11th CEF Networks Workshop, Prague

# Optical footprint of KREONET/KREONet2 improvement and other research and development activities

April 19, 2023

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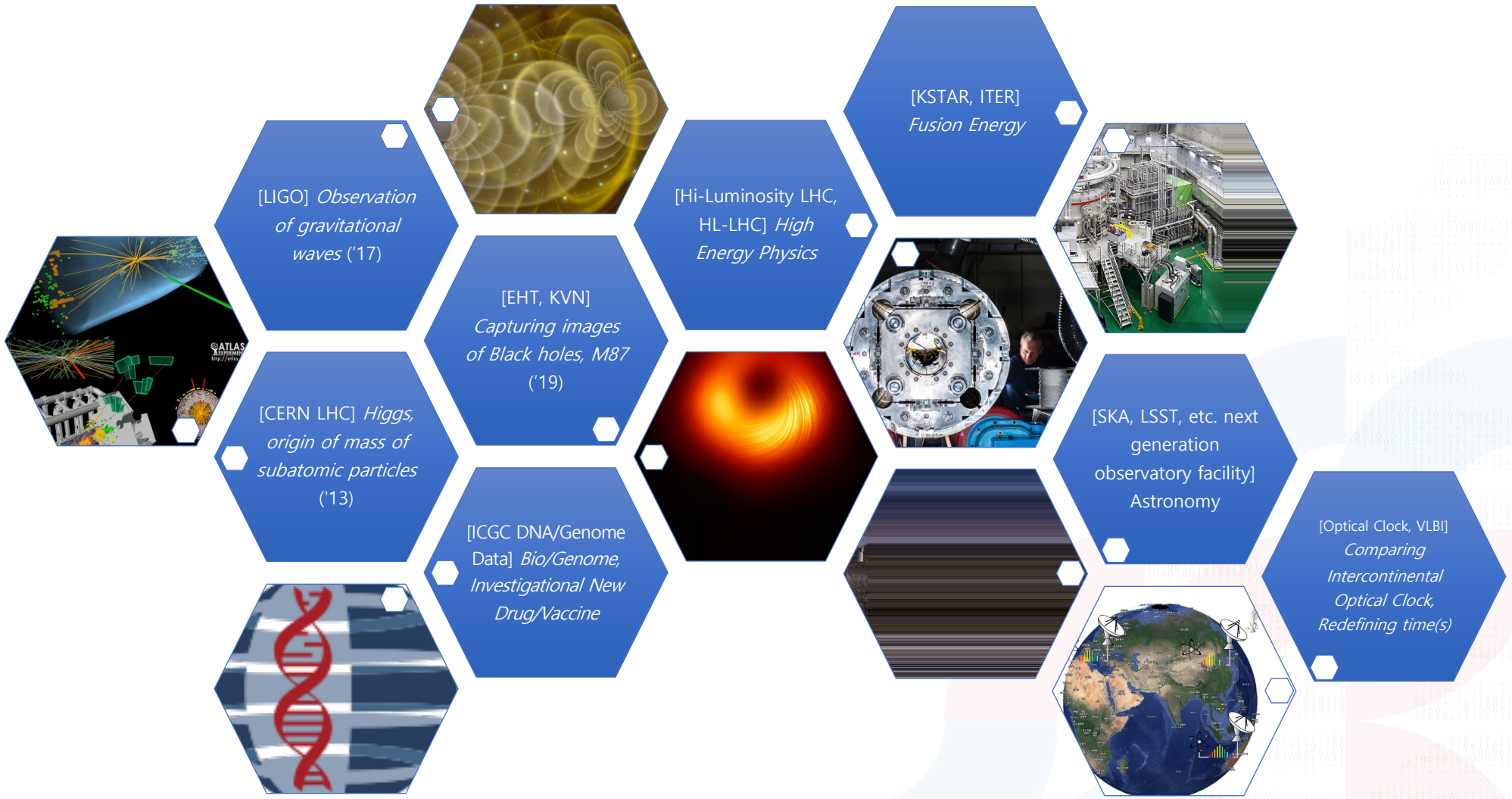
S&T Infra,
Changing the world with Data KiSTi

KREONET

# KREONET/KREONet2 enabling Science Discovery




**Big science, Data Intensive Science, Interdisciplinary research**

# KREONET/KREONet2, national science and research network

## KREONET/KREONet2 (AS1237/ AS17579)

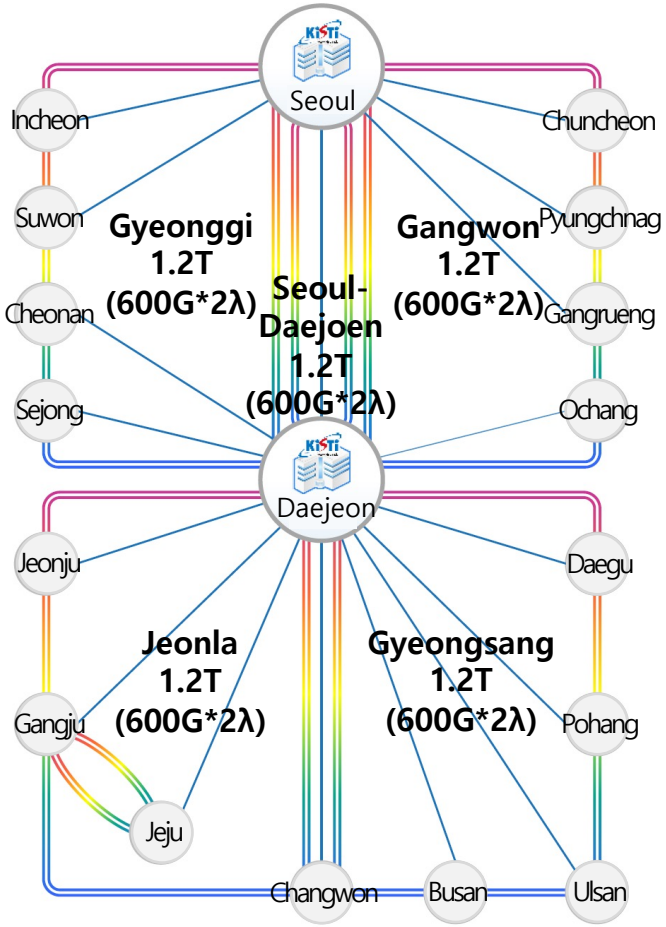
- KREONET (Korea Research Environment Open Network)
- Korea's National Science & Research Network, managed and operated by KISTI since 1988
- GLORIAD-KR, Core Member of GLORIAD project since 2005
- Advanced Research Network in "Utilization and Promotion of National Supercomputing" Act (implemented in 2011 in Korea)
- 100Gbps national-wide backbone with 17 Domestic Regional GigaPoPs and 5 International GigaPoPs
- About 200 connected R&E organizations : National Research Institute and Lab, University, University Hospital, Research Institute of Company, library, Public Sector etc.
- 365*24 NOC (Network Operation Center) Service
- Directly linking domestic internet exchanges (KT, SKB, Sejoing Telecom) and international internet exchanges (GIX/Seoul, Cogent/Seattle, AMS-IX/Amsterdam(to-be), HK-IX(to-be))
- Directly connected to network of public clouds (Google, Amazon, Microsoft)
- L1 Lightpath, L2 VPN, L3 R&E IP service, Science DMZ

## KRLight

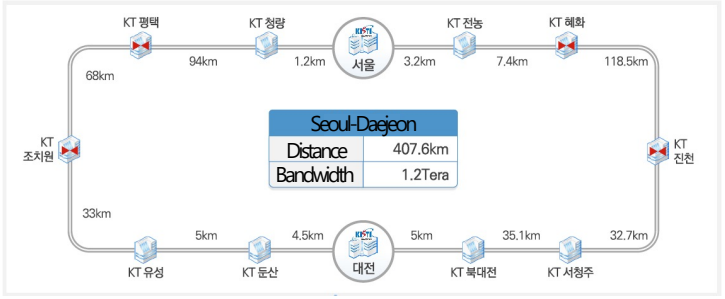
- GLIF Open Lightpath Exchange (GOLE), managed and operated by KISTI
- Transcontinental GOLE (GLIF Open Lightpath Exchange) : Asia – North America - Europe
- Distributed GOLE: Daejeon/KR, Hong Kong/CN, Seattle/US, Chicago/US, Amsterdam/NL
- Integrated with R&E IP network : KREONet2 (AS17579)

# KREONET Optical Transport System

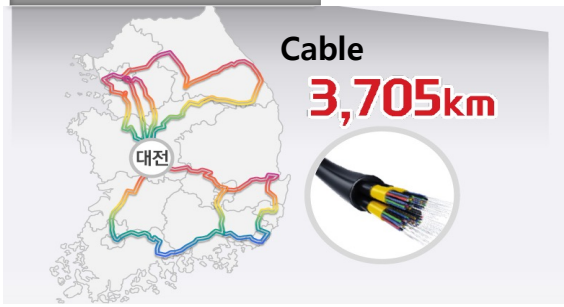
## Topology



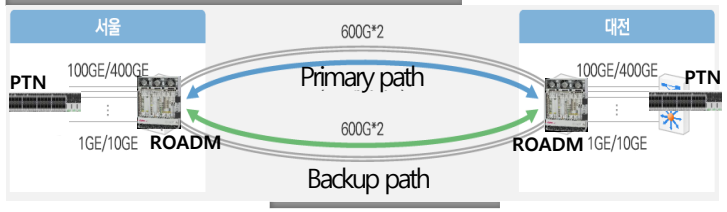

## Physical Path (Seoul-Daejeon Ring)




## Cable Path

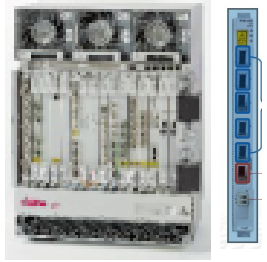



## Logical Path (Seoul-Daejeon Ring)




## Redundant Path(Daejeon)

## Devices

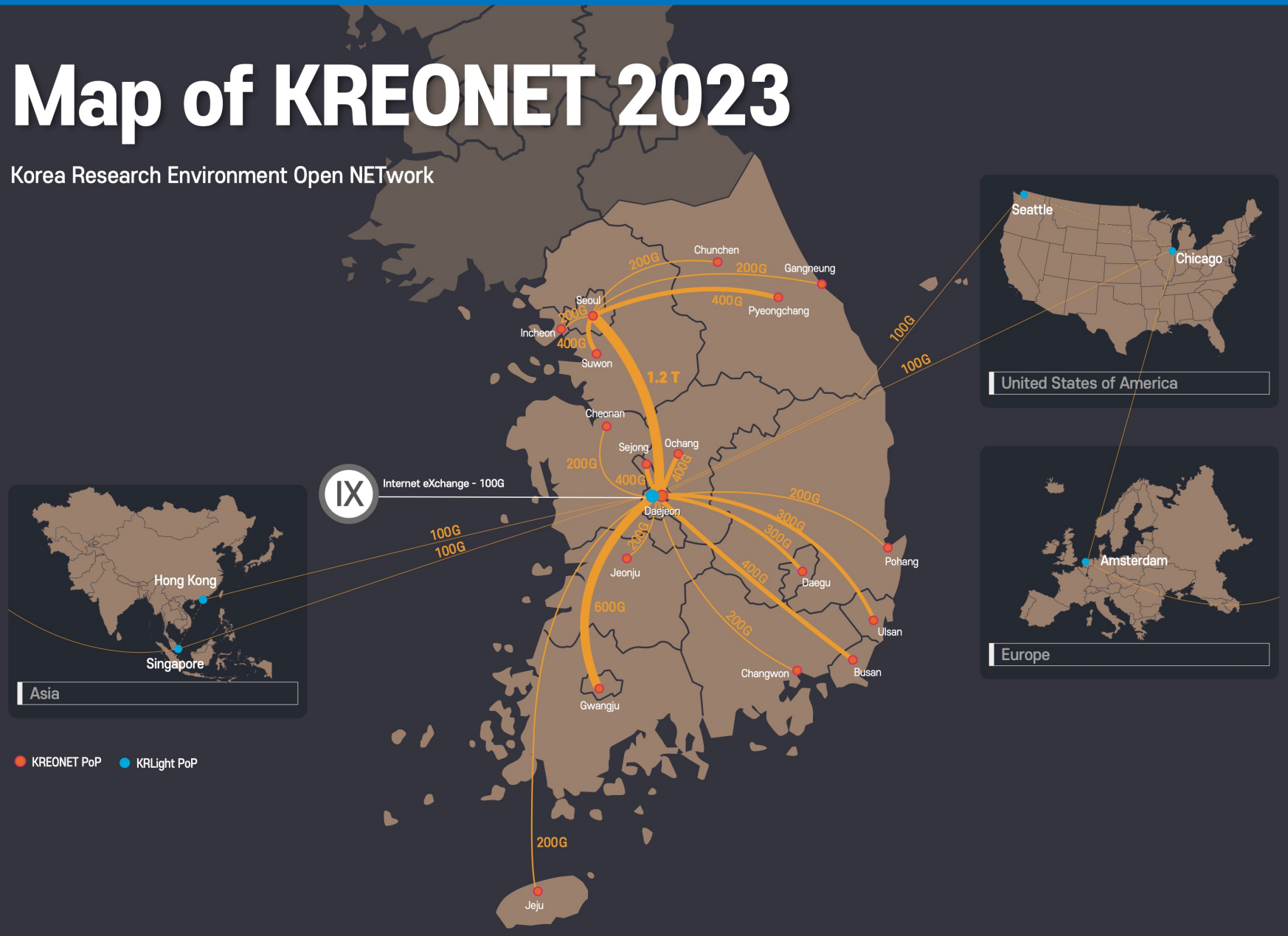
| ROADM(22EA) | Ciena AF6500-14 | PTN(30EA) | Ciena 5164 |
|---|---|---|---|
|  | • POTN/**ROADM**/CE<br>• Wavelength :<br>42ch 800G support<br>• WaveLogic 5e MOTR :<br>- 95Gbaud<br>- 112.5Ghz spacing<br>- NNI(600G)<br>- UNI(400G or 100G) | | • MPLS-TP<br>• Segment Routing<br>• 200GbE(QSFP54)<br>• 100GbE(QSFP28)<br>• 1/10/25GbE(SFP)<br>• (**CE**) E-LINE, E-LAN, E-TREE |

# KREONET, NREN of Korea

KISTI SINCE 1962

## Map of KREONET 2023

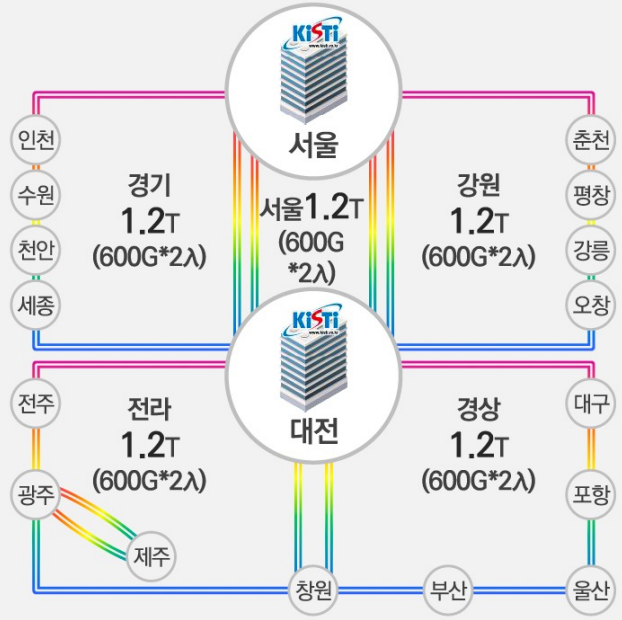
Korea Research Environment Open NETwork



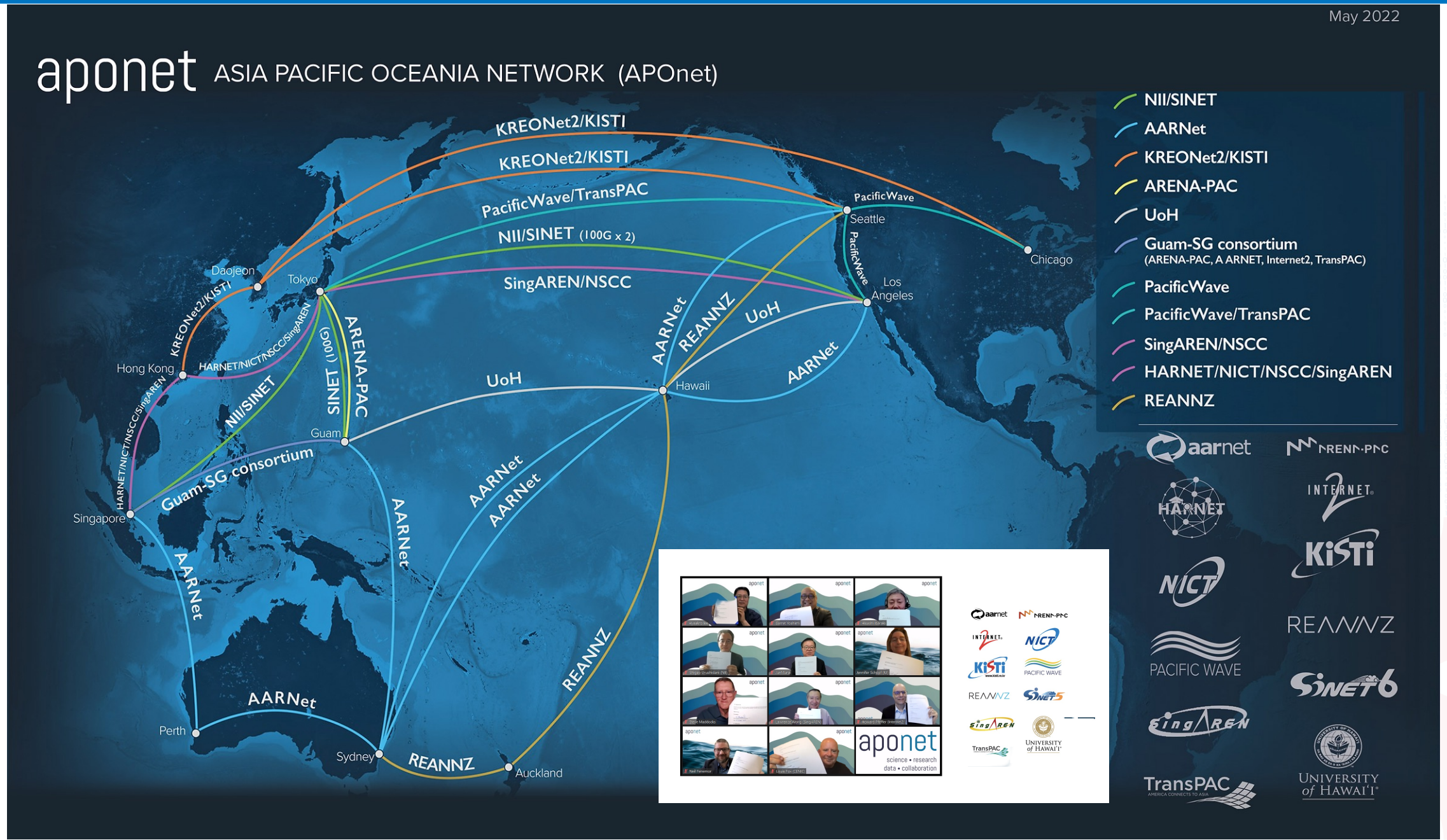

Ciena 6500-14/6154
600Gbps Wavelength
6Tbps Total Capacity
100/400GE L2 Interface

Cisco NCS5504/57C3
SR-MPLS, SR-TE, TI-LFR
L2/L3 VPN

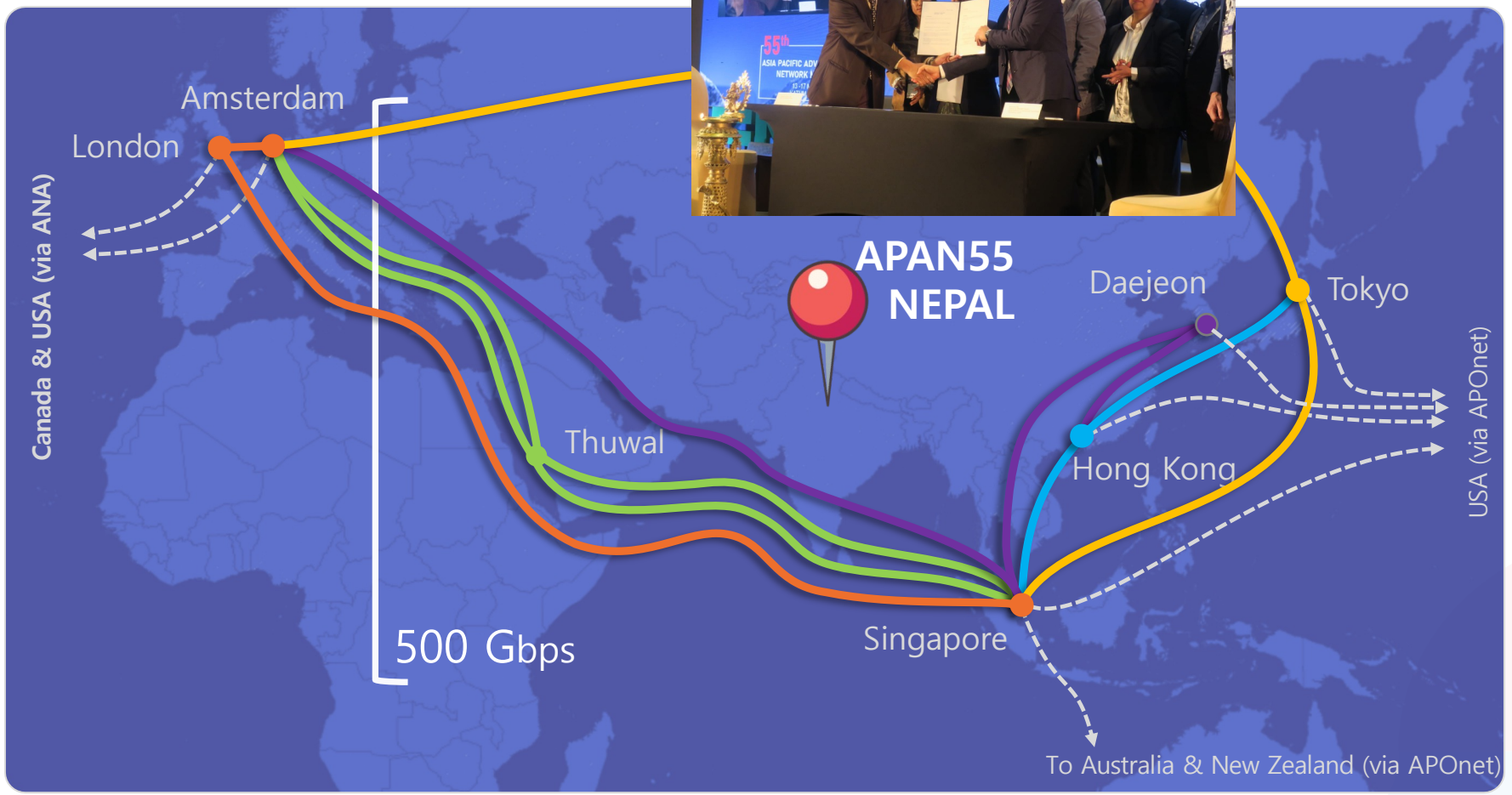
Network Automation with
NSO (Network Service Orchestrator)



# Asia Pacific Oceania Network (APOnet)



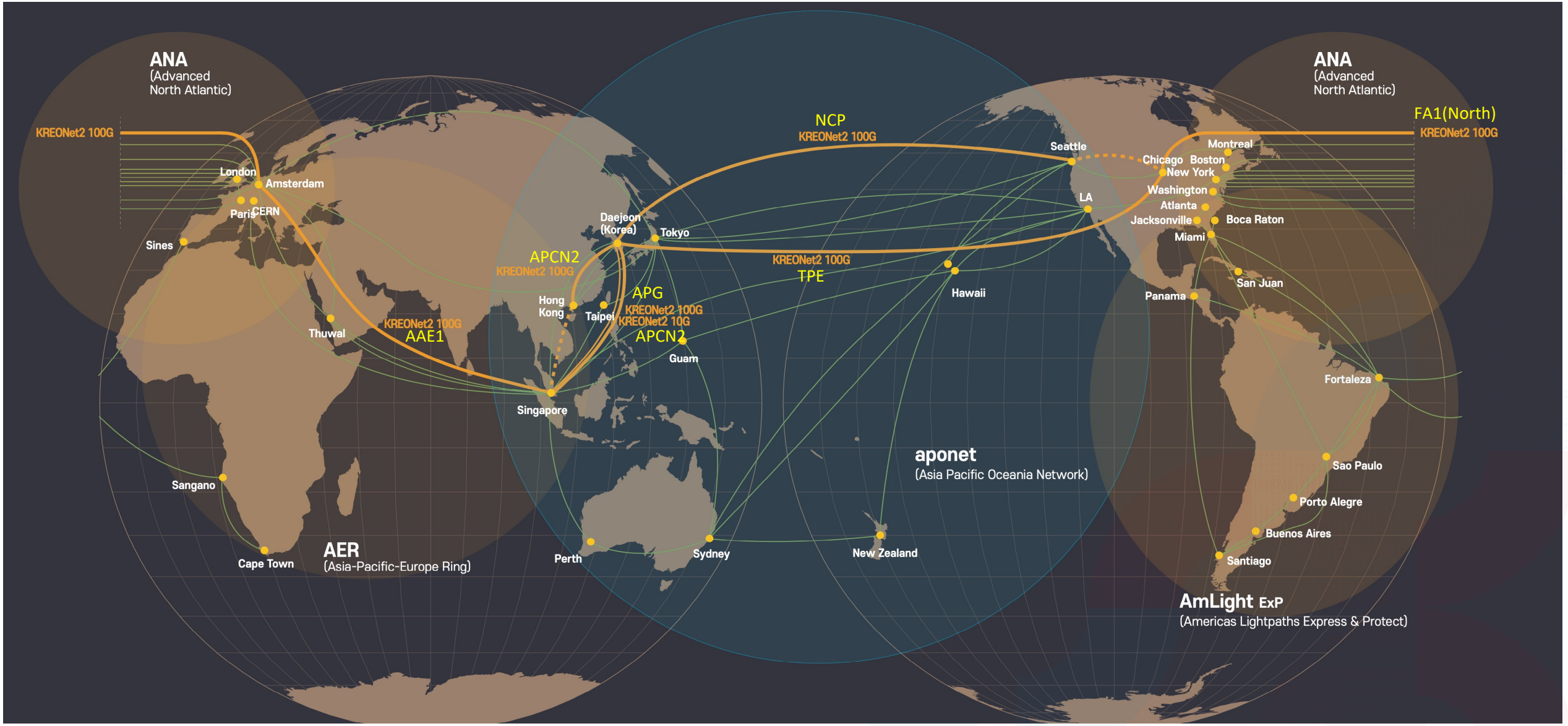
# Asia-Pacific Europe Ring (AER)




HARNET, NICT & SingAREN
NII
GEANT, SURF, NORDUnet, AARnet, SingAREN & TEIN*CC
KAUST
KISTI

AER
ASIA-PACIFIC
EUROPE RING

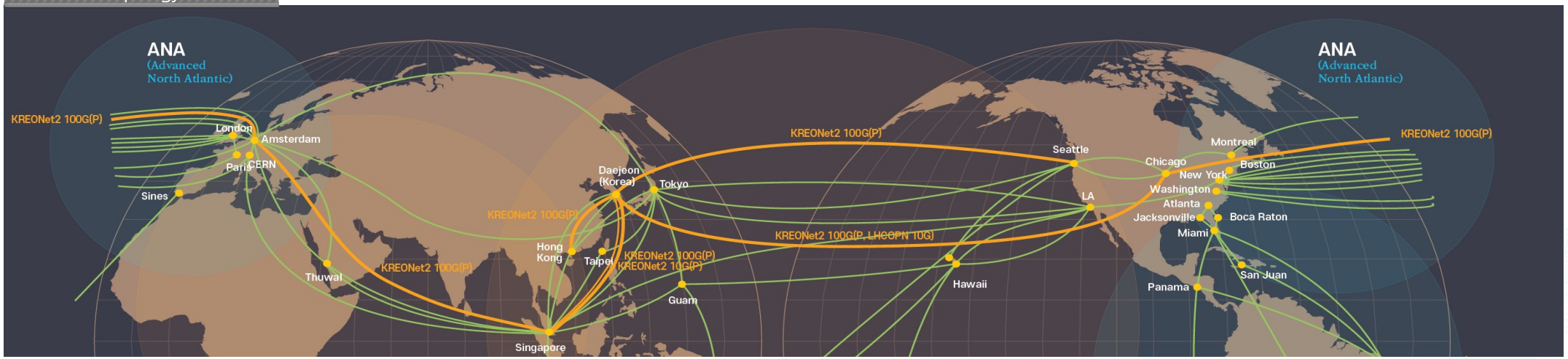
# KREONet2, International




Ciena 6500-14, Cisco NCS5504/57C3

# KREONet2 Optical Footprint

## Topology

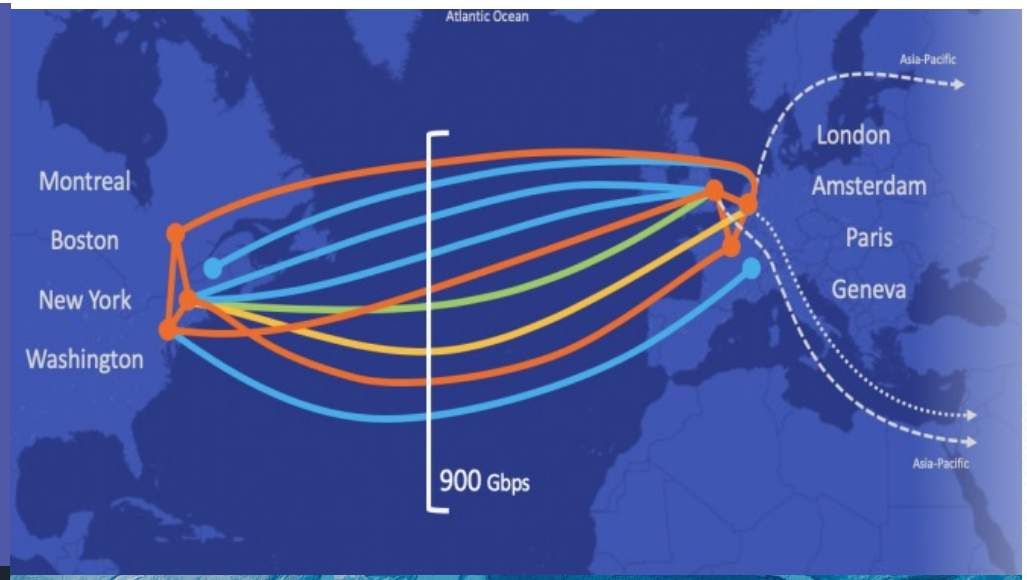


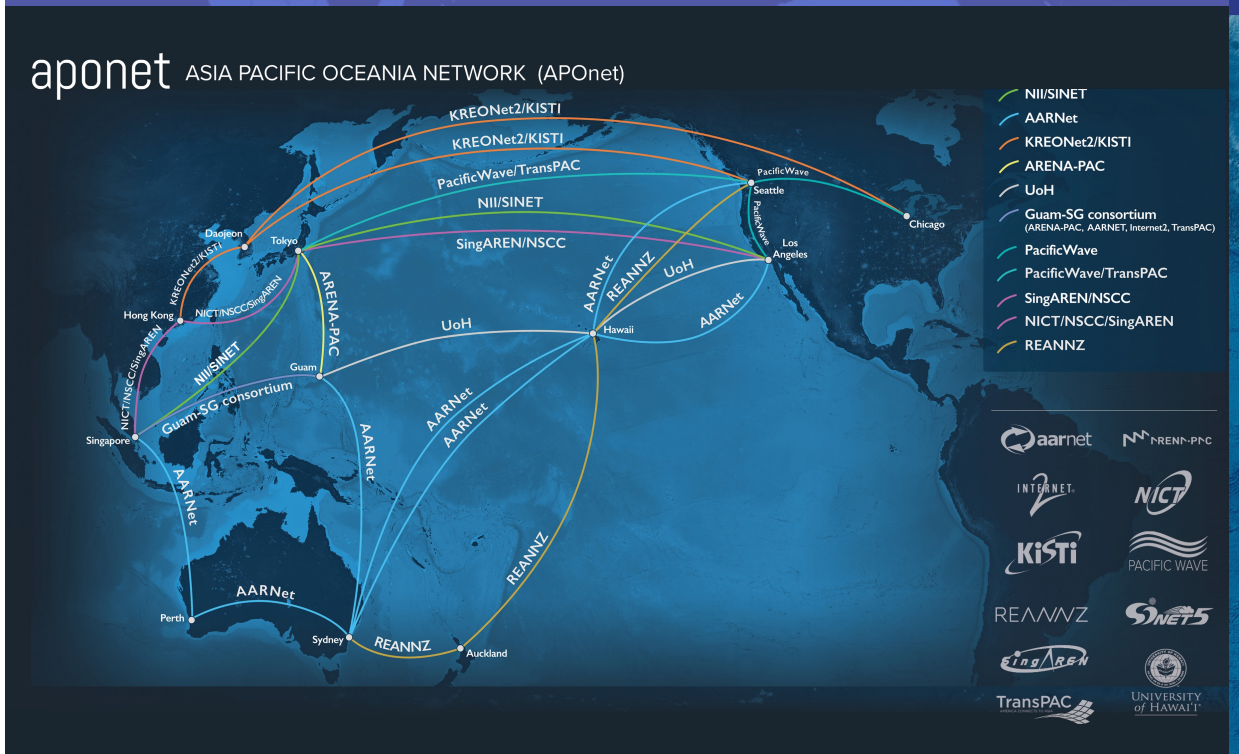

## Cable System

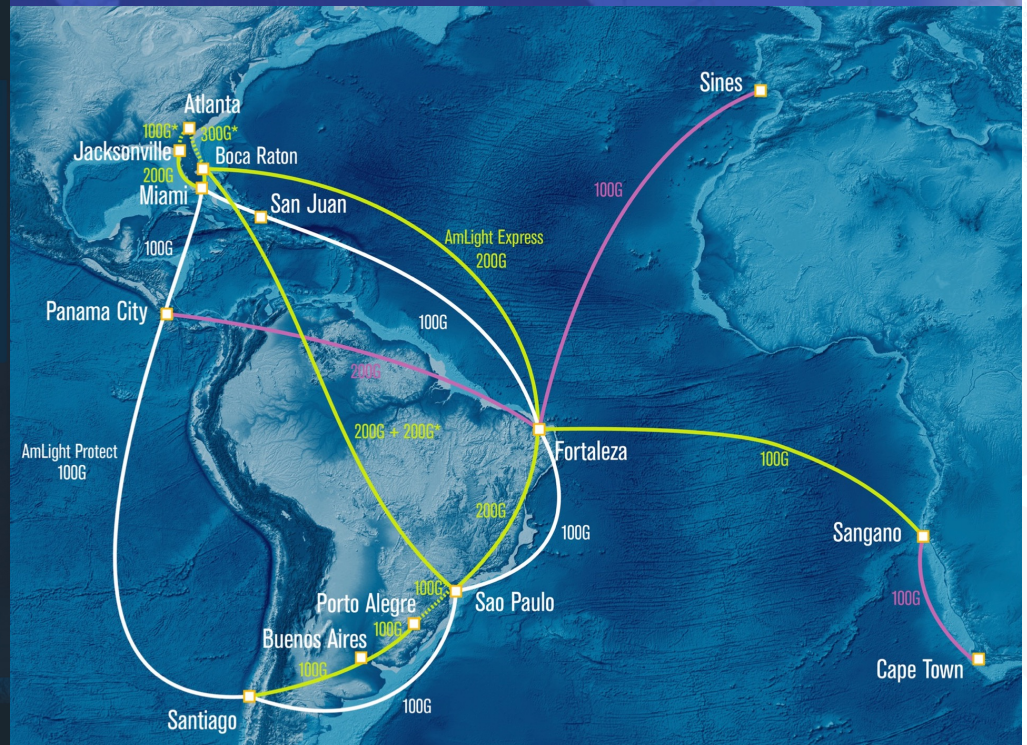
**68,590KM long**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Daejeon-Hong Kong 100G | 4,410 km | Daejeon | (280km) underground | Busan | APCN2 | (4,070km) submarine | TongFuk | (60km) underground | Hong Kong |
| 02 | Daejeon-Singapore 100G | 5,705 km | Daejeon | (280km) underground | | APG | (5,390km) submarine | Changi | (35km) underground | Singapore |
| 03 | Daejeon-Singapore 10G | 10,776 km | Daejeon | (280km) underground | | APCN2 | (10,476km) submarine | Katong | (20km) underground | |
| 04 | Daejeon-Seattle 100G | 10,936 km | Daejeon | (300km) underground | | NCP | (10,413km) underground | ViaWest | (243km) underground | Seattle |
| 05 | Daejeon-Chicago 100G | 14,638 km | Daejeon | (520km) underground | Geoje | TPE | (10,888km) submarine | hillsboro | (3,500km) underground | Chicago |
| 06 | Singapore-Amsterdam 100G | 14,463 km | Singapore | (1,650km) underground | - | AAE1 | (12,500km) submarine | Butterworth | (313km) underground | Amsterdam |
| 07 | Chicago-Amsterdam 100G | 7,652 km | Chicago | ( 1,310km) underground | NorthPort | FA-1(North) | ( 5,300 km) submarine | Skewjack | (1,042km) underground | |

# Global Research and Education Network (GREN), GNA-G Compliant

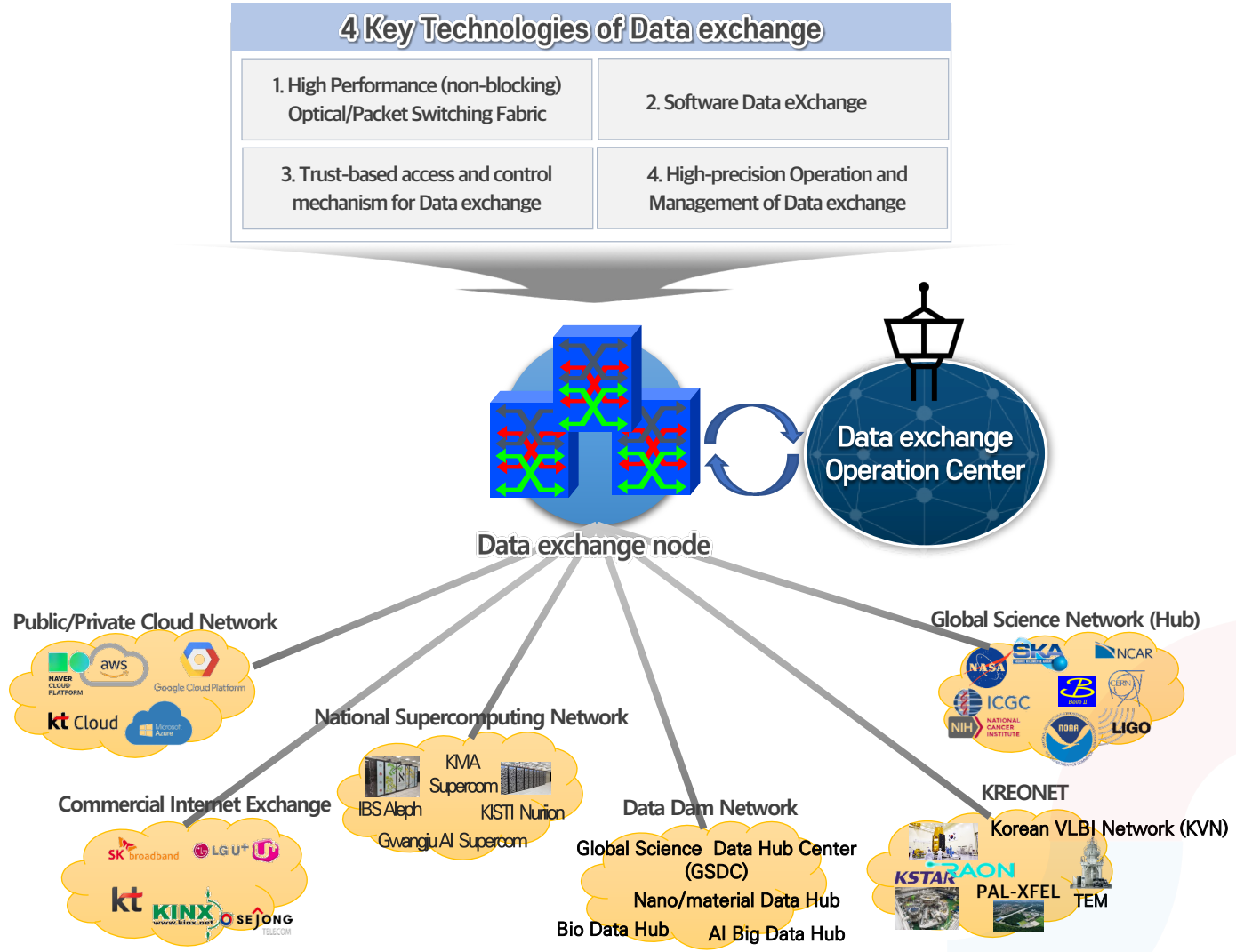


# Korea Data Exchange Initiative

## 5 years funding (about 10M USD) new project (2023~)



# Korea Open EXchange Point (KOEXP) Initiative

- KOEXP as Korea Data Exchange Facility, the first open exchange in Korea
  - Built and operated by KISTI/KREONET
  - **Collocation space** in datacenter facility nearby largest submarine cable landing station (CLS) in Busan city
  - **Convenient Access Point for** Asia Pacific Submarine Cables with reliability
  - DCI interconnection btw KREONET/KREONet2 and KOEXP
  - **Free backhaul connection btw KOEXP and CLS**
- Distributed KOEXP (Busan, Daejeon, and Seoul)
  - Research and Education Network: KREONET/KREONet2, National Supercomputing Network, etc.
  - Public Cloud Network: NHN Cloud, Naver Cloud, …
- Open in June/July, 2023

## Benefits of KOEXP@ Busan

**The first Open Exchange** located in Busan Cable Landing Station ever

**Enough capacity** of Submarine cables from East and West

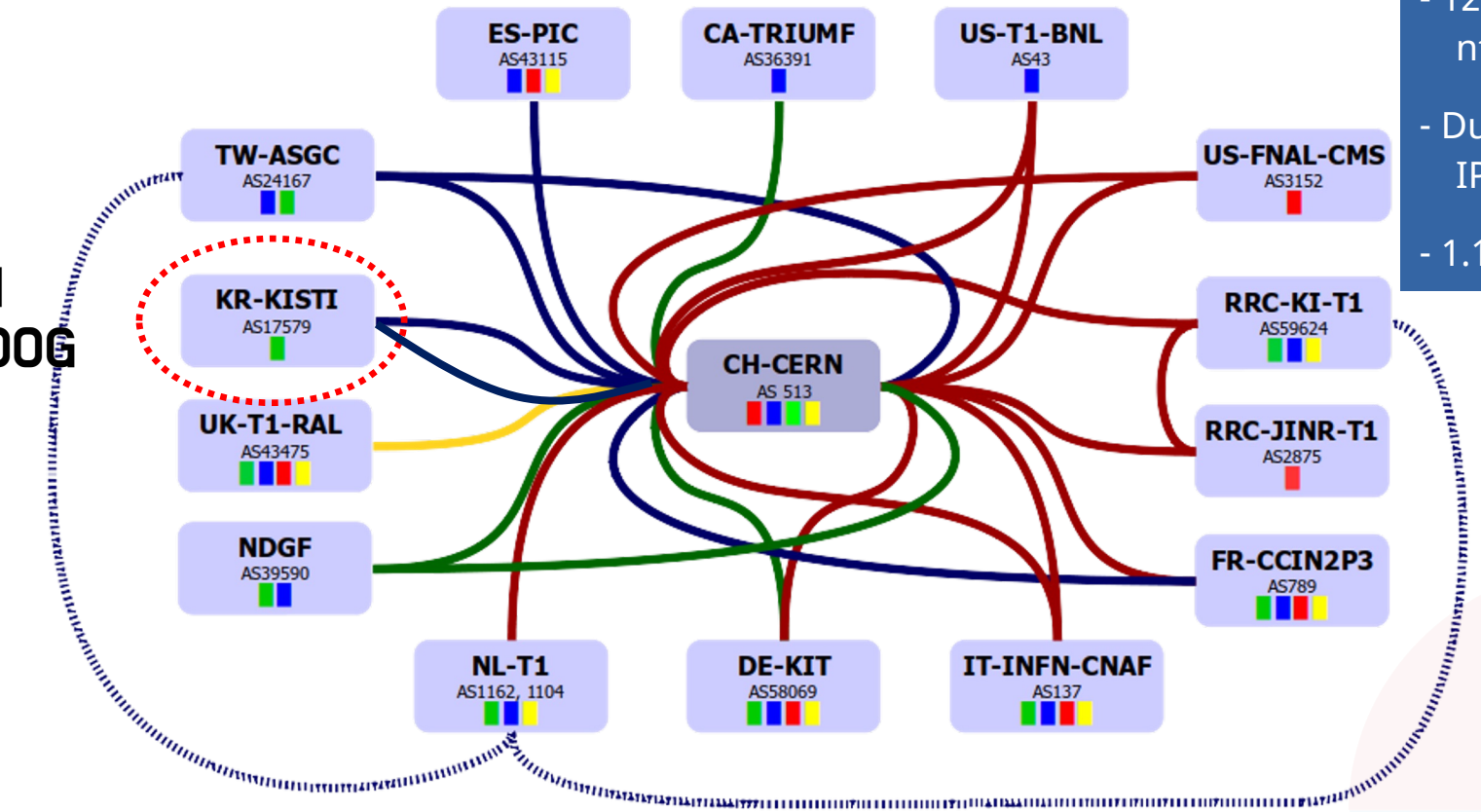
**Simply connect** on submarine cables with cross-connections

**Operated by Experts Group** of Submarine Cable NOC (KT) and KISTI

# LHCOPN LHC Optical Private Network

## Private network connecting Tier0 and Tier1s

**KISTI - CERN : 20G -> 2*100G**



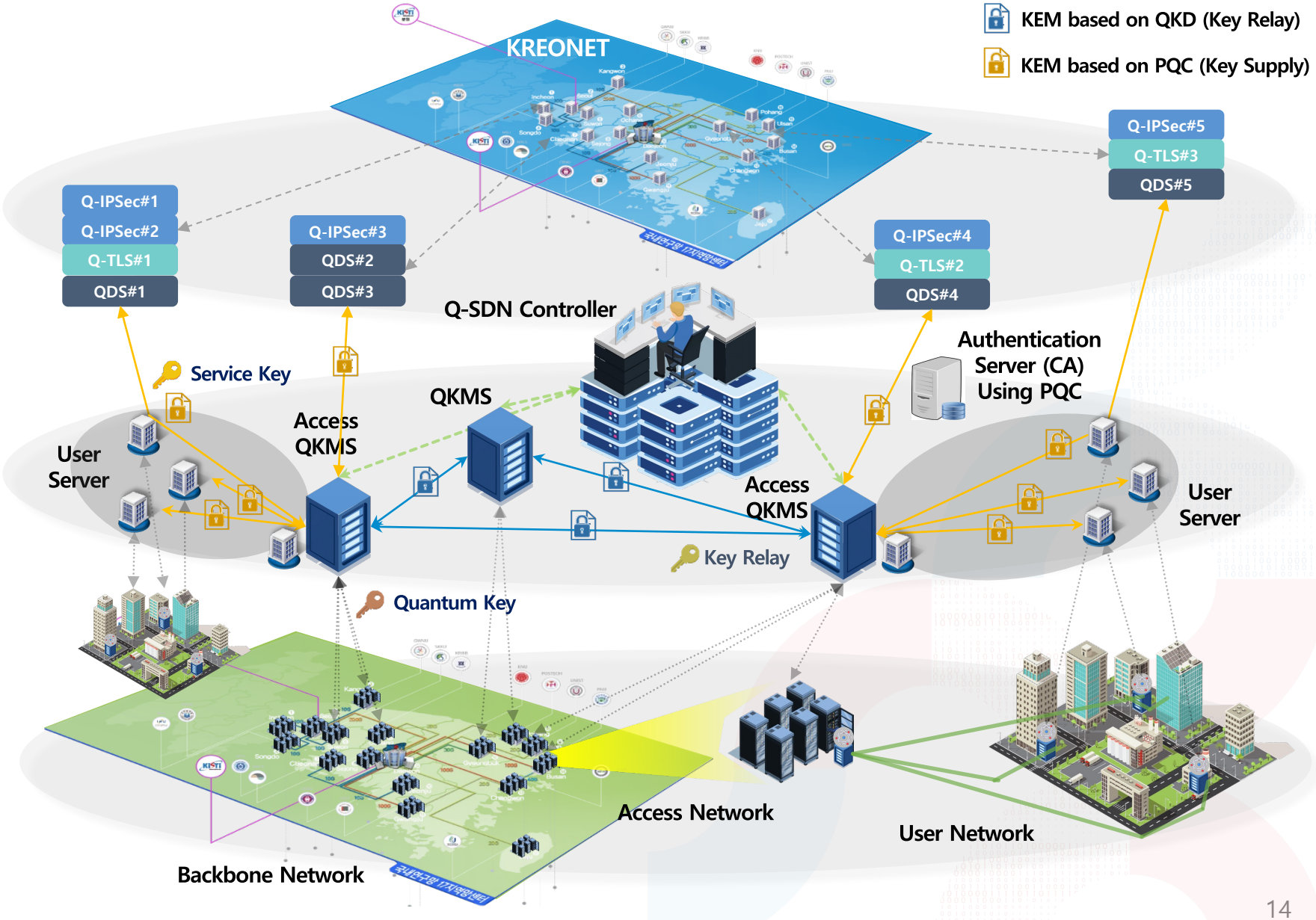

https://twiki.cern.ch/twiki/bin/view/LHCOPN/OverallNetworkMaps

**Numbers**

- 14 Tier1s + 1 Tier0
- 12 countries in 3 continents
- Dual stack IPv4-IPv6
- 1.1Tbps to the Tier0

## ❑ QKD system for KREONET

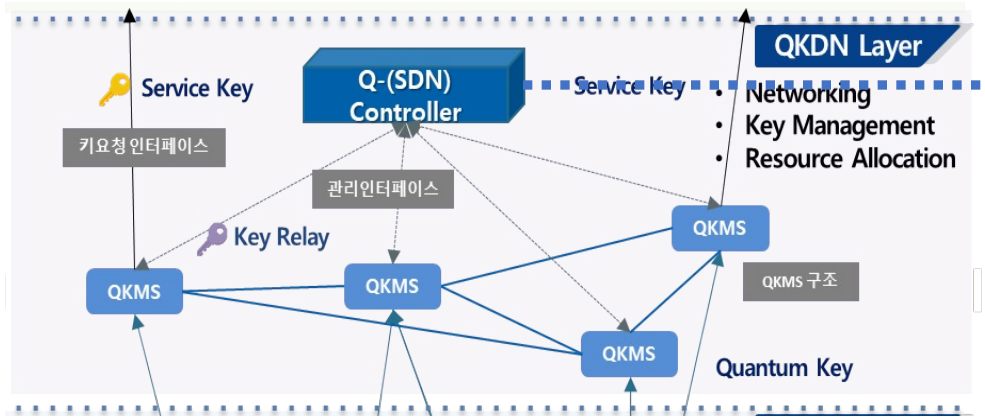
- Enhancing the security of KREONET through preemptive action against quantum computers
- QKD system for backbone network
  - Long-distance QKD system development
- QKD system for access network
  - Multiplexable QKD system with reasonably sized receiving end
- Networkization of QKD system
  - Reduction of cost, complexity, and operational difficulty of QKD system

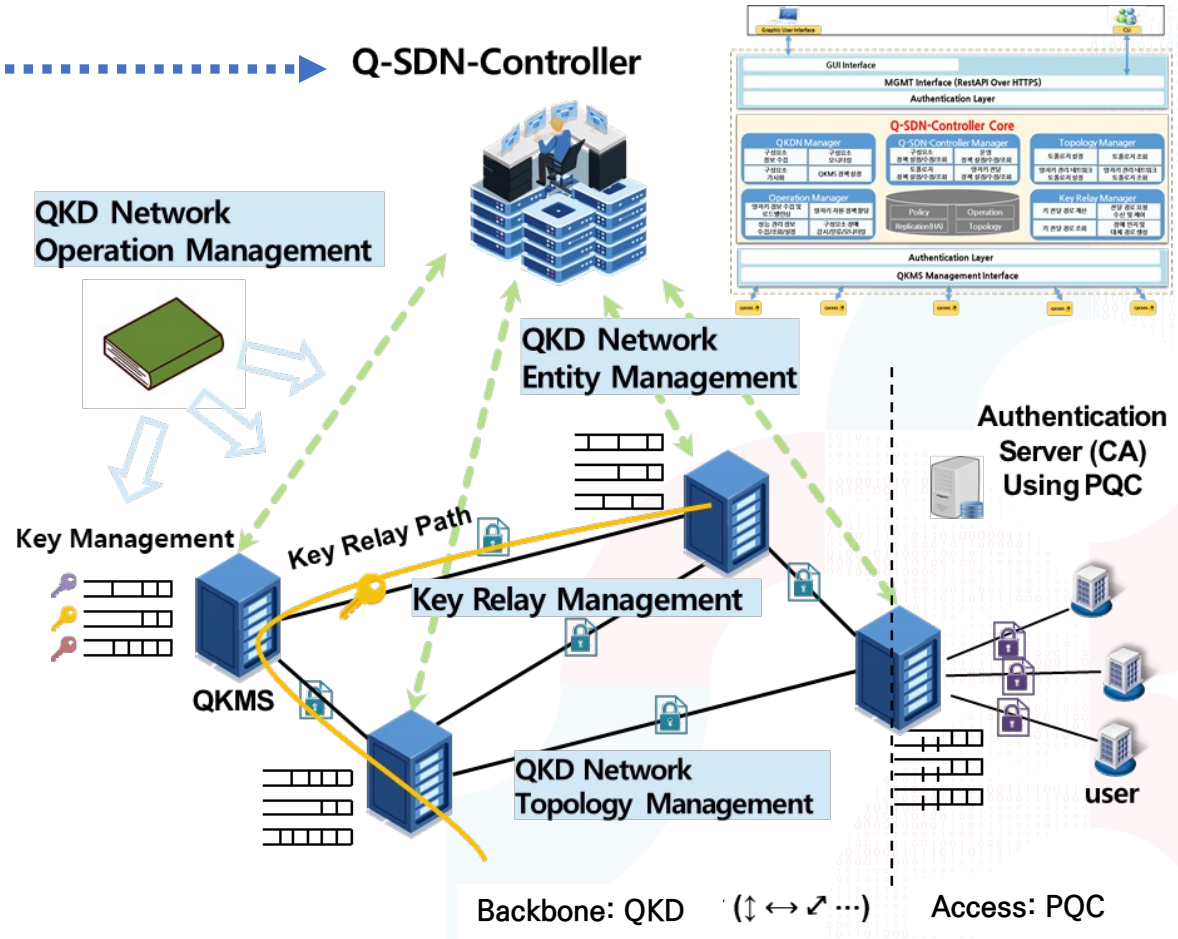


# KREONET QKDN Layer and Q-SDN Controller

## ❑ QKD Management System

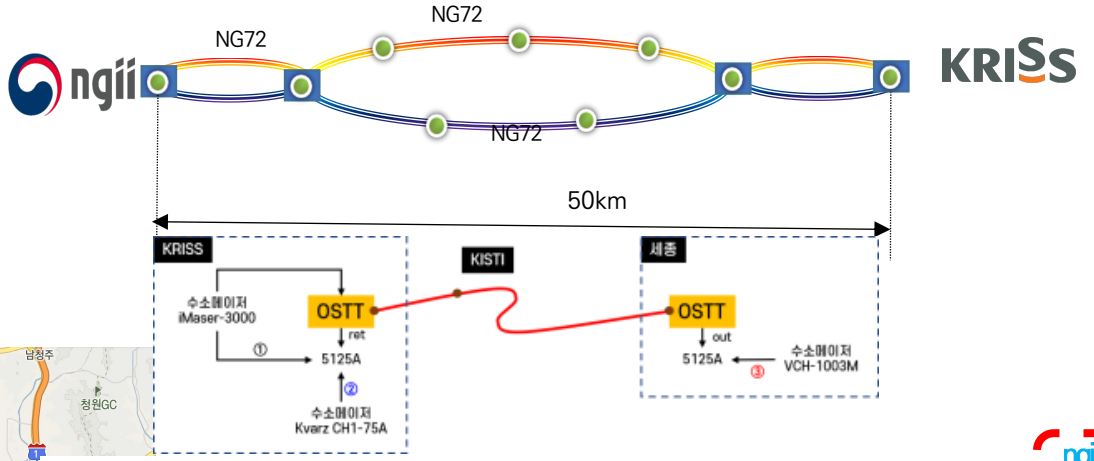
- Highly compatible KREONET QKMS with quantum crypto communication
- KREONET Q-SDN Controller for integrated control of QKDN
- QKDN Operation & Management Protocol
- Single Domain → Multiple Domain → Inter-Domain → Cross Layer → Orchestration & Intelligence

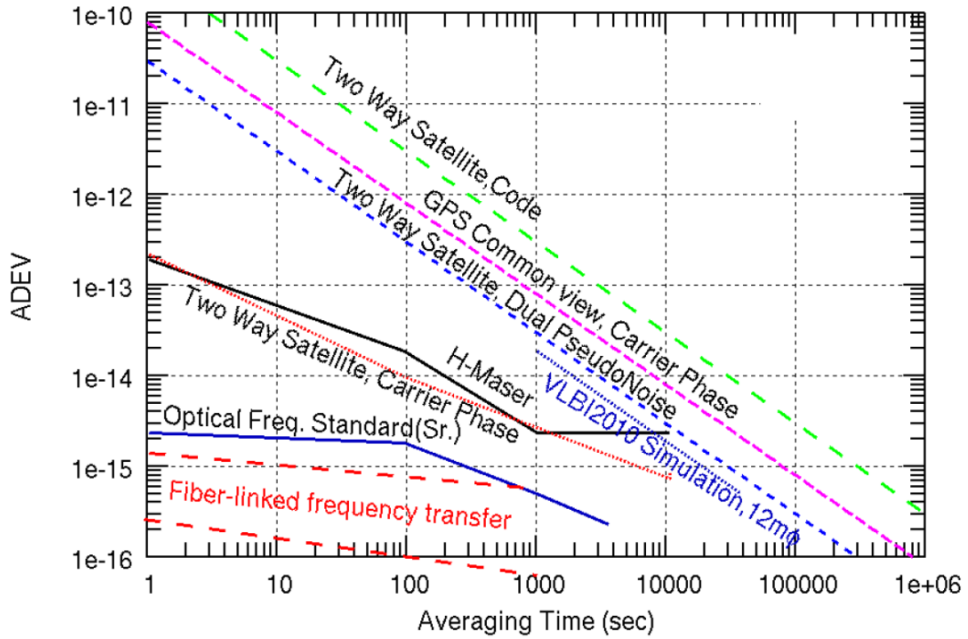


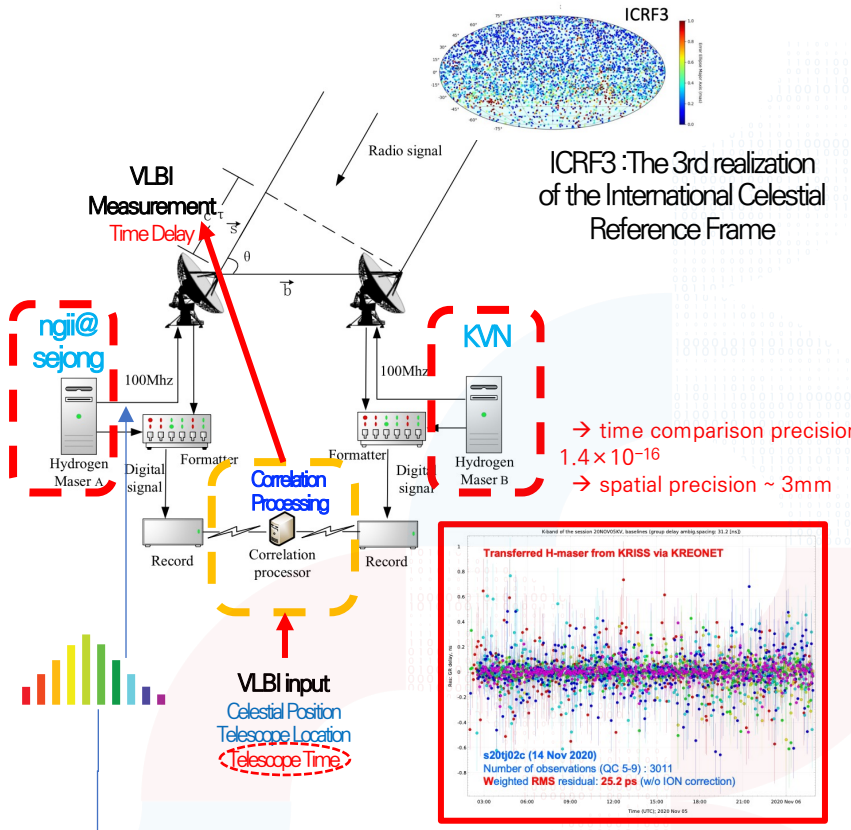



# High-Precision Time Synchronization/Measurement with Broadband-VLBI

VLBI antenna
@ Sejong Space Geodetic Observation Center

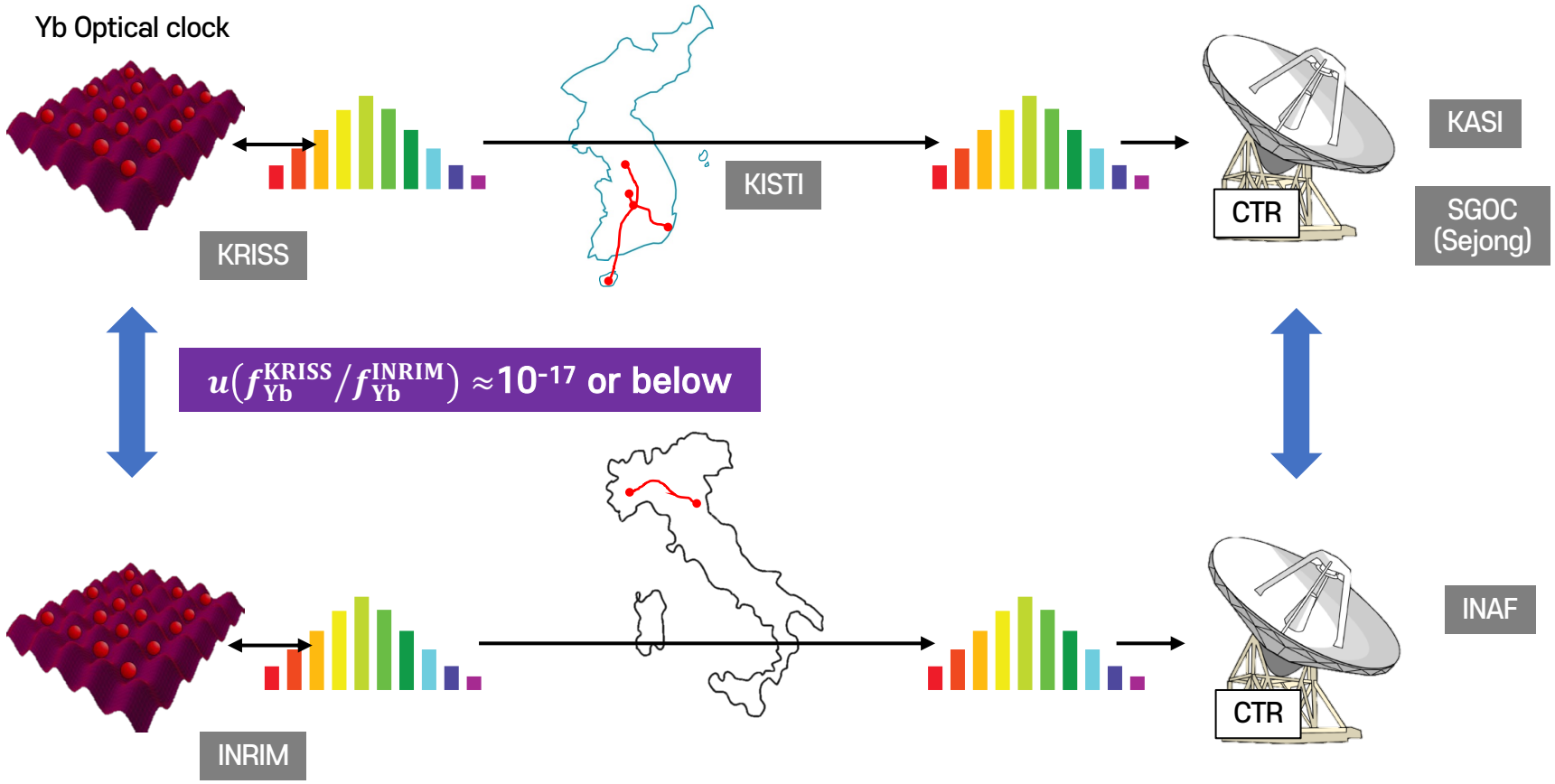


# Inter-continental optical clock comparison using broadband VLBI

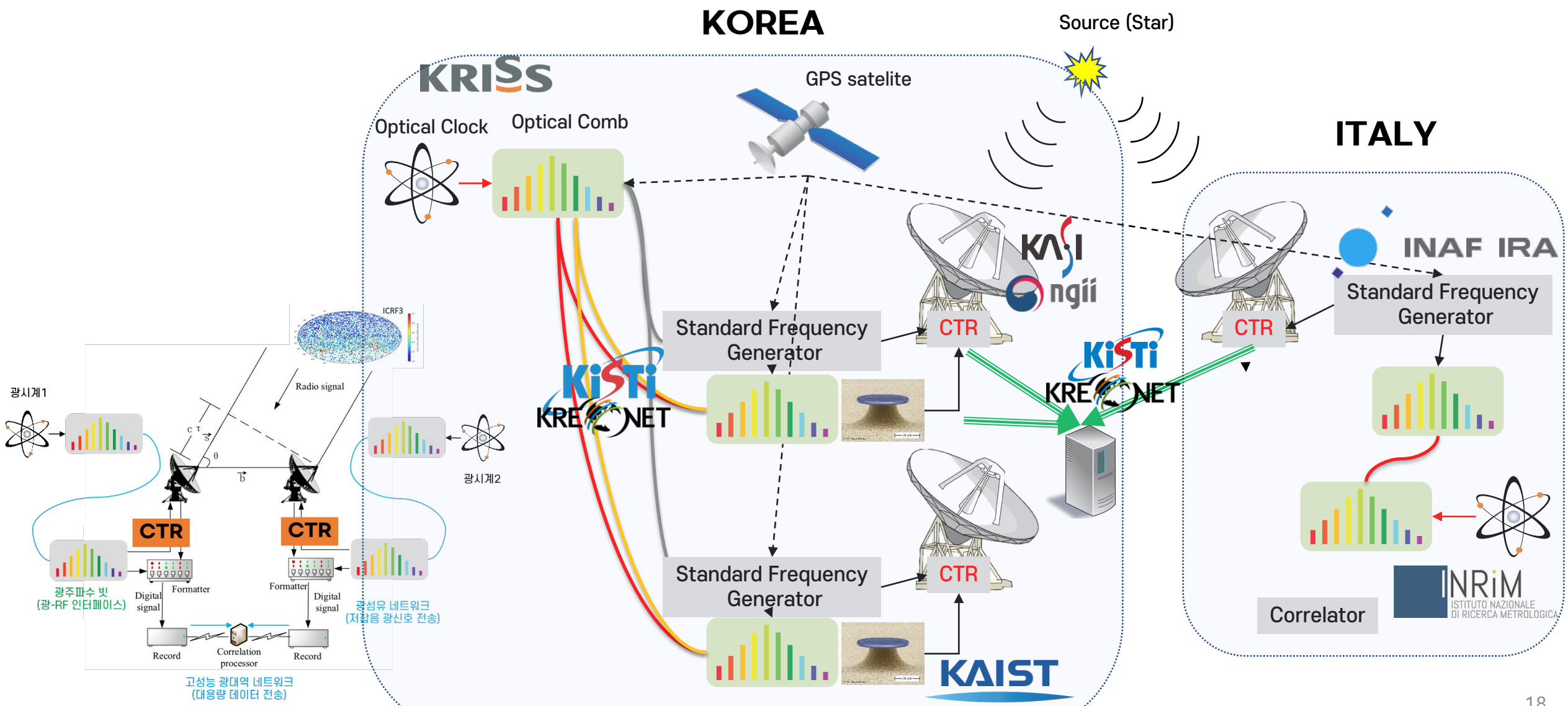
## 5 years funding (about 7M USD) new project (2022~)




| | KOREA | ITALY |
|---|---|---|
| Optical clock | Yb, running | Yb/Sr, running |
| Fiber link | KRISS – KISTI – KVN (except Jeju) | INRIM – Medicina |
| Transferred frequency | RF (OSTT, PikTime) CW laser f-comb @ Sejong or KVN | CW laser f-comb @ Medicina |
| VLBI | 22/43/86 GHz @ Sejong 22/43/86 GHz @ KVN | 22/43/86 GHz @ Medicina |

CTR : Compact Triple-band Receiver (K,Q, W band)

# Inter-continental optical clock comparison using broadband VLBI



# GNA-G (Global Network Advancement Group)

https://www.gna-g.net/

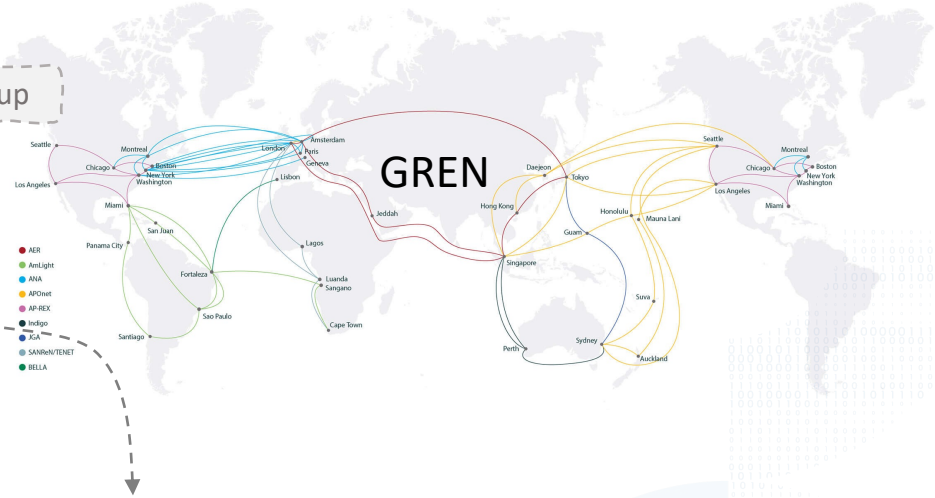
GNA-G participant CEOs etc

Global NREN CEO Forum

Strategic Security Focus Group

GNA-G Executive Liaison

GNA-G Leadership Team




GNA Architecture v2.0

Research & Development

Operational

Proposed WG: subsea cable sensing and smart cables

GREN Map WG

AutoGOLE/SENSE WG

Data Intensive Science WG

GREN Connecting Offshore Students WG

GREN Engineering Advancement WG

GNA-G Routing WG

Network Automation WG

GXP Architectures & Services

GREN: Collaboration on the intercontinental transmission layer

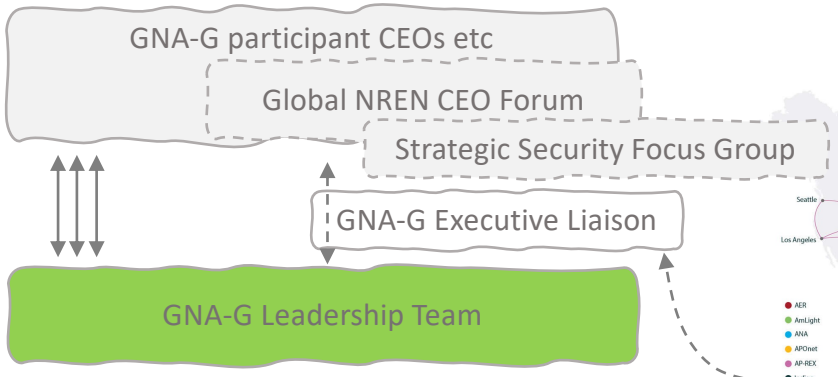
Link consortia

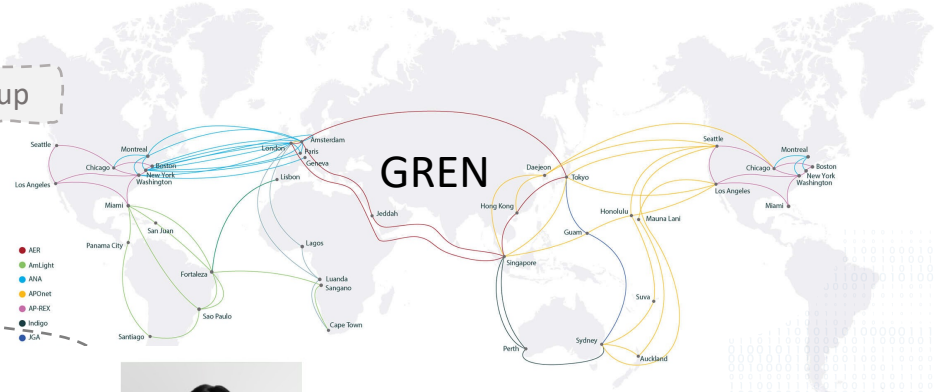
AER APR ANA AmLight ...

# GNA-G (Global Network Advancement Group)

GNA-G
Global Network Advancement Group

https://www.gna-g.net/



**David Wilde, Chair**
AARNet (Australia)

**Harvey Newman**
Caltech (USA)

**Buseung Cho**
KISTI (South Korea)

**Ivana Golub**
PSNC (Croatia/Poland)

**Marco Teixeira**
RedCLARA (Latin America)

**Alex Moura**
KAUST (Saudi Arabia)

GNA-G Leadership Team

GNA Architecture v2.0

GREN Map WG

GREN: Collaboration on the intercontinental transmission layer

Link consortia

AER | APR | ANA | AmLight | ...

S&T Infra,
Changing the world with Data KiSTi

# Thank you

Buseung Cho (bscho@kisti.re.kr)