Supporting International Partnerships in Science: The Role of International Networks at Indiana University

Brenna Meade

International Networks at Indiana University

Network Engineer

SC22 WAN Lead

SC23 NRE / XNET Lead

Women In Networking @ SC (WINS) Lead

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2022-23 Transition Updates

- **Leadership**
  - Dr. Jennifer Schopf left IU Fall 2022
  - Jim Williams leading team transition
- TransPAC & NEA3R remain at IU

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TransPAC History

15+ year history

Cooperative partnership among Indiana University, APAN, TEIN*CC, JGN-x/NICT-Japan, NII-Japan, CERNET, and others

- 30Gbps deployed between US and Asia
- 10Gbps LA-Tokyo funded by NSF
- 10Gbps Tokyo-LA funded by NICT
- 10Gbps LA-Beijing funded by CERNET+NSF

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TransPAC Today

- TransPAC-PacWave 100G Seattle-Tokyo
- Guam-Singapore Circuit Consortium 100G up and running since January 2022
  - SingAREN to GOREX (Singapore to Guam)
  - Consortium includes AARNet, I2, IN@IU, ARENA-PAC, PNWGP, U Hawaii, SingaREN

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TransPAC: Looking to the future

- Working with TransPAC partners to determine the timeline for 400G upgrade
- Support for international science collaborations and experiments
  - SCAsia, DMC, SC23
- One-on-one direct work with applications to support international<>US collaboration
- TestBed support with FAB/FABRIC
- Science support for applications
  - LHCONE Network Service Provider (NSP)
  - General end-to-end performance assistance
- Network research

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AP-REX 2.0

- Create US Consortium of Exchange Point and Link Operators to Improve Coordination of Activities in the Domestic US
    - GXPs may operate differently but we can all work together!
- Provide for efficient use of resources for trans US traffic, including:
    - Leverage common cores for routing production traffic to minimize operating costs
    - Provide dedicated links for experimental and meeting specific use (SC)
- Support research testbeds (e.g. FABRIC, BRIDGES)
- Encourage consistent set of operating principles and software features, including:
    - AutoGOLE/SENSE
    - P4 and related instrumentation
    - Performance Assurance Services (PAS) test infrastructure
    - Measurement, monitoring, and reporting applications

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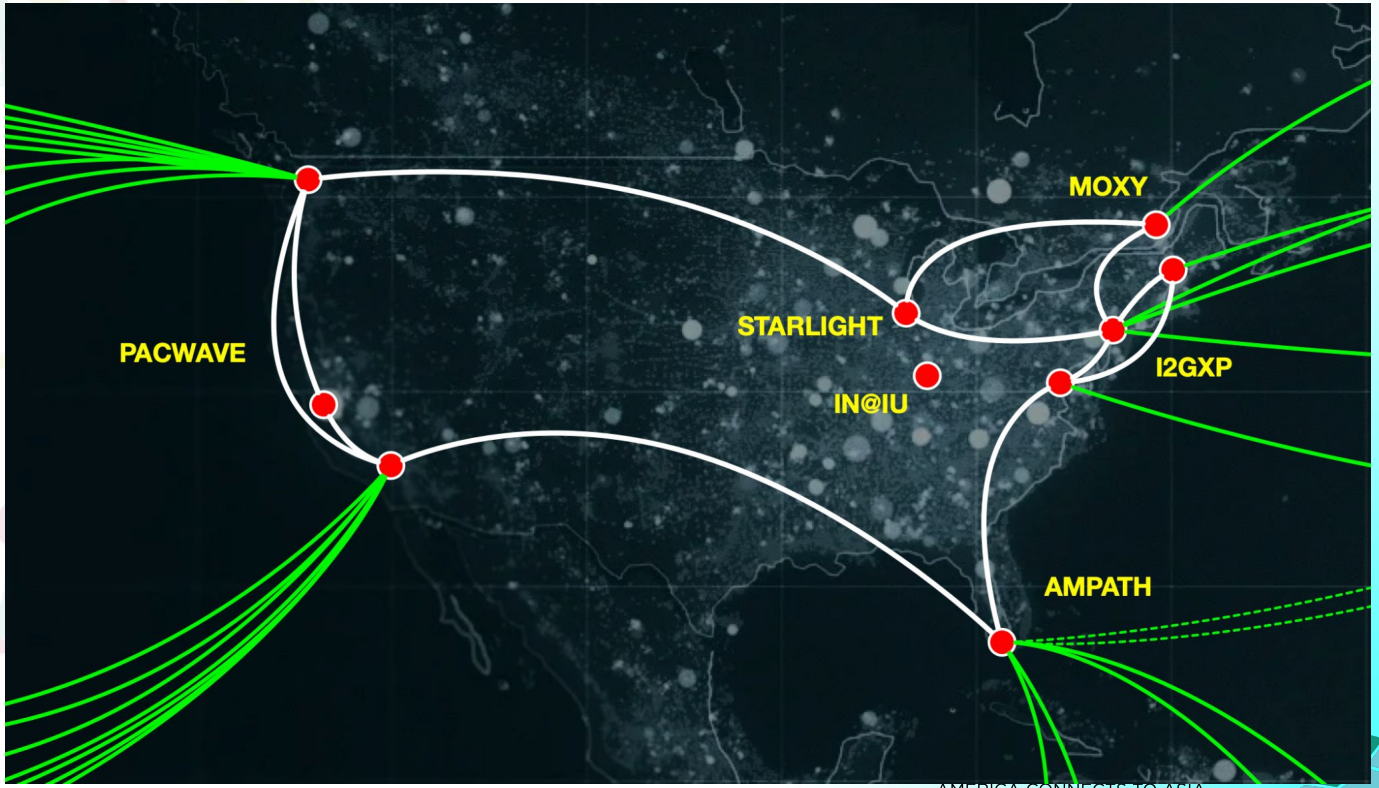
AP-REX 2.0- Connecting GXPs in the US together

Partners

- Internet2
- PacWave
- AMPATH / FIU
- CANARIE
- IU International
- MOXY
- StarLight International / National Communications Networks Exchange Facility



ANA- Collaboration to Support Science

Advanced North Atlantic (ANA)

- Collaboration between CANARIE, Energy Sciences Network (ESnet), Internet2, GÉANT, NORDUnet,SURFnet, NEA3R for connectivity between North America and Europe

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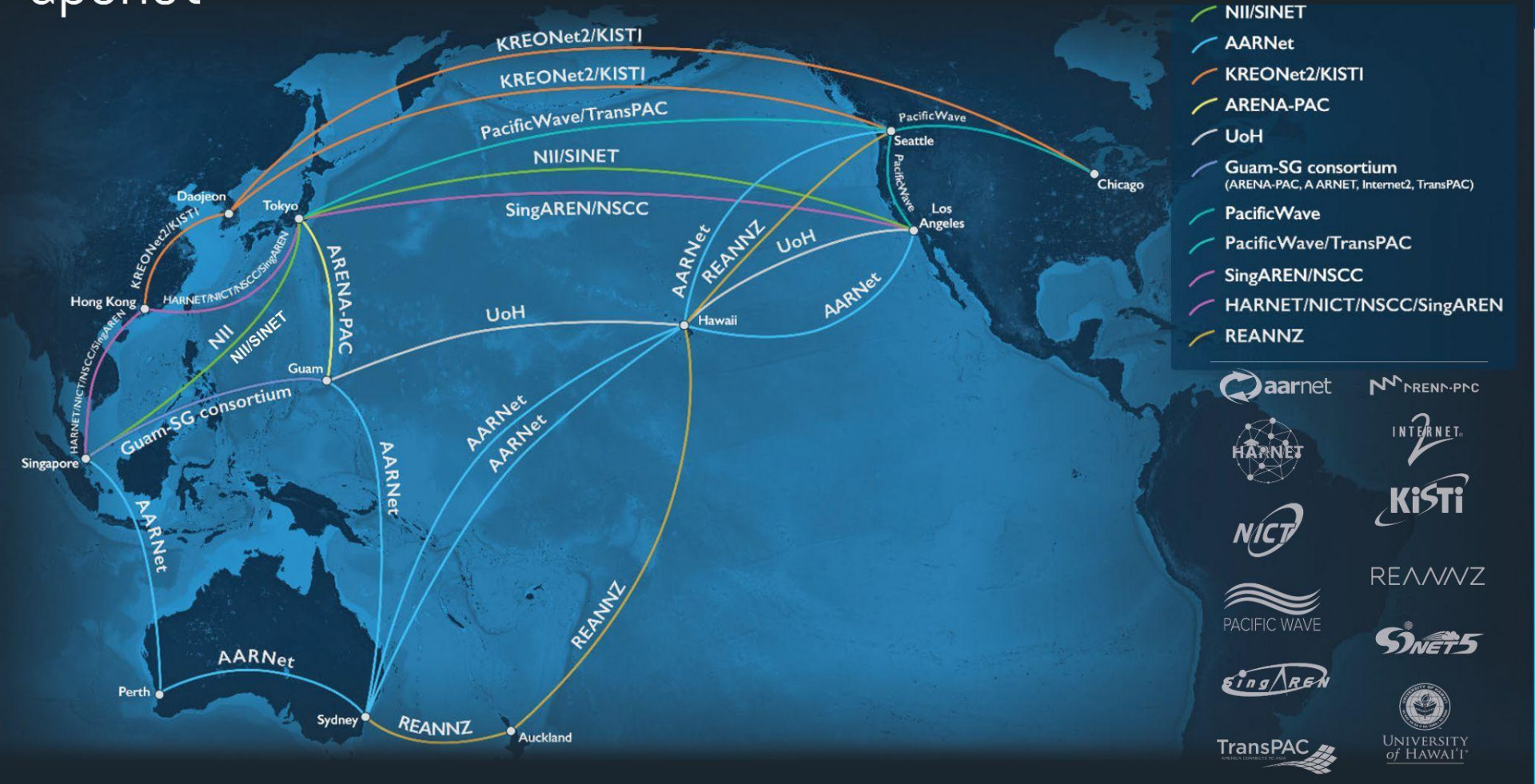
aponet ASIA PACIFIC OCEANIA NETWORK (APOnet)



APOnet Project Activities

1. **Supporting highly available connectivity**
   - Build multiple paths between R&E networks
2. **Backup traffic**
   - *“Official” backup paths being identified*
3. **Cooperation and coordination**
   - Engineering- Monthly
   - Policy - Every 8 weeks
4. **Network research and services**
   - Explore and cooperatively deploy, emerging networking technologies/services

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Project Activities

5. **Application development and support**
   - Experimentation with high bw demand apps
   - Troubleshooting end-to-end connectivity
6. **External experiment support**
   - Access for pragmatic experiments
7. **Preferred route identification and resolution**
   - *Joint with Routing Working Group*
8. **Sharing of measurement data**
   - http://aponet.netsage.global

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How can we improve research support?

- Improved collaboration with international partners and international research exhibitions
- Understanding who's using our network
- Working together to identify and improve slow rates of transfer
- Looking at data transfer patterns to understand use cases

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Monitoring Using NetSage

- NetSage advanced measurement services for R&E data traffic
  - Better understanding of current traffic patterns across instrumented circuits
  - Better understanding of large flow sources/sinks
  - Performance information for data transfers
- Original Collaboration between Indiana, LBNL, and U Hawaii
- Originally funded by the NSF international program, software is now being deployed domestically as well
- International networks dashboards: http://portal.netsage.global

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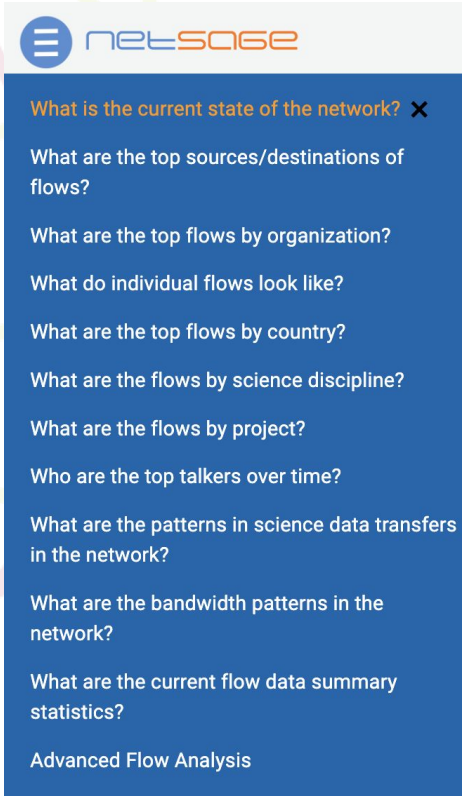
APOnet Netsage

Bandwidth Dashboard

The map shows the minimum, maximum, and average bandwidth utilization of the circuits and exchange points over the selected time period.
The rows below the map show each of the links in more detail, including traffic rate and total volume transferred.
A combined view of the average and maximum bandwidth utilization is shown at the bottom of the page.
All times are displayed in browser local time

Single Link Max A-Z	Single Link Max Z-A	Average Across All Links	Total Transferred
58.0 Gb/s	63.9 Gb/s	3.65 Gb/s	7.42 PB

Using Netsage to answer questions



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Top Destinations from Singapore

# Flows	Total Volume
2,777,355	352.8 TB

By Volume

Destination Country	Total Volume	Largest Flow	# Flows
Singapore	278.8 TB	1.6 TB	2.3 Mil
United States	45.1 TB	351.1 GB	265.0 K
Philippines	10.1 TB	150.3 GB	138.4 K
Australia	4.8 TB	54.0 GB	1.9 K
Japan	4.4 TB	48.6 GB	43.0 K
Hong Kong	2.8 TB	9.8 GB	32.6 K
Switzerland	1.9 TB	415.8 GB	1.4 K
India	752.8 GB	11.3 GB	8.4 K
Antigua and Barbuda	686.1 GB	5.4 GB	9.5 K
South Africa	672.5 GB	4.6 GB	299.0
Indonesia	548.5 GB	7.1 GB	10.2 K

By Rate

Destination Country	Peak	Average	# Flows
Australia	43.1 Gb/s	2.1 Gb/s	1.9 K
Singapore	41.5 Gb/s	178.5 Mb/s	2.3 Mil
United States	31.5 Gb/s	138.0 Mb/s	265.0 K
Indonesia	24.8 Gb/s	61.2 Mb/s	10.2 K
Hong Kong	16.6 Gb/s	74.9 Mb/s	32.6 K
India	11.8 Gb/s	67.3 Mb/s	8.4 K
Philippines	5.9 Gb/s	46.0 Mb/s	138.4 K
Japan	5.0 Gb/s	66.5 Mb/s	43.0 K
New Zealand	4.8 Gb/s	2.4 Gb/s	131.0
Vietnam	4.7 Gb/s	57.0 Mb/s	3.8 K
France	2.5 Gb/s	16.3 Mb/s	469.0

Flows by Country : Singapore (Last 7 Days)

Top Flow Pairs with Endpoint(s) in Singapore

Source Organization	Destination Organization	Total Vol.	Largest Flow	# Flows	Avg Rate	Peak Rate
A*STAR	Amazon.com, Inc.	56.8 TB	190.9 GB	156.2 K	293.3 Mb/s	12.0 Gb/s
Microsoft Corporation	Nanyang Technological University	38.5 TB	116.1 GB	276.0 K	150.4 Mb/s	41.5 Gb/s
Amazon.com, Inc.	A*STAR	38.2 TB	89.1 GB	128.2 K	104.5 Mb/s	13.5 Gb/s
Nanyang Technological University	Microsoft Corporation	35.8 TB	204.5 GB	857.1 K	295.6 Mb/s	19.7 Gb/s
A*STAR	Alibaba (US) Technology Co., Ltd.	24.0 TB	37.2 GB	11.1 K	111.5 Mb/s	3.6 Gb/s
National Library of Medicine	SingAREN	22.0 TB	286.3 GB	2.2 K	270.2 Mb/s	2.1 Gb/s
Nanyang Technological University	Amazon.com, Inc.	14.5 TB	1.0 TB	63.8 K	207.4 Mb/s	24.5 Gb/s
A*STAR	A*STAR	12.8 TB	144.4 GB	4.0 K	990.4 Mb/s	3.3 Gb/s
Amazon.com, Inc.	Nanyang Technological University	11.4 TB	188.1 GB	112.9 K	124.4 Mb/s	14.1 Gb/s
Valve Corporation	National University of Singapore	10.1 TB	3.9 GB	61.3 K	3.3 Mb/s	915.0 Mb/s
Nanyang Technological University	Apple Inc.	9.9 TB	11.9 GB	118.6 K	80.5 Mb/s	16.6 Gb/s
Fastly, Inc.	National University of Singapore	9.8 TB	17.8 GB	142.7 K	54.6 Mb/s	13.5 Gb/s
University of Chicago	A*STAR	8.1 TB	61.5 GB	470.0	16.2 Mb/s	61.7 Mb/s
Nanyang Technological University	Google LLC	7.7 TB	173.5 GB	52.2 K	222.7 Mb/s	23.7 Gb/s

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Flow by Organization : SingAREN (Last 7 days)

Top Flows Received by SingAREN

# Flows	Total Volume
6,466	31.7 TB

By Volume

Source Organization	Total Volume ↓	Largest Flow	# Flows
National Library of Medicine	22.0 TB	286.3 GB	2.2 K
University of Hawaii	4.2 TB	10.7 GB	1.2 K
Australian Academic and Research Network (AARNet)	3.0 TB	20.6 GB	712.0
Indiana University	653.9 GB	7.3 GB	203.0
Jisc Services Limited	538.1 GB	12.2 GB	161.0
SWITCH	498.8 GB	184.7 GB	12.0
National Institute of Informatics	399.1 GB	7.1 GB	130.0
Institute of Technology Bandung	152.1 GB	5.5 GB	229.0
SingAREN	85.6 GB	7.9 GB	396.0
Multimedia Development Corporation	43.1 GB	2.8 GB	20.0
China Education and Research Network Center	25.1 GB	1.2 GB	53.0

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Individual Flows

Individual Flows

This dashboard shows per-flow level data, given a particular source and destination organization.
The table shows the volume, rate, duration (in hours, minutes and seconds) and retransmits for the top 1000 largest flows.
Click on the timestamp of an individual flow to show more detailed information about that flow.
Please note that the retransmit information is only available for archive flow data;
and rate and duration will be zero for flows where only one sample was detected.
All times are displayed in browser local time.

# Flows	Total Volume	Avg Rate
9	1.1 TB	1.5 Gb/s

Flows from Source to Destination

Timestamp	Source Organization	Source Subnet	Destination Organization	Destination Subnet	Total Volume ↓	Rate	Duration	Retransmits
2023-02-28 12:58:01	SingAREN	103.5.243.x	A*STAR	202.83.250.x	161.2 GB	1.74 Gb/s	00:12:21	null
2023-02-27 13:06:52	SingAREN	103.5.243.x	A*STAR	202.83.250.x	159.7 GB	1.74 Gb/s	00:12:15	null
2023-03-01 13:06:50	SingAREN	103.5.243.x	A*STAR	202.83.250.x	159.4 GB	1.69 Gb/s	00:12:35	null
2023-02-24 13:00:53	SingAREN	103.5.243.x	A*STAR	202.83.250.x	158.8 GB	1.70 Gb/s	00:12:28	null
2023-02-23 13:05:53	SingAREN	103.5.243.x	A*STAR	202.83.250.x	158.3 GB	1.67 Gb/s	00:12:39	null
2023-02-26 13:06:52	SingAREN	103.5.243.x	A*STAR	202.83.250.x	158.3 GB	1.70 Gb/s	00:12:25	null
2023-02-25 13:05:51	SingAREN	103.5.243.x	A*STAR	202.83.250.x	153.7 GB	1.62 Gb/s	00:12:37	null
2023-02-25 13:00:52	SingAREN	103.5.243.x	A*STAR	202.83.250.x	4.0 GB	305 Mb/s	00:01:45	null
2023-02-25 00:43:23	SingAREN	192.229.232.x	A*STAR	202.83.250.x	14.9 MB	583 Mb/s	00:00:00	null

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SC22 : Dallas

Trans-Pacific - APOnet SC22 Network Research Exhibitions (NRE)

- SC22 NRE 013 - GNA-G AutoGOLE/SENSE: End-to-End Network Services and Workflow Integration
- SC22 NRE 019 - Caltech Global Petascale to Exascale Workflows for Data Intensive Science Accelerated by Next Generation Programmable Network Architectures and ML Applications
- SC22 NRE 022 - NICT Uncompressed 8K video processing on edge-computing
- SC22 NRE 023 - NICT Full 400Gbps E2E DATA/VIDEO transfer across the Trans-Pacific

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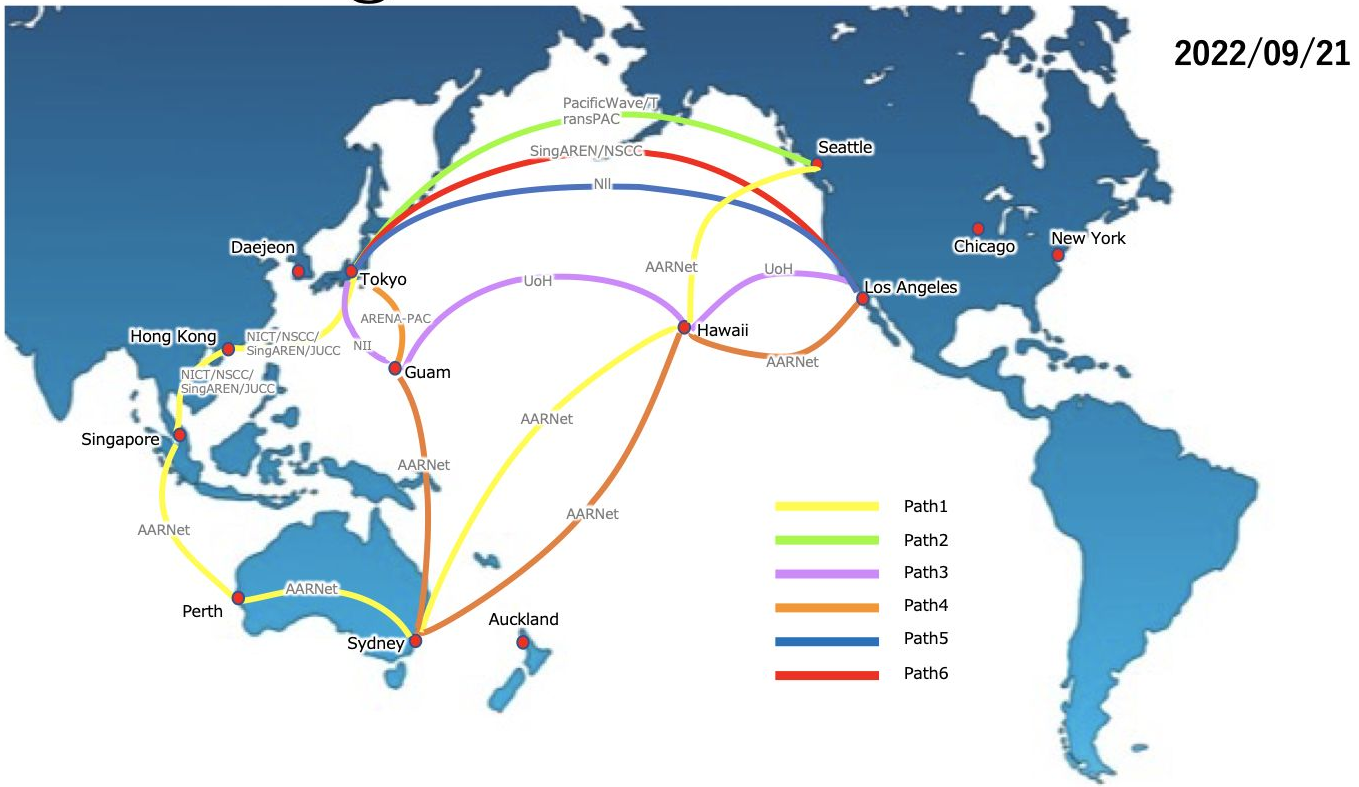
SC22: APOnet coordination of 600 gbps over the Pacific to support 6 demos from NICT

WAN Configuration



SC23

- Focus on more demonstrations from the international community
- SCinet Research Exposition
  - Allows researchers who do not have the resources for their own booth to showcase their experiments

Preliminary Submissions:

June 2, 2023

Contact nre-leads@scinet.supercomputing.org for more info

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Routing Working Group

- 170 members, over 20 countries, over 80 institutions
- Find and resolve anomalous routes
  - Asymmetric Routing
  - R&E data using a commodity route
  - Data taking an inefficient route affecting performance
  - Routing loops preventing access
- 18 cases investigated to date
  - 15 solved cases
  - 2 on hold due to pending links

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GNA-G / APAN Routing Working Group

Email the Chairs!

meadeb@iu.edu

addlema@iu.edu

warrick.mitchell@aarnet.edu.au

Join the routing working group!

Mailing list routing-wg@gna-g.net

Slack

- APAN Slack Instance, Channel: Routing

Web

- https://www.gna-g.net/join-working-group/gna-g-routing-wg/

Contact any of the co-chairs for more information!

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Do you or your colleagues know of any US science collaborations sending “big data”? or have engineering issues?

Contact International Networks at Indiana University

meadeb@iu.edu

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Thank You APOnet Partners!