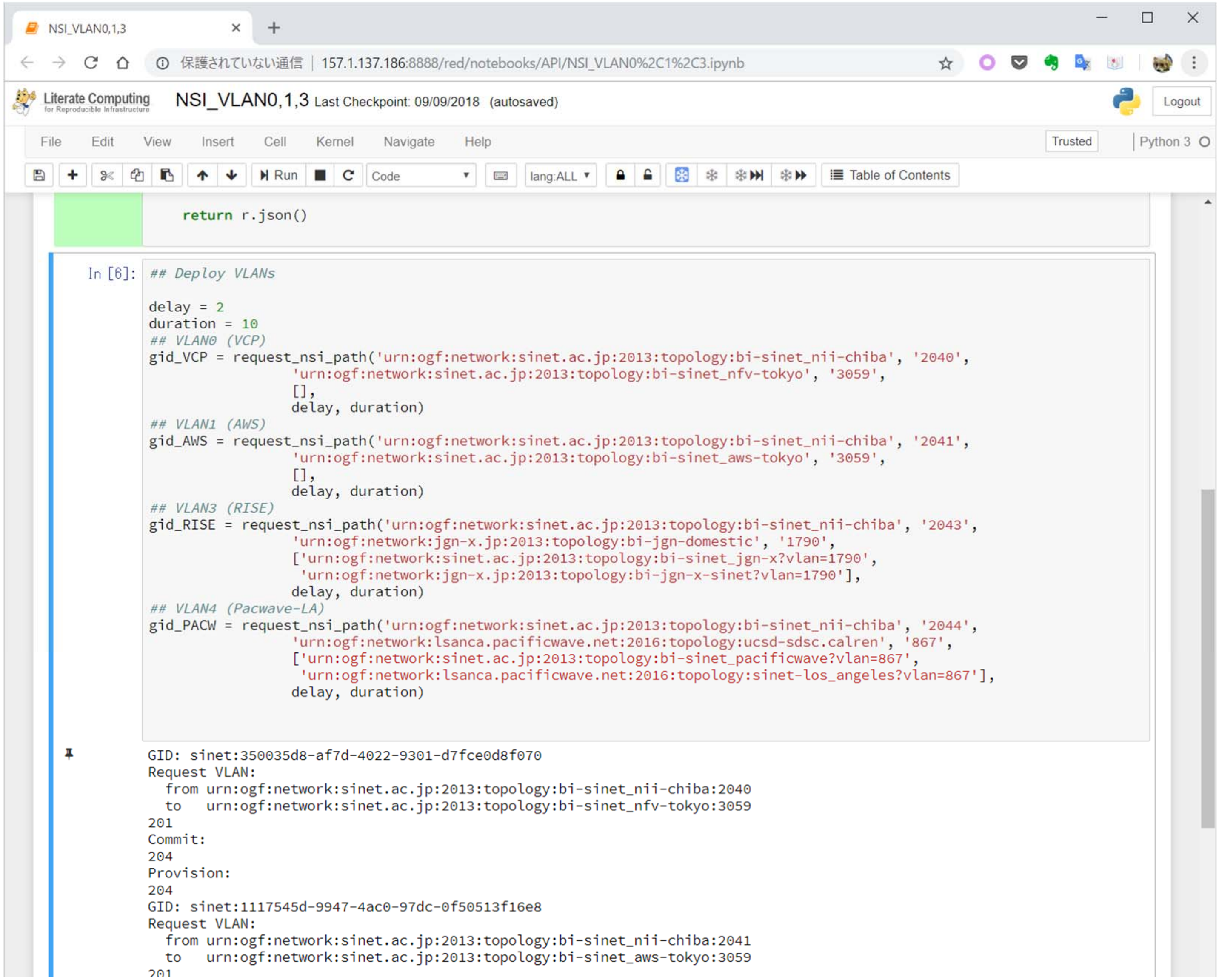
Deployment of international L2VLAN and Inter-Cloud environment can be fully controlled in a programmable manner on the Jupyter-based SDK.

Demo

Demo:


NSI Requester
https://requester.nsi.nii.ac.jp/rest/nsi_requester/
NSI Requester
73298937@naist.jp (nsi2-user)
aist.go.jp
jgn-x.jp
sinet_nii-chiba
sinet_naist
sttlwa.pacificwave.net
es.net
lsanca.pacificwave.net
caltech.edu

Demo:


NSI_VLAN0,1,3
保護されていない通信 | 157.1.137.186:8888/red/notebooks/API/NSI_VLAN0%2C1%2C3.ipynb
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NSI_VLAN0,1,3 Last Checkpoint: 09/09/2018 (autosaved)
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```
    return r.json()
```

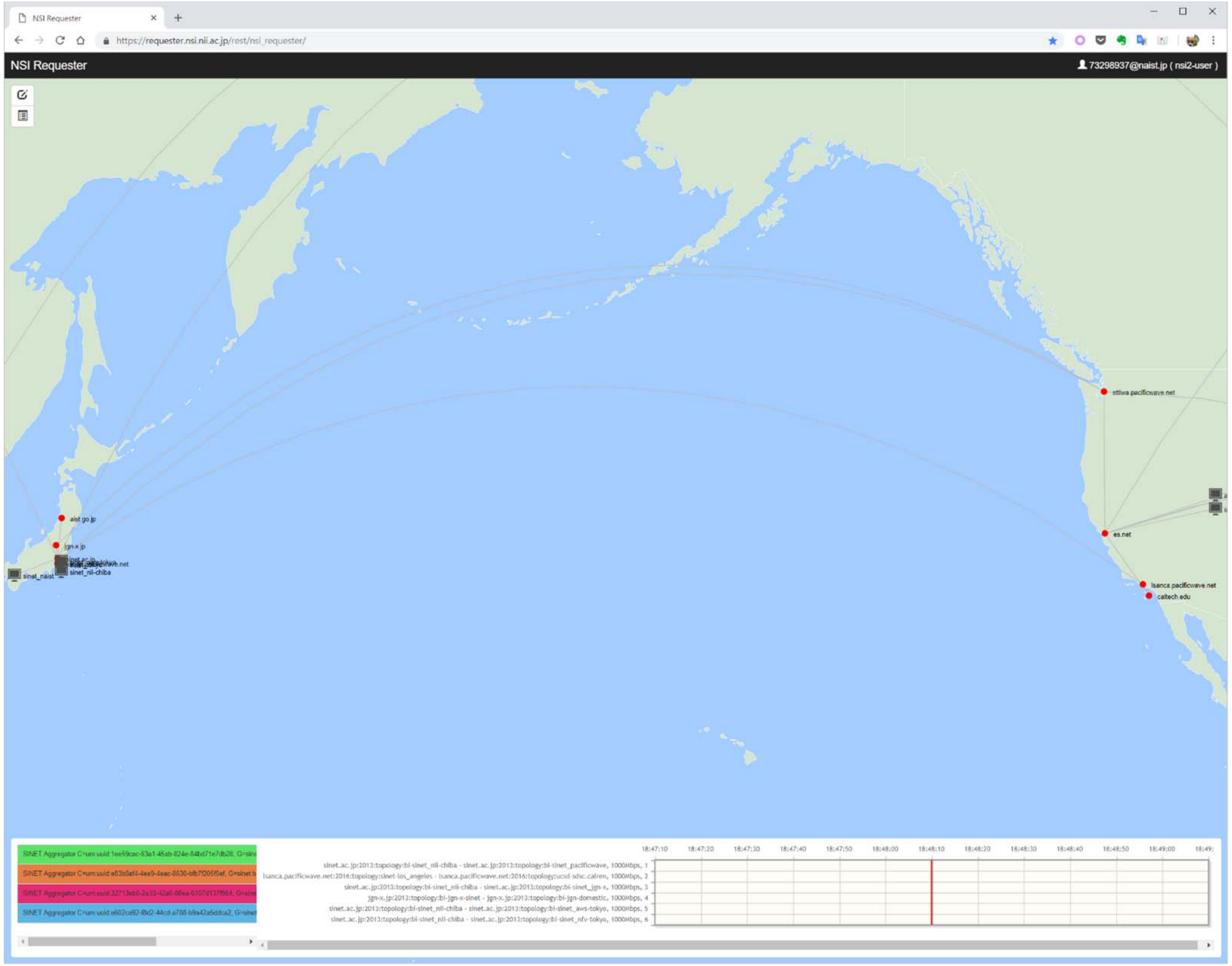
In [6]:

```
## Deploy VLANs

delay = 2
duration = 10
## VLAN0 (VCP)
gid_VCP = request_nsi_path('urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba', '2040',
                 'urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nfv-tokyo', '3059',
                 [],
                 delay, duration)
## VLAN1 (AWS)
gid_AWS = request_nsi_path('urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba', '2041',
                 'urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_aws-tokyo', '3059',
                 [],
                 delay, duration)
## VLAN3 (RISE)
gid_RISE = request_nsi_path('urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba', '2043',
                 'urn:ogf:network:jgn-x.jp:2013:topology:bi-jgn-domestic', '1790',
                 ['urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_jgn-x?vlan=1790',
                  'urn:ogf:network:jgn-x.jp:2013:topology:bi-jgn-x-sinet?vlan=1790'],
                 delay, duration)
## VLAN4 (Pacwave-LA)
gid_PACW = request_nsi_path('urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba', '2044',
                 'urn:ogf:network:lsanca.pacificwave.net:2016:topology:ucsd-sdsc.calren', '867',
                 ['urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_pacificwave?vlan=867',
                  'urn:ogf:network:lsanca.pacificwave.net:2016:topology:sinet-los_angeles?vlan=867'],
                 delay, duration)
```

```
GID: sinet:350035d8-af7d-4022-9301-d7fce0d8f070
Request VLAN:
  from urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba:2040
  to   urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nfv-tokyo:3059
201
Commit:
204
Provision:
204
GID: sinet:1117545d-9947-4ac0-97dc-0f50513f16e8
Request VLAN:
  from urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_nii-chiba:2041
  to   urn:ogf:network:sinet.ac.jp:2013:topology:bi-sinet_aws-tokyo:3059
201
```

Demo:



SINET Aggregator C=urn:uuid:1ee59cac-83a1-45ab-824e-84bd71e7db28, G=sine
SINET Aggregator C=urn:uuid:e83b8af4-4ee9-4eac-8630-bfb7f205f0ef, G=sinet:b
SINET Aggregator C=urn:uuid:32713eb6-2a33-42a6-86ea-0107d137f964, G=sine
SINET Aggregator C=urn:uuid:a602ca92-f8d2-44cd-a788-b9a42a5ddca2, G=sinet

```
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_pacificwave, 1000Mbps, 1
lsanca.pacificwave.net:2016:topology:sinet-los_angeles - lsanca.pacificwave.net:2016:topology:ucsd-sdsc.calren, 1000Mbps, 2
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jgn-x.jp:2013:topology:bi-jgn-x-sinet - jgn-x.jp:2013:topology:bi-jgn-domestic, 1000Mbps, 4
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_aws-tokyo, 1000Mbps, 5
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_nfv-tokyo, 1000Mbps, 6
```
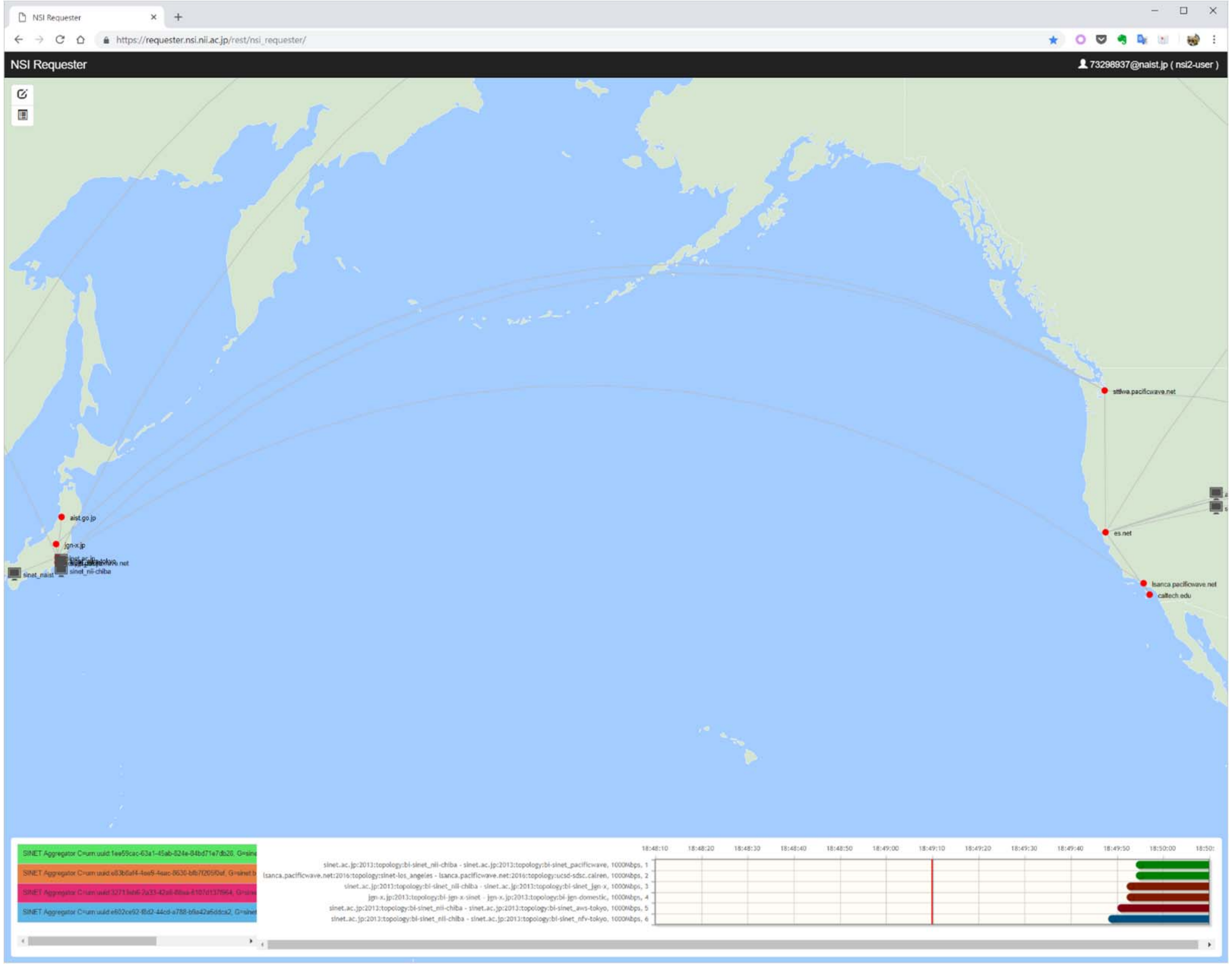

Demo:



🟩 SINET Aggregator C=urn:uuid:1ee59cac-63a1-45ab-824e-84bd71e7db28, G=sine

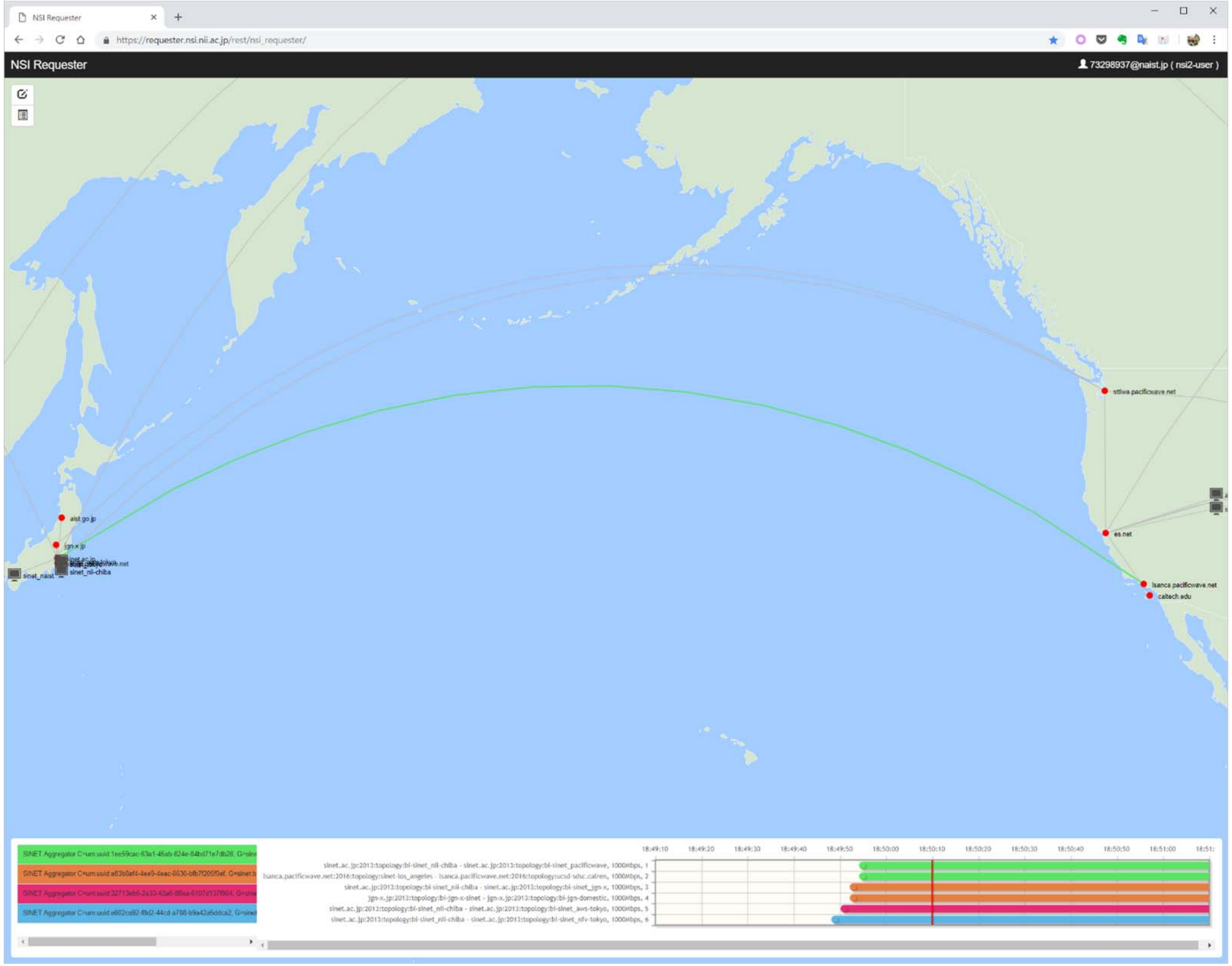
🟧 SINET Aggregator C=urn:uuid:e83b6af4-4ee8-4eac-8630-bfb7f205f0ef, G=sinet.b

🟥 SINET Aggregator C=urn:uuid:3271bdb6-2a33-42a8-88aa-8107d137f964, G=sine

🟦 SINET Aggregator C=urn:uuid:e602ce92-f8d2-44cd-a788-b9a42a5ddca2, G=sinet

sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_pacificwave, 1000Mbps, 1
lsanca.pacificwave.net:2016:topology:sinet-los_angeles - lsanca.pacificwave.net:2016:topology:ucsd-sdsc.calren, 1000Mbps, 2
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_jgn-x, 1000Mbps, 3
jgn-x.jp:2013:topology:bi-jgn-x-sinet - jgn-x.jp:2013:topology:bi-jgn-domestic, 1000Mbps, 4
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_aws-tokyo, 1000Mbps, 5
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_nfv-tokyo, 1000Mbps, 6

Demo:



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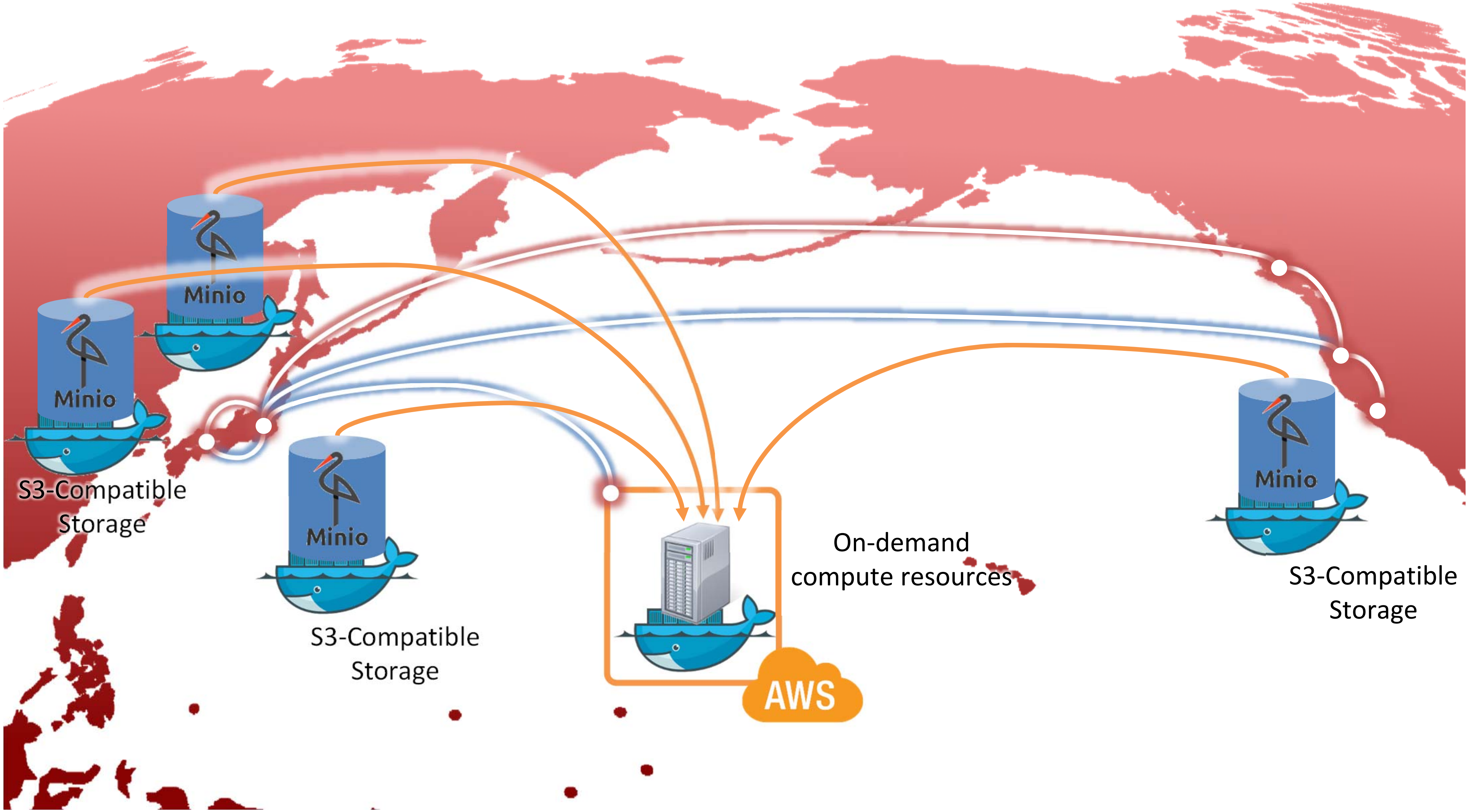
SINET Aggregator C=urn:uuid:e83b0af4-4ee9-4eac-8630-bfb7f205f0af, G=sinet:b

SINET Aggregator C=urn:uuid:32713eb6-2a33-42a6-86ea-6107d137f664, G=sine

SINET Aggregator C=urn:uuid:a602ca92-f8d2-44cd-a788-b9a42a5ddca2, G=sinet

sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_pacificwave, 1000Mbps, 1
lsanca.pacificwave.net:2016:topology:sinet-los_angeles - lsanca.pacificwave.net:2016:topology:ucsd-sdsc.calren, 1000Mbps, 2
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_jgn-x, 1000Mbps, 3
jgn-x.jp:2013:topology:bi-jgn-x-sinet - jgn-x.jp:2013:topology:bi-jgn-domestic, 1000Mbps, 4
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_aws-tokyo, 1000Mbps, 5
sinet.ac.jp:2013:topology:bi-sinet_nii-chiba - sinet.ac.jp:2013:topology:bi-sinet_nfv-tokyo, 1000Mbps, 6

Use case: Distributed Storage Service Deployment



Conclusion & Future Plan

- We established a network testbed for use by different PRAGMA researchers and institutes
- The network testbed offers complete freedom for researchers to access network resources with SDN
- We are currently working on integrating ENT with the Inter-Cloud service (VCP) and dynamic NVLAN service (NSI) provided by NII

- Future Plan
  - Expanding network (Direct L2 and/or virtual overlay)
  - Multipath control for the integrated environment with ENT and VCP/NSI