KAUST Update

Alex S. Moura, KAUST

JET Meeting

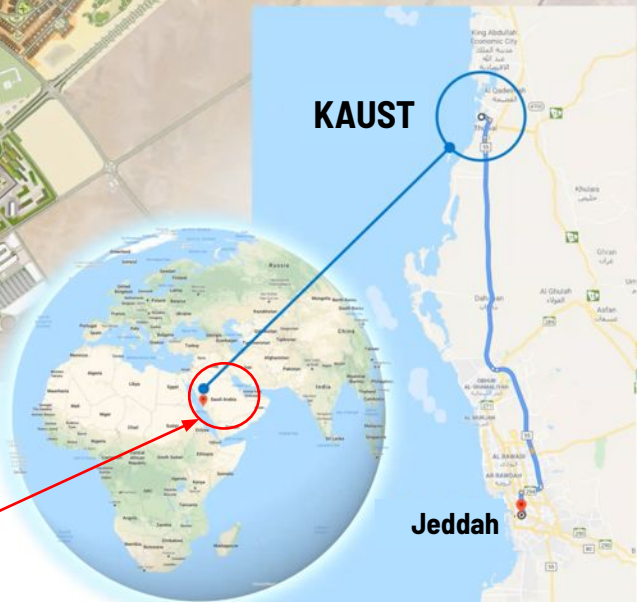
SC22 @ Caltech booth #2820

November 16th 2022

Slides: https://bit.ly/kaust-update-jet-sc22

About KAUST

KAUST Campus



About KAUST


KAUST
Quick Facts
*Academic year 2020
1200
Students
80%
of Students
are Ph.D.
60%
of Students are
International
180
Faculty
476
Post Docs
2200
Alumni
7:1
Student to
Faculty Ratio
400
Research
Scientists & Staff
7000
Community
Members
108
Nationalities
Total campus size
39 Million+
square meters

KAUST Programs and Research Centers

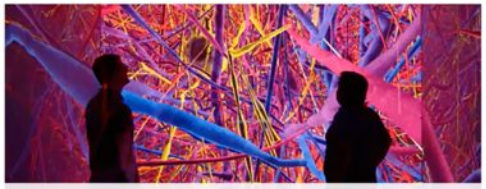
Biological and Environmental Science and Engineering (BESE)

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

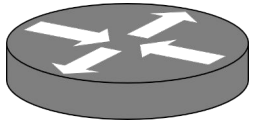
1. Advanced Membranes and Porous
2. Materials Center
3. Ali I. Al-Naimi Petroleum
4. Engineering Research Center
5. Clean Combustion Research Center
6. Catalysis Center
7. Solar Center

KAUST Campus Network in Numbers

- Research network provider
- Business Network
- On-site data centers/on site cloud
- Residential Internet service provider (Phone, TV, Internet)
- Emergency and Security Services (911)
- Commercial ISP
- International Service Provider

1.2
PB of internet traffic/month

3
International PoPs



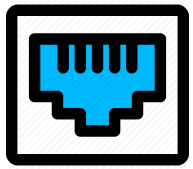
8478
Active network components

~3500
Homes connected with 1 Gb/s speed via optical fiber

100 Gbps
Fully meshed core network

4x 100 Gbps
International links to Amsterdam and Singapore

4000+
Wi-Fi Access points



124,476
Network ports

HPC: 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.

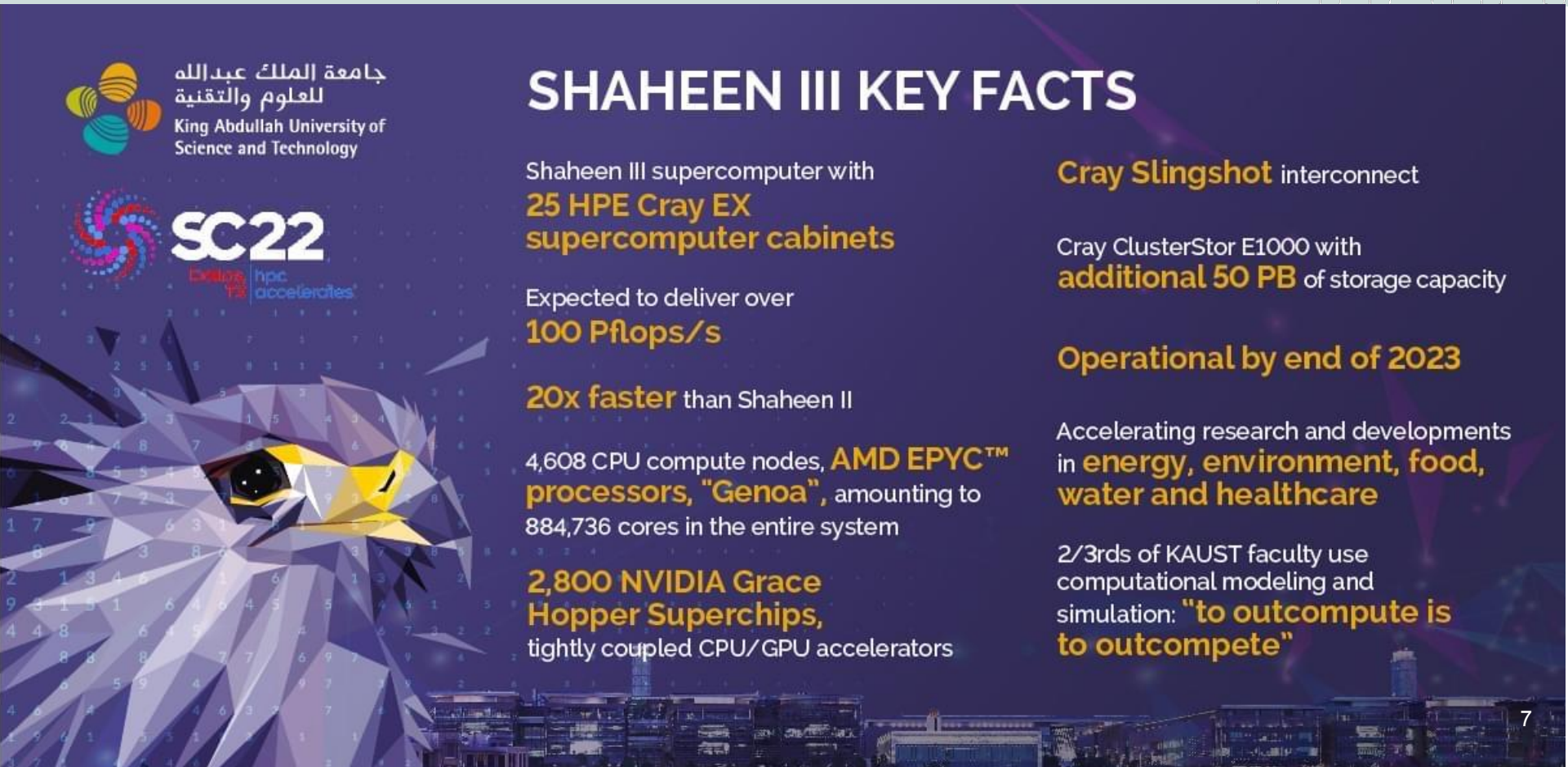
Congratulations from the TOP500 Editors

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

HPC: Shaheen III



HPC: Shaheen III

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

SC22 Exhibitor hpc accelerates

SHAHEEN III KEY FACTS

Each HPE Cray EX cabinet is equipped with **4608 CPU compute nodes**

with two **AMD EPYC™** processors, amounting to **884,736 cores** in the entire system

Seven **HPE Cray EX4000** cabinets will include **704 GPU** compute nodes, each with **4 NVIDIA Grace Hopper Superchips** CPU/GPU modules

Storage expansion to support complex workloads in modelling, simulation and AI using **HPE's Cray ClusterStor E1000** storage system adding **50 petabytes** of storage capacity.

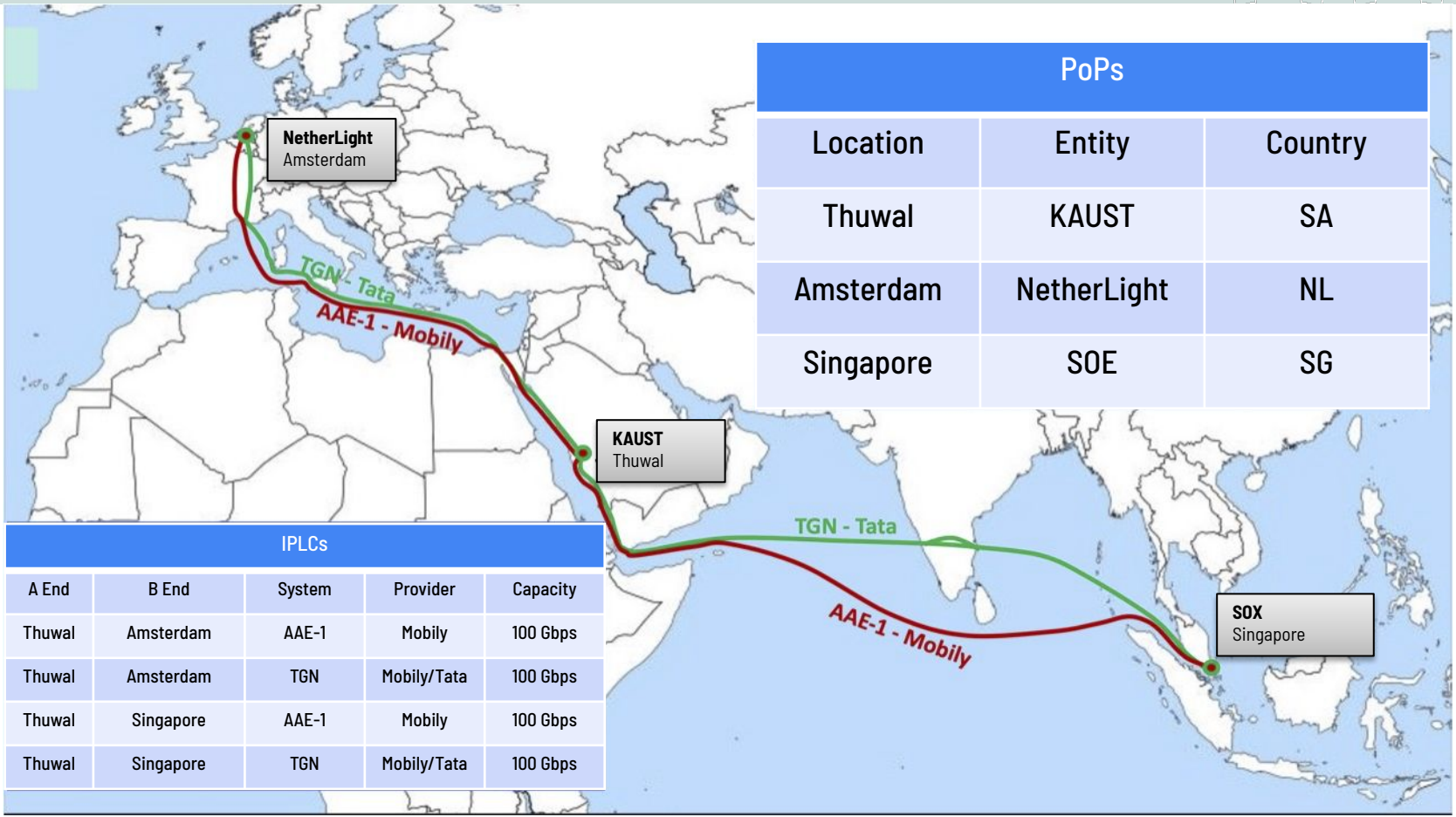
HPE Machine Learning Development Environment, an enterprise machine learning training platform (Determined AI) to assist research teams focus on innovation making it easy to set up, manage, secure and share AI compute clusters.

International Networking

- January 21st 2021: KAUST inaugurated 400 Gbps[1,2] of int'l capacity
- Two undersea cable systems: AAE-1 and TGN
- 2x 100 Gbps directly to NetherLight in Amsterdam
- 2x 100 Gbps directly to SingAREN Open Exchange in Singapore

1. Connecting KAUST at the speed of science
2. KAUST Global Connectivity Launch Event

International Networking

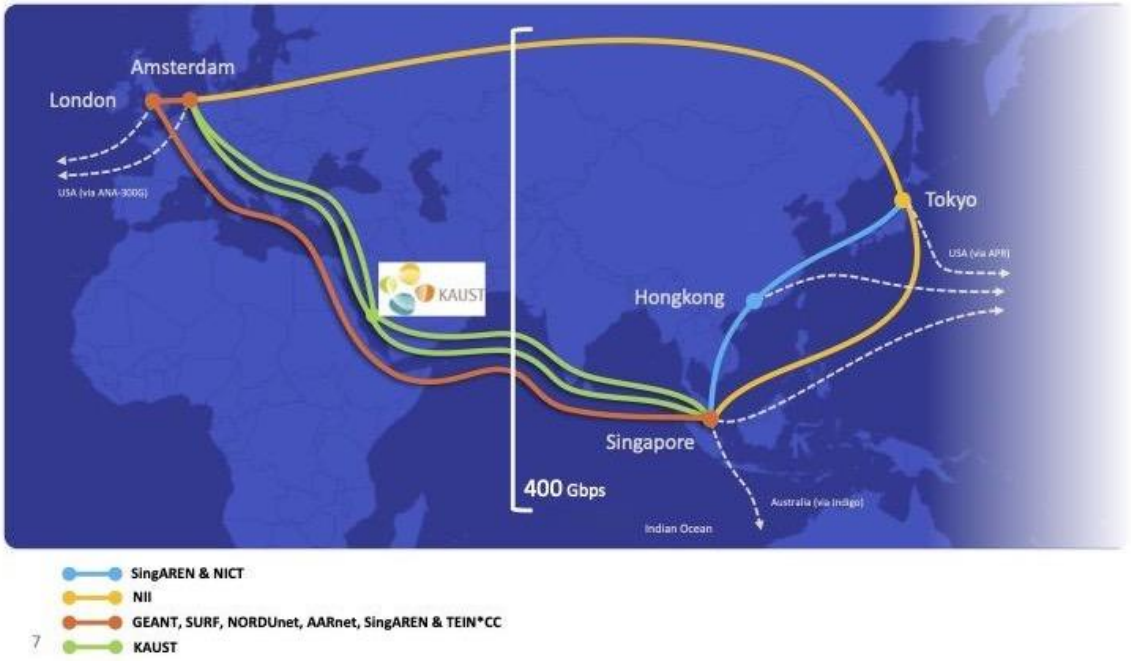


PoPs		
Location	Entity	Country
Thuwal	KAUST	SA
Amsterdam	NetherLight	NL
Singapore	SOE	SG

IPLCs				
A End	B End	System	Provider	Capacity
Thuwal	Amsterdam	AAE-1	Mobily	100 Gbps
Thuwal	Amsterdam	TGN	Mobily/Tata	100 Gbps
Thuwal	Singapore	AAE-1	Mobily	100 Gbps
Thuwal	Singapore	TGN	Mobily/Tata	100 Gbps

International Networking: Asia-Pacific Europe Ring (AER)

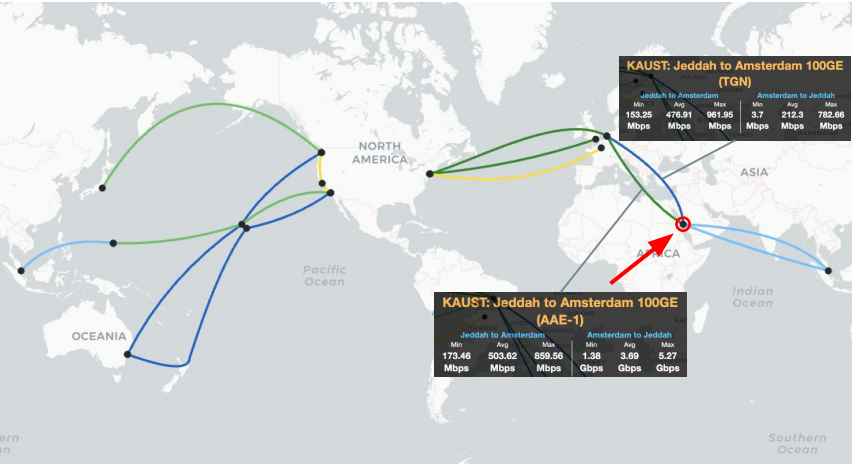
March 7th 2022: KAUST joined the AER during APAN 53



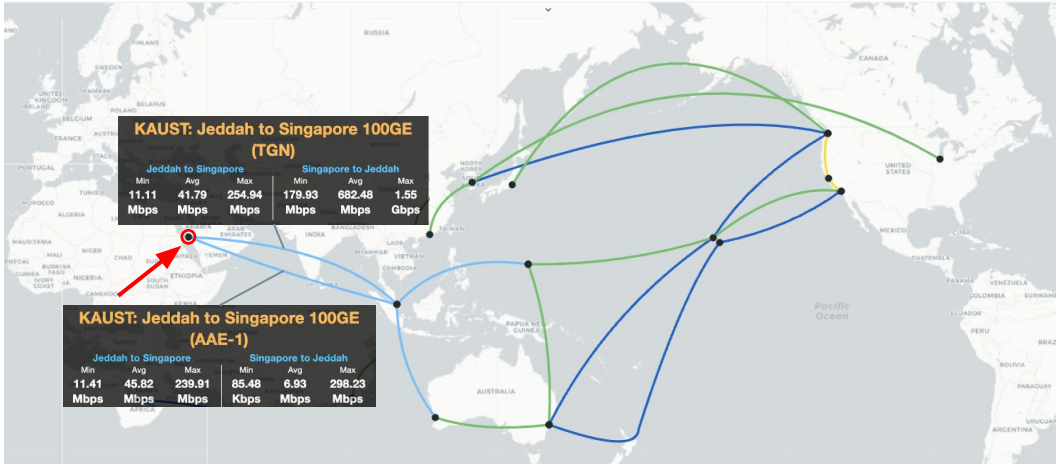
Renewal of MoU expands collaboration between Europe and Asia-Pacific regions, new members added

Source: SURFnet

NetSage



International - netsage.global

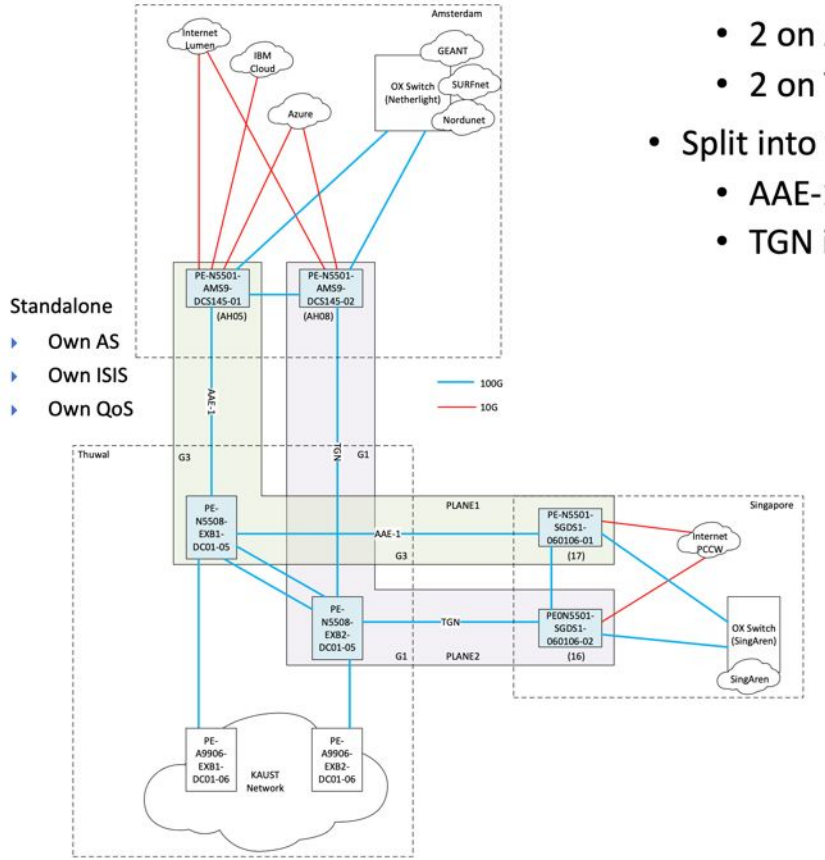


TransPAC/APOnet - netsage.global

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

GlobalNOC
Global Research Network Operations Center

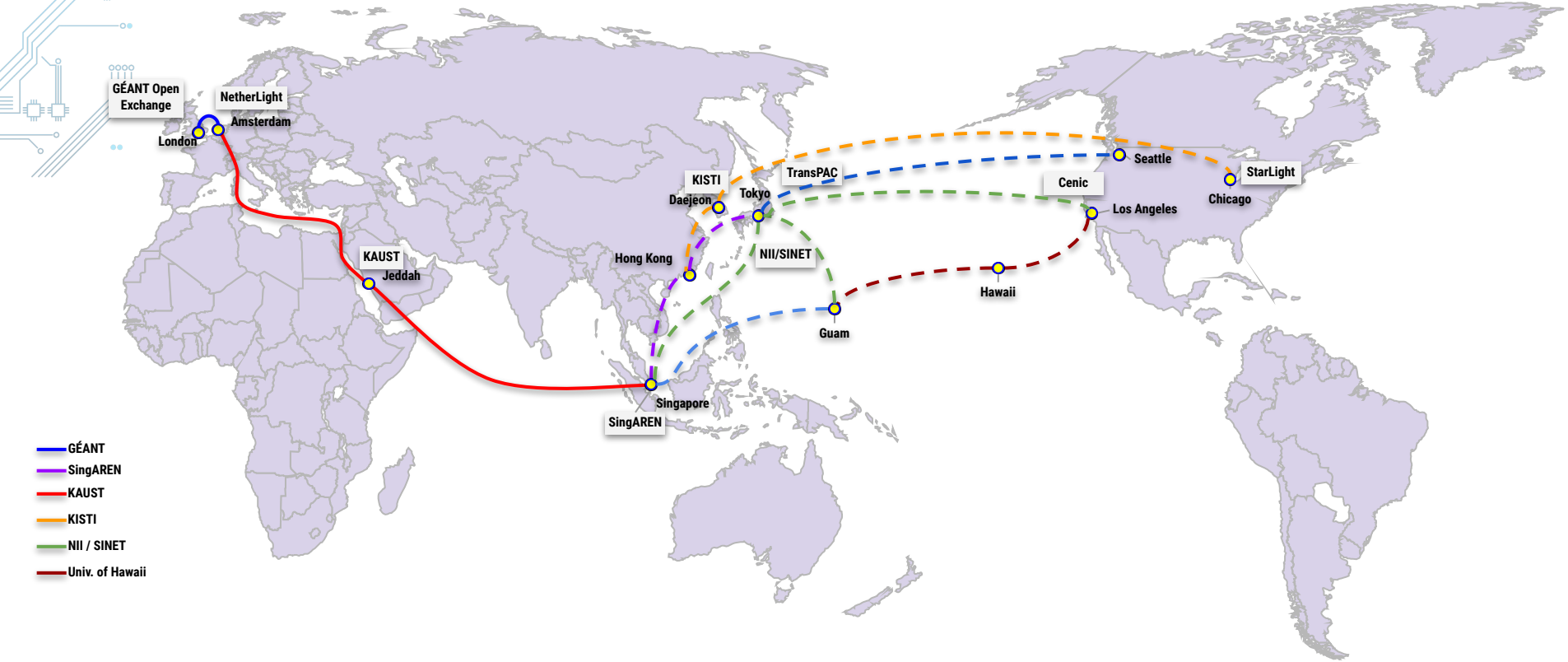
International Networking



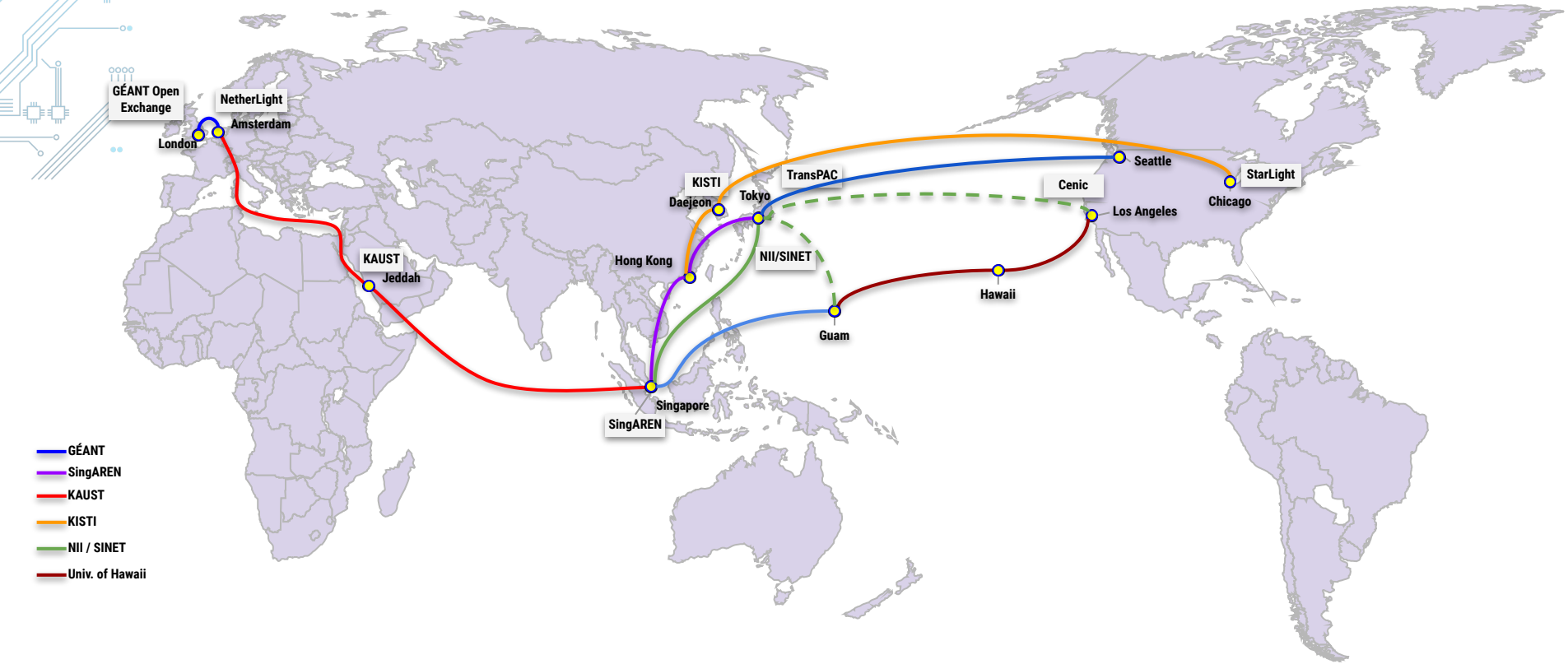
- Four 100G international circuits
  - 2 on AAE-1
  - 2 on TGN
- Split into two data planes
  - AAE-1 is data plane 1
  - TGN is data plane 2

- Built on Cisco's NCS platforms
- Forwarding is Segment Routing MPLS
- ISIS and BGP protocols
  - Segment Routing is an extension of ISIS
  - BGP signals the VPN information
- Service delivered using EVPN
- QoS used to guarantee bandwidth
- Segment Routing Traffic engineering in use (SR-TE)

SC22 Caltech Network Research Exhibit



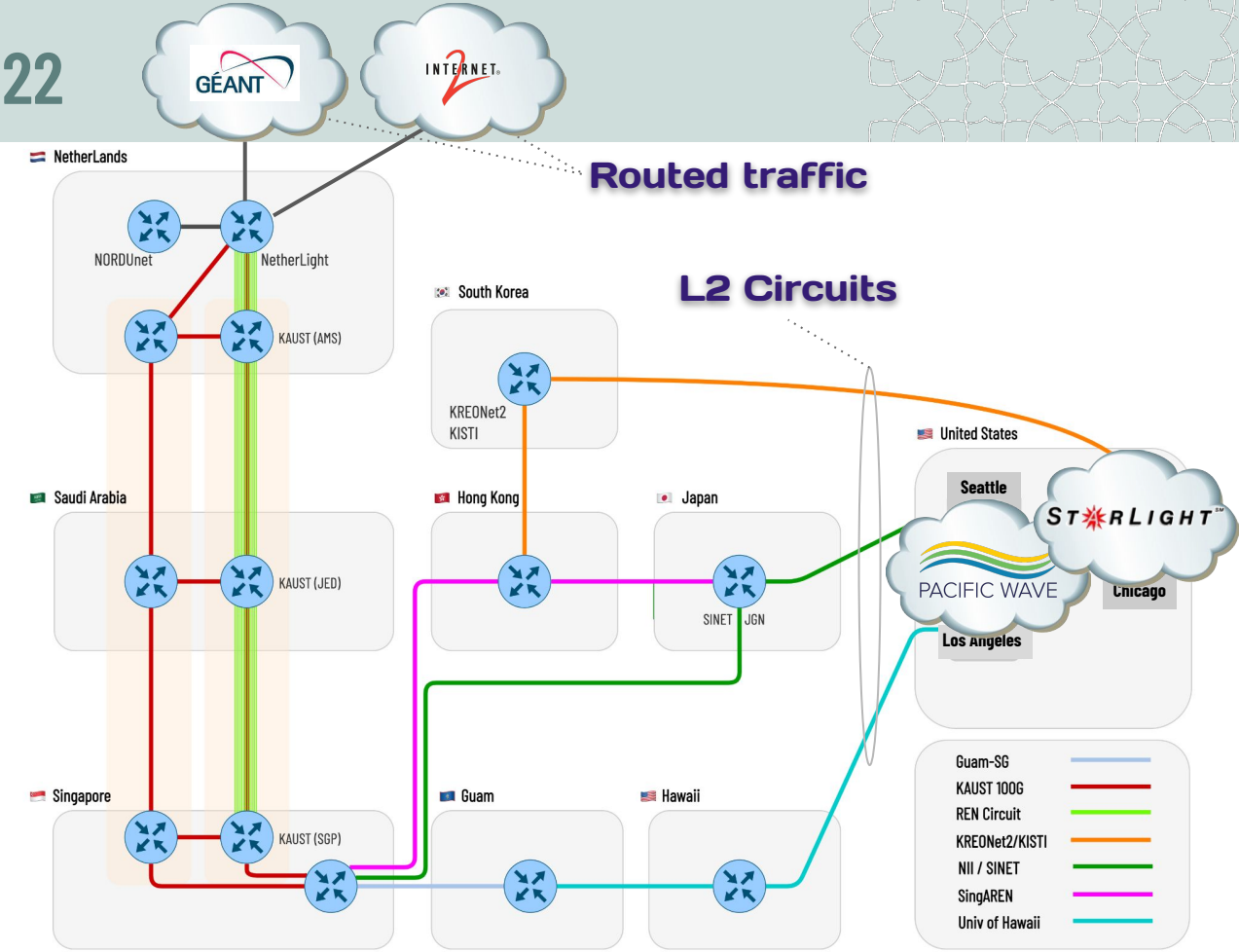
SC22 Caltech Network Research Exhibit



GÉANT Networks • Services • People | NL Light | جامعة الملك عبدالله للعلوم والتقنية King Abdullah University of Science and Technology | Asia@Connect | APAN | aponet | TransPAC America Connects to Asia | International Networks at Indiana University | Internet2 | StarLight℠

AER Update - Aug 2022

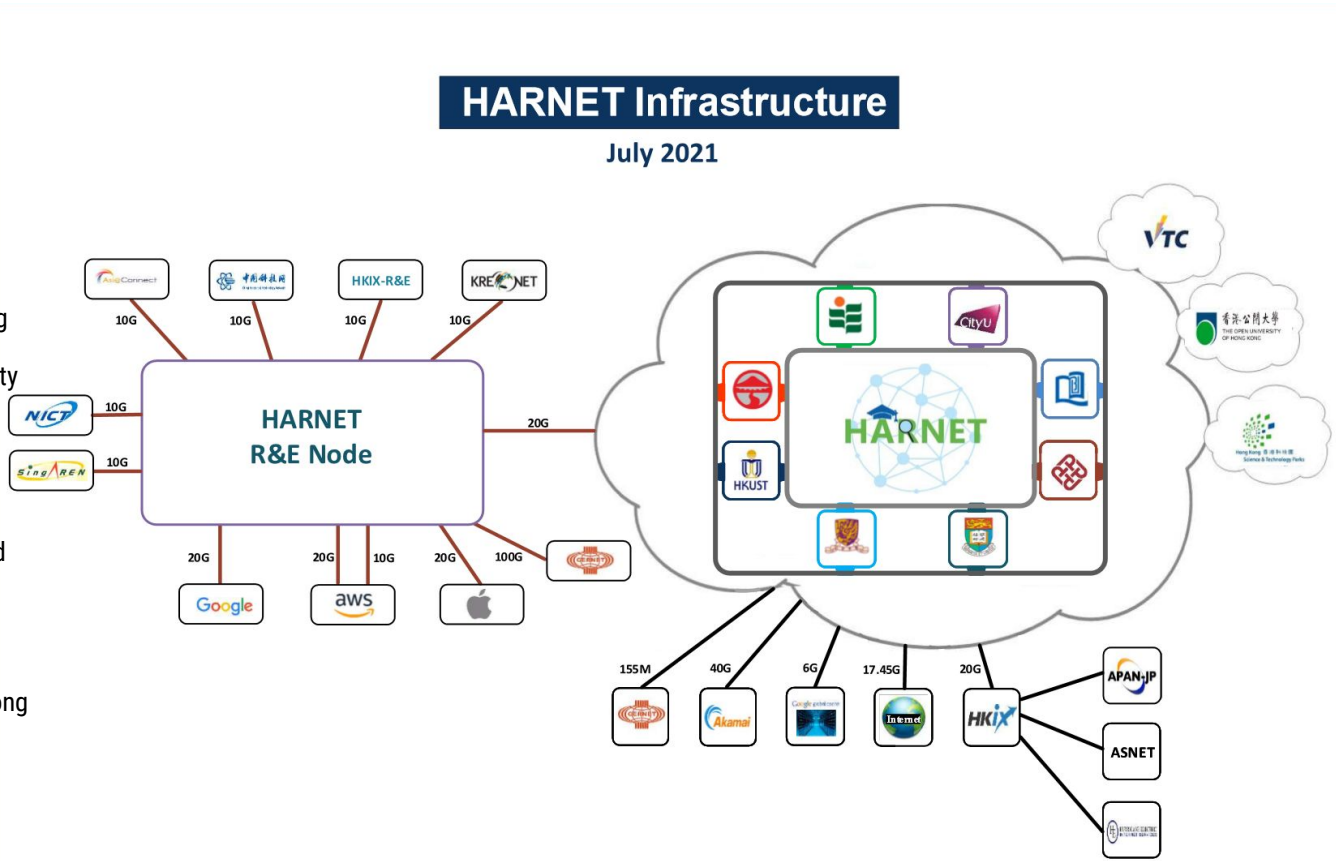
- Since the AER MoU, KAUST is coordinating with REN partners deployment of sharing spare capacity
- KAUST is supporting the following partners by offering point-to-point circuits for submarine cable backup paths:
  - AARnet
  - GÉANT
  - NetherLight
  - NII/SINET
  - SingAREN
- The SC22 NRE Demonstrations will also be supported by KAUST closing the ring from Amsterdam to Singapore and back to the US
  - SC22 NRE



XKIX - Hong Kong

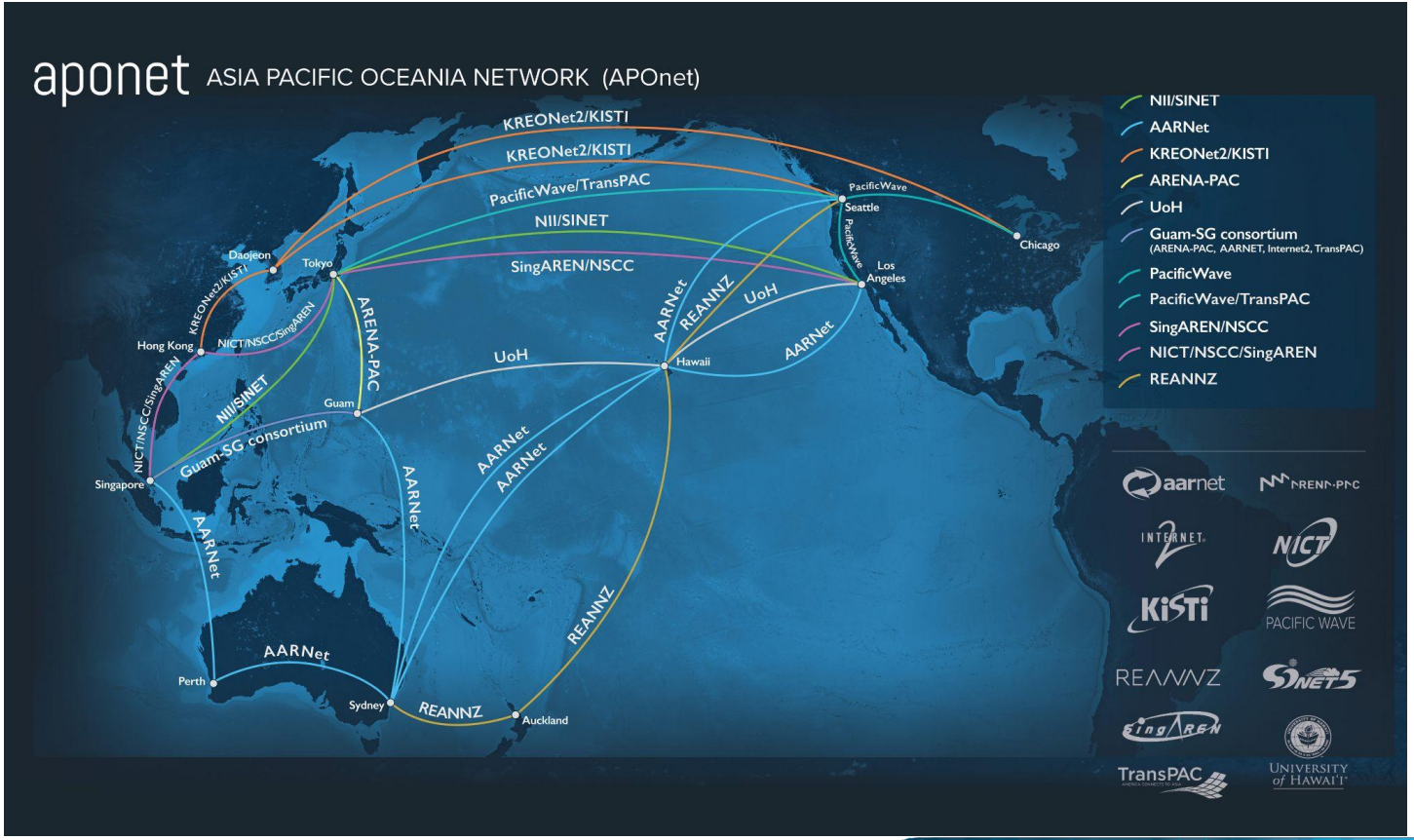
MEMBERS

- The University of Hong Kong
- The Chinese University of Hong Kong
- The Hong Kong Polytechnic University
- City University of Hong Kong
- Hong Kong Baptist University
- Hong Kong University of Science and Technology
- Lingnan University
- The Education University of Hong Kong

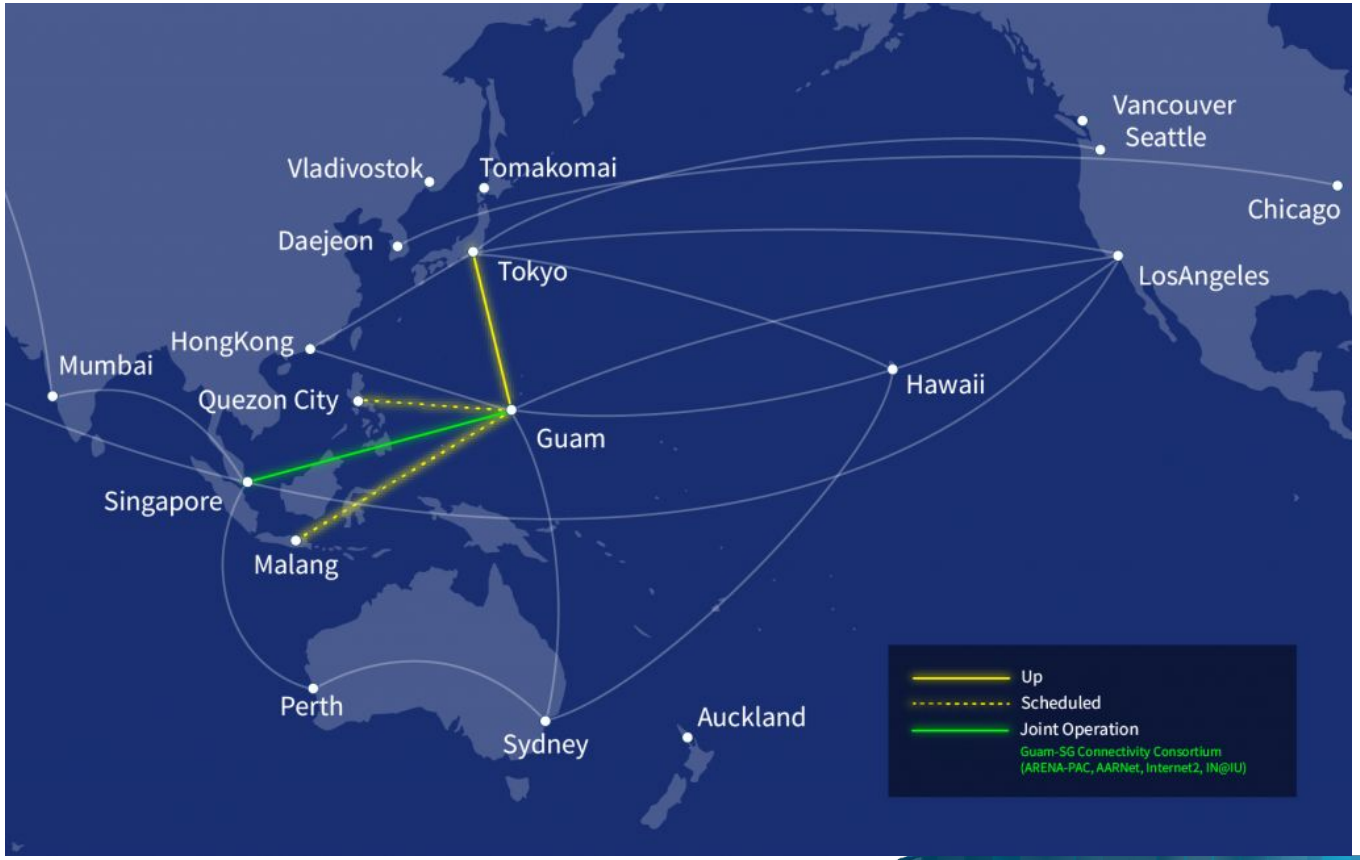


APOnet - Asia Pacific Oceania Network

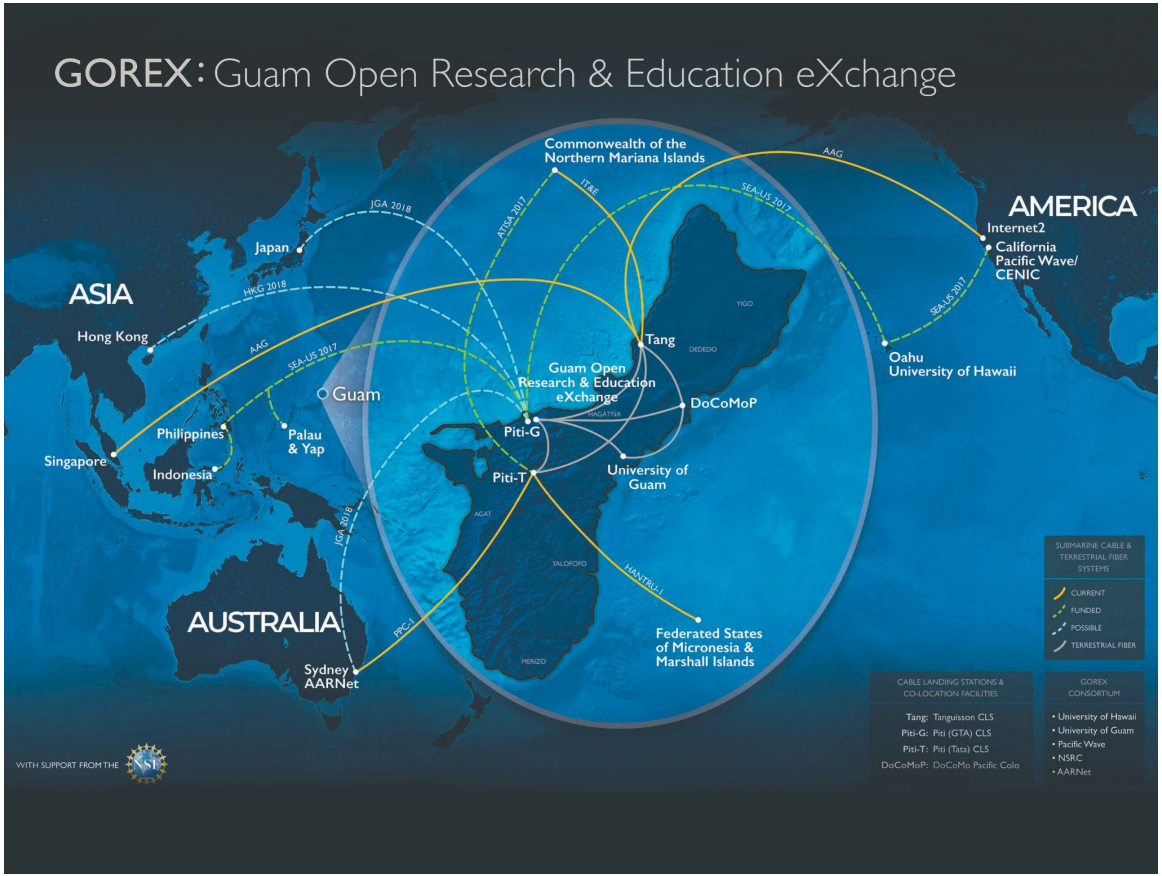
- Australia's Academic and Research Network (AARNet),
- Arterial Research and Educational Network in Asia-Pacific (ARENA-PAC),
- University Corporation for Advanced Internet Development d/b/a (Internet2),
- Korea Institute of Science and Technology Information (KISTI),
- National Institute of Information and Communications Technology (NICT),
- National Institute of Informatics (NII),
- Pacific Wave International Exchange,
- Research and Education Advanced Network New Zealand (REANNZ),
- Singapore Advanced Research and Education Network (SingAREN),
- TransPAC, and
- University of Hawaii (UH)



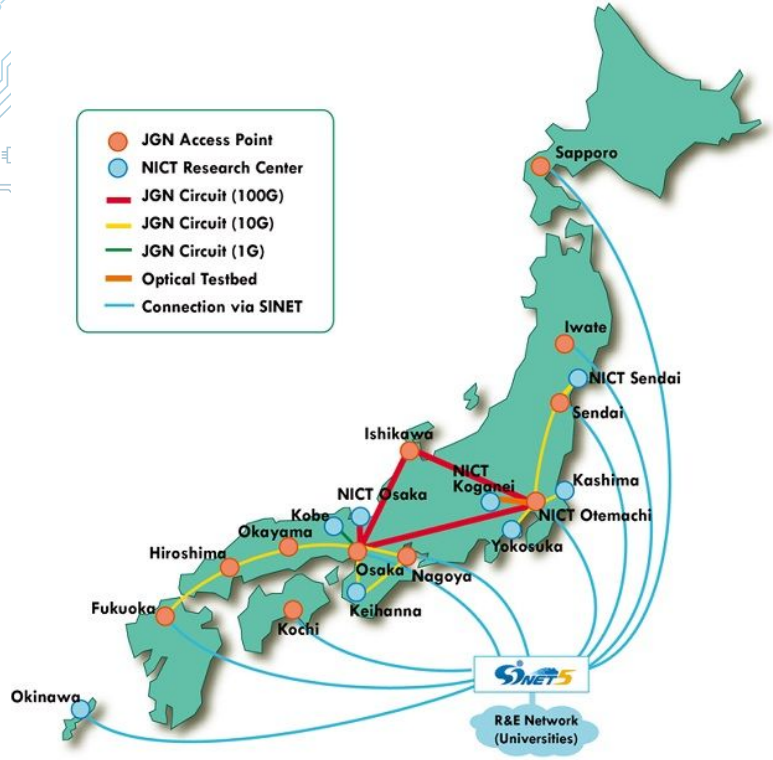
ARENA-PAC


Vancouver
Seattle
Chicago
Vladivostok
Tomakomai
Daejeon
Tokyo
LosAngeles
HongKong
Mumbai
Quezon City
Hawaii
Guam
Singapore
Malang
Perth
Sydney
Auckland
Up
Scheduled
Joint Operation
Guam-SG Connectivity Consortium
(ARENA-PAC, AARNet, Internet2, IN@IU)

GOREX

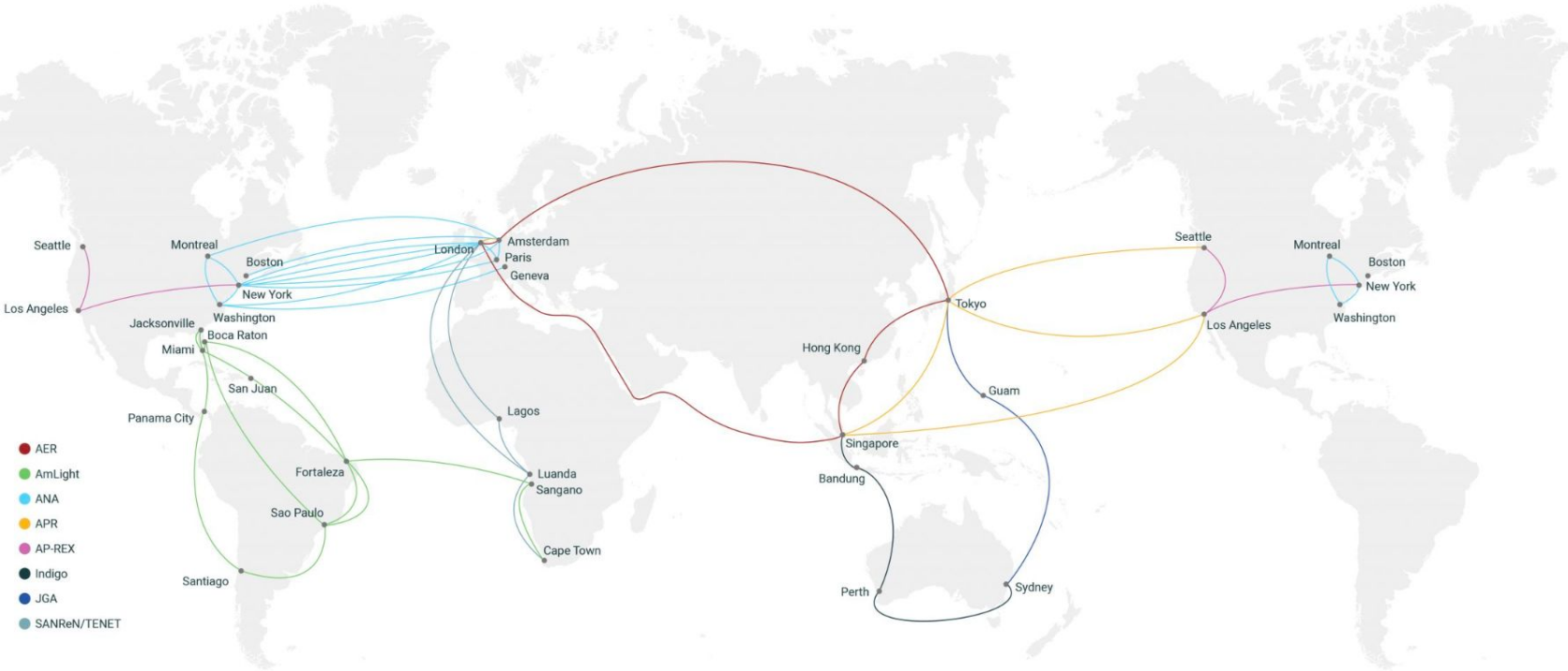

GOREX: Guam Open Research & Education eXchange
Commonwealth of the Northern Mariana Islands
AMERICA
Internet2
California
Pacific Wave/
CENIC
ASIA
Japan
Hong Kong
Singapore
Philippines
Indonesia
Palau & Yap
Guam
Tang
Guam Open Research & Education eXchange
DoCoMoP
Piti-G
Piti-T
University of Guam
Oahu
University of Hawaii
Federated States of Micronesia & Marshall Islands
AUSTRALIA
Sydney
AARNet
JGA 2018
HKG 2018
AAG
SEA-US 2017
ATISA 2017
IT&E
SEAUS 2017
JGA 2018
HANTRU-1
PPC-1
YIGO
DEDEDO
HAGATNA
AGAT
TALOFOFO
MERIZO
WITH SUPPORT FROM THE
SUBMARINE CABLE & TERRESTRIAL FIBER SYSTEMS
CURRENT
FUNDED
POSSIBLE
TERRESTRIAL FIBER
CABLE LANDING STATIONS & CO-LOCATION FACILITIES
Tang: Tanguisson CLS
Piti-G: Piti (GTA) CLS
Piti-T: Piti (Tata) CLS
DoCoMoP: DoCoMo Pacific Colo
GOREX CONSORTIUM
• University of Hawaii
• University of Guam
• Pacific Wave
• NSRC
• AARNet

JGN


JGN Access Point
NICT Research Center
JGN Circuit (100G)
JGN Circuit (10G)
JGN Circuit (1G)
Optical Testbed
Connection via SINET
Sapporo
Iwate
NICT Sendai
Sendai
Ishikawa
NICT Koganei
Kashima
NICT Osaka
Kobe
NICT Otemachi
Okayama
Hiroshima
Yokosuka
Osaka
Nagoya
Keihanna
Fukuoka
Kochi
Okinawa
SINET5
R&E Network (Universities)


Europe
USA
SINET(Japan)
NORDUnet
NORDUnet(Europe)
GÉANT
GÉANT(Europe)
SURF NET
SURF(Europe)
AsiaConnect
TEIN(Asia, Europe)
APAN
APAN(Asia, Pacific)
KOREN
KOREN(Korea)
KREONET
KREONET(Korea)
HKIX
HKIX(Hong Kong)
CERNET(China)
CSTNET(China)
HKIX(Hong Kong)
JGN
JGN(Japan)
Tokyo
WIDE
WIDE Project(Japan)
TransPAC
TransPAC(USA)
SingAREN(Singapore)
Seattle
Chicago
PacificWave(USA)
StarLight(USA)
Internet2(USA)
LA
CENIC
CalREN(USA)
Maffin
Maffin(Japan)
HongKong
ASGC(Taiwan)
Asnet(Taiwan)
TWAREN
TWAREN(Taiwan)
Bangkok
UniNet
UniNet(Thailand)
ThaiREN(Thailand)
ThaiSarn
ThaiSarn(Thailand)
ASTI(Philippines)
ARENA-PAC(JP/AU)
Guam
Hawaii
University of Hawai'i
University of Hawaii(USA)
CAE-1
Singapore
SingAREN(Singapore)
AARNet
AARNet(Australia)
Perth
Sydney
Auckland
JP-HK-SG lines
Tokyo-Hong Kong: 100Gbps
Hong Kong-Singapore: 100Gbps
SG-TH line
Singapore-Bangkok: 1 Gbps

GNA-G


Seattle
Montreal
Boston
New York
Los Angeles
Washington
Jacksonville
Boca Raton
Miami
San Juan
Panama City
London
Amsterdam
Paris
Geneva
Lagos
Fortaleza
Luanda
Sangano
Sao Paulo
Cape Town
Santiago
Tokyo
Hong Kong
Guam
Singapore
Bandung
Perth
Sydney
Seattle
Los Angeles
Montreal
Boston
New York
Washington
AER
AmLight
ANA
APR
AP-REX
Indigo
JGA
SANReN/TENET

Science DMZ

Science DMZ and DTN setup

Clean 100Gbps paths from Science DMZ

Chassis: Gigabyte R281-NO0

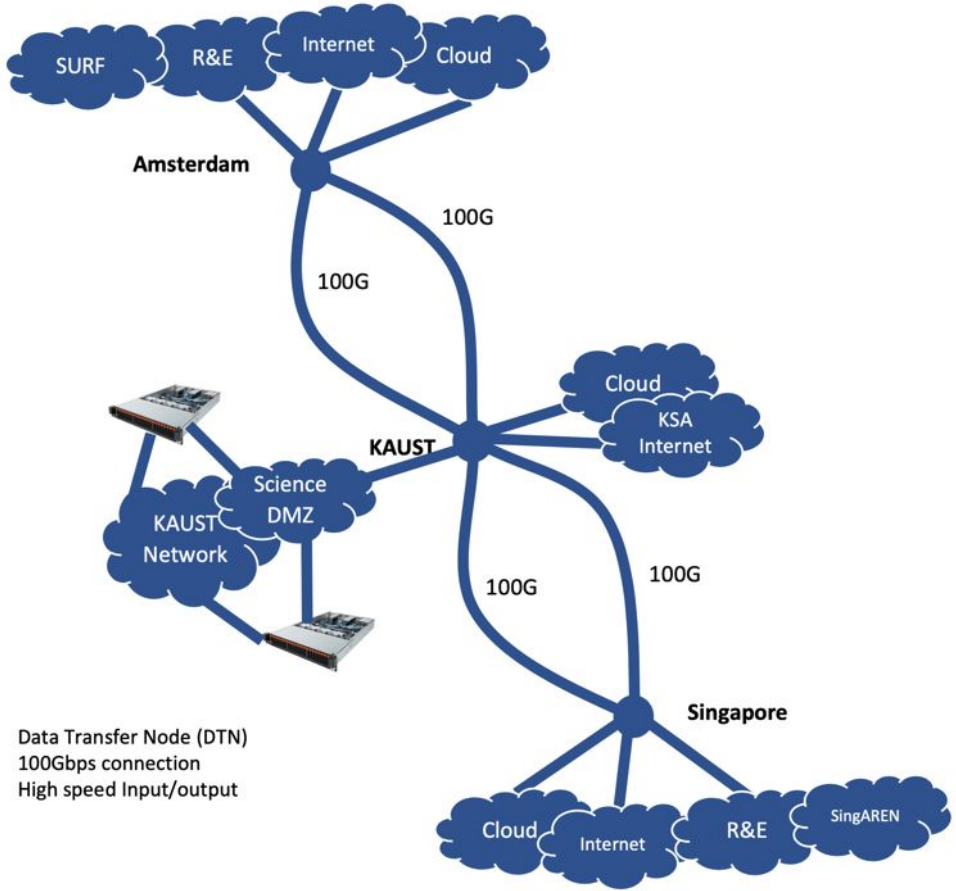
Memory: 12 x 16GB DDR4 (192GB)

CPU: 2 x intel Gold 6256

Interface: 100Gbps Cisco QSFP-100G-SR4-S

Storage: 10 x Intel P4610 1.6TB (160TB)

Operating System: Centos 7.9

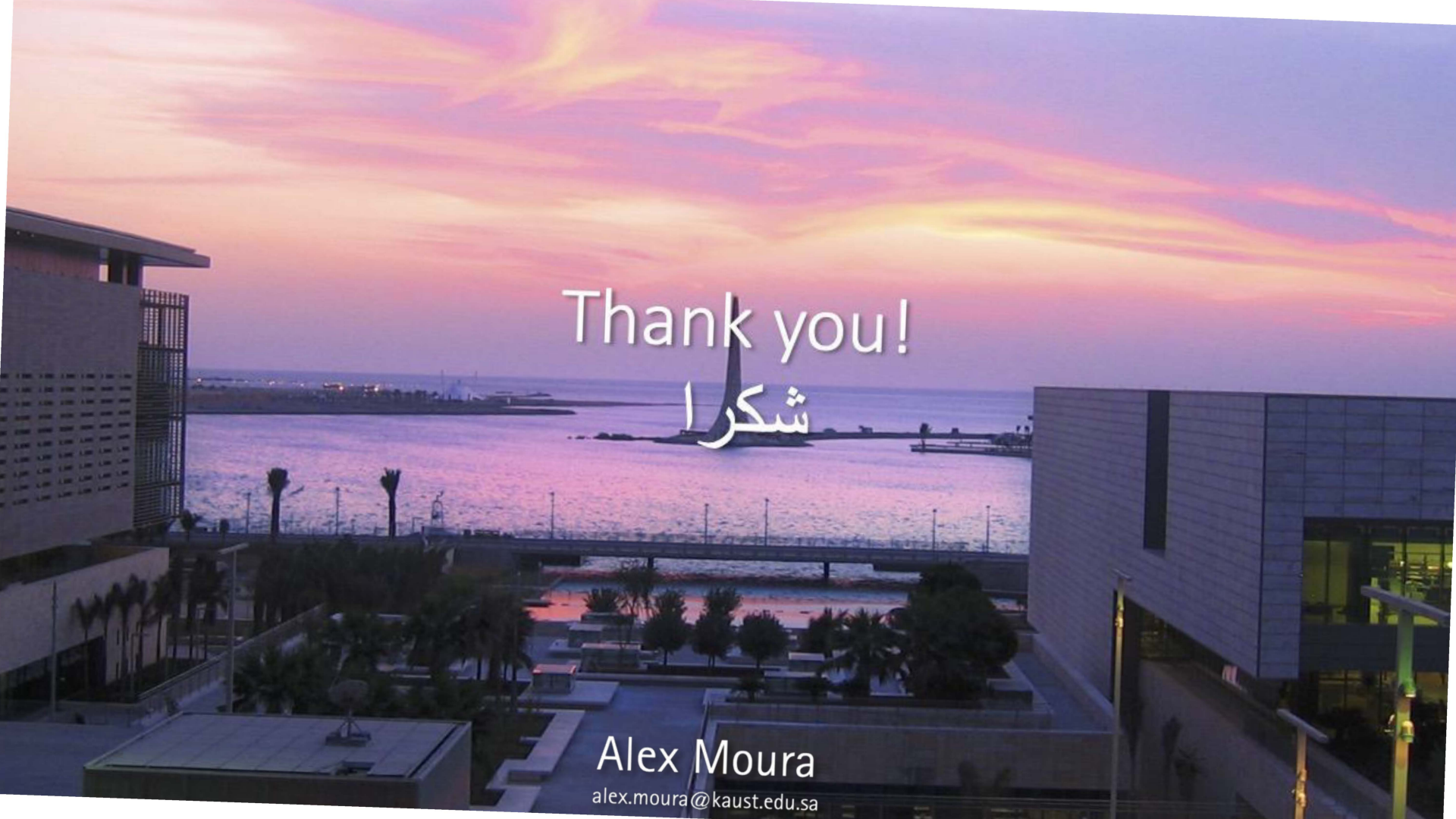


Research Demands

- **CERN CMS Project**
  - PhD Program
  - Research projects using Shaheen II. In the future, Shaheen III
- **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.
- **Others**
  - Zettar DTN tests between **Shaheen II** and **Pawsey (AU)**

Next steps

- Integrate NetFlow monitoring to NetSage
- Refresh the campus network performance measurement mesh w/ perfSONAR v5
- Collaboration with Caltech in SC22 Network Research Exhibit
- Direct circuit peerings with Pacific Wave (LA and SEA) and StarLight (US)
- Enabling AutoGOLE/SENSE and RARE/FreeRouter in Science DMZ
- In evaluation
    - FAB program of the FABRIC Testbed
    - A programmable campus network testbed based on P4 platform


Thank you!
شكرا
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"Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Networking and Information Technology Research and Development Program."

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