KREONET development in Republic of Korea

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Researcher

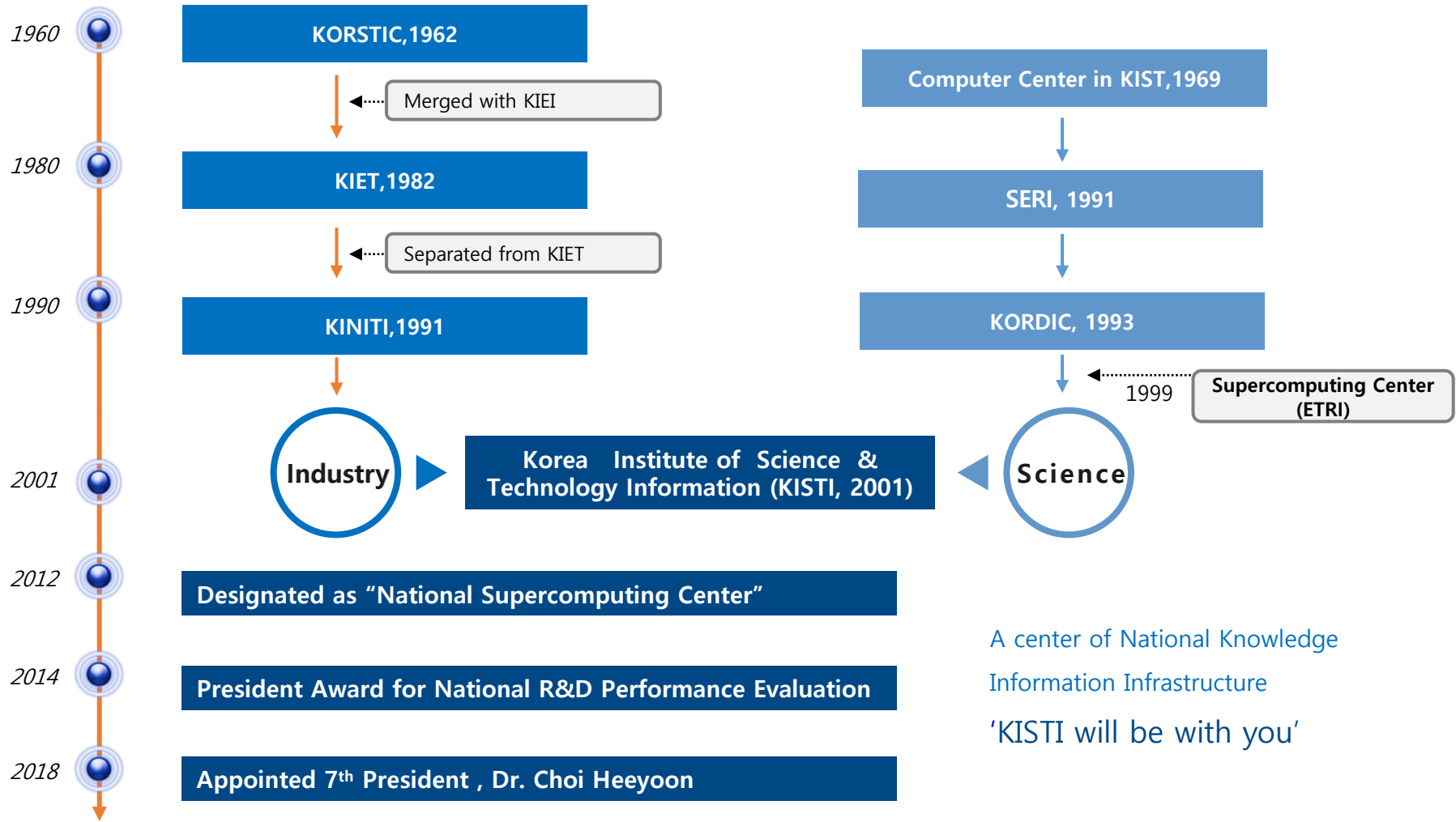KREONET Center / Div. of National Supercomputing

Korea Institute of Science and Technology Information (KISTI)

Contents

- Introduction of KISTI and KREONET
- KREONET / KROENet2 and KRLight
- Science DMZ and Optimized Research Platform
- Science and Research Collaboration in Asia
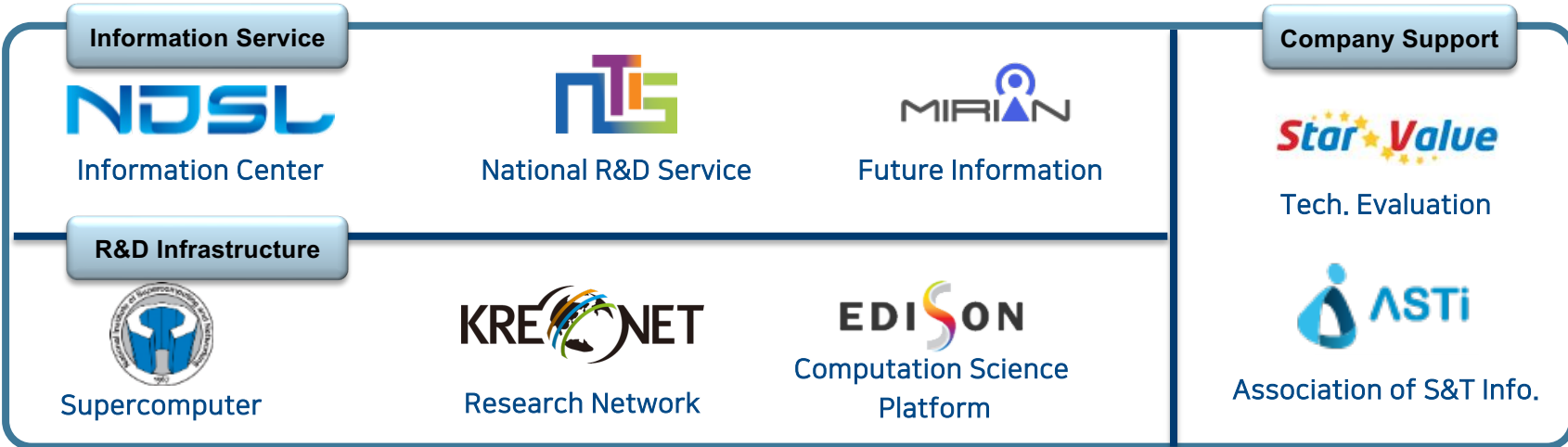- Network Research Demonstrations

History of KISTI

1960 — **KORSTIC,1962**

↓ Merged with KIEI

1980 — **KIET,1982**

↓ Separated from KIET

1990 — **KINITI,1991**

Computer Center in KIST,1969

↓

SERI, 1991

↓

KORDIC, 1993

↓ 1999 — **Supercomputing Center (ETRI)**

Industry ▶ **Korea Institute of Science & Technology Information (KISTI, 2001)** ◀ **Science**

2001

2012 — **Designated as "National Supercomputing Center"**

2014 — **President Award for National R&D Performance Evaluation**

2018 — **Appointed 7th President , Dr. Choi Heeyoon**

A center of National Knowledge Information Infrastructure

'KISTI will be with you'

Mandate & Research Areas

> The only research institute designated by Science and Technology Framework Act for establishing National S&T Infrastructure

KISTI Infrastructure and Service

Information Service

Information Center

National R&D Service

Future Information

Company Support

Tech. Evaluation

R&D Infrastructure

Supercomputer

Research Network

Computation Science Platform

Association of S&T Info.

KREONET National Science and Research Network, Korea

Initial Phase

Pioneer of Internet

- **First** national-wide Internet Service in Korea, 1988

- Training and extending of internet technology and service

- 1 of 5 Natl. Basic Information System
  - defense, administration, finance, public security, **education/research**

- (capacity) Kbps/Mbps

Current Phase

Enabler of Science Discovery and Innovation

- Cyberinfrastructure to empower data intensive science in global level

- Core member of GLORIAD since 2005
  - GLORIAD (Global Ring Network for Advanced Application Development)

- Advanced Research Network designated by Korean HPC ACT, 2012
  - 국가초고성능컴퓨터 활용 및 육성에 관한 법률 / 1 of 1461 ACTs in Korea

- Global leadership for technology and application
  - Building user / network community

- Early adaptor of advanced technologies and services
  - To develop & to introduce to the market

- (capacity) Gbps/Tbps

- 16 Domestic GigaPoPs & 4 Intl. GigaPoPs, 2019

- 365x24 NOC in KISTI Daejeon

- L1 Lightpath, L2 Carrier Ethernet Service, L3 R&E IP service

MAP OF KREONET 2019

ver. 2019.1.30

KOREA RESEARCH ENVIRONMENT OPEN NETWORK

Seattle

Chicago

United States of America

100G

LHCOPN 10G

Gangneung

Incheon
Seoul
Songdo
Suwon

100G

100G

Cheonan

Sejong   Ochang

IX   Internet eXchange – 10G

Daejeon

Amsterdam
CERN

Europe

Pohang

Jeonju

Daegu

Ulsan

100G

Hong Kong

China

100G   100G

100G

Gwangju   Changwon   Busan

10G
100G   ● KREONET POP
● KRLIGHT POP

Jeju

MAP OF KREONET 2019

After upgrading, 2019

KOREA RESEARCH ENVIRONMENT OPEN NETWORK

Seattle

Chicago

100G

100G

Gangneung

United States of America

Incheon

Seoul

Suwon

300G

LHCOPN 10G

Cheonan

100G

Sejong   Ochang

IX

Internet eXchange – up to 10G

Daejeon

Amsterdam

CERN

Pohang

Europe

Daegu

100G

Jeonju

120G

Ulsan

20G

120G

Changwon

Busan

Hong Kong

Gwangju

China

10G	
100G	

● **KREONET POP**

● **KRLIGHT POP**

Jeju

KREONET / KROENet2 Services

- KREONET Advanced Networking Service
  - [L1VPN/OPN] L1 Lightpath
  - [L2VPN/L2OPN] L2 Carrier Ethernet Service, L2 Lightpath
  - R&E IP service
  - Internet Service

- KREONET Security Service : Security Monitoring and Control
  - S&T-SEC, Science and Technology Security Center

- KREONET Science DMZ Service

- KREONET-PERT : Performance Enhancement and Response Service
  - perfSONAR/MadDash

- eduroam : Global Wi-Fi Roaming Service
  - National Roaming Operator

- KAFE (Korea Access Federation) : Streamline your online collaborations

- Domain Name Service, NTP Service, …

KiSTi 한국과학기술정보연구원
Korea Institute of Science and Technology Information
www.kisti.re.kr

eduroam **Global Wi-Fi Roaming Service for R&E**

- Borderless Research and Education via Free Wi-Fi Service with One ID

- 69 Partners, 22K APs in Korea
- Max DAU 2.5K, MAX MAU 7K in 2018
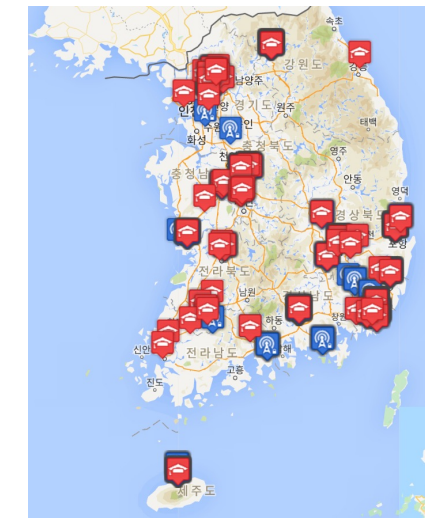
DAU (Daily Active Users) in 2018
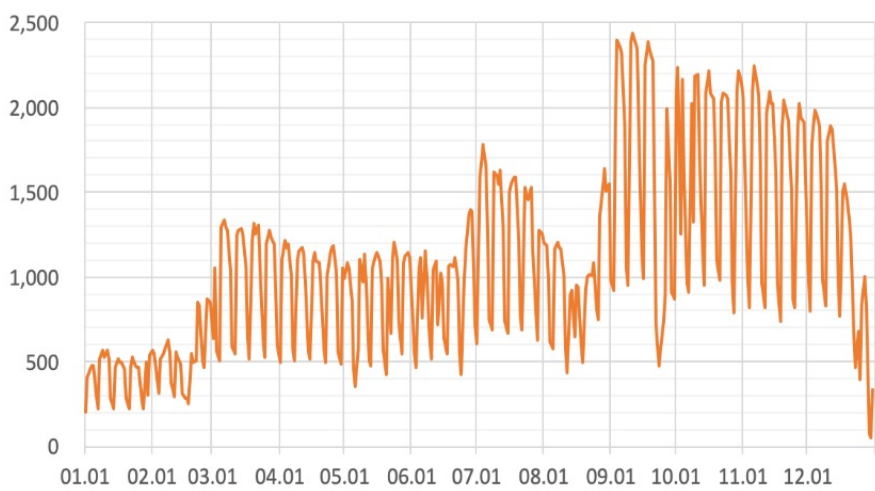
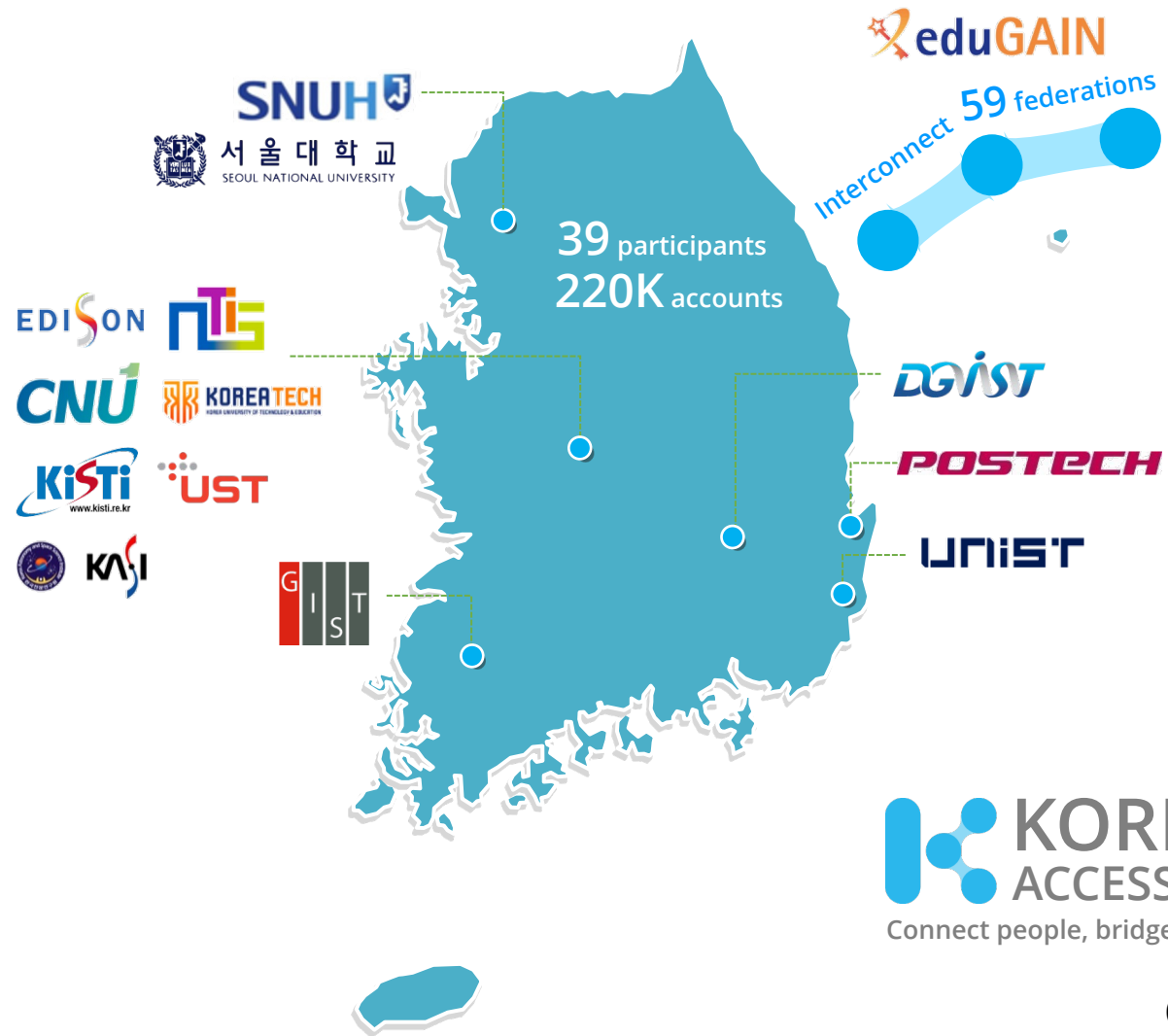**MAU (Monthly Active Users) in 2018**
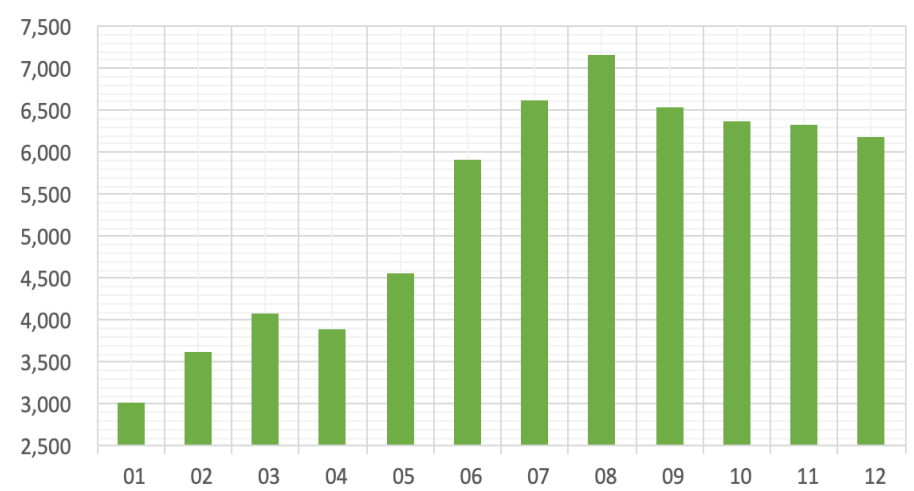
KAFE Access with Your Home Account

Identity path: End-to-end via user web browser
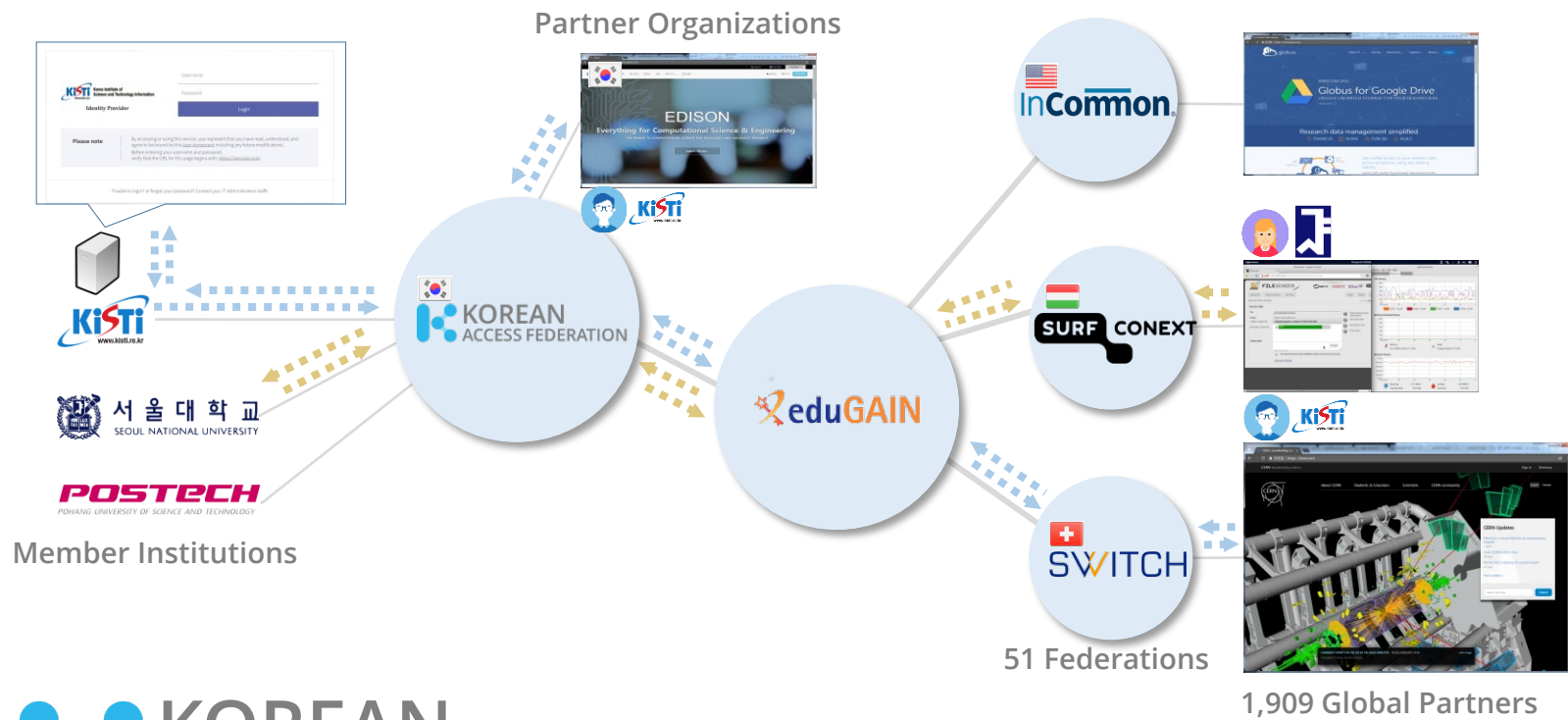
Partner Organizations

Member Institutions

51 Federations

1,909 Global Partners

KOREAN
ACCESS FEDERATION

Connect people, bridge organizations, enable more science

Contact : Dr. Jinyong Jo, KISTI

KISTI 한국과학기술정보연구원
Korea Institute of Science and Technology Information
www.kisti.re.kr

KAFE **Status**

eduGAIN

Interconnect **59 federations**

SNUH

서울대학교
SEOUL NATIONAL UNIVERSITY

39 participants
220K accounts

EDISON

NTIS

CNU

KOREATECH
KOREA UNIVERSITY OF TECHNOLOGY & EDUCATION

KISTI
www.kisti.re.kr

UST

KASI

GIST

DGIST

POSTECH

UNIST

● **47** Federated Services
+ CERN, LIGO, CILogon
+ Globus online
+ Video conferencing tools
+ File storage and transfer
+ Computational platform
+ eduroam visitor account
+ groupware service
+ IEEE Xplore
  and more ...

**KOREAN
ACCESS FEDERATION**
Connect people, bridge organizations, enable more science

Contact: Dr. Jinyong Jo, KISTI

GLIF **Global Lambda Integrated Facility**

KRLight, OLE (Open Lightpath Exchange)

Linking the world with lambda
→ Global Cyber-infrastructure, supporting
Collaborative Scientific R&D project

GLIF Map 2017: Global Lambda Integrated Facility   Visualization by Robert Patterson, NCSA, University of Illinois at Urbana-Champaign   Data Compilation by Maxine Brown, University of Illinois at Chicago   Texture Retouch by Jeff Carpenter, NCSA   Earth Texture, visibleearth.nasa.gov   www.glif.is

KRLight Distributed Open Lightpath eXchange-Korea

Univ. of Hong Kong

HKOX
Hong Kong Open eXchange
Hong Kong

CERNET

1Gbit/s

1Gbit/s

10Gbit/s

Google
Google

10Gbit/s

ESnet

10Gbit/s

PACIFIC WAVE
Seattle

10Gbit/s

CA*net4, Internet2, PNWGP, CENIC UltraLight, ESnet, AARNET, REANNZ KAREN, NORDUnet

KRLight
(KREONet2)
Seattle, USA

GRP

STARLIGHT
The Optical STAR TAP
Chicago

CANARIE, Internet2, ESnet, ASGCnet , CERN, MREN, TWAREN,

10Gbit/s+ 2.5Gbps

10Gbit/s

100Gbps

KRLight
(KREONet2)
Hong Kong, CN

10Gbps*2

KRLight
(KREONet2)
Daejeon, KR

10Gbit/s

KRLight
(KREONet2)
Chicago, USA

10Gbit/s*2

CERN

10Gbit/s

100Gbit/s

KRLight
(KREONet2)
Amsterdam, NL

HKIX
Hong Kong

10Gbit/s

10Gbit/s

Asi@Connect
Hong Kong

100Gbit/s*n

KREONET
Daejeon

10Gbit/s

KIAE
Russia

10Gbit/s

10Gbit/s

HKOEP
中国科技网
China Science & Technology Network
Hong Kong

TransPAC, CUHK, APAN-JP, JGN-X, Microsoft, ASNet, NUS …

NLLight
Amsterdam

GEANT, NORDUnet, SURFnet

KRLight Topology - Jan, 2019
(Buseung Cho, bscho@kisti.re.kr)

Peering with KREONet2   GOLE (L2 transit)

GLOBAL Research Network & Collaboration
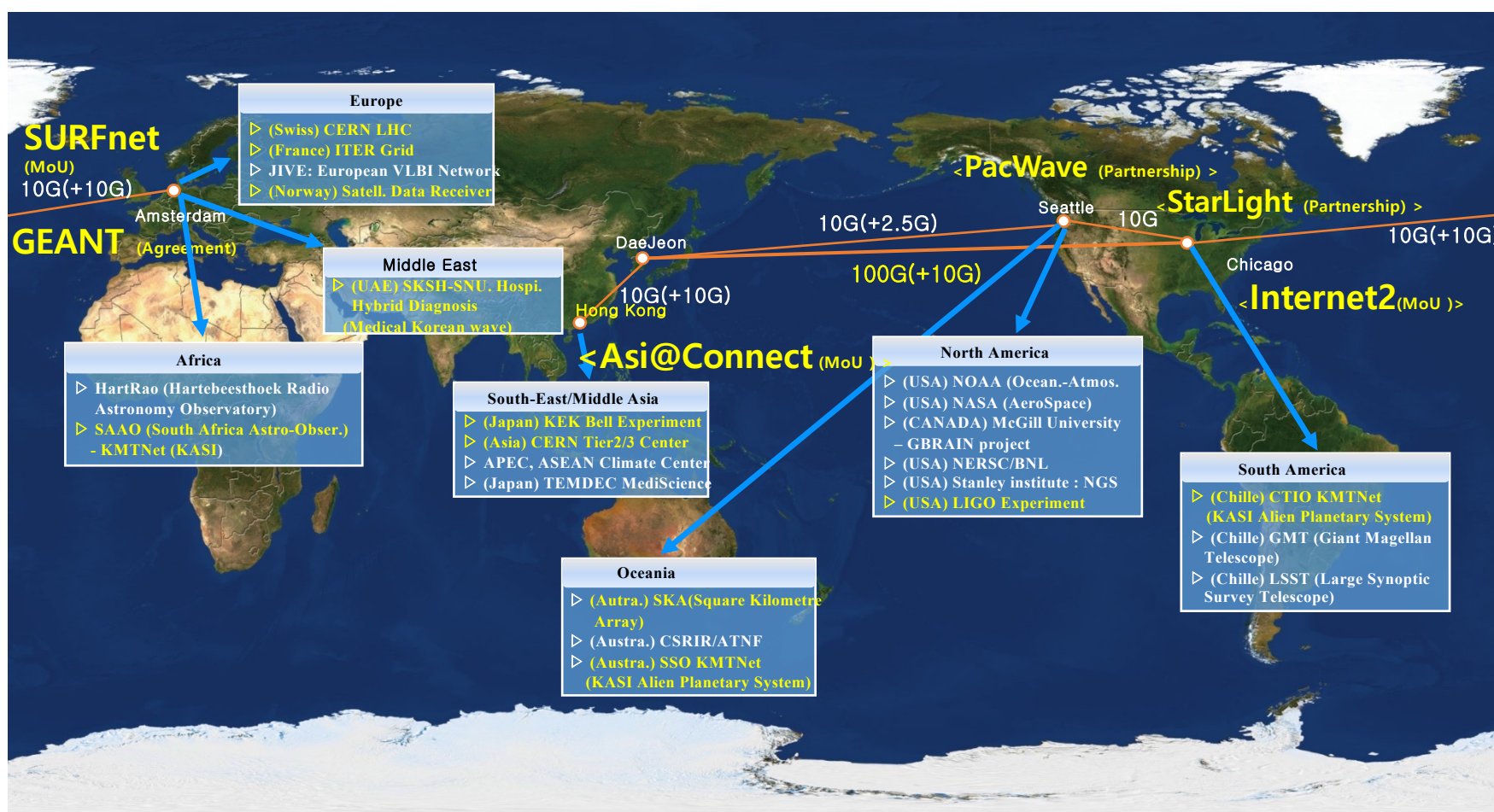
MoU between KISTI and TEIN*cc, 2016

1. **exchange information** of advanced network technology and collaborative research project for global leadership
2. **provide appropriate interconnection** between Parties' members (users) and networks for the purpose of development and use of advanced research and education applications.
3. **promote collaboration** relating the development of next-generation networking and applications in research, science and higher education.
4. collaborate on human resources development, organization of workshops or meetings to promote advanced technologies and applications.

"Making better global network connectivity, promoting applications and exploring opportunities"

High Energy Physics & Fusion Energy Science

Bio/Genome Research & Medical Science

Astronomy & Climate Changes

Advanced Scientific Computing Research

Future Internet & Construction

Education & e-Culture

KRE(O)NET
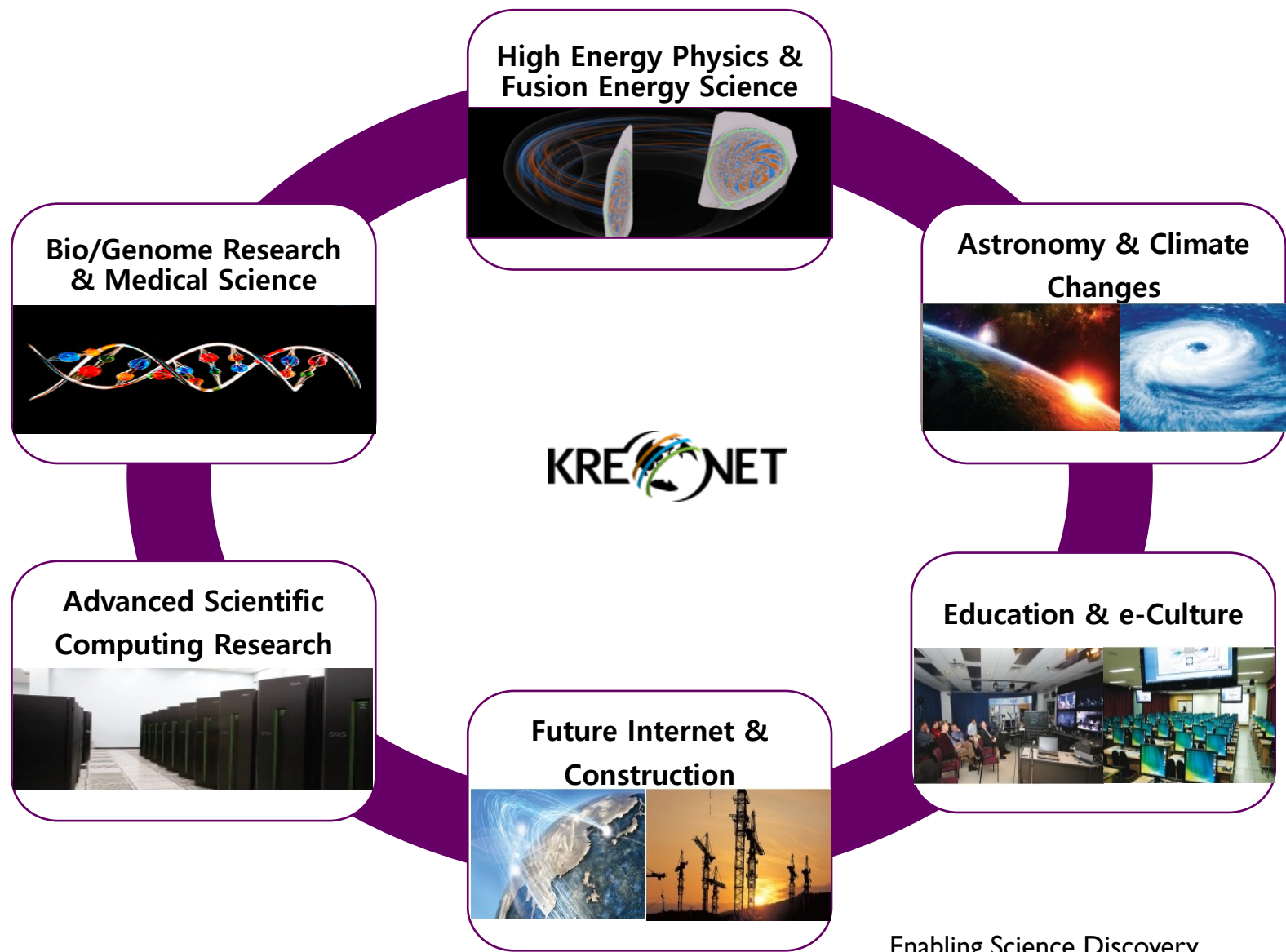
Enabling Science Discovery
- New particle, "Higgs" in CERN LHC
- Gravitational Wave in LIGO
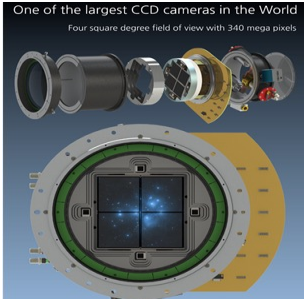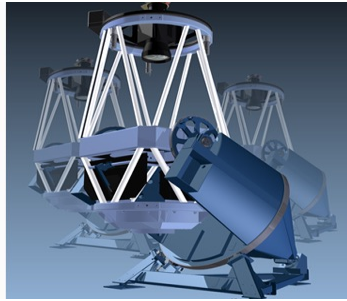
KMTNet (Korea Microlensing Telescopes Network)
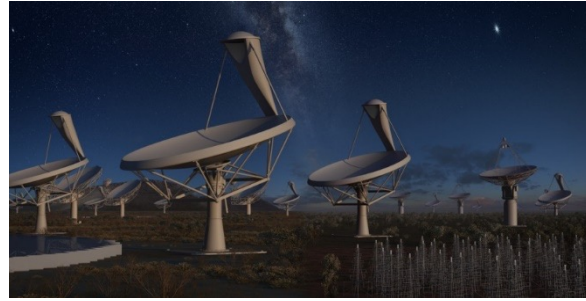
SKA (Square Kilometre Array)
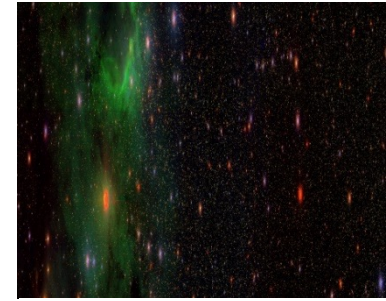
SDSS (Sloan Digital Sky Survey)
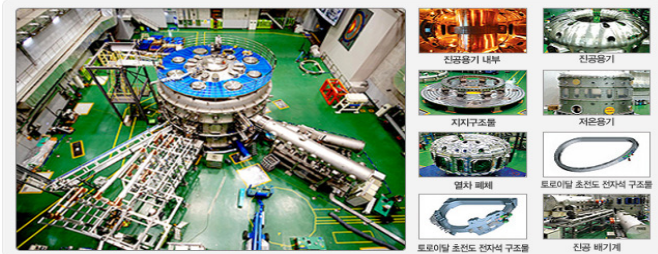
KSTAR (Korea Superconducting Tokamak Advanced Research)
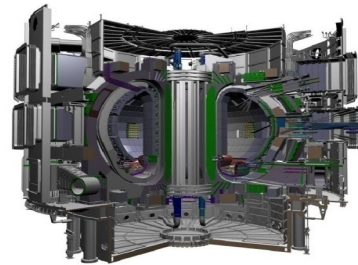
ITER   International Thermonuclear Experimental Reactor

Neutrino Detector

CERN, LHC, KEK, Belle, Freilab, CDF

Climate Change
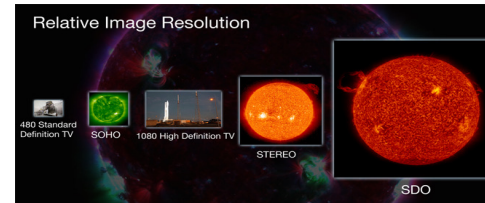
SDO (Solar Dynamics Observatory)

Medical Science

Integration of distributed supercomputing resources

E-Culture

KVN
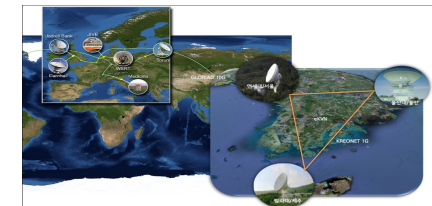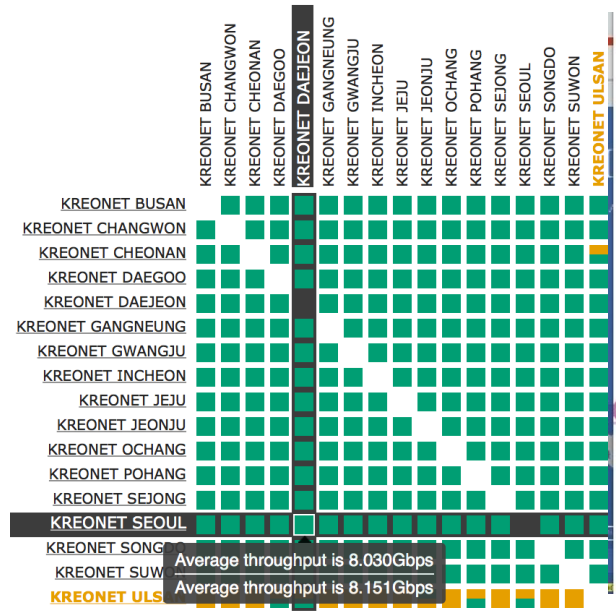

Global e-VLBI project

KREONET/KREONet2 Monitoring System

PerfSONAR/MadDash

- Installed in 17 domestic nodes and 4 international nodes
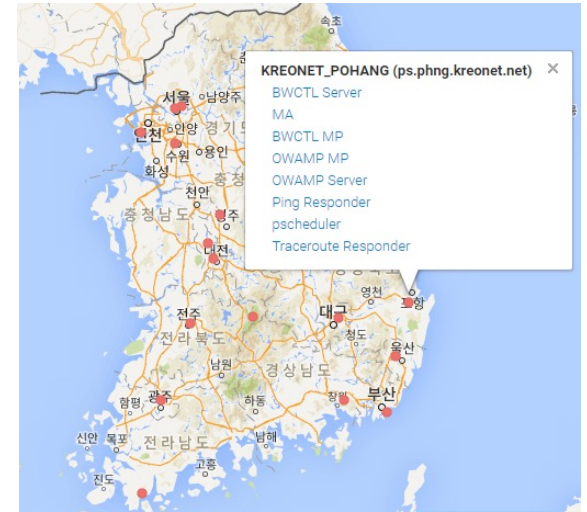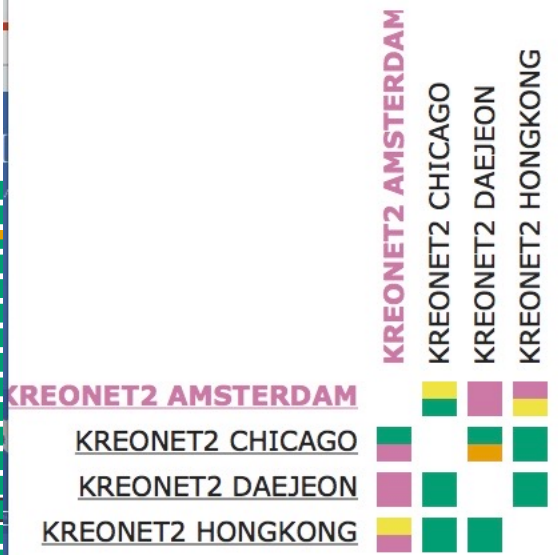
KREONET/KREONet2 Monitoring System

PerfSONAR/MadDash

- Installed in 20 nodes for 5 Research Communities (up to 50)

첨단커뮤니티 최대전송성능 (Gbps)		게놈·바이오		미래네트워크		기상기후						천문우주						고에너지물리			
		서울/서울대병원	대전/KAIST/의과학대학원	광주/GIST/K1	서울/숭실대/K1	오창/기상슈퍼컴	부산/APCC	부산/부경대/환경대기과학과	부산/부산대/대기환경과학과	서울/기상청본원	대전/공군기상단	대전/천문연/상관센터	서울/천문연/연세전파천문대	울산/천문연/울산전파천문대	제주/천문연/탐라전파천문대	세종/국토부/VLBI	대전/항우연	서울/서울대/물리학과	서울/숭실대/물리학과	서울/시립대/물리학과	부산/부산대/물리학과
서울/서울대병원			0.999	0.999	0.999	0.999	0.996	0.999	0.994	0.999	0.976	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.922
대전/KAIST/의과학대학원	0.268		0.999	0.999	0.784	0.977	0.951	0.999	0.999	0.999	9.550	0.999	9.161	9.521	0.999	0.970	8.004	0.999	0.980	0.952
광주/GIST/K1	0.026	0.119		0.038	0.021	0.017	0.019	0.018	0.012	0.025	0.080	0.026	0.028	0.038	0.031	0.089	0.038	0.021	0.023	0.020
서울/숭실대/K1	0.994	0.999	0.999		0.999	0.996	0.996	0.998	0.996	0.992	0.998	0.999	0.999	0.999	0.994	0.999	0.999	0.999	0.999	0.932
오창/기상슈퍼컴	0.982	0.999	0.999	0.999		0.996	0.999	0.994	0.999	0.979	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.941
부산/APCC	0.987	0.999	0.999	0.999	0.990		0.990	0.987	0.999	0.999	0.996	0.998	0.994	0.999	0.999	0.992	0.999	0.999	0.999	0.891
부산/부경대/환경대기과학과	0.999	0.999	0.999	0.999	0.999	0.999		0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.891
부산/부산대/대기환경과학과	0.979	0.999	0.979	0.999	0.978	0.972	0.977		0.977	0.974	0.979	0.993	0.986	0.999	0.977	0.975	0.999	0.999	0.968	0.881
서울/기상청본원	0.978	0.999	0.999	0.999	0.981	0.999	0.995	0.995		0.976	0.983	0.999	0.994	0.999	0.988	0.977	0.999	0.999	0.999	0.898
대전/공군기상단	0.991	0.999	0.999	0.999	0.977	0.993	0.996	0.992	0.988		0.974	0.999	0.984	0.999	0.988	0.996	0.999	0.999	0.999	0.831
대전/천문연/상관센터	0.262	9.562	0.999	0.999	0.776	0.968	0.986	0.999	0.999	0.999		0.999	9.158	8.960	0.999	0.975	8.087	0.999	0.990	0.907
서울/천문연/연세전파천문대	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999		0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.943
울산/천문연/울산전파천문대	0.181	9.051	0.999	0.999	0.870	0.980	0.980	0.999	0.999	0.999	9.066	0.999		5.376	0.999	0.945	7.748	0.999	0.962	0.974
제주/천문연/탐라전파천문대	0.202	9.414	0.999	0.999	0.902	0.963	0.950	0.999	0.999	0.999	9.028	0.999	8.940		0.999	0.944	7.193	0.999	0.948	0.972
세종/국토부/VLBI	0.986	0.999	0.999	0.999	0.999	0.994	0.993	0.994	0.979	0.999	0.989	0.999	0.997	0.999		0.999	0.999	0.999	0.999	0.880
대전/항우연	0.976	0.999	0.999	0.999	0.978	0.993	0.994	0.993	0.999	0.999	0.976	0.999	0.982	0.999	0.999		0.999	0.999	0.999	0.807
서울/서울대/물리학과		8.555	0.999	0.999	0.860	0.968	0.966	0.999	0.999	0.999	6.838	0.999	6.816	8.586	0.999	0.921		0.999	0.961	0.881
서울/숭실대/물리학과	0.976	0.999	0.996	0.999	0.969	0.972	0.969	0.967	0.999	0.976	0.977	0.977	0.973	0.999	0.986	0.976	0.999		0.976	0.956
서울/시립대/물리학과	0.997	0.999	0.999	0.999	0.984	0.995	0.997	0.993	0.999	0.986	0.999	0.999	0.998	0.999	0.989	0.979	0.999	0.999		0.921
부산/부산대/물리학과	0.903	0.999	0.936	0.919	0.947	0.958	0.947	0.931	0.941	0.863	0.861	0.948	0.918	0.914	0.920	0.869	0.966	0.935	0.878	
연동 대역폭 (Gbps)	1.00	10.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00	1.00	10.00	10.00	1.00	1.00	10.00	1.00	1.00	1.00
최대전송성능 측정치 (Gbps)	0.999	9.562	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	9.562	0.999	9.161	9.521	0.999	0.999	8.586	0.999	0.999	0.999
90%전송성능 달성도	111%	106%	111%	111%	111%	111%	111%	111%	111%	111%	106%	111%	102%	106%	111%	111%	95%	111%	111%	111%

데이터 수신지

데이터 발생지

Science DMZ and
Optimized Research Platform

Science DMZ

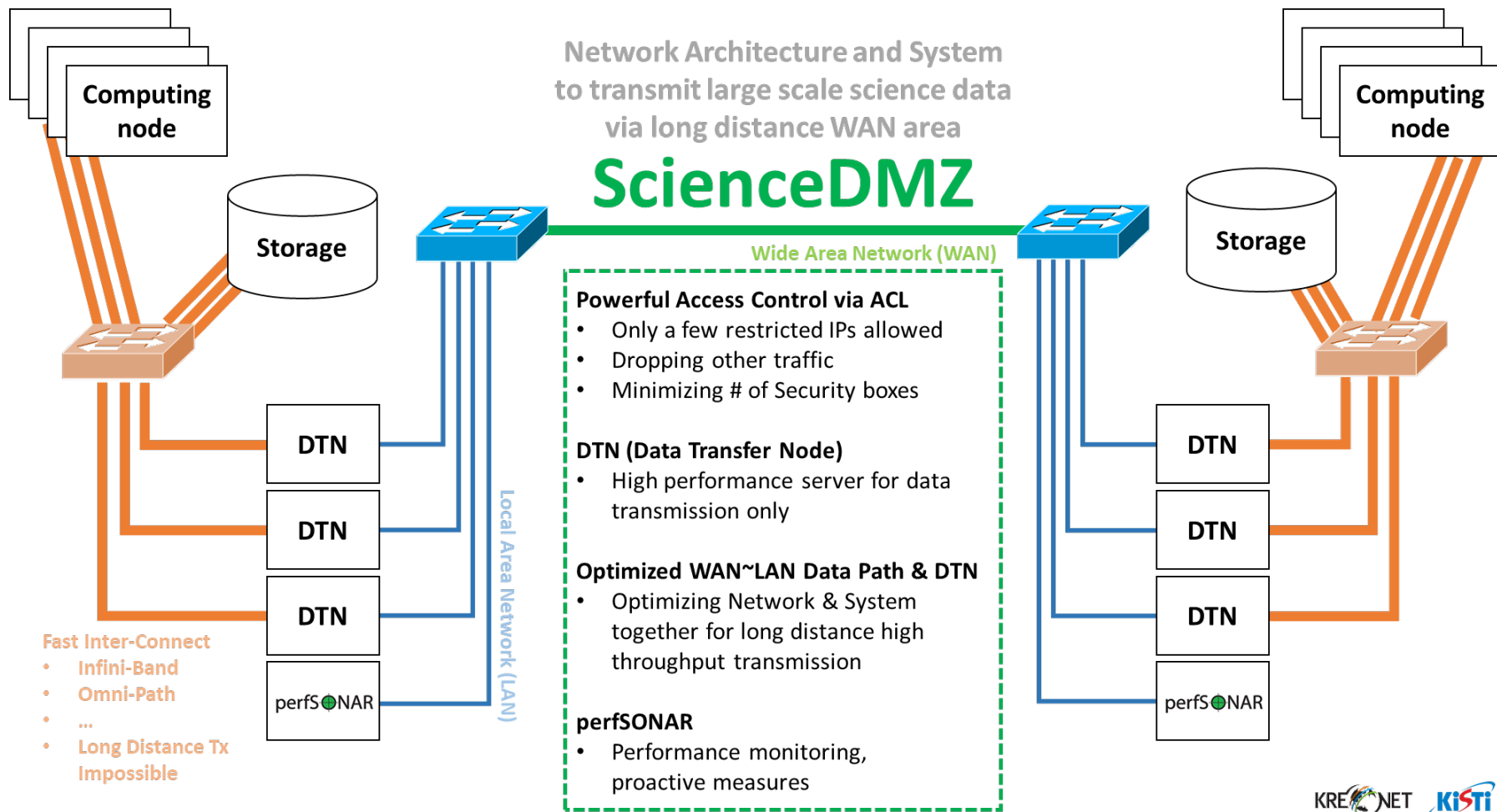**Throughput vs. Increasing Latency with .0046% Packet Loss**
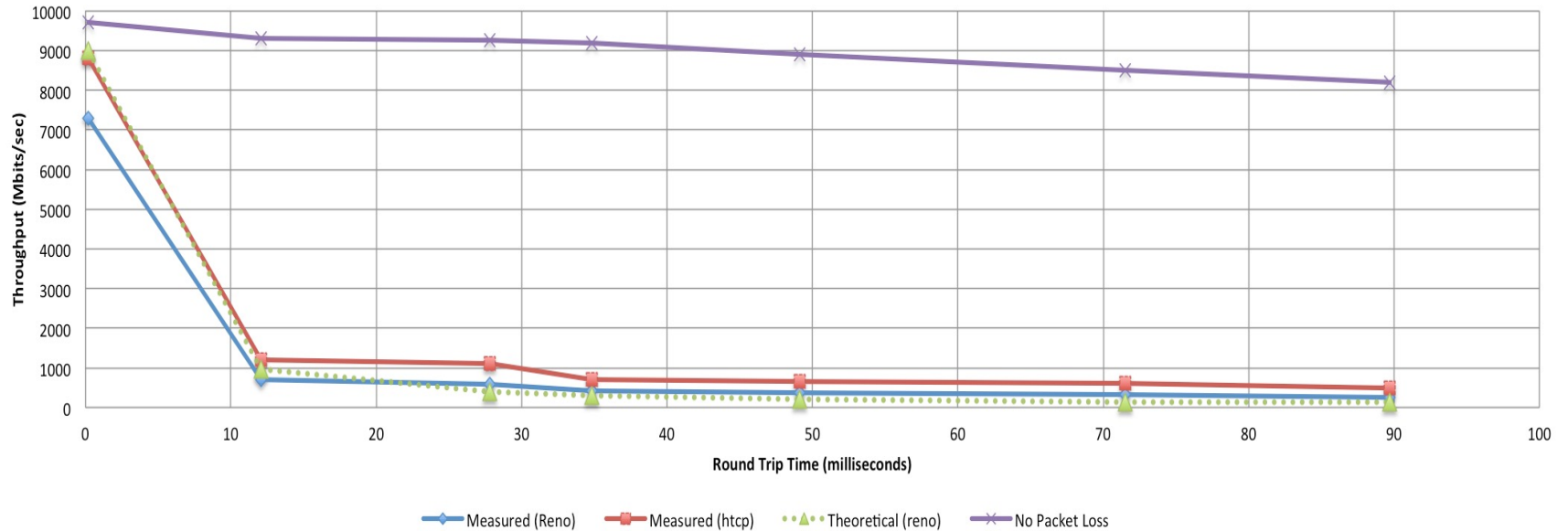
Eli Dart, Lauren Rotman, Brian Tierney, Mary Hester, and Jason Zurawski. The Science DMZ: A Network Design Pattern for Data-Intensive Science. In Proceedings of the IEEE/ACM Annual SuperComputing Conference (SC13), Denver CO, 2013.
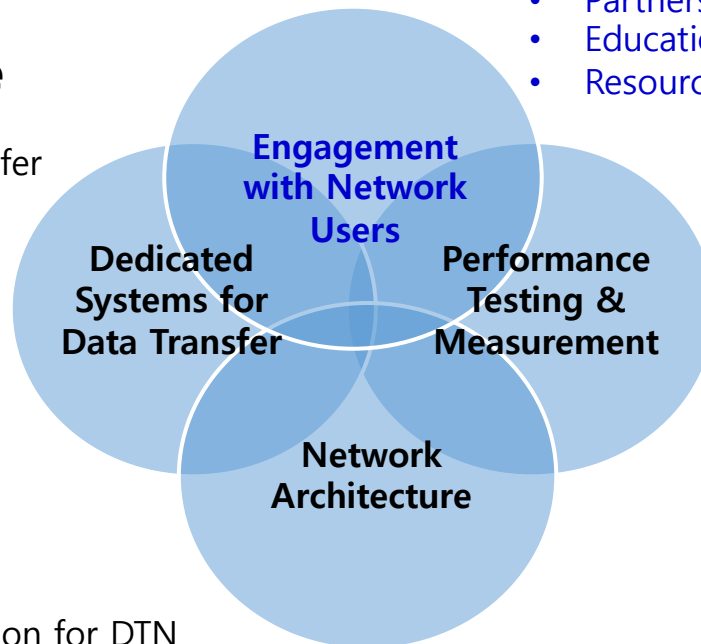
Science DMZ

Science DMZ

Network Architecture and System to transmit large scale science data via long distance WAN area

ScienceDMZ

Wide Area Network (WAN)

Powerful Access Control via ACL
- Only a few restricted IPs allowed
- Dropping other traffic
- Minimizing # of Security boxes

DTN (Data Transfer Node)
- High performance server for data transmission only

Optimized WAN~LAN Data Path & DTN
- Optimizing Network & System together for long distance high throughput transmission

perfSONAR
- Performance monitoring, proactive measures

Computing node

Storage

Local Area Network (LAN)

DTN

DTN

DTN

perfSONAR

Fast Inter-Connect
- **Infini-Band**
- **Omni-Path**
- **...**
- **Long Distance Tx Impossible**

Science DMZ Superfecta : Engagement

Engagement
- Partnerships
- Education & Consulting
- Resources & Knowledgebase

Data Transfer Node
- High performance
- Configured for data transfer
- Proper tools

Engagement with Network Users

Dedicated Systems for Data Transfer

Performance Testing & Measurement

Network Architecture

perfSONAR
- Enables fault isolation
- Verify correct operation
- Widely deployed in ESnet and other networks, as well as sites and facilities

Science DMZ
- Dedicated location for DTN
- Proper security
- Easy to deploy - no need to red esign the whole network

ESnet Science Engagement (engage@es.net) - 11/14/24

KISTI's Science DMZ Activities for Data Intensive Science

- **Focus on Data-Intensive Science Community in Korea**
  - Bio/Genome (K*GENOME, GENOME RDC), Astronomy (e-VLBI, SDO, KMTnet, LSST), High Energy Physics (CERN LHC Alice Tier1, CMS Tier2/3), Fusion Energy (KSTAR/NFRI), Climate Change (National Center for Meteorological Supercomputer, APEC Climate Center) etc.

- **100G last-mile connection supports by KREONET**
  - KASI (astronomy), KSTAR/NFRI (fusion energy)

- **Science Engagement** : Technical support and Training

- International Participation and Collaboration to PRP & NRP

- Global partnership and leadership in Asia : **Asia PRP** with Australia and Singapore

- Participation in SC18 Network Research Exhibition

- **100G DTN directly connected to KRLight**

K*GENOME

Genome RDC

LSST

eKVN

HEP (CMS, ALICE)

KBSI TEM

KSTAR

GSDC

Supercomputer(5th)

SDO
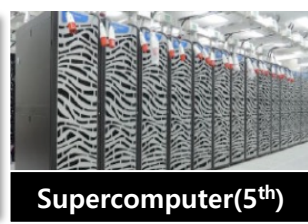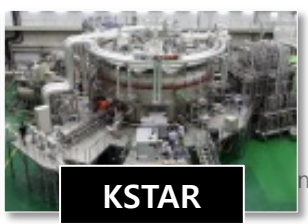
Science DMZ for National Supercomputer, HPC

- Building Science DMZ and DTN for KISTI 5th Generation Supercomputer (25.7 petaflops)
- Participation for the PetaScale DTN transfer Project
  - DTN Cluster with 100G
  - Globus Online
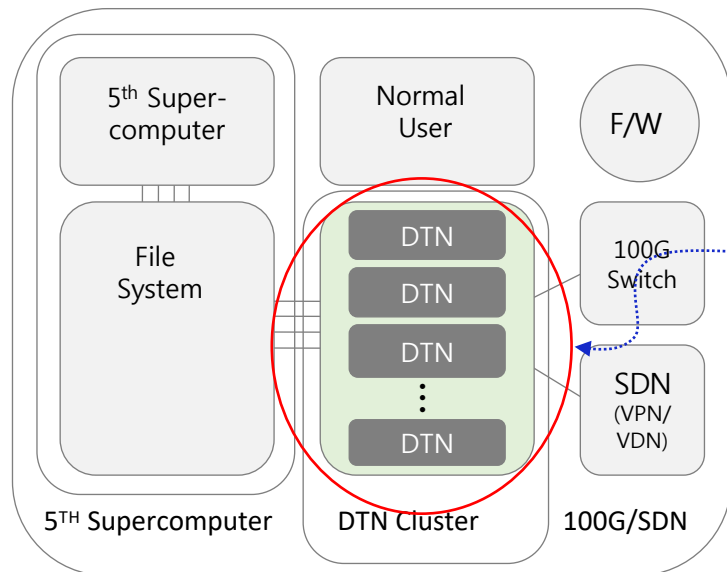
Peta Scale transfer environment over KISTI 5th Generation Supercomputer

Collaboration with NERSC Science DMZ
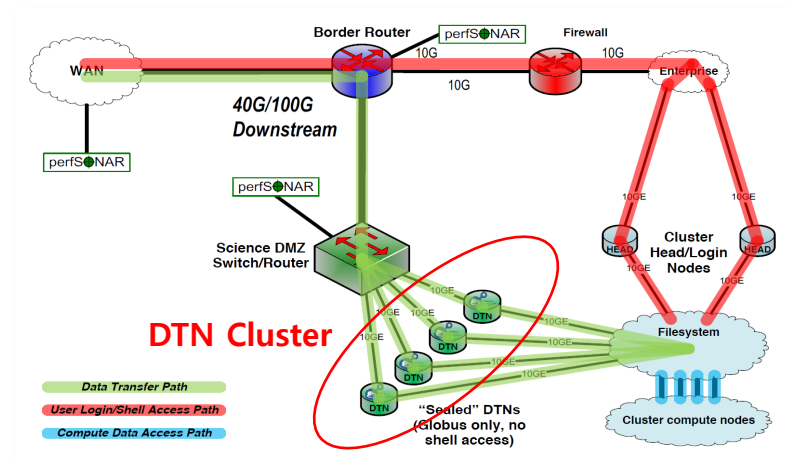
Science DMZ architecture for HPC

PRP/NRP and KISTI/KRLight Science DMZ

Expanding to the Global Research Platform
via CENIC/Pacific Wave, Internet2, and International Links

Korea Shows Distance is Not the Barrier to Above 5Gb/s Disk-to-Disk Performance
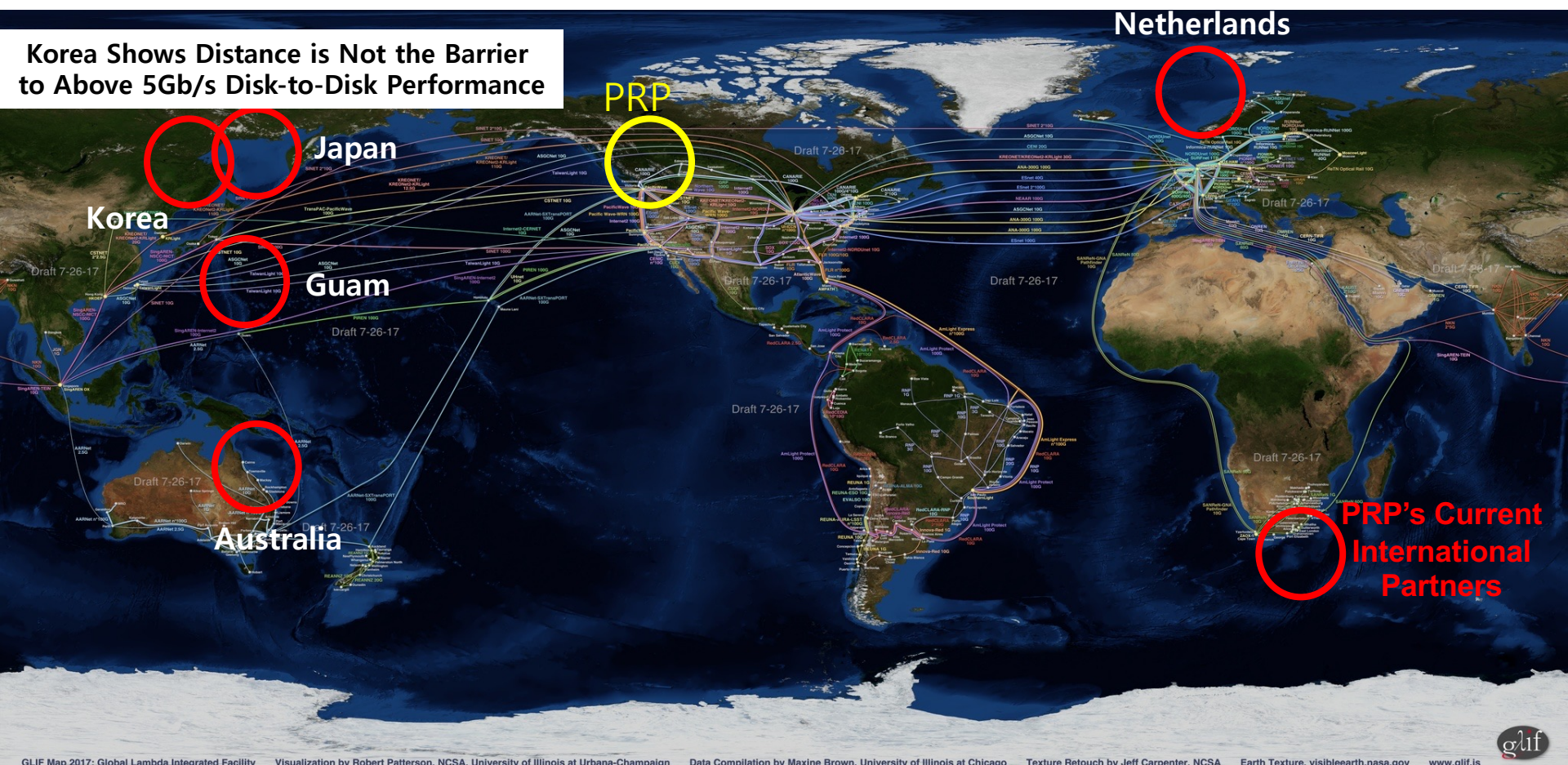
Netherlands

PRP

Korea

Japan

Guam

Australia

PRP's Current International Partners

GLIF Map 2017: Global Lambda Integrated Facility   Visualization by Robert Patterson, NCSA, University of Illinois at Urbana-Champaign   Data Compilation by Maxine Brown, University of Illinois at Chicago   Texture Retouch by Jeff Carpenter, NCSA   Earth Texture, visibleearth.nasa.gov   www.glif.is

Source: Larry Smarr(Calit2), 2nd NRP Workshop@Bozeman 2018

End-to-end Performance Monitoring via perfSONAR & MadDash

Optimized Research Platform for Data Intensive Science

RAON, IBS
(heavy-ion accelerator)

Research Institute

Supercomputer

Data Center

Research Institute
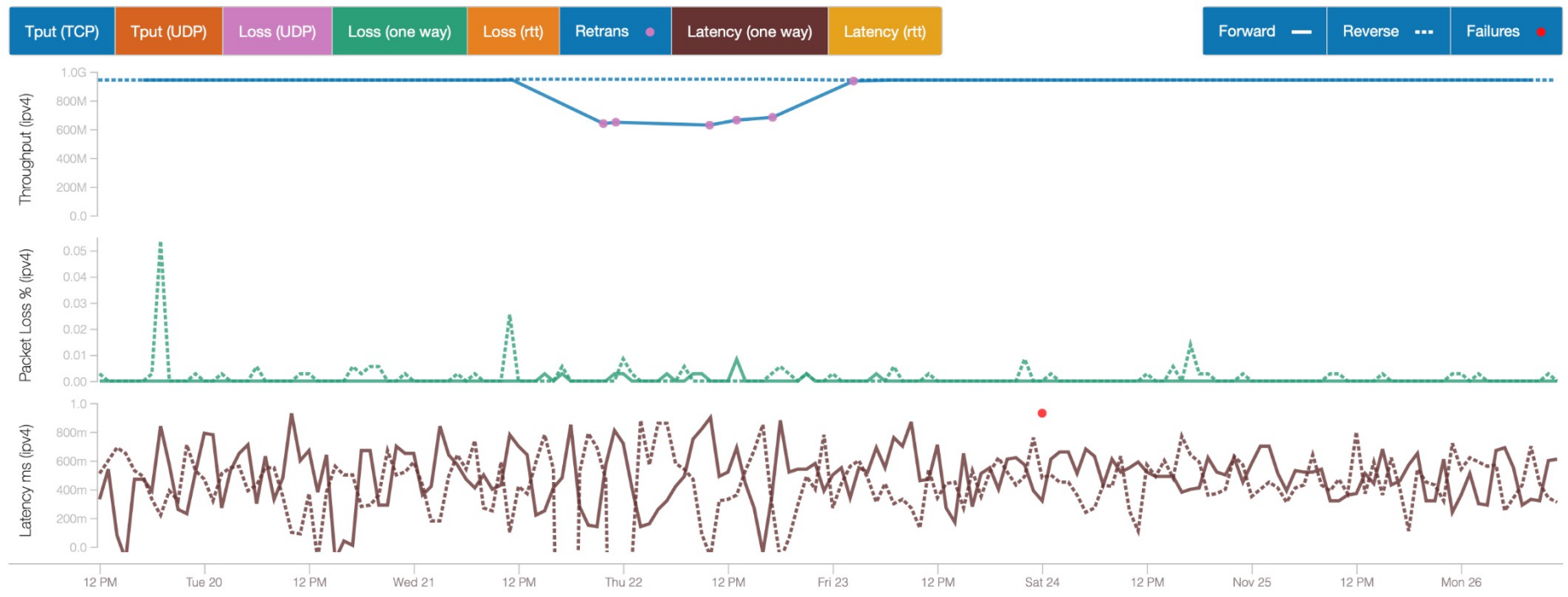
Research Institute
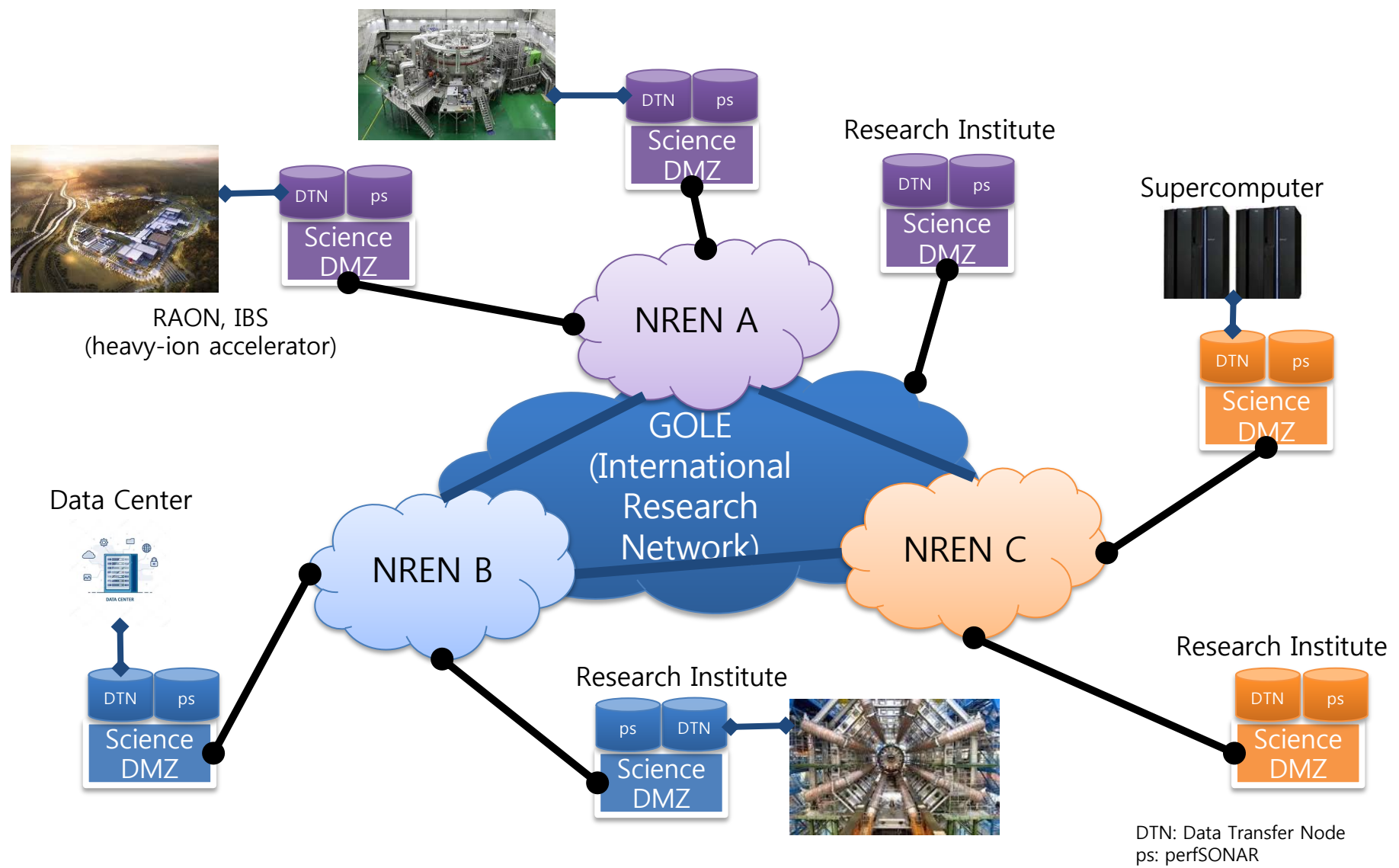
DTN: Data Transfer Node
ps: perfSONAR

Science and Research Collaboration in Asia

LHCOPN, KVN, SKA

LHCOPN
LHC Optical Network
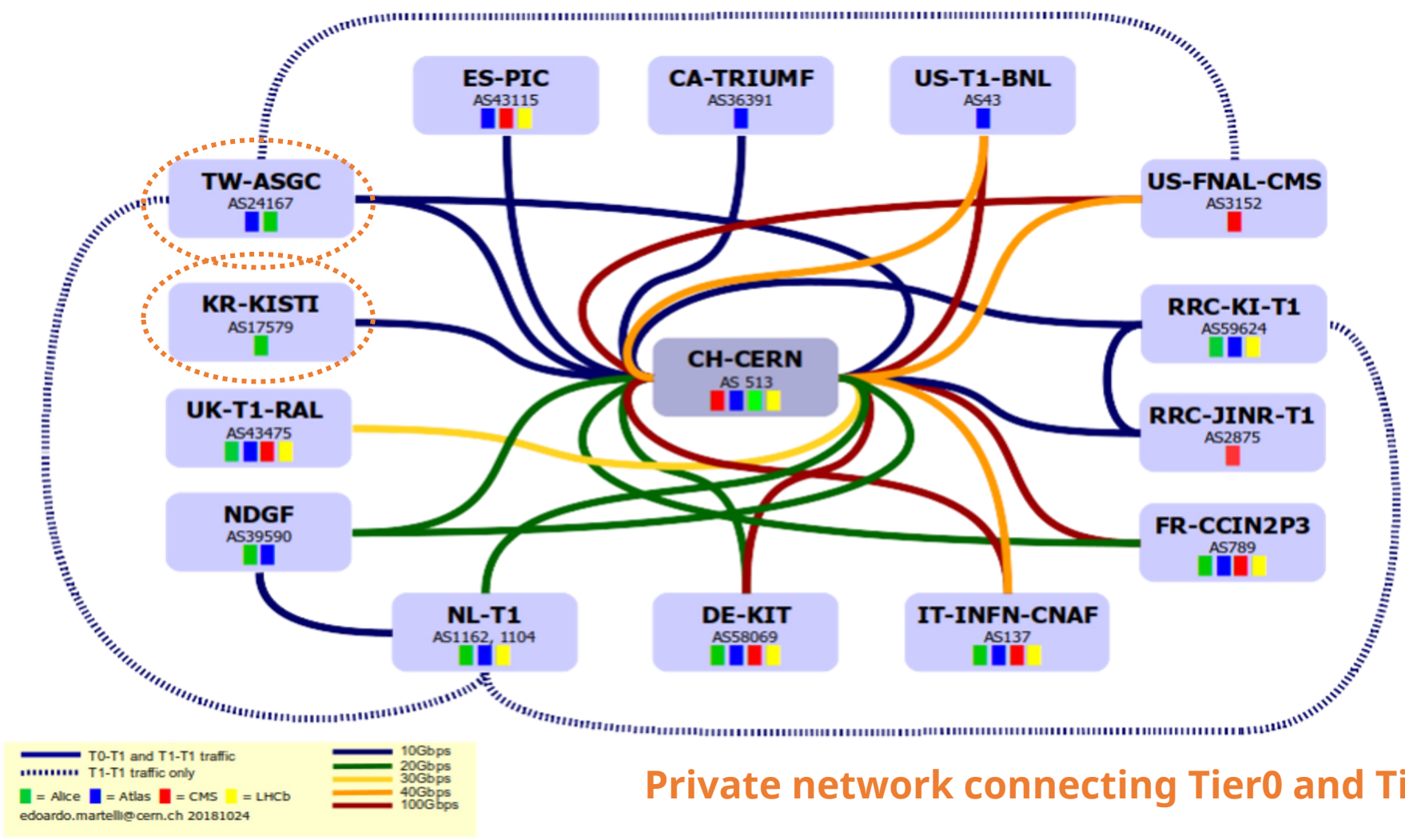
Private network connecting Tier0 and Tier1

LHCOPN **LHC Optical Network**

- Optical private network connecting Tier0 and Tier1s
  - Dedicated network to LHC data transfers and analysis
    - ❖ LHCOPN IP prefixes

Science and Research Collaboration in Asia - LHCOPN

KiSTi 한국과학기술정보연구원 Korea Institute of Science and Technology Information
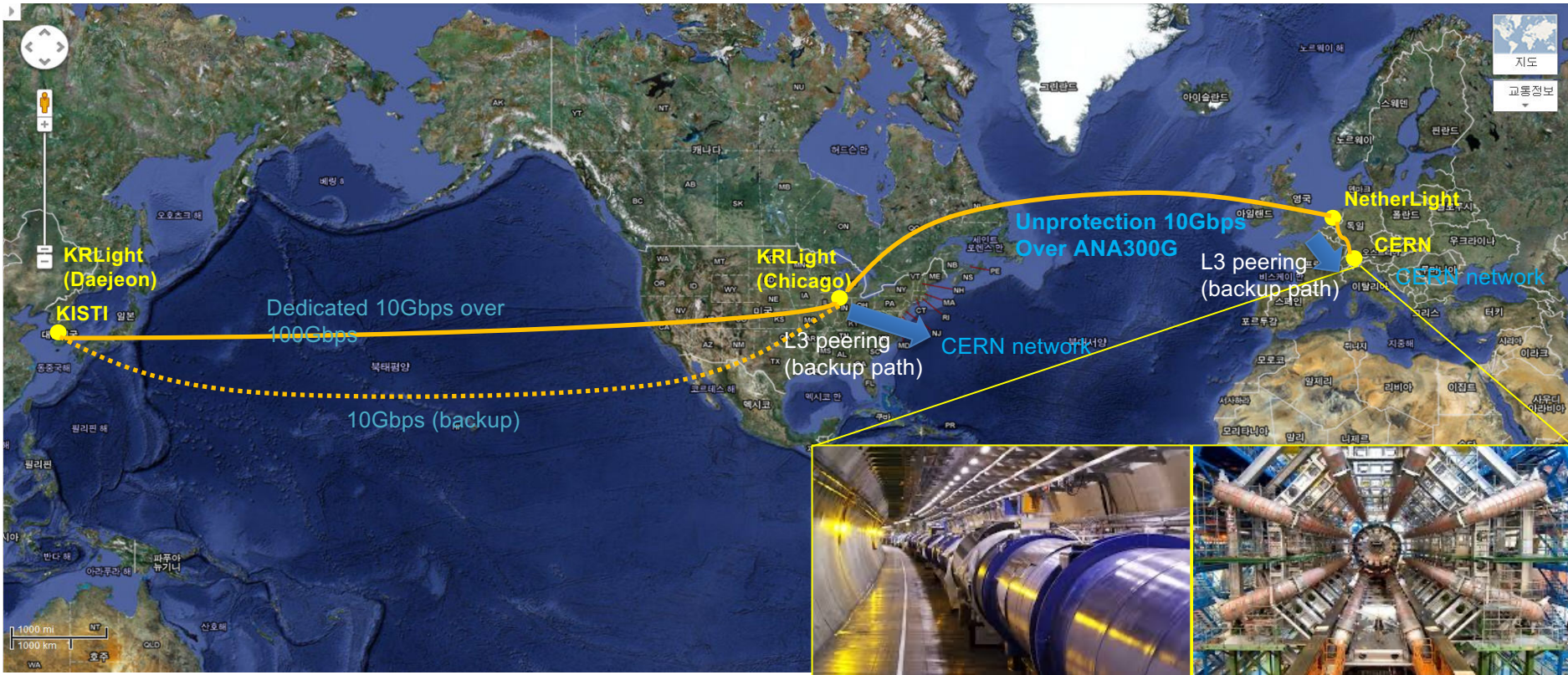
- 20 R&E networks
- 14 Tier1s and ~70 Tier2s in 5 continents
- ~250 perfSONAR instances
- 6 collaborations
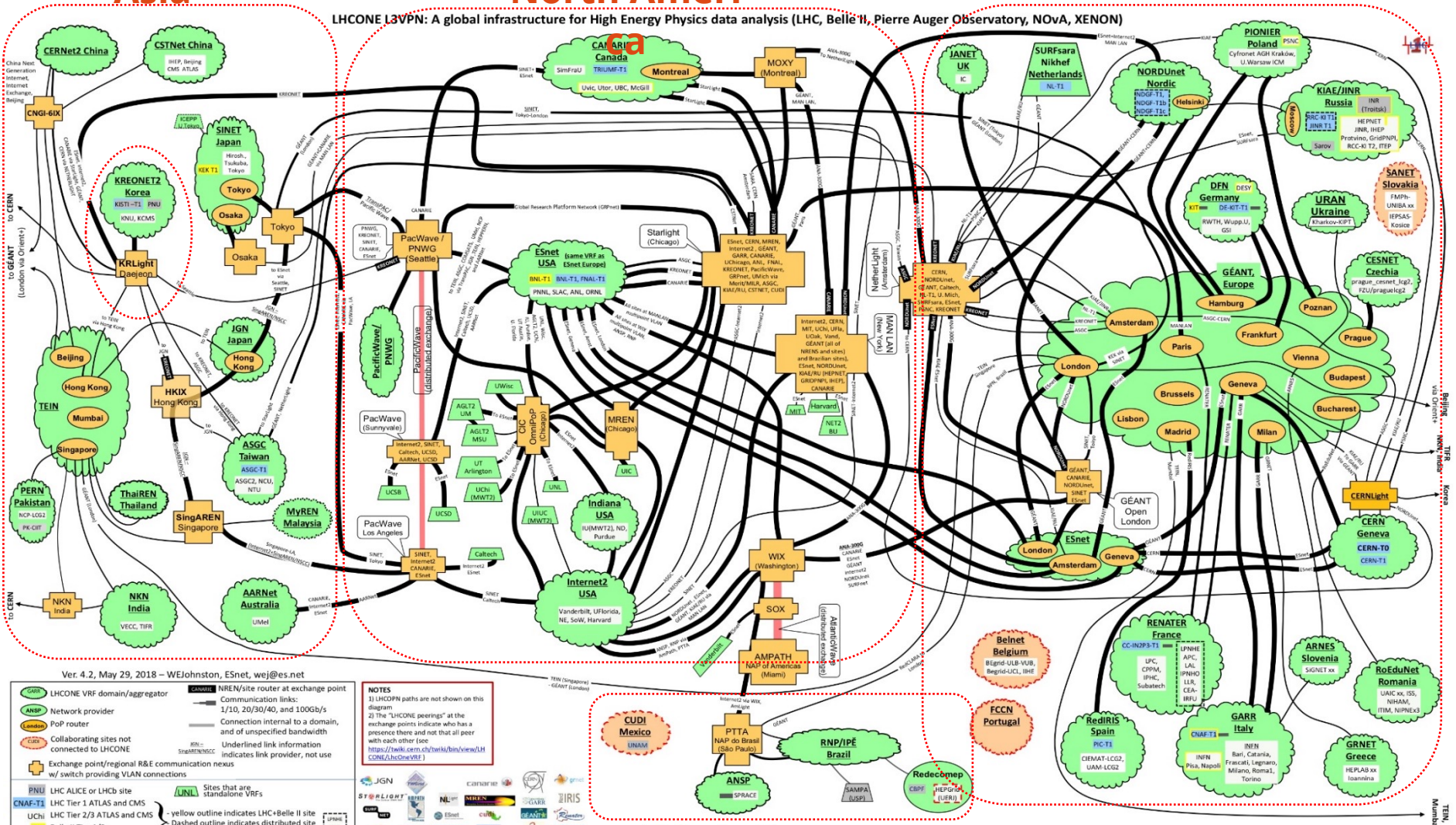
Asia　North America　South America　Europe

Data Intensive Science : The East-Asian VLBI

The East-Asian VLBI Network
(Image Credit: Reto Stöckli, NASA Earth Observatory)

- 6.7 GHz
- 8 GHz
- 22 GHz
- 43 GHz
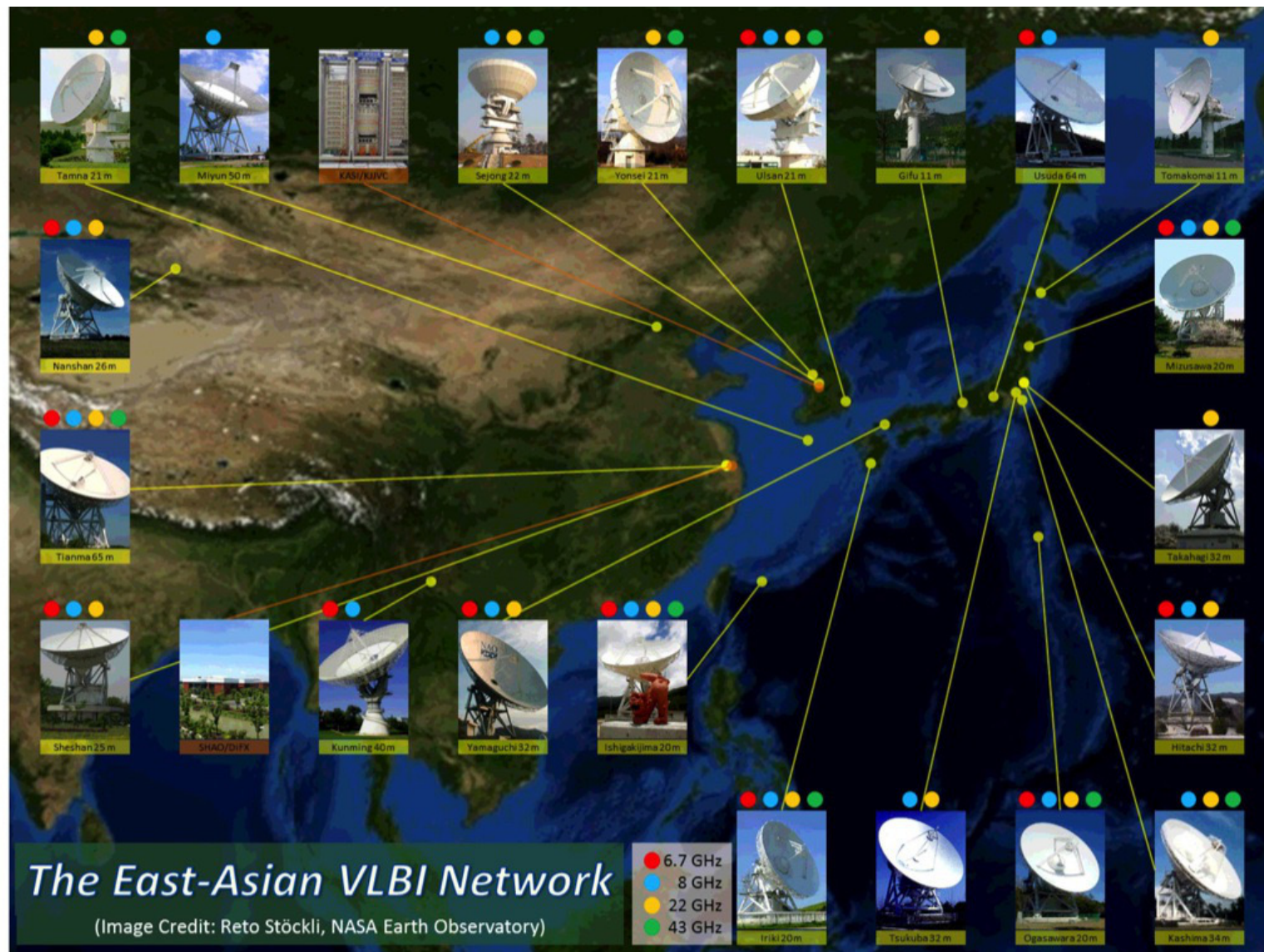
e-KVN (e-VLBI Network in Korea)

@East Asia

@Europe

Korea-Japan
Correlation
Center (KJCC)
@Daejeon

100G

40G (+1G)

Yonsei Astronomy Observatory
@Seoul

Daejeon

100G

KRLight

KREONet2

Seoul

KREONET

@Austrailia

10G(+1G)

Jeju

10G   **Sejong**

Ulsan

10G(+1G)

Tamna Astronomy Observatory
@ Jeju

VLBI antenna
@ SejongSpace Geodetic Observation Center

Ulsan Astronomy Observatory
@Ulsan
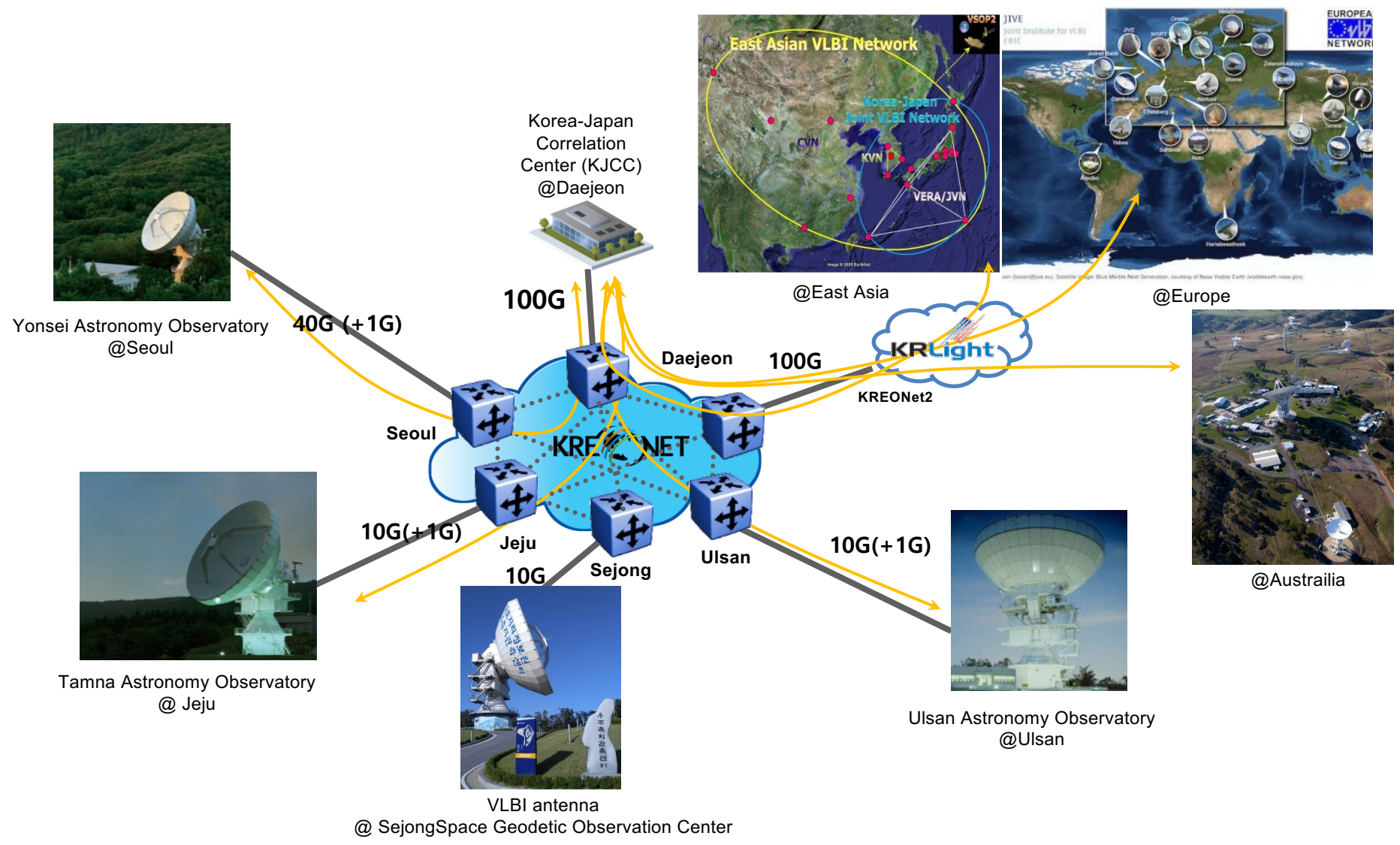
ASKAP (Australian Square Kilometer Array Pathfinder)

KISTI 5th Supercomputing Center/GSDC (100Gbps, 10Gbps*n)

100G

100G

100G

Pawsey Supercomputing Centre (10Gbps*n)

KEY
- Other R&E PoP
- Other R&E Network
- AARNet PoP
- 5 Gbps
- 5 Gbps backup
- 10 Gbps
- 100 Gbps
- n* 100G DWDM Transmission
- Subsea cable investment (Indigo Project)
- Subsea cable investment (JGA Project)
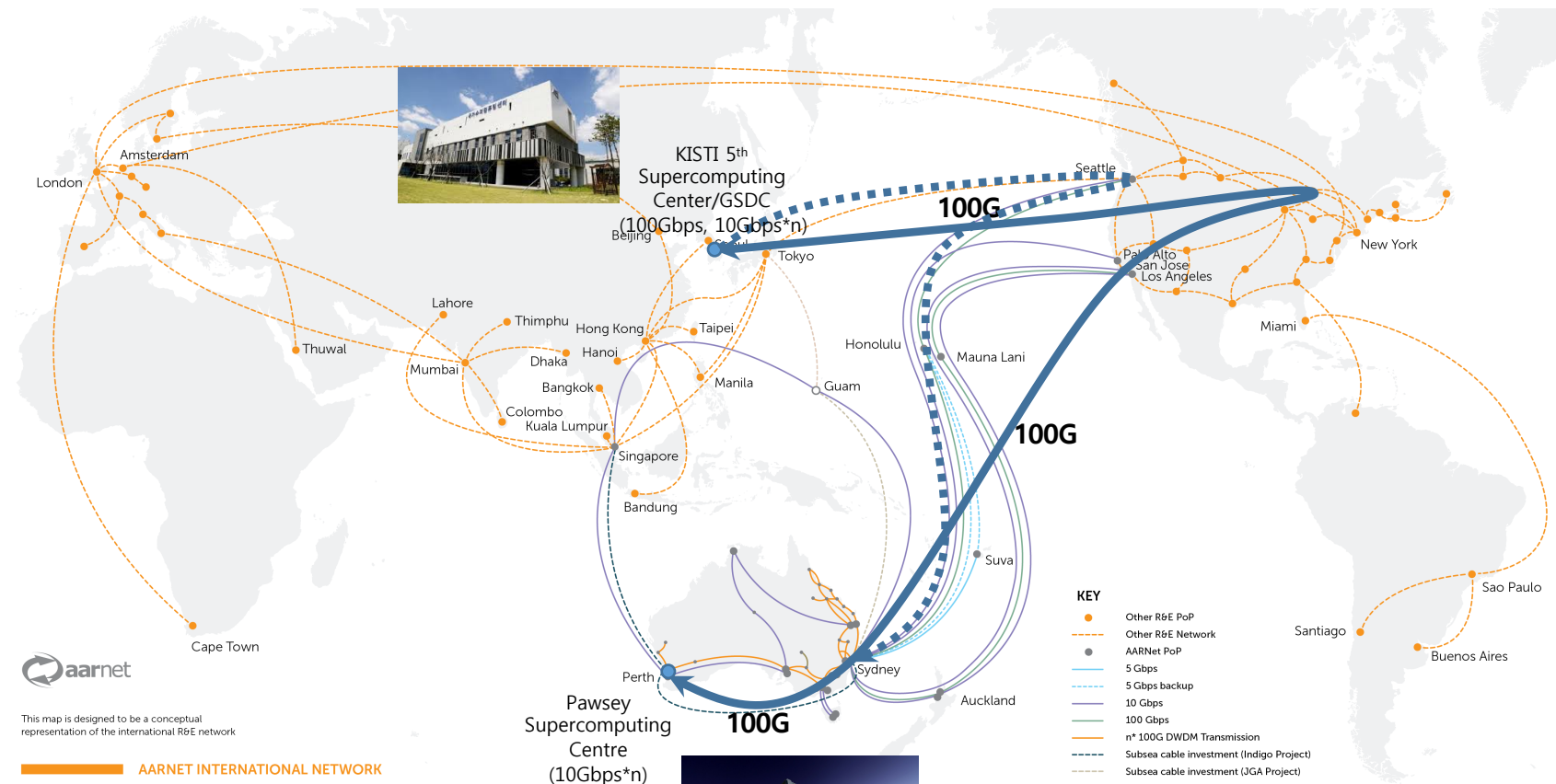
This map is designed to be a conceptual representation of the international R&E network

AARNET INTERNATIONAL NETWORK

ASKAP antennas → Correlator for on-site processing : 1.9Tb/s
→ Pawsey Supercomputing Centre in Perth (40Gbit/s)

한국과학기술정보연구원
Korea Institute of Science and Technology Information
www.kisti.re.kr

Network Research Demonstrations

LHCOPN, KVN, SKA

Inter-continental 100Gbps Data Transmission between Korea and Chile

- **Set up 100Gbps path from Chile to Korea via US**
- For **LSST data Transmission** from Chile to real user of Korea via US
- KASI (Korea Astronomy and Space Science Institute), one of the international contributors on behalf of the LSST Korea with 100G DTN at KASI and KISTI in Daejeon
  - Working on SC18 Network Research Exhibition "Global Petascale to Exascale Science Workflows Accelerated by Next Generation SDN Architectures and Applications" led by Harvey Newman, Caltech

100GE

KREONet2

100GE

KREONET

KASI

KASI ScienceDMZ with Lustre File System

LSST: Chile via StarLight/SC18
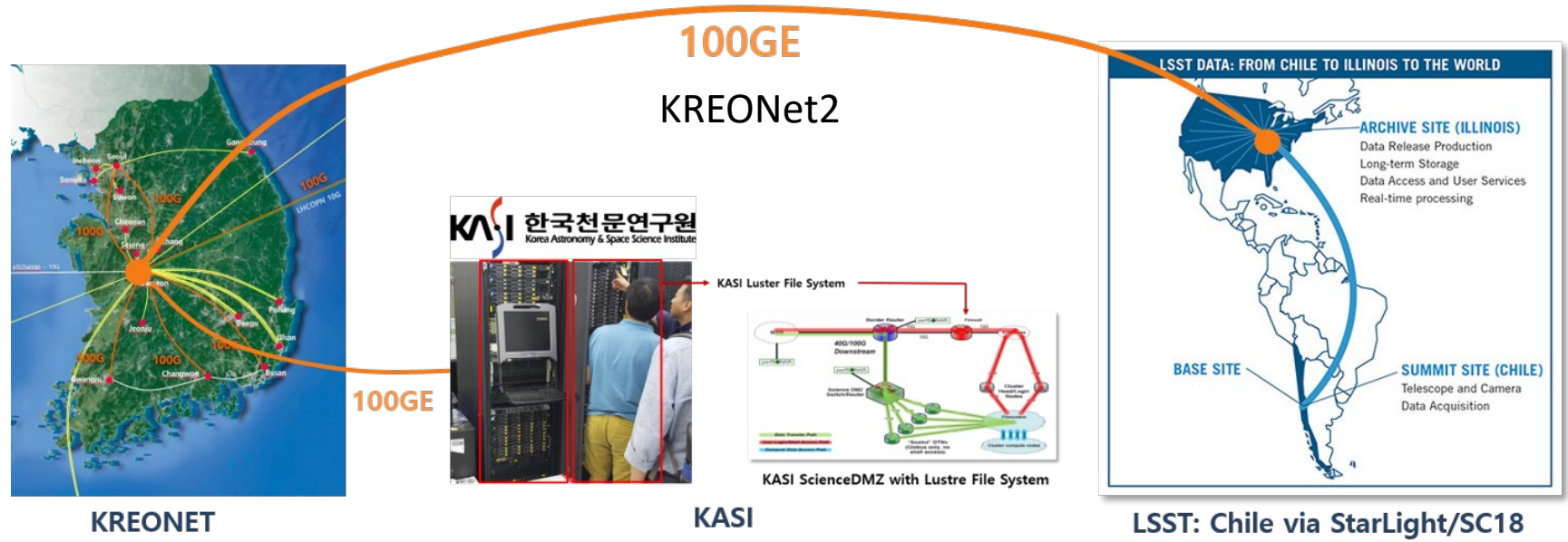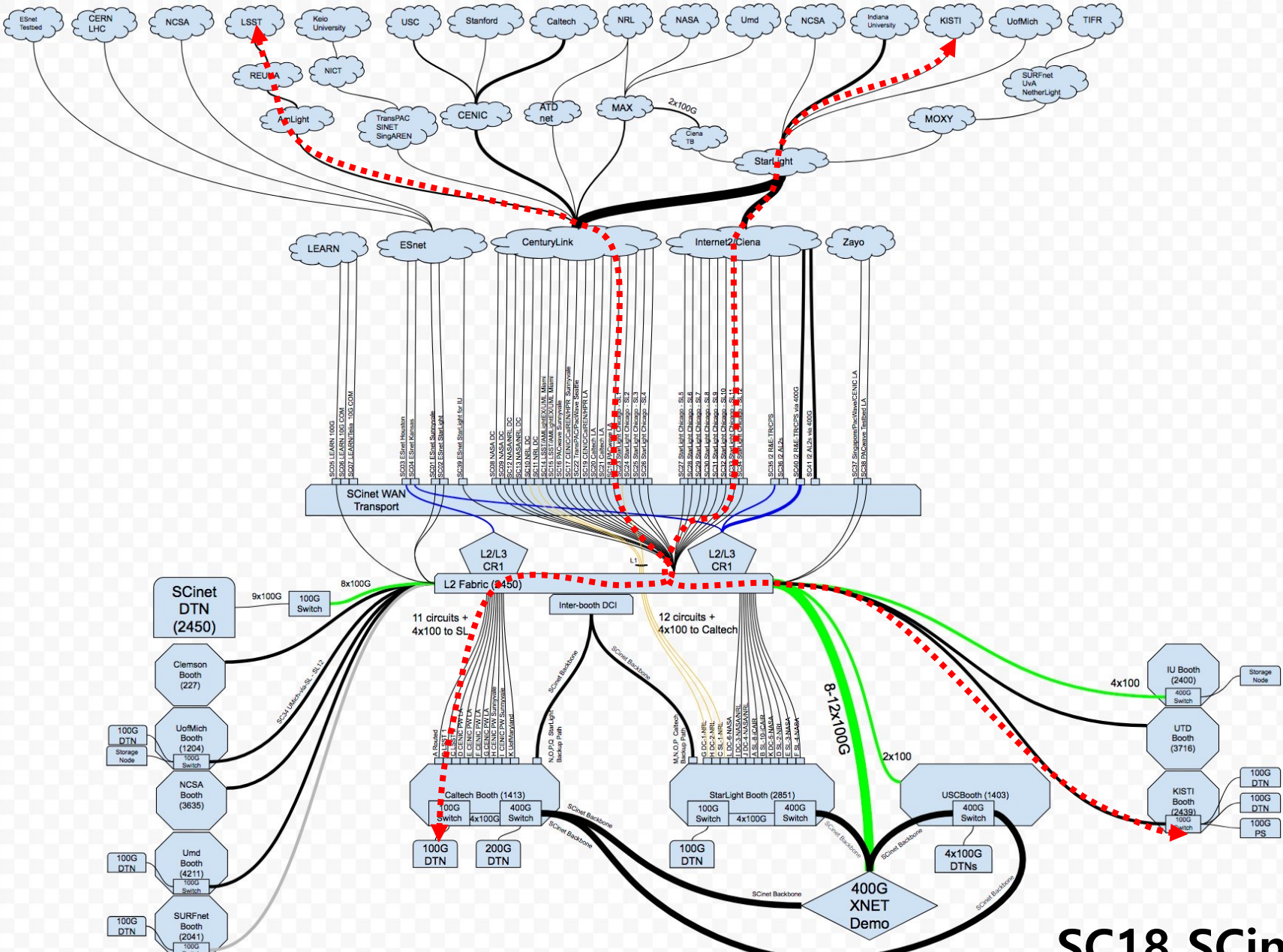
SC18 SCinet

LSST/SC18 Demo Topology

KASI/KISTI(Korea) – FIU(US)

KASI/KISTI(Korea) – LSST Base Site (Chile)
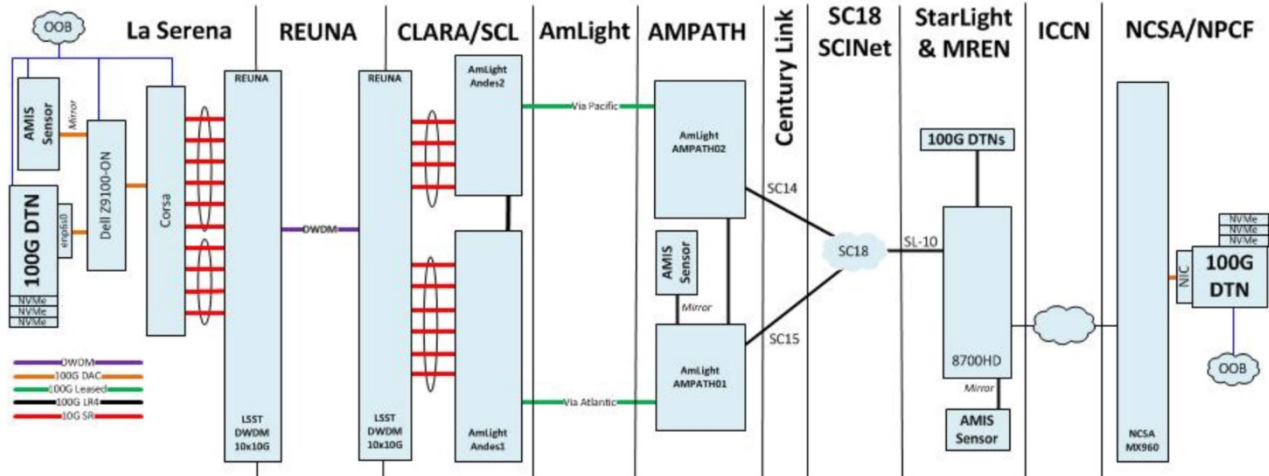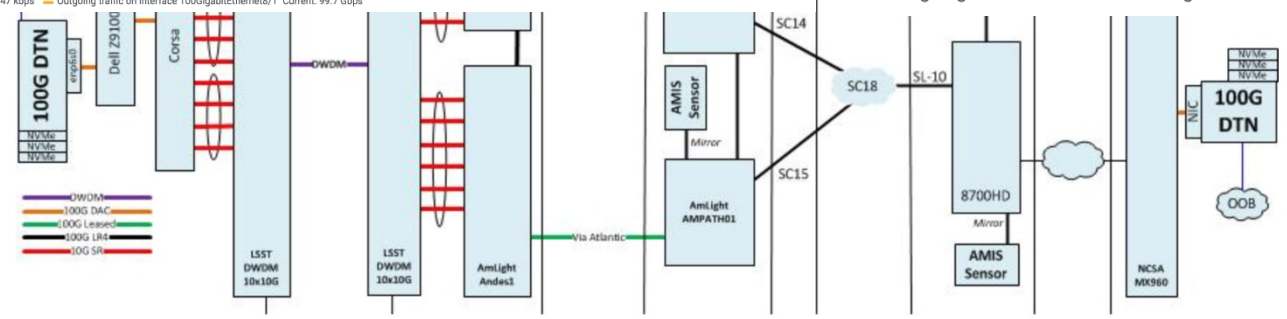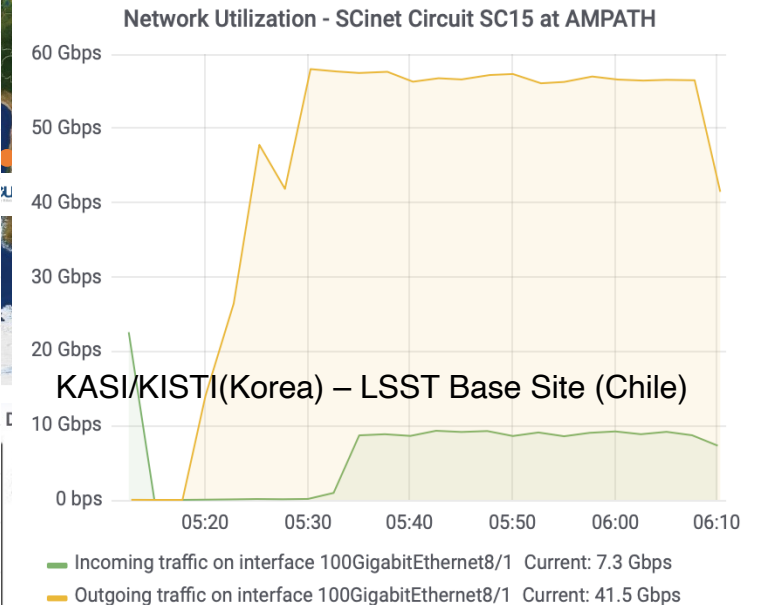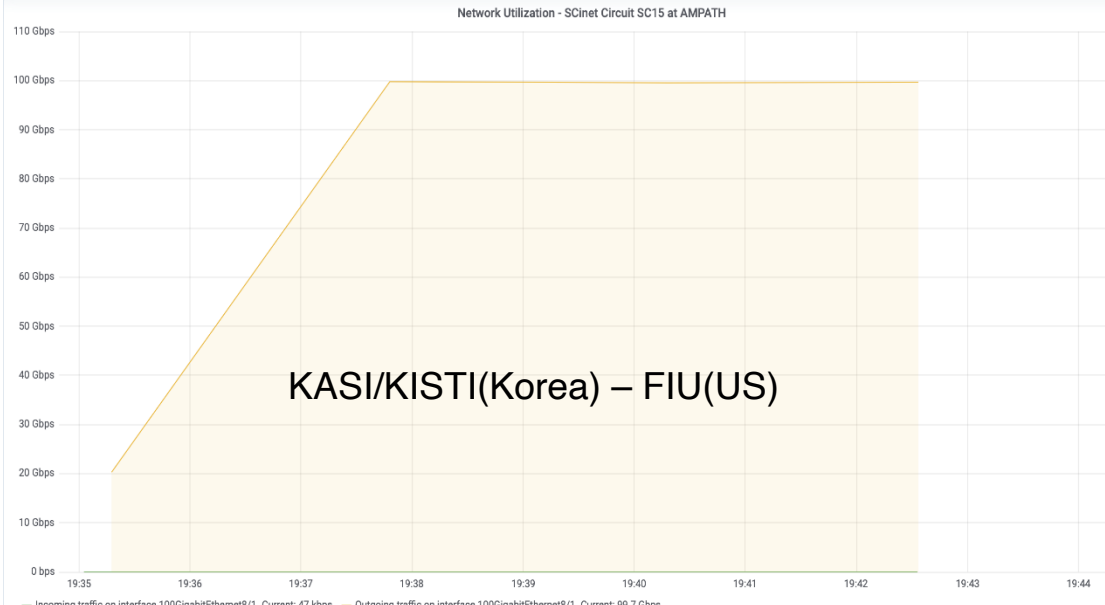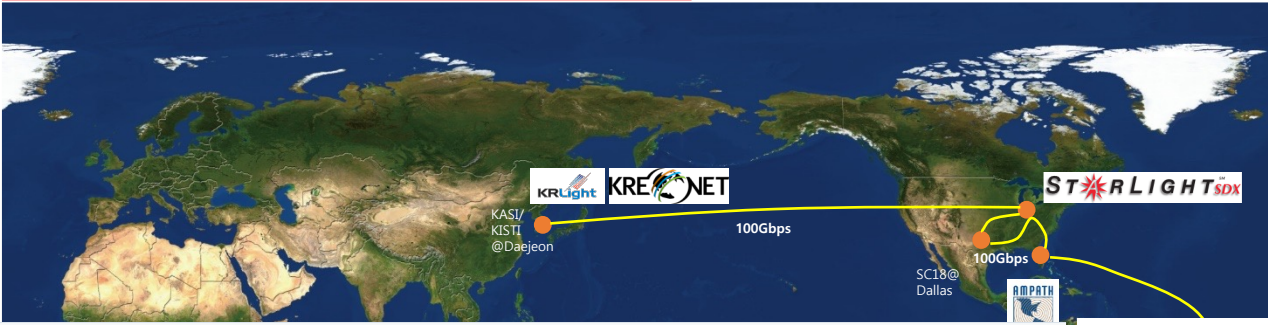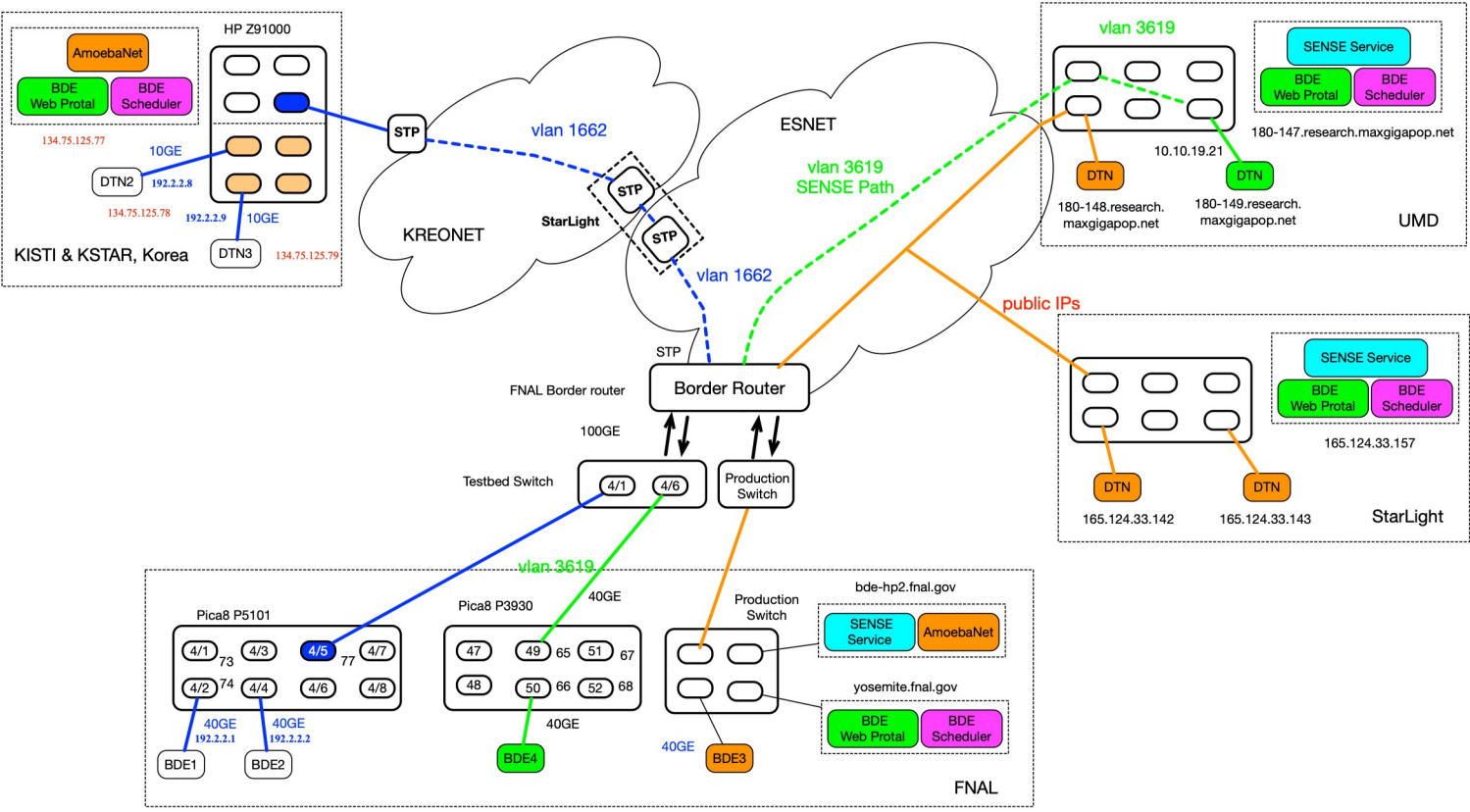
BigData Express Project, Collaboration between KISTI and Fermilab

- Working on SC18 Network Research Exhibition **"Providing Programmable Data Streaming to Large Computational Sciences"** led by Wenji Wu, FNAL
- Partners: FNAL, ORNL, PPPL, iCAIR, KISTI, KSTAR/NFRI

BigData Express Project

- Collaborative effort by Fermilab, Oakridge National Laboratory and KISTI
- Funded by DOE's Office of Advanced Scientific Computing Research (ASCR)
- **BigData Express seeks to provide a schedulable, predictable, and high-performance data transfer service for DOE's large-scale science computing facilities (e.g., LCFs, US-LHC computing facilities)**
- **BigData Express Key Features**
  - A data-transfer-centric architecture to seamlessly integrate and efficiently coordinate the various resource in an end-to-end loop
  - A time-constraint-based scheduler to schedule data transfer tasks
  - An admission control mechanism to provide guaranteed resources
  - for admitted data transfer tasks
  - An end-host-based rate control mechanism to improve data transfer schedulability and reduce cross-interference between data transfers
 - Extensive use of SDN and SDS to improve network storage I/O performance
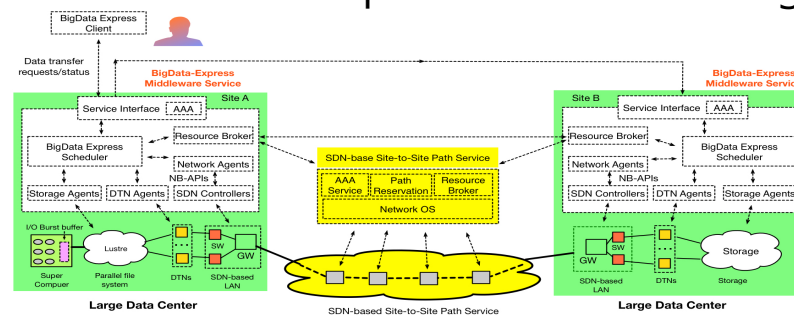
World 1st inter-continental UWV transmission

- 360° media delivery with ultra high quality based on MPEG OMAF
  - OMAF improves the quality of 360° media per same unit bandwidth through a packing process which results in bandwidth consumption reduction
  - Real-time stitching of 4K captured video for live streaming
- OMAF delivery over MPEG MMT for live streaming
  - MMT minimizes delivery delay of OMAF based 360° media
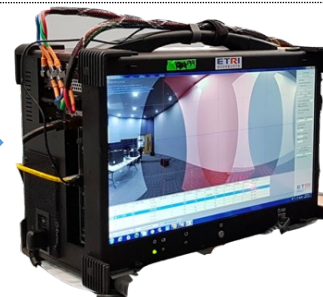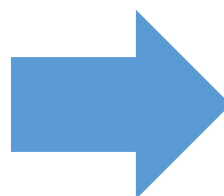 - Smooth and seamless switching of streams
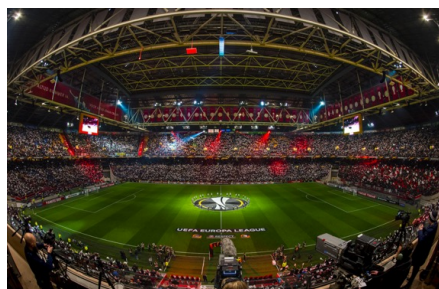
Amsterdam Arena
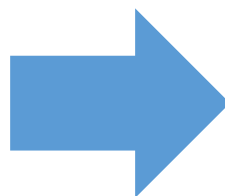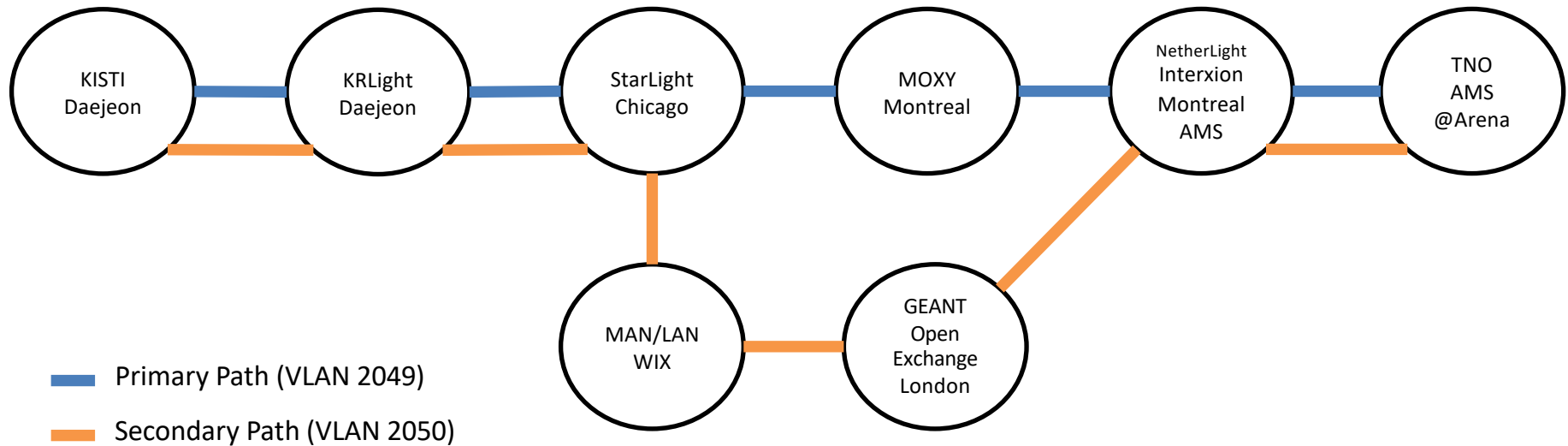

IBC and Korea

Two sets of 3x4K camera systems

ETRI real-time stitching system

4Kx4K or 8Kx2K

via Three 12G-SDIs

World first intercontinental UWV transmission

Daejeon – Amsterdam Live Broadcast International Network

- Primary Path (VLAN 2049)
- Secondary Path (VLAN 2050)

Network nodes: KISTI Daejeon, KRLight Daejeon, StarLight Chicago, MOXY Montreal, NetherLight Interxion Montreal AMS, TNO AMS @Arena, MAN/LAN WIX, GEANT Open Exchange London

https://www.tno.nl/nl/over-tno/nieuws/2018/9/ultra-wide-vision-primeur-real-life-real-time-experience-van-evenementen/

World

KISTI
Daejeon

TNO
AMS
@Arena

Prima

Secon

htt   nementen/

Summary

- **High performance science and research network in Korea, KREONET/KREONet and KRLight**

- **Global Science Gateway for Data Intensive Science**
  - Nature and History of the Universe : CERN LHC, LSST, SKA and eVLBI
  - Human Genome Project (Exabyte Data)
  - Earth Science & Climate data, Supercomputer networking etc.

- **Optimized Research Platform for Data Intensive Science**
  - Science DMZ as critical infrastructure model to enable high performance networking

- **Science and Research Collaboration in Asia**

- Several Network Research Demonstration in SC18 and intercontinental UWV transmission

Thank you