



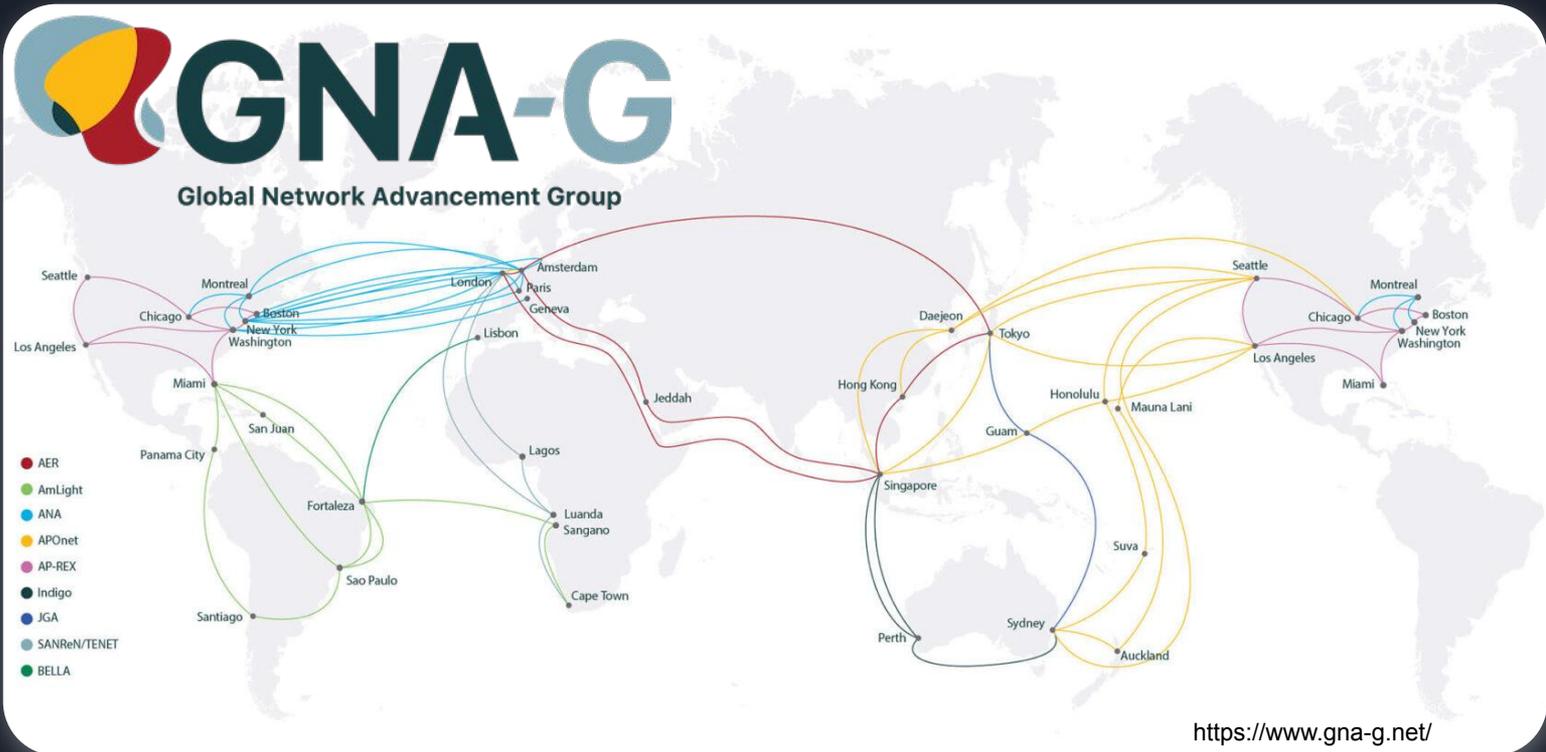
Think Global, Act Global to be More Resilient!

Simon Green
Technical Manager (Network & Services)
SingAREN

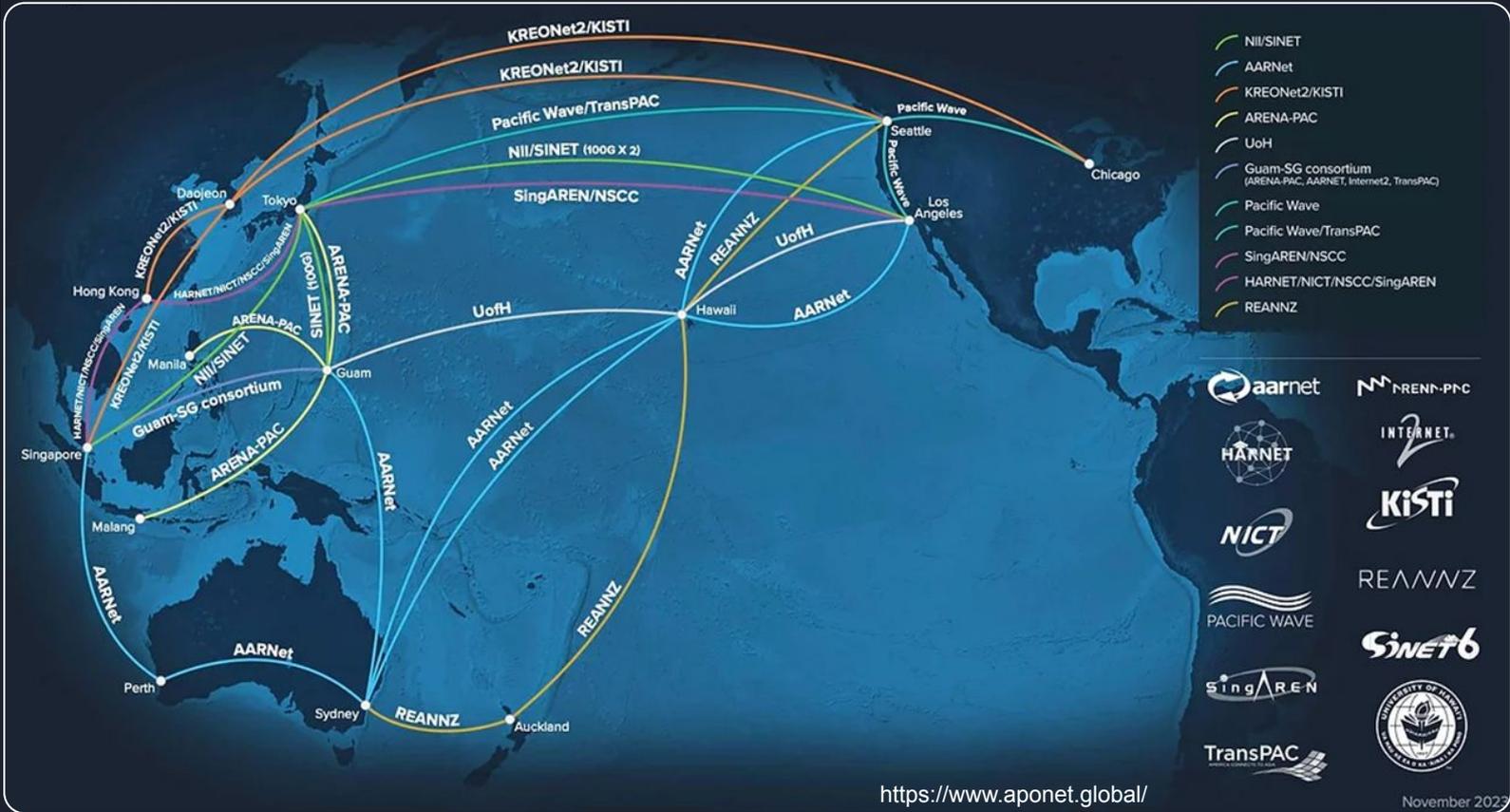
TNC24



Global Research and Education Network

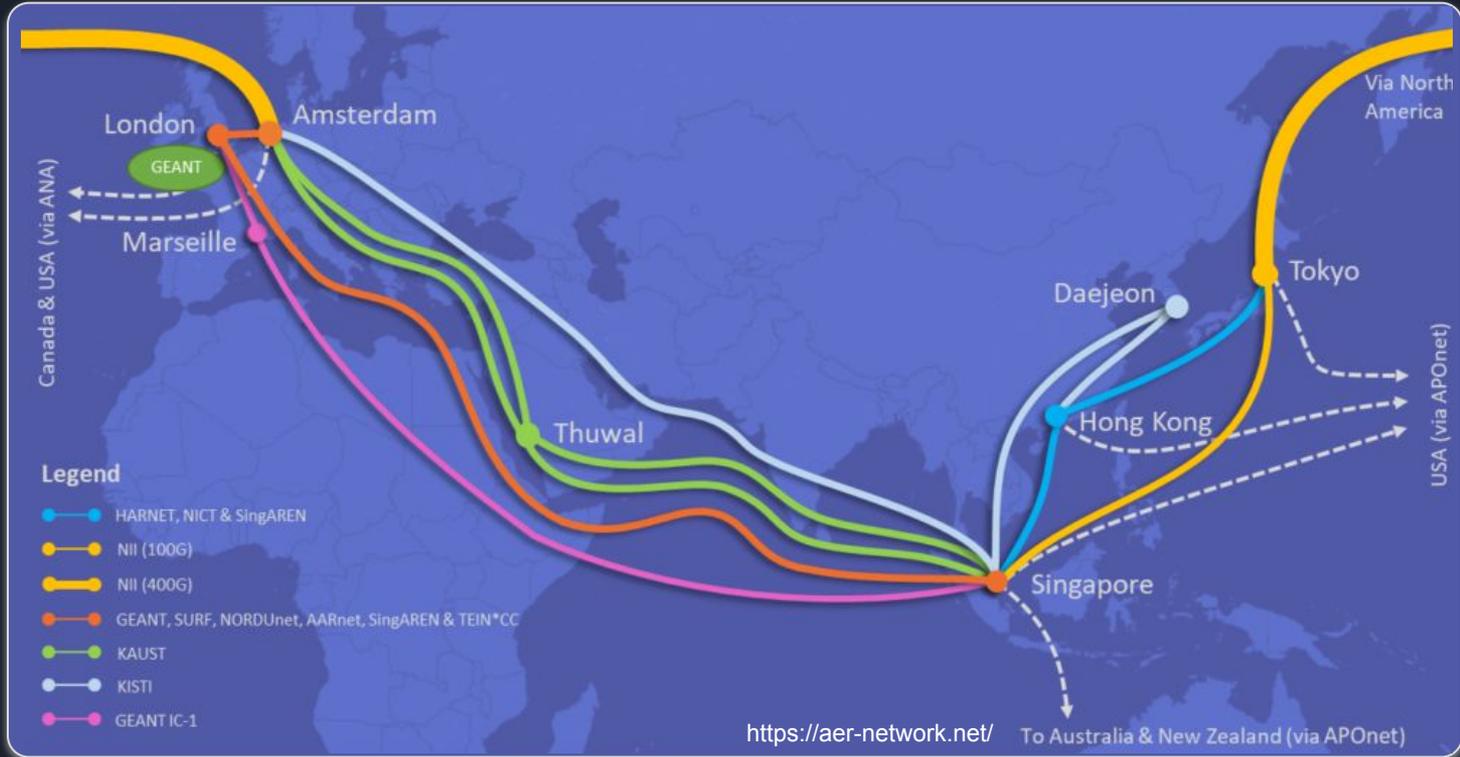


aponet ASIA PACIFIC OCEANIA NETWORK (APOnet)



AER

ASIA-PACIFIC EUROPE RING





Benefits of the Global Research and Education Network

High-Speed

100GE+ Global Backbone

02

Resilient & Flexible

01

Multiple physical paths for primary and backup links

Efficient

03

Less power per data transferred over 100GE compared to 10GE

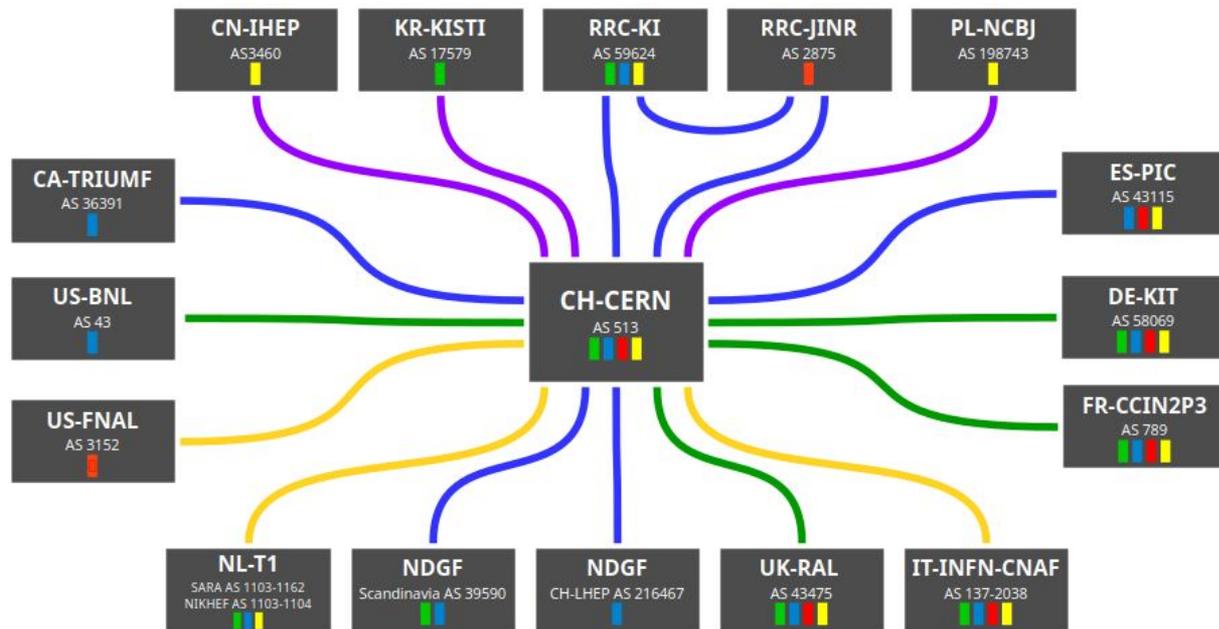


Enabling
Day-to-Day
Research Projects
& Demonstrations



- Large Hadron Collider Networks (LHCOPN & LHCONE)
- Remote Robot Telesurgery Demo
- OpenScience Data Federation
- SCinet Network Research Exhibition (NRE) Demos
- and more!

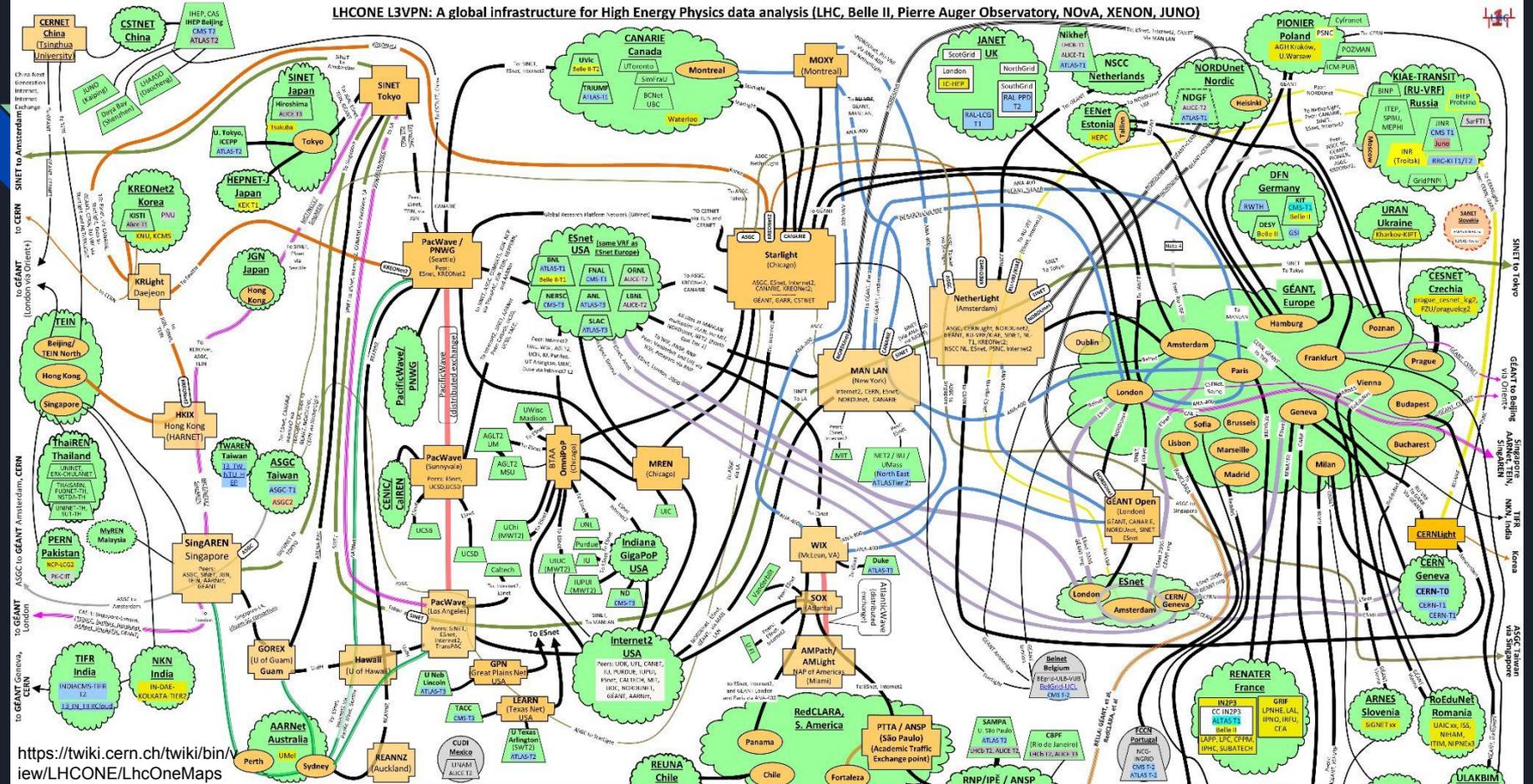
LHCOPN



Line speeds:	Experiments:
20Gbps	■ = Alice ■ = Atlas
100Gbps	■ = CMS ■ = LHCb
200Gbps	
400Gbps	
800Gbps	
	Last update: 20240308 edoardo.martelli@cern.ch

<https://twiki.cern.ch/twiki/bin/view/LHCOPN/OverallNetworkMaps>

LHCONE L3VPN: A global infrastructure for High Energy Physics data analysis (LHC, Belle II, Pierre Auger Observatory, NOVA, XENON, JUNO)



LHCONE Map Ver. 6.0, 2022-11-15 - WEJohnston, Esnet, wej@es.net

LHCONE VRF domain/aggregator
 A Provider network
 Connector network - providers, e.g., an L3 path between VRFs.
 Provider network PoP router
 WLCG sites that are not connected to LHCONE
 Exchange point

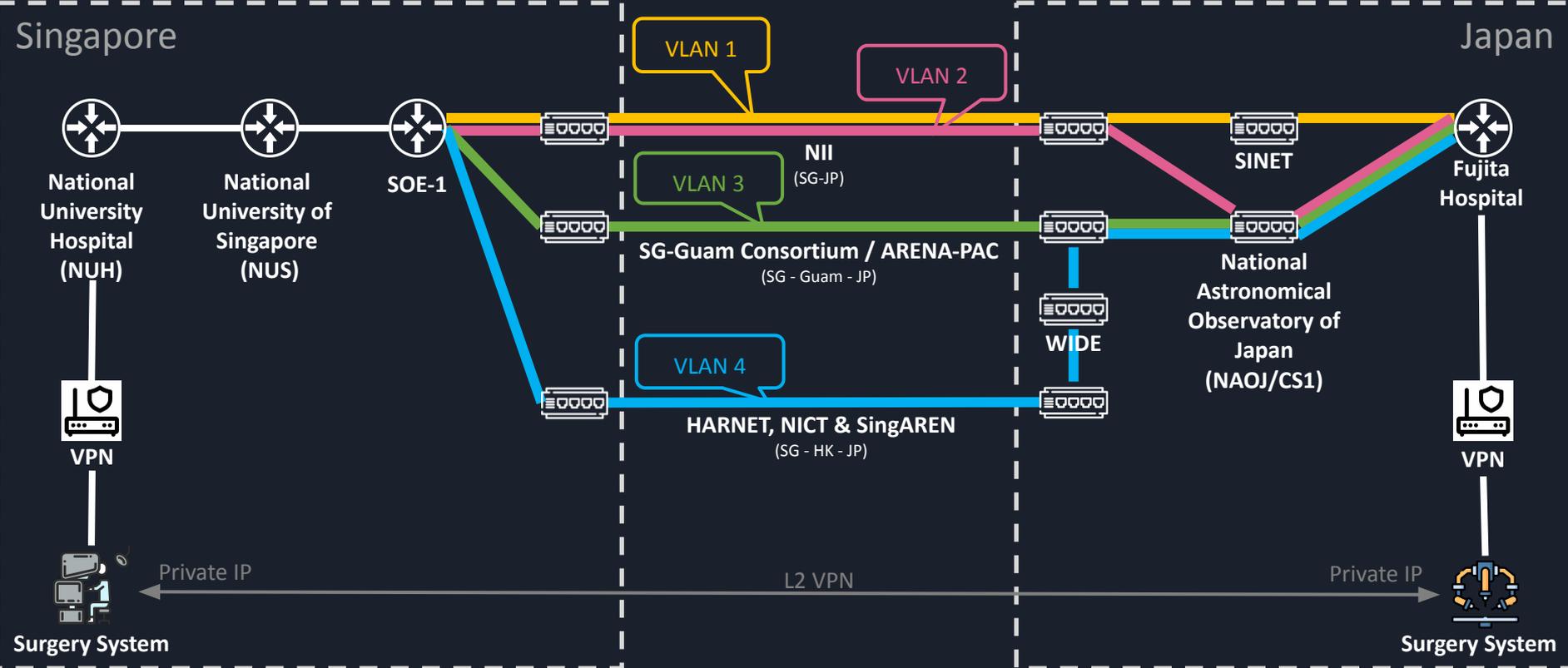
International infrastructure by provider/collaboration

- AARNet
- CAIC, Russia
- SINET, Japan, global ring
- ASGC, Taiwan
- Esnet transatlantic, USA
- NICT/NCCC/ SingAREN
- SINET
- NORDUnet
- CAIC, Russia
- KREONET2, Korea
- BELLA; GEANT, et al
- RoCLARA, et al

Other Infrastructure:
 SHKRTI: LHC ALICE or LHCb site
 CNAT-T1: LHC Tier 1 ATLAS and CMS
 UChi: LHC Tier 2/3 ATLAS and CMS
 KEK: Belle II Tier 1/2
 JUNO: JUNO
 UNL: Sites that are Standalone VRFs

Notes:
 1) Only links involved in LHCONE are shown
 2) LHCONE links are not shown on this diagram
 3) For map explanation see "Interpreting the LHCONE Map" at <https://www.drobes.com/it/papers/2014/05/20140528/InterpretingLHCONEMap.pdf>
 4) GEANT and CANARIE have shutdown the peering between their VRF and KfUP, as a result of the Ukraine war.

Robotic Telesurgery Trial - Network Plans

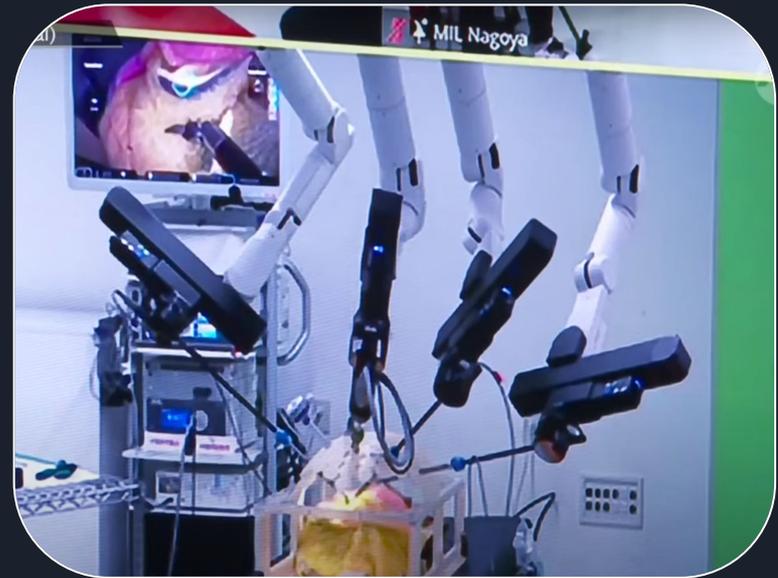


Robotic Telesurgery Trial

Singapore and Japan Clinician-Scientists Collaborate on Groundbreaking Telesurgery Trial Spanning over 5,000km in Nov 2023



Singapore - Controlling Unit



Japan - Robotic Operation Unit

Resiliency Showcase

Singapore - Japan Backbone



Resiliency Showcase

Singapore - Japan Backbone

APAN-JP/SINET Singapore - Japan Backbone

Path Priority	Path	Circuit Owner(s)
1	Singapore - Hong Kong - Japan	HARNET / NICT / NSCC / SingAREN
2	Singapore - Japan	SINET
3	Singapore - Guam - Japan	SG-Guam Consortium SINET (Guam-JP)
4	Singapore - Australia - Guam - Japan	AARNet SINET



Resiliency Showcase

Singapore - Japan Backbone

Primary Backbone Path
Singapore - Hong Kong - Japan
(HARNET / NICT / NSCC / SingAREN)



Resiliency Showcase

Singapore - Japan Backbone

Affected Circuit (Downtime)	Singapore - Hong Kong (late Jan - Apr 2023 - 90 days)
Failover Link	Singapore - Japan (SINET)
Access to Japan and Hong Kong	Yes



Resiliency Showcase

Singapore - Japan Backbone

Affected Circuit (Downtime)	Singapore - Hong Kong (late Jan - Apr 2023 - 90 days) Singapore - Japan (start Feb - end Feb 2023 - 30 days)
Failover Link	Singapore - Guam - Japan (SG-Guam Consortium + SINET)
Access to Japan and Hong Kong	Yes



Resiliency Showcase

Singapore - Japan Backbone

Potential Third Link Failover Case

Possible Affected Circuits (Downtime)	SG-HK SG-JP SG-Guam-JP
Failover Link	SG-AU-Guam-JP (AARNet + SINET)
Access to Japan and Hong Kong	Yes



Network System Challenges

Varying Operating Procedures per System

Each network system needs to determine the processes and tools to manage the system successfully



Additional Setup for Resiliency

Operators need to be open with users and determine resiliency requirements



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Network System Challenges

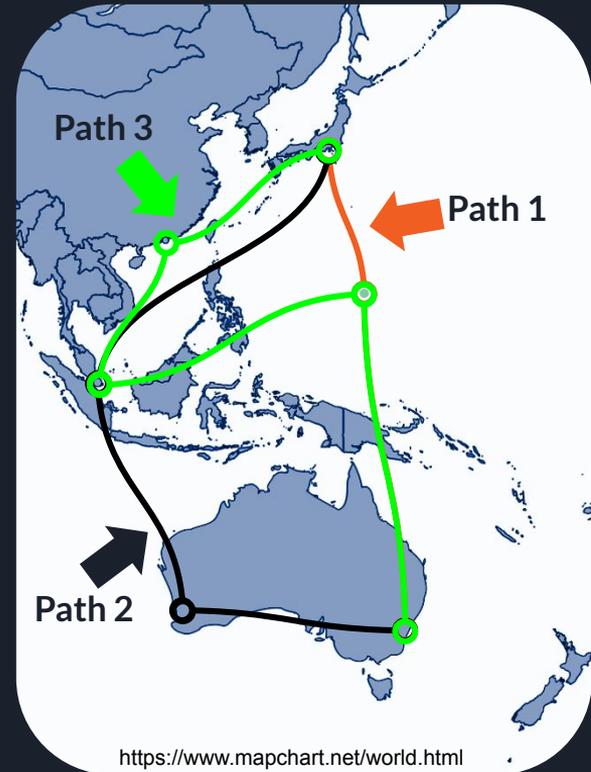
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Future Work & Discussion

400GE international
backbone
More diverse paths



Standardisation of
operations between
network systems



System-wide
automation



Thank
You!