KAUST Update for AutoGOLE
Mini-GRP - SCA2023

Singapore - 02 Mar 2023

Alex S. Moura

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

About KAUST

KAUST Campus

Saudi Arabia

KAUST Programs and Research Centers

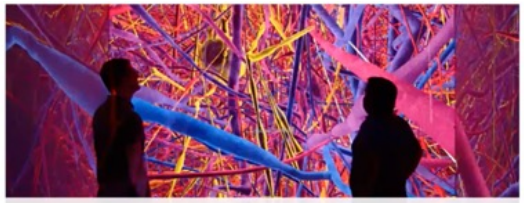
Biological and Environmental Science and Engineering (BESE)

PROGRAMS

1. Bioscience
2. Bioengineering
3. Environmental Science &
4. Engineering
5. Marine Science
6. Plant Science

RESEARCH CENTERS

1. Center for Desert Agriculture
2. Red Sea Research Center
3. Water Desalination and
4. Reuse Center



Computer, Electrical and Mathematical Science and Engineering (CEMSE)

PROGRAMS

1. Applied Mathematics & Computational Science
2. Computer Science
3. Electrical and Computer Engineering
4. Statistics

RESEARCH CENTERS

1. Computational Bioscience
2. Research Center
3. Extreme Computing
4. Research Center
5. Visual Computing Center

Physical Science and Engineering (PSE)

PROGRAMS

1. Applied Physics
2. Chemical Engineering
3. Chemical Science
4. Earth Science and Engineering
5. Energy Resources and Petroleum Engineering
6. Material Science and Engineering
7. Mechanical Engineering

RESEARCH CENTERS

1. Advanced Membranes and Porous
2. Materials Center
3. Ali I. Al-Naimi Petroleum
4. Engineering Research Center
5. Clean Combustion Research Center
6. Catalysis Center
7. Solar Center

Shaheen II

SHAHEEN II - CRAY XC40, XEON E5-2698V3 16C 2.3GHZ, ARIES INTERCONNECT

Site:	King Abdullah University of Science and Technology
Manufacturer:	Cray/HPE
Cores:	196,608
Memory:	0 GB
Processor:	Xeon E5-2698v3 16C 2.3GHz

TOP500 CERTIFICATE

The List.

Shaheen II - Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect

King Abdullah University of Science and Technology, Saudi Arabia

is ranked

No. 7

among the World's TOP500 Supercomputers

with 5.54 Pflop/s Linpack Performance

in the 45th TOP500 List published at ISC15 in Frankfurt, Germany, July 13th, 2015.

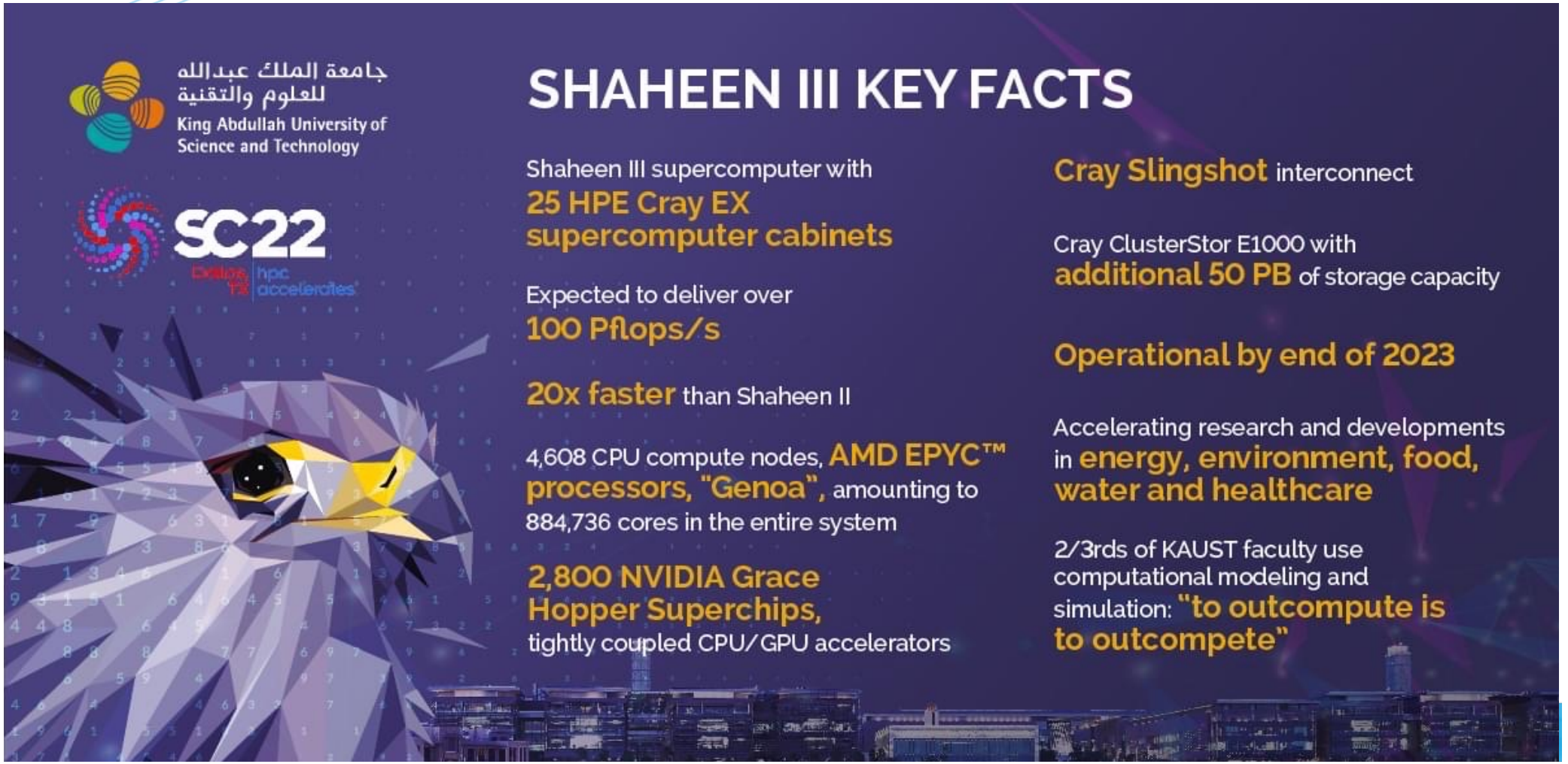
Congratulations from the TOP500 Editors

Erich Strohmaier — Jack Dongarra — Horst Simon — Martin Meuer

List	Rank	System	Vendor	Total Cores	Rmax (TFlops)	Rpeak (TFlops)	Power (kW)
11/2021	89	Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect	Cray/HPE	196,608	5,537.0	7,235.2	2,834.00

KAUST Core Labs: Shaheen II is the largest, fastest, and most powerful supercomputer in the Middle East

Shaheen III


جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology
SC22
Dallas, TX
hpc accelerates
SHAHEEN III KEY FACTS
Shaheen III supercomputer with
25 HPE Cray EX supercomputer cabinets
Expected to deliver over
100 Pflops/s
20x faster than Shaheen II
4,608 CPU compute nodes, AMD EPYC™ processors, "Genoa", amounting to 884,736 cores in the entire system
2,800 NVIDIA Grace Hopper Superchips,
tightly coupled CPU/GPU accelerators
Cray Slingshot interconnect
Cray ClusterStor E1000 with
additional 50 PB of storage capacity
Operational by end of 2023
Accelerating research and developments in energy, environment, food, water and healthcare
2/3rds of KAUST faculty use computational modeling and simulation: "to outcompute is to outcompete"

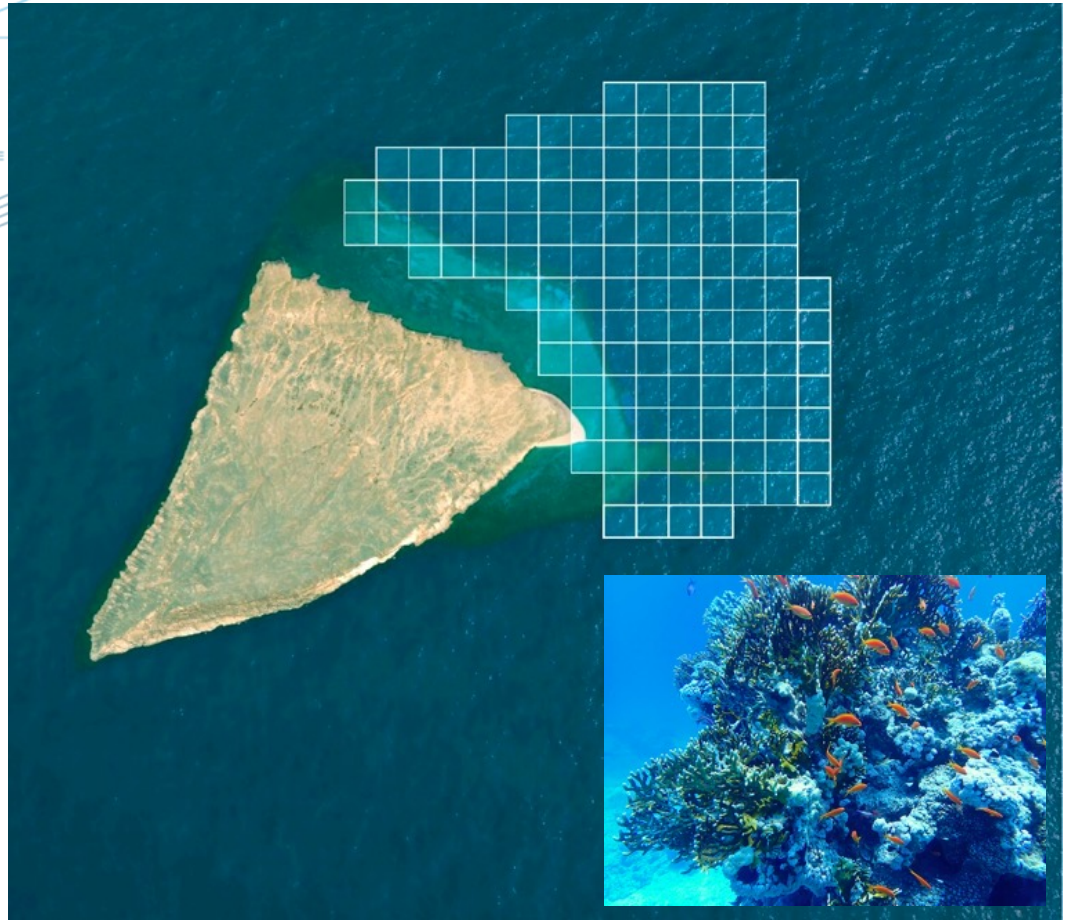
Research Demands

- **Reefscape Restoration Initiative (KRRI)**
  - Collab. w/ Center for Environmental Imaging* | SANDIN LAB @ UCSD
- **CERN CMS Project**
  - PhD Program
  - Research projects using Shaheen
- **NASA JPL / CALTECH**
  - Produce az/el masks for potential landing sites on the lunar surface, and they are expecting to have about 2TB of data to transfer by the end of this phase.

* Center for Environmental Imaging | SANDIN LAB (ucsd.edu)

KAUST Reefscape Restoration Initiative - KRRI

KAUST Reefscape Restoration Initiative - KRRI



The KAUST Reefscape Restoration Initiative at Shushah Island will preserve and enhance ~100 hectares of reefscape around Shushah Island, located approximately 20 km offshore NEOM in the Red Sea. Photo: KAUST

The project involves growing hundreds of thousands of corals in nurseries to be planted first across a 100-hectare pilot site located in the Red Sea east of Shushah Island, approximately 20 kilometers from NEOM in the Tabuk province of Saudi Arabia. The work underscores the Kingdom's commitment to study and protect corals and coral reefs in the region and beyond. It will also include a research and ecotourism center to further knowledge about coral reef ecosystems and the biodiversity of species they support.

Project Major Elements

Pilot Nursery

A 1000 sq.m pilot facility near the primary nursery site, expected to be operational by Q4 of 2022.

KAUST's Coral Nursery in NEOM

Design, construct and operate world's largest (~4 football fields) coral nursery at Haddah beach in NEOM with expected coral production of 400K per year.

Shushah Island Reefscape

Prepare, develop, enhance, monitor and manage ~100 Hectares of reefscape near Shushah Island. First corals to be out-planted from ex-situ nursery by Q2 2024.

Digital Twin and Monitoring

Performance monitoring, data visualization and management.

KAUST Shushah Island Research Center

Superlative, non-invasive educational visitor experiences for engaging tourists, scientists and students around the world.

KRRI Summary

The KAUST Reefscape Restoration Initiative is a large-scale coral reef restoration program in the Red Sea in the Kingdom of Saudi Arabia (KSA) initiated in 2021 and funded by King Abdullah University of Science and Technology (KAUST) in partnership with NEOM. The initiative will begin with a 100-hectare (1 Sq. Km) reef restoration project at Shushah Island.

One objective of the KRRI is to develop a Digital Twin – which will serve as scientific platform – and Monitoring of the area, which will be lead by the Monitoring, Visualization and Data Management team, responsible for monitoring all factors of the coral reef ecosystem that could influence the success and failure of restoration and conservation, which is one of the most important elements of a conservation, restoration, and enhancement project.

Goals

- Ultimate visualization is a full digital twin that will incorporate physical, environmental, biological, and restoration and conservation data
- Digital Twin serving as an educational and scientific platform

Next steps

- A detailed baseline survey of the reefscape will be completed in the near future
- Develop innovative tools that increase monitoring efficiency and automate data collection

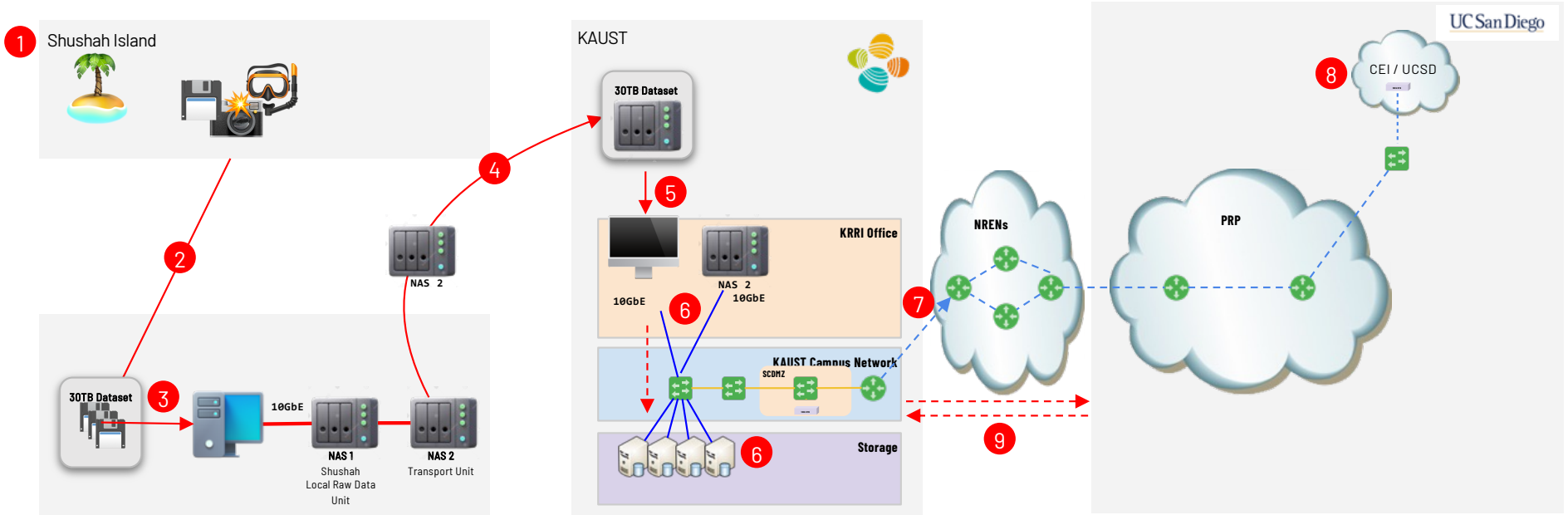
KRRI Summary

- Sensors and other digital monitoring technologies will track which corals are doing well and at what site — information the team will use to make decisions about strategies that will help corals thrive in the future.

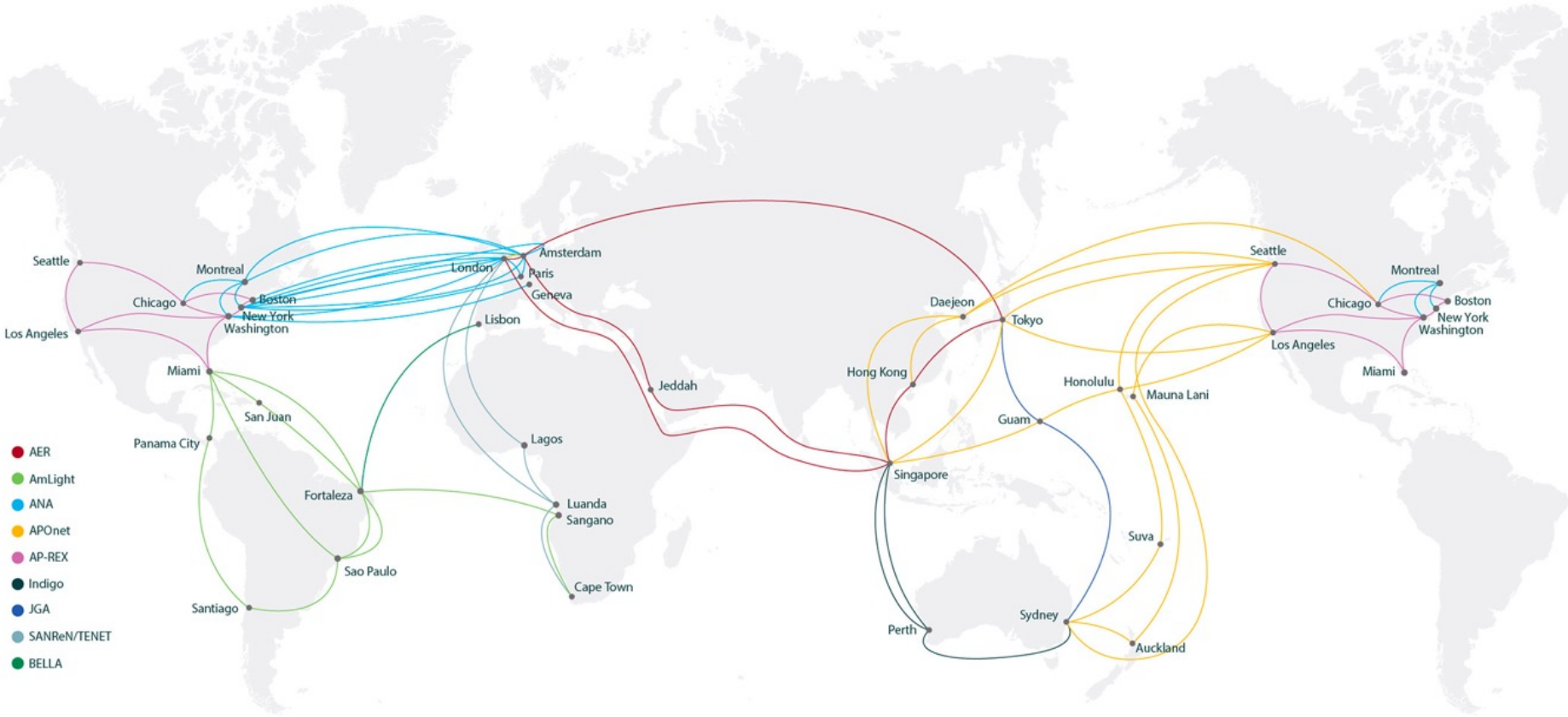
- KAUST's computational resources will play a big part in this effort.

KRRI Data Workflow Overview

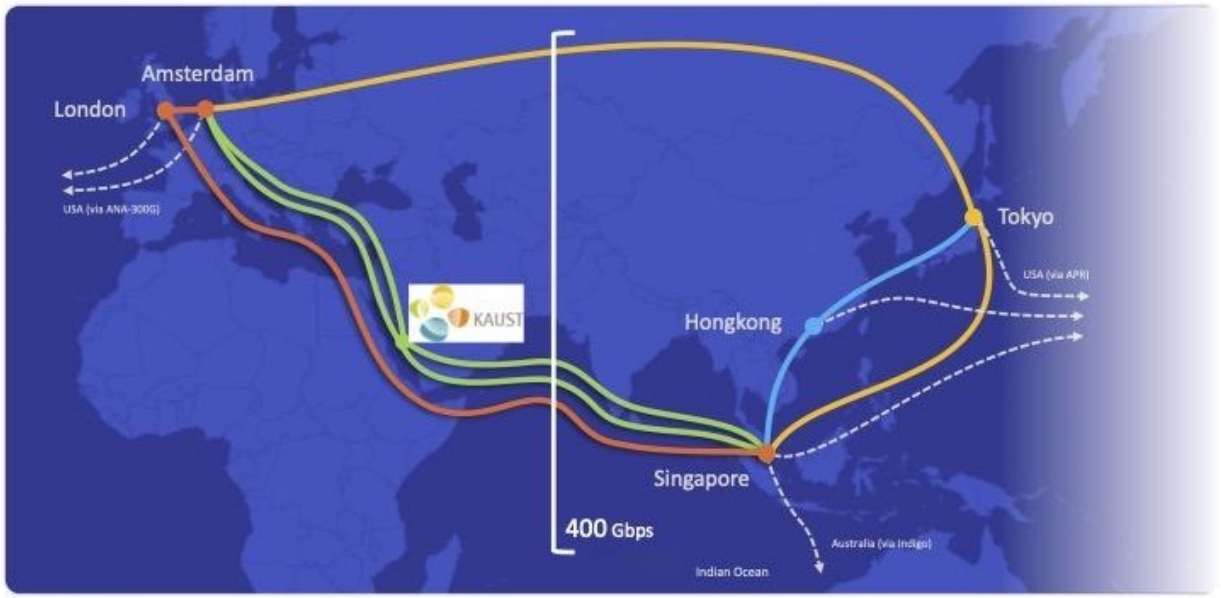
1. Coral reefs images are captured at Shushah
2. Image files are shipped in HDDs to KRRI office in Neom
3. Dataset is copied to larger disks using a NAS
4. Dataset copy is shipped in larger HDDs to KAUST office
5. Dataset arrives at KAUST KRRI Office and is copied to local NAS
6. Dataset is uploaded from KRRI Office to campus storage
7. Dataset is transmitted to CEI at UCSD using DTNs
8. Dataset is processed by CEI and a new dataset is generated
9. Processed dataset is downloaded from CEI back to KAUST and stored to used in next steps of the research



GNA-G


Seattle
Montreal
Chicago
Boston
New York
Washington
Los Angeles
Miami
San Juan
Panama City
Fortaleza
Sao Paulo
Santiago
London
Amsterdam
Paris
Geneva
Lisbon
Jeddah
Lagos
Luanda
Sangano
Cape Town
Daejeon
Tokyo
Hong Kong
Singapore
Guam
Perth
Sydney
Suva
Auckland
Honolulu
Mauna Lani
Seattle
Montreal
Chicago
Boston
New York
Washington
Los Angeles
Miami
AER
AmLight
ANA
APOnet
AP-REX
Indigo
JGA
SANReN/TENET
BELLA

International Networking: Asia-Pacific Europe Ring (AER)



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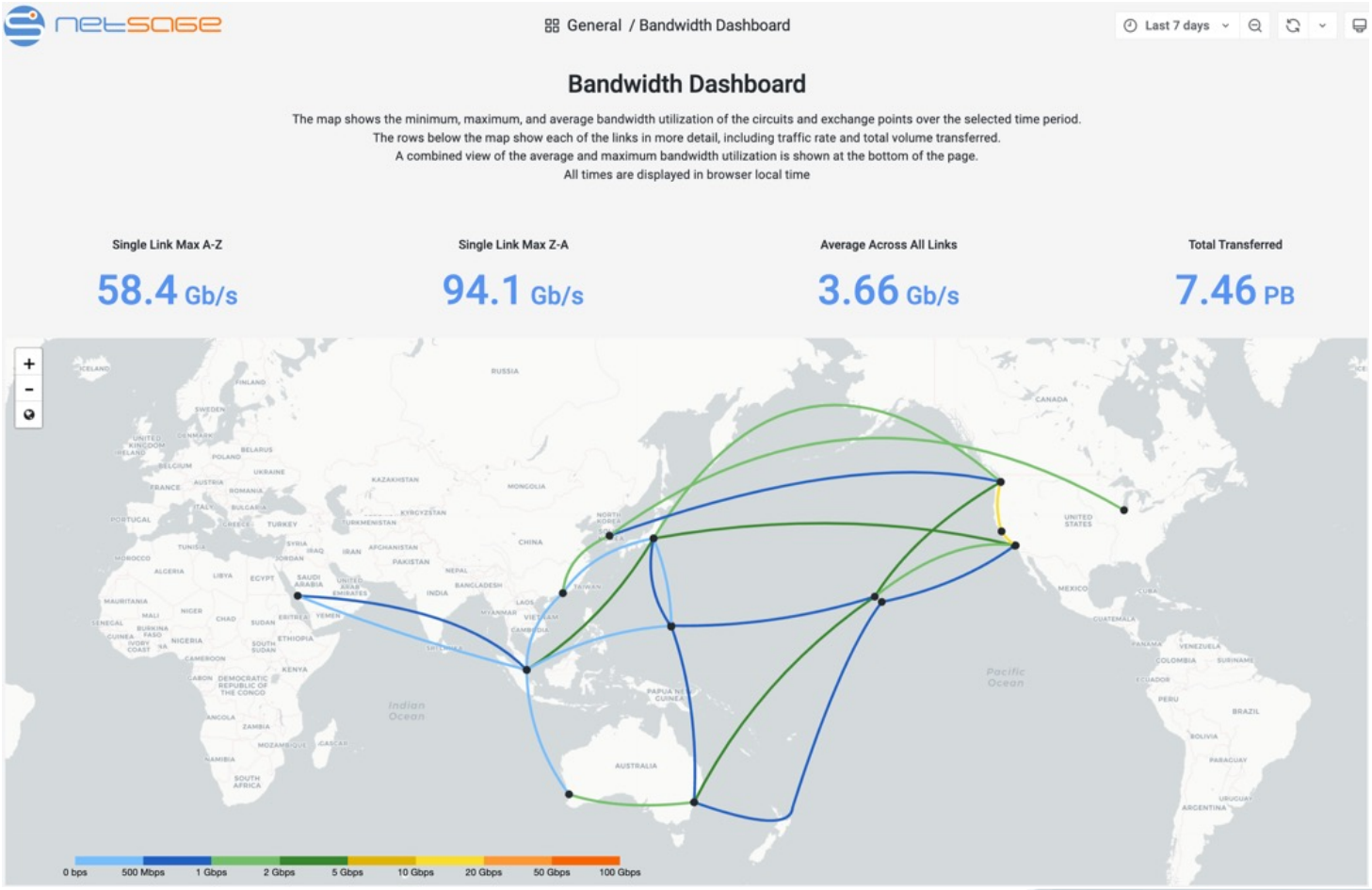
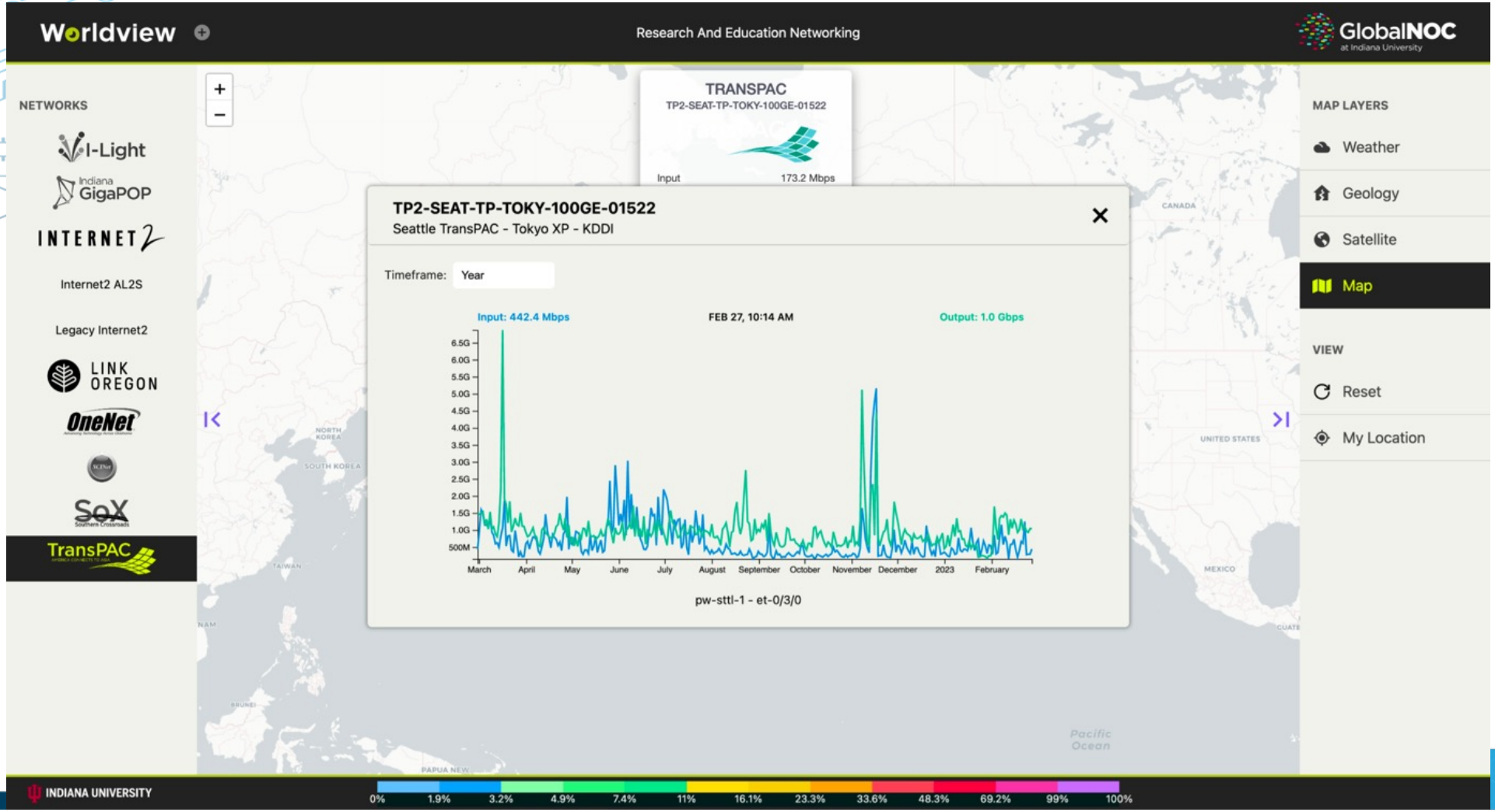
SURF

TransPAC and APOnet



TransPAC


Worldview
Research And Education Networking
GlobalNOC
at Indiana University
NETWORKS
I-Light
Indiana GigaPOP
INTERNET2
Internet2 AL2S
Legacy Internet2
LINK OREGON
OneNet
SoX
Southern Crossroads
TransPAC
TRANSPAC
TP2-SEAT-TP-TOKY-100GE-01522
Input
173.2 Mbps
TP2-SEAT-TP-TOKY-100GE-01522
Seattle TransPAC - Tokyo XP - KDDI
Timeframe:
Year
Input: 442.4 Mbps
FEB 27, 10:14 AM
Output: 1.0 Gbps
6.5G
6.0G
5.5G
5.0G
4.5G
4.0G
3.5G
3.0G
2.5G
2.0G
1.5G
1.0G
500M
March
April
May
June
July
August
September
October
November
December
2023
February
pw-sttl-1 - et-0/3/0
MAP LAYERS
Weather
Geology
Satellite
Map
VIEW
Reset
My Location
CANADA
UNITED STATES
MEXICO
NORTH KOREA
SOUTH KOREA
TAIWAN
BRUNEI
PAPUA NEW
Pacific Ocean
INDIANA UNIVERSITY
0%
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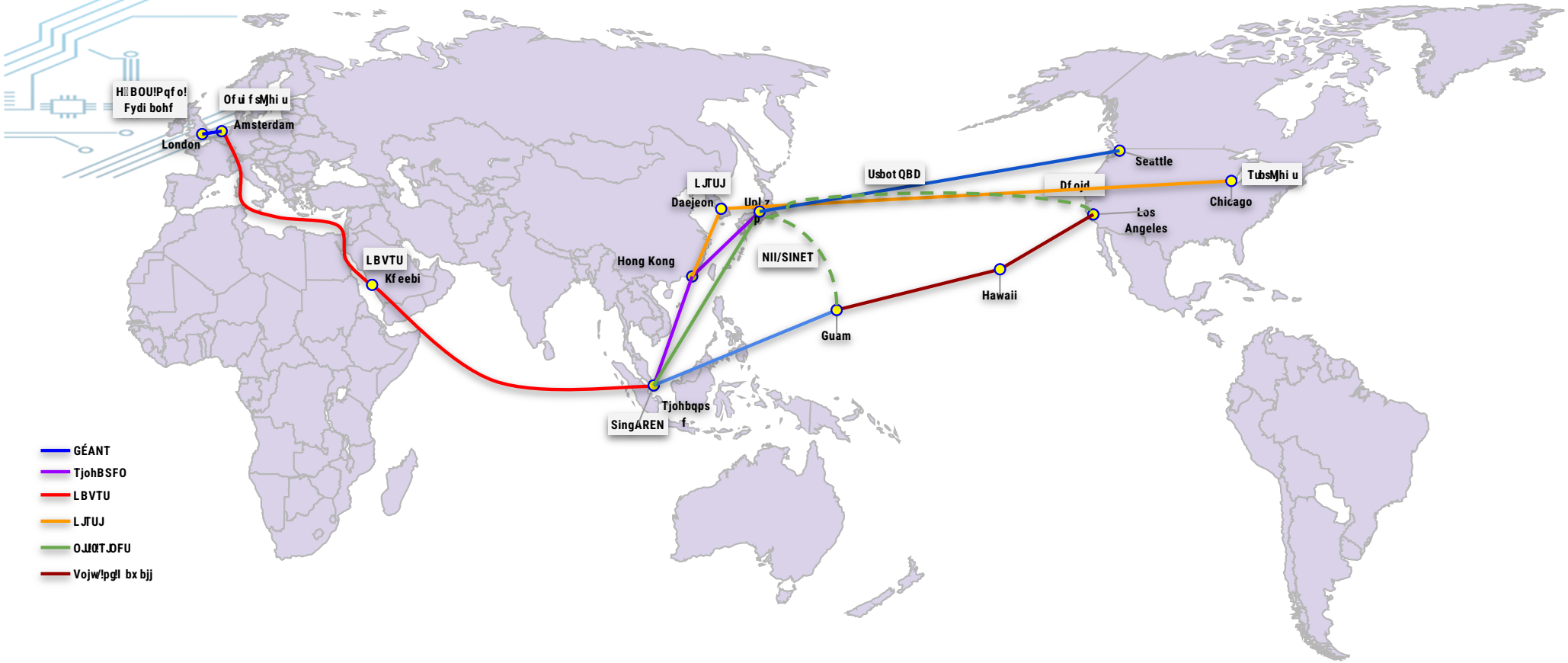
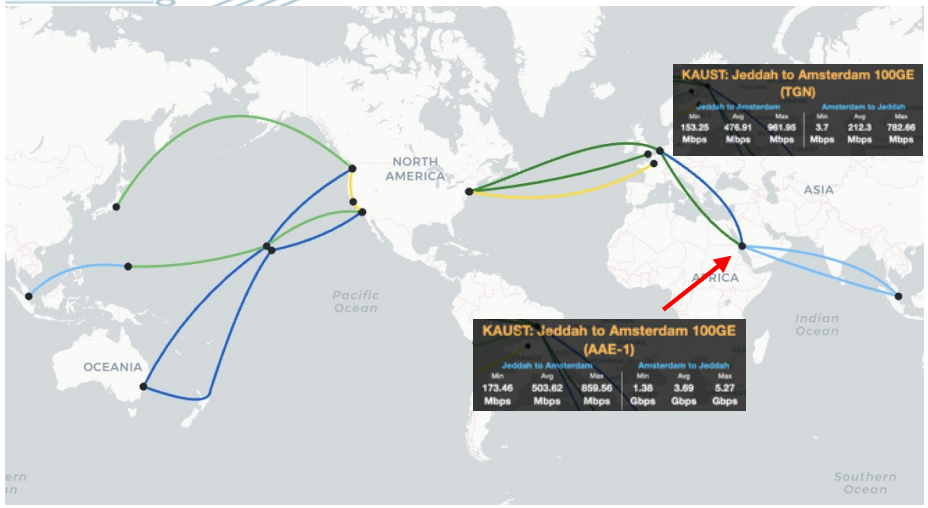
3.2%
4.9%
7.4%
11%
16.1%
23.3%
33.6%
48.3%
69.2%
99%
100%

KAUST Circuits to US

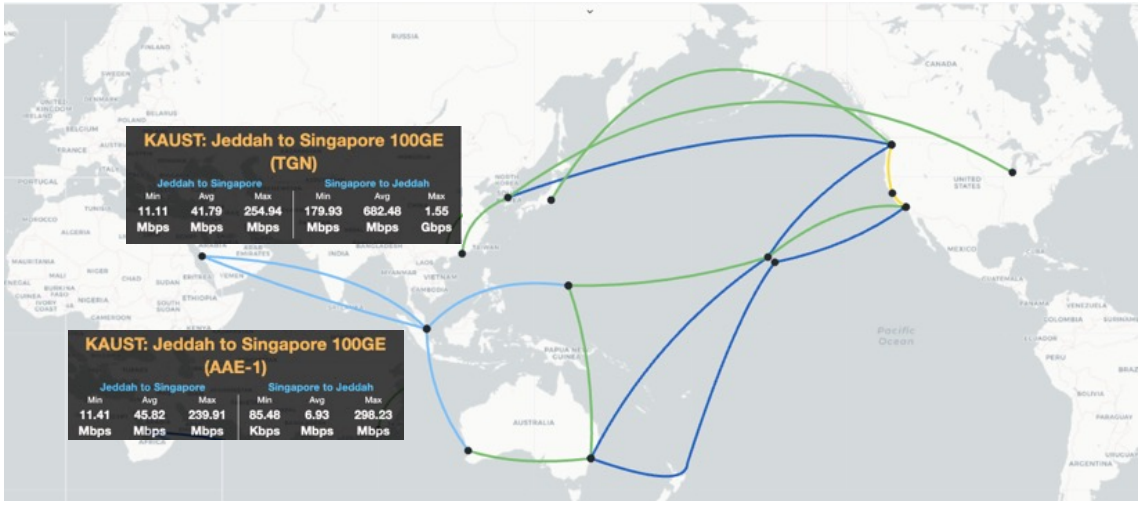


NetSage

GlobalNOC
Global Research Network Operations Center



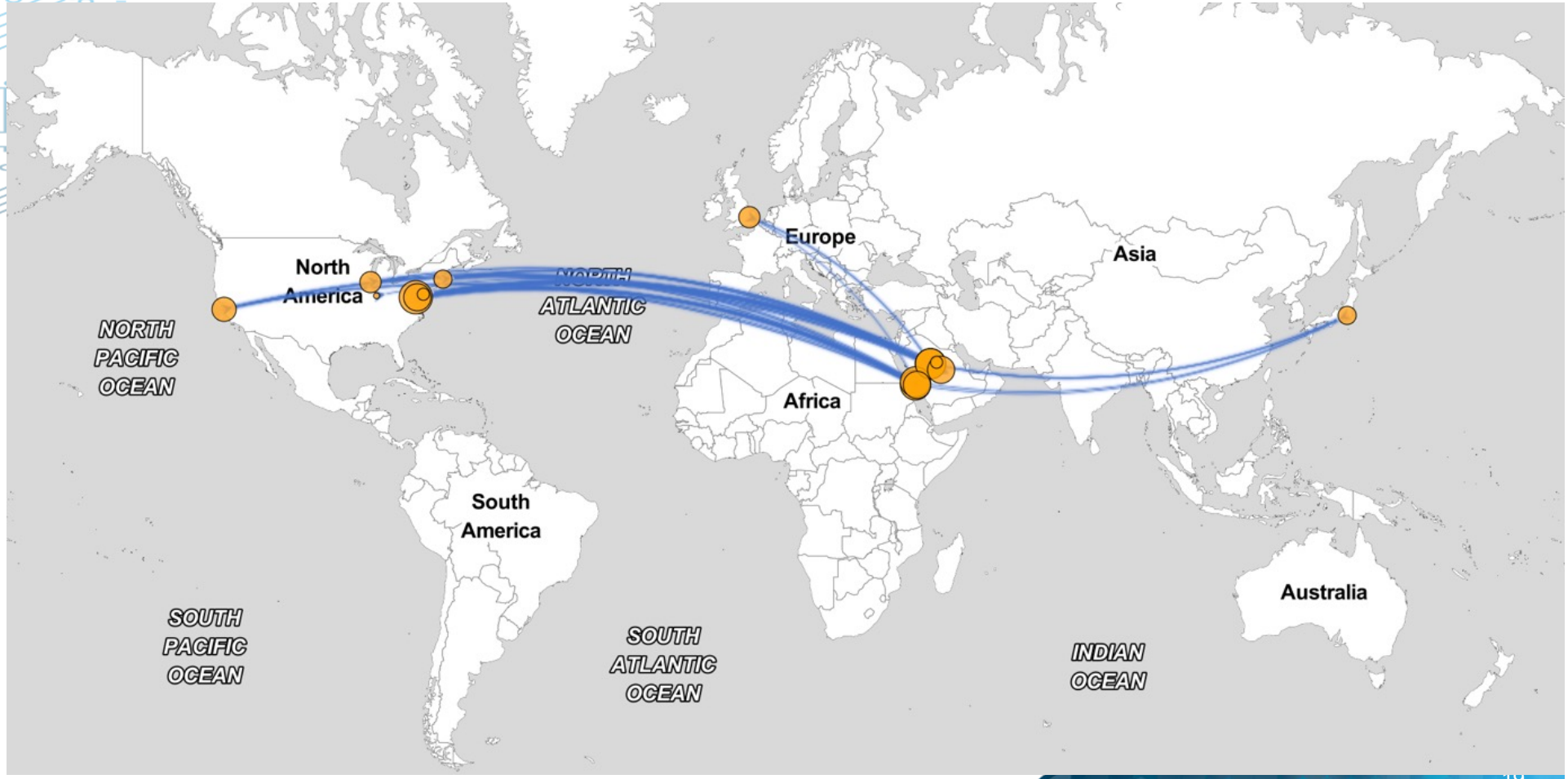
International - netsage.global



TransPAC/APOnet - netsage.global

Work in progress: network flows information (TBD, late 2022)

KAUST Flows: BIO.Genomics and Bioinformatics



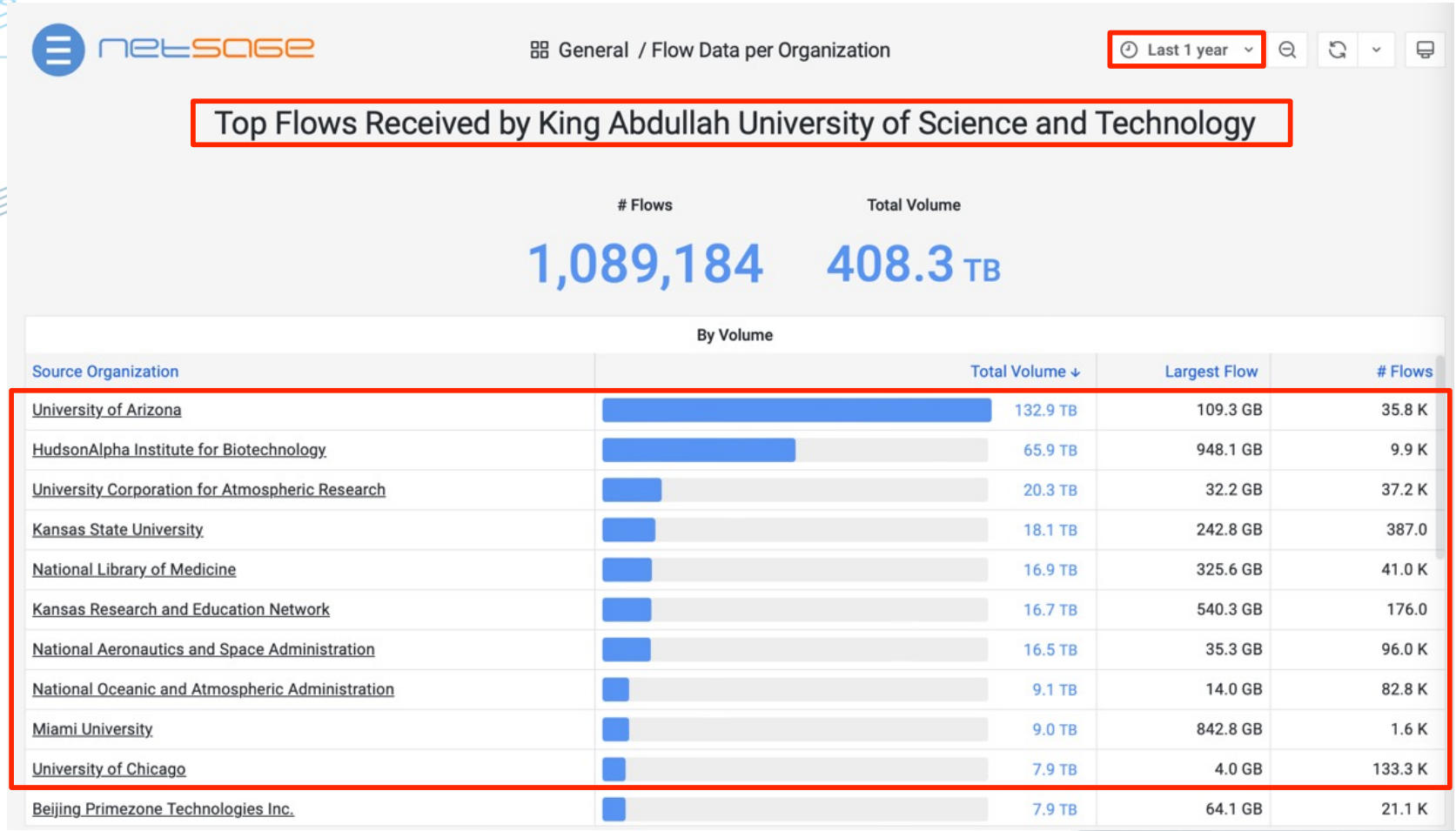
Source: NetSage

KAUST Flows: Top Talkers Over Time

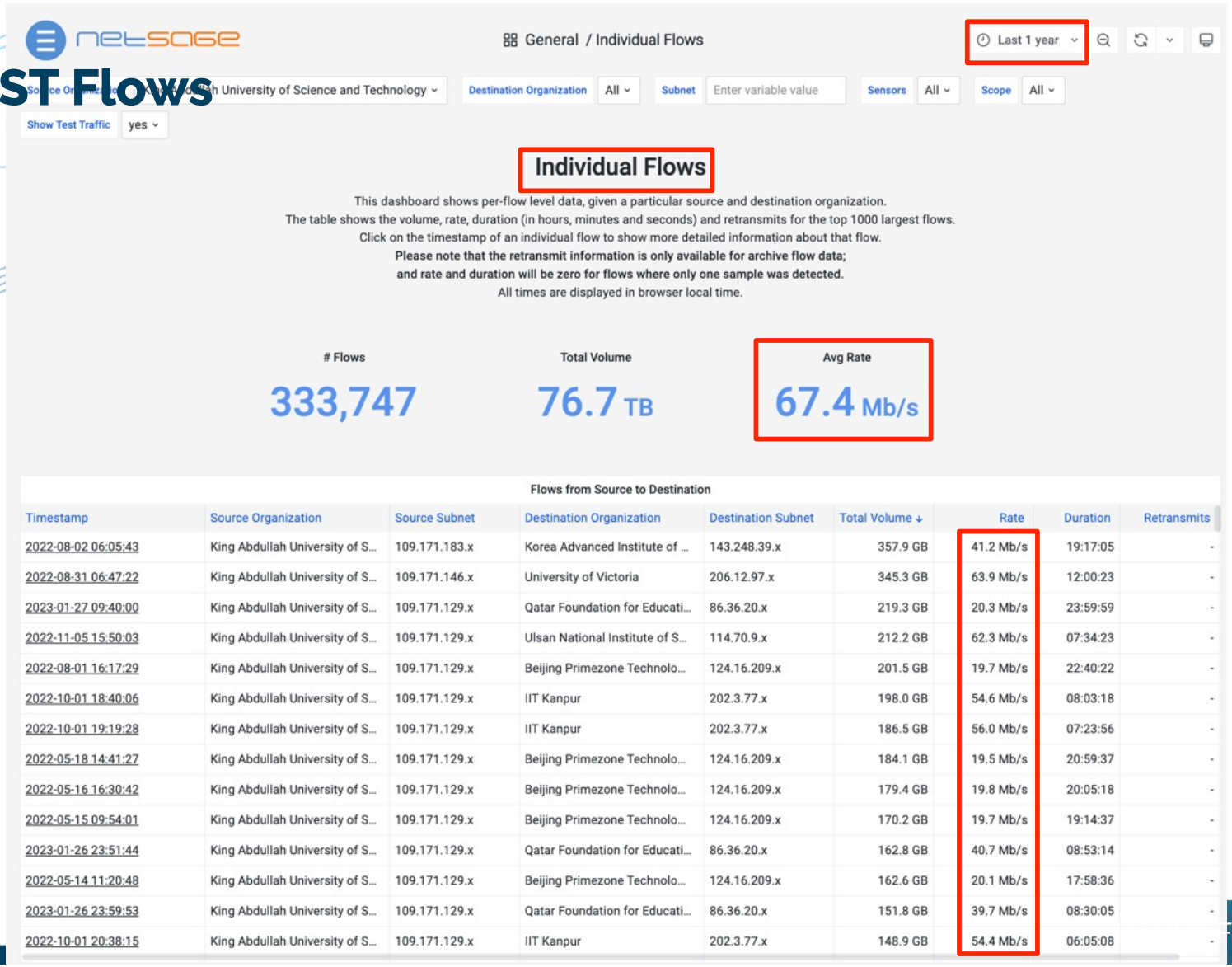
1. HudsonAlpha Institute for Biotechnology
2. University of Arkansas for Medical Sciences
3. Miami University
4. University Corporation for Atmospheric Research
5. National Oceanic and Atmospheric Administration
6. National Aeronautics and Space Administration
7. University of Hawaii
8. National Library of Medicine
9. Stanford University
10. University of Texas at Austin

Source: NetSage

KAUST Flows

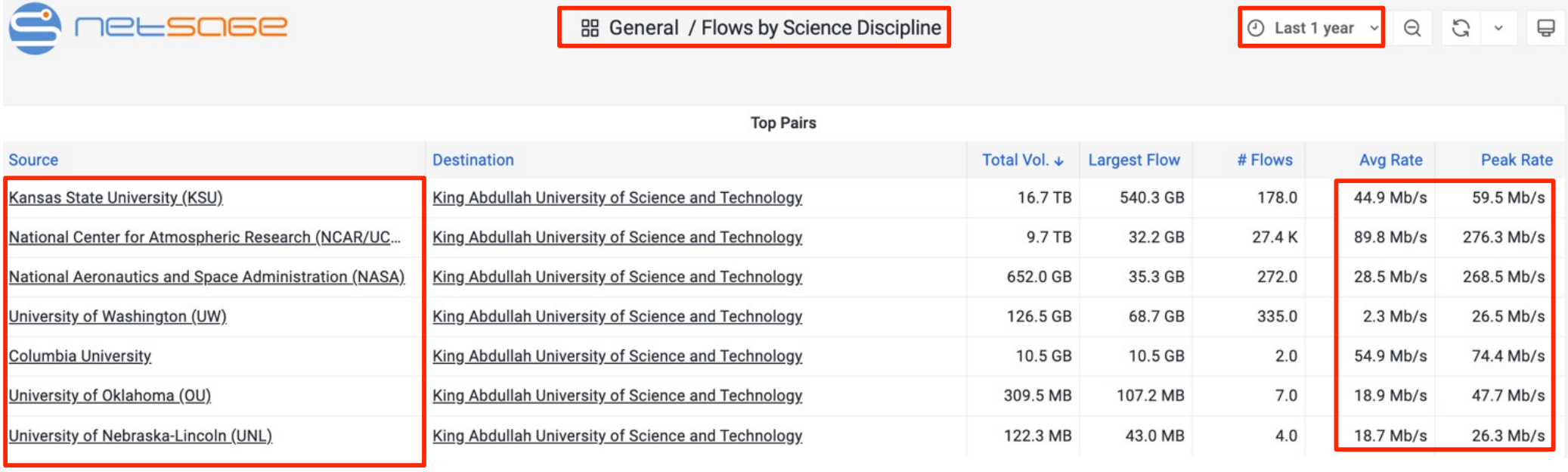

netsage
General / Flow Data per Organization
Last 1 year
Top Flows Received by King Abdullah University of Science and Technology
Flows
1,089,184
Total Volume
408.3 TB
By Volume
Source Organization
Total Volume
Largest Flow
Flows
University of Arizona 132.9 TB 109.3 GB 35.8 K
HudsonAlpha Institute for Biotechnology 65.9 TB 948.1 GB 9.9 K
University Corporation for Atmospheric Research 20.3 TB 32.2 GB 37.2 K
Kansas State University 18.1 TB 242.8 GB 387.0
National Library of Medicine 16.9 TB 325.6 GB 41.0 K
Kansas Research and Education Network 16.7 TB 540.3 GB 176.0
National Aeronautics and Space Administration 16.5 TB 35.3 GB 96.0 K
National Oceanic and Atmospheric Administration 9.1 TB 14.0 GB 82.8 K
Miami University 9.0 TB 842.8 GB 1.6 K
University of Chicago 7.9 TB 4.0 GB 133.3 K
Beijing Primezone Technologies Inc. 7.9 TB 64.1 GB 21.1 K

KAUST Flows



Timestamp	Source Organization	Source Subnet	Destination Organization	Destination Subnet	Total Volume ↓	Rate	Duration	Retransmits
2022-08-02 06:05:43	King Abdullah University of S...	109.171.183.x	Korea Advanced Institute of ...	143.248.39.x	357.9 GB	41.2 Mb/s	19:17:05	-
2022-08-31 06:47:22	King Abdullah University of S...	109.171.146.x	University of Victoria	206.12.97.x	345.3 GB	63.9 Mb/s	12:00:23	-
2023-01-27 09:40:00	King Abdullah University of S...	109.171.129.x	Qatar Foundation for Educati...	86.36.20.x	219.3 GB	20.3 Mb/s	23:59:59	-
2022-11-05 15:50:03	King Abdullah University of S...	109.171.129.x	Ulsan National Institute of S...	114.70.9.x	212.2 GB	62.3 Mb/s	07:34:23	-
2022-08-01 16:17:29	King Abdullah University of S...	109.171.129.x	Beijing Primezone Technolo...	124.16.209.x	201.5 GB	19.7 Mb/s	22:40:22	-
2022-10-01 18:40:06	King Abdullah University of S...	109.171.129.x	IIT Kanpur	202.3.77.x	198.0 GB	54.6 Mb/s	08:03:18	-
2022-10-01 19:19:28	King Abdullah University of S...	109.171.129.x	IIT Kanpur	202.3.77.x	186.5 GB	56.0 Mb/s	07:23:56	-
2022-05-18 14:41:27	King Abdullah University of S...	109.171.129.x	Beijing Primezone Technolo...	124.16.209.x	184.1 GB	19.5 Mb/s	20:59:37	-
2022-05-16 16:30:42	King Abdullah University of S...	109.171.129.x	Beijing Primezone Technolo...	124.16.209.x	179.4 GB	19.8 Mb/s	20:05:18	-
2022-05-15 09:54:01	King Abdullah University of S...	109.171.129.x	Beijing Primezone Technolo...	124.16.209.x	170.2 GB	19.7 Mb/s	19:14:37	-
2023-01-26 23:51:44	King Abdullah University of S...	109.171.129.x	Qatar Foundation for Educati...	86.36.20.x	162.8 GB	40.7 Mb/s	08:53:14	-
2022-05-14 11:20:48	King Abdullah University of S...	109.171.129.x	Beijing Primezone Technolo...	124.16.209.x	162.6 GB	20.1 Mb/s	17:58:36	-
2023-01-26 23:59:53	King Abdullah University of S...	109.171.129.x	Qatar Foundation for Educati...	86.36.20.x	151.8 GB	39.7 Mb/s	08:30:05	-
2022-10-01 20:38:15	King Abdullah University of S...	109.171.129.x	IIT Kanpur	202.3.77.x	148.9 GB	54.4 Mb/s	06:05:08	-

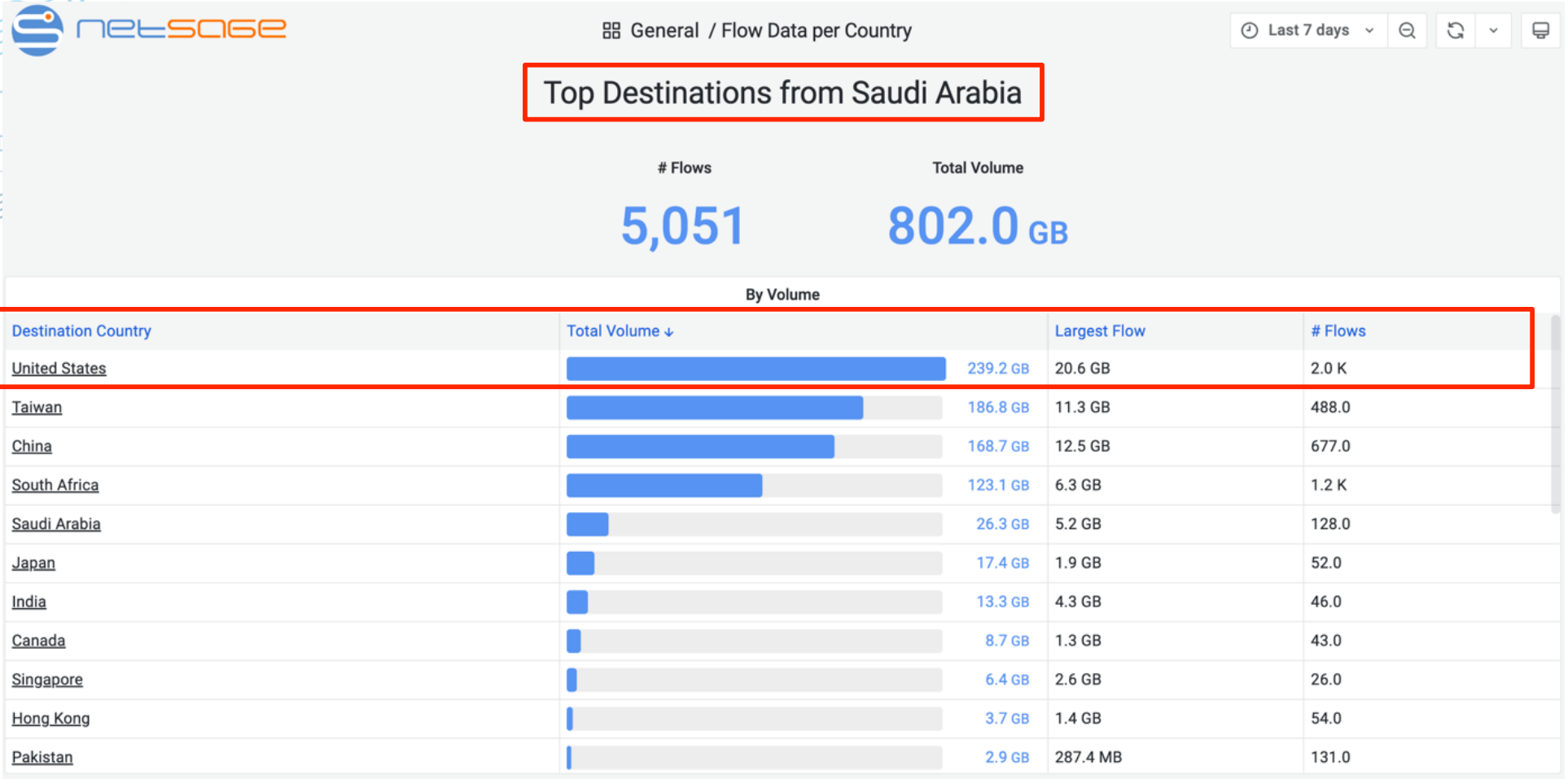
KAUST Flows



Top Pairs

Source	Destination	Total Vol. ↓	Largest Flow	# Flows	Avg Rate	Peak Rate
Kansas State University (KSU)	King Abdullah University of Science and Technology	16.7 TB	540.3 GB	178.0	44.9 Mb/s	59.5 Mb/s
National Center for Atmospheric Research (NCAR/UC...	King Abdullah University of Science and Technology	9.7 TB	32.2 GB	27.4 K	89.8 Mb/s	276.3 Mb/s
National Aeronautics and Space Administration (NASA)	King Abdullah University of Science and Technology	652.0 GB	35.3 GB	272.0	28.5 Mb/s	268.5 Mb/s
University of Washington (UW)	King Abdullah University of Science and Technology	126.5 GB	68.7 GB	335.0	2.3 Mb/s	26.5 Mb/s
Columbia University	King Abdullah University of Science and Technology	10.5 GB	10.5 GB	2.0	54.9 Mb/s	74.4 Mb/s
University of Oklahoma (OU)	King Abdullah University of Science and Technology	309.5 MB	107.2 MB	7.0	18.9 Mb/s	47.7 Mb/s
University of Nebraska-Lincoln (UNL)	King Abdullah University of Science and Technology	122.3 MB	43.0 MB	4.0	18.7 Mb/s	26.3 Mb/s

KAUST Flows


netsage
General / Flow Data per Country
Last 7 days
Top Destinations from Saudi Arabia
Flows
5,051
Total Volume
802.0 GB
By Volume
Destination Country
Total Volume
Largest Flow
Flows
United States 239.2 GB 20.6 GB 2.0 K
Taiwan 186.8 GB 11.3 GB 488.0
China 168.7 GB 12.5 GB 677.0
South Africa 123.1 GB 6.3 GB 1.2 K
Saudi Arabia 26.3 GB 5.2 GB 128.0
Japan 17.4 GB 1.9 GB 52.0
India 13.3 GB 4.3 GB 46.0
Canada 8.7 GB 1.3 GB 43.0
Singapore 6.4 GB 2.6 GB 26.0
Hong Kong 3.7 GB 1.4 GB 54.0
Pakistan 2.9 GB 287.4 MB 131.0

KAUST Flows

By Rate

Destination Country	Peak ↓	Average	# Flows
United States	576.0 Mb/s	5.1 Mb/s	2.0 K
China	299.6 Mb/s	25.5 Mb/s	677.0
Canada	170.1 Mb/s	29.1 Mb/s	43.0
Taiwan	118.7 Mb/s	48.9 Mb/s	488.0
South Korea	95.9 Mb/s	11.9 Mb/s	14.0
Japan	95.7 Mb/s	8.7 Mb/s	52.0
Saudi Arabia	94.0 Mb/s	19.4 Mb/s	128.0
South Africa	90.4 Mb/s	2.6 Mb/s	1.2 K
Hong Kong	82.2 Mb/s	3.7 Mb/s	54.0
Pakistan	45.1 Mb/s	3.3 Mb/s	131.0
Singapore	17.3 Mb/s	4.7 Mb/s	26.0

KAUST Flows

Top Sources to Saudi Arabia

# Flows	Total Volume
26,974	12.6 TB

By Volume

Source Country	Total Volume ↓	Largest Flow	# Flows
United States	12.0 TB	198.2 GB	25.0 K
Japan	438.3 GB	17.5 GB	494.0
South Africa	57.7 GB	2.7 GB	639.0
Saudi Arabia	26.3 GB	5.2 GB	128.0
China	22.6 GB	7.3 GB	211.0
Canada	16.0 GB	690.4 MB	114.0
Hong Kong	10.2 GB	1.5 GB	53.0
India	7.1 GB	771.4 MB	63.0
Singapore	4.5 GB	3.5 GB	25.0
South Korea	2.2 GB	410.7 MB	16.0
Thailand	1.6 GB	192.9 MB	30.0

KAUST Flows

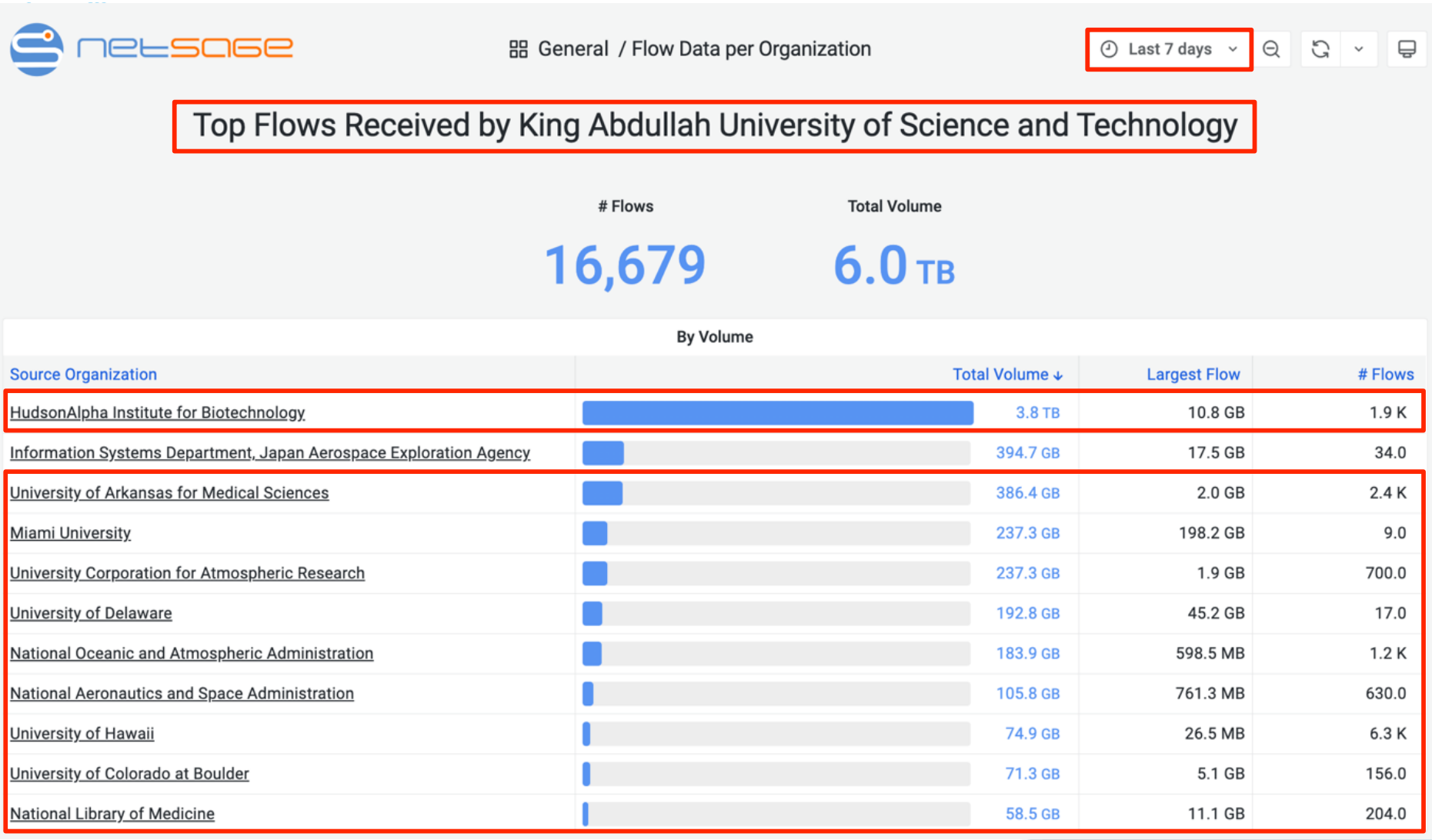
By Rate

Source Country	Max	Average	# Flows
United States	926.6 Mb/s	38.2 Mb/s	25.0 K
Pakistan	322.4 Mb/s	36.9 Mb/s	11.0
China	256.7 Mb/s	17.8 Mb/s	211.0
Japan	190.4 Mb/s	27.0 Mb/s	494.0
Canada	159.5 Mb/s	45.6 Mb/s	114.0
India	145.1 Mb/s	10.0 Mb/s	63.0
Kenya	128.7 Mb/s	77.4 Mb/s	3.0
Indonesia	119.5 Mb/s	69.8 Mb/s	2.0
South Korea	102.0 Mb/s	26.8 Mb/s	16.0
Saudi Arabia	94.0 Mb/s	19.4 Mb/s	128.0
Hong Kong	88.3 Mb/s	10.7 Mb/s	53.0

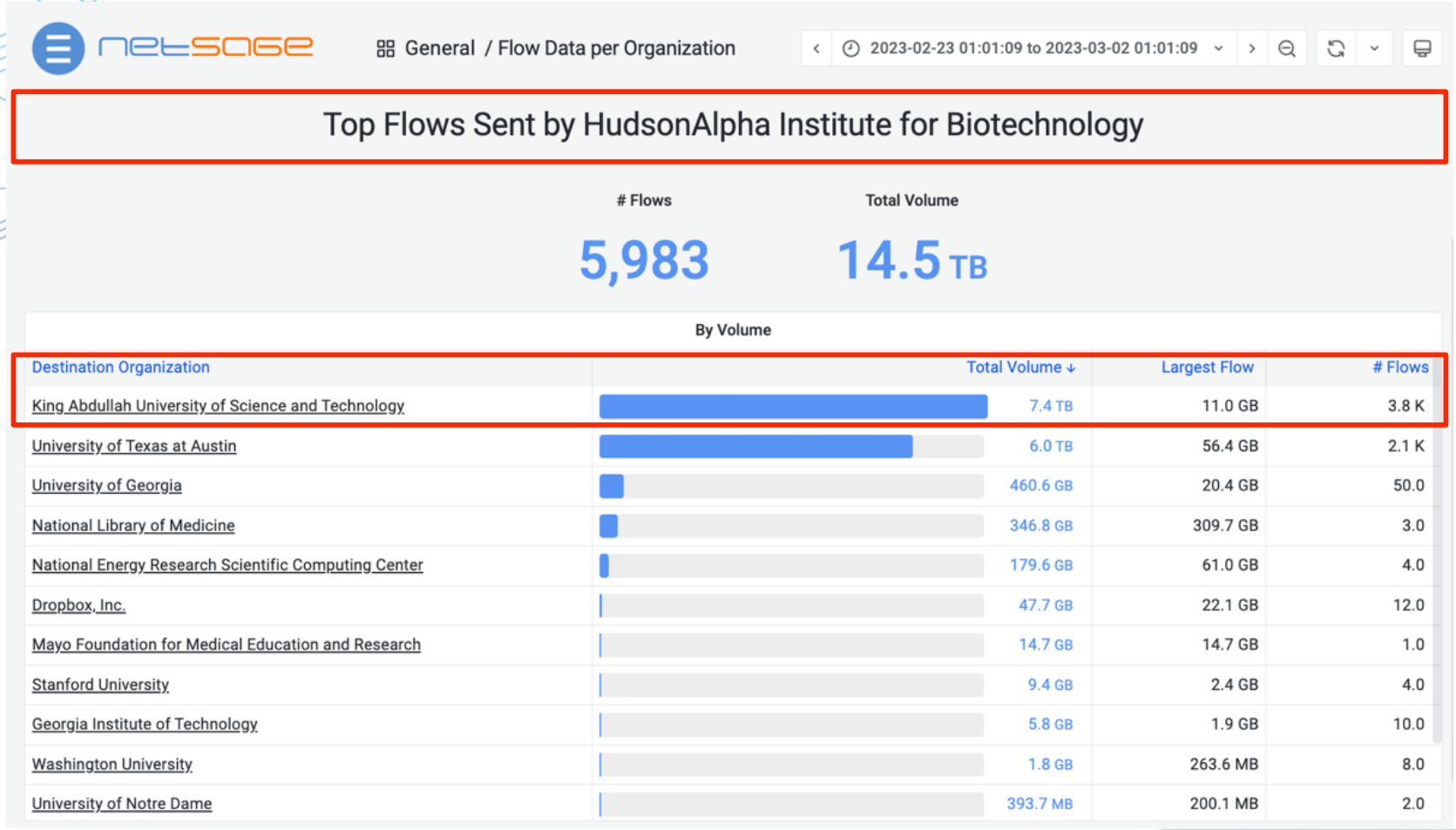
KAUST Flows

Top Flow Pairs with Endpoint(s) in Saudi Arabia

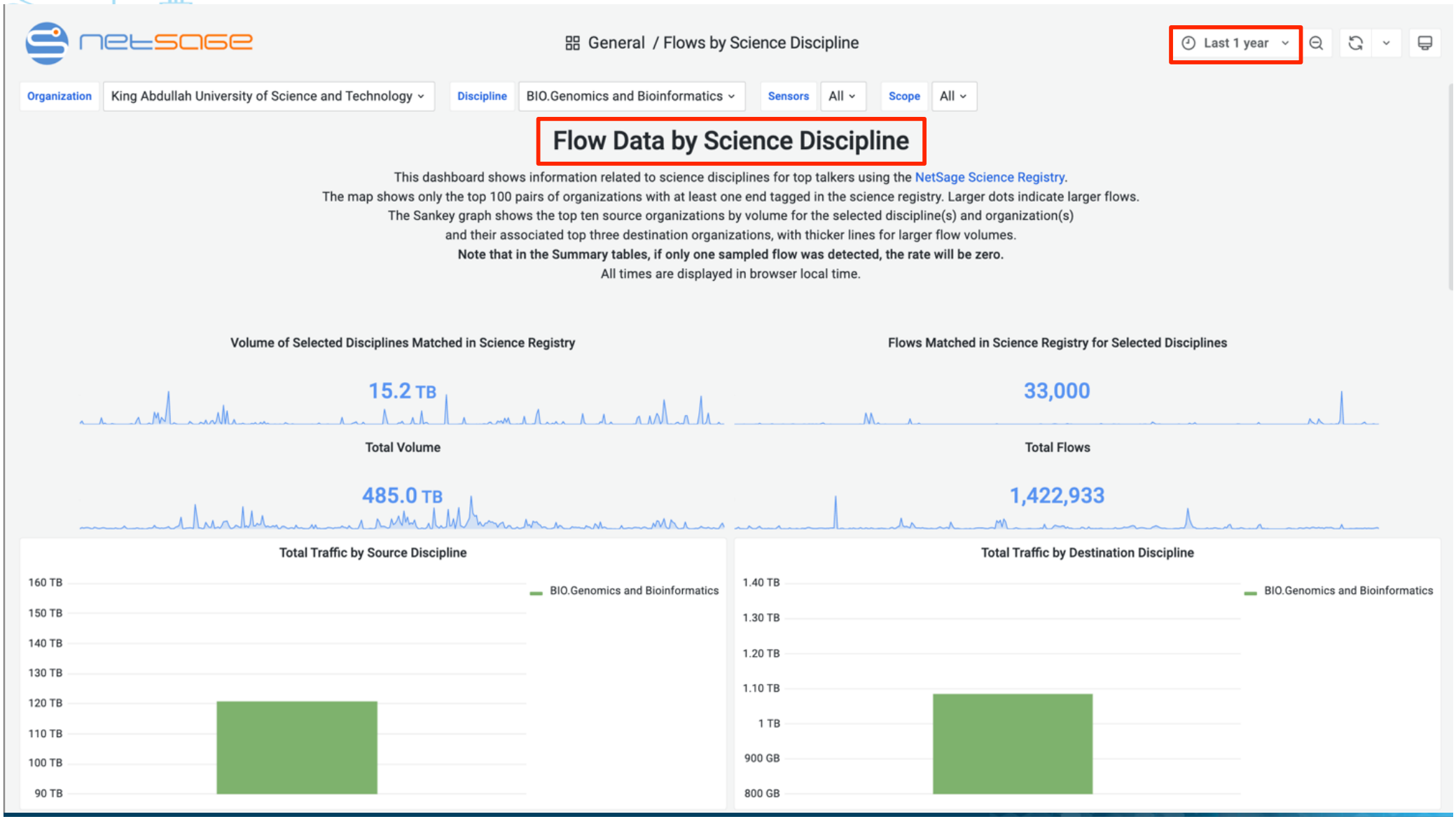
Source Organization	Destination Organization	Total Vol. ↓	Largest Flow	# Flows	Avg Rate	Peak Rate
HudsonAlpha Institute for Biotechnology	King Abdullah University of Science and Technology	7.4 TB	11.0 GB	3.8 K	87.0 Mb/s	157.2 Mb/s
University of Arizona	King Abdullah University of Science and Technology	811.9 GB	5.3 GB	1.2 K	81.2 Mb/s	204.4 Mb/s
University of Arkansas for Medical Sciences	King Abdullah University of Science and Technology	765.8 GB	2.0 GB	4.9 K	16.5 Mb/s	43.1 Mb/s
University Corporation for Atmospheric Research	King Abdullah University of Science and Technology	443.5 GB	1.9 GB	1.3 K	91.0 Mb/s	384.0 Mb/s
University Corporation for Atmospheric Research	ARABIAN INTERNET & COMMUNICATIONS SERVICES CO.LTD	403.2 GB	8.1 GB	85.0	94.4 Mb/s	167.2 Mb/s
Information Systems Department, Japan Aerospace Exploration...	King Abdullah University of Science and Technology	394.7 GB	17.5 GB	35.0	2.7 Mb/s	32.6 Mb/s
Southern Methodist University	Etihad Etisalat, a joint stock company	311.8 GB	68.2 GB	38.0	16.9 Mb/s	49.3 Mb/s
Miami University	King Abdullah University of Science and Technology	237.3 GB	198.2 GB	10.0	14.3 Mb/s	52.9 Mb/s
University of Delaware	King Abdullah University of Science and Technology	192.8 GB	45.2 GB	16.0	7.4 Mb/s	28.2 Mb/s
University of Colorado at Boulder	King Abdullah University of Science and Technology	187.4 GB	5.1 GB	410.0	11.3 Mb/s	330.2 Mb/s
King Abdullah University of Science and Technology	Education Bureau, Kaohsiung City Government, Taiwan	186.8 GB	11.3 GB	487.0	49.0 Mb/s	118.7 Mb/s
National Oceanic and Atmospheric Administration	King Abdullah University of Science and Technology	186.3 GB	598.5 MB	1.2 K	16.9 Mb/s	138.6 Mb/s
King Abdullah University of Science and Technology	China Education and Research Network Center	121.8 GB	11.5 GB	611.0	27.2 Mb/s	299.6 Mb/s
Indiana University	Saudi Telecom Company JSC	93.9 GB	5.3 GB	132.0	28.3 Mb/s	708.6 Mb/s


netsage
General / Flow Data per Organization
Last 7 days
Top Flows Received by King Abdullah University of Science and Technology
Flows
16,679
Total Volume
6.0 TB
By Volume
Source Organization
Total Volume
Largest Flow
Flows
HudsonAlpha Institute for Biotechnology 3.8 TB 10.8 GB 1.9 K
Information Systems Department, Japan Aerospace Exploration Agency 394.7 GB 17.5 GB 34.0
University of Arkansas for Medical Sciences 386.4 GB 2.0 GB 2.4 K
Miami University 237.3 GB 198.2 GB 9.0
University Corporation for Atmospheric Research 237.3 GB 1.9 GB 700.0
University of Delaware 192.8 GB 45.2 GB 17.0
National Oceanic and Atmospheric Administration 183.9 GB 598.5 MB 1.2 K
National Aeronautics and Space Administration 105.8 GB 761.3 MB 630.0
University of Hawaii 74.9 GB 26.5 MB 6.3 K
University of Colorado at Boulder 71.3 GB 5.1 GB 156.0
National Library of Medicine 58.5 GB 11.1 GB 204.0

KAUST Flows



Destination Organization	Total Volume ↓	Largest Flow	# Flows
King Abdullah University of Science and Technology	7.4 TB	11.0 GB	3.8 K
University of Texas at Austin	6.0 TB	56.4 GB	2.1 K
University of Georgia	460.6 GB	20.4 GB	50.0
National Library of Medicine	346.8 GB	309.7 GB	3.0
National Energy Research Scientific Computing Center	179.6 GB	61.0 GB	4.0
Dropbox, Inc.	47.7 GB	22.1 GB	12.0
Mayo Foundation for Medical Education and Research	14.7 GB	14.7 GB	1.0
Stanford University	9.4 GB	2.4 GB	4.0
Georgia Institute of Technology	5.8 GB	1.9 GB	10.0
Washington University	1.8 GB	263.6 MB	8.0
University of Notre Dame	393.7 MB	200.1 MB	2.0


netsage
General / Flows by Science Discipline
Last 1 year
Organization
King Abdullah University of Science and Technology
Discipline
BIO.Genomics and Bioinformatics
Sensors
All
Scope
All
Flow Data by Science Discipline
This dashboard shows information related to science disciplines for top talkers using the NetSage Science Registry.
The map shows only the top 100 pairs of organizations with at least one end tagged in the science registry. Larger dots indicate larger flows.
The Sankey graph shows the top ten source organizations by volume for the selected discipline(s) and organization(s)
and their associated top three destination organizations, with thicker lines for larger flow volumes.
Note that in the Summary tables, if only one sampled flow was detected, the rate will be zero.
All times are displayed in browser local time.
Volume of Selected Disciplines Matched in Science Registry
15.2 TB
Total Volume
485.0 TB
Flows Matched in Science Registry for Selected Disciplines
33,000
Total Flows
1,422,933
Total Traffic by Source Discipline
160 TB
150 TB
140 TB
130 TB
120 TB
110 TB
100 TB
90 TB
BIO.Genomics and Bioinformatics
Total Traffic by Destination Discipline
1.40 TB
1.30 TB
1.20 TB
1.10 TB
1 TB
900 GB
800 GB
BIO.Genomics and Bioinformatics

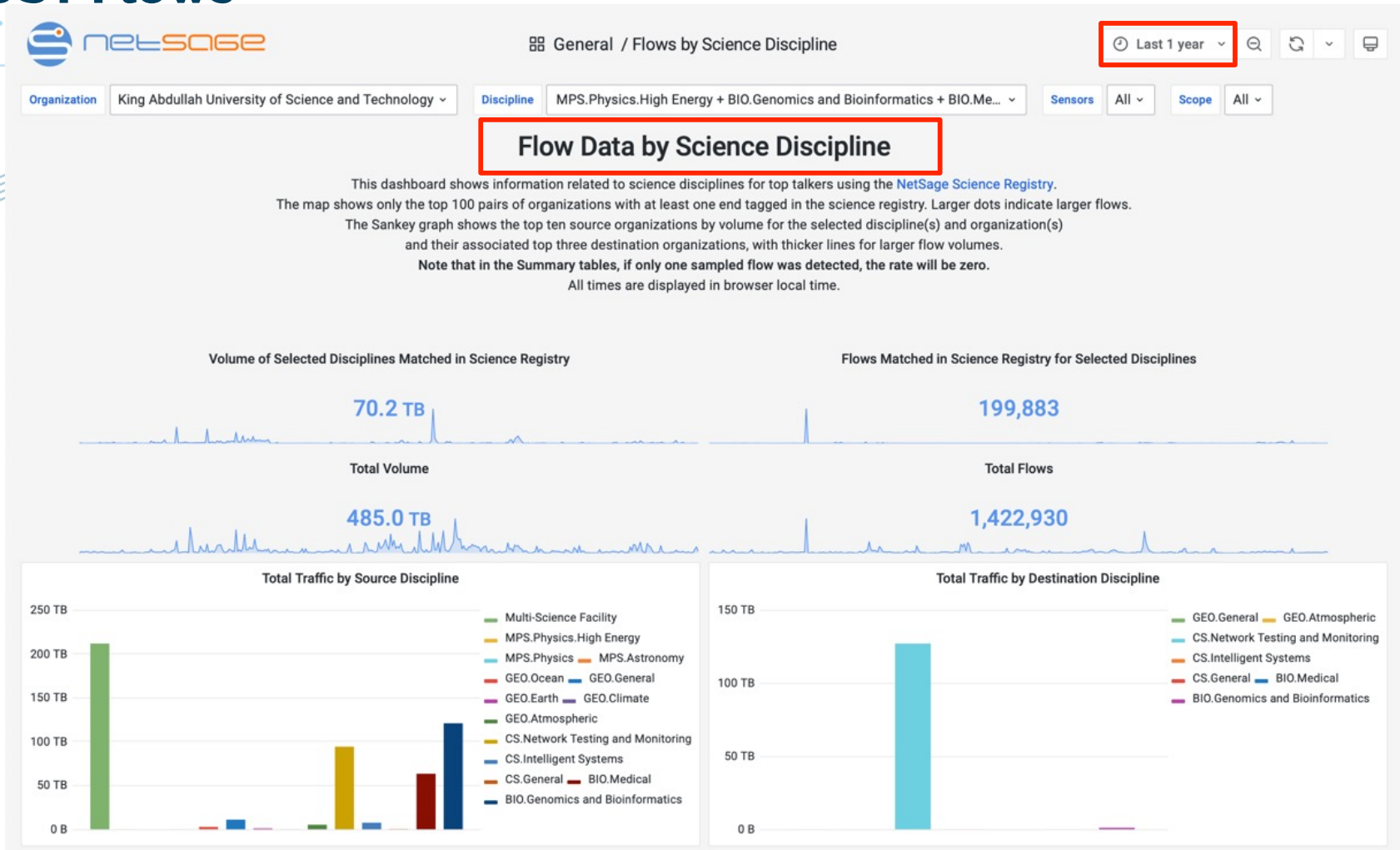
KAUST Flows

Top Pairs

Source	Destination	Total Vol. ↓	Largest Flow	# Flows	Avg Rate	Peak Rate
National Library of Medicine (NLM)	King Abdullah University of Science and Technology	14.4 TB	279.7 GB	32.0 K	35.5 Mb/s	5.5 Gb/s
University of California, Santa Cruz (UCSC)	King Abdullah University of Science and Technology	401.5 GB	81.8 GB	617.0	66.8 Mb/s	304.5 Mb/s
Argonne National Laboratory (ANL)	King Abdullah University of Science and Technology	140.2 GB	16.4 GB	54.0	42.3 Mb/s	132.5 Mb/s
European Bioinformatics Institute (EMBL-EBI)	King Abdullah University of Science and Technology	52.5 GB	20.0 GB	79.0	5.8 Mb/s	95.7 Mb/s
Kyoto University	King Abdullah University of Science and Technology	30.2 GB	1.6 GB	25.0	30.9 Mb/s	100.6 Mb/s
Broad Institute	King Abdullah University of Science and Technology	23.9 GB	3.4 GB	128.0	12.3 Mb/s	17.6 Mb/s
University of Delaware (UD)	King Abdullah University of Science and Technology	2.0 GB	932.0 MB	26.0	27.4 Mb/s	104.2 Mb/s
Indiana University (IU)	King Abdullah University of Science and Technology	360.0 MB	360.0 MB	1.0	87.2 Mb/s	87.2 Mb/s

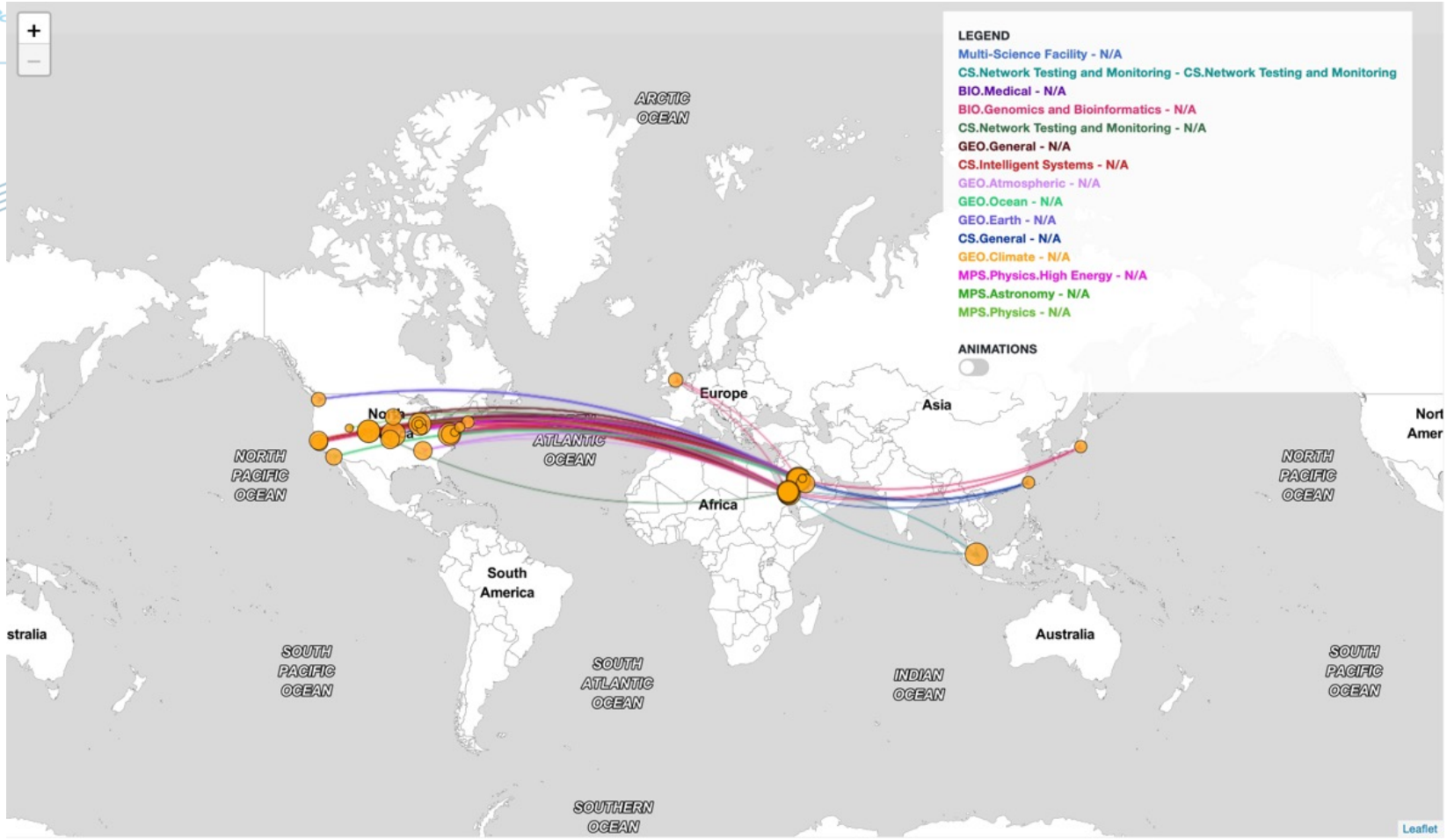
Source: NetSage

KAUST Flows



Source: NetSage

KAUST Flows



Source: [NetSage]

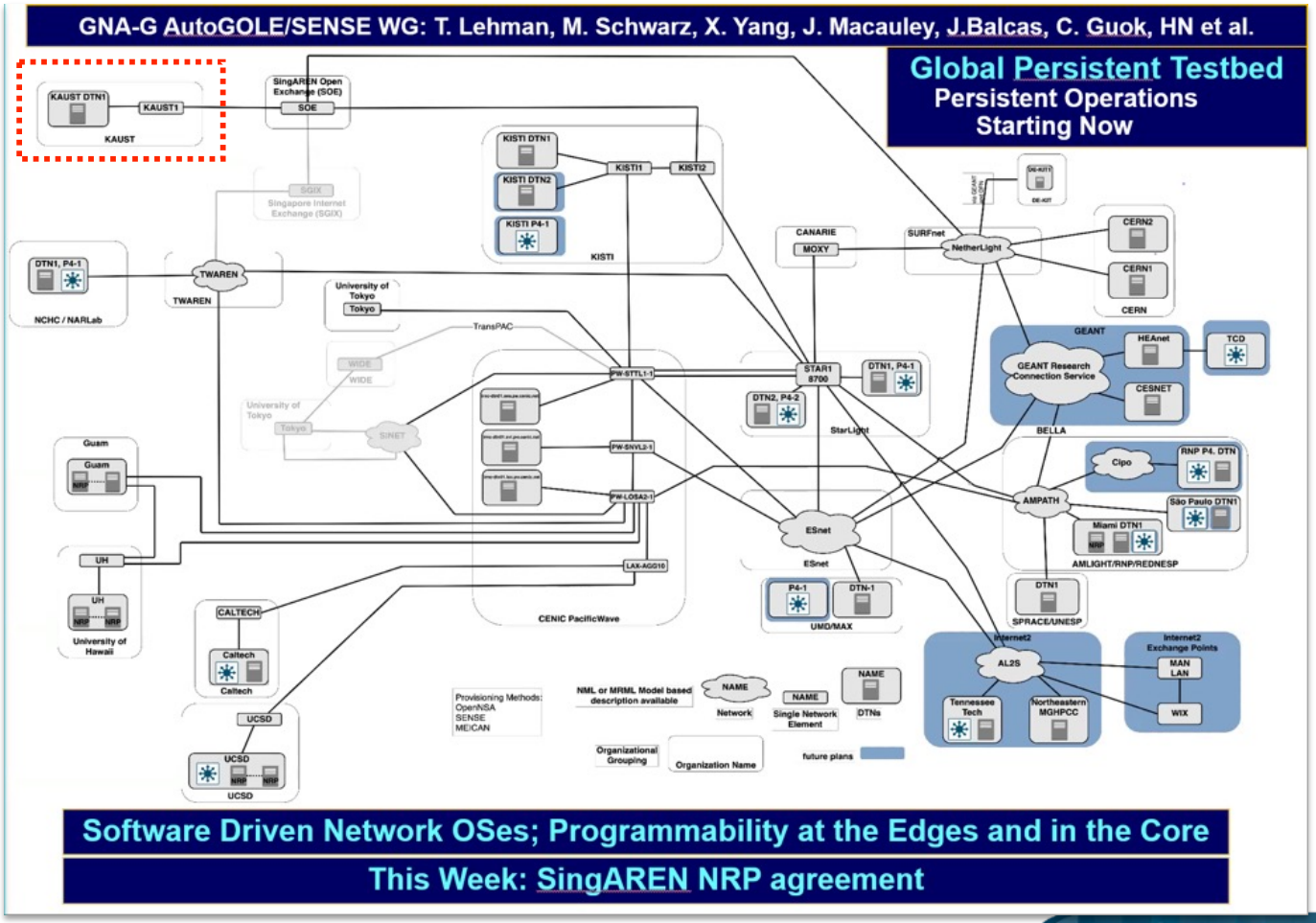
KAUST Flows

Top Pairs

Source	Destination	Total Vol. ↓	Largest Flow	# Flows	Avg Rate	Peak Rate
Kansas State University (KSU)	King Abdullah University of Science and Technology	16.7 TB	540.3 GB	178.0	44.9 Mb/s	59.5 Mb/s
National Library of Medicine (NLM)	King Abdullah University of Science and Technology	14.4 TB	279.7 GB	32.0 K	35.5 Mb/s	5.5 Gb/s
National Center for Atmospheric Research (NCAR/UCAR)	King Abdullah University of Science and Technology	9.9 TB	32.2 GB	27.5 K	89.6 Mb/s	276.3 Mb/s
National Cancer Institute (NCI)	King Abdullah University of Science and Technology	7.9 TB	4.0 GB	133.2 K	25.5 Mb/s	227.9 Mb/s
King Abdullah University of Science and Technology	National Supercomputing Center Singapore	6.5 TB	85.8 GB	177.0	10.1 Gb/s	23.4 Gb/s
National Supercomputing Center Singapore	King Abdullah University of Science and Technology	4.0 TB	102.0 GB	175.0	6.3 Gb/s	27.9 Gb/s
National Oceanic and Atmospheric Administration (NOAA)	King Abdullah University of Science and Technology	1.2 TB	673.1 MB	2.1 K	32.2 Mb/s	168.1 Mb/s
King Abdullah University of Science and Technology	Stanford University	1.1 TB	20.1 GB	195.0	2.4 Gb/s	8.7 Gb/s
Stanford University	King Abdullah University of Science and Technology	936.1 GB	156.3 GB	52.0	79.0 Mb/s	124.6 Mb/s
National Aeronautics and Space Administration (NASA)	King Abdullah University of Science and Technology	652.0 GB	35.3 GB	273.0	28.4 Mb/s	268.5 Mb/s
University of California, Santa Cruz (UCSC)	King Abdullah University of Science and Technology	401.5 GB	81.8 GB	617.0	66.8 Mb/s	304.5 Mb/s
Scripps Institute of Oceanography (SIO)	King Abdullah University of Science and Technology	341.1 GB	40.7 GB	117.0	33.3 Mb/s	113.7 Mb/s

Source: NetSage

AutoGOLE/SENSE Infrastructure



Credit: Tom Lehman

Roadmap

- Share NetFlow data to NetSage
- Campus network performance measurements w/ perfSONAR v5.0
- Collaborate with SC23 Network Research Exhibit
- Circuits to PRP/NRP and StarLight
- AutoGOLE-SENSE Testbed
- RARE/FreeRtr and P4 Testbed
    - Use programmable P4 devices overlaid on the AutoGOLE/SENSE to experiment on pre-production networks leveraging open ecosystems from industry / RENs

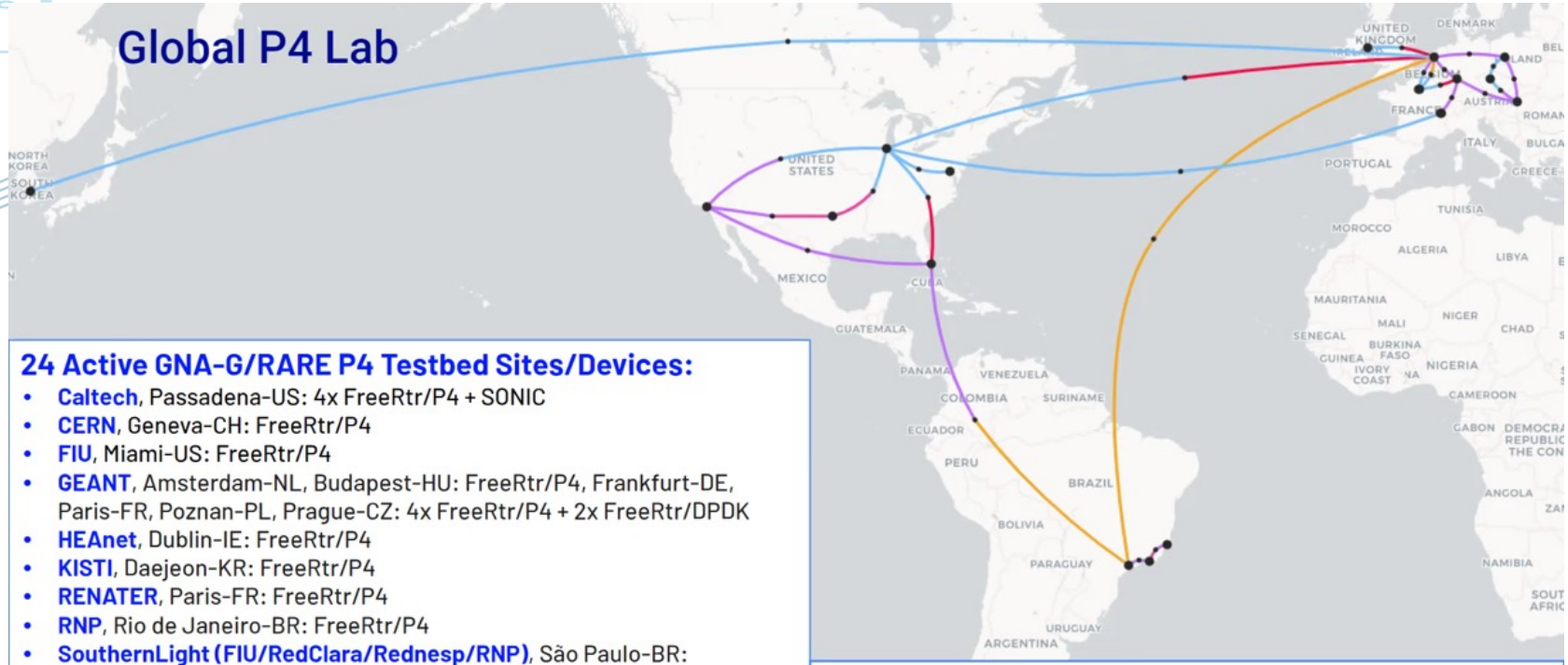
Integration of End-Site Resources and Science Workflows

- Automated provisioning and traffic engineering of paths across wide area networks and exchange points is important

- However to really add value to science applications integration of these services is needed with:
  - End Site network, compute, and storage infrastructure
  - Science workflow agents and middleware

Credit: Tom Lehman

Roadmap: Global P4 Testbed



24 Active GNA-G/RARE P4 Testbed Sites/Devices:

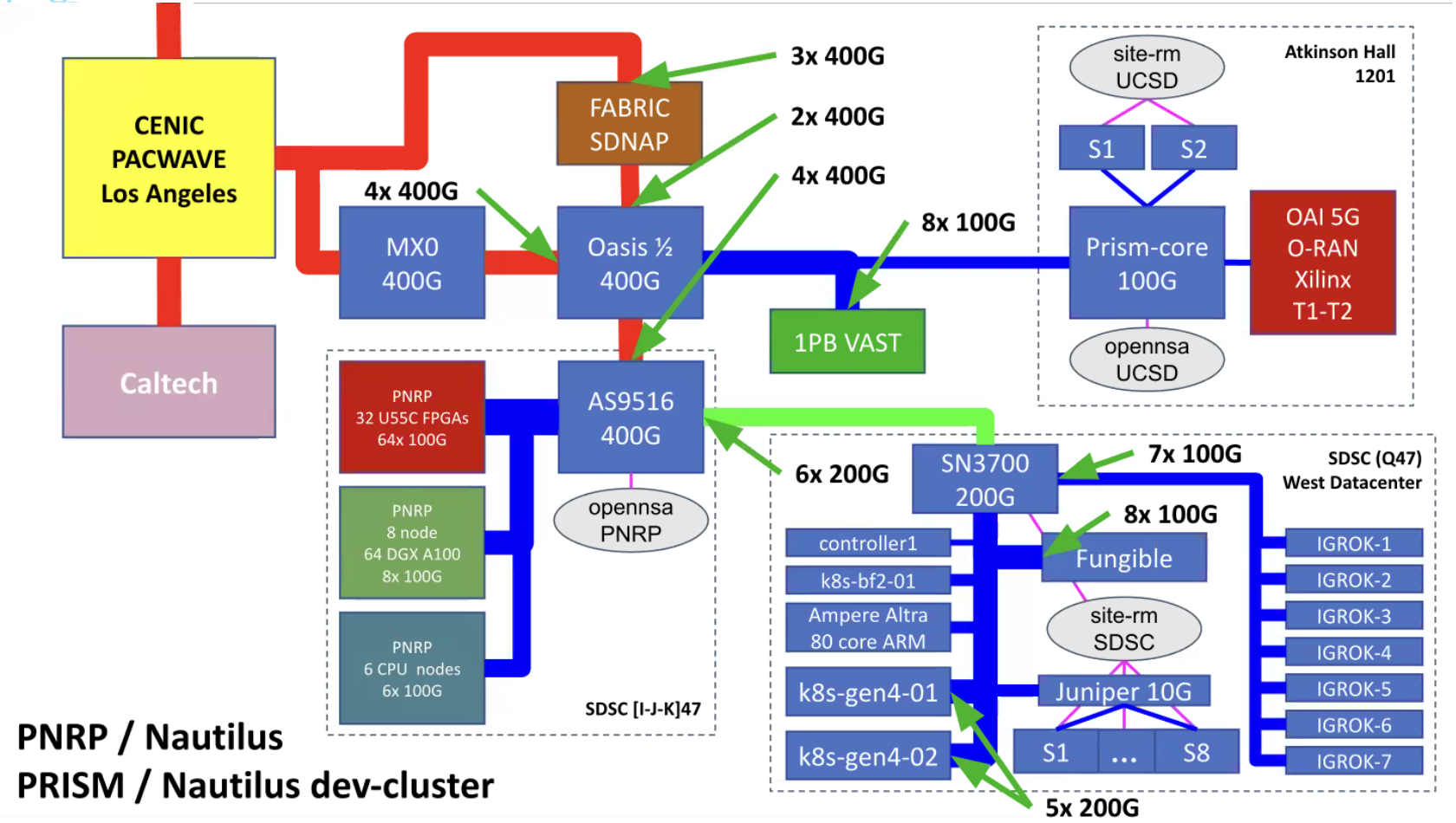
- **Caltech**, Passadena-US: 4x FreeRtr/P4 + SONIC
- **CERN**, Geneva-CH: FreeRtr/P4
- **FIU**, Miami-US: FreeRtr/P4
- **GEANT**, Amsterdam-NL, Budapest-HU: FreeRtr/P4, Frankfurt-DE, Paris-FR, Poznan-PL, Prague-CZ: 4x FreeRtr/P4 + 2x FreeRtr/DPDK
- **HEAnet**, Dublin-IE: FreeRtr/P4
- **KISTI**, Daejeon-KR: FreeRtr/P4
- **RENATER**, Paris-FR: FreeRtr/P4
- **RNP**, Rio de Janeiro-BR: FreeRtr/P4
- **SouthernLight (FIU/RedClara/Rednesp/RNP)**, São Paulo-BR: FreeRtr/P4
- **StarLight**, Chicago-US: FreeRtr/P4
- **SWITCH**, Geneva-CH: FreeRtr/P4
- **TCD**, Dublin-IE: FreeRtr/P4
- **Tennessee Tech**, Cookeville-US: FreeRtr/P4
- **UFES**, Vitória-BR: FreeRtr/P4
- **UMd/MAX**, College Park-MD: FreeRtr/P4

+5 Expected Sites/Devices (2023):

- **JISC**, London-UK: FreeRtr/P4
- **KAUST**, Saudi Arabia-SA: FreeRtr/DPDK
- **RNP**, Rio de Janeiro-BR: +1 SONiC/P4
- **UCSD**, San Diego-US: SONiC/P4
- **UFES**, Vitória-BR: +1 FreeRtr/P4

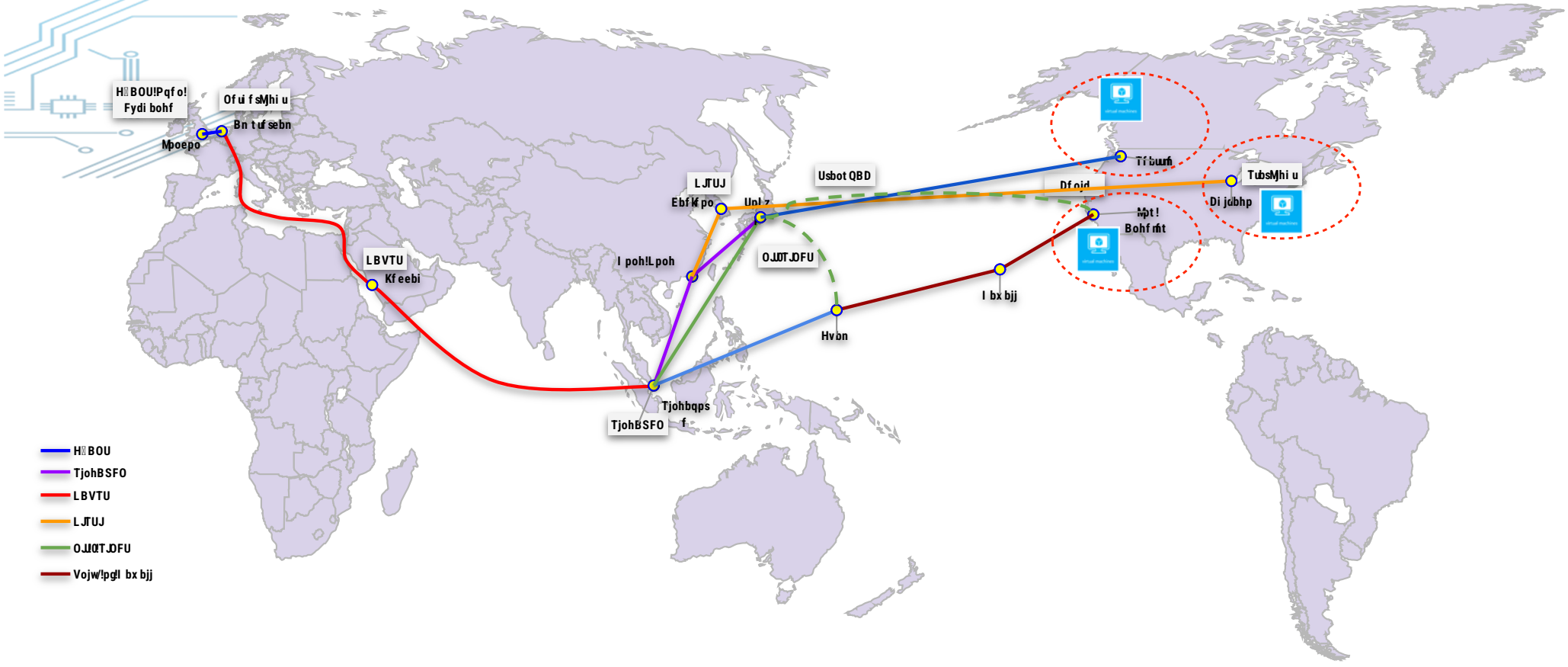
Credit: Marcos Schwarz and Frederic Loui

R&D Networks change and get complex very fast

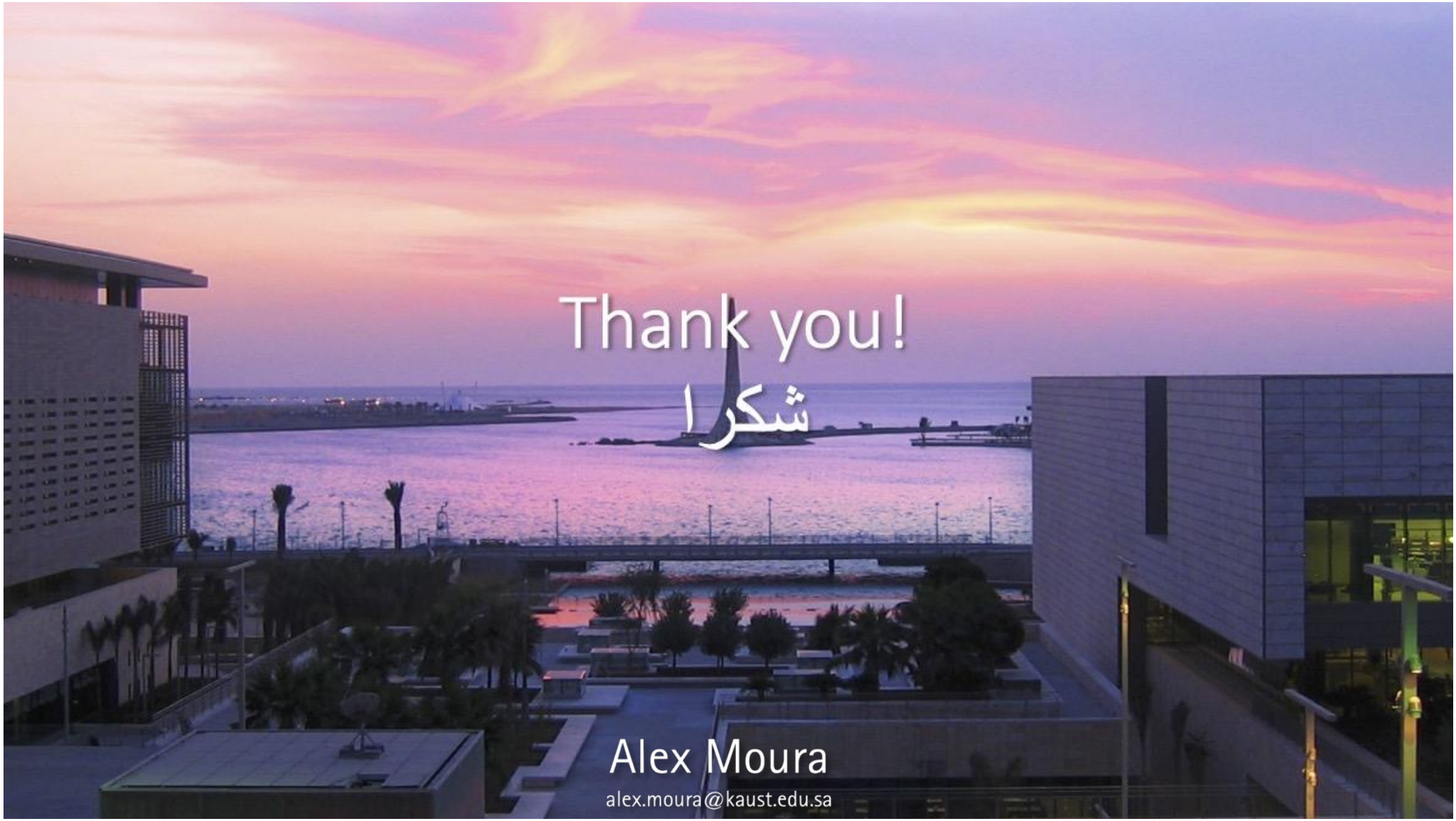


Credit: John Graham

KAUST Circuits to US



Let's talk!


Thank you!
شكرا
Alex Moura
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