

Future evolution of network and application Asian region

April 8, 2024

Buseung Cho

Director of KREONET

KISTI

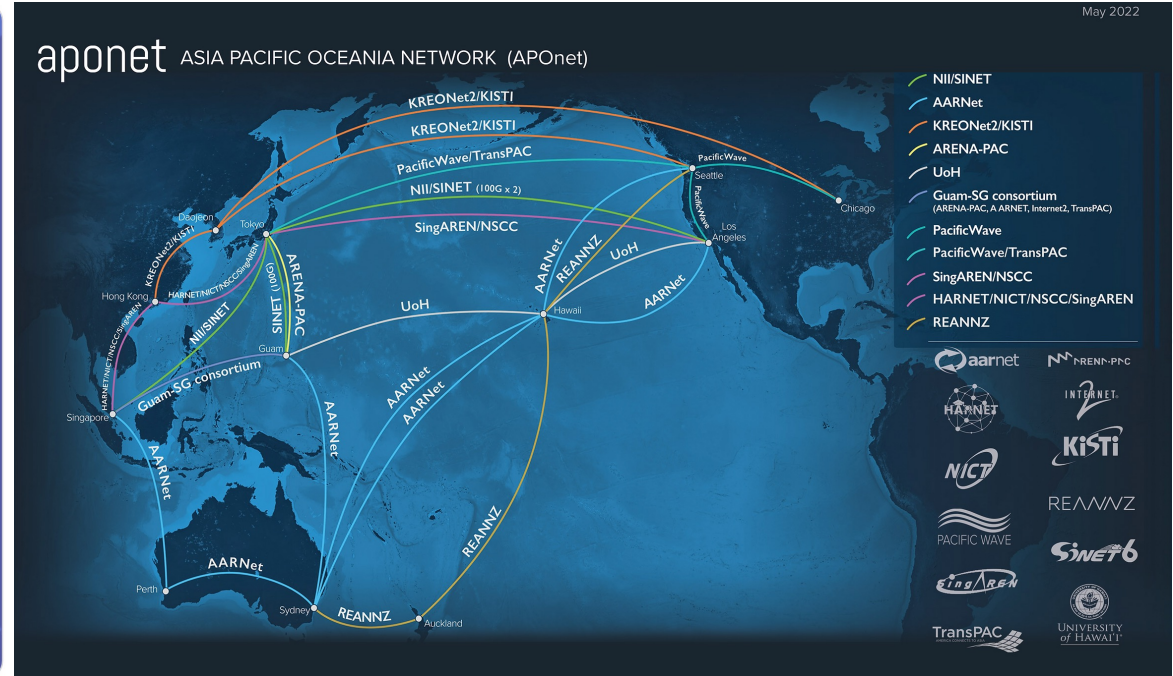
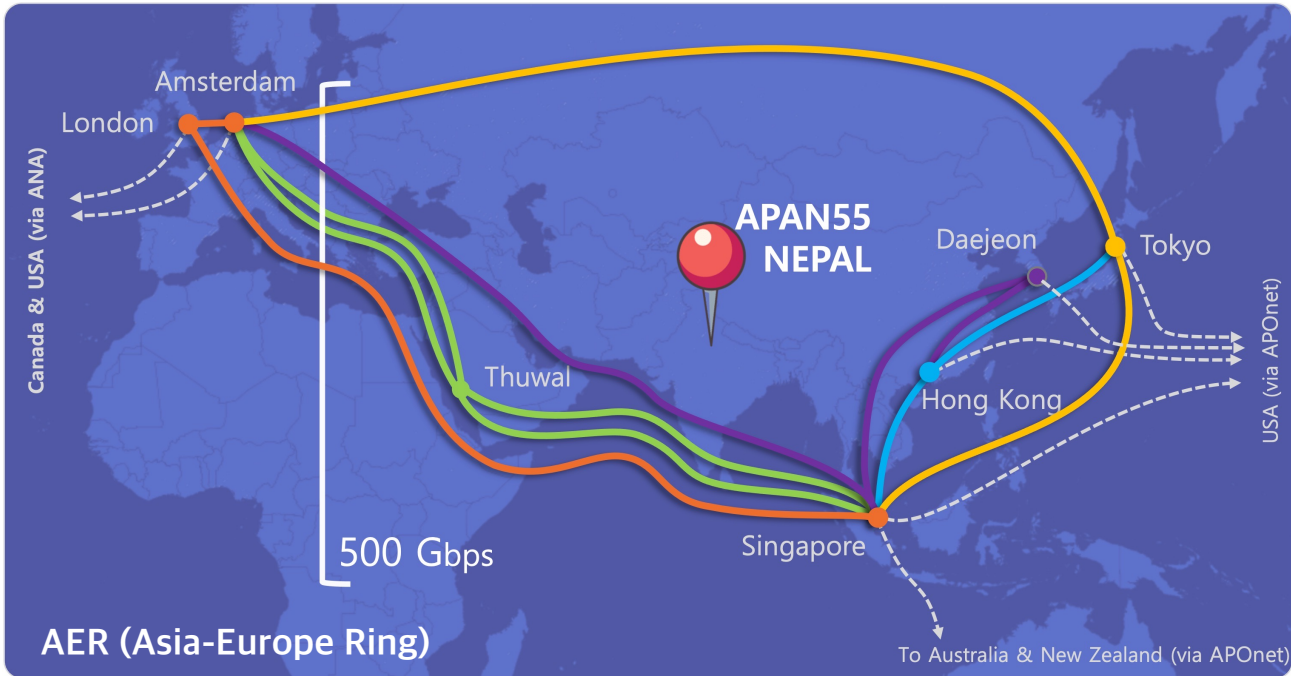


S&T Infra,

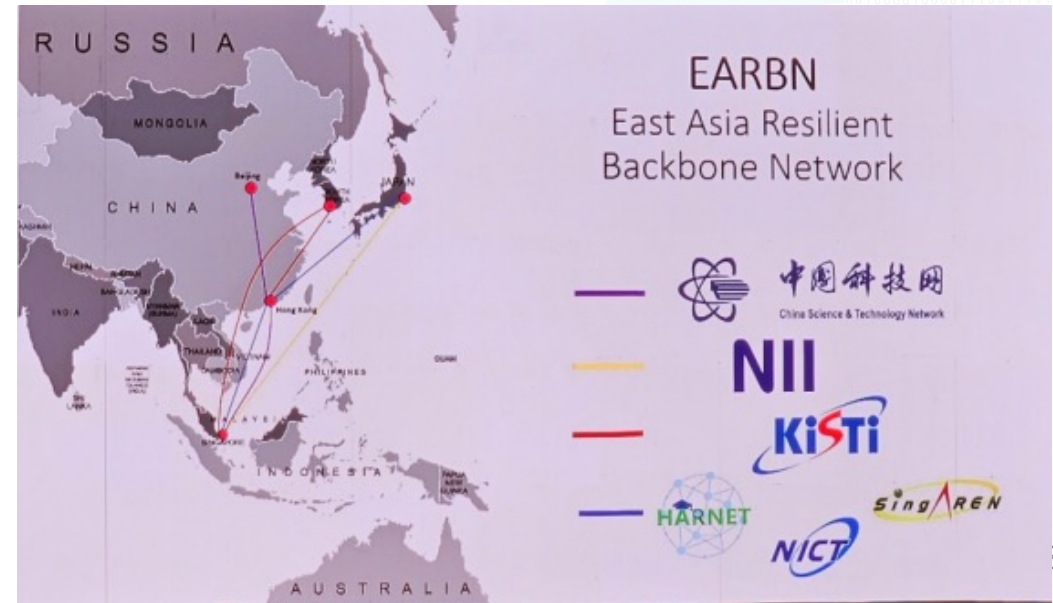
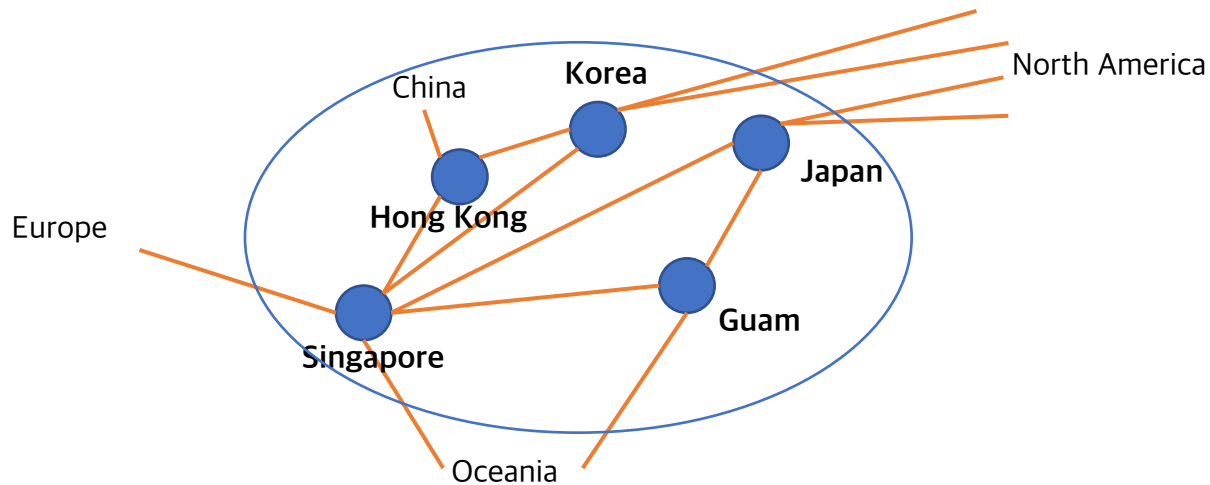
Changing the world with Data **KiSTi**

KREONET

- **Research Networks in Asia**
- **NREN Open Exchange**
 - NDeX, Korea
- **Big Science Facilities and Applications**
- **Key Science, Korea and New Technologies**
- **Summary**



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

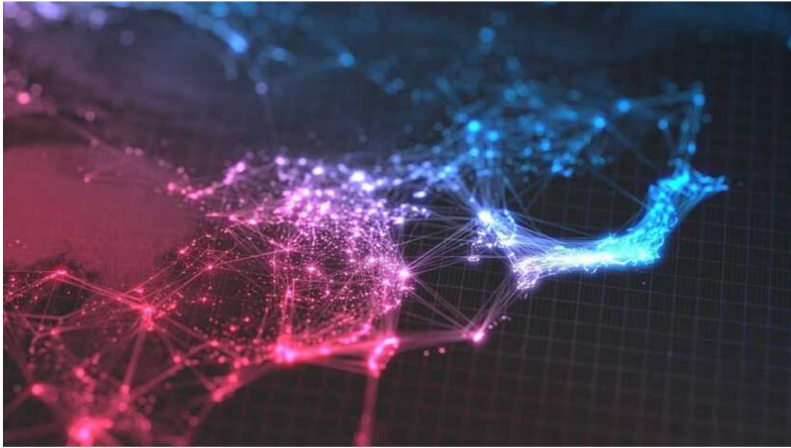


New Asia's Submarine Cable Project

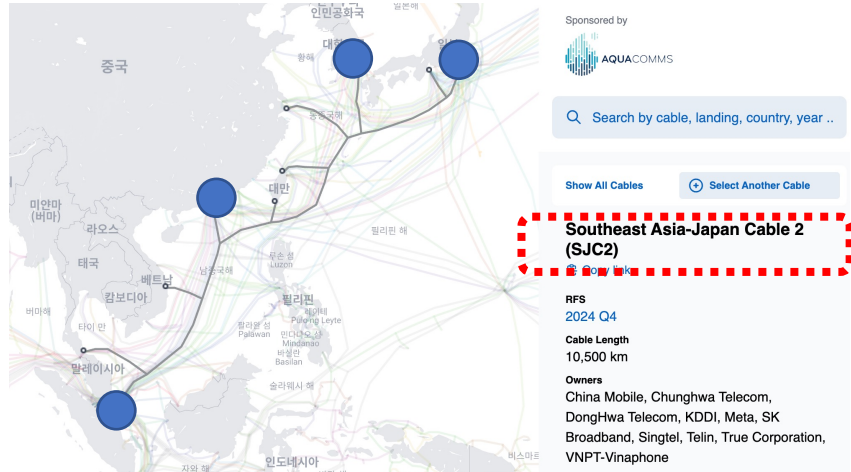
capacity

12 of Asia's most important submarine cable projects

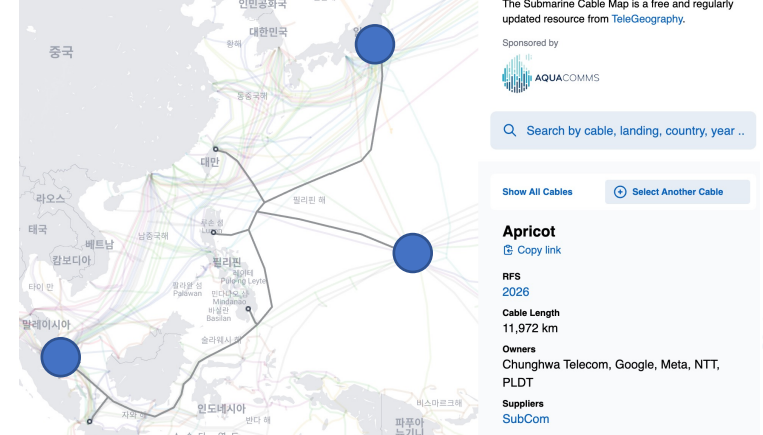
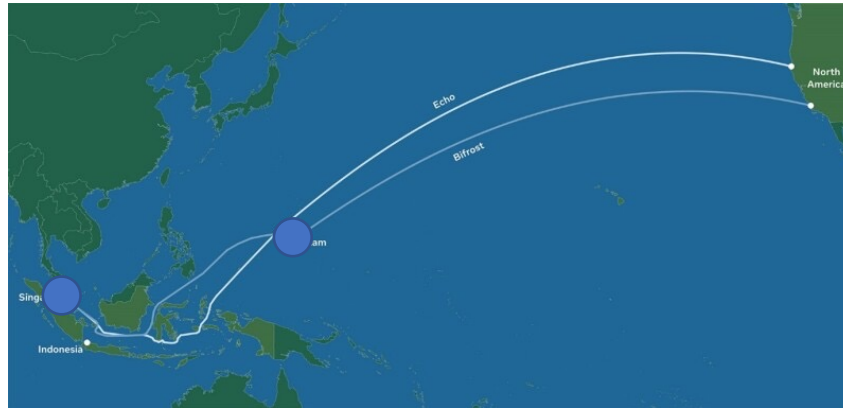
Bill Yates August 29, 2023 11:41 AM



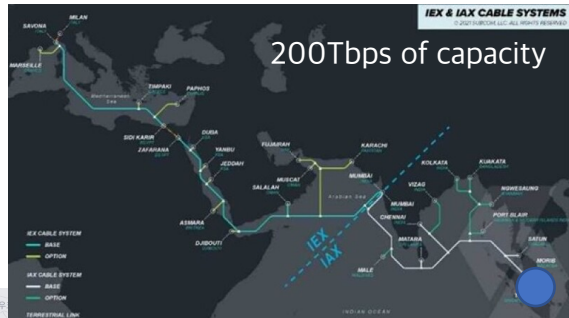
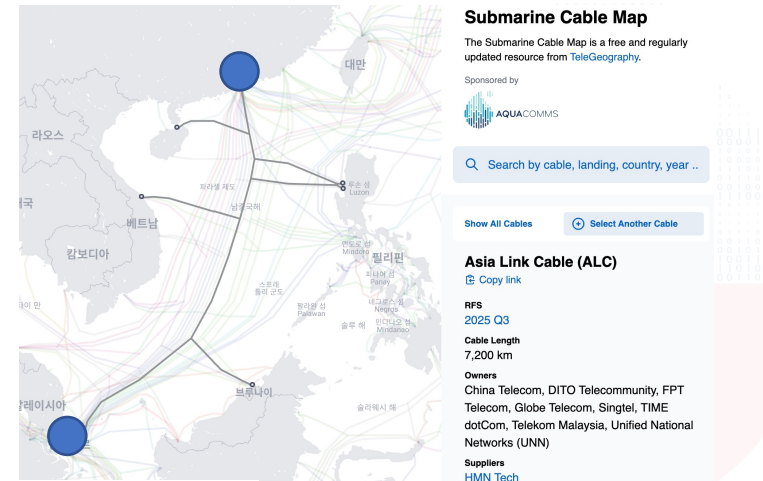
Massive growth in connectivity demand in Asia has led to increased capacity requirements, and construction of submarine and subsea cables is growing to meet this demand. An estimated \$2.6 billion worth of current and future submarine cable projects are planned for completion by 2025 – here are profiles of 12 of the most important.



8 fibre pairs offering a total capacity of 144Tbps



190Tbps link between Singapore and Japan via Indonesia, the Philippines, Taiwan and Guam



Show All Cables [Select Another Cable](#)

SeaMeWe-6

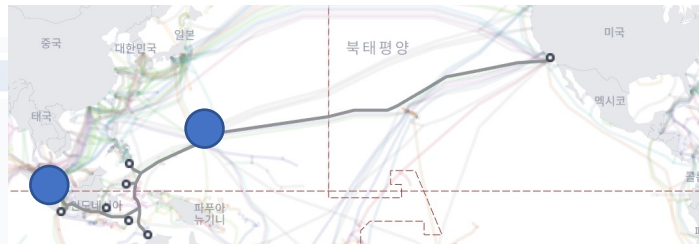
[Copy link](#)

RFS 2025

Cable Length 21,700 km

Owners

Bahrain Telecommunications Company



256Tbps through 16 fibre pairs

Show All Cables

[Select Another Cable](#)

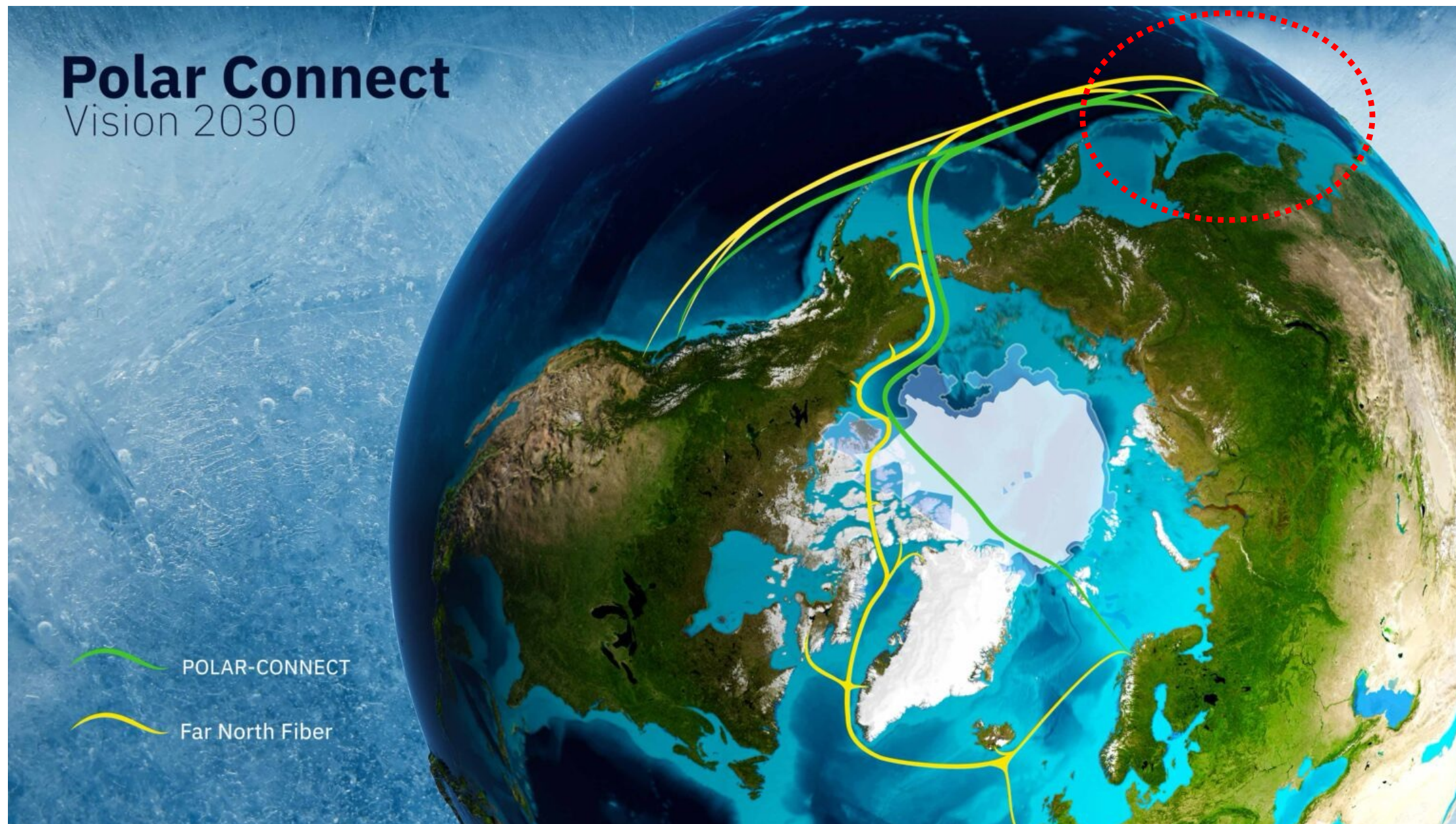
Asia Connect Cable-1 (ACC-1)

[Copy link](#)

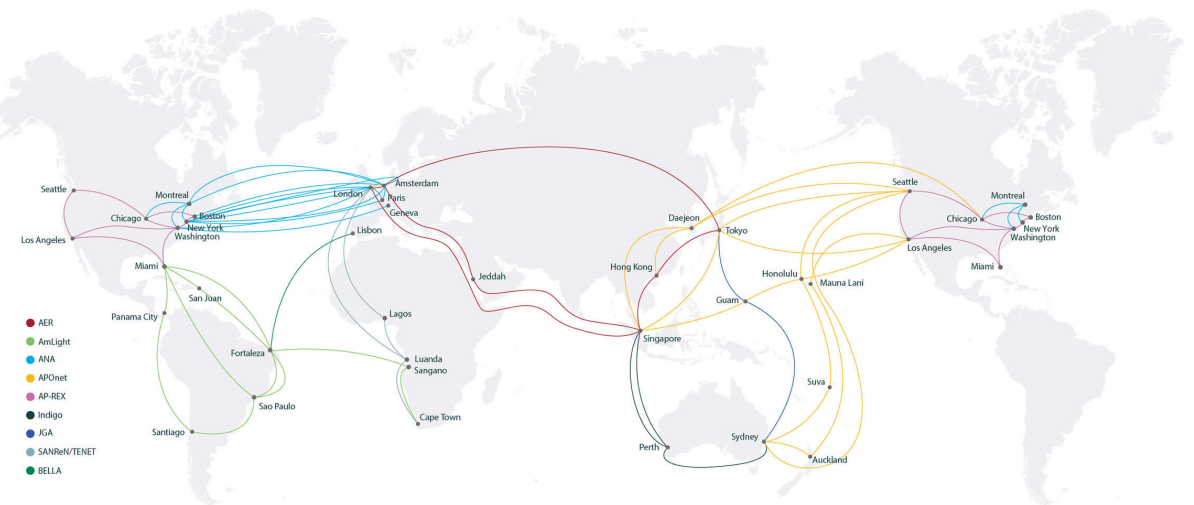
RFS 2027

Cable Length 19,000 km

Polar Connect Vision 2030



- The importance of **open exchange** is increasingly highlighted in Asia.
 - **Hub of submarine cables**
 - Easily access local and global cloud provider
 - Colo, co-located with other big networks
 - **Geographical stability** from natural disasters such as earthquakes and tsunamis
 - **Lower cost to maintain the facilities**
 - Transparent exchange on L1~L3
 - On-site technical support
 - Scalability of space and other resources



GREX: A unified, collaborative, global advanced network infrastructure uniquely supporting the needs of research and education.

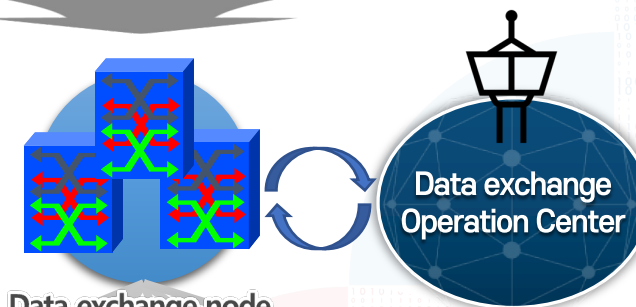
National Data eXchange (NDeX) Initiative, Korea



The first NREN Open eXchange in Korea, co-located with cloud datacenter (KT/KT Cloud) nearby the largest submarine cable landing station (CLS) in Busan city

4 Key Technologies of Data exchange

1. High Performance (non-blocking) Optical/Packet Switching Fabric	2. Software Data eXchange (SDX)
3. Trust-based access and control mechanism for Data exchange	4. High-precision Operation and Management of Data exchange



Public/Private Cloud Network



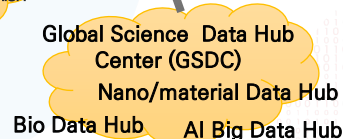
National Supercomputing Network



Commercial Internet Exchange



Data Dam Network



Global Science Network (Hub)





KREONET





National Data eXchange (NDeX) Initiative, Korea

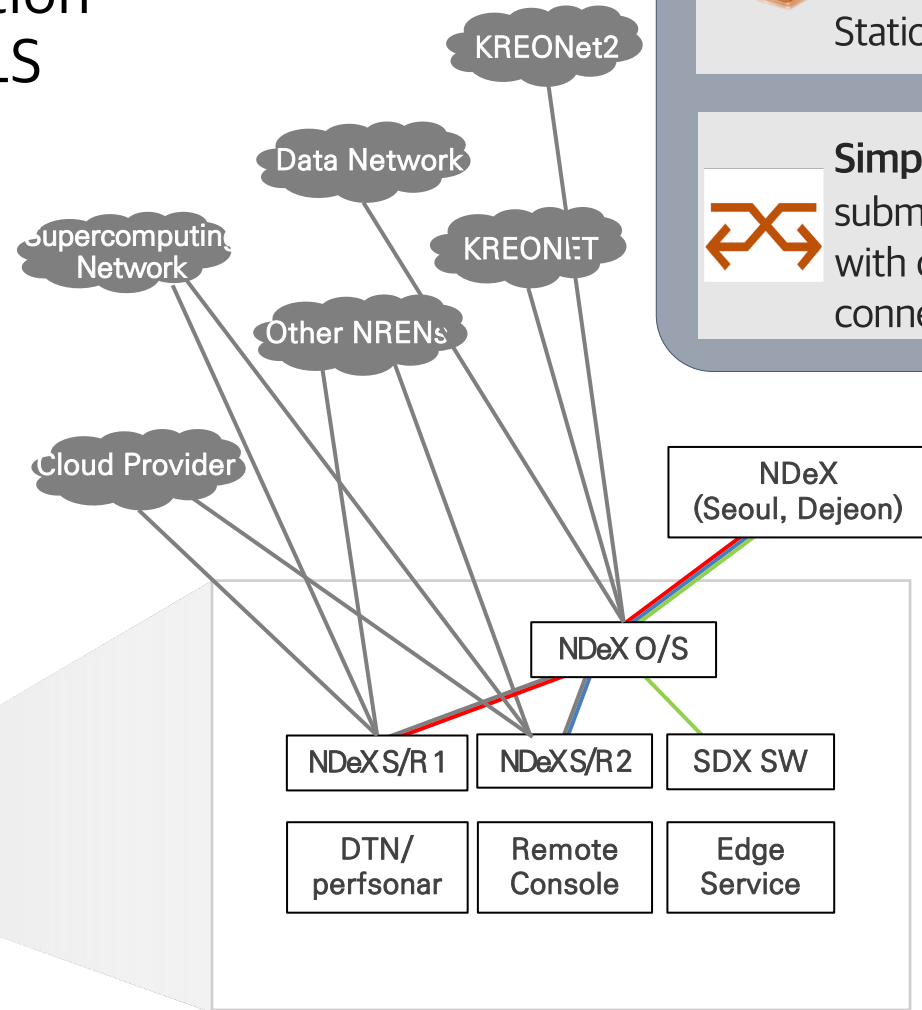
- Opened in July, 2023
- Free backhaul connection between NDeX and CLS

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

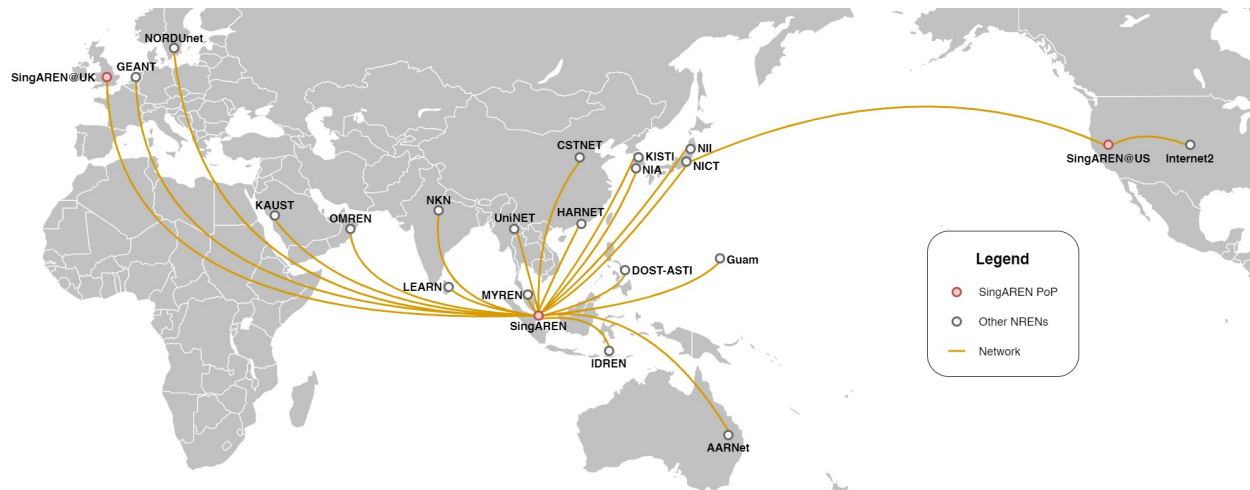
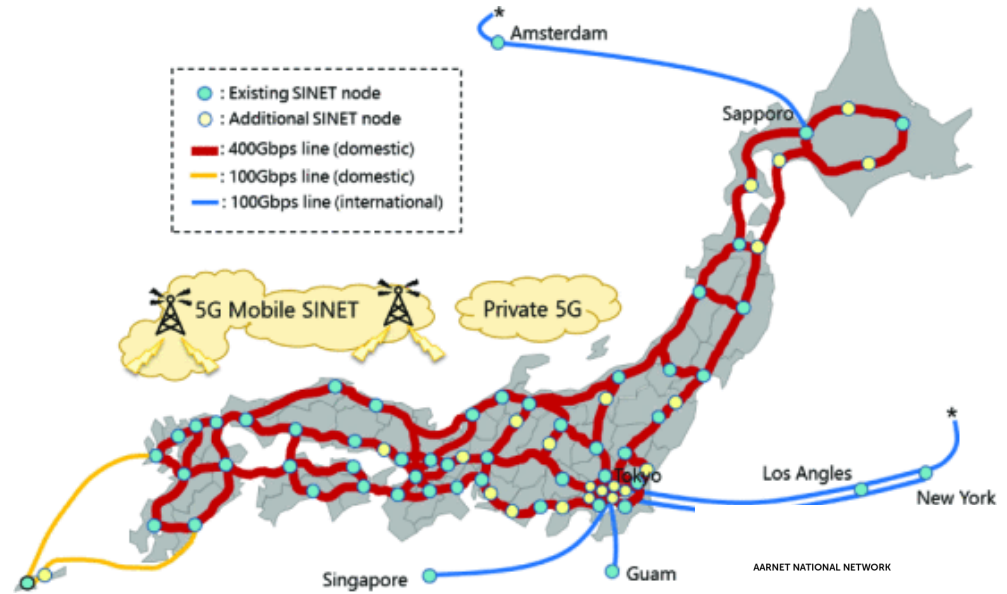
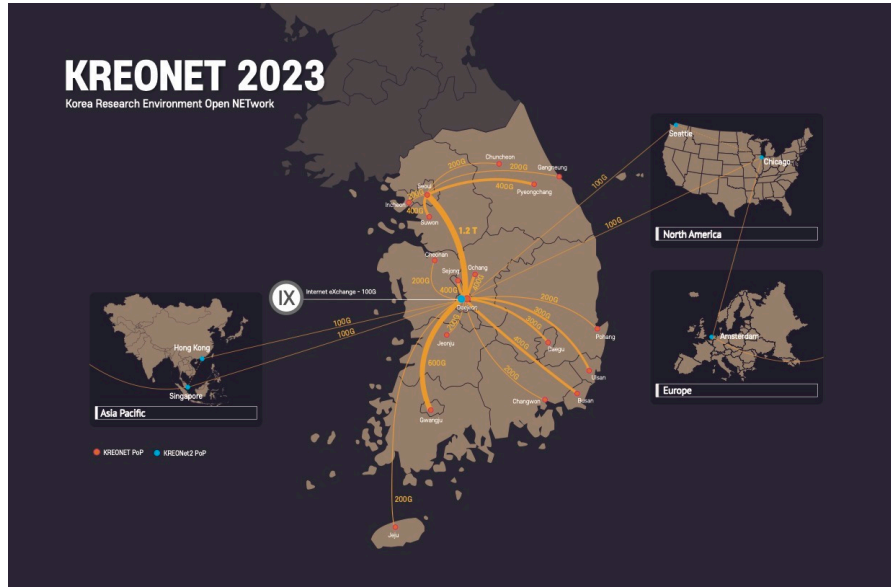
 **Enough capacity** of Submarine cables from East and West

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

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

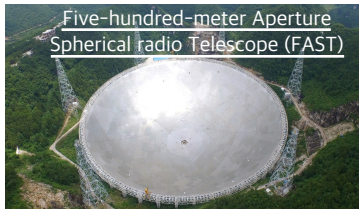


400Gbps/600Gbps wavelength, 100GE/400GE



400Gbps wavelength

Big Science Facilities in Asia



Five-hundred-meter Aperture Spherical radio Telescope (FAST)



Shanghai Synchrotron Radiation Facility (SSRF)



Experimental Advanced Superconducting Tokamak (EAST)



RAON Heavy Ion Accelerator



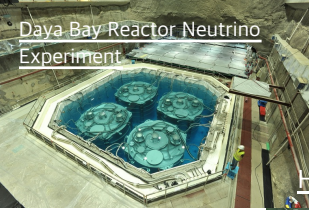
Pohang Accelerator Laboratory X-ray Free Electron Laser (PAL-XFEL)



Neutrino Detector Facility



Beijing Electron Positron Collider (BEPC)



Daya Bay Reactor Neutrino Experiment



Heavy Ion Research Facility in Lanzhou (HIRFL)



Korea Superconducting Tokamak Advanced Research (KSTAR)



KVN (Korean VLBI Network)



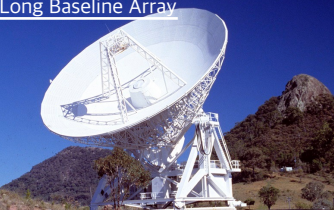
Ochang Advanced Synchrotron for Industry and Science



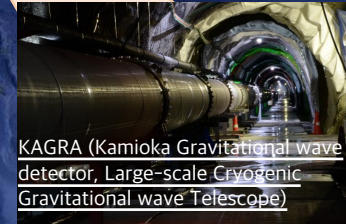
ASKAP radio telescope



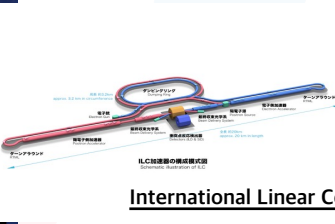
SKA-Low telescope



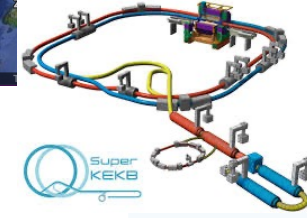
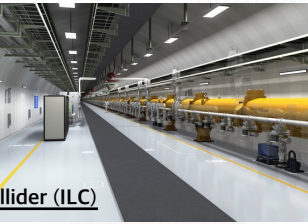
Long Baseline Array



KAGRA (Kamioka Gravitational wave detector, Large-scale Cryogenic Gravitational wave Telescope)



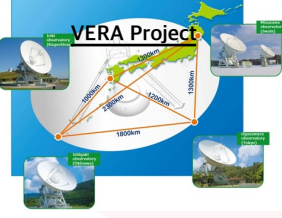
International Linear Collider (ILC)



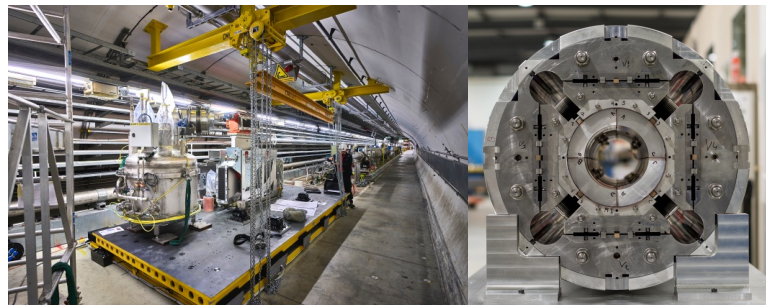
SuperKEKB



X-ray free electron laser (XFEL)

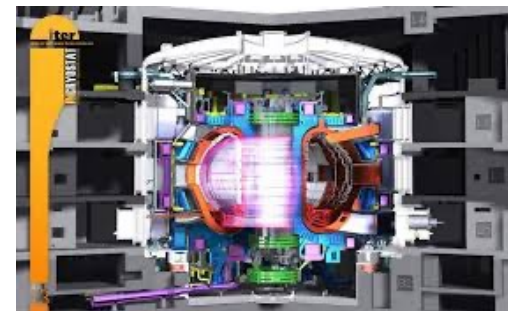
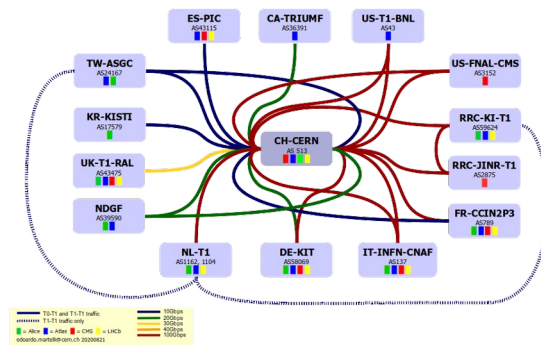


VERA Project



High-Luminosity LHC@CERN

LHC@OPN



ITER (International Thermonuclear Experimental Reactor) @France



LIGO (Laser Interferometer Gravitational-Wave Observatory) @ United States



ALMA (Atacama Large Millimeter Array) @Chile



IceCube @Antarctica

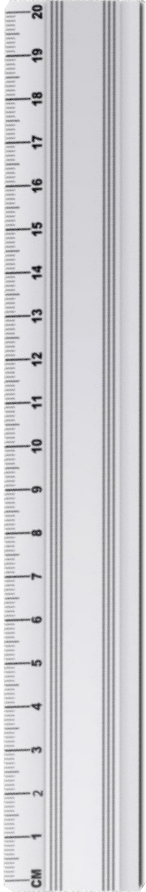


National Ignition Facility @LLNL



SKA (Square Kilometer Array)

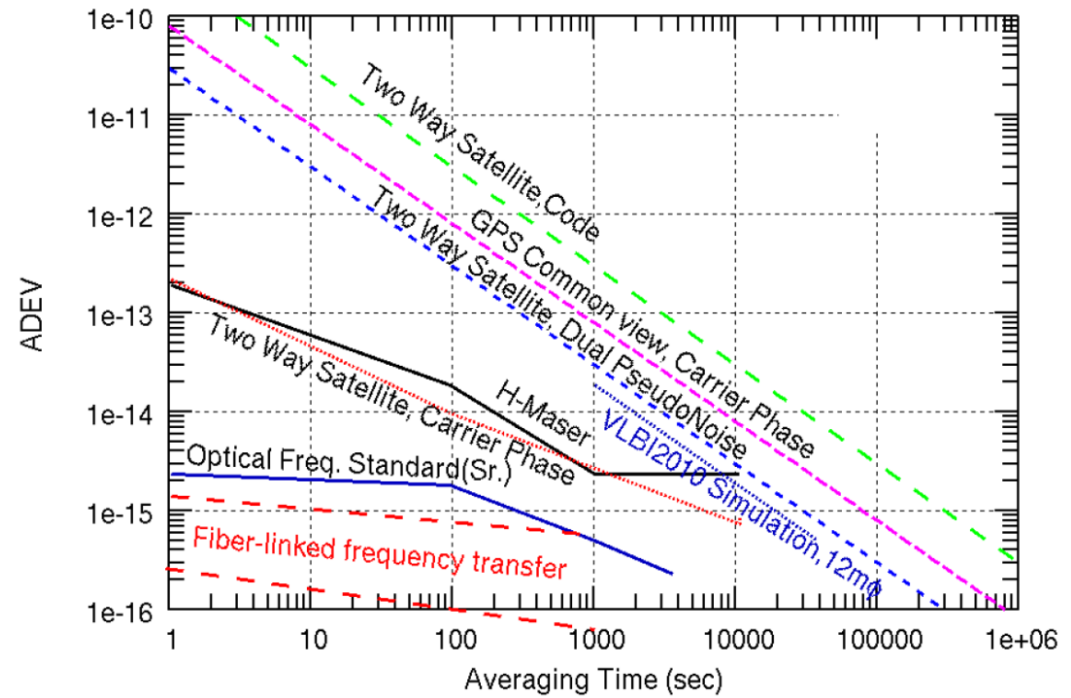
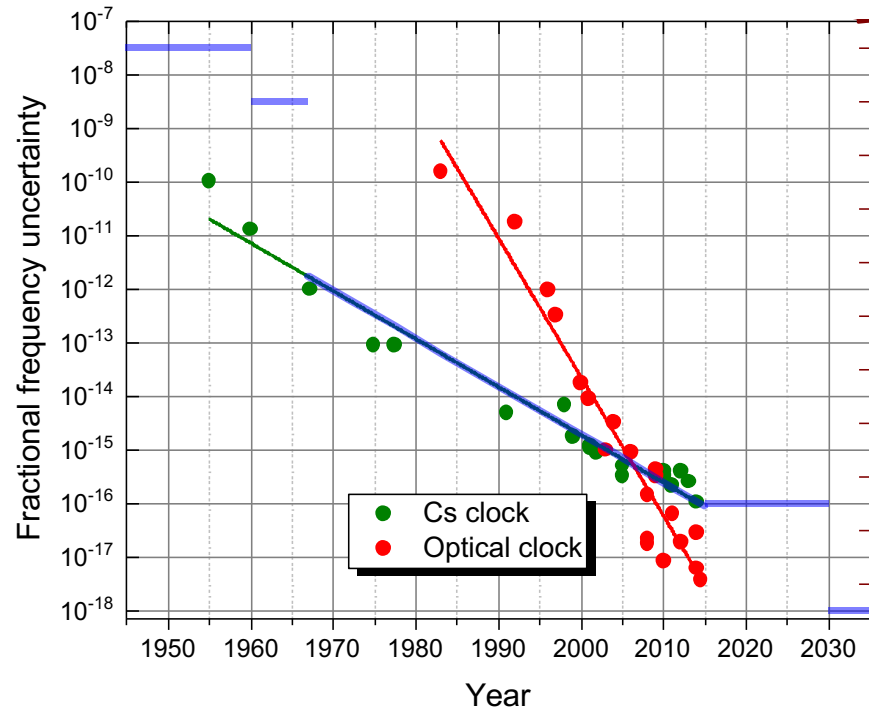
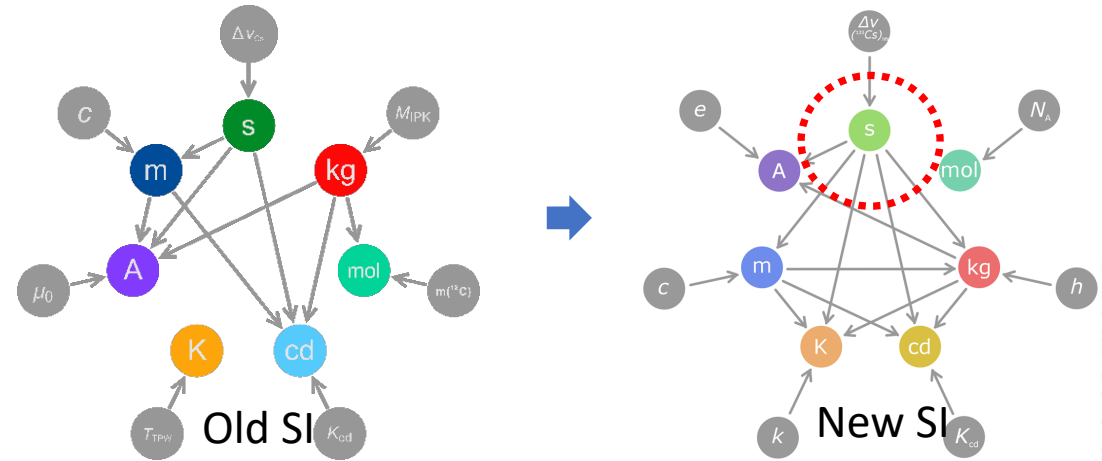




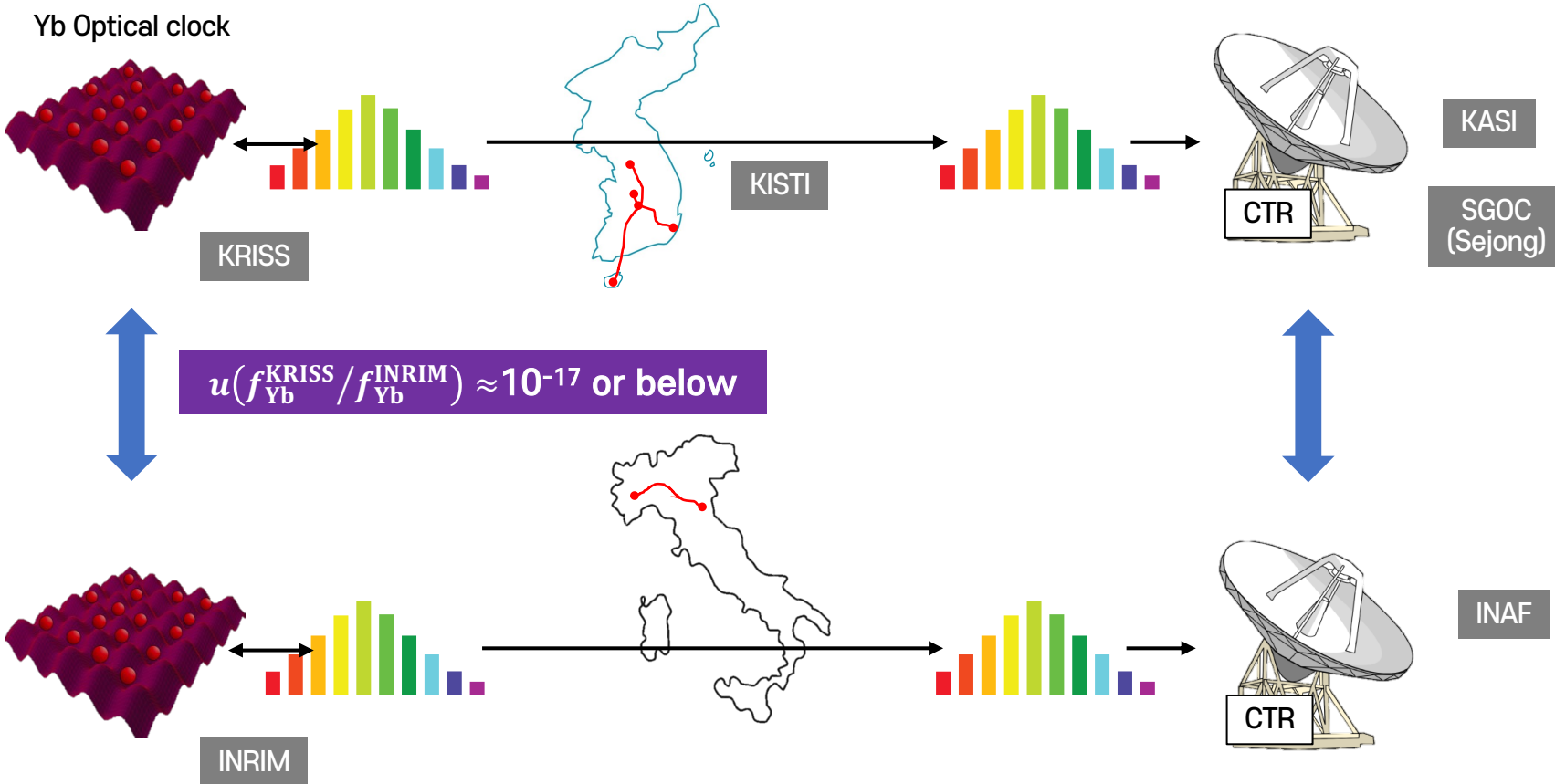
“Never measure anything but frequency!”



-- Arthur Schawlow
(1981 Nobel prize in Physics)



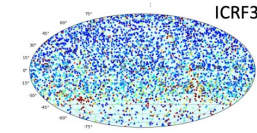
Inter-continental optical clock comparison using broadband VLBI



	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



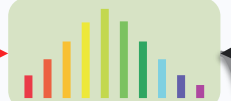
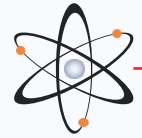
ICRF3 : The 3rd realization of the International Celestial Reference Frame

KOREA

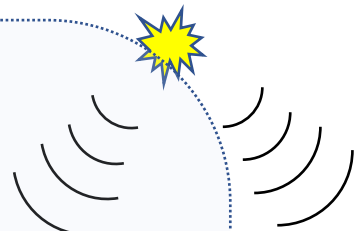
Source (Star)

KRISS

Optical Clock Optical Comb



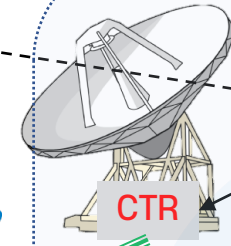
GPS satellite



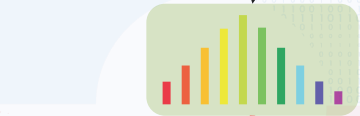
ITALY

INAF IRA

Standard Frequency Generator



CTR



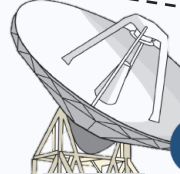
CTR



Correlator

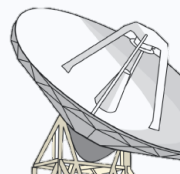
INRiM
ISTITUTO NAZIONALE
DI RICERCA METROLOGICA

Standard Frequency Generator



CTR

Standard Frequency Generator



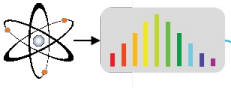
CTR

KAIST

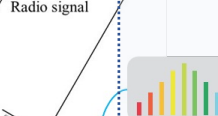
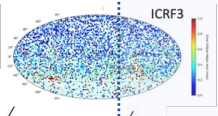
KiSTi
KREONET

KiSTi
KREONET

광시계1



광주파수 빔
(광-RF 인터페이스)

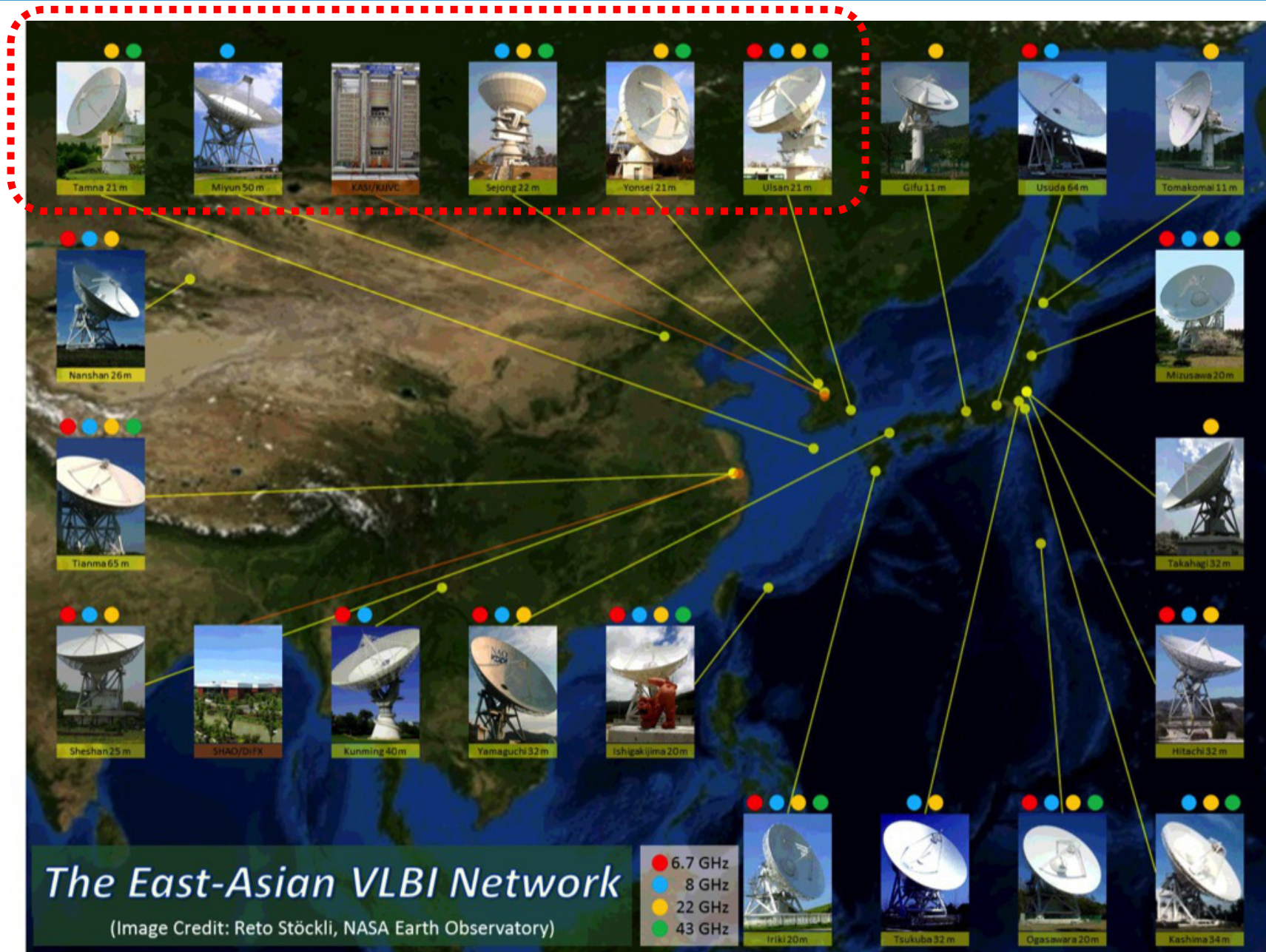


광시계2

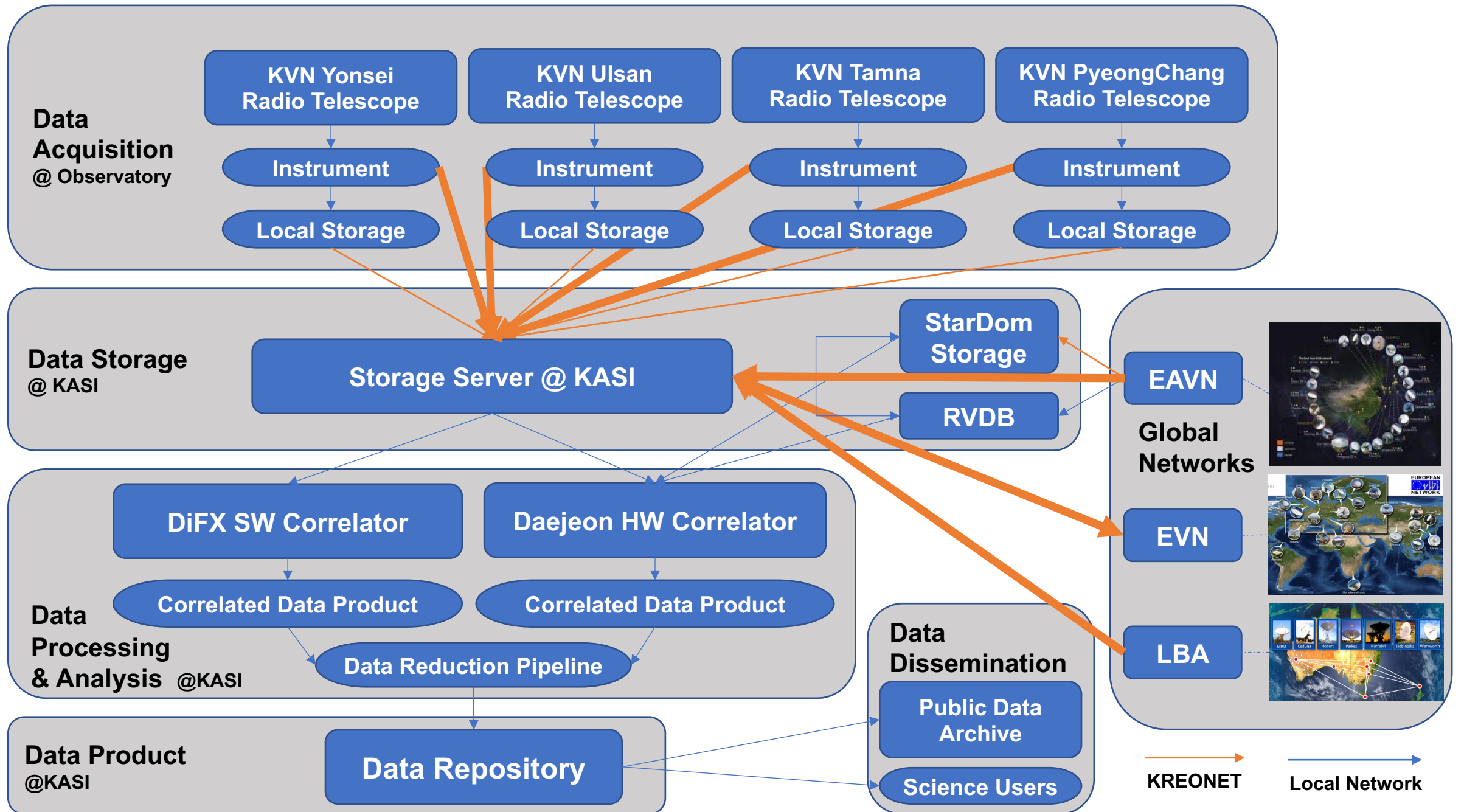
고성능 광대역 네트워크
(대용량 데이터 전송)

광섬유 네트워크
(저잡음 광신호 전송)

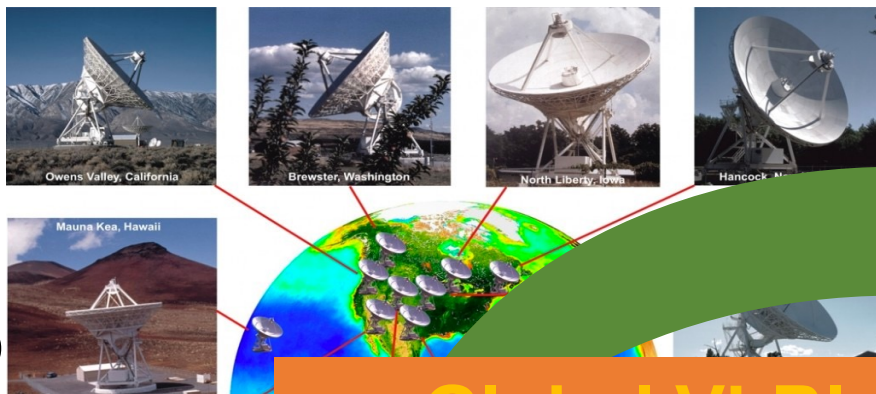
KVN (Korean
VLBI Network)



KVN Data Science Flow



VLBA
(North America)



EVN
(Europe)



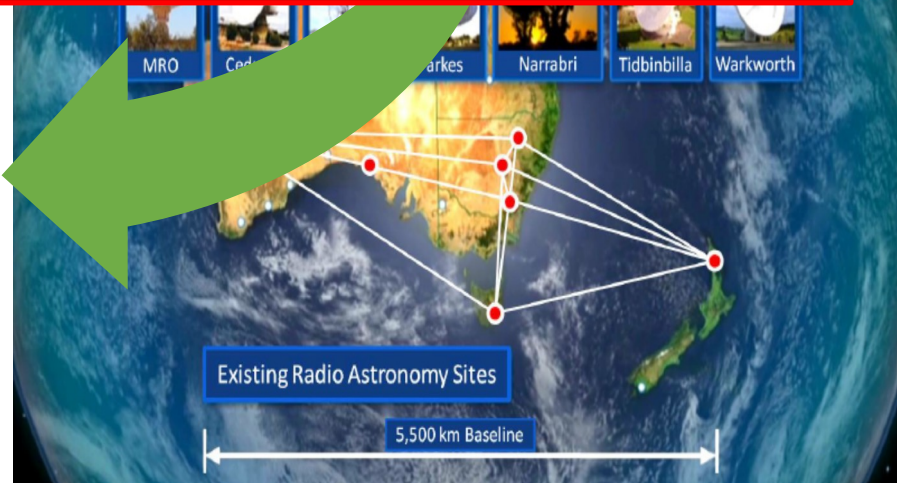
Global VLBI Alliance Initiative

- “Earth VLBI alliance” : VLBA + EVN + EAVN + LBA + ...
- Provide simpler the global VLBI access for astronomers in order to pursue the breakthrough science by maximizing the power of VLBI in worldwide

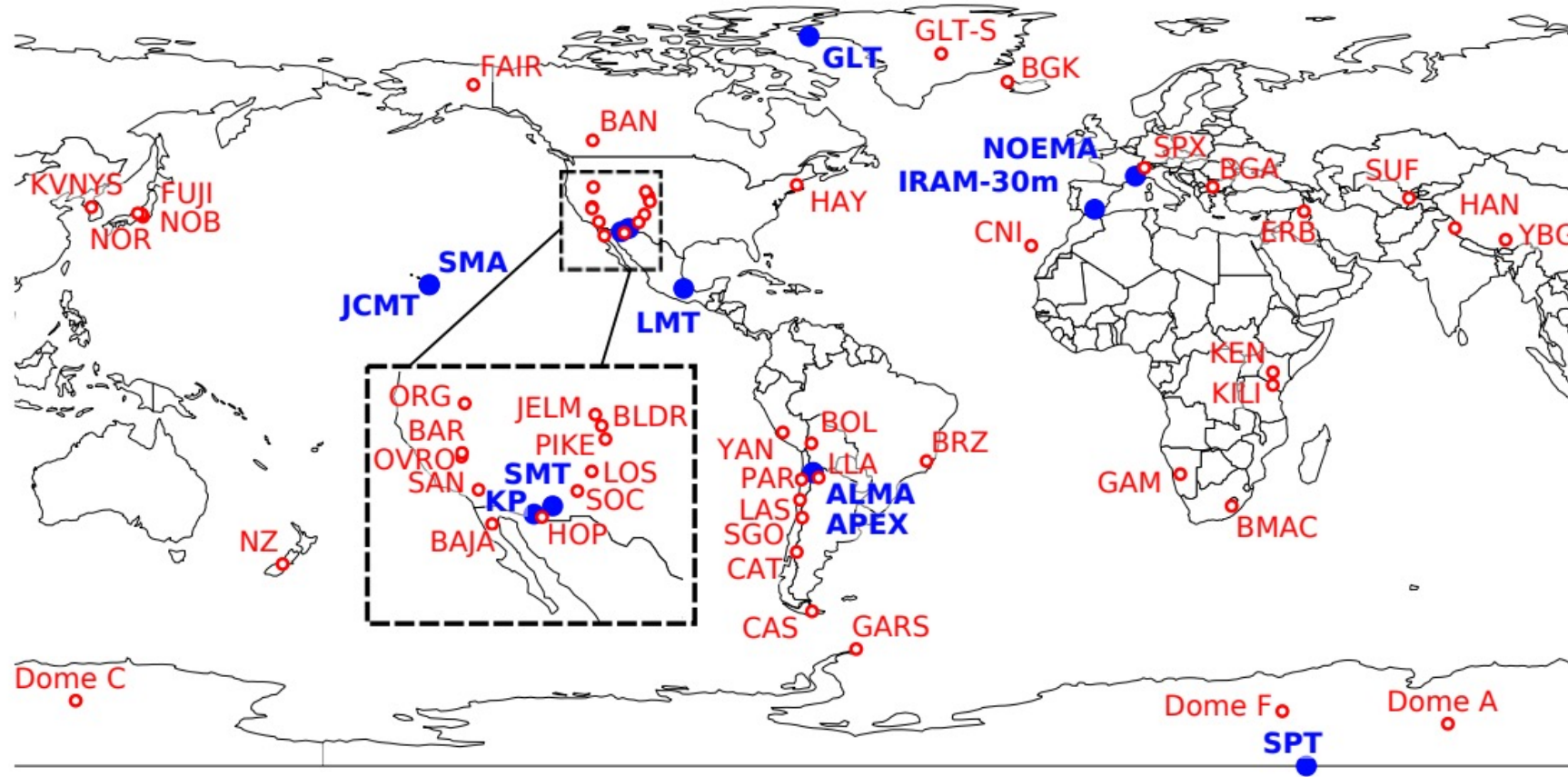
EAVN
(East-Asian)



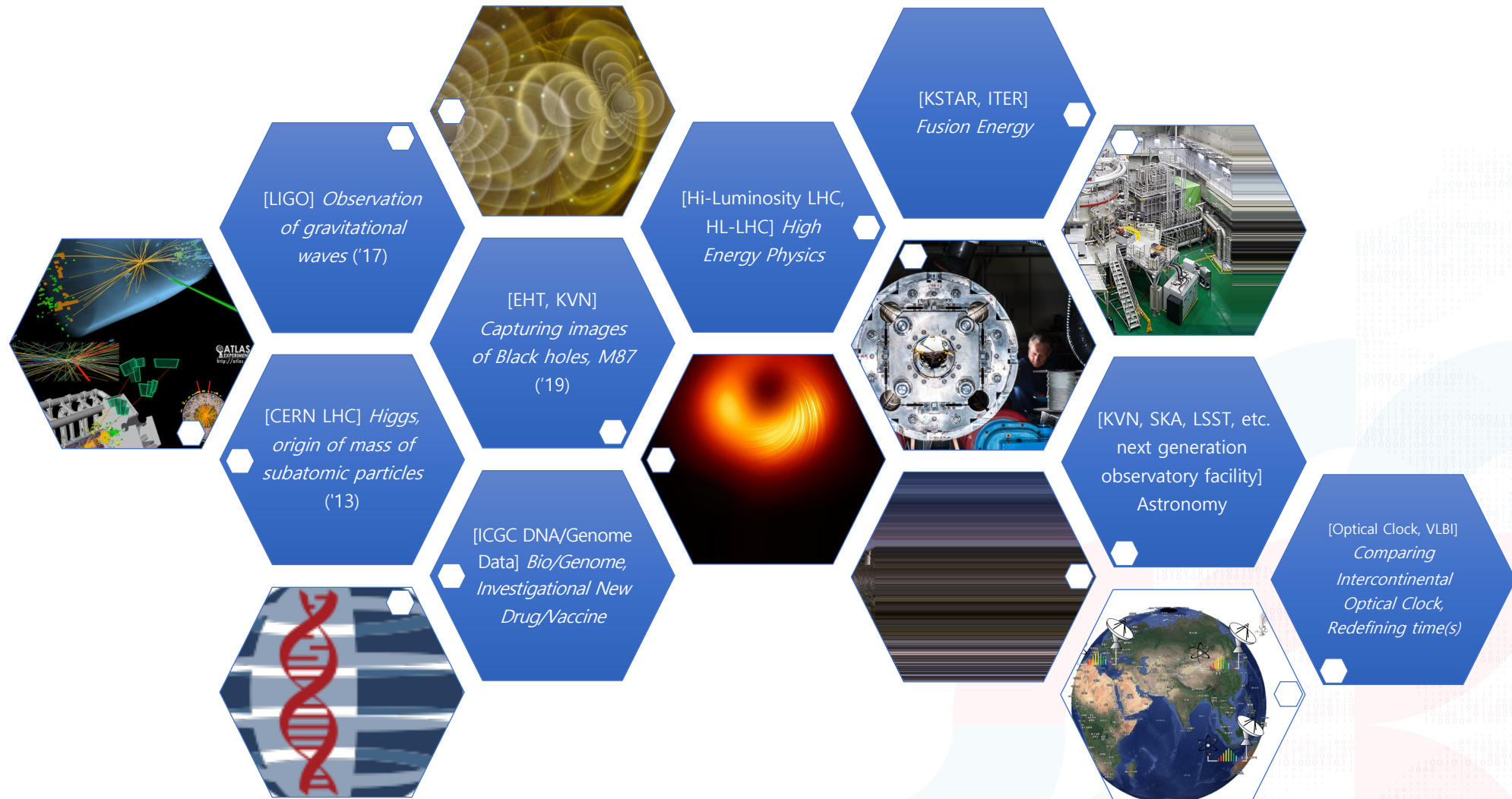
LBA
(Oceania)



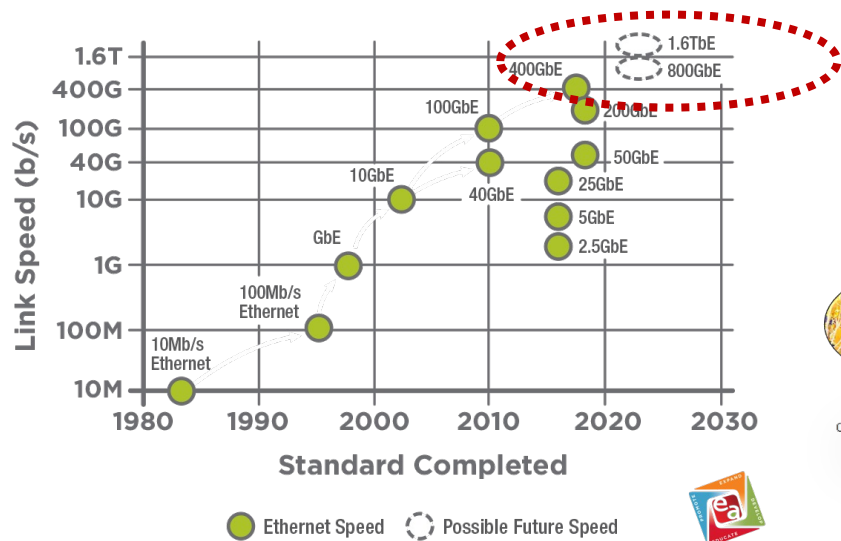




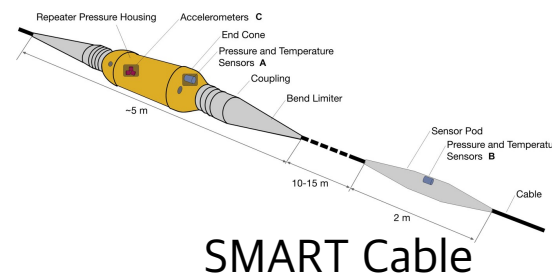
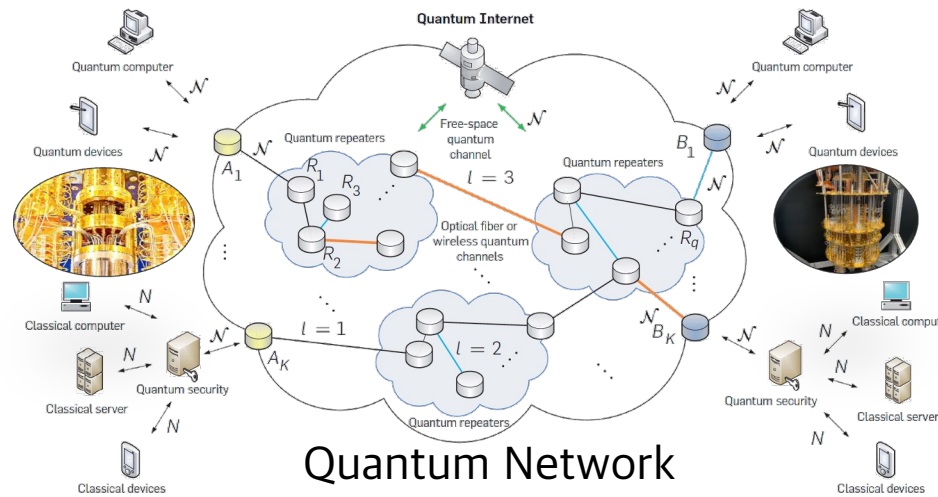
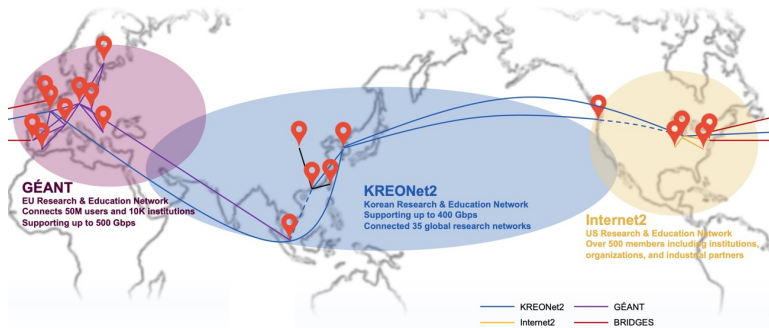
Multiple frequency bands (86, 230, and 345 GHz)



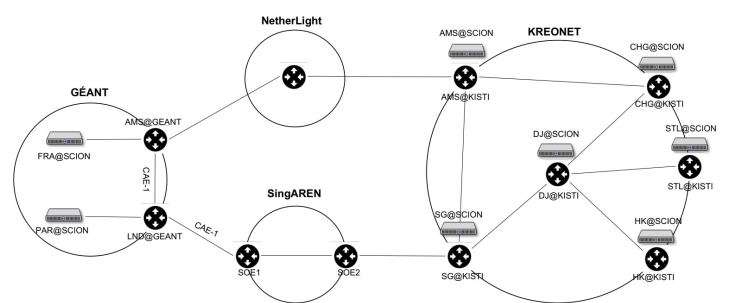
Big science, Data Intensive Science, Interdisciplinary research



Current SCIERA Connectivity (As of 2023)



SCION (SCALABILITY, CONTROL, AND ISOLATION ON NEXT-GENERATION NETWORKS)



Metaverse

- Tightly-coupled networks through NREN open exchange
 - Open exchange architecture as a reference model
 - GNA-G Global network architecture: GXP (Global eXchange Point) Compliance
- The **Asian international R&E network backbone** will be more closely connected not by one country, but through individual or collaborative investment by multiple countries
- The participation of Asian countries in **international collaborative research based on large experimental facilities** like LHC, SKA, ITER located both inside and outside of Asia will increase
- Specially, **VLBI-based collaborative research** that connects radio telescopes scattered throughout Asia for astronomical research will become more active
- New network technologies can enable new scientific and educational research by providing new service



S&T Infra,
Changing the world with Data **KiSTi**

Thank you

Buseung Cho (bscho@kisti.re.kr)

