The journey

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Singapore Advanced Research and Education Network
www.singaren.net.sg
ipv6.singaren.net.sg

The journey in phases

SingAREN project	SingAREN Society	SingAREN NRI
1997	2003	2013	2019

APAN Meeting in Singapore (Oct 1997)

SINGAREN

SINGAPORE ADVANCED RESEARCH AND EDUCATION NETWORK

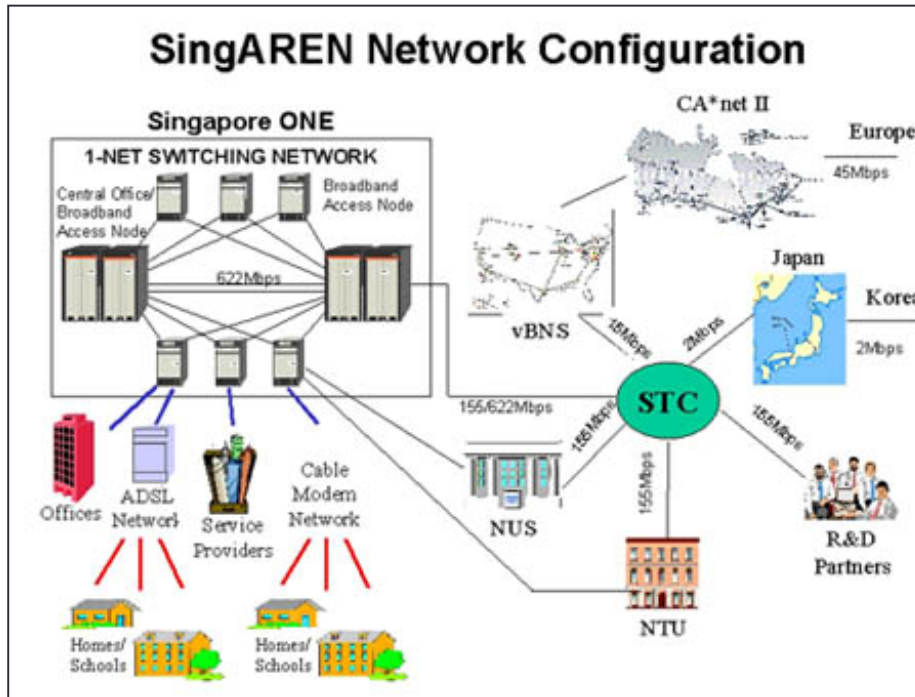# The Project…

- **Phase 1 - SingAREN**
  - Nov 1997 to Mar 2001
  - Funded by NSTB & TAS
  - International links to
    - USA
    - Korea
    - Japan
  - 18 Projects

- **Phase 2 – SingAREN21**
  - Apr 2001 to Sep 2003
  - Funded by A*STAR
  - International links to
    - USA
    - Korea
  - 17 Broadband Projects

SingAREN Network Configuration (Nov 1997 to 1998)

SingAREN Network Configuration

Nov '97:
- Launch of 14Mbps ATM link to STARTAP (Chicago)
- Launch of SingAREN-vBNS linkup via STARTAP
- Peering with CA*net (Canada)

Feb '98:
- Launch of 2Mbps ATM link to Japan
- Peering with ESnet
- Became APAN exchange point (together with Japan and Korea)

Nov '98:
- Launch of 2Mbps ATM link to Korea

SingAREN Activity Milestones…

- **Oct 97**: Hosted APAN Meeting & APAN-SingAREN Joint Application Workshop
- **Nov 97**: MoU with National Science Foundation
- **Apr 98**: Launch of SingAREN Broadband Project
- **Jun 98**: Canada-Singapore Joint IT Council Meeting
- **Sep 98**: Established Satellite link to Malaysia
- **Apr 98**: MoU with UCAID (Internet2)
- **Apr 99**: Launch of SPRINGi project
- **Aug 99**: Peering with SURFnet (Netherlands)
- **Sep 99**: Peering with NORDUnet (Denmark, Finland, Iceland, Norway & Sweden)
- **Dec 99**: SingAREN & Sun/Netscape Alliance Distributed Applications Competition
- **Feb 00**: Launch of SingAREN Test Center
- **Dec 00**: Advanced e-Business Applications Competition

SingAREN21 Activity Milestones…

- **Mar 01:** Participated in 1st TEIN Expert Group Meeting
- **Jun 01**: Launch of SingAREN Broadband21 Projects
- **Aug 01**: Launch of iVCnet
- **Dec 01**: Enabled Genome Data File Transfer
- **Jan 02:** R&D Cooperation discussion with Ministry of Information & Communication (Korea)
- **Mar 02**: Launch of Kent Ridge Advanced Network Project
- **Mar 02**: Participated in 2nd TEIN Expert Group Meeting
- **Apr 02**: Launch of SingAREN IPV6 Project

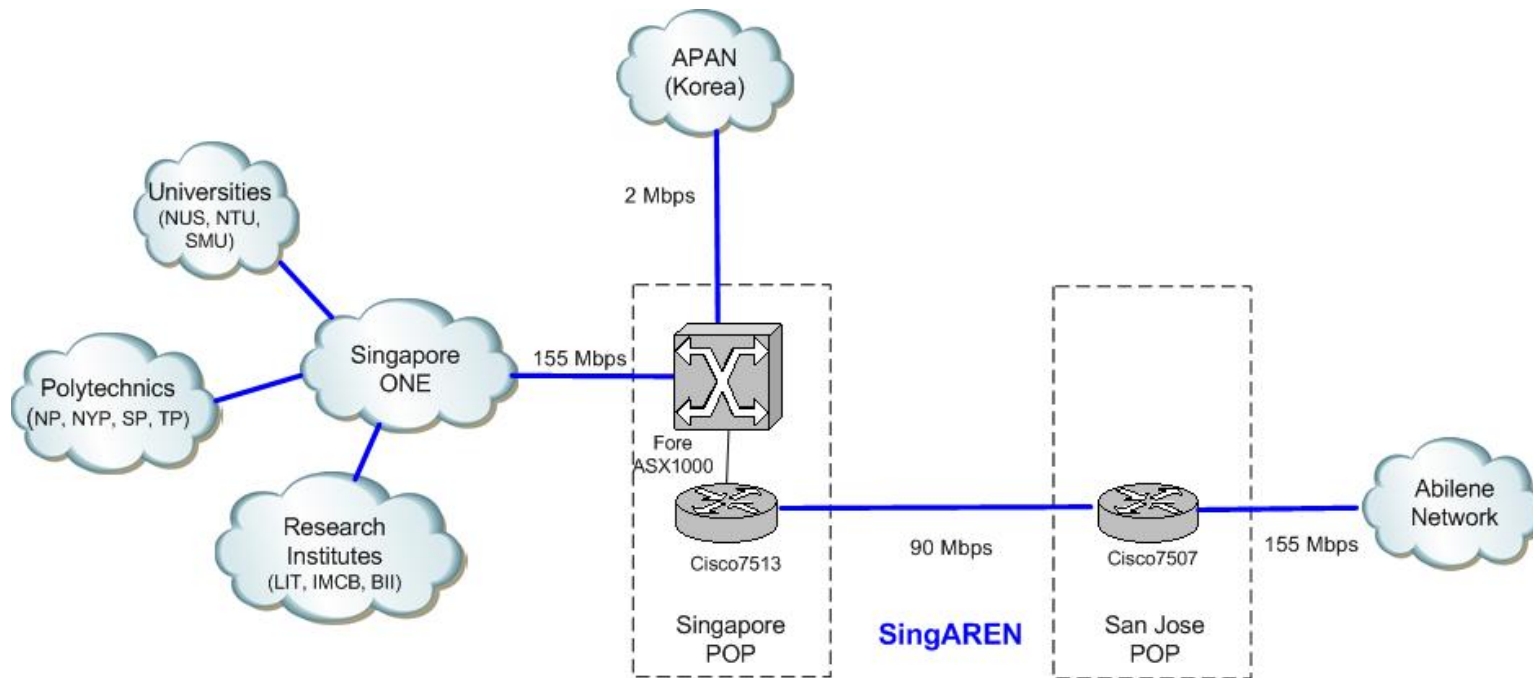# SingAREN International Connection (Oct 2001 to 2002)
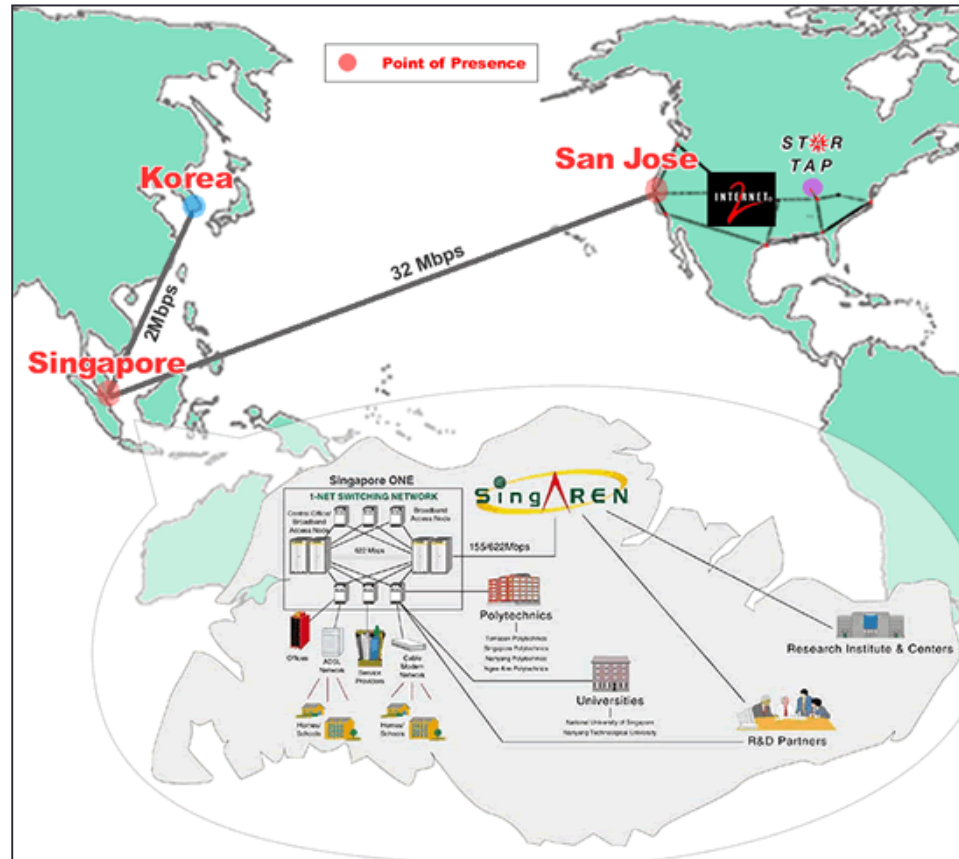
Sep 00:

Upgrade of SG-US link to 27Mbps and Launch of SingAREN US PoP in San Jose

Aug 02:

Upgrade of SG-US link to 32Mbps

SingAREN Network Configuration (Oct 2002-2003)

Oct 02: Migration of US link to 90Mbps Packet-over-Sonet

The Society

Objectives:

- *To advocate and champion advanced network application and technology*
- *Collective representation of the community*
- *Cost-competitive adoption of an advanced Internet technology in the R&E*

Registered with Registry of Society (Singapore)

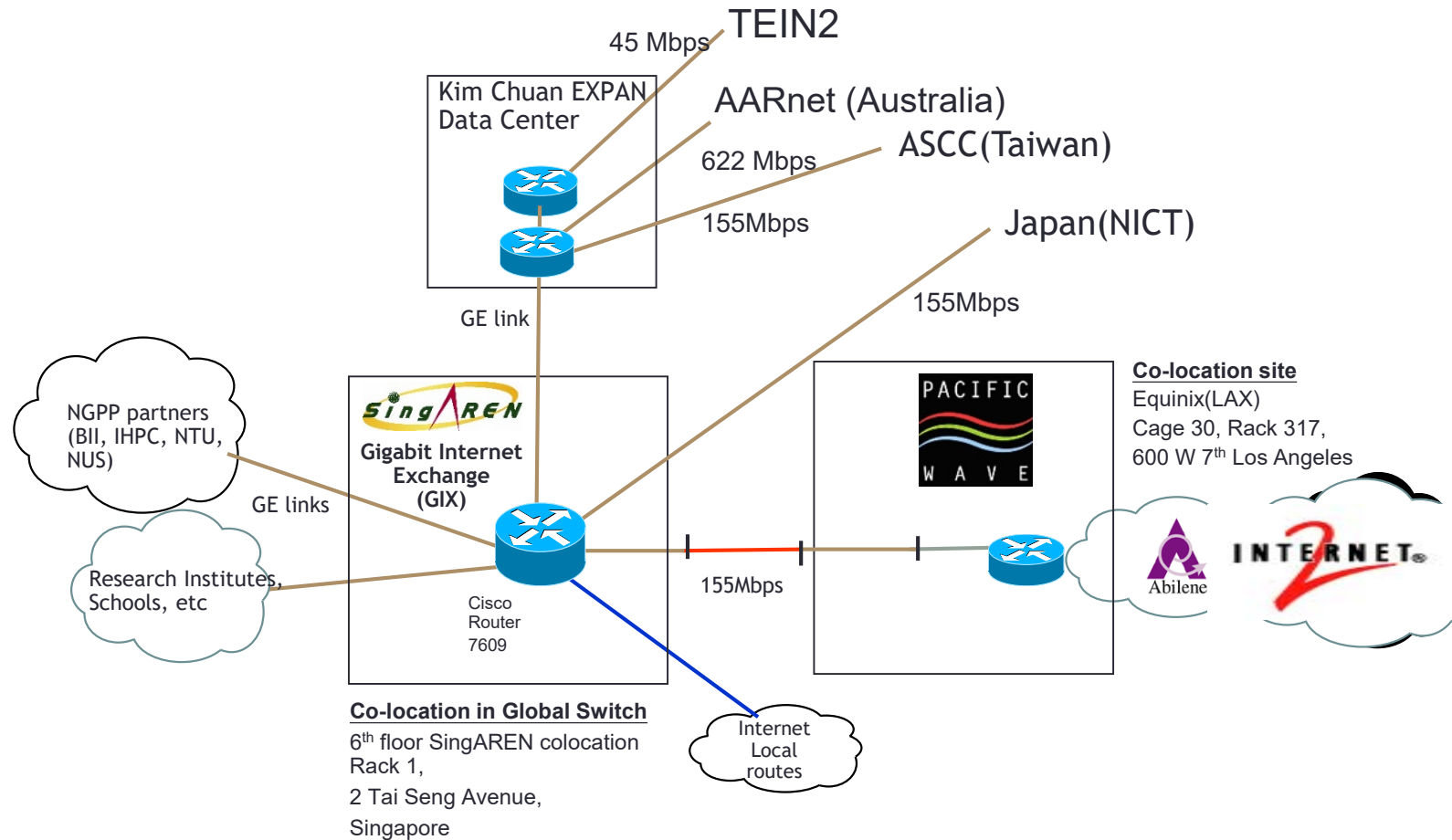- *Formed: 30 Sep 2003*
- *Executive Committee*
- *Members: Institution & Individual*

Funded by members

SingAREN GIX - 2005
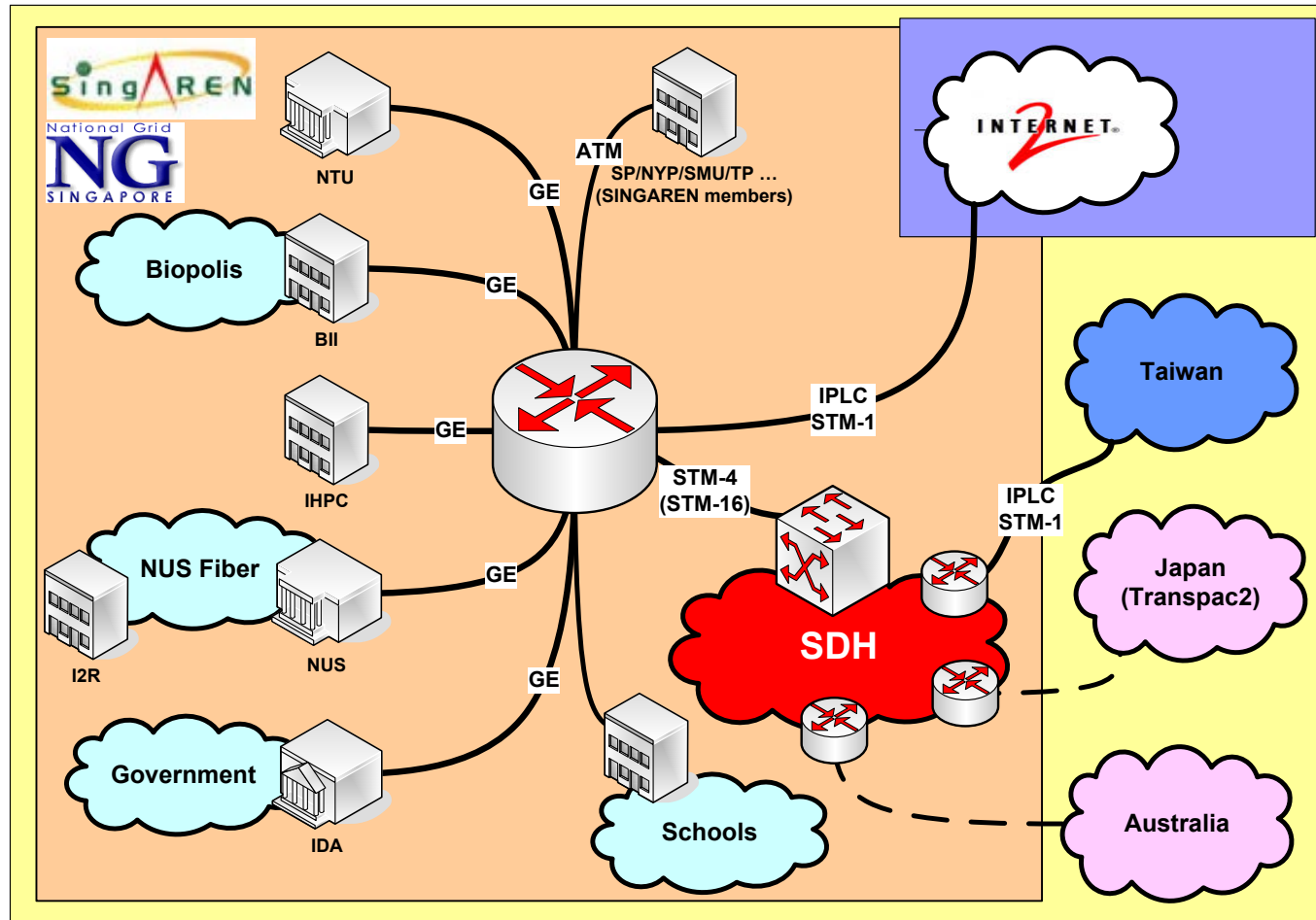
SingAREN GIX (Gigabit Internet Exchange)

5th TEIN2 Tech Committee Meeting (March 2005)

Australia (March 2005)

MoU Signing with AARnet during SingAREN Symposium 2005

Grid Asia (May 2005)

Tele-medicine (Aug/Nov 2005)

1st kick-off meeting in August 2005

Telecast of Live Telemedicine in November 2005

Japan (Nov 2005)

Launch of JGNII

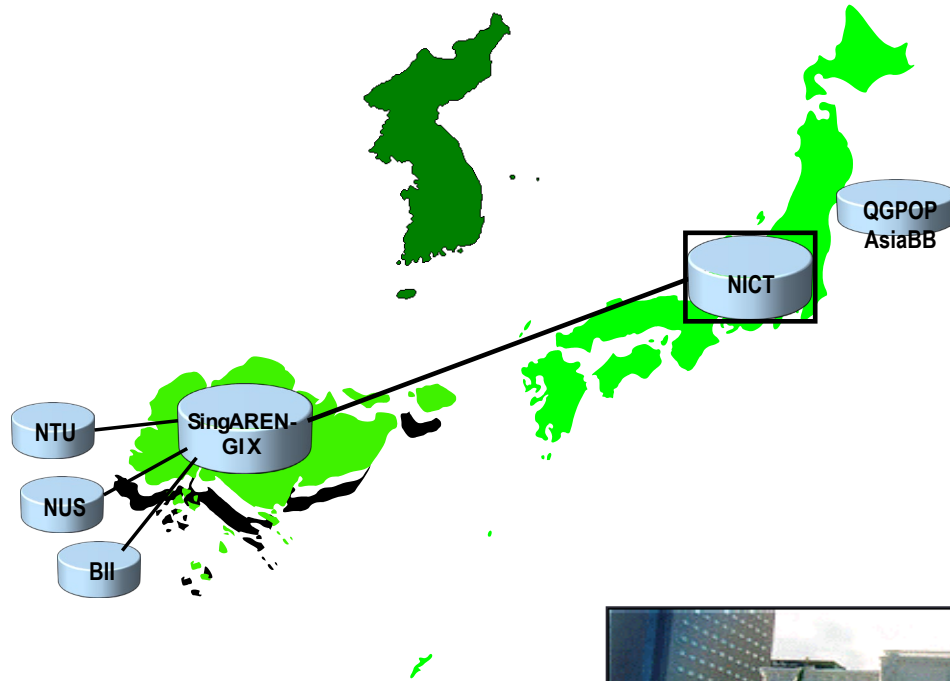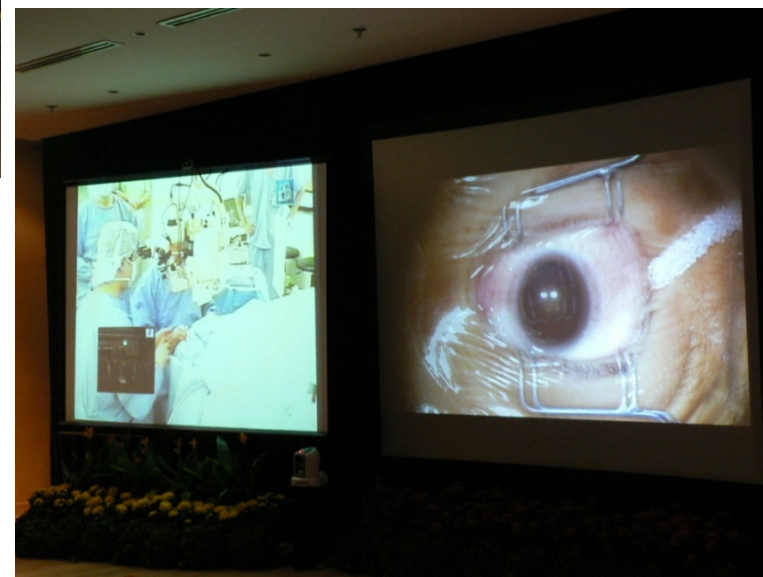MoU Signing with NICT

Sapporo Snow Fest (Feb 2006)

Uncompressed digital video transmission between Sapporo, Singapore & Korea.

World's 1st 3D-High Definition Telemedicine Transmission in Ophthalmology (Feb 2006)

Asahikawa College, Japan &

Singapore National Eye Centre

22nd APAN Meeting, Singapore (July 2006)

Global Information Day (Mar 2007)
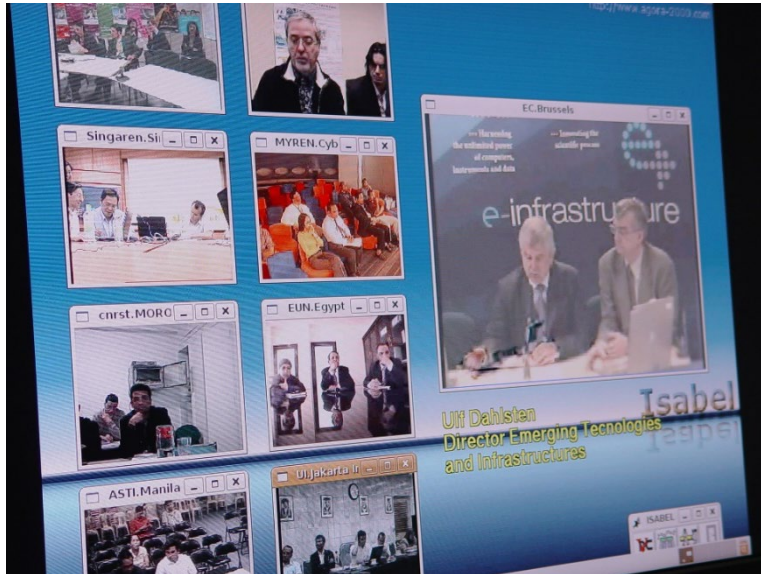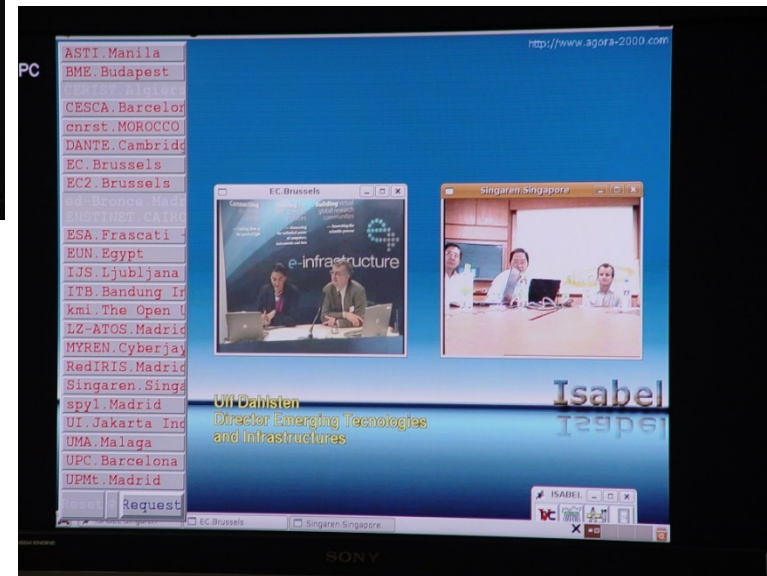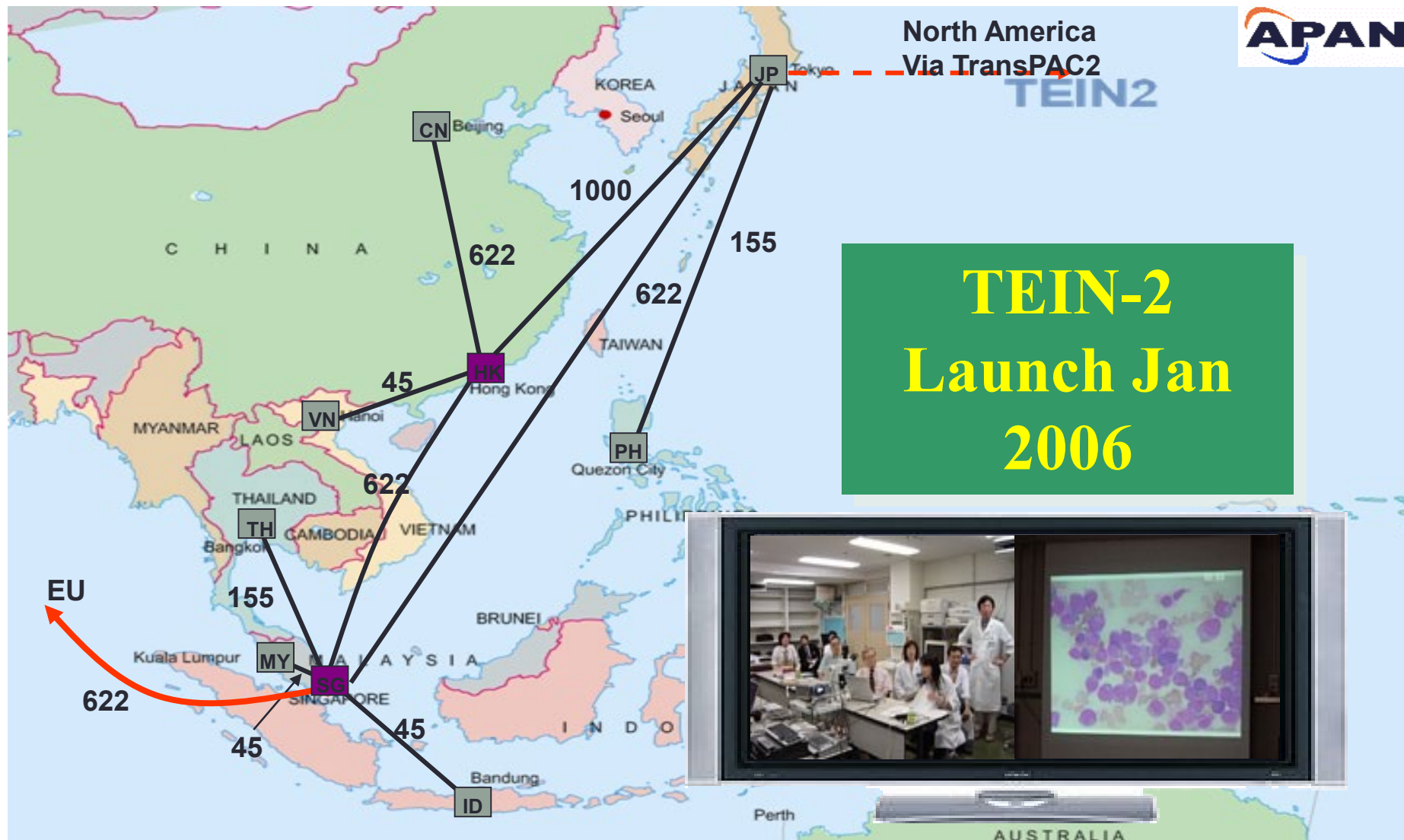
SINGAREN LIGHTWAVE INTERNET EXCHANGE

SLIX – Project Overview

S$9.98 million project funded by National Research Foundation 2013-2019

New Services

New Routers
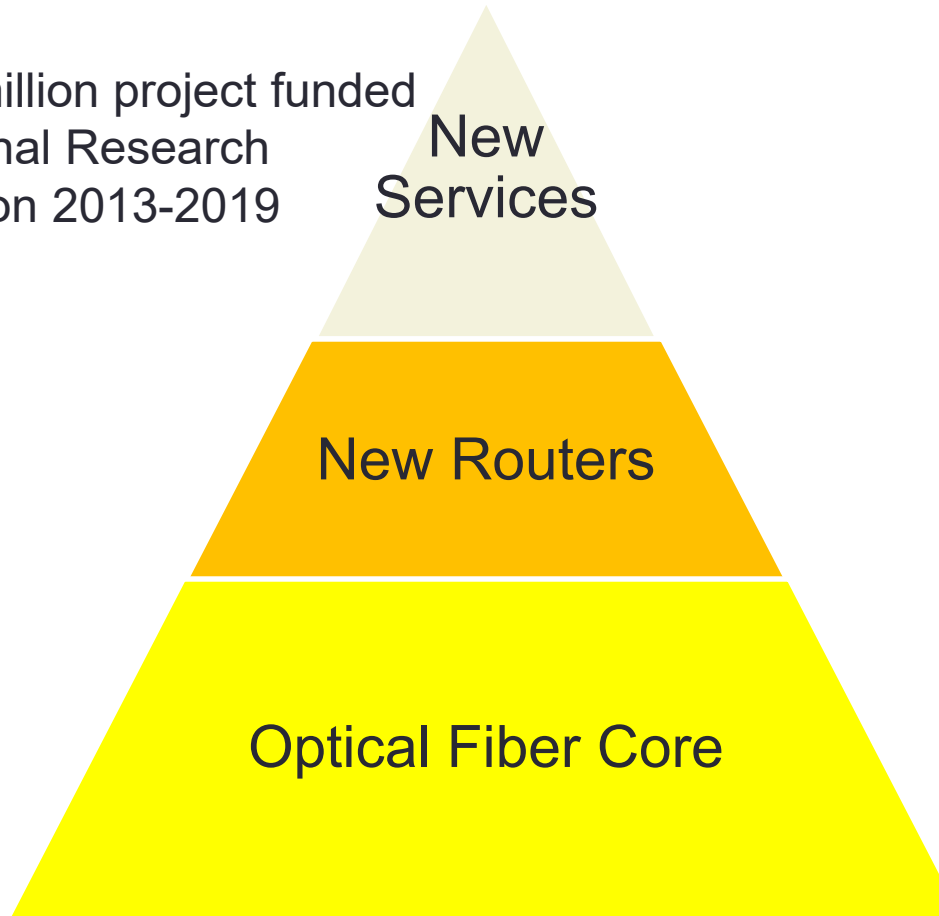
Optical Fiber Core

New Services
(1) Local database mirroring with partner provider to minimize multiple downloads from overseas

New Routers
(1) Increase capacity and incorporate 100Gbps backbone

Optical Fiber Core
(1) Connects SingAREN, A*STAR, NTU and NUS.
(2) Technology-proof fiber core overcomes existing capacity limitations and allows future capacity upgrades.
(3) Long-term leasing to reduce costs
(4) On par with peer R&E networks

SingAREN-Lightwave Internet Exchange (SLIX)
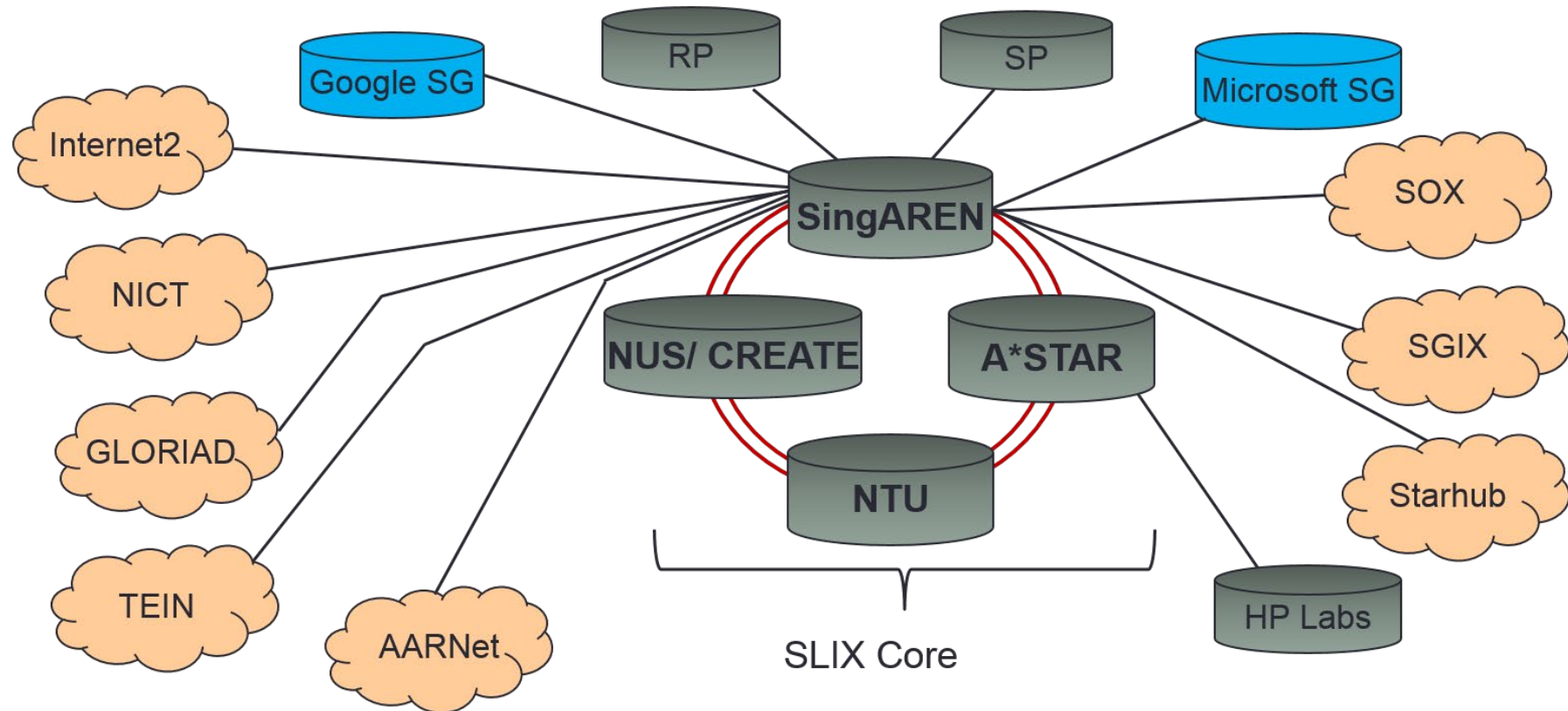
Launch of SLIX
28 August 2014

SingAREN-NSCC MoU
19 Oct 2015

- SingAREN will provide NSCC with access to its dark fiber.
- SingAREN will manage the international link interconnection for NSCC.
- NSCC will procure the networking devices to establish the SingAREN Open Exchange Point.
- NSCC will upgrade the interconnection between the core members of SLIX.

SingAREN Network Infrastructure

NKN (India)
Internet2 (U.S.)
NIA (KR)
NSCC
ESSEC
RP
SP
Google SG
NICT (JP)
Amazon SG
NII (JP)
Microsoft SG
GEANT (EU)
SOX
AARNet (AU)
TEIN (EU & Region)
SOE
SingAREN
SGIX
LEARN (LK)
NUS/ CREATE
A*STAR
Starhub
MYREN (MY)
INHERENT (ID)
NTU

SLIX Core

Legend:

SOE : SingAREN Open Exchange
SLIX : SingAREN-Lightwave Internet Exchange

: 100G
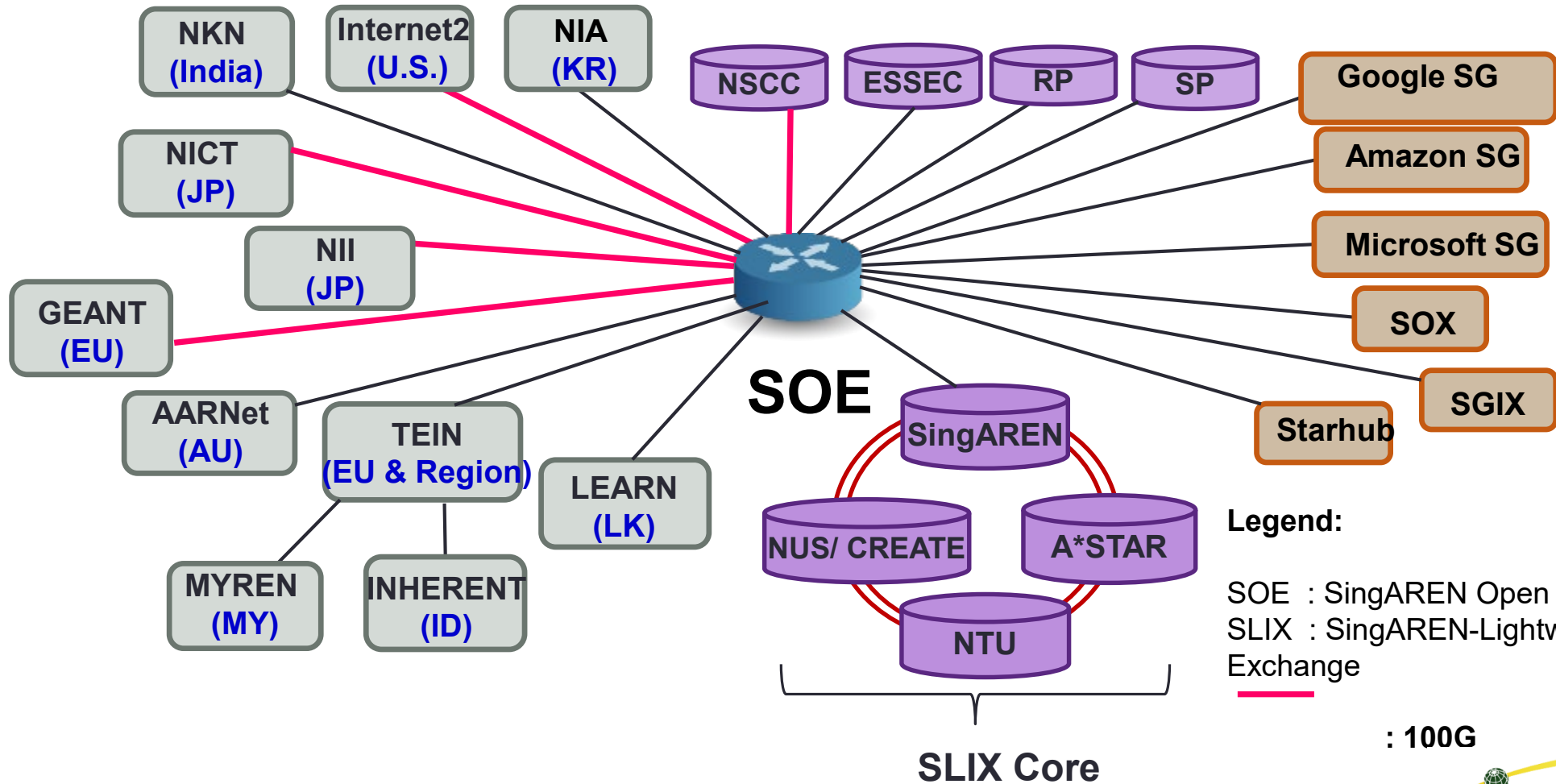
Asi@Connect

The EU co-funded Asi@Connect project provides a dedicated regional high capacity and high quality internet network, Trans Eurasia Information Network(TEIN), for Research and Education (R&E) communities across Asia-Pacific and Europe, and leverages e-infrastructures developed for public service projects.

TEIN Map

Legend:
- 100 Gbps
- 10 Gbps
- 2.5 Gbps
- 2 Gbps
- 1 Gbps
- 622 Mbps
- 155 Mbps
- 100 Mbps
- 45 Mbps
- 10 Mbps
- Planned
- TEIN PoPs
- TEIN NOC

via North America

The following links are fully financed/co-financed by the link owners whose support is gratefully acknowledged

- **A** National Institute of Information and Communications, Japan / National Supercomputing Centre, Singapore
- **B** National Institute of Information and Communications, Japan / Thailand Research and Education Network, Thailand
- **C** National Institute of Informatics, Japan
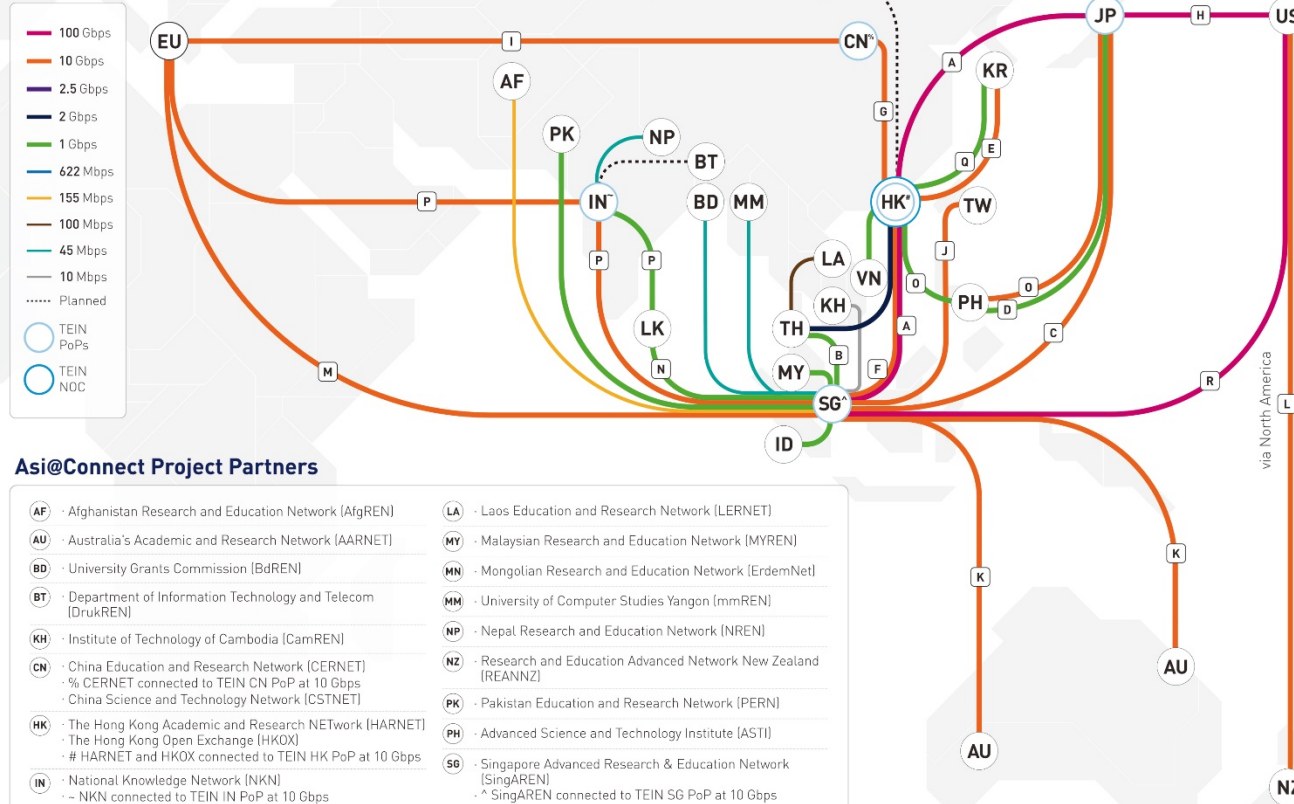- **D** Ministry of Agriculture, Forestry and Fisheries Research Network, Japan
- **E F** National Information Society Agency, South Korea
- **G** China Education and Research Network, China
- **H** TransPAC/Pacific Wave, USA
- **I** Co-funded by China and EU
- **J** Academia Sinica Grid Computing, Republic of Chinese Taipei
- **K** Australia, Academic and Research Network, Australia
- **L** Research and Education Advanced Network New Zealand
- **M** National Supercomputing Centre, Singapore
- **N** Lanka Education and Research Network, Sri Lanka
- **O** Advanced Science and Technology Institute, Philippines
- **P** National Knowledge Network, India
- **P** Korea Research Environment Open NETwork, South Korea
- **R** National Supercomputing Centre, Singapore / Internet2, USA

Asi@Connect Project Partners

- **AF** · Afghanistan Research and Education Network (AfgREN)
- **AU** · Australia's Academic and Research Network (AARNET)
- **BD** · University Grants Commission (BdREN)
- **BT** · Department of Information Technology and Telecom (DrukREN)
- **KH** · Institute of Technology of Cambodia (CamREN)
- **CN** · China Education and Research Network (CERNET) / % CERNET connected to TEIN CN PoP at 10 Gbps / China Science and Technology Network (CSTNET)
- **HK** · The Hong Kong Academic and Research NETwork (HARNET) / · The Hong Kong Open Exchange (HKOX) / # HARNET and HKOX connected to TEIN HK PoP at 10 Gbps
- **IN** · National Knowledge Network (NKN) / · ~ NKN connected to TEIN IN PoP at 10 Gbps
- **ID** · Institut Teknologi Bandung (ITB)
- **JP** · Ministry of Agriculture, Forestry and Fisheries Research Network (MAFFIN) / · National Institute of Information and Communications (NICT) / · National Institute of Informatics (NII)
- **KR** · National Information Society Agency (NIA) / · Korea Research Environment Open NETwork (KREONET)
- **LA** · Laos Education and Research Network (LERNET)
- **MY** · Malaysian Research and Education Network (MYREN)
- **MN** · Mongolian Research and Education Network (ErdemNet)
- **MM** · University of Computer Studies Yangon (mmREN)
- **NP** · Nepal Research and Education Network (NREN)
- **NZ** · Research and Education Advanced Network New Zealand (REANNZ)
- **PK** · Pakistan Education and Research Network (PERN)
- **PH** · Advanced Science and Technology Institute (ASTI)
- **SG** · Singapore Advanced Research & Education Network (SingAREN) / · ^ SingAREN connected to TEIN SG PoP at 10 Gbps
- **LK** · Lanka Education and Research Network (LEARN)
- **TW** · Academia Sinica Grid Computing (ASGC)
- **TH** · Thailand Research Education Network Association (ThaiREN)
- **VN** · National Agency for Science and Technology Information (NASATI)

* As of October 2018. Ongoing updates
** Other regions (Central Asia, Africa and Latin America) can be connected via global R&E networks such as EU(GÉANT) and US(Internet2)

Possibilities with Asi@Connect

- Telemedicine
- Earth Observation
- Food Security
- e-Science
- e-learning
- e-Culture
- Advanced ICT Technology
- Capacity Building Programs

Collaboration Asia-Europe-1 (CAE-1)

- A new high performance direct 100 gigabit per second (Gbps) link between Singapore(SOE) and GeantOPEN(London).
- 15 year IRU
- Cable system: SMW5
- Established June 2019

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Collaboration Asia-Europe – 1 (CAE-1)

London, EU

100Gbps
CAE-1

Singapore

Asia Pacific Ring (APR)

APR is a **resilient, high speed network system** in excess of 100 Gbit/s.

Objective: **Facilitate advanced research and education collaboration** across the Pacific between Asia and North America.

2019

100Gbps *SINET*

400Gbps
ANA-400G
Internet2,NRODUnet/GEANT/SURFnet

100Gbps
SINET

100Gbps
KRLight

100Gbps
SINET

100Gbps
TransPAC/Pacific Wave/WIDE

Slough, EU

South Korea

100 Gbps
NICT/SingAREN

Tokyo, JP

Los Angeles, USA

100Gbps
SingAREN/Internet2

Singapore

100Gbps
By
CAE1

Hawaiki
(REANZZ)

Project Indigo
(AARnet)

Asiapacific-Europe Ring (AER)

Asia-Pacific Ring (APR)

SingAREN Services

- **Global wireless service** for secure internet connectivity across eduroam-participating institutes, through the user's home institution account and password

- Worldwide federation of RADIUS servers that facilitates network access for roaming users - available in 76 countries

- Service is available in institutes of higher learning and research institutes in Singapore

- https://www.singaren.net.sg/eduroam.php

SingAREN Services

Institutions that have deployed eduroam:

A*STAR

ESSEC Asia Pacific

INSEAD

James Cook University Singapore (JCU)

Nanyang Technological University (NTU)

National Institute of Education (within NTU campus)

National University of Singapore (NUS)

Singapore Institute of Management (SIM)

Singapore Institute of Technology (SIT)

Singapore Management University (SMU)

Singapore University of Social Sciences (SUSS)

Singapore University of Technology and Design (SUTD)

Singapore Access Federation (SGAF)

- **Federated Identity Management** authentication and authorisation system based on SAML (Security Assertion Markup Language)
- Facilitates **Single Sign-On** for online services and applications
- Convenience of using user's home organization credentials
- Institutions connected to SGAF:
  - Agency for Science, Technology and Research (A*STAR)
  - National University of Singapore (NUS)
  - Nanyang Technological University (NTU)
  - Singapore Management University (SMU)
  - Singapore University of Technology and Design (SUTD)
- https://www.singaren.net.sg/SGAF-services.php

SingAREN Services

Singapore Access Federation (SGAF)

FileSender SG

Powered by:

National Supercomputing Centre

- Allows users to send large file attachments
- Up to 50GB per file
- Secure authenticated service

- Single sign-on to NSCC facilities

SingAREN Services

Database Mirroring Service

- Service launched in April 2016
- Enables high speed downloads of major scientific databases for Singapore's R&E community
- Relevant for users with frequent access to large overseas databases
- Examples of mirrored databases:
  - National Center for Biotechnology Information (NCBI), U.S.
  - UCSC Human Genome Browser, U.S.
  - European Bioinformatics Institute (EBI)
  - GenomeNet, Japan

- http://dbmirror.singaren.net.sg/

SingAREN Services

Database Mirroring Service

The researchers in Singapore will enjoy **faster data download through the SingAREN Database Mirroring Service**.

	*Download of 45 GB file through:	
	NCBI home database (U.S.)	**SingAREN Database Mirroring**
Download Speed	16 MB/ sec	**83 MB/ sec**
Time taken	47 mins	**9 mins**

Network test done on 12 Dec 18

Other SingAREN Services

- Bilateral disaster recovery
  - A*STAR and NTU have bilateral disaster recovery facilities through the SLIX network.

- Advanced high-speed network technology testbeds and demonstrations
  - Infiniband demos between A*STAR and NUS
  - Infiniband demos between Singapore and US/Japan/Europe
  - High speed TCP transmission(100G) across the Pacific

Applications: SLIX

Enabling Cancer Genomics Research with Advanced R&E Networks
- Enabling high-speed access to international genomic databases

Precision Medicine: Improving how diseases are treated
- SingAREN facilitates large data transfers for the GenomeAsia 100K project through its resilient international links & high-speed fiber network.

JGN Experiment over 100G SG-HK-JP Network and Asia Pacific Ring, 6 Feb 18
- SingAREN , in collaboration with NICT and NTU, carried out high speed 8k and 4k video streaming of the Sapporo Snow Festival, and Sceneries of Singapore through SLIX , SG-HK-JP 100G and SG-U.S. 100G links.

SingAREN Activities

Singapore:

- Technical Training Workshops
- Sharing Sessions by Network Experts
- Social Events

Regional:

- Engage with the international R&E community

45th ASIA-PACIFIC ADVANCED NETWORK MEETING 25 - 29 March 2018 SINGAPORE

The 3rd Asi@Connect GOVERNORS' MEETING & PROJECT MEETING
March 26(Mon) Matrix Building, Biopolis, Singapore

Seminar: Optimizing Big Data Transfers, using Science DMZ and Dedicated Data Transfer Nodes, 23 May 2018

Speaker: Andrew Howard, Network Manager, National Computational Infrastructure, The Australian National University

Topic: Utilizing Data Transfer Nodes (DTNs) for Science DMZs to support high speed big data transfers around the world

SingAREN Year-end Celebration 2018

SingAREN Members

Government, Institutes, Industries

National Research Foundation — Prime Minister's Office Singapore

SG NSCC SINGAPORE — National Supercomputing Centre

Agency for Science, Technology and Research SINGAPORE

Fraunhofer SINGAPORE

StarHub

amazon web services

PCCW Global

NTT Communications — Transform. Transcend.

TERRABIT NETWORKS — We connect. We transform.

Universities

NUS — National University of Singapore

NANYANG TECHNOLOGICAL UNIVERSITY

SMU — SINGAPORE MANAGEMENT UNIVERSITY

SUTD — SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

SiT — SINGAPORE INSTITUTE OF TECHNOLOGY

ESSEC BUSINESS SCHOOL

SUSS — SINGAPORE UNIVERSITY OF SOCIAL SCIENCES

INSEAD — The Business School for the World

Polytechnics & International Schools

NYP Nanyang Polytechnic

SINGAPORE POLYTECHNIC

REPUBLIC POLYTECHNIC

UWC SOUTH EAST ASIA

SingAREN

Our Partners

Take-away

- Persevere. Need a lot of patience.
- Need to work closely with government. Government-Researchers-NREN.
- Government plays a major role to take an NREN to the next phase.
- Your members are the client. Understand their needs, ie services(more than connectivity).
- Work abit like business, as without financial soundness you cannot carry out activities.
- Need to look long-term in procurement. More cost-effective.
- Work closely with other NRENs

THANK YOU