

5rd Global Research Platform Workshop@Osaka

National Data eXchange and KREONET with Korea Research Platform

September 16, 2024

Buseung Cho, Ph.D.

Director, KREONET Center/KISTI
Associate Professor, UST
APAN Board of Director
GNA-G LT Member



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

As a specialized research institute of national S&T Information
Contributing to national S&T promotion and industrial development

Information Collection, Analysis,
Service on S&T and Industry

Research on Technology, Policy and
Standardization of Information

Establishment and
Operation of Advanced
Information Infra.

ScienceON, Access to Knowledge Infra.
for advanced R&D

science ON

GSDC

data·n

KREONET

nlS

KOAR



ASTi

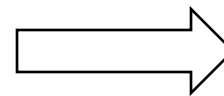
COMPAS

KoreaScience

STAR VALUE 5.0™

Major Research Areas

- National Supercomputing infra. and advanced technology development
- **National Science and research Network (KREONET) and global network**
- S&T Information collection, management and joint application
- Knowledge information DB and informatization
- Research and analysis of domestic and global S&T trends



KREONET Center

Director: Dr. Buseung Cho

Service Team

Team Leader: Dr. SeungHae Kim

Technology Enhancement Team

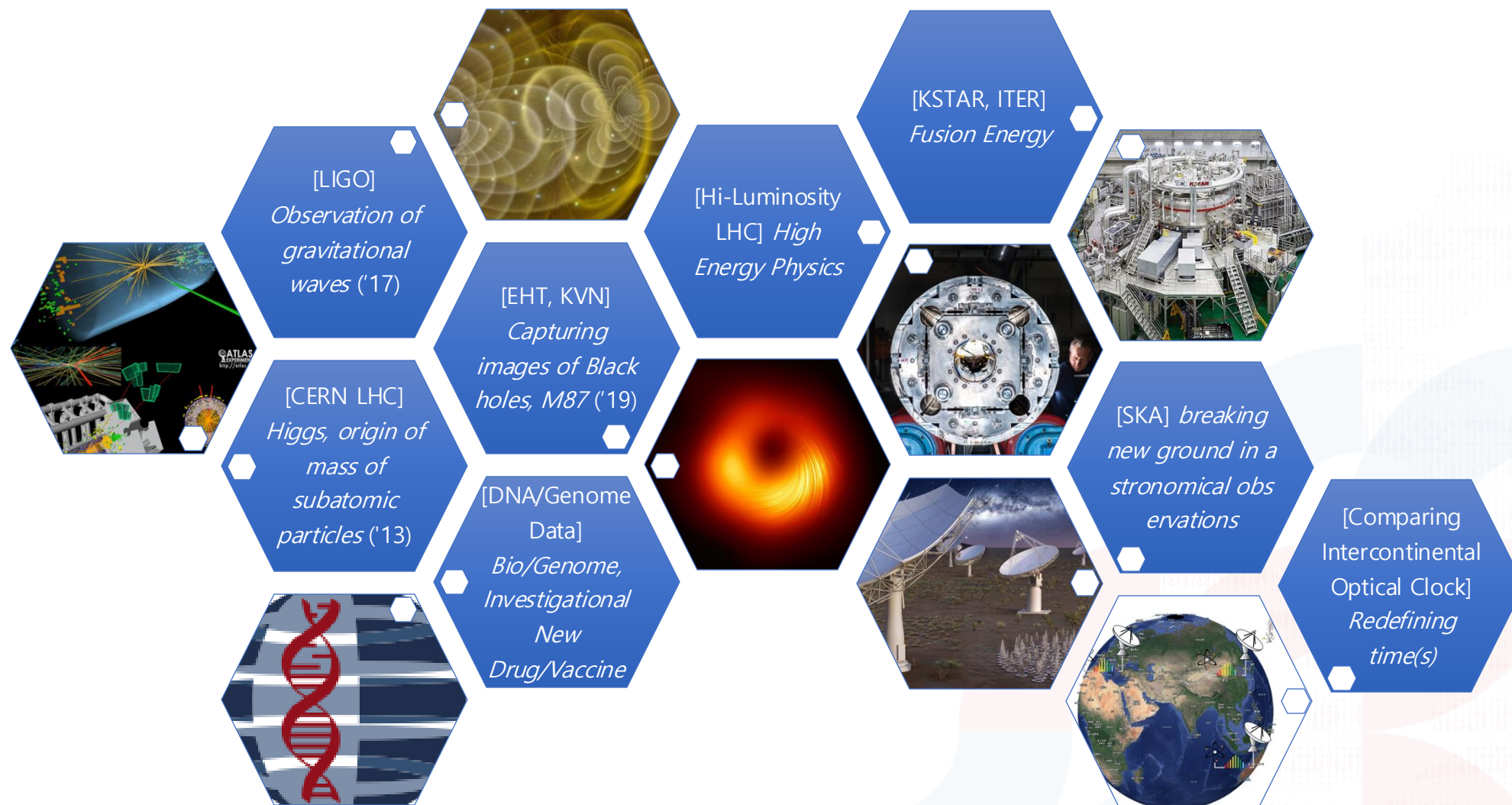
Team Leader: Dr. Dongkyun Kim

KREONET/KREONet2 (AS1237/AS17579)

- KREONET (Korea Research Environment Open Network)
- Korea's National Science & Research Network, managed and operated by KISTI since 1988
- Advanced Research Network in “Utilization and Promotion of National Supercomputing” Act (implemented in 2011 in Korea)
- **First 600Gbps wavelength national-wide optical backbone in Asia**
- **100Gbps/400Gbps national-wide backbone with 18 Domestic Regional GigaPoPs and 6 International GigaPoPs**
- About 200 connected R&E organizations : National Research Institute and Lab, University, University Hospital, Public library, Public Sector etc.
- 365*24 NOC (Network Operation Center) Service
- Directly linking domestic internet exchanges (KT, LG-U+, Sejoing Telecom) and international internet exchanges (GIX/Seoul, Cogent/Seattle, AMS-IX/Amsterdam, HK-IX/Hong Kong)
- Directly connected to network of public clouds (Google, Amazon, Microsoft)
- **L1 Lightpath, L2 VPN, L3 R&E IP service, Science DMZ**
- **National-scale ID Federation, Korea Access Federation (KAFF), a member of eduGAIN**

NDeX (National Data eXchange)



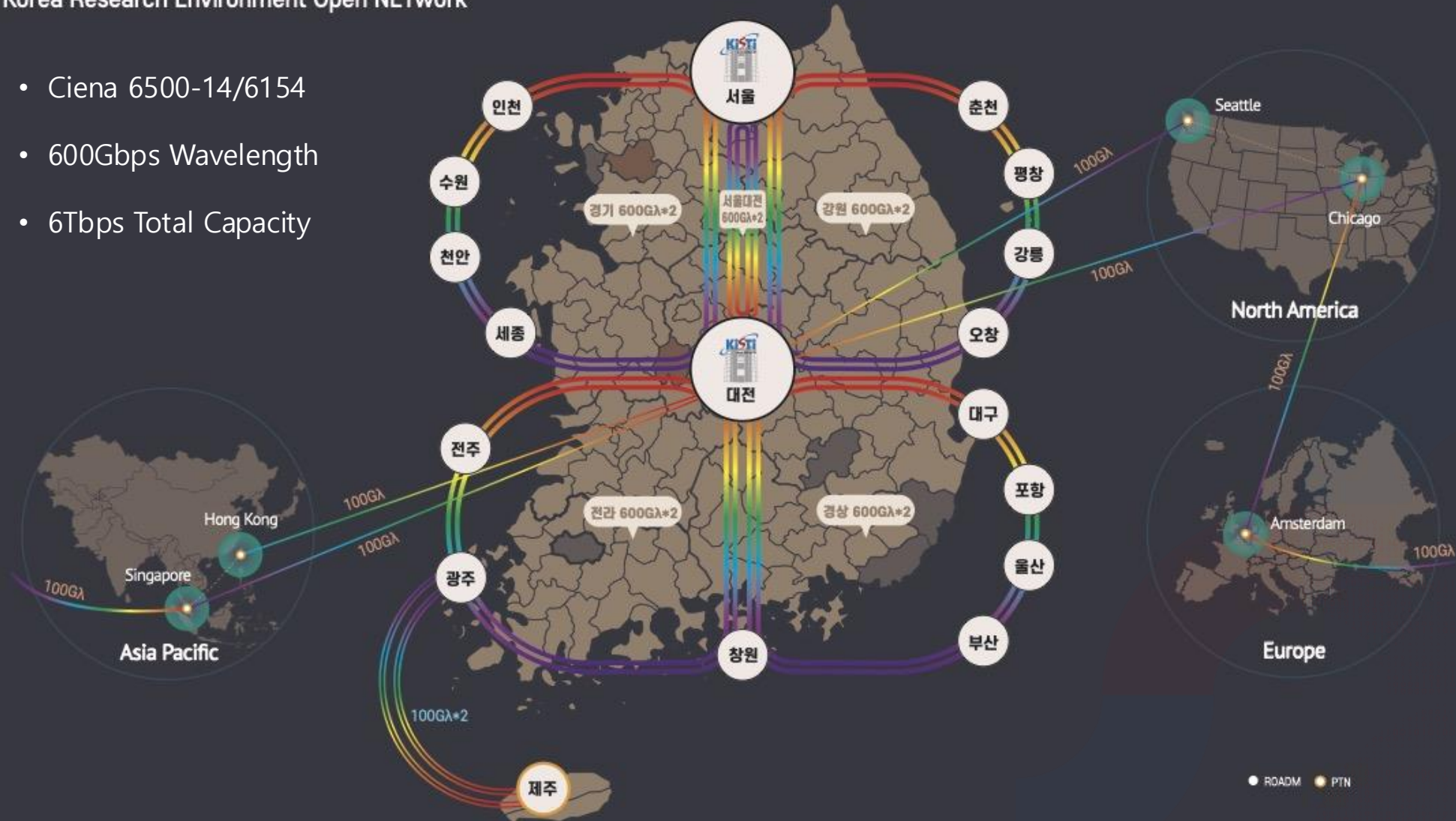


Big science, Data Intensive Science, Interdisciplinary research

KREONET Optical Backbone 2023

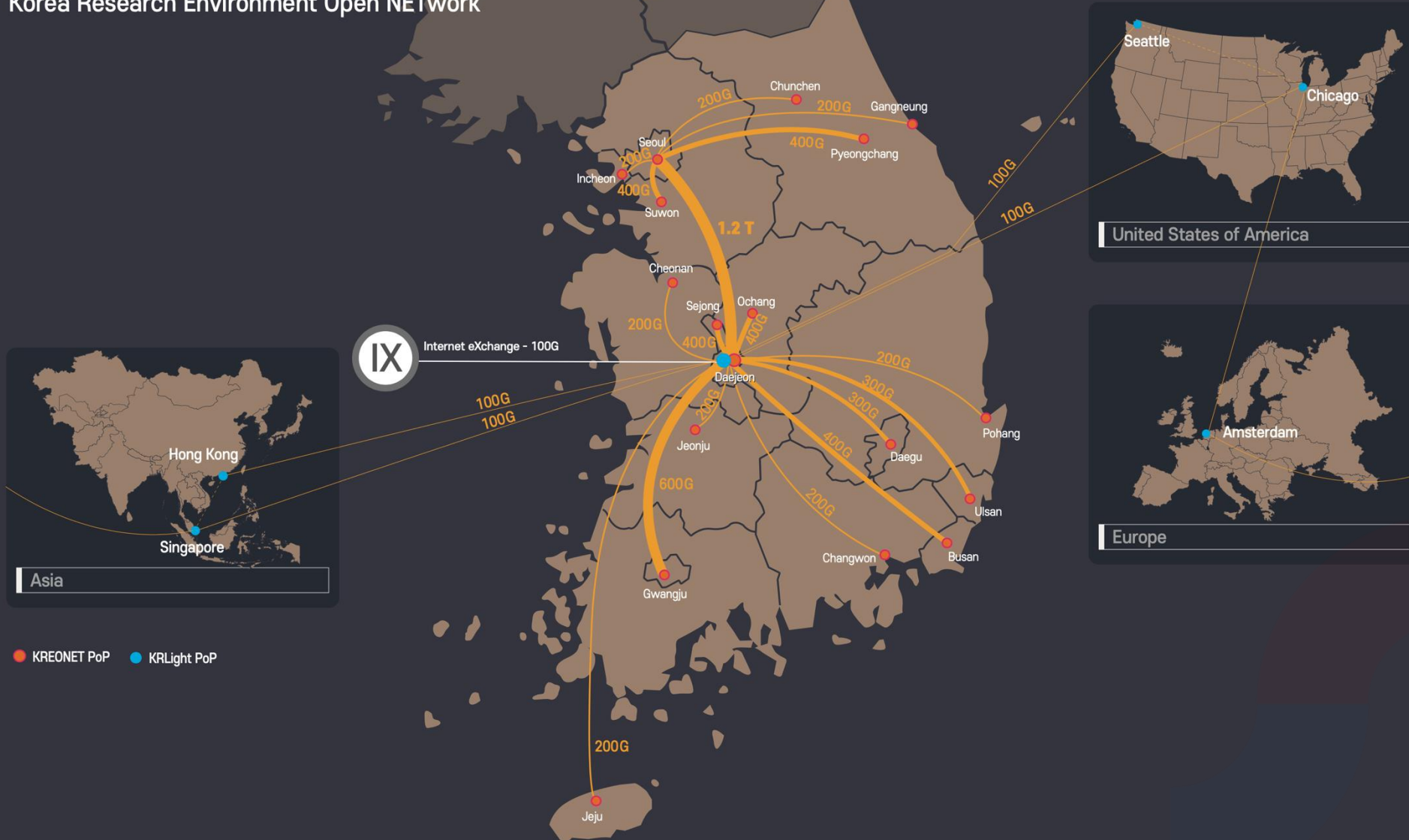
Korea Research Environment Open NETwork

- Ciena 6500-14/6154
- 600Gbps Wavelength
- 6Tbps Total Capacity



Map of KREONET 2023

Korea Research Environment Open NETwork



100/400Gbps L2 Inter face

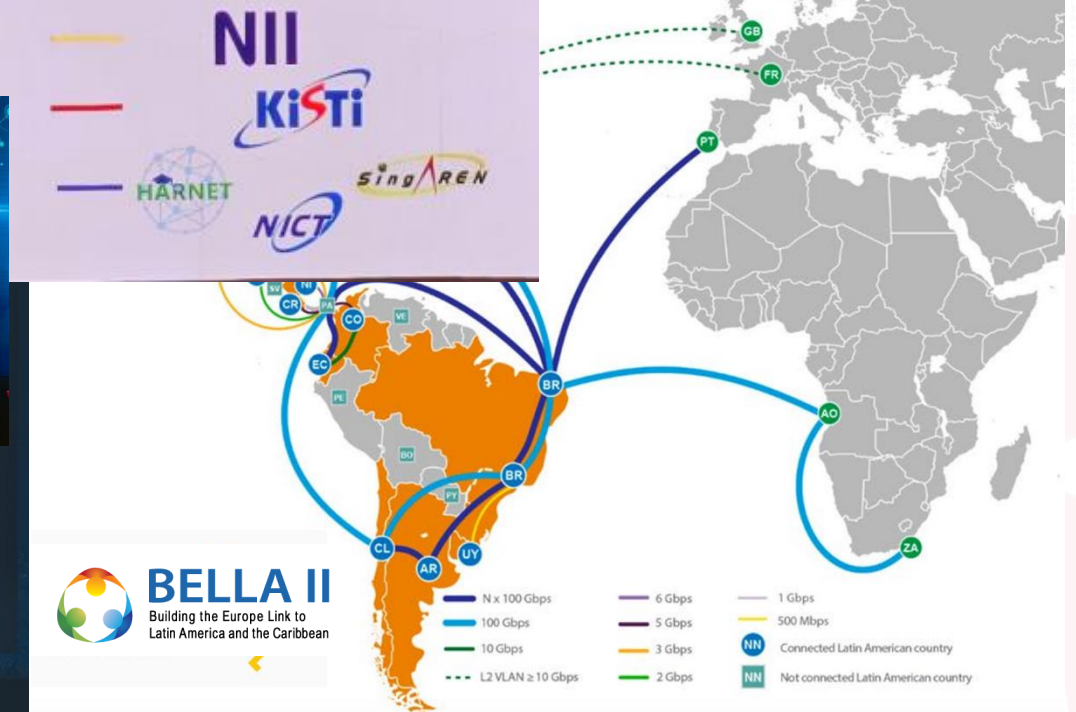
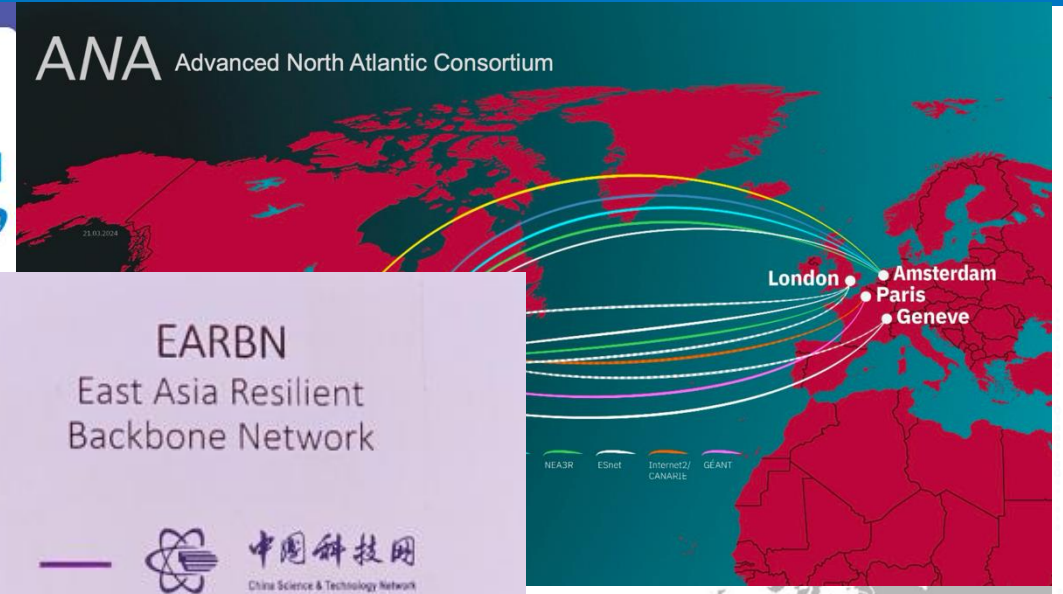
Segment Routing

- L2/L3 VPN
- TI-LFR, 50ms protection

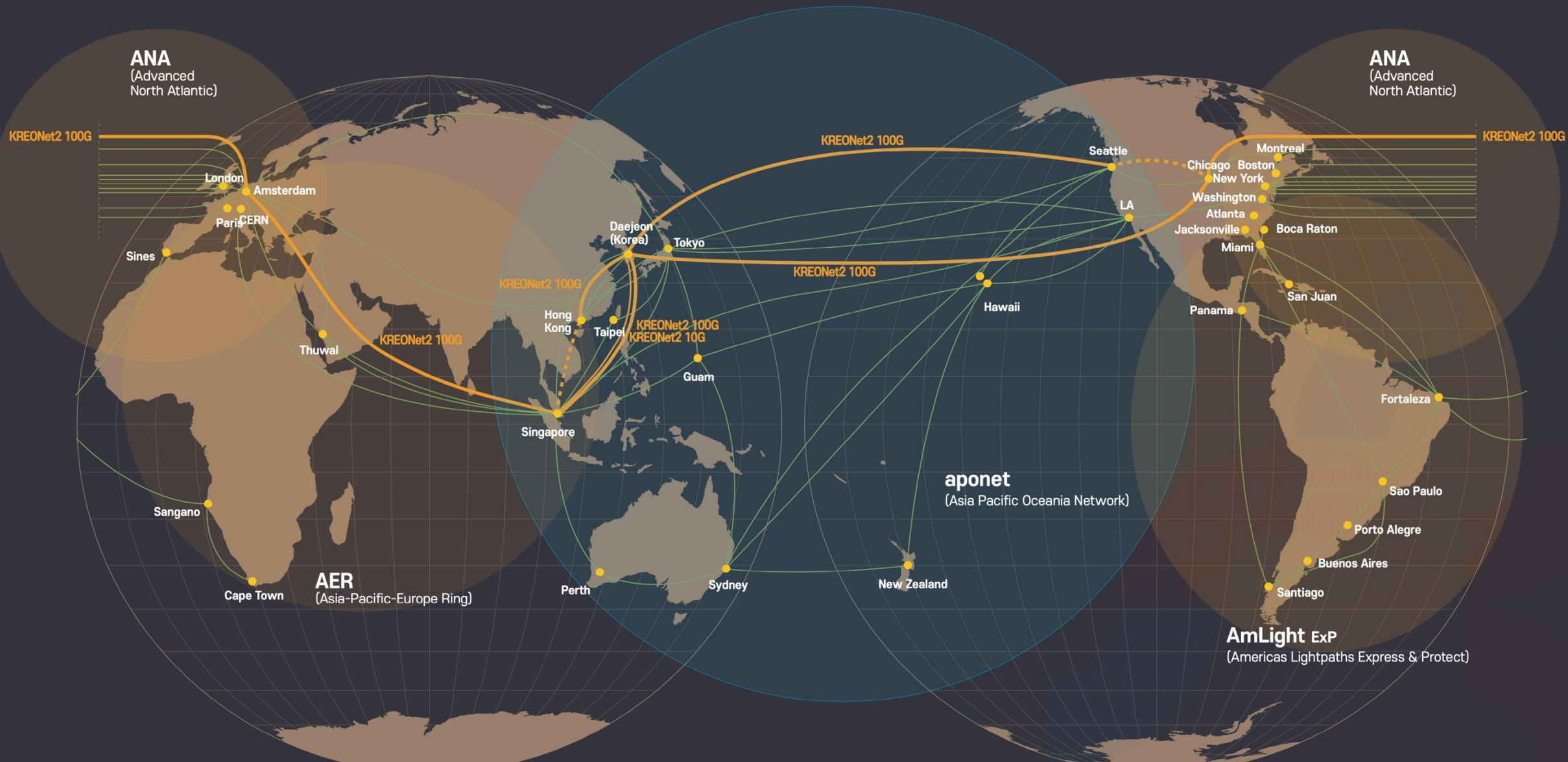
198 Members

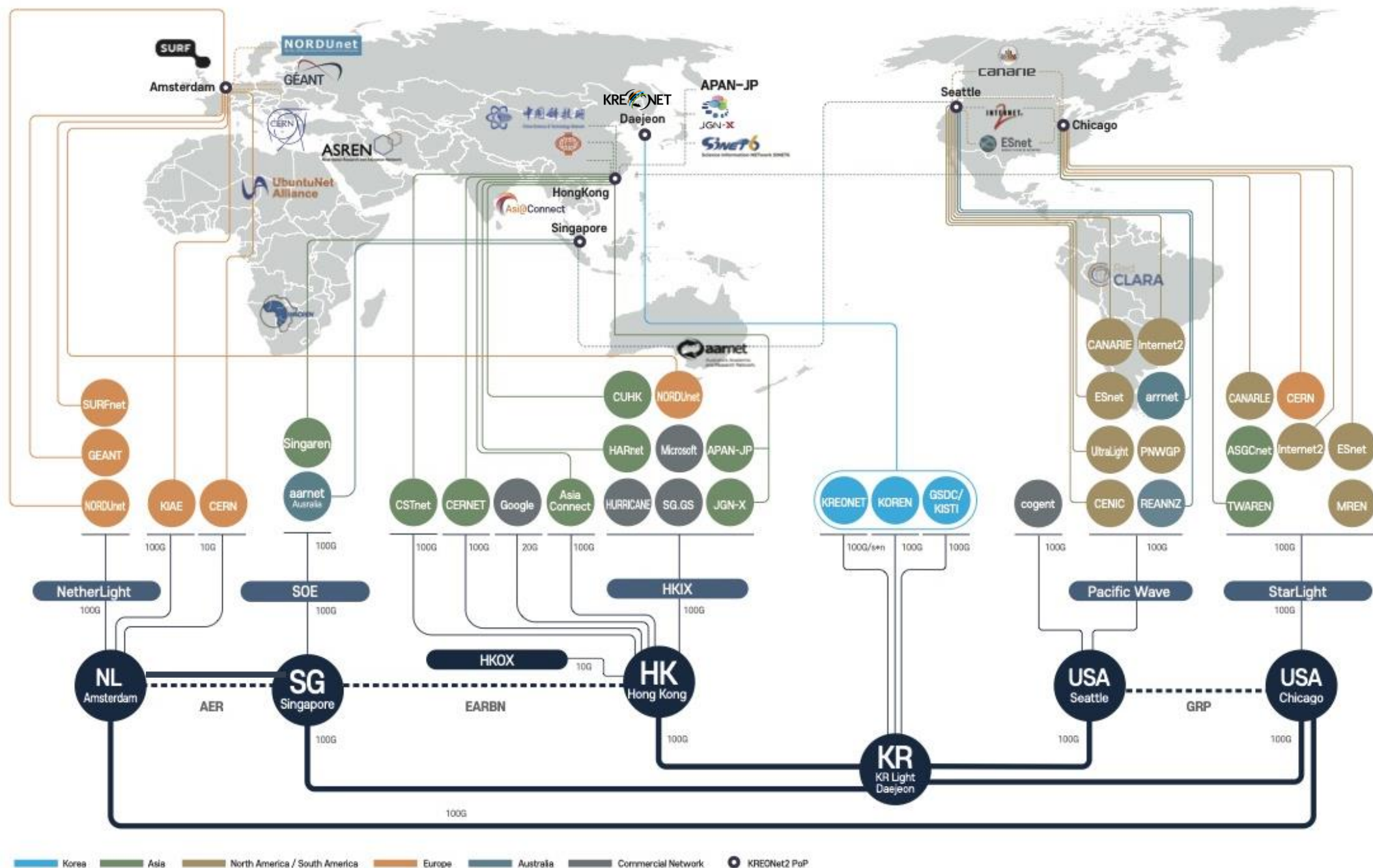
- National R&D Lab.
- University
- University Hospital
- Public Organization such Library, Science Museum etc.

Network Automation
(for Configuration)

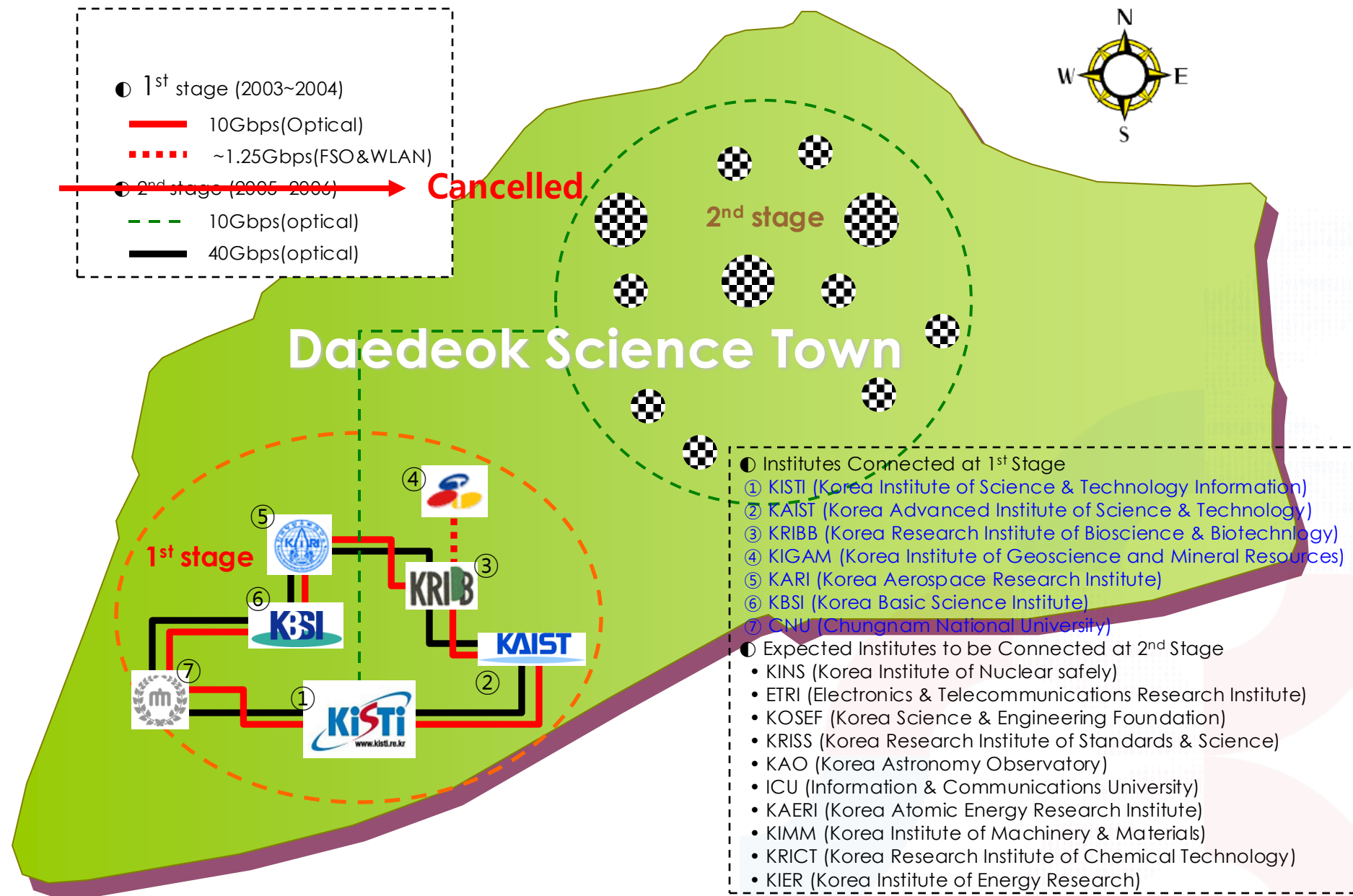


Map of KREONET2 2023

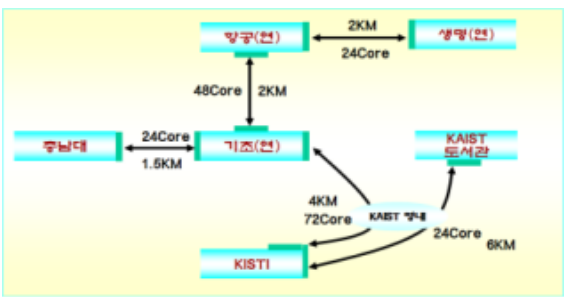
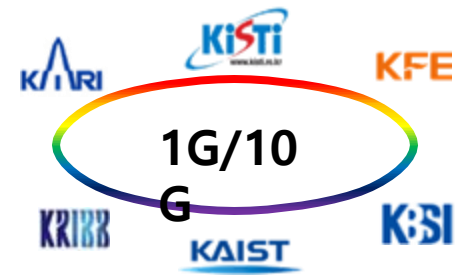




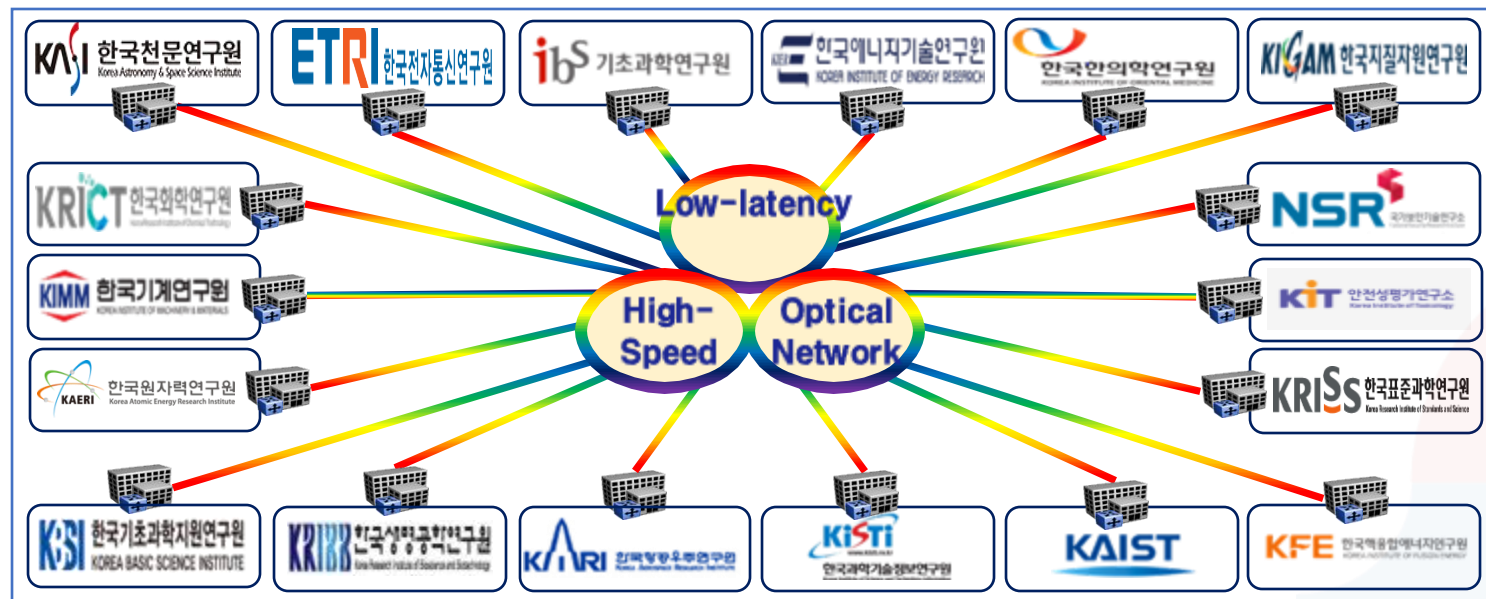
- Metropolitan Area Science Network based on Optical Fiber covering Daedeok Science Town, in Daejeon City



AS-IS
(SuperSIReN I)



TO-BE
(SuperSIReN II)



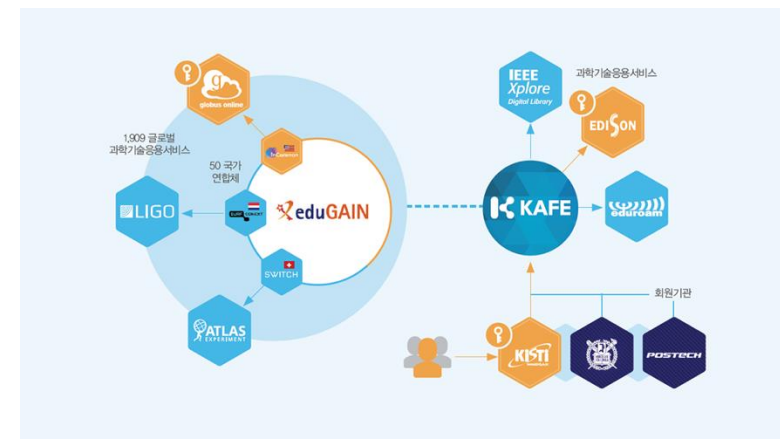
Service and Application

- 5G+/6G, AI, Trust Networking
- Seismic Sensing with Fiber
- Optical Frequency Transfer
- Precise Timing Distribution
- 100G/400G/800G Transportation
- Quantum Comm./Quantum sensing

Trust and Identity: Korea Access Federation (KAFE)



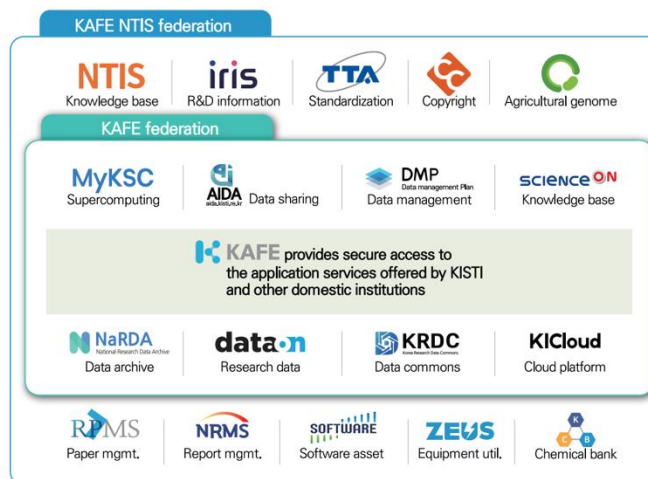
KAFE Members



4,500

Inter-federated members
(CERN, CILogon, etc)

KAFE for national cyber-infrastructures

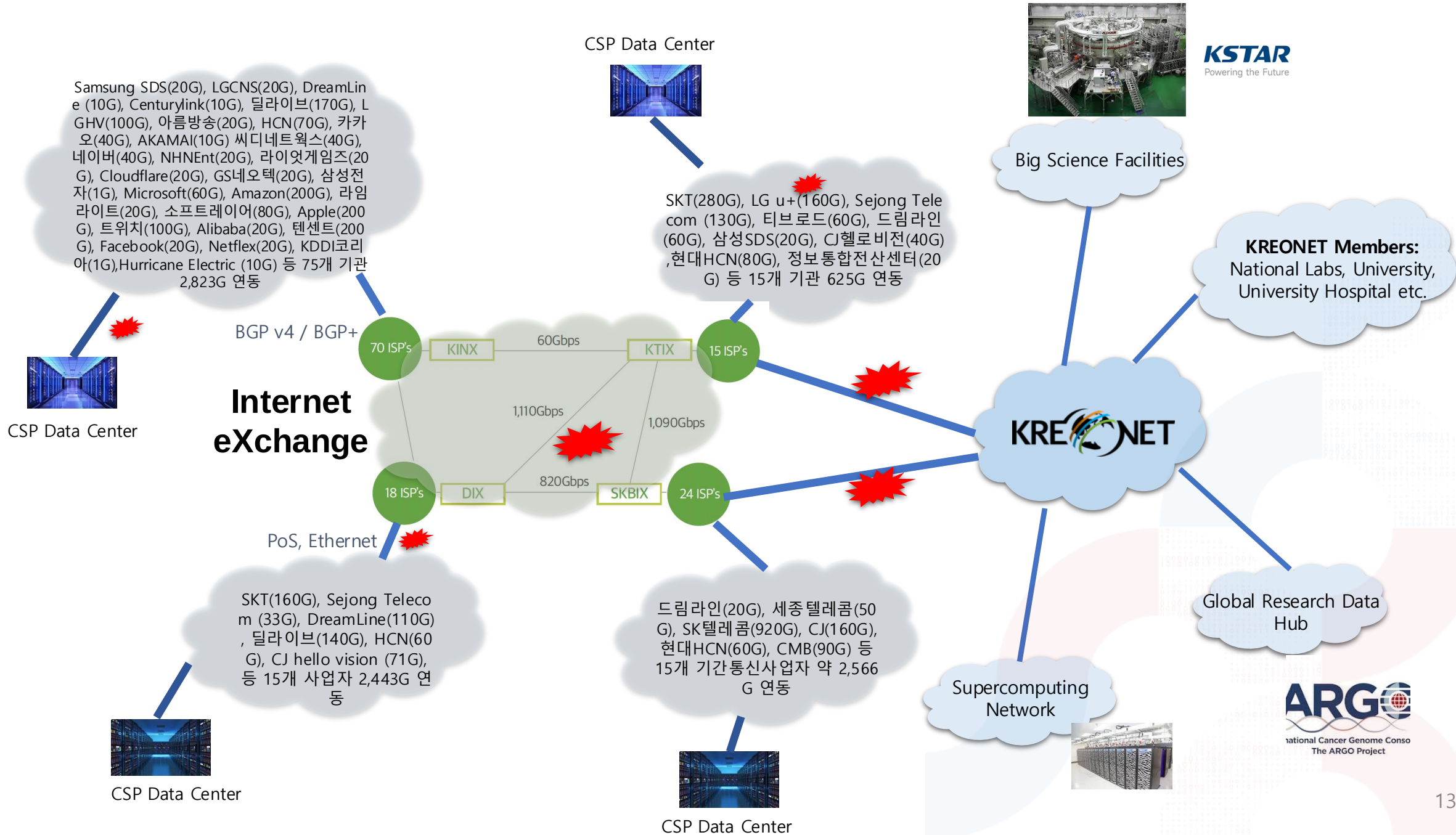


R&D activities: IAM platforms for cyber-infrastructures

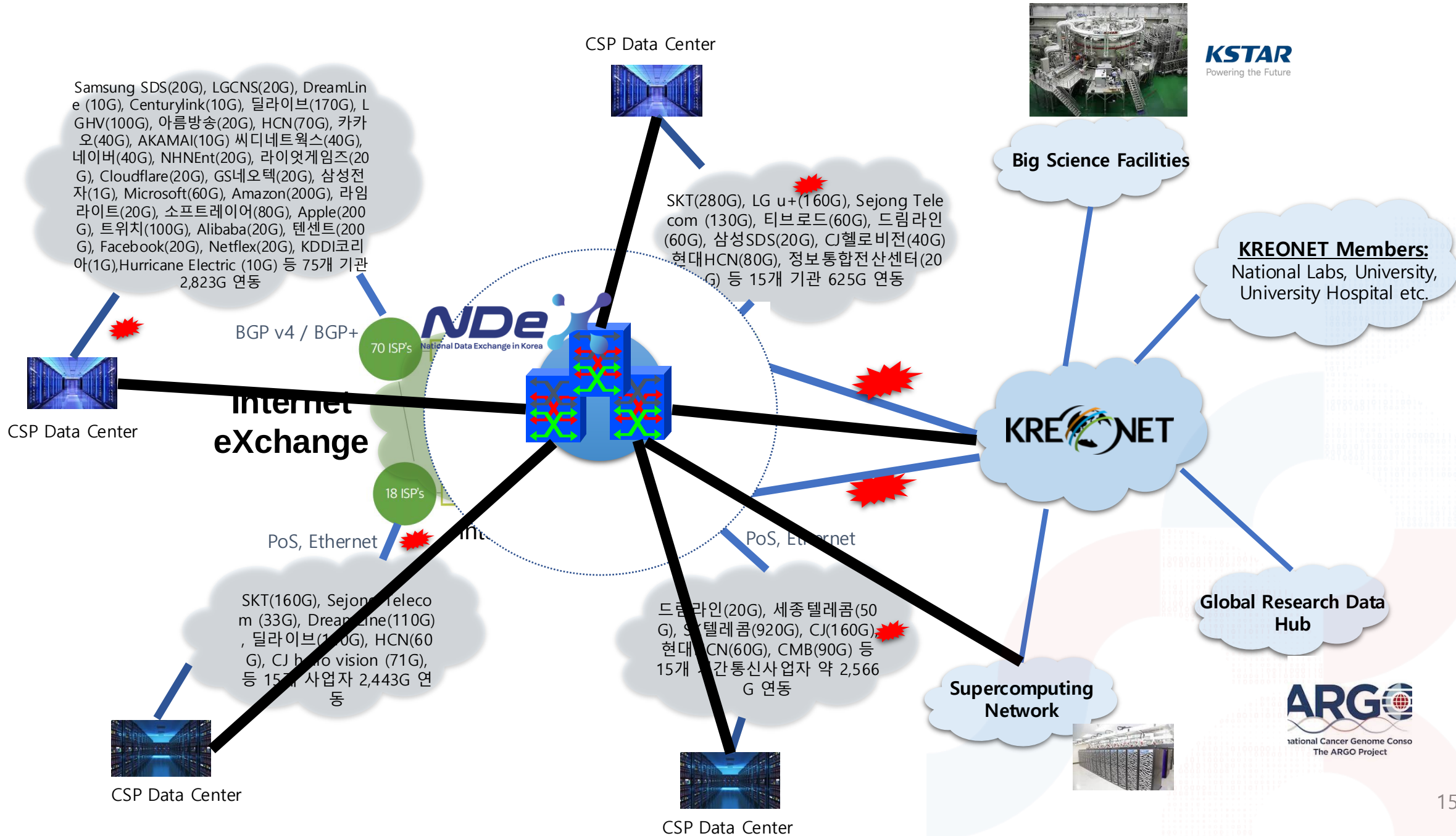


trustHUB: national T&I HUB
service for science apps.
e.g, CILogon

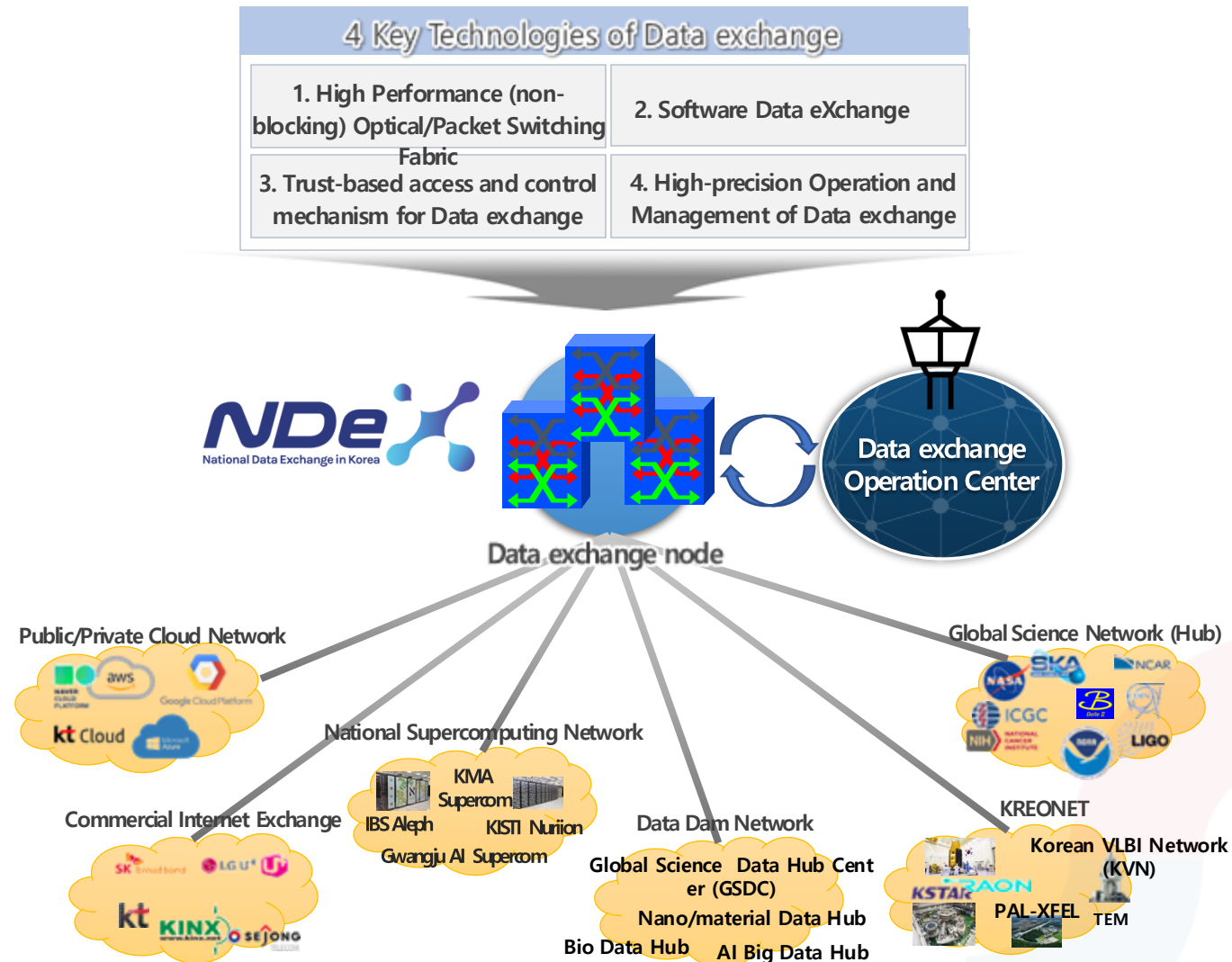
Keycloud: IAM platform for big-
science infrastructures
e.g., Keycloak, INDIGO IAM



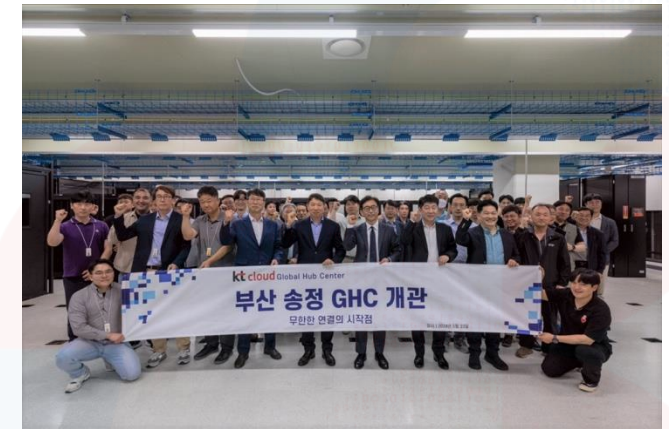
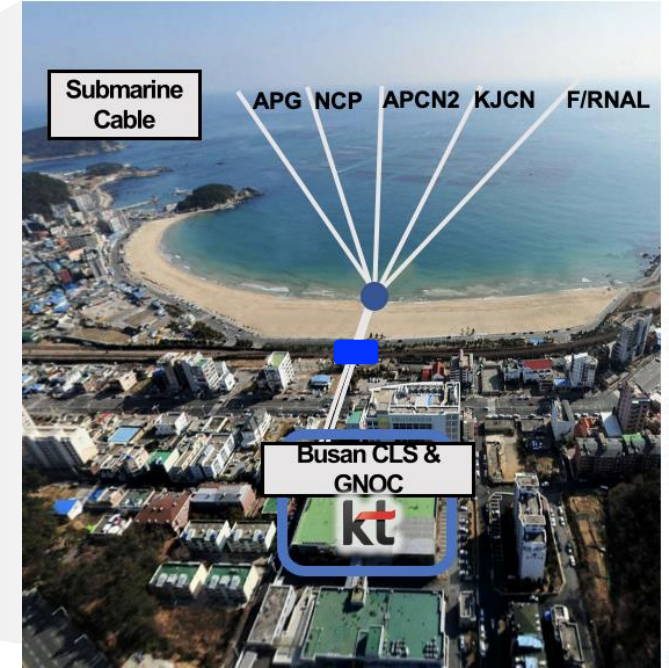
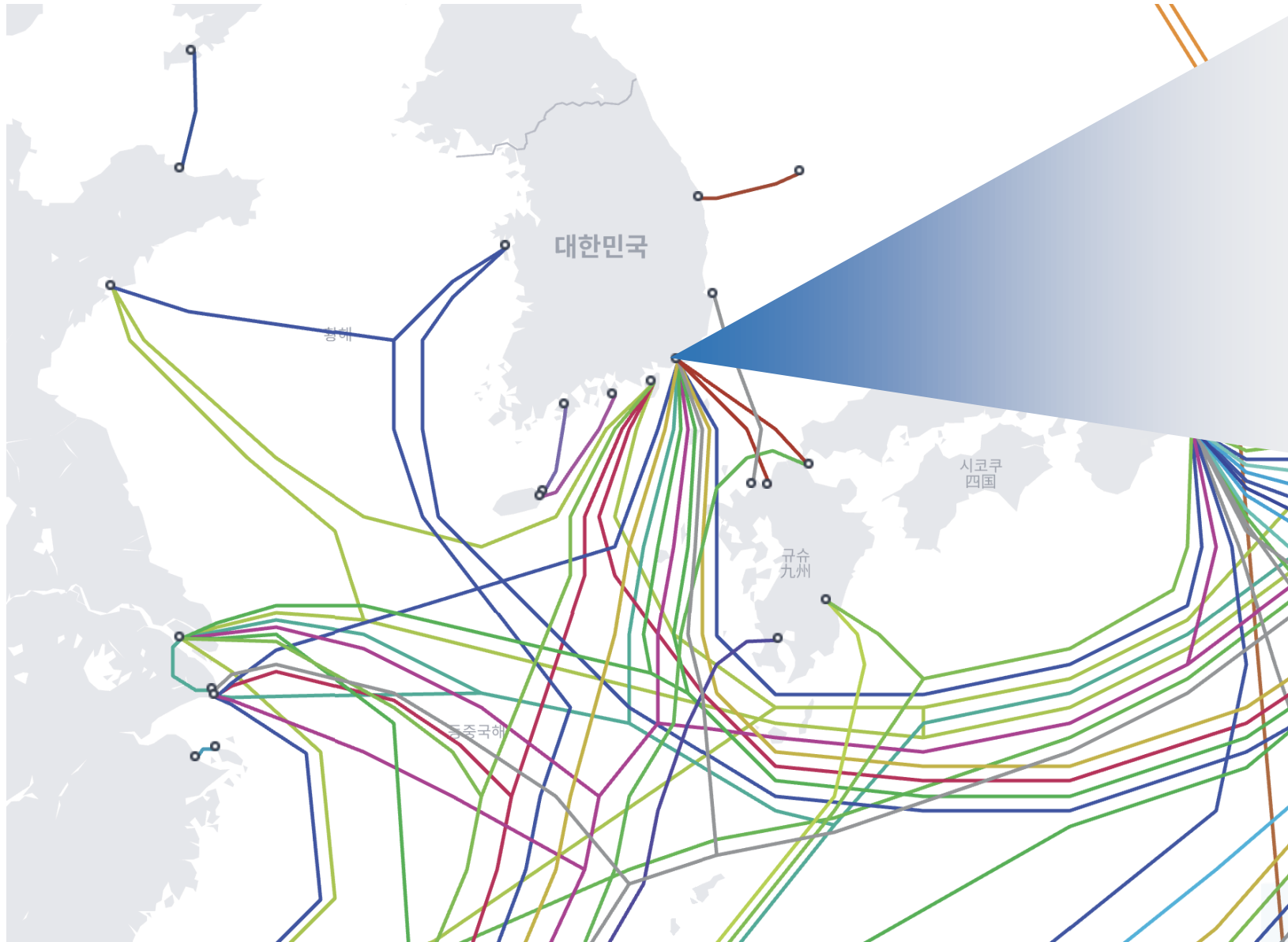
- Challenges
 - Big Gap between Commercial Internet and Non-commercial network
 - Difficulty to directly accessing datacenters of CSP via IX
 - Lack of colocation space for R&E network and CSP network
- Solutions: National Data eXchange (NDeX)
 - Conceptually one big switch
 - Directly connects KREONET/KREONet2 and CSP networks including supercomputing centers with multiple 100G/400G
 - Providing carrier-neutral colocation spaces nearby submarine landing station and CSP's datacenter operated by KISTI
 - Renewal and expansion of KRLight



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

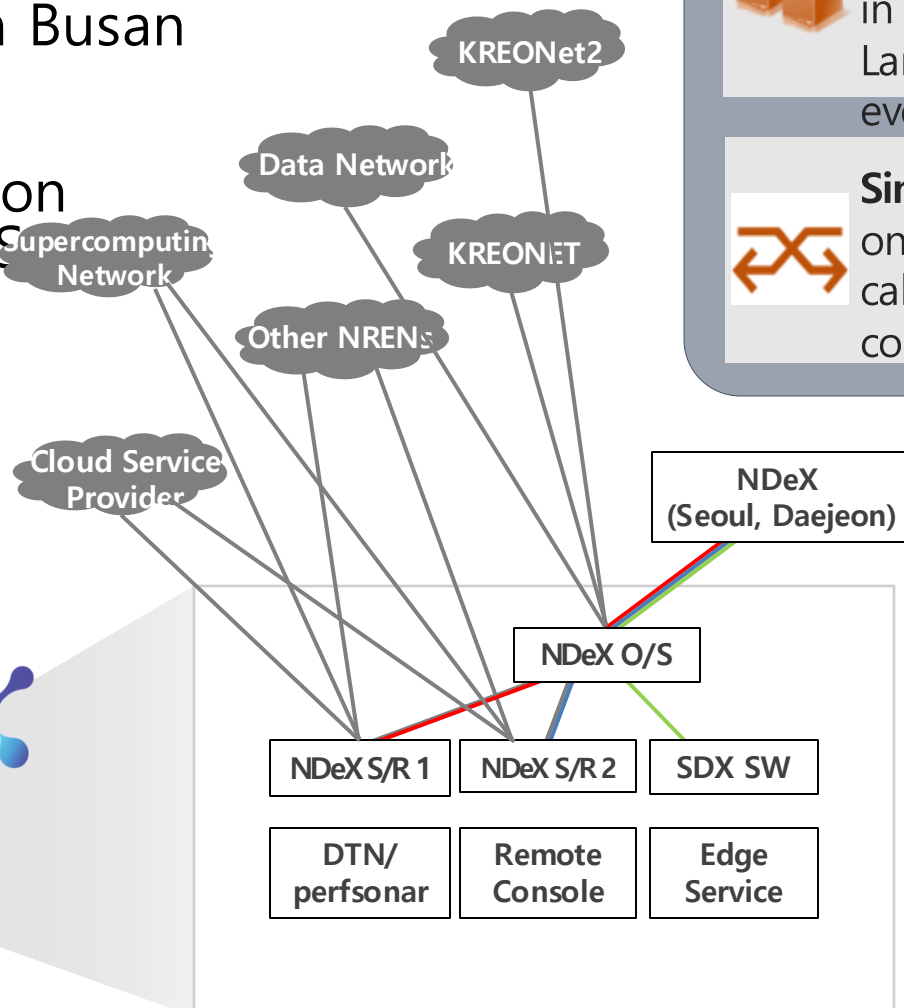


What Happened at Busan Cable Landing Station (CLS), Korea.



Opening Ceremony of **KT Cloud's SongJeong GHC (Global Hub Center)**
as HCX (Hyper Connectivity eXchange)

- **First Open eXchange** in Korea co-located with KT Cloud/KT next to the largest submarine cable landing station (CLS) in Busan
- 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

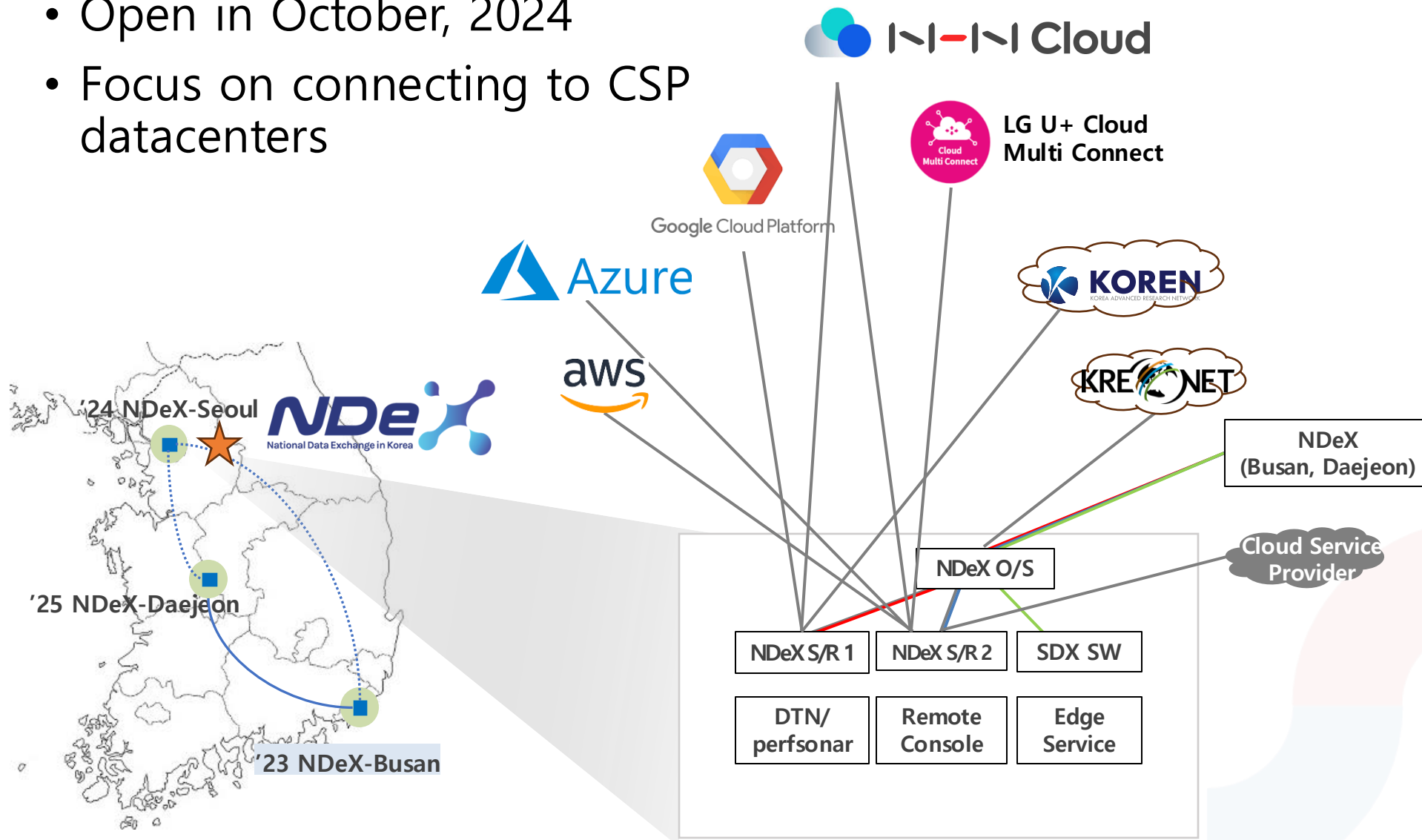


Operated by Experts Group of Submarine Cable NOC (KT/KT Cloud) and KISTI

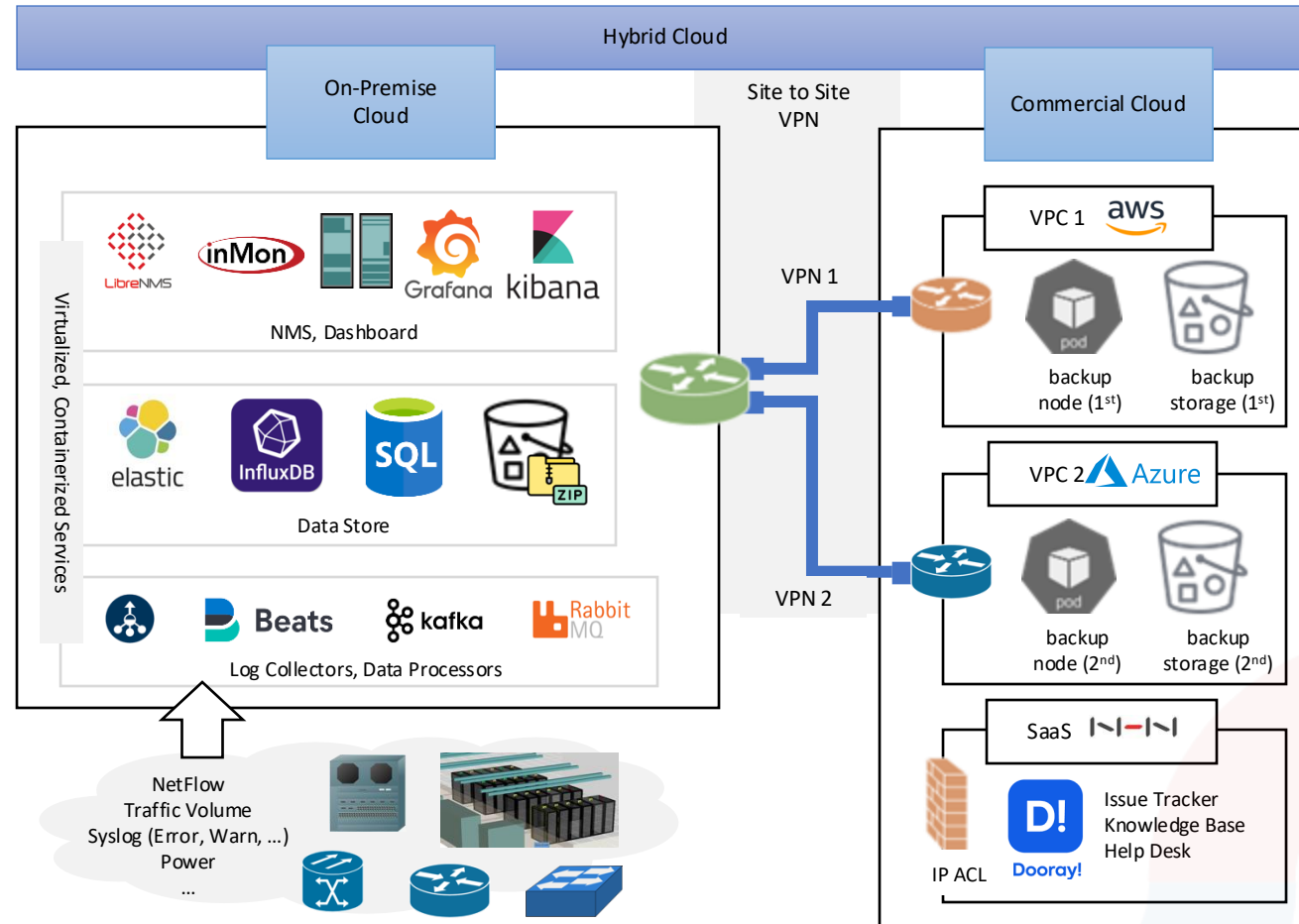


Opening Ceremony of NDeX
in Busan, Sep. 9, 2023

- Open in October, 2024
- Focus on connecting to CSP datacenters



Carrier-neutral Mega Datacenter



*National
Supercomputer*



"NURION"
Supercomputer
@KISTI

*[Weather, climate,
environment]*



Meteorological
Supercomputer
@KMA

*[autonomous
driving]*



"Dream-AI"
Supercomputer
@GIST

[Space]



"Olaf"
Supercomputer
@IBS

*[Nuclear Fusion
E& Accelerator]*



"KAIROS"
Supercomputer
@NFRI

[Material & Nano]

UNIST

Supercomputer
Center
@UNIST

[Life & Health Care]

"NABIS"

Supercomputer
@National Institute
Agricultural Sciences

[disaster]

...

**<National Supercomputing Center &
10 Specialized HPC Centers>**

kt Cloud



Google Cloud Platform



Cloud



NAVER
CLOUD
PLATFORM



aws



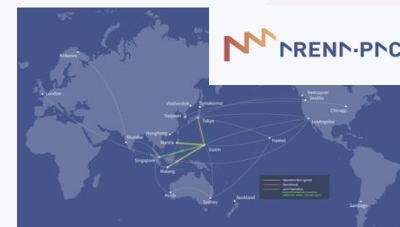
Microsoft
Azure



Gwangju AI Datacenter

Samsung Cloud Platform

<CSP Network>



NREN-PNC



NRENs from US, Asia-Pacific, others

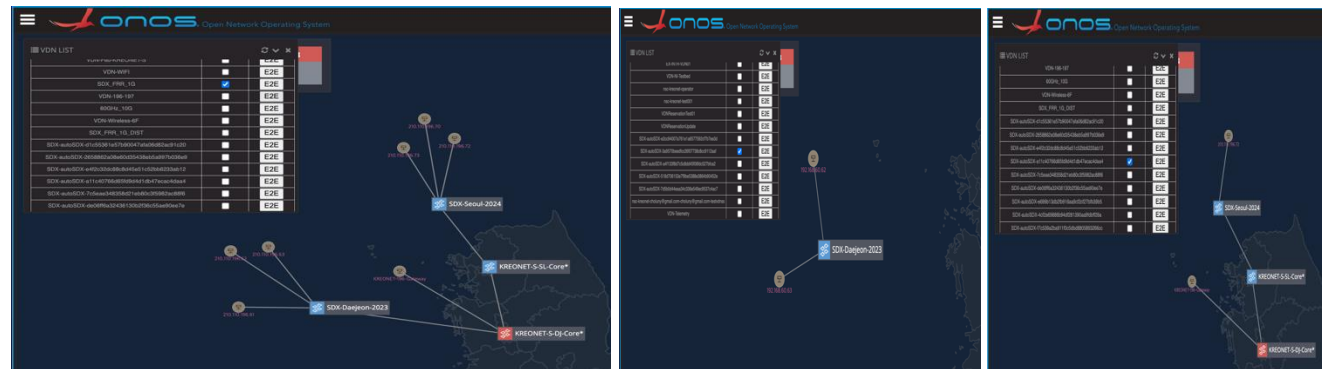
<Research Network>

- L1/L2/L3 transit, IB?
- NDeX ps
- NDeX Globus Connect Service
- Software Defined eXchange
- Open Storage Network
- Hybrid Cloud
- ...

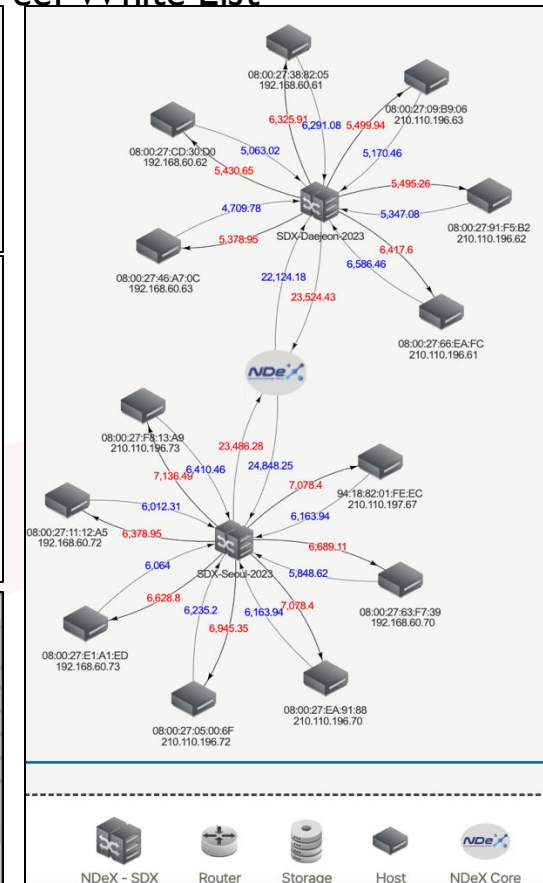
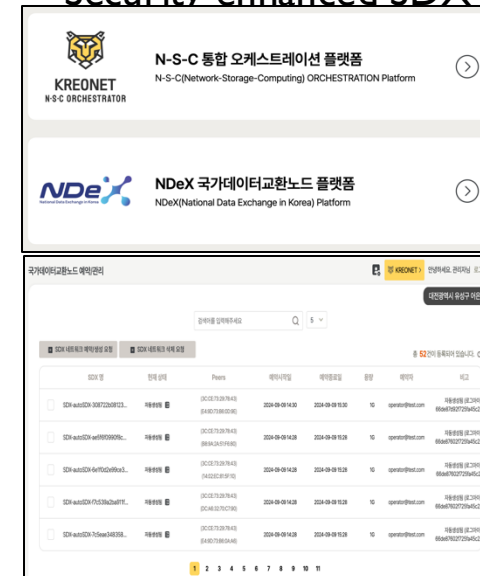
3-node ONOS Cluster Controlling dist. SDXs



SDX Substrate & Software info.



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



시스템 현황

대전광역시 유성구 어은동

VDN 50	Flow 412	Host 122
Device 16	Link 166	SDX 28

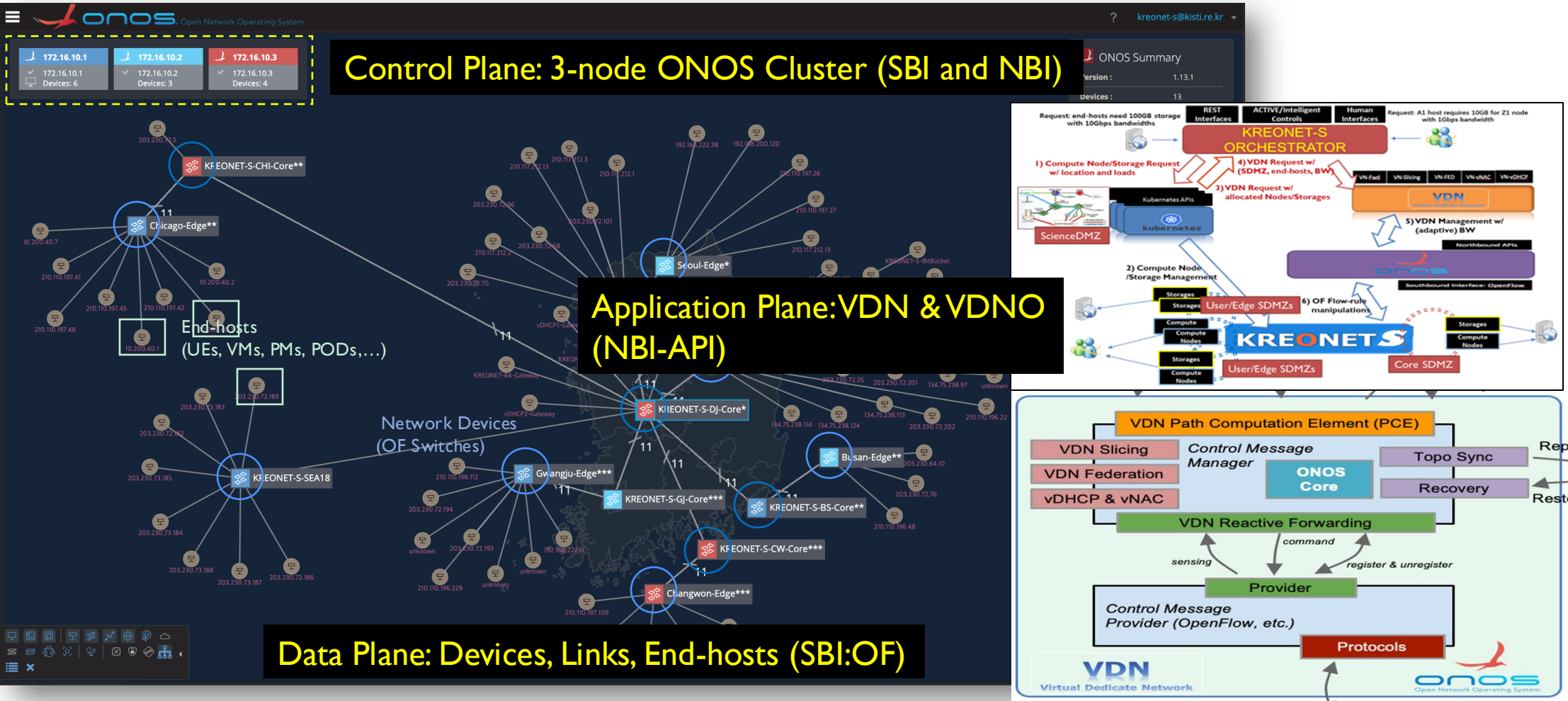
SDK 네트워크 명칭	
SDK 네트워크 명	
SDK 네트워크 명	
제어 할지	- 제어 종료 할
제어 시작 할	
SDK	
SDK Mode	Peer List
SDK Channel-2023 (SWITCH)	
SDK Switch-2023 (SWITCH)	
상대편 Peer	
상대편 Peer가 없음(0)	
상대 -188	
비고	

Diagram illustrating the components of the NDeX architecture:

- NDeX - SDX
- Router
- Storage
- Host
- NDeX Core

Contact: Dr. Dongkyun Kim

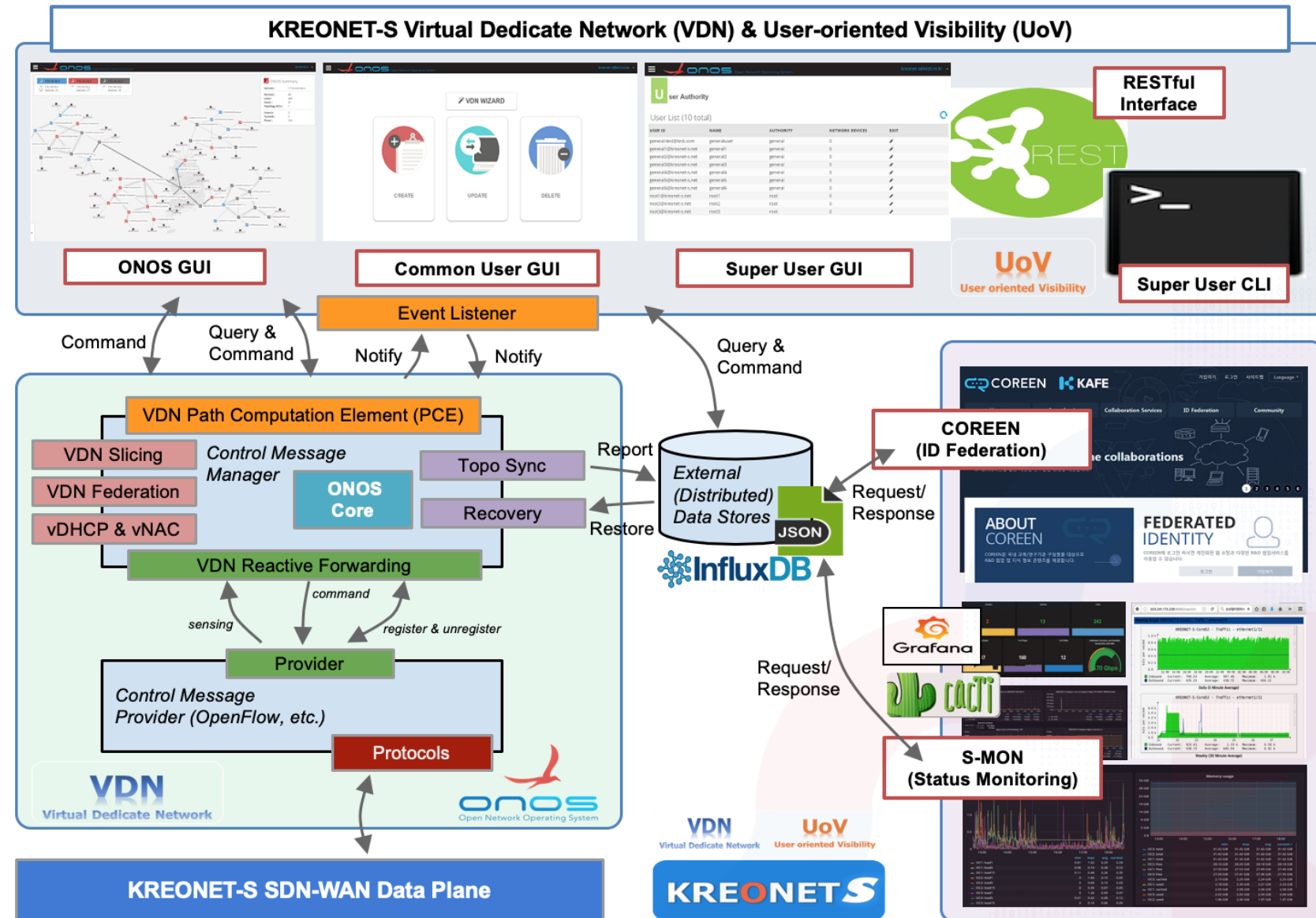
Nation-wide SDN Environment for Advanced R&E Community over KREONET in Korea



Global Network Topology View of KREONET-S in ONOS GUI

Virtual Network & Resource Embedding

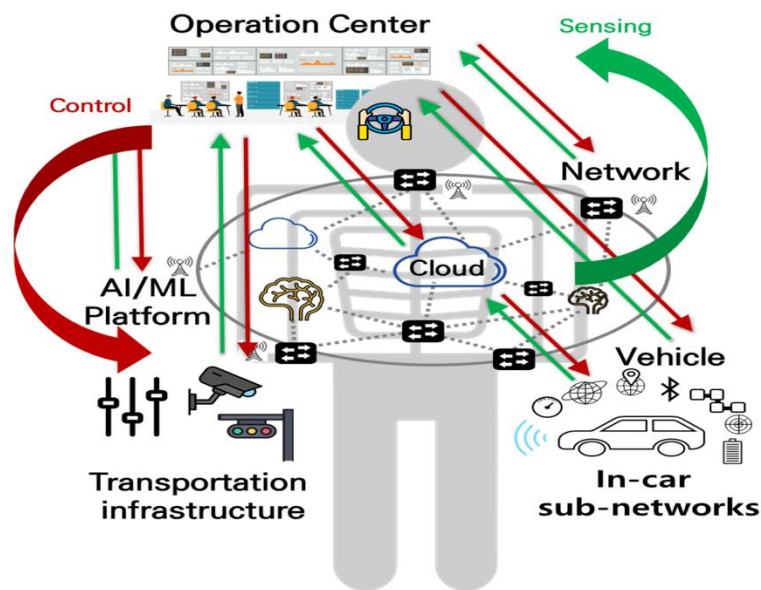
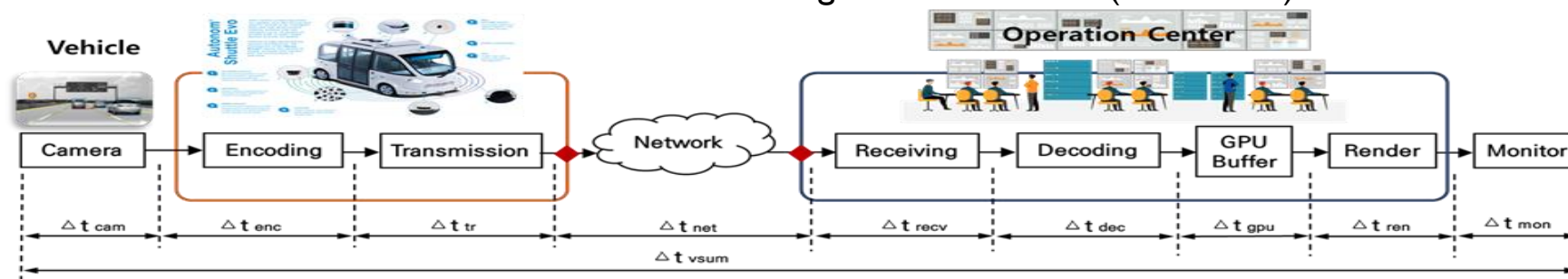
- **Automated End-host/UE Awareness** for Accurate Access Control
- **Strictly Isolated and Dedicated Networking** with High Performance (~100Gbps)
Guaranteed and Strict E2E Network Security Provided





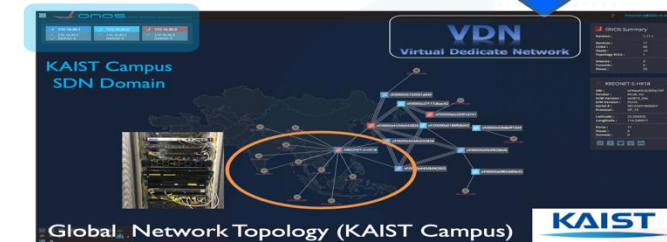
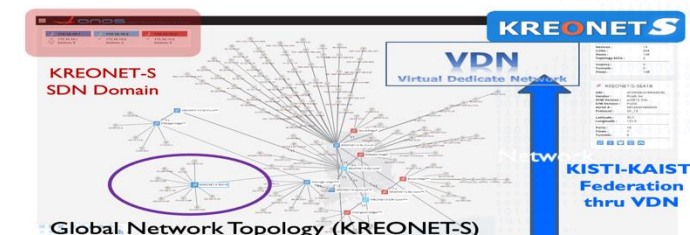
SDN-based Private 5G (5G+) Network Deployment in KAIST Campus

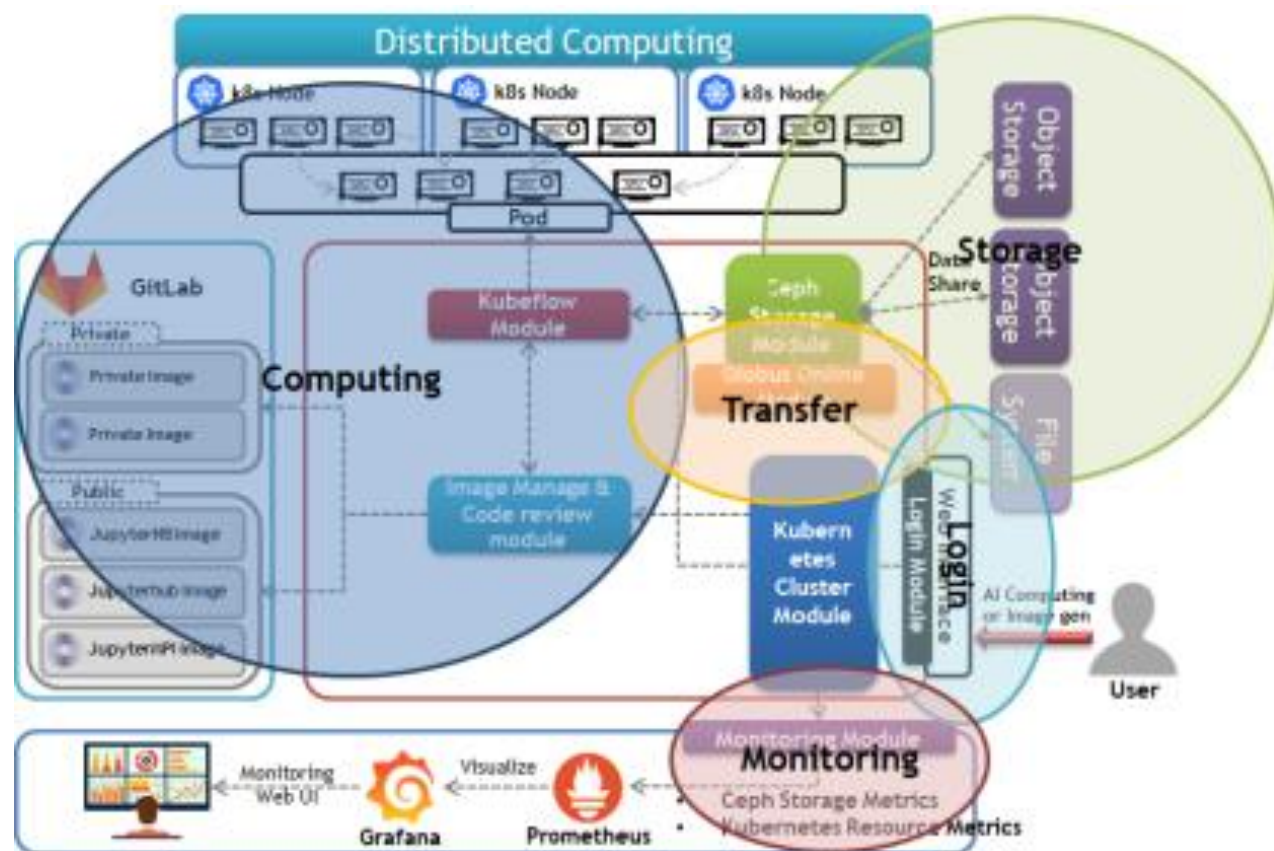
- Upstream and Downstream Transmission: Autonomous Vehicles and Edge Computing Facility (Remote Steering/Operation Center)
- Upstream: Real-time Video/Sensor Data to Operation Center (~250Mbps for each Car)
- Downstream: Real-time Remote Control & Steering Data to Vehicles (~2ms RTT)

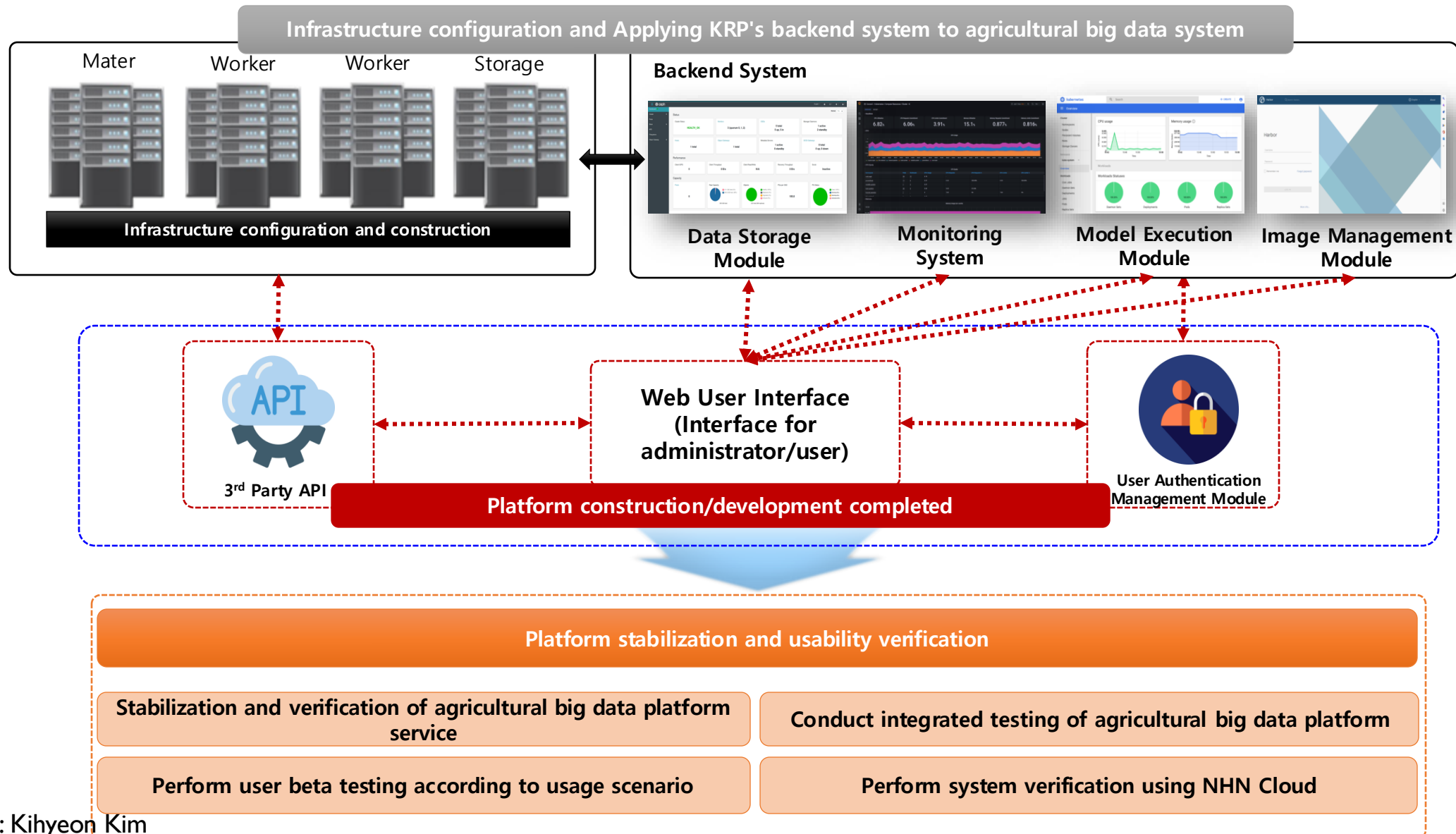


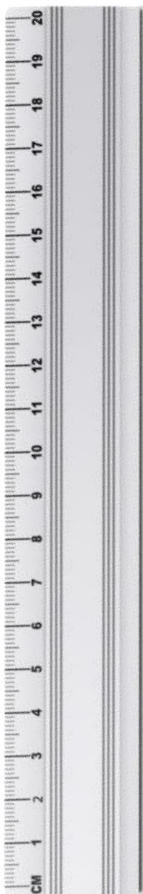
SDN/VDN Federation for High-performance Data Transmission between individual SDN Domains

- KREONET-S (KISTI) and KAIST (Edge Computing/SDN Domain)





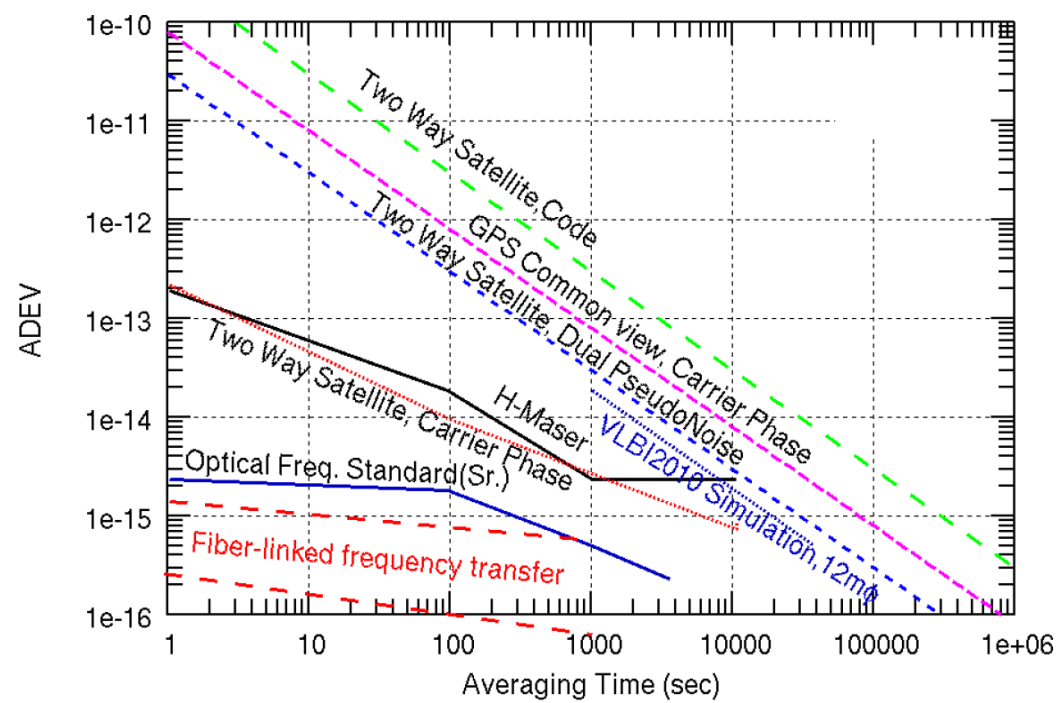
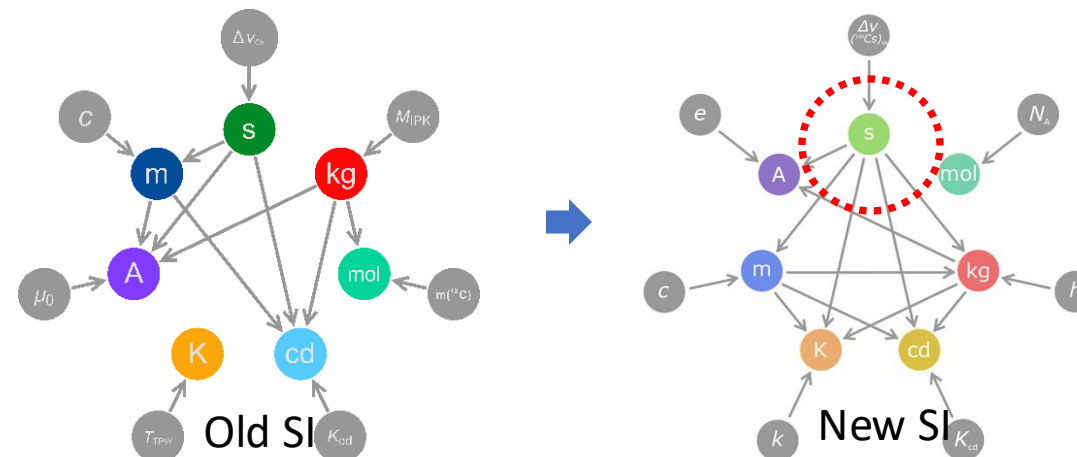
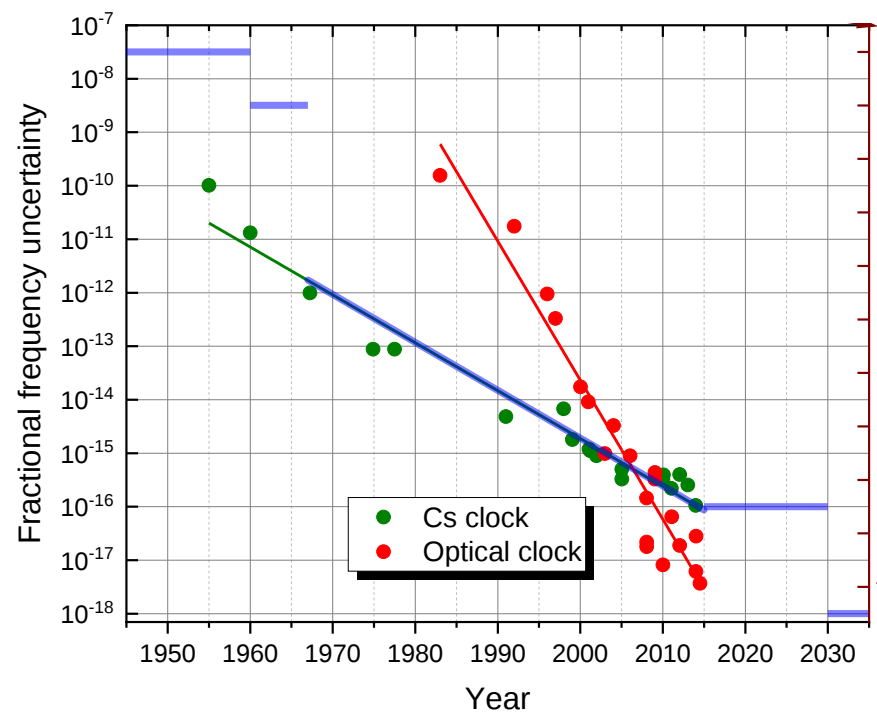


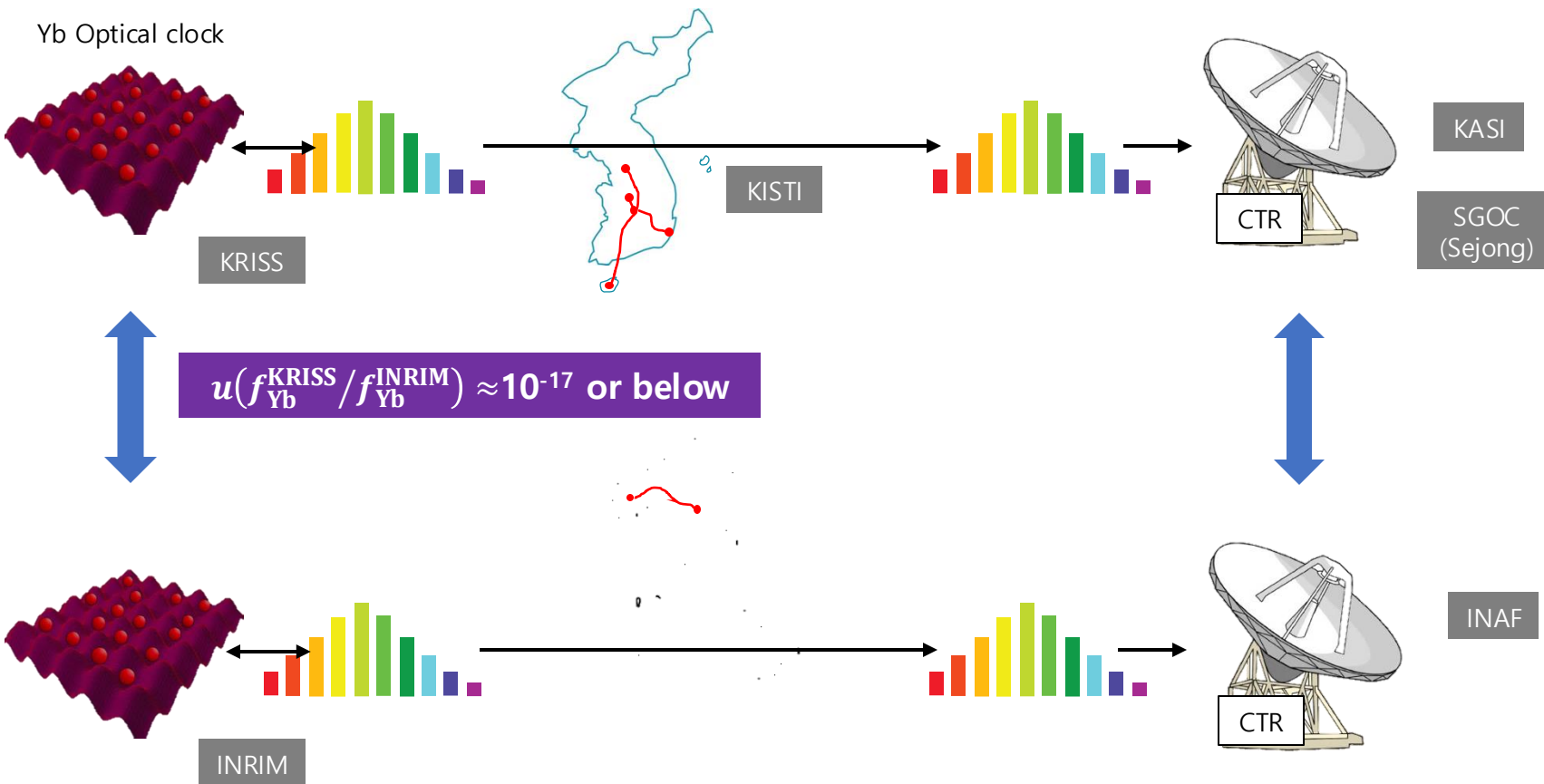


“Never measure anything but frequency!”



-- Arthur Schawlow
(1981 Nobel prize in Physics)



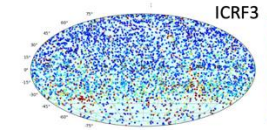


	KOREA	ITALY
Optical clock	Yb, running	Yb/Sr, running
Fiber link	KRISs – KISTI – KVN (except Jeju)	INRIM – Medicina
Transferred frequency	RF (OSTT, PikTime) CW laser f-comb @ Sejong or KVN	CW laser f-comb @ Medicina
VLBI	22/43/86 GHz @ Sejong 22/43/86 GHz @ KVN	22/43/86 GHz @ Medicina

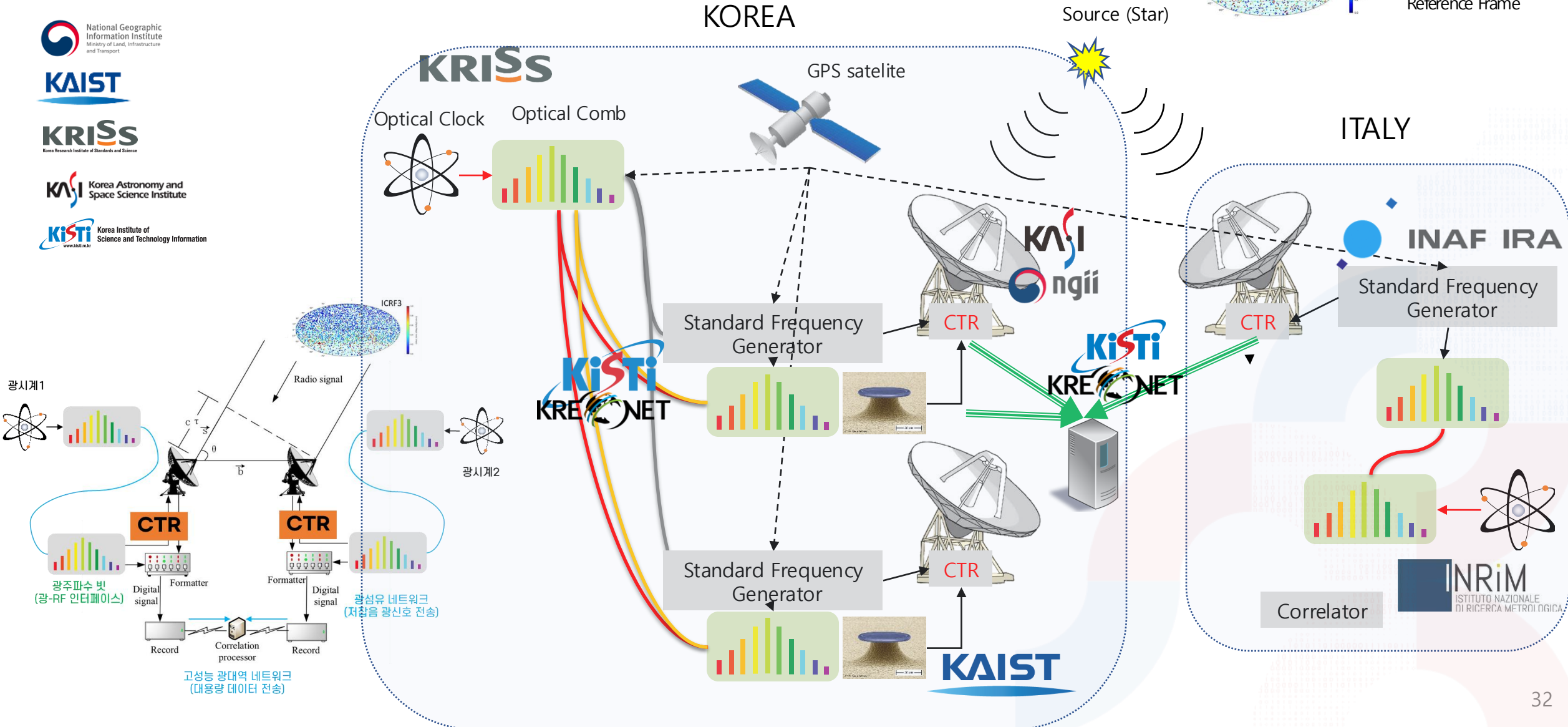
CTR : Compact Triple-band Receiver (K,Q, W band)

Inter-continental optical clock comparison using broadband VLBI

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



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



- **KREONET/KREONet2**, national terabit science and research network
- Support Data Intensive Science : LHC, ITER/KSTAR, SKA(KRSRC), ...
- Strong global collaboration to make more resiliency international network
- **SuperSReN II** project, Metropolitan Area Science Network based on Optical Fiber covering Daedeok Science Town, in Daejeon City
- **Korea National Data eXchange (NDeX)** Initiative
- Automated SDX Platform Development on NDeX in Korea
- Smart Mobility Experiments based on SD-5G Private Network and KREONET-S
- Inter-continental optical clock comparison: Data + Non-Data (RF/OF)



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

Thank you

Buseung Cho (bscho@kisti.re.kr)



❑ 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

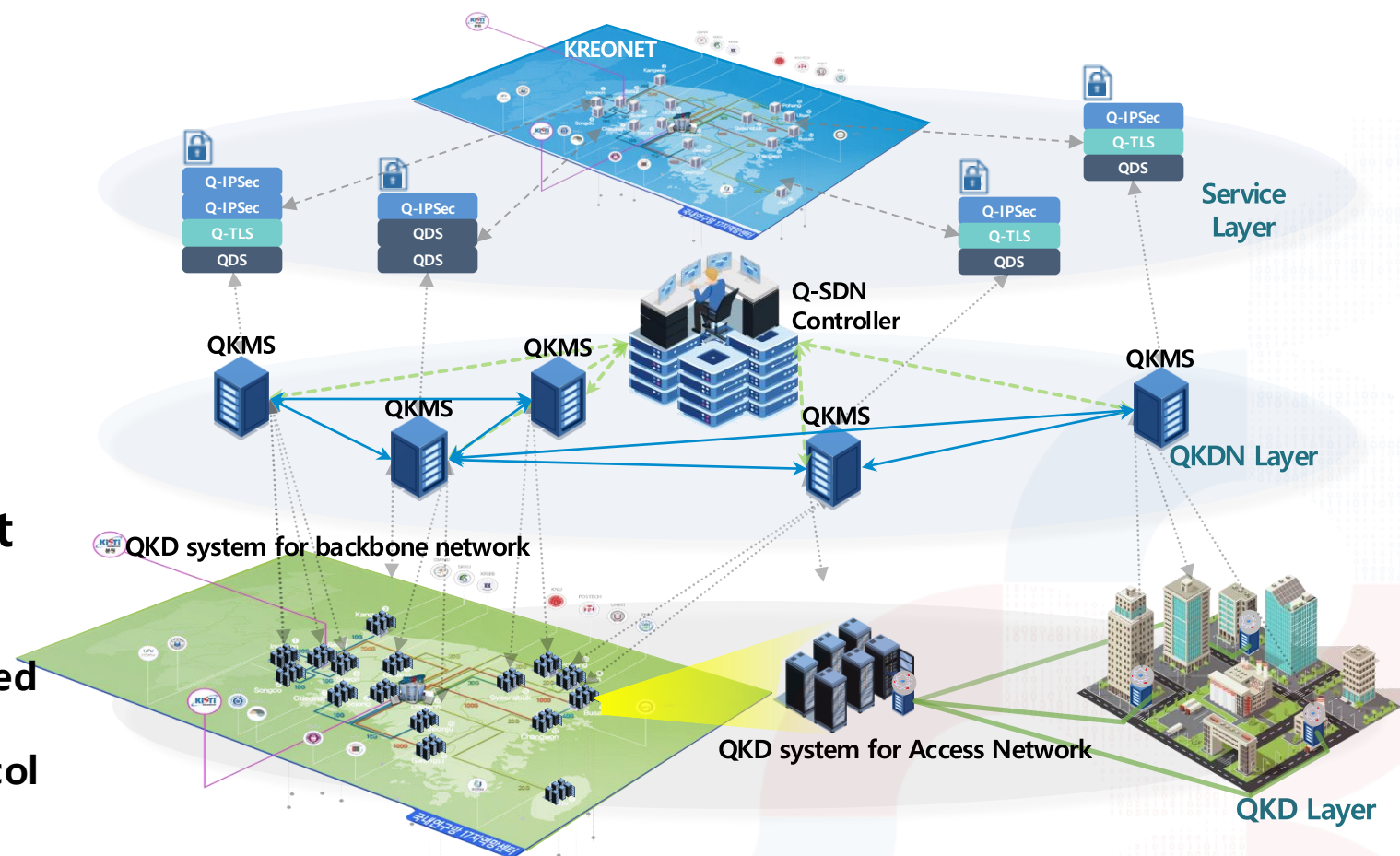
❑ QKD Management Environment

- 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



* QKND : Quantum Key Distribution Network
 * QKMS : Quantum Key Management System
 * Q-SDN : Quantum-Software Defined Networking