6th GLOBAL RESEARCH PLATFORM WORKSHOP

NDeX (National Data eXchange) & KREONET

Buseung Cho, Ph.D.

Director, KREONET/KISTI
Associate Professor, UST
APAN Board of Directors

Contents


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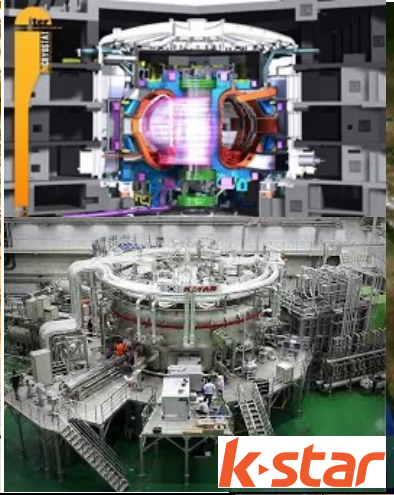
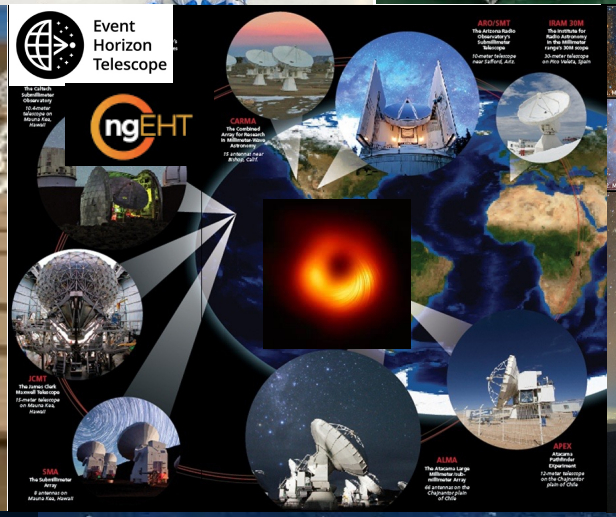
china eu india japan korea russia usa

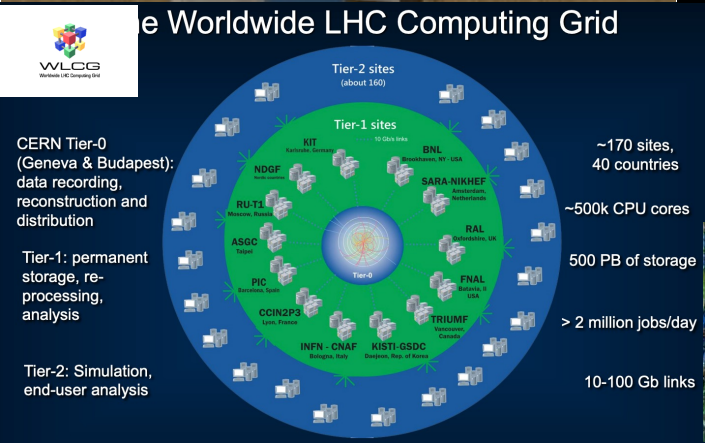

k·star


The East-Asian VLBI Network
(Image Credit: Reto Stöckli, NASA Earth Observatory)
6.7 GHz
8 GHz
22 GHz
43 GHz


SKA
SQUARE KILOMETRE ARRAY


Event Horizon Telescope
ngEHT


VERA C. RUBIN OBSERVATORY
LSST
Legacy Survey of Space and Time


WLCG
Worldwide LHC Computing Grid
Tier-2 sites
(about 160)
Tier-1 sites
10 Gb/s links
KIT
BNL
NDGF
SARA-NIKHEF
RU-T1
RAL
ASGC
FNAL
PIC
TRIUMF
CCIN2P3
INFN - CNAF
KISTI-GSDC
Tier-0
CERN Tier-0 (Geneva & Budapest): data recording, reconstruction and distribution
Tier-1: permanent storage, re-processing, analysis
Tier-2: Simulation, end-user analysis
~170 sites, 40 countries
~500k CPU cores
500 PB of storage
> 2 million jobs/day
10-100 Gb links


ALICE
CMS
ATLAS
LHCb

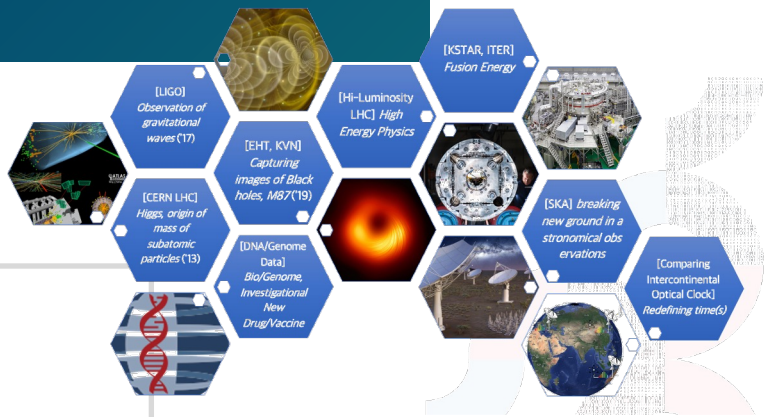

LIGO

HiLumi
HL-LHC PROJECT

Mission of KREONET

Enabling and Accelerating Science Discovery

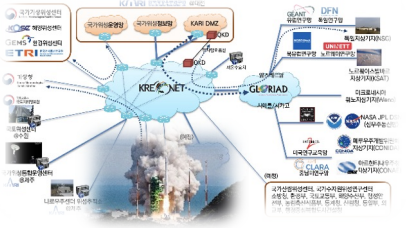
Providing opportunities for **global large-scale scientific collaboration** based on **big research facilities, high-performance computing, and big data** in fields such as high-energy physics, astronomy and space science, nuclear fusion, and bio-life sciences



- Discovery of the Higgs boson ('13, CERN LHC)
- Detection of gravitational waves ('17, LIGO)
- Imaging of the M87 black hole ('18, EHT+KVN)
- First-ever capture of the black hole at the center of our galaxy ('22, KVN)
- KSTAR/ITER fusion energy research, HL-LHC, SKA/LSST for dark matter exploration
- Redefinition of the second through VLBI-based optical clock comparisons

Enhancing national and social contribution as Mission Critical Network

Mission-critical national network infrastructure designed for specific purposes, requiring **ultra-broadband, low latency, high operational reliability, and advanced security**



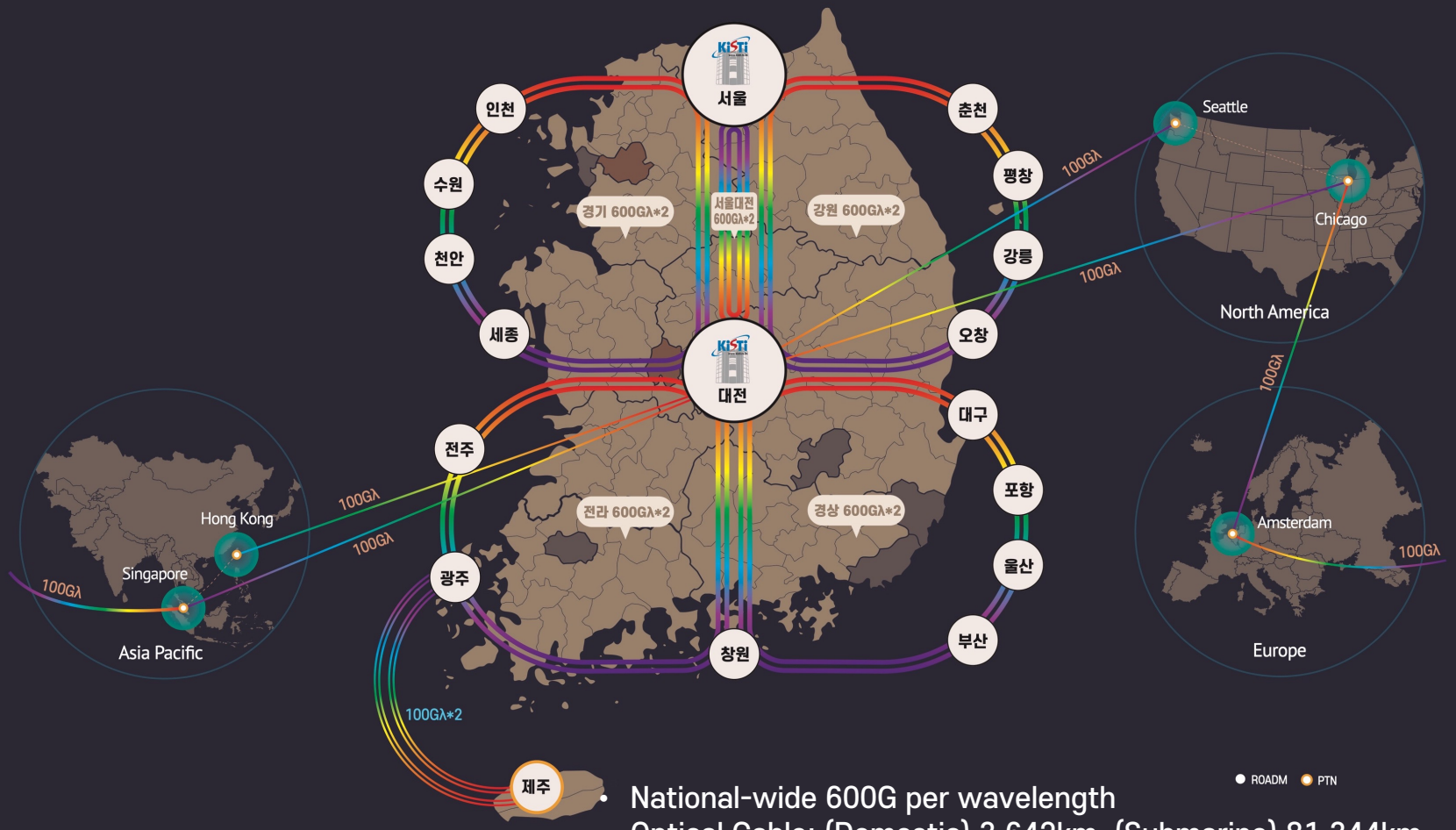
- National terrestrial and satellite data network & deep space exploration network
- National bio data network for secure transmission of bio-genomic data

Innovating science and technology through the integration of AI, HPC, and Big Data in the digital transformation era

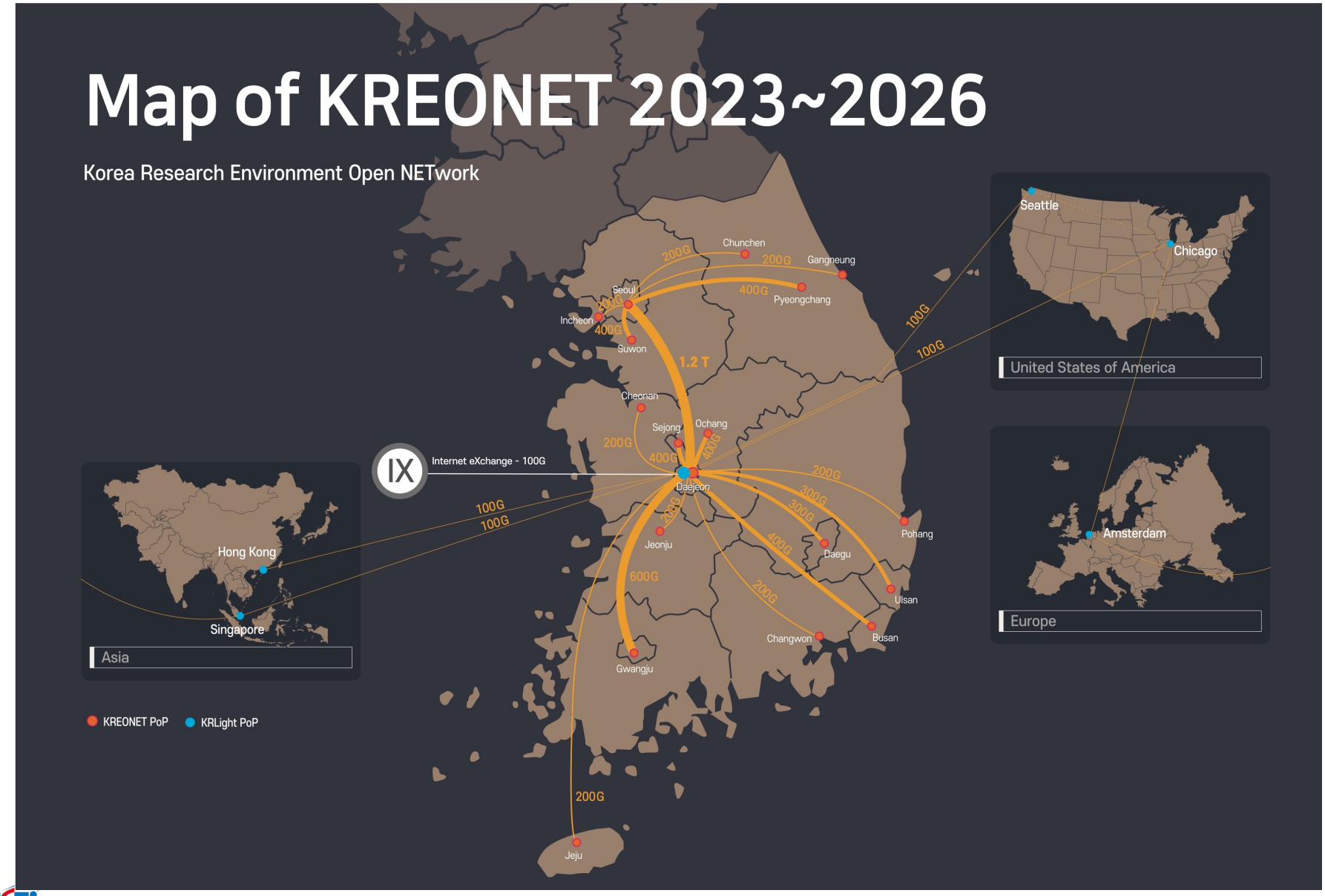
Addressing national and social issues in a timely manner through **data- and AI-based real-time response systems**, supporting digital transformation based on **open science**, and leading the **national high-performance computing ecosystem** via shared high-performance computing network infrastructure

KREONET Optical Backbone 2023~2026

Korea Research Environment Open NETwork

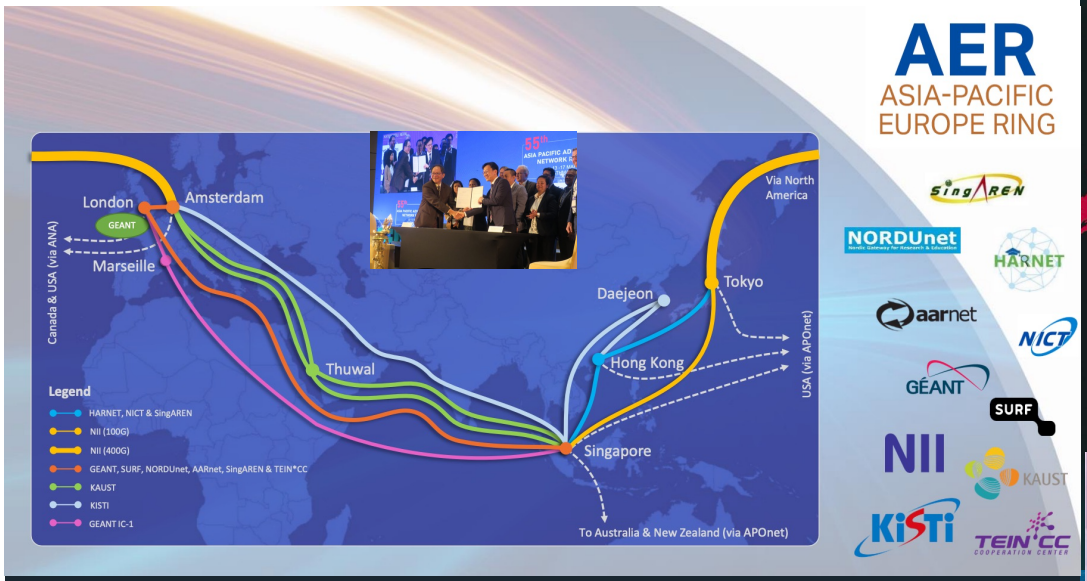


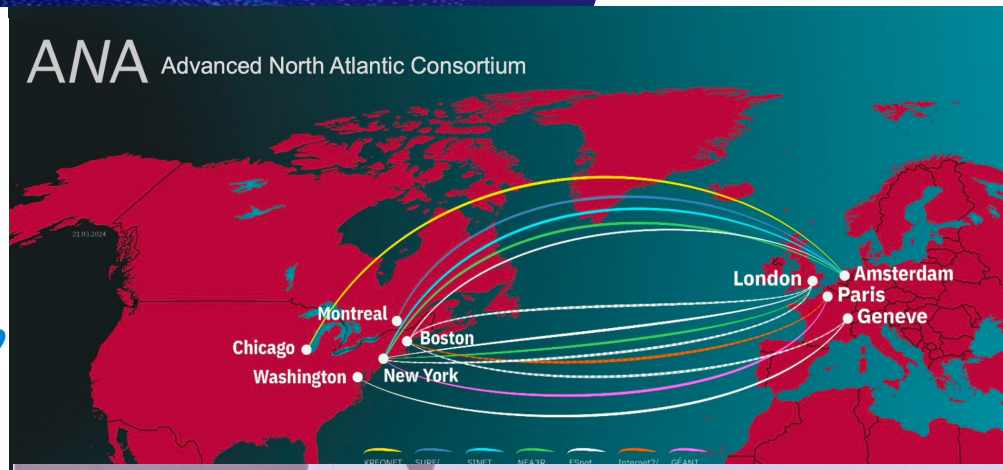
- National-wide 600G per wavelength
- Optical Cable: (Domestic) 3,642km, (Submarine) 81,344km

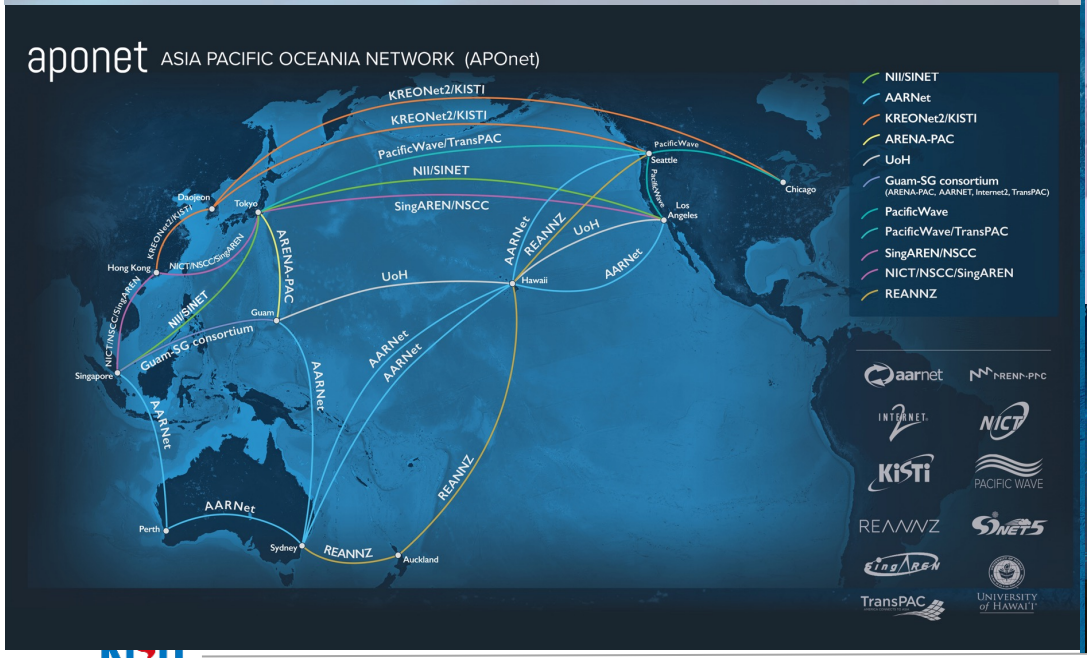

Map of KREONET 2023~2026
Korea Research Environment Open NETwork
Seattle
Chicago
United States of America
Amsterdam
Europe
Hong Kong
Singapore
Asia
IX
Internet eXchange - 100G
Chunchen
Gangneung
Pyeongchang
Seoul
Incheon
Suwon
Cheonan
Sejong
Ochang
Daejeon
Jeonju
Gwangju
Jeju
Pohang
Daegu
Ulsan
Changwon
Busan
200G
400G
1.2 T
600G
100G
KREONET PoP
KRLight PoP

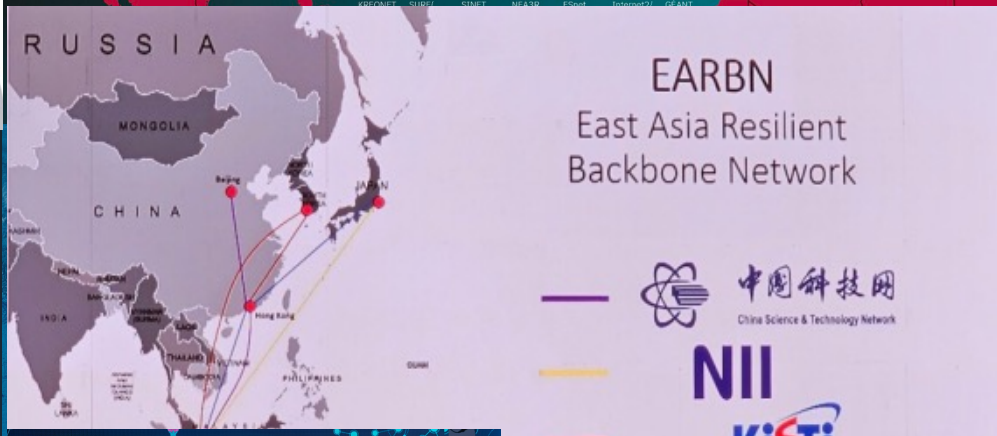
KREONET Infrastructure : International Collaboration

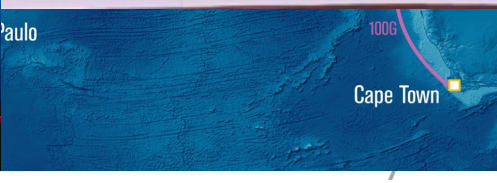
KISTI SINCE 1962



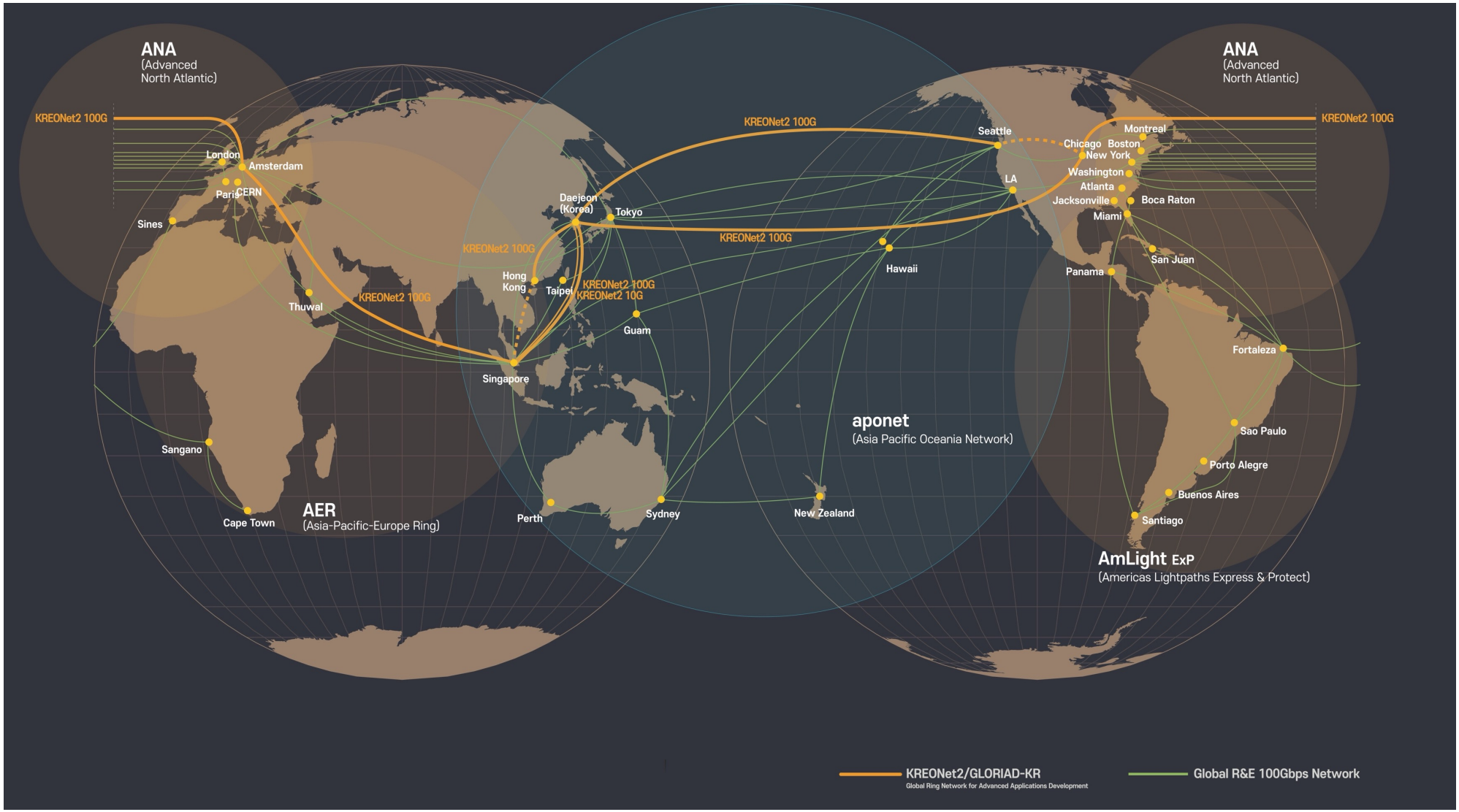








KREONET Infrastructure: International



KREONET Service

4 Trust & Identity Service	KAFE, eduroam
3 Collaborative Application Service	Webinar
4 Network Security Service	CERT-KREONET
4 Network Performance Monitoring Service	perfSONAR
4 Large-scale Data Transfer Service	globus
2 SCION Secure Backbone Service	SCION, Hercules with SCION(trial)
5 IPv4/IPv6 Internet Service	
4 High Performance Networking Service	Lightpath, L2/L3 VPN, Virtual Dedicate Network, Science DMZ
1 Time & Frequency Transfer Service (Pilot service)	ELSTAB
1 Quantum Key Distribution Service (Pilot service)	Key Management System (KMS)

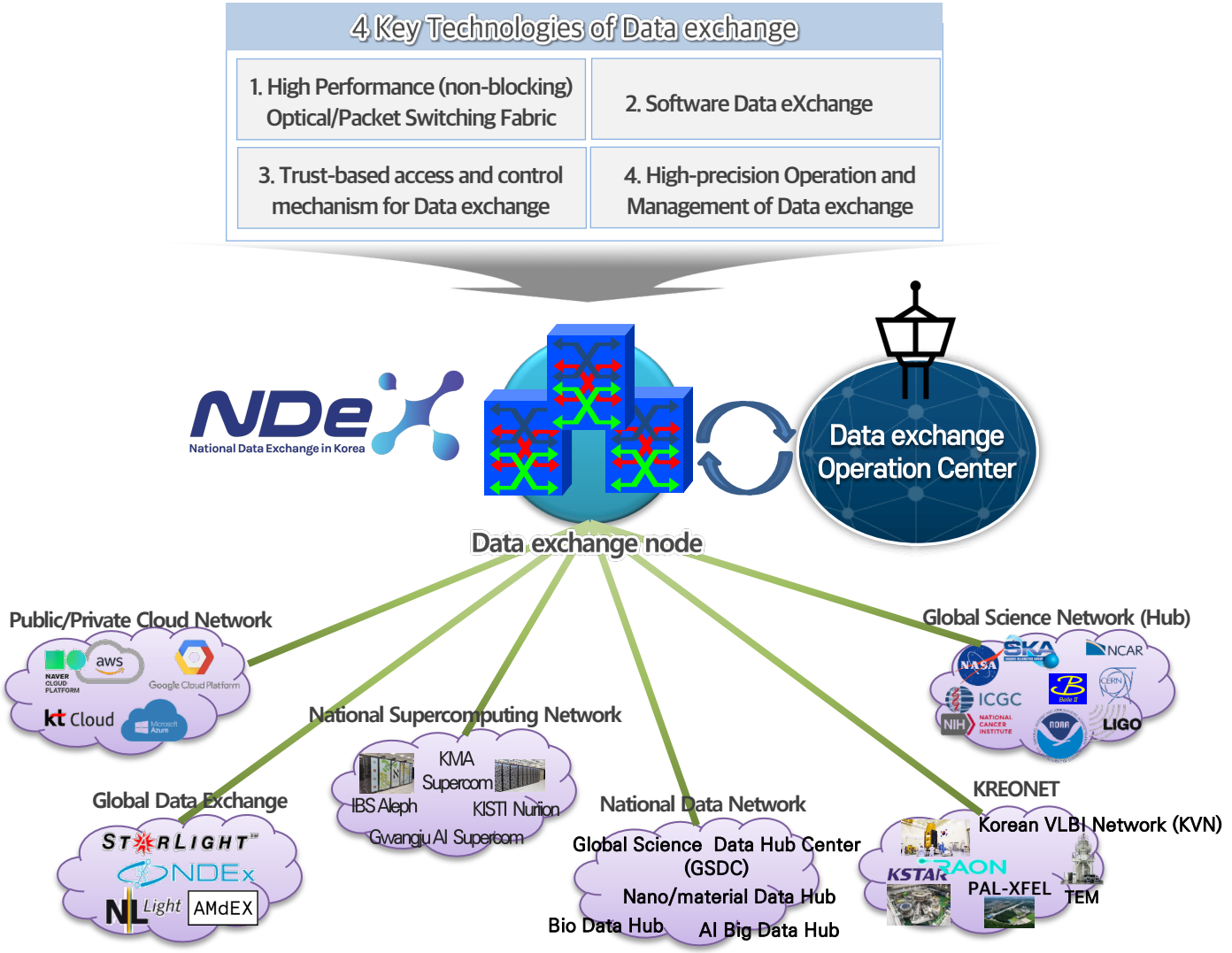
Service Maturity Level

1 2 3 4 5

1: Restrictive service (prototyping)
2: initial introduction stage
3: pre-commercial level (service improvement needed)
4: Commercial level (continuous feature enhancement)
5. Fully commercial level

KREONET In-house Development Service

Korea National Data eXchange (NDeX) Initiative



Korea National Data eXchange (NDeX) Infrastructure

LG U+ Cloud Multi Connect

Google Cloud Platform

Azure

aws

KREONET

(virtual)

'24 NDeX-Seoul

'25 NDeX-Daejeon (To-be)

NDeX National Data Exchange in Korea

KREONET

(virtual) Gwangju

'23 NDeX-Busan
@(CLS) Cable Landing Station

kt cloud CLOUD

KREONET

NDeX O/S

NDeX S/R1	NDeX S/R2	SDX SW
DTN/ perfsonar	Remote Console	Edge Service

NDeX Node

"NURION" (National Supercom)

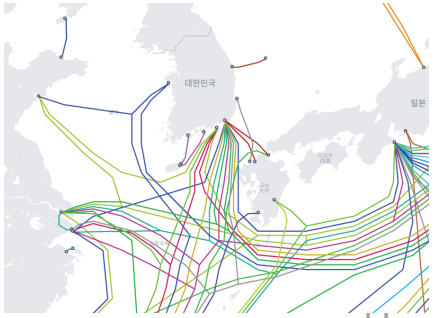
Meteorological Supercomputer

"KAIROS" (Nuclear Fusion Energy)

"Olaf" (Space)

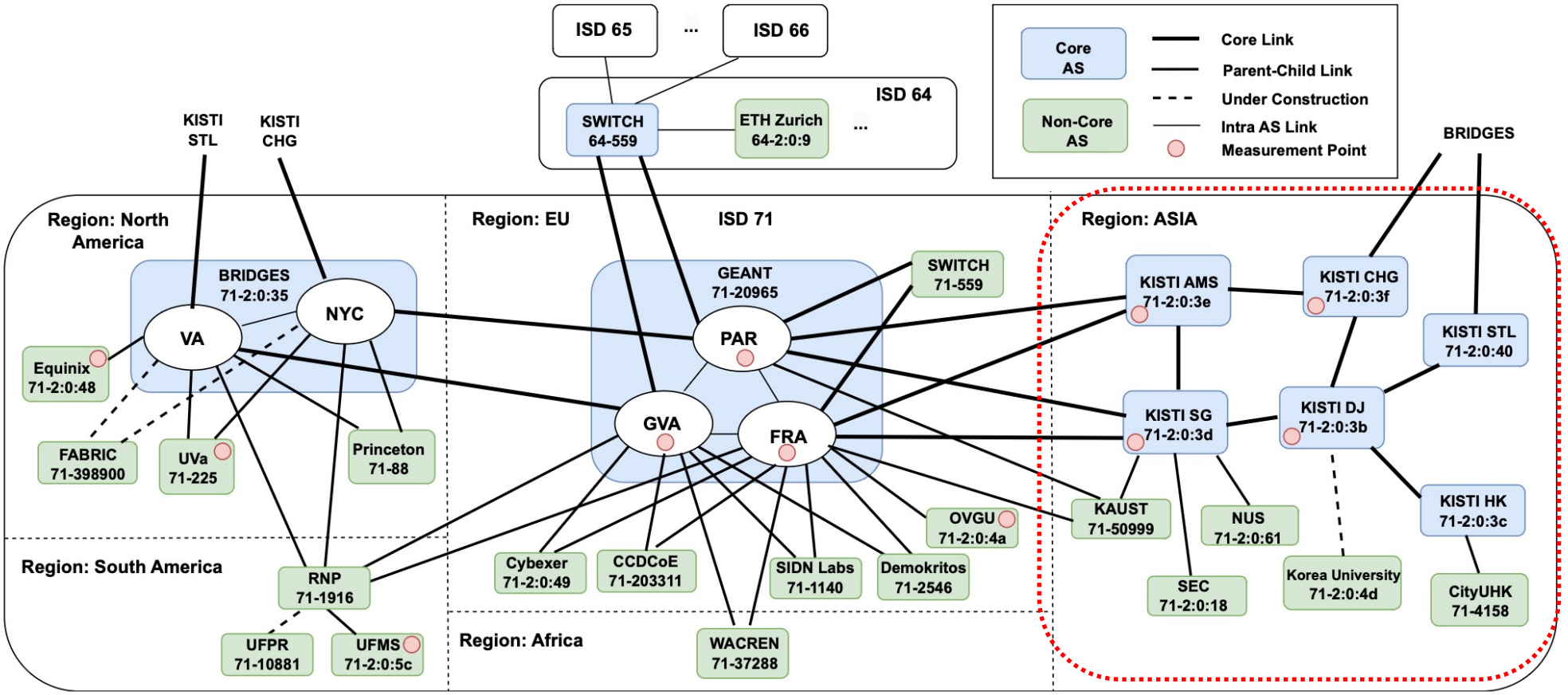
Gwangju AI Datacenter

"Dream-AI" (autonomous driving)

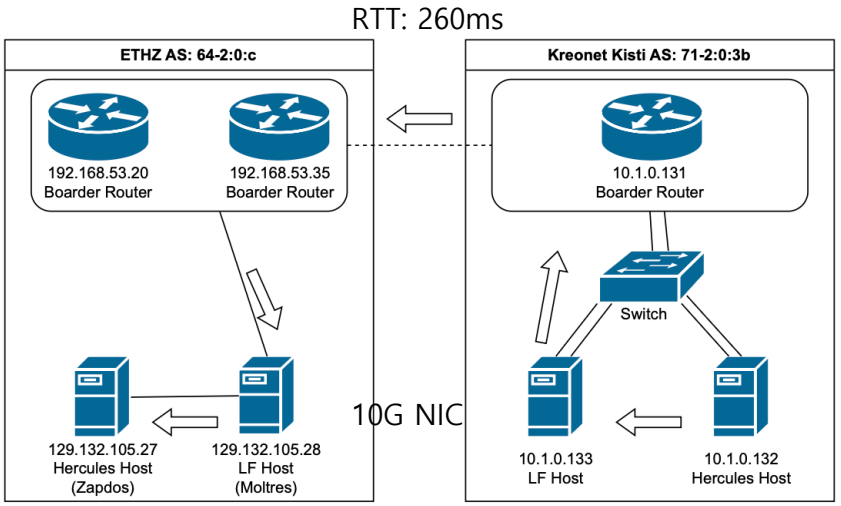


SCION : inter-domain path-aware architecture

- INTER-DOMAIN MULTIPATH ROUTING
- PATH CONTROL
- PATHS ARE AUTHENTICATED AT DISCOVERY AND VERIFIED AT FORWARDING



KREONET SCION Hercules/LF test



Two Paths

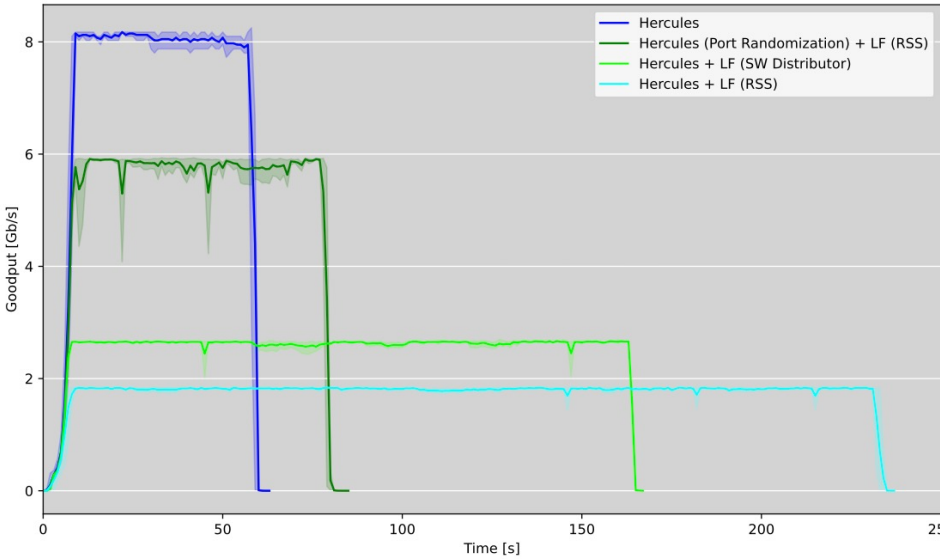
- ETHZ (64-2:0:9), SWITCH (64-559), GEANT (71-20965), KISTI SG (71-2:0:3d), KISTI DJ (71-2:0:3b)
- ETHZ (64-2:0:9), SWITCH (64-559), GEANT (71-20965), KISTI AMS (71-2:0:3e), KISTI SG (71-2:0:3d), KISTI DJ (71-2:0:3b)

- Hercules : High-volume data-transfer tool with integrated multipath capabilities and Performance-oriented Congestion Control (PCC)
  - Linux's express data path (XDP) socket type to bypass the traditional in-kernel network stack

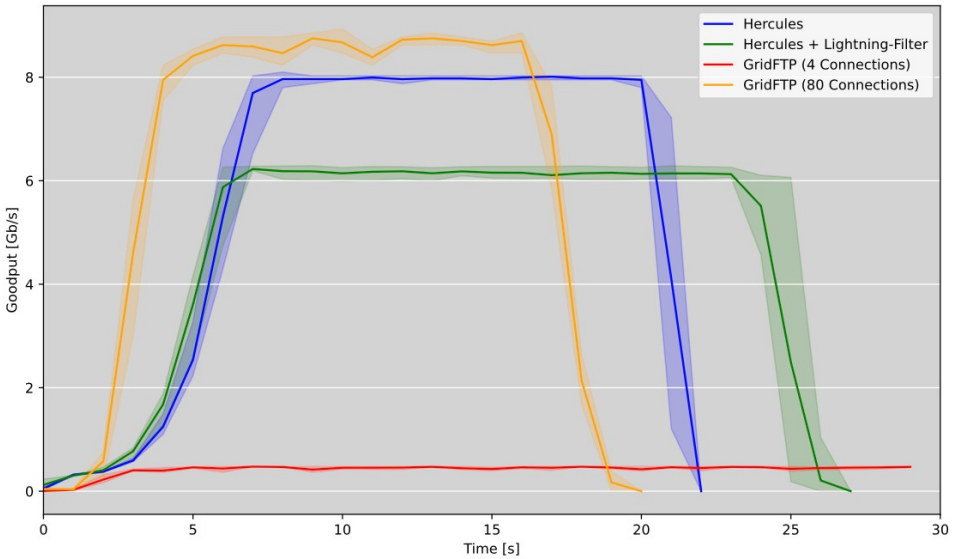
- Lightning-Filter (LF) is a high-speed traffic filtering mechanism that performs authentication, rate limiting, and duplicate detection.
  - DPDK framework, enabling high-speed packet processing

Ref. Aaron Bojarski, Hercules & Lightning-Filter Deployment; Tales of the Setup Process, May 2025

KREONET SCION Hercules/LF test results



Performance of different Hercules + Lightning-Filter configurations.
(KREONET → ETHZ, 50GB file)



Hercules vs. GridFTP.
(KREONET → ETHZ, 15 GB file)

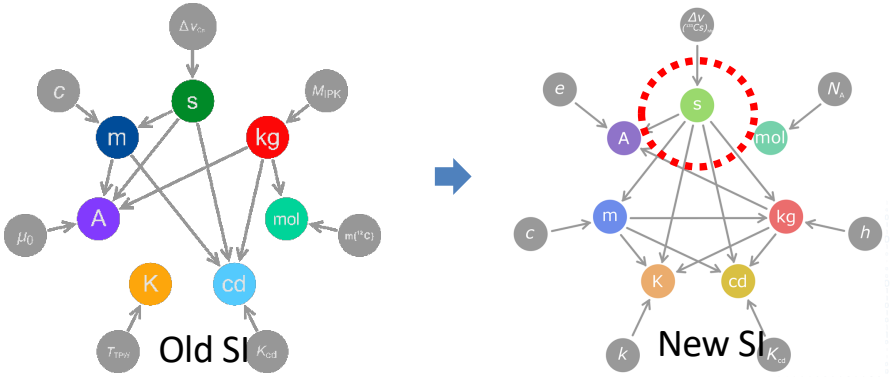
Ref. Aaron Bojarski, Hercules & Lightning-Filter Deployment; Tales of the Setup Process, May 2025

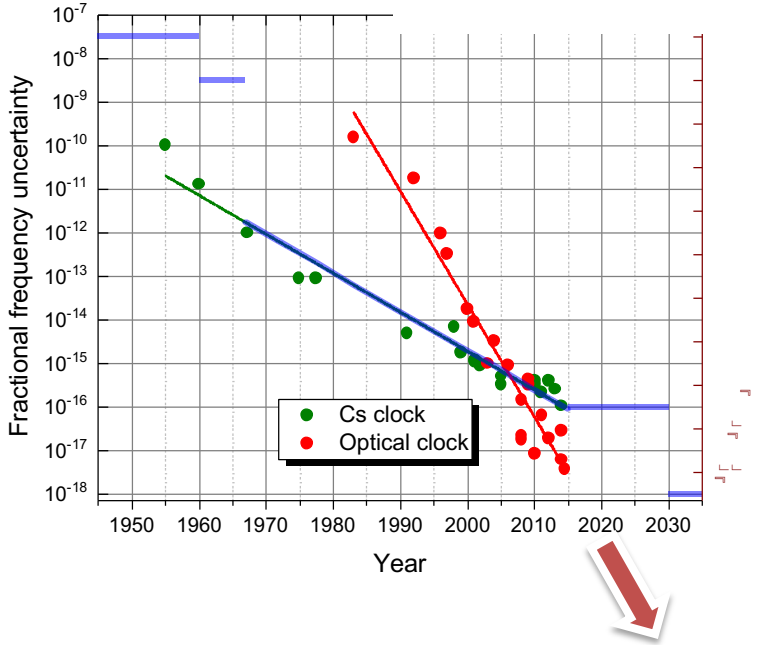
New SI and Optical Clock

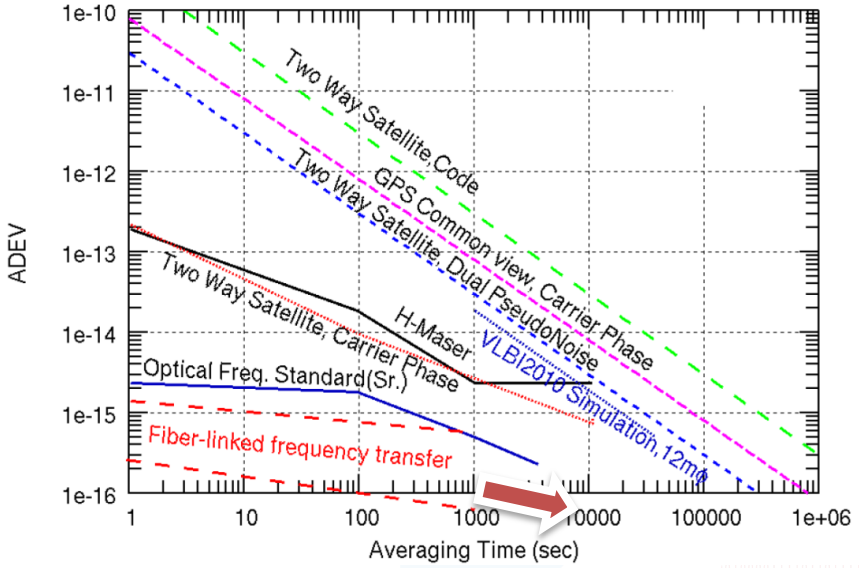
"Never measure anything but frequency!"

-- Arthur Schawlow

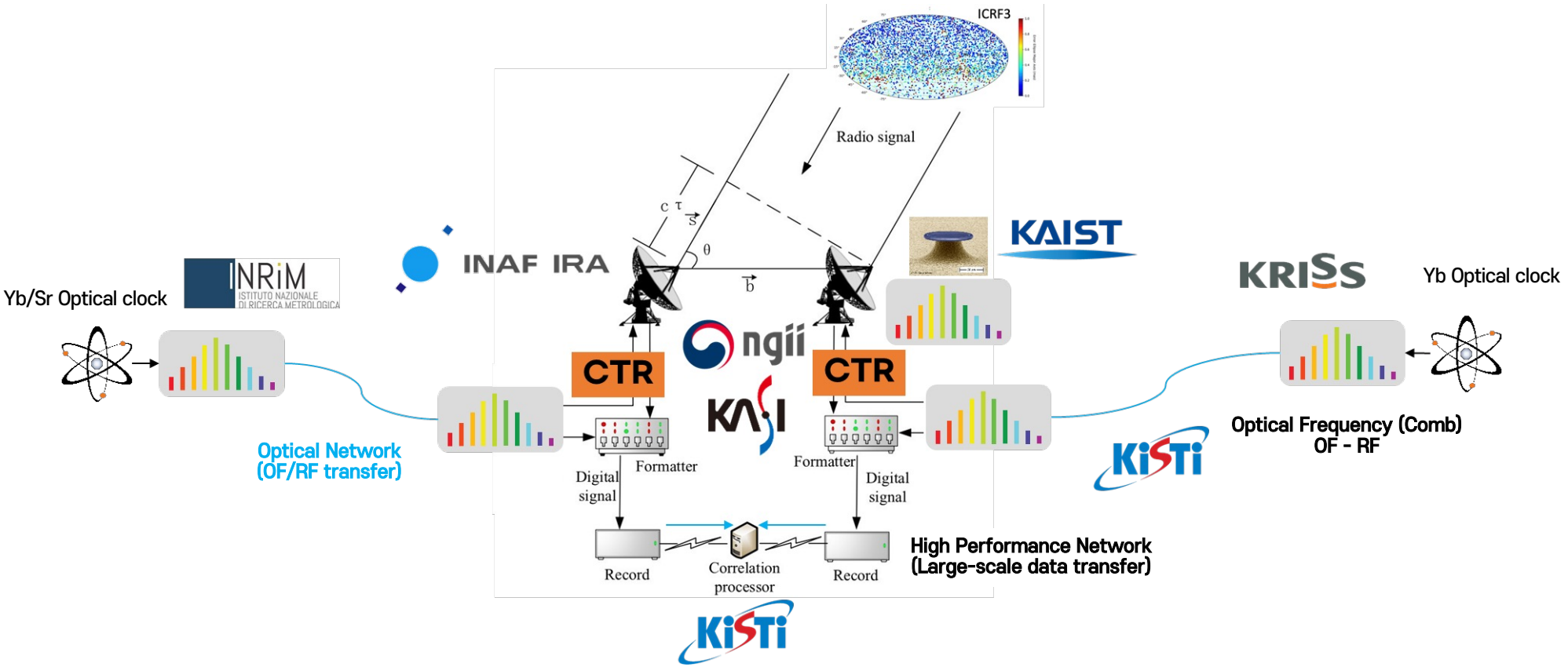
(1981 Nobel prize in Physics)







Inter-continental optical clock comparison using broadband VLBI

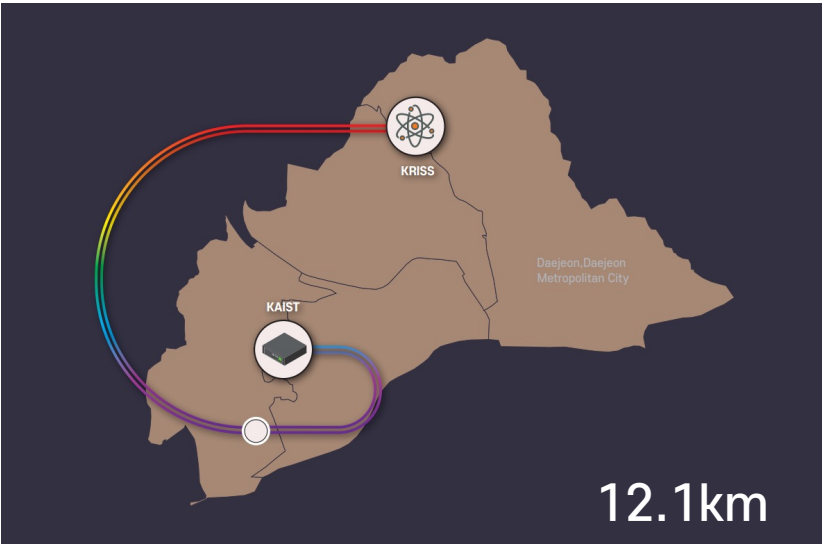


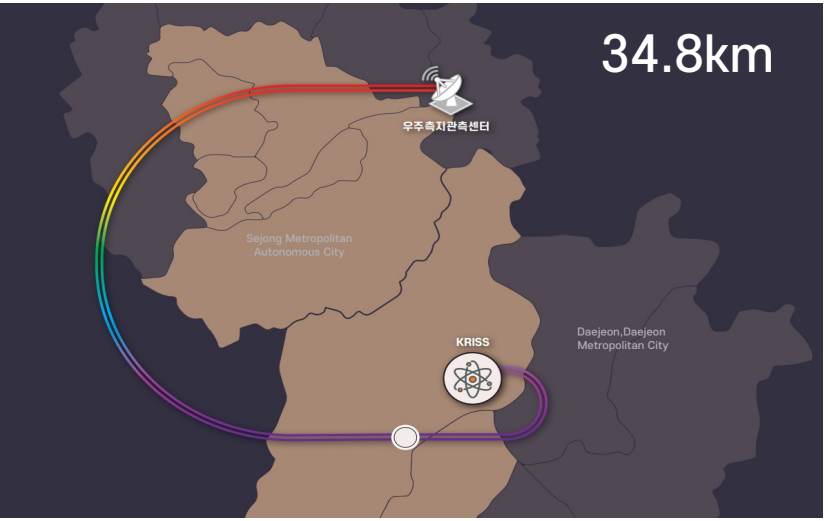
Italy

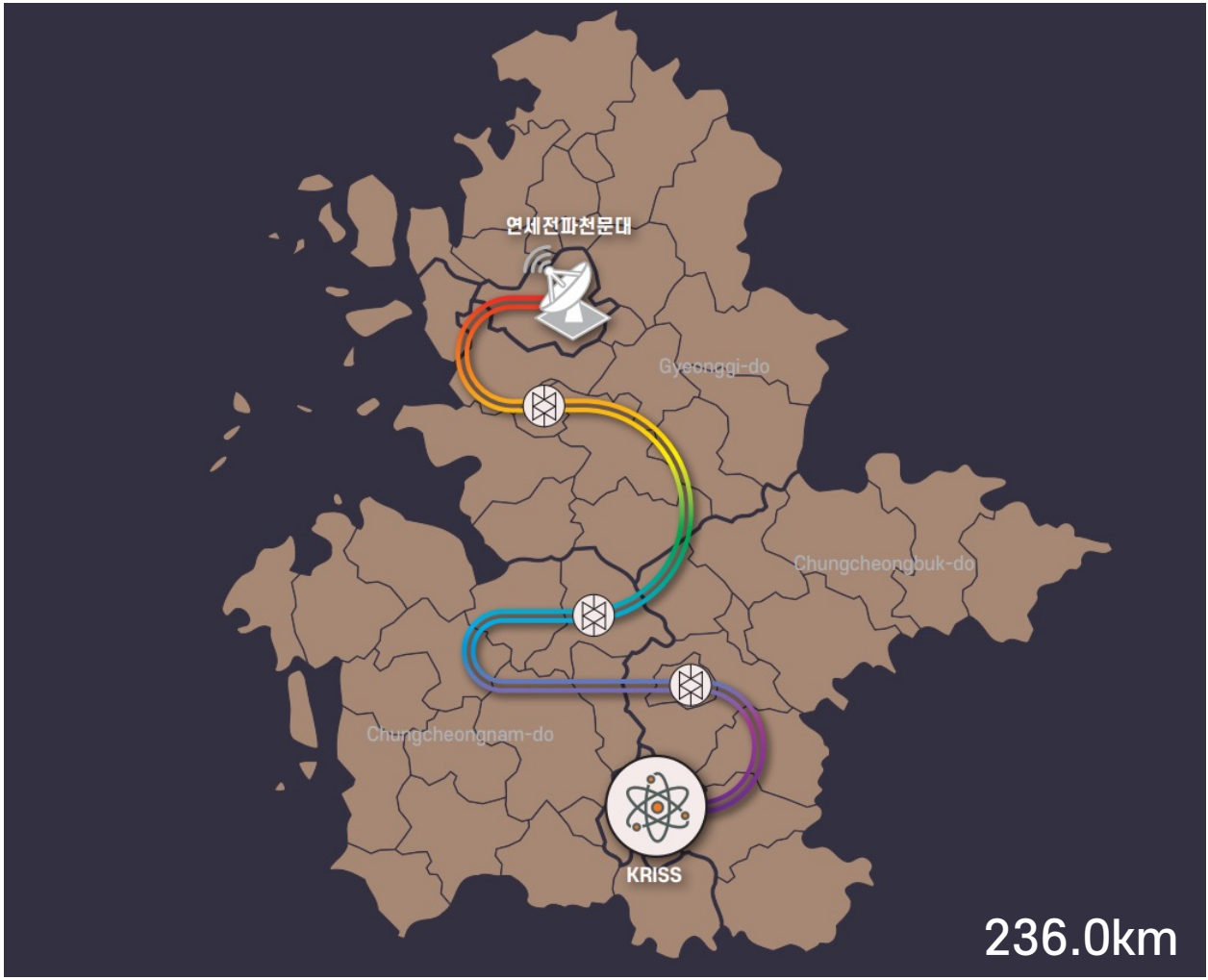
$u\left(f_{\mathrm{Yb}}^{\mathrm{KRISS}}/f_{\mathrm{Yb}}^{\mathrm{INRIM}}\right) \approx 10^{-17}$ or below

S.Korea

T/F Transfer Network



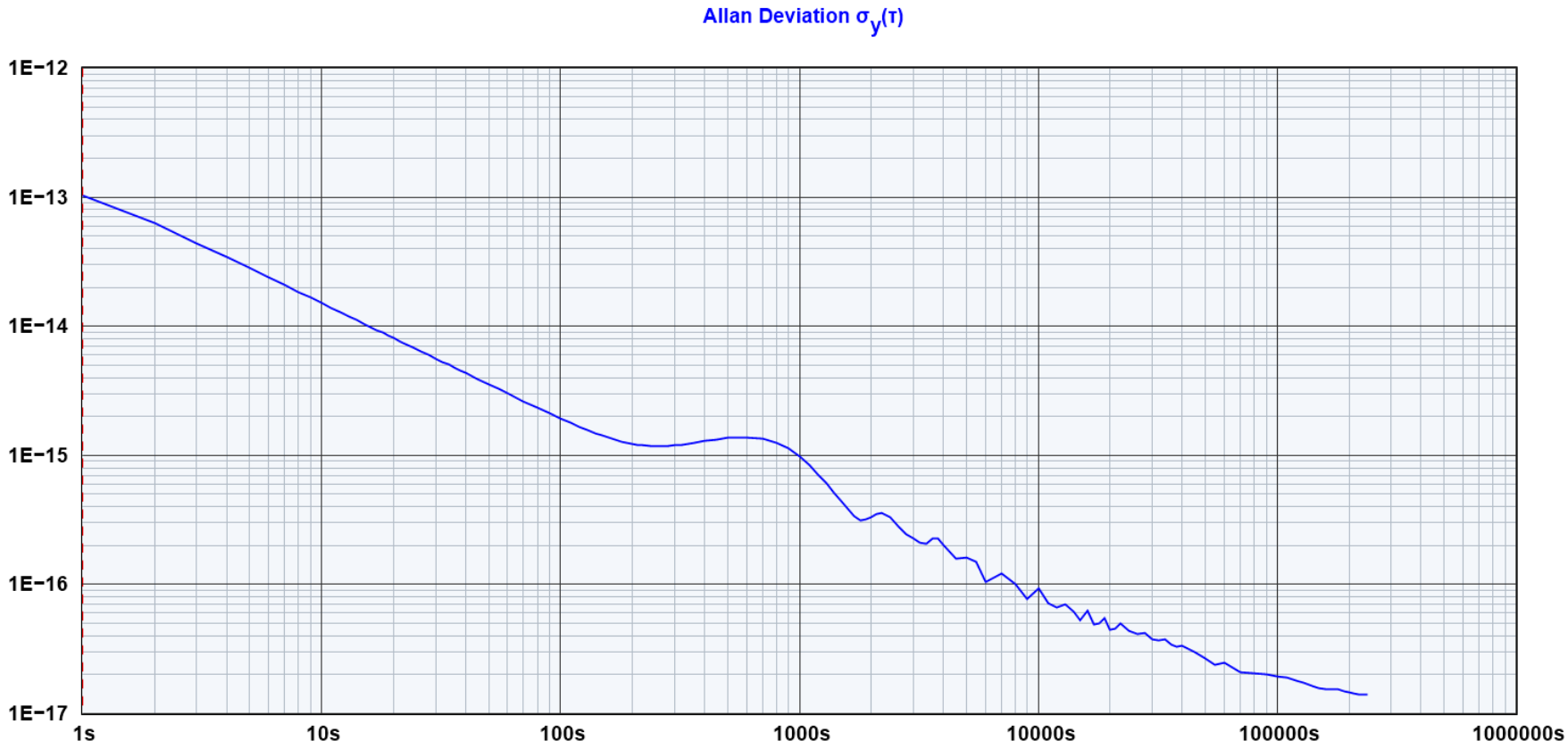




Fiber-optic time and frequency distribution system

OSTT-4 (ELSTAB)

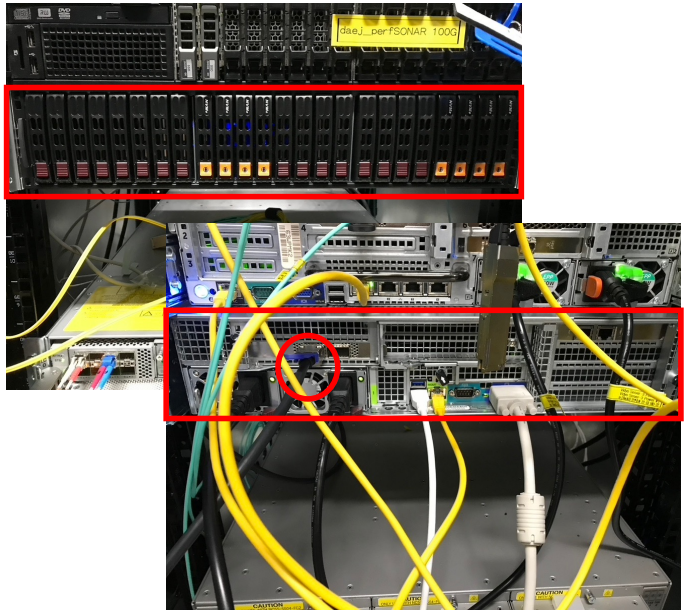
RF Stability



Trace	Notes	Input Freq	ADEV at 1s	Duration	Elapsed	Acquired	Instrument
OSTT residual	OSTT from Sejong	10.0 MHz	1.04E−13	30 d	11d 3h 40m 50s	963650 pts	Microchip 53100A

DTN-based "Transient" endpoint at KREONET PoPs

- Deployment of a "**Transient" endpoint** based on a high performance DTN at KREONET DJ PoP
  * HW/SW performance tuning, tracepathing, iperf M2M test, NVMe mount, VROC-based RAID0 configuration, ACL configuration at the Border router, and so on.
- Providing a high-speed, large-capacity data transfer environment and the dissemination of a reference model over KREONET ScienceDMZ
  * Target users: KREONET users, KISTI Globus endpoint admins and Read-Only performance testers



<Supermicro SYS-220U-TNR server>

<DTN Hardware spec.>

	Description
CPU	2*Intel Xeon Gold 6334 3.6Ghz, 8C
Memory	512GB(16*32GB) RAM
NVMe	30.72TB(8*3.84TB) NVMe, VROC-based RAID0
SSD	1.92TB(2*0.96TB) SSD
NIC	100G NIC(Mellanox Connect-X5 EN)

<DTN Software config.>

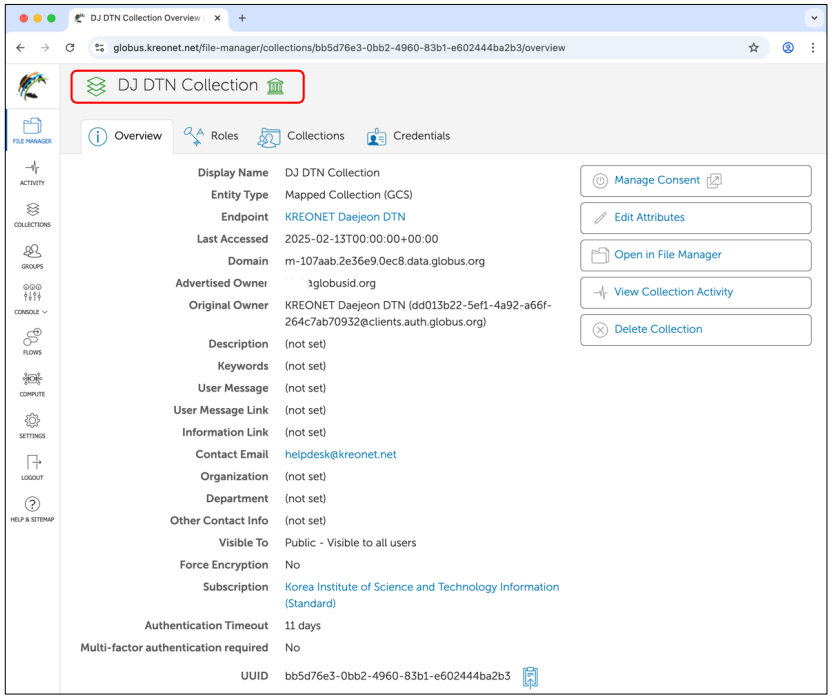
	Description
Operating system	Rocky 9.2
TCP algorithm	Cubic
Socket buffer size	approx. 2.5Gbytes (100Gbps*0.2sec*1/8byte) Tuned for Large BDP
MTU	9000 bytes (for Jumbo frame)
Transfer tool	Globus Connect Server v5.4
Monitoring tool	ps, top, netstat, iperf
Bandwidth	100Gbps

Contact: Dr. Wontaek Hong, KREONET advancement team

Mapped and Guest Collection in KREONET Daejeon DTN

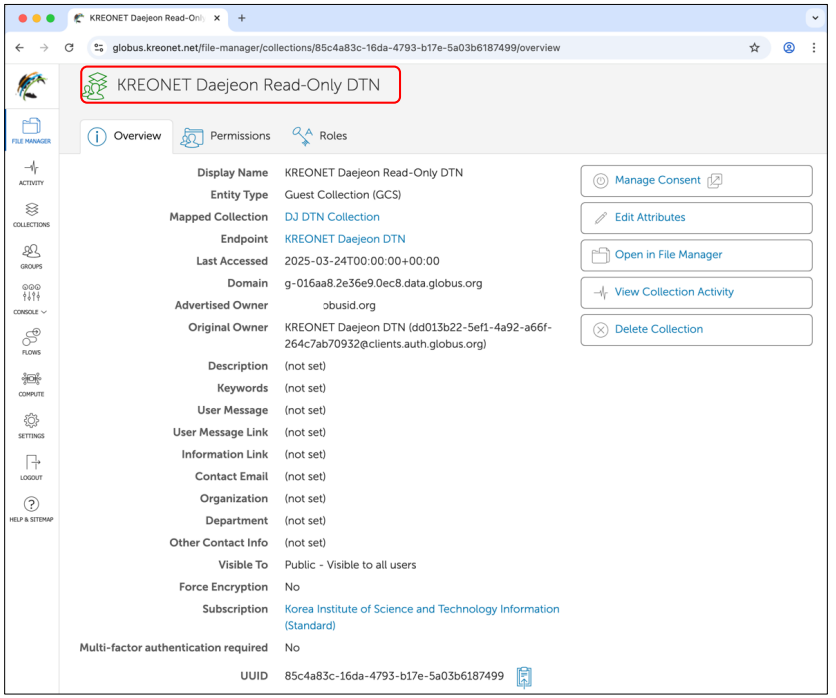
- DJ DTN Collection (Read-Write)

* A transfer test result from ESnet Sunnyvale Read-Only DTN to DJ DTN Collection: approx. 41.2Gbps
  + using Climate-Medium+Climate-Large data set (approx. 500GB)
* Up to 10 days of use after admin approval



- KREONET Daejeon Read-Only DTN

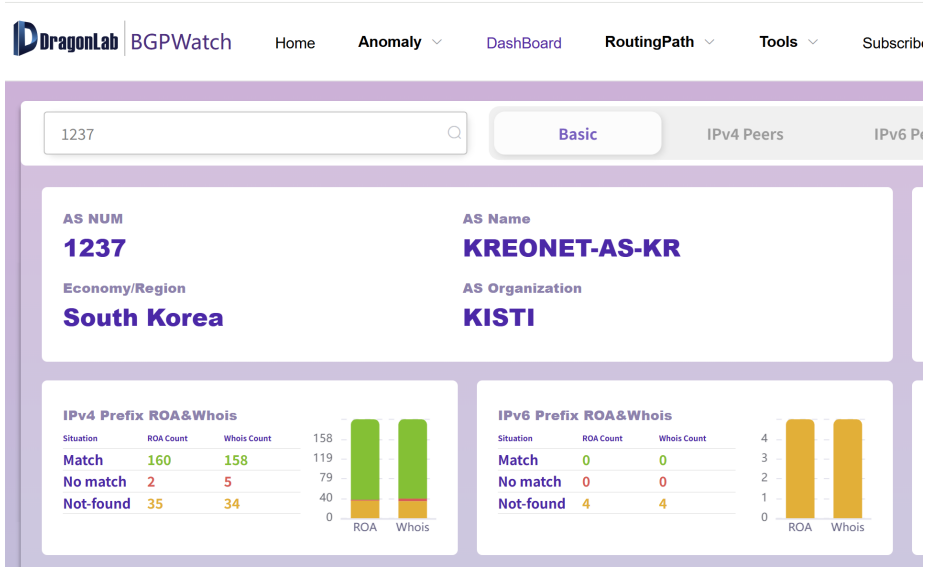
* For data transfer tests from KREONET Daejeon DTN endpoint
* No local account required



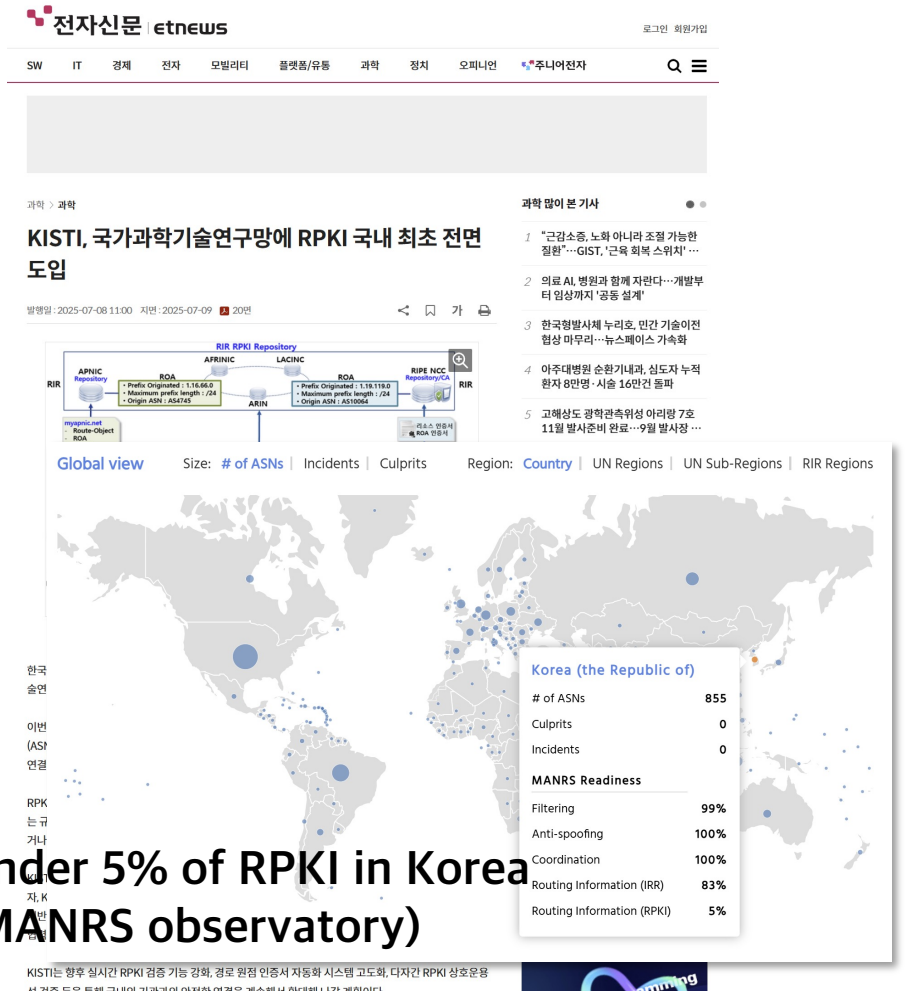
Contact: Dr. Wontaek Hong, KREONET advancement team

KREONET RPKI Deployment

- Created 186 ROAs
  - 160 prefixes for KREONET (as 1237)
  - 26 prefixes for KREONet2 (as17579)
- Built 2 Validators on KREONET
- Start to filter invalid route



- (News release) First RPKI Deployment, Korea

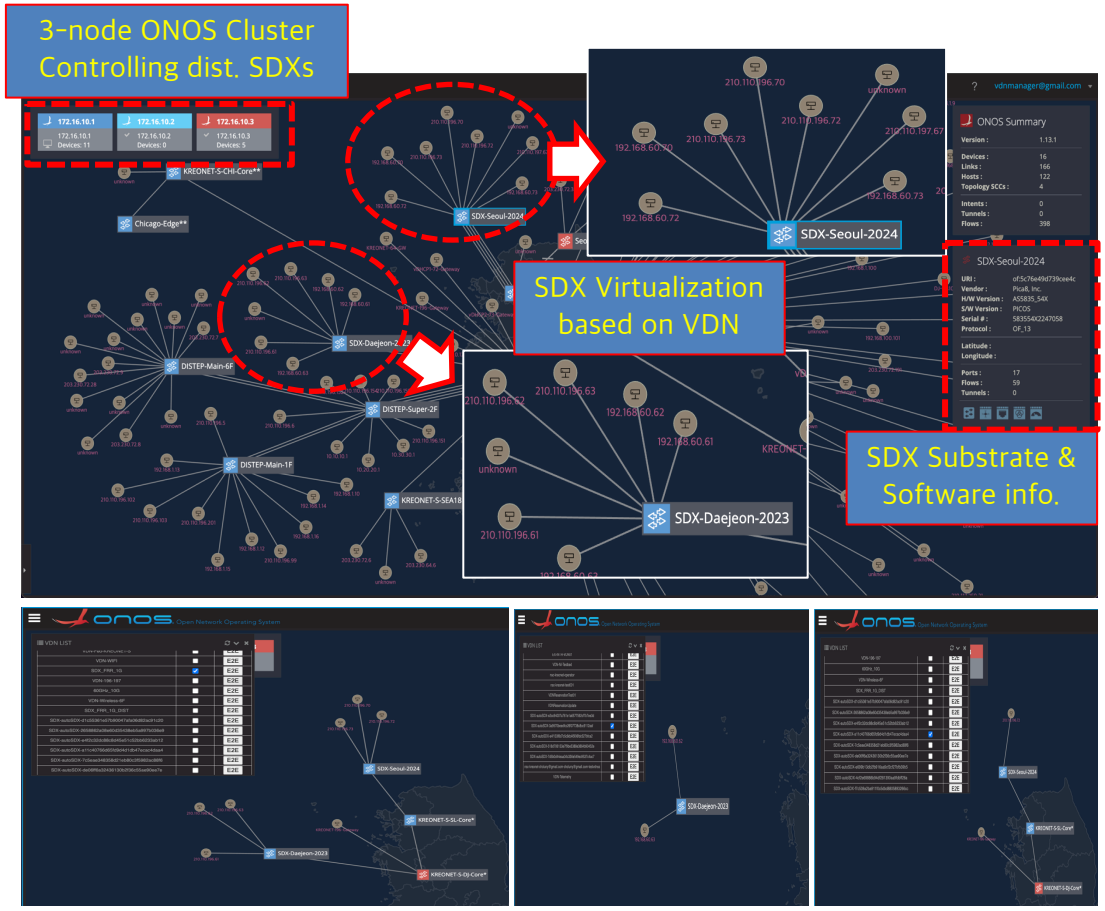


Under 5% of RPKI in Korea (MANRS observatory)

Contact: Chanjin Park, team leader of KREONET service team

Automated SDX Platform Development on NDeX in Korea

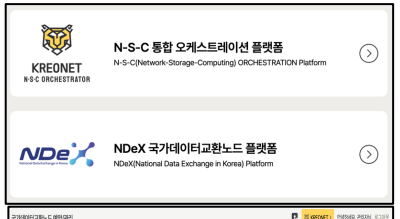
SDX Testbed Deployment based on KREONET-S/VDN

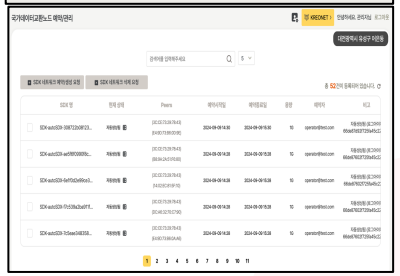


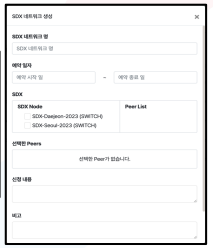
Automatically Generated SDX Peer Network Slices based on the Secured White List

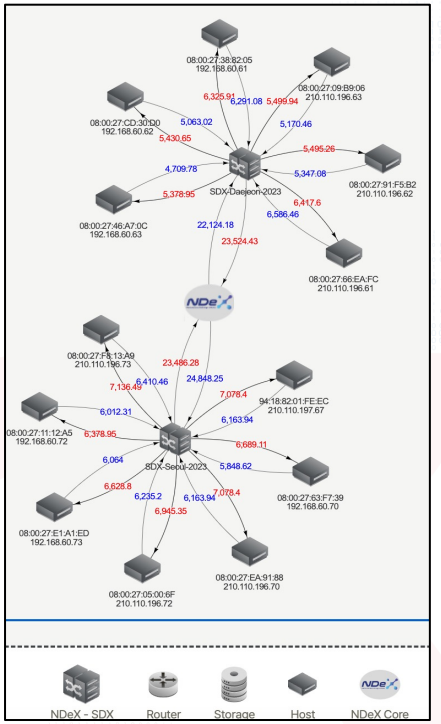
Data aware SDX Automation Platform

- Automated Slice Provisioning for selected Peers
- Automated SDX Resource Management on demand of real-time Data Flows
- SDX Resource Reservation (Calendaring)
- SDX Topology Visualization with Status Info.
- Security enhanced SDX-Peer White List









Contact: Dr. Dongkyun Kim, team leader of KREONET Advancement team

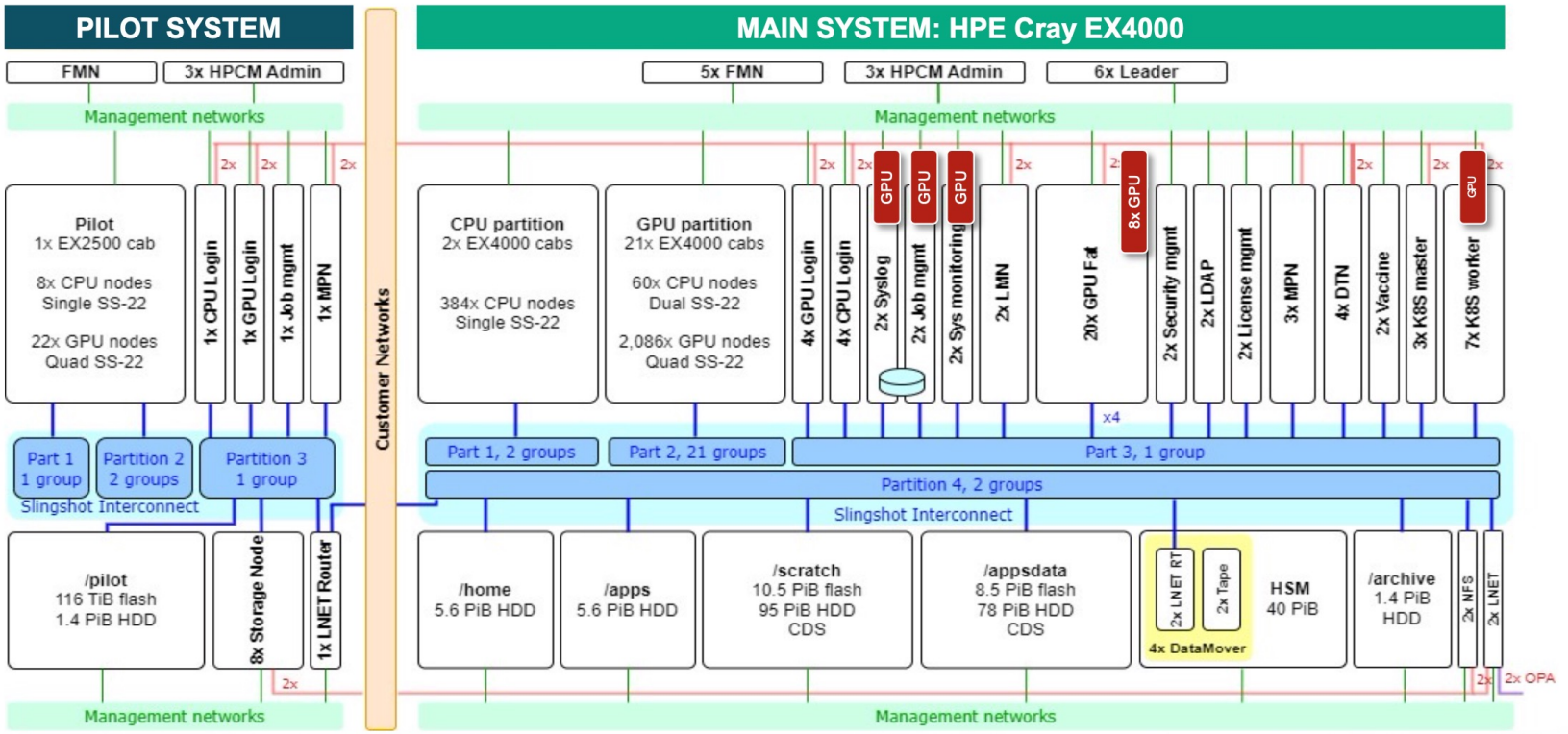
KISTI's 6th Generation National Supercomputer

614PF(FP64, peak) HPE Cray EX4000 System

GPU Partition 588.28 PF (4 GH200 x 2,084 nodes)
CPU Partition 15.72 PF (2 AMD Turin x 800 nodes)
GPU-Fat Nodes 10.72 PF (8 H200 x 20 nodes)
Pilot System 6.21 PF (4 GH200 x 22 node, AMD x 8 node)

205PB의 Cray ClusterStor Storage System

4 Lustre Parallel File Systems
21PB NVMe + 184PB HDD
Flash Read BW 9.0 TB/s, Write BW 6.5 TB/s



Beta Service: May 2026 ~

New KREONET Optical Backbone Network

- More than 800G per wavelength national-wide optical backbone network
- 400G per wavelength international backbone network in Korea - North America - (Europe)
- 100G & 400G (800G?) level user interfaces
- Pilot Service for Time & Frequency Transfer and Quantum Key Distribution
- Automation for the national-wide KREONET and GXP with NSI, SURF ultimate Provider Agent (SuPA) & NSO
- Trial Open Line System for a specific section (Seoul-Daejeon-Busan)
- KISTI's 6th Generation National Supercomputer, LHC ALICE Tier1 & new CMS Tier1, SKA & KRSRC, LSST, DUNE …
- AIOps: KREONET LLM (Domain Specific LLM)

Thank you.