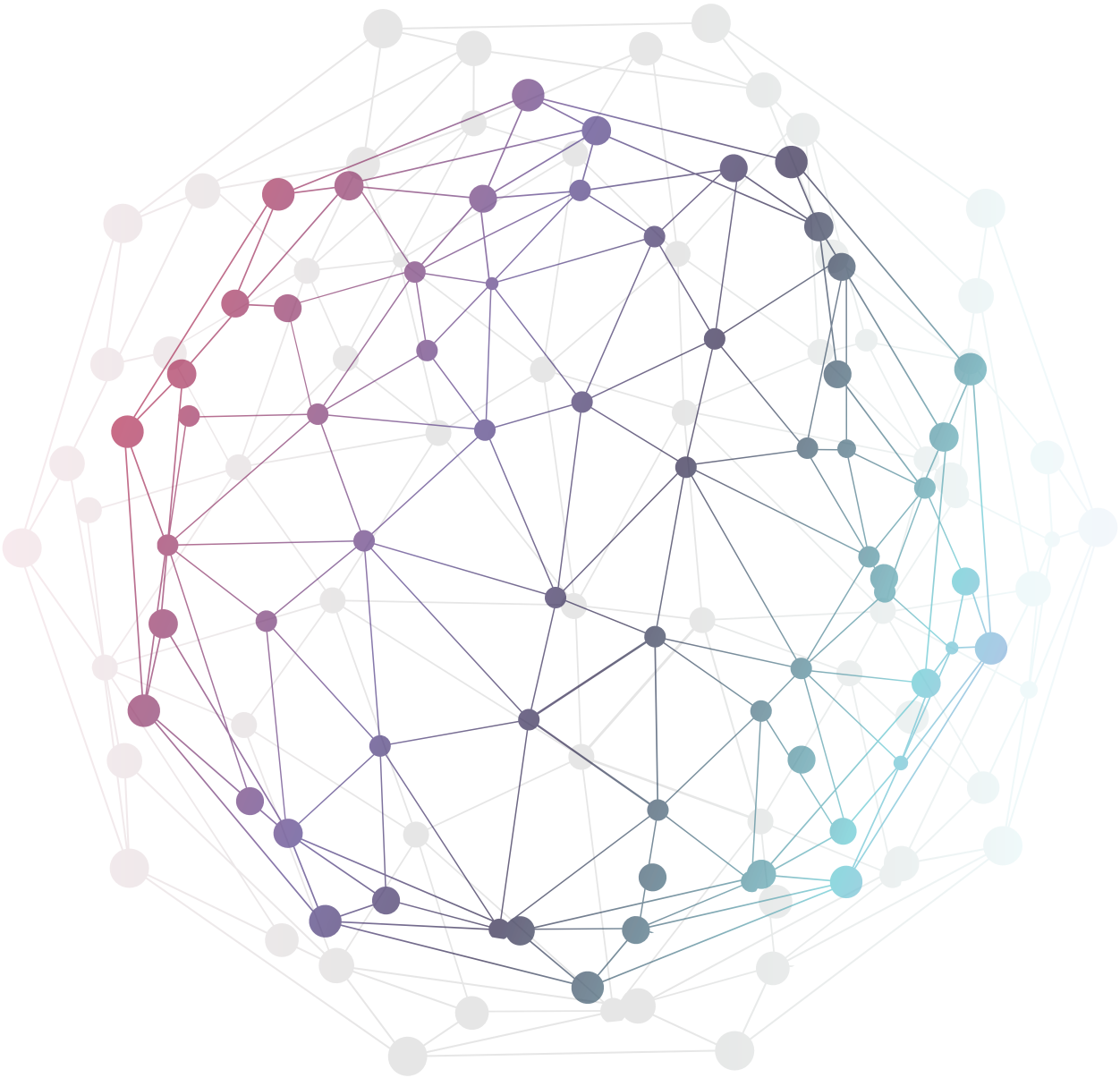
KOREN

KOREA ADVANCED RESEARCH NETWORK



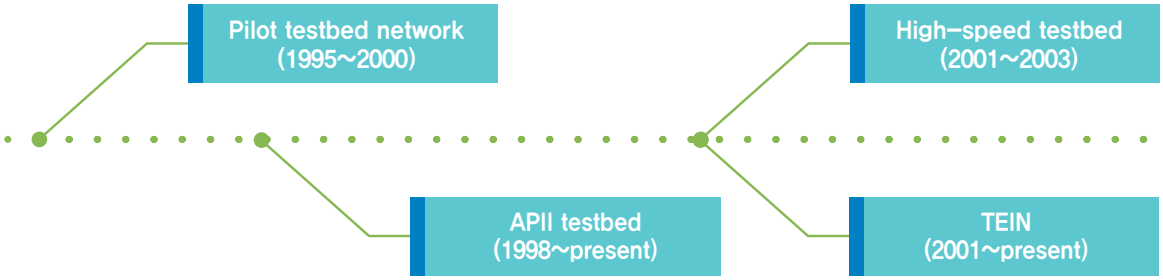
Ministry of Science, ICT and Future Planning

NIA

NATIONAL INFORMATION SOCIETY AGENCY

KOREN Leads Future Network Society.

Contents



KOREN

1995 Established the plan for a pilot testbed network
Provided 155M access link
Installed and verified ATM* exchange prototype
1998 Established network operation center
1999 Deployed 622M backbone network between Seoul and Daejeon
2000 Deployed 155M backbone network among Daejeon–Gwangju–Busan–Daegu

Pilot testbed network

2001 Established the plan for a high-speed testbed network
2002 Tested the function of domestic optical equipment and interface
Deployed 5G backbone network between Seoul and Daejeon
Upgraded access link from 155M to 1G
2003 Deployed 2.5G backbone network among Daejeon–Gwangju–Busan–Daegu

High-speed testbed

2004 Established a plan for BcN testbed network
Deployed 20G backbone network between Seoul and Daejeon
Installed BcN* QoS router prototypes and tested them to ensure QoS
2007 Deployed 10G backbone network among Daejeon–Gwangju–Busan–Daegu
2008 Upgraded access link from 1G to 10G
2009 Introduced DCN* service

BcN testbed

2011 Established a plan for the internet development to prepare for the future
ROADM*-based enhancement among six large cities
Deployed 30G backbone network between Seoul and Daejeon
Deployed 10G backbone network among Daejeon–Gwangju–Busan–Daegu
Provided access link from 1G to 10G
Established integrated optical packet transmission test network
Installed and tested a smart node prototype
2012 Established 10G testbed between Korea and Japan and conducted OpenFlow related test
2013 Established a plan for the new Internet business roadmap
Established high-quality broadband of domestic research network and international research network
– Conducted tests and verification for outcomes induced from R&D of future Internet field and boosted commercialization
– Discovered and supported joint research subject among countries in Asia
2014 Established a plan for the support for government researches
Deployed 100G backbone network between Seoul and Daejeon
Deployed wireless testbed
Deployed 10G SDN backbone network between Seoul and Daejeon

Advanced testbed network

※ ATM : Asynchronous Transfer Mode
※ BcN : Broadband convergence Network

APII

1995	APEC TEL approved APII testbed project
1996	APII testbed forum was held
1998	APII started between Korea and Japan (2M)
1999	APII started between Korea and Singapore (2M)
2001	APII started between Korea and US (45M)
2005	APII closed between Korea and US
2007	APII between Korea and Japan upgraded to 10G
2008	APII testbed project was transferred from KISDI to NIA Signed a MoU for APII operation between NIA (Korea) and NICT (Japan)
2009	Established broadcasting and communication convergent testbed between Korea and Japan
2011	Signed the MoU for the extension of 10G APII operation
2013	Formed dual (duplicative) network connection between Korea and Japan (10G circuit opening between Seoul and Tokyo)

TEIN

2000	Approved TEIN at the 3rd ASEM summit
2001	TEIN opening between Korea and France(2M)
2002	Upgraded TEIN to 10M
2003	Upgraded TEIN to 45M
2004	Upgraded TEIN circuit between Korea and France to 155M
2006	Opened and upgraded TEIN2 between Korea and Singapore to 622M
2008	TEIN project was transferred from KISDI to NIA
2009	Opened and upgraded TEIN3 among Korea–Hong Kong–Singapore to 2.5G Suggested the establishment of the TEIN cooperation center in Korea
2010	ASEM summit approved the establishment of the TEIN cooperation center in Korea
2011	Supported the establishment of the TEIN cooperation center at home
2013	Opened 10G TEIN4 among Korea–Hong Kong–Singapore

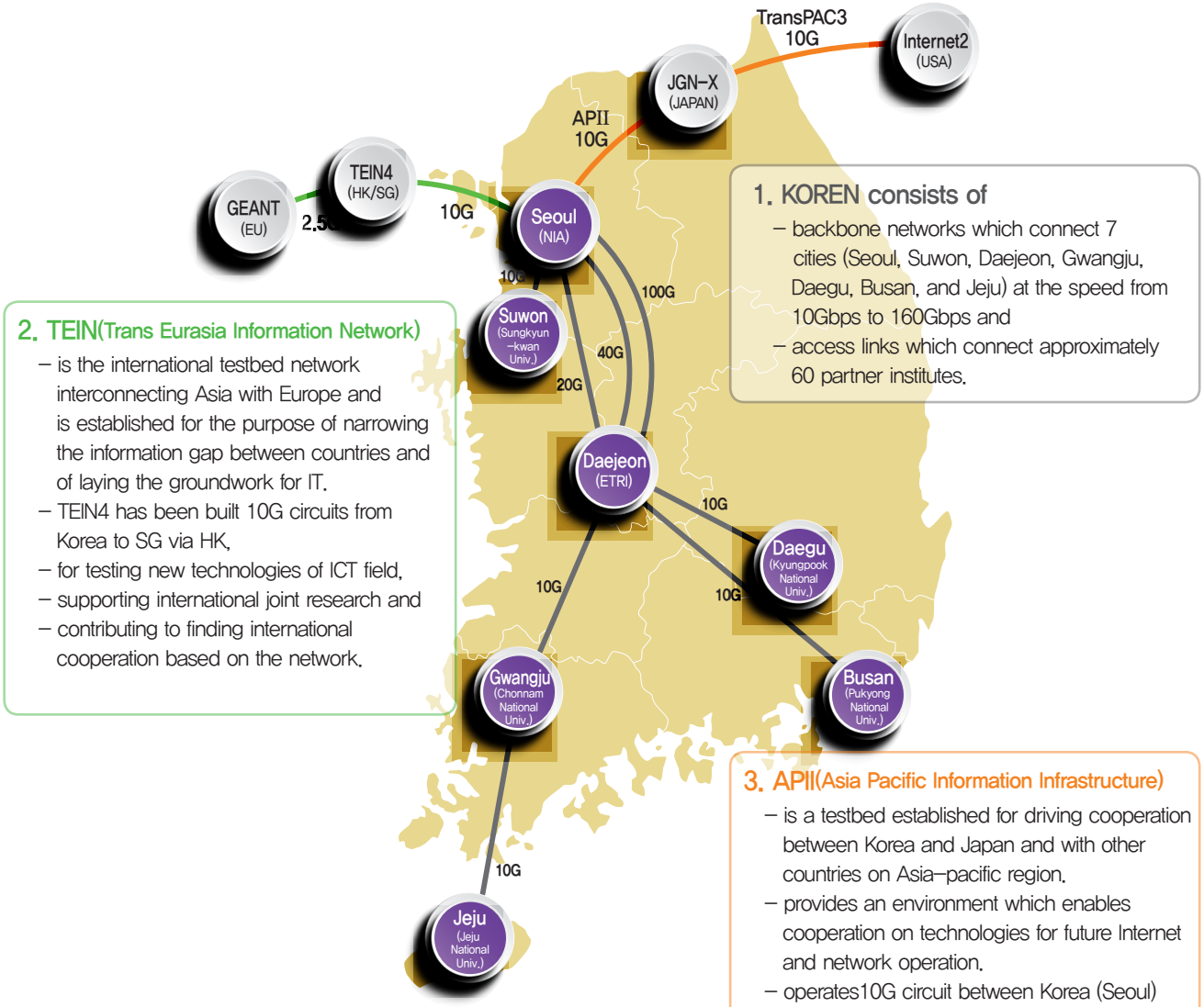
※ DCN : Dynamic Circuit Network
※ ROADM : Reconfigurable Optical Add Drop Multiplexer

Advanced Testbed Network, KOREN

KOREN (KOrea advanced REsearch Network) Is
an advanced and non-profit testbed network infrastructure, which provides high-quality broadband network to the industry, academia, and research institutions, enabling verification tests for future network related technologies and laying the groundwork for international joint research cooperation in the cutting-edge ICT field.

1. KOREN Status

KOREN consists of the backbone network and access links and is interconnected with other global advanced testbed networks such as Internet2, GEANT3 and so on through TEIN and APII.



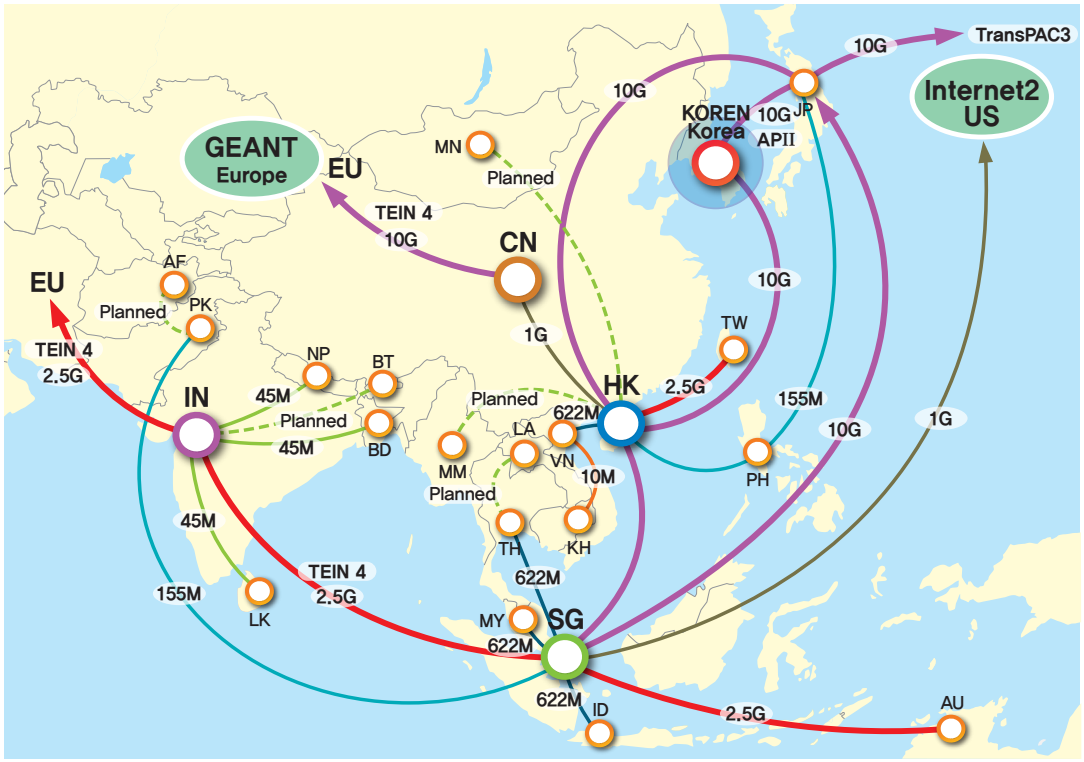
1. KOREN consists of
- backbone networks which connect 7 cities (Seoul, Suwon, Daejeon, Gwangju, Daegu, Busan, and Jeju) at the speed from 10Gbps to 160Gbps and
- access links which connect approximately 60 partner institutes.

2. TEIN(Trans Eurasia Information Network)
- is the international testbed network interconnecting Asia with Europe and is established for the purpose of narrowing the information gap between countries and of laying the groundwork for IT.
- TEIN4 has been built 10G circuits from Korea to SG via HK,
- for testing new technologies of ICT field,
- supporting international joint research and
- contributing to finding international cooperation based on the network.

3. APII(Asia Pacific Information Infrastructure)
- is a testbed established for driving cooperation between Korea and Japan and with other countries on Asia-pacific region.
- provides an environment which enables cooperation on technologies for future Internet and network operation.
- operates10G circuit between Korea (Seoul) and Japan(Toyko).

〈 KOREN Backbone & Global Connections 〉 [July 2014]

International Advanced Testbed Networks, TEIN and APII were born to establish network infrastructures to conduct various international joint research and exchange information with international research agencies by interconnecting global testbed networks.
TEIN and APII connect a total of 65 countries comprised of 21 Asian nations, 43 European countries and the U.S.
APII circuit between Seoul and Tokyo reaches Internet2, the American testbed network through TransPAC3 circuit which connects between the U.S. and Japan.
TEIN4 circuit which connects from Korea to Hong Kong, Singapore, and India reaches GEANT3, European testbed network.



〈 International Advanced Testbed Network Status 〉 [July 2014]

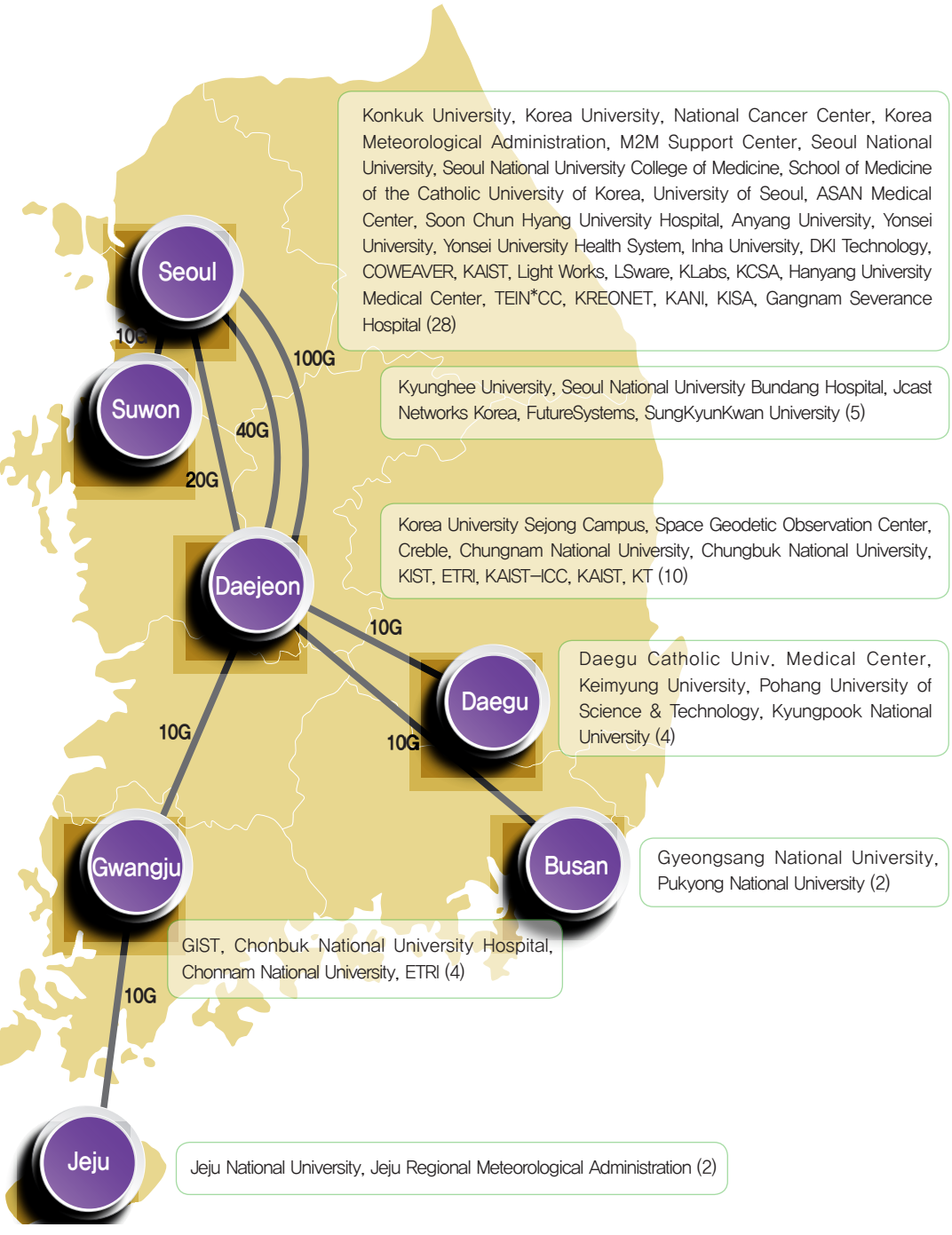
Ref.

※ Sixty-five countries connected with International Advanced Testbed Networks (21 Asian countries, 43 European nations and the US)

(21 countries in Asia)	Republic of Korea, China, Japan, Taiwan, Singapore, Australia, Bangladesh, Bhutan, Cambodia, India, Indonesia, Laos, Malaysia, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, Vietnam, Myanmar, Afghanistan
(43 countries in Europe)	Austria, Slovenia, Belgium, Croatia, Czech, Italy, Cyprus, Germany, Greece, Estonia, Portugal, Ireland, Bulgaria, Israel, United Kingdom, Russia, Lithuania, Hungary, Poland, Spain, France, Luxembourg, Romania, Slovakia, Latvia, the Netherlands, Switzerland, Turkey, Malta, Denmark, Finland, Iceland, Norway, Sweden, Armenia, Montenegro, Serbia, Azerbaijan, Georgia, Macedonia, Belarus, Moldova, Ukraine
(1 country in North America)	the United States of America

2. KOREN members

Fifty-five Korean domestic research institutions that utilize KOREN



〈 July 2014 〉

Twenty-one Asian nations utilizing TEIN

TEIN Participating Organizations
Nepal : Nepal Research and Education Network (NREN)
*Laos : Lao Education and Research Network (LERNet)
Malaysia : Malaysian Research and Education Network (MYREN)
*Myanmar : Myanmar Research and Education Network (mmREN)
Bangladesh : University Grants Commission (UGC)
*Bhutan : Department of Information Technology and Telecom (DIT&T)
Vietnam : National Agency for Science and Technology Information (NASATI)
Sri Lanka : Lanka Education and Research Network (LEARN)
Afghanistan : Afganistan Research and Education Network (AfgaREN)
India : National Knowledge Network (NKN)
Indonesia : Institut Teknologi Bandung (ITB)/INHERENT
*Cambodia : Institute of Technology of Cambodia (ITC)
Thailand : Thailand Research Education Network Association (ThaiREN)
Pakistan : Pakistan Education and Research Network (PERN)
Philippines : Advanced Science and Technology Institute (ASTI)
Singapore : Singapore Advanced Research & Education Network (SingAREN)
Japan : National Institute of Information and Communications (NICT)
National Institute of Information (NII)
Ministry of Agriculture, Forestry and Fisheries Research Network (MAFFIN)
China : China Education and Research Network (CERNet),
China Science & Technology Network (CSTNet)
Republic of Korea : National Information Society Agency (NIA)
Australia : Australia, Academic and Research Network (AARNet)
Hong Kong : Hong Kong Academic and Research Network (HARNet)

*Countries shown in red indicate TEIN partners but network interworking is not yet established.

※ All European countries participate in TEIN as the EU and interconnect TEIN through GEANT(Gigabit European Academic NeTwork). (Please refer to the box at the bottom of page 5.)

Potential for the Future,

A Stage is Opened up for Various Activities.

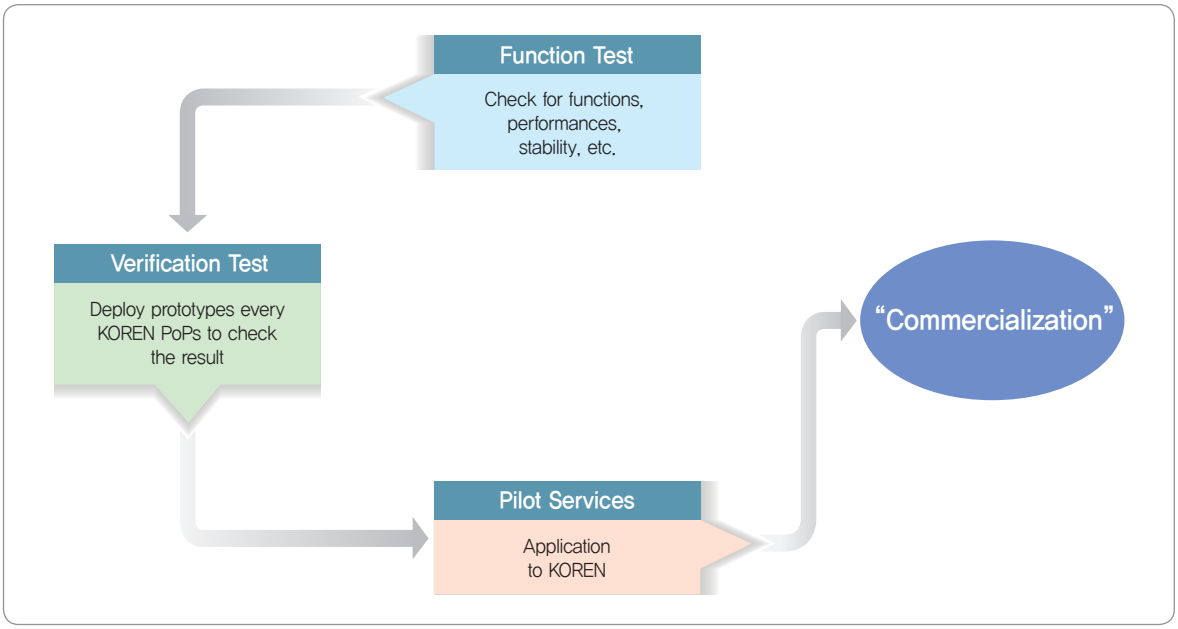
1. Support for Commercialization of Domestic Network Technology
2. Support for coordination of International Cooperation
3. Deployment of Communication Infrastructure for 'Creative Economy Innovation Centers'
4. Contribution to KR Government ICT Strategies and Plans
5. Stimulating KOREN Usage

KOREN's Goal and Activities

KOREN has been a reputable, high-quality testbed network which tests new technologies that various institutions possess from the industry, academia, and research institutes fast and safely with the purpose of the 'World-Best ICT and Internet infrastructure'. Each and every individual or organization that needs network infrastructure for relevant activities below can apply for and utilize KOREN.

First, KOREN promotes leading technology in advanced network infrastructure and boosts commercialization of domestic equipment to realize a creative economy.
Second, KOREN opens international cooperative assignments.
Third, KOREN connects 'creative economy innovation centers' and IoT infrastructure.
Fourth, KOREN paves the way for implementing Korean government ICT strategies and plans such as Giga Internet, Big Data, and so on.

First, KOREN promotes leading technology in advanced network infrastructure and helps boost commercialization of competitive domestic equipment to realize a creative economy.



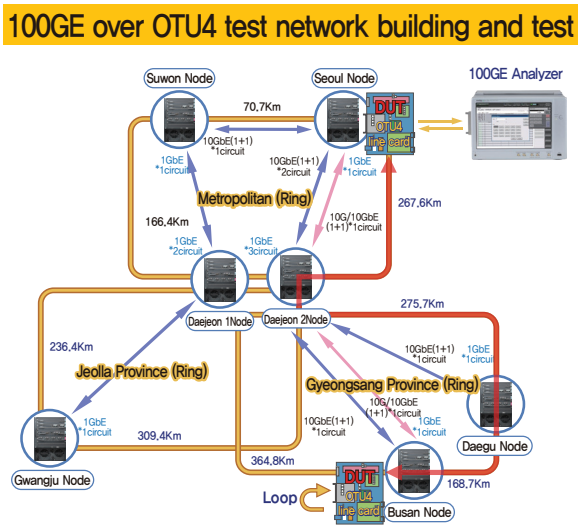
〈 Approach to the Commercialization of Domestic Technologies and Prototypes 〉

① Function Test – Enhance the quality of outcomes through the verification of many research projects related to future Internet at the 'next-generation test & verification center'.

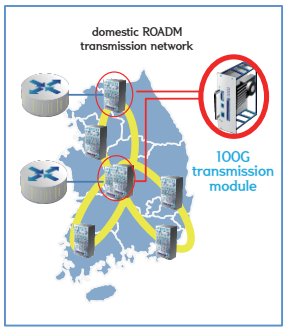
	Candidate Projects (2013)
1	Port agnostic ekement technology and distributed high-capacity NG-PON2 core technology for the next-generation application platform
2	RF/PON based giga-class bidirectional transmission system structure and standardization study
3	Development and commercialization of tera-scale core routers
4	Interoperability technology of heterogeneous content transmission networks for building open content delivery infrastructure
5	Caching in embedded system and routing original technology for name address based networking
6	DTN technology for mobile/sensor network application
7	SDN core technology for carrier-class service infrastructure
8	Integration of heterogeneous cloud resources to manage multiple services broker and open big data analytics platform development collaboration
9	Integrated control and management system of OpenFlow-based wired and wireless devices
10	Knowledge assets for leverage big data (Knowledge Base) construction and real-time linked data application technology
11	Immersed smartwork core technology for multilateral collaboration
12	Embedded computing media convergence-type delivery system technology for high-definition video services support
13	The next generation of large coherent optical OFDM technology
14	Network-based consumer-oriented convergence service cross-platform technology
15	Cloud computing based IDC switch development

◆ Case of Function Test

In 2012, 100G line card developed by domestic company was deployed on the KOREN, conducted 'ROADM based 100G Ethernet' which transmits 100G-scale data, and succeeded transmission test between Seoul and Busan(712Km) and commercialization. Since 2014 the line card has been applying KOREN backbone 100G expansion.



〈 100G transmission equipment test on KOREN 〉

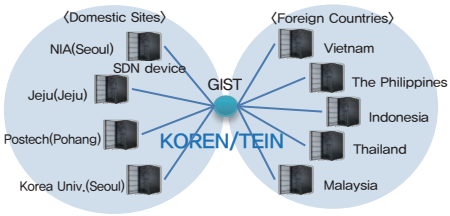


〈 100G transmission equipment establishment on KOREN backbone 〉

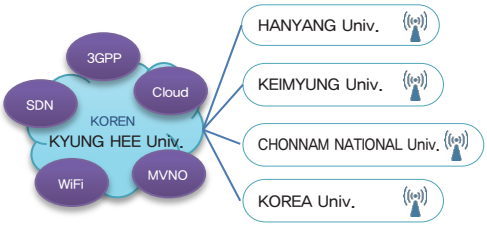
② Verification Test – Prototype devices or technologies are temporarily deployed on KOREN PoP and checked their performance. KOREN raises the completion level by complementing their functions and plays a role as a reference site.

◆ Verification examples utilized KOREN in 2013

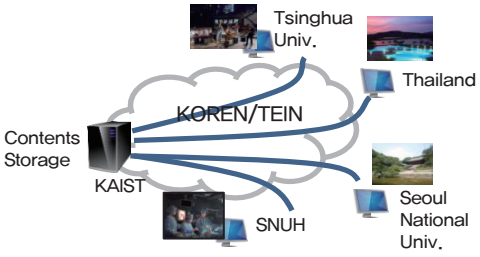
Various verification tests were conducted via KOREN in 2013. KOREN set up appropriate test environment for KOREN users, provided virtual networks and supported skills. As a result, KOREN could go one step forward to its aim to help commercialize our advanced technology in advanced network infrastructure and competitive domestic equipment.



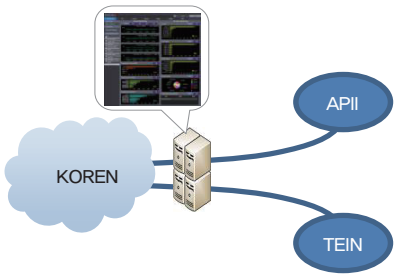
〈 Expanding and Improving of SDN Test Infrastructure for OpenFlow-based Network, OF@TEIN (2012~2013) 〉



〈 Open Mobile Network Testbed (2013) 〉



〈 Open Contents Transmission Testbed (2012~2013) 〉



〈 Integrated Real-time Traffic Control Technology (2013) 〉

③ Pilot Services – KOREN is planning to apply R&D results based on SDN technologies and Cloud environment.

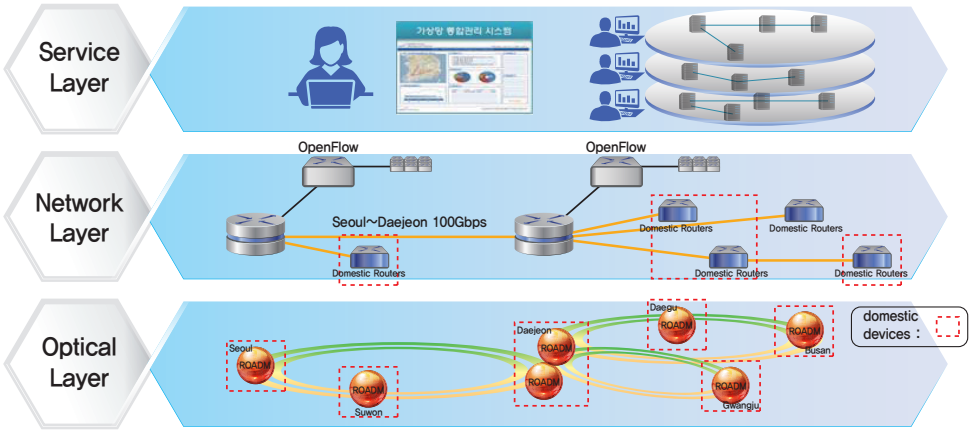
	2012	2013
Verifications	8 (e.g. technical development of contents focused smart node)	15 (e.g. for commercialization of tera-scale core routers)
Pilot Program	Gigabit Internet Backbone, IoT Internet, and Cloud Service	Each telecom company's CDN inter-linkage, link with Big Data Analysis Systems

〈 Performance of KOREN from 2012 to 2013 〉

The next shows the real cases of helping commercialization by applying domestic equipment.

◆ Case #1. KOREN with domestic components

KOREN's backbone is interlinked with equipment developed by domestic companies.
Domestic equipment has been deployed and utilized since 2011, and KOREN deploys some equipment in 2014.



〈 Deployment of Domestic Equipment on KOREN 〉

◆ Case #2. Internet phone produced with domestic components

KOREN conducted interoperability test and security test relative to the National Intelligence Service's qualification. Based on this result, public institutions converted to Internet phones which consist of components made in Korea and the conversion rate reached 89% at the end of the year of 2013.

〈 Encryption Testbed of Internet Phones in KOREN 〉

KOREN is open for anyone or any organizations that require verifications related to advanced network and test domestic equipment.

2 Second, KOREN opens international cooperative assignments.

KOREN consolidates cooperation with international society by opening up and driving technical cooperation projects and international joint research which utilize KOREN and International testbed networks, TEIN and APII.

◆ Main projects that KOREN works together with International Advanced Testbed

Verification of New Network Technology	– Testing IPv6, QoS, and Multicast (2000 ~) – Testing Extended Optical Tech (100Gbps) (2013)
Commercial Equipment Test Operation	– Internet phone and switchboards Interoperability Test (2008, 2013)
Supporting High– Quality Video Contents	– Support medical surgery live broadcasting to domestic and foreign sites (2004~) – Telemedicine for Korean national/resident (Uzbekistan, Kazakhstan, January 2013~) – Korea–Spain, Japan Cyber Performance (Musical Ensemble, 2006 ~) – Multi–cultural families reunion via Video Conference System (Korea–Vietnam, Korea – Philippines, 2009)
National Projects	– Gigabit Internet Backbone (2009~) – IoT Support Center Network Support (2012~) – Big Data Analysis Center Network Support (2013 ~)

◆ Major KOREN Activities – Expanding Medical Alliance

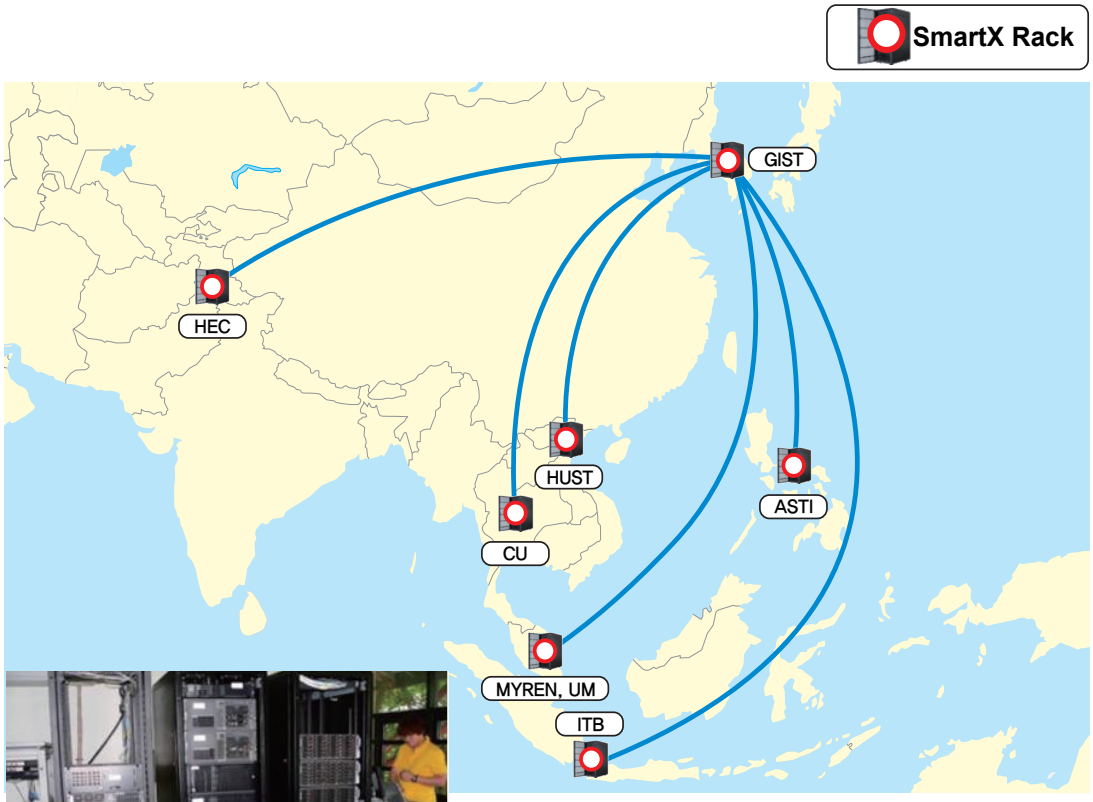
Activities such as medical demonstrations have been conducted since 2004.
As part of international cooperation in 2013, KOREN and TEIN helped broadcast high–capacity and high–quality live surgery to nine large hospitals in five nations.

〈 Medical Surgery Live Broadcasting 〉

〈 Medical Surgery Live Broadcasting 〉

◆ Case of building the international cooperative environment

KOREN helped install SDN related domestic equipment such as SmartX Rack in six ASEAN nations including Pakistan and five domestic organizations as well as expanded and improved OF@TEIN, the test environment for OpenFlow-based SDN. Based on our advanced domestic technology, KOREN opens up technical cooperation with other countries and builds international cooperative testbed environment.

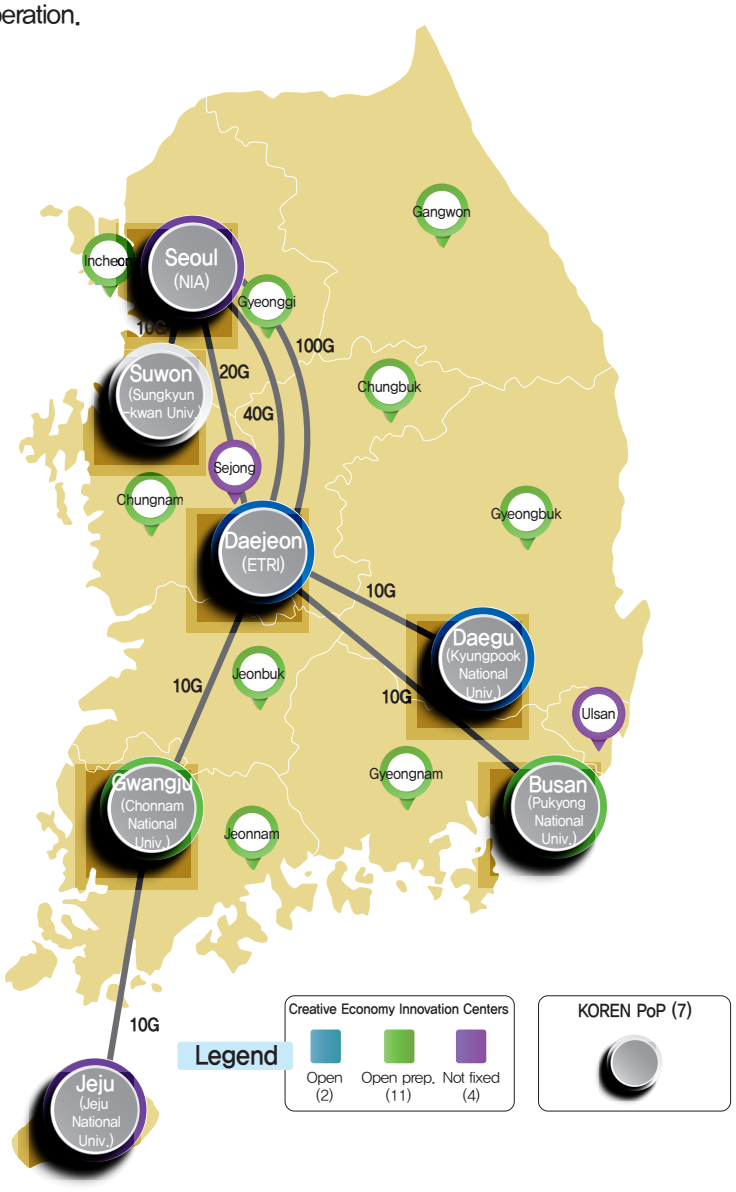


〈 SDN Infrastructure in 7 Asian Countries (January 2014) 〉

KOREN plans to spread the Korean Wave – "Hanryu," and become a bridge to connect between Asia and Europe by conducting joint projects and facilitating overseas advancement of our domestic technology. KOREN helps you participate global issues in advanced network infrastructure and contribute related skills.

Third, KOREN forms a communication infrastructure of 'Creative Economy Innovation Centers' and 'Internet of Things'.

KOREN links each region-specific pilot project and Creative Economy Innovation Centers established in 17 areas for the purpose of spreading the creative economy and strengthening the capability of small and medium-sized businesses and venture companies. In doing so, KOREN helps foster a creative economy and supports various creative industries such as high-bandwidth and cutting-edge software, IoT and others. Also, KOREN is planning to combine 17 physical sites into one big virtual community by employing methods such as remote training and video conferencing which enable efficient cooperation.



〈 July 2014 〉

Fourth, KOREN paves the way for implementing Korean government ICT strategies and plans such as Giga Internet, Big Data, and so on.

KOREN has evolved into a multipurpose network of hyper-connected society, creating the future internet convergence services and building a stable foundation for the virtuous cycle in the ecosystem. KOREN, as a foundation of the future ICT and network industry development, plays a role as follows:

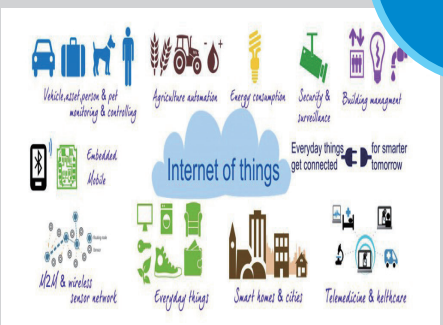
Giga Internet

· Verify network efficiency and intellectualization technology such as SDN of Giga Internet content by connecting each carrier's test network on the KOREN-based environment

Big Data

· Connect KOREN with Korea Big Data Center which provides infrastructure for universities and companies not available to equip with big data infrastructure
· Utilize KOREN to transmit Giga class' high-capacity data difficult to tackle in the commercial networks

KOREN



· Possible to use research and test environment for mobile-based stable Machine to Machine, connecting KOREN with M2M Support Center
· Realize the real-time Jeju web-casting video information service

Internet of Things (IoT)

· Provide a platform capable of allocating virtual resources by interconnecting KOREN to around 100 cloud nodes
· Conduct the stability test of domestic prototypes and verify the high-capacity data transmission related to security issue

Cloud

CDNI: set of interfaces and mechanisms required for interconnecting two independent content delivery networks (CDNs) that enables

Hyper-connected society's multipurpose network, KOREN!
KOREN, as a communication infrastructure for future ICT and Korean government ICT strategies, is always ready to be your partner.

5 Fifth, other activities to stimulate KOREN usage

With continuous promotion and training, KOREN helps expand the domestic advanced network community and strengthens international cooperative activities such as APAN, Internet2 and TERENA.

① KOREN project introduction and technical seminars (June 2014)

– Share outcomes from KOREN-based research so far and introduce projects in 2014

〈 2014 KOREN Business Fairs & Technical Seminar 〉

② Newsletter

– Publish monthly newsletter with up-to-date R&E related news

③ KOREN Forum

– As a community of KOREN members, KOREN Forum delivers various activities to leverage using KOREN

▶ Activities and Roles

– Promote the research, development, test, and verification activities by utilizing KOREN

– Represent Korea as a user of International Research Network Consortium such as APAN

– NET Challenge Camp : Discovering and developing novel ideas of Future Network (2014)

〈 KOREN Forum Workshop 〉

④ Participate in events organized by various International Research Institutes

- TEIN Project Meeting(TEIN NOC Workshop)
- APII Workshop
- APAN Meeting and other R&E related events, i.e. Internet 2 Global Summit, Terena Networking Conference
- Internet2 Global Summit

〈 TEIN NOC Workshop 〉

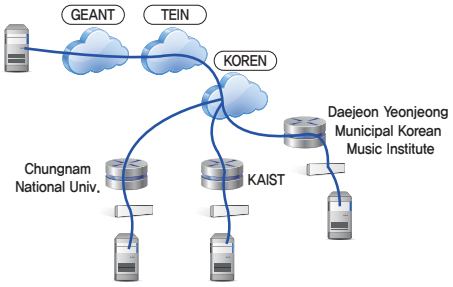
⑤ Multi-cultural Family Reunion (2010)

- Support for multicultural families' reunion via Video Conference System connected with KOREN

〈 Multi-cultural Families Reunion via Video Conference 〉

⑥ Cyber Performance (2010-2012)

- Media transmission trials to share the network based cultural contents and technology



〈 Demonstration of Cultural Contents Transmission Between Korea-Spain 〉

Stable Services,

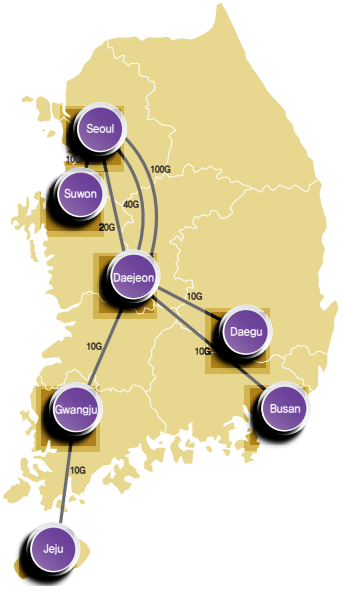
1. Circuit Service
2. Network Resource Service
3. Video Conference Service
4. Equipment Rental Service
5. Technical and Operational Support (NOC Service)

KOREN Provides Various Network Services.

KOREN Services for You

1. Circuit Service

KOREN consists of backbone networks which connect 7 major cities (Seoul, Suwon, Daejeon, Gwangju, Daegu, Busan, and Jeju) at the speed from 10Gbps to 160Gbps and access links which connect approximately 60 members.



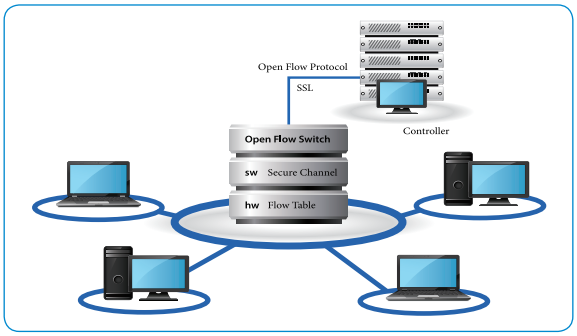
PoP — Primarily, 1~10G bandwidth is available — partners

- L3* (BGP*, Static), L2* (Vlan) interconnection
- IPv4/IPv6 service
- Access for other international R&E network such as TEIN, APII, and GEANT
- Metropolitan area centered Full-Mesh transport network over 20G
- Provide environment for checking optical transmission equipment and technologies
  · 40G and 100G circuit was tested between Seoul and Daejeon (2013)

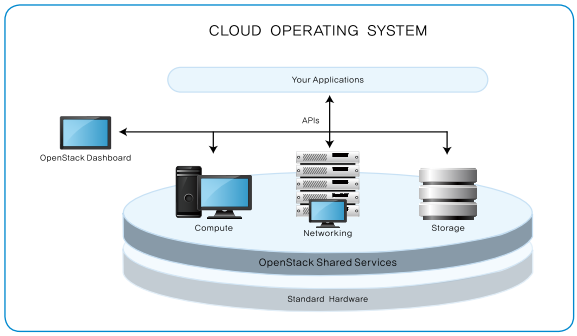
L2: Layer 2, also known as the Data Link layer, is the second level in the seven-layer OSI reference model for network protocol design.
L3: Layer 3, also known as the network layer, is responsible for packet forwarding including routing through intermediate routers, whereas the data link layer is responsible for media access control, flow control and error checking.
OSI seven layer: The open Systems Interconnection (OSI) model is a reference tool for understanding data communication between any two networked systems.
BGP: Border Gateway Protocol (BGP) is a standardized exterior gateway protocol designed to exchange routing and reachability information between autonomous systems (AS) on the Internet.

2. Network Resource Service

Configure virtual networks to research, develop, test, and apply new types of the Internet protocols
- Provide programmable virtual network resources and necessary bandwidth with SDN/OpenFlow technology



〈 SDN connection 〉



〈 Cloud solution concept image 〉

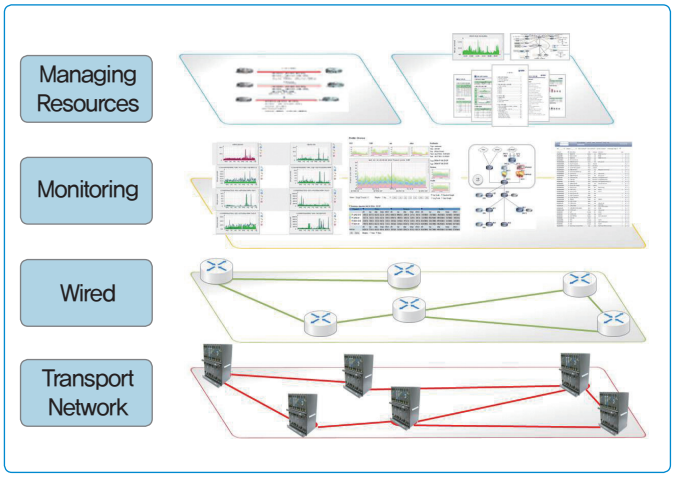
3. Video Conference Service

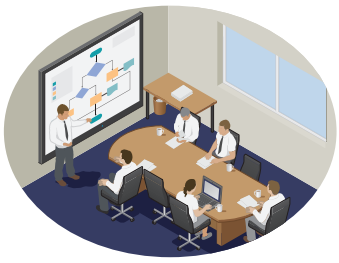
The video conference system, provided by KOREN (http://vc.koren.kr) makes it possible for researchers to cooperate effectively by desktop-based high-quality web conferences, seminars, and HD telepresence.

4. NOC Operation Service

KOREN is under the supervision of KOREN NOC (Network Operation Center) for secured and genuine network management.

- Operate backbone network of KOREN and provide support for resource management and network service.
- Conduct performance management and carry out technical cooperation and policy cooperation with other NOCs.
- Provide technical consultations and network resources for members.





KOREN NOC

※ KOREN's Technical Support Service

Provide technical support which tackles various problems caused by circuit connection and Internet access to accelerate, boost, and optimize research

Technical support of research projects for members

- Technical support for research projects related to overseas projects
- Support for domestic research which requires KOREN connection
- Support for interconnection with BGP and MPLS* network
- Support for OF@KOREN – OF@TEIN* interconnection

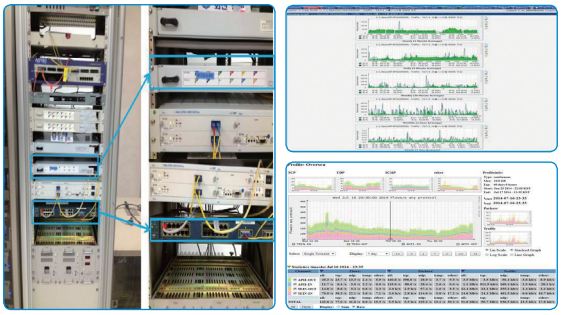
MPLS(Multi Protocol Label Switching):
Scalable, protocol-independent transport. In an MPLS network, data packets are assigned labels. Packet-forwarding decisions are made solely on the contents of this label, without the need to examine the packet itself.

OF@KOREN – OF@TEIN:
OpenFlow-based KOREN-TEIN interlinked network

Support for members' KOREN utilization

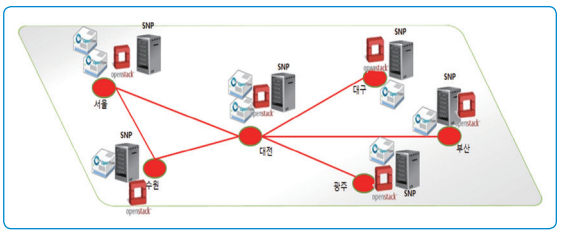
- Provide optimized network environment for infrastructural modifications
- Provide speed and quality measurement using Iperf*
- Equipment rental and replacement support

Iperf :
commonly used network testing tool that can create TCP and UDP data streams and measure the throughput of a network that is carrying them. Iperf is a tool for network performance measurement written in C



KOREN solution support

- Cloud, SDN* Platform support
- Live demonstration support
- Medical teleconference support by DVTS* and DV4*



SDN: Software – defined networking (SDN) is an approach to computer networking that allows network administrators to manage network services through abstraction of lower level functionality.
DVTS: Digital Video Transport System (DVTS), is a free and simple piece of software which allows high quality audio and video to be streamed on IEEE 1394 over IP networks. It uses 30Mbs uncompressed audio and video.
DV4 (Quallmage/Quatre Multipoint DV Conference System): 'Quatre' optimizes high-speed video processing and enables meetings between multiple remote sites with DV at the original quality. This system is most frequently used in 4 stations. Video image from each site is merged into one image by 'Quatre server' , and is then sent back to original site.

Hyper-connected Digital Revolution Era,

KOREN is always there for you.

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