# Infrastructure SINET 100G Global Ring and Data Exploitation

Sep. 18, 2019


Tomohiro Kudoh

Professor, Information Technology Center, The University of Tokyo

Cross Appointment Fellow, National Institute of Advanced Industrial Science and Technology (AIST)

Visiting Professor, National Institute of Informatics (NII)

# Two topics



- **Overview of SINET**
  - 100Gbps domestic mesh and international ring
- **Data Exploitation Platform**
  - PoC environment for everyone/everyday data exploitation applications, leveraged by SINET

# SINET (Science Information Network )



- **Japanese academic backbone network**
  - Operated by NII (National Institute of Informatics)
  - Connects more than 800 universities and research institutions.
  - Connects many research facilities: seismology, space science, high-energy physics, nuclear fusion, computing science, and so on.
  - Being used by over 2 million users
  - Supports international research collaboration through international lines.
- **More than 100Gbps connection to every prefecture in Japan**
- **100Gbps international ring**
- **Started mobile connection service**

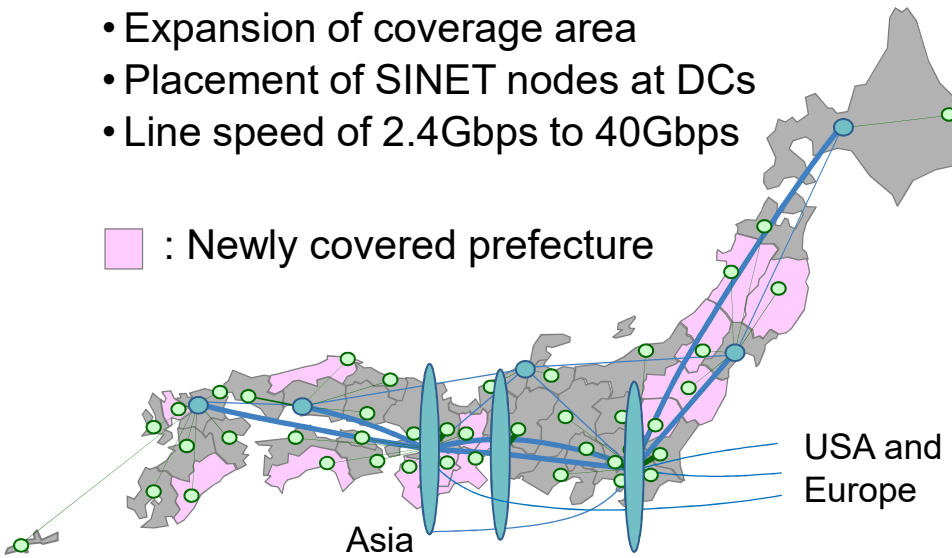
# History of SINET

| | |
|---|---|
| 1987 | Packet exchange network as predecessor of SINET |
| 1992 | SINET as Internet backbone (29 sites, 6-50Mbps) |
| 2002 | Super-SINET for leading-edge science (14 sites, up to 10Gbps) in parallel to SINET |
| 2007 | SINET3 (34 prefectures, 1Gbps to 40Gbps) as integrated backbone with new services |
| 2011 | SINET4 (47 prefectures, 2.4Gbps to 40Gbps) with highly-available nodes and lines |
| 2016 | SINET5 (47 prefectures, 100Gbps or more) with 100Gbps International lines and mobile capability |

SINET4

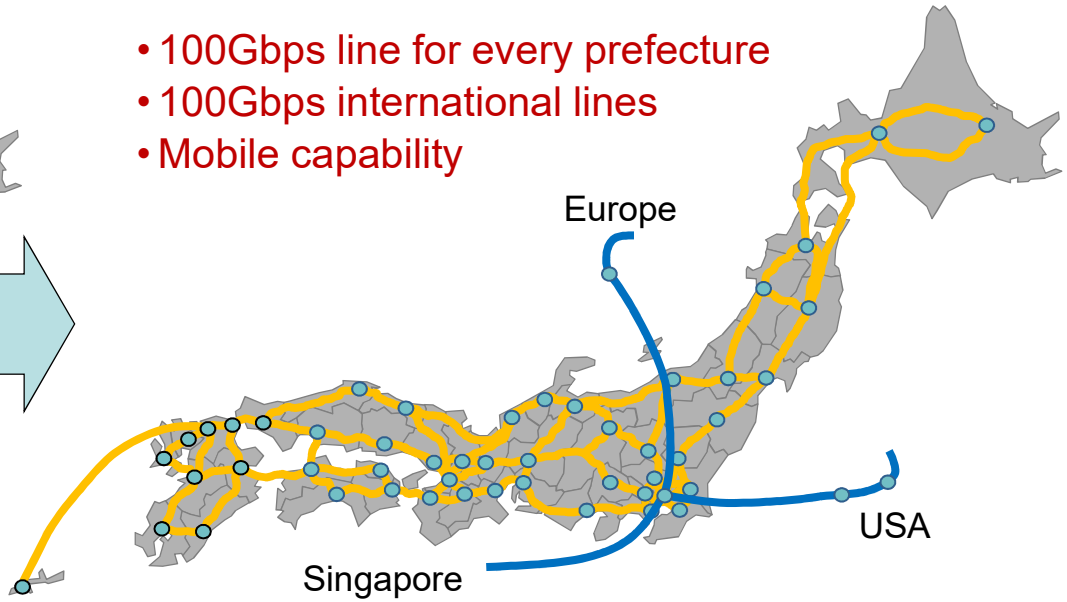
- Expansion of coverage area
- Placement of SINET nodes at DCs
- Line speed of 2.4Gbps to 40Gbps

: Newly covered prefecture




SINET5

- 100Gbps line for every prefecture
- 100Gbps international lines
- Mobile capability



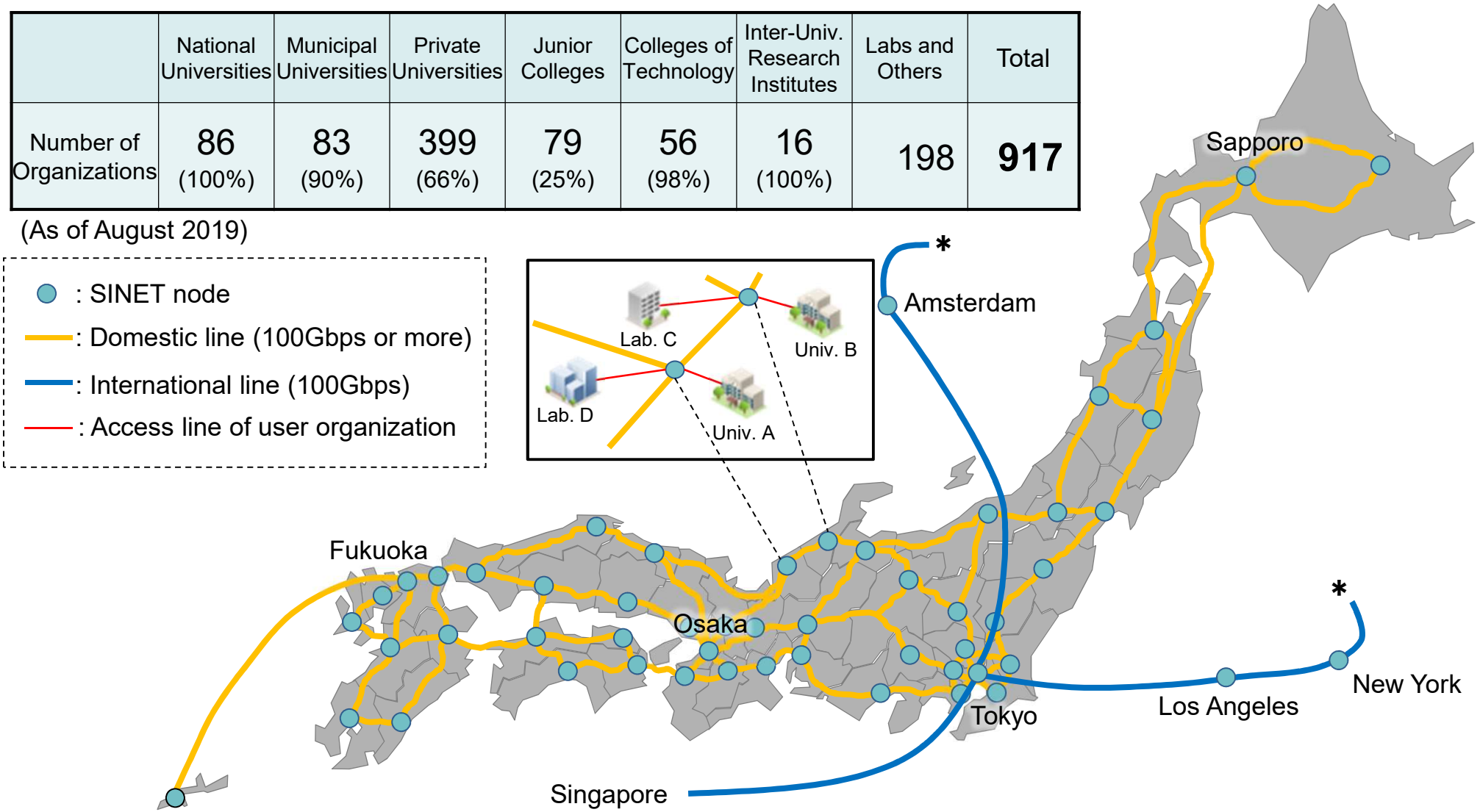

© 2019 National Institute of Informatics

# SINET5

- **SINET5**, which covers all the prefectures with 100-Gbps lines, started its operation in April 2016. The international lines were upgraded to 100Gbps in early 2019.
- It is used by 917 universities and research institutions, and by more than 3 million users.

| | National Universities | Municipal Universities | Private Universities | Junior Colleges | Colleges of Technology | Inter-Univ. Research Institutes | Labs and Others | Total |
|---|---|---|---|---|---|---|---|---|
| Number of Organizations | 86 (100%) | 83 (90%) | 399 (66%) | 79 (25%) | 56 (98%) | 16 (100%) | 198 | **917** |

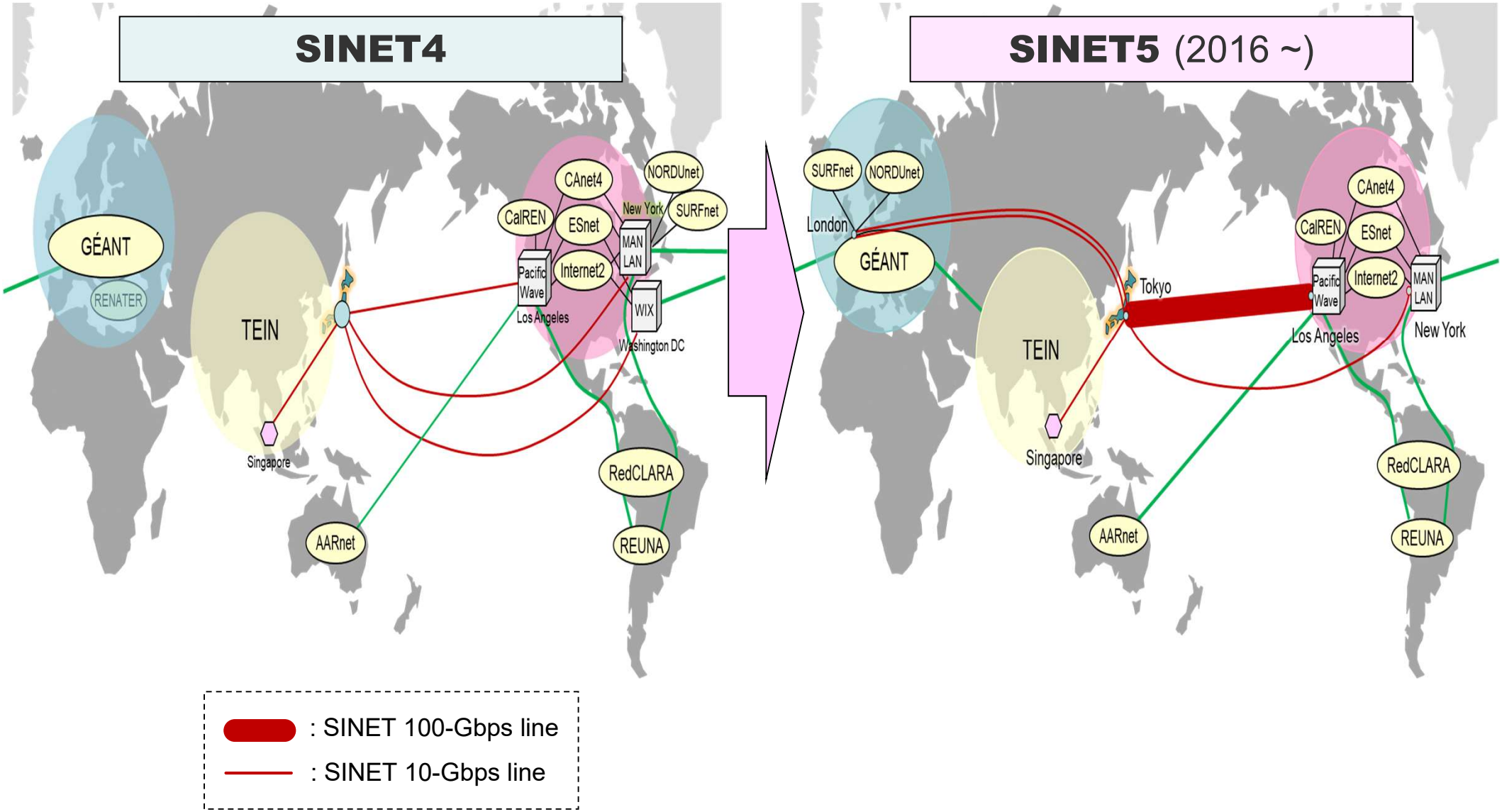
(As of August 2019)




© 2019 National Institute of Informatics

# Topology Change of International Lines

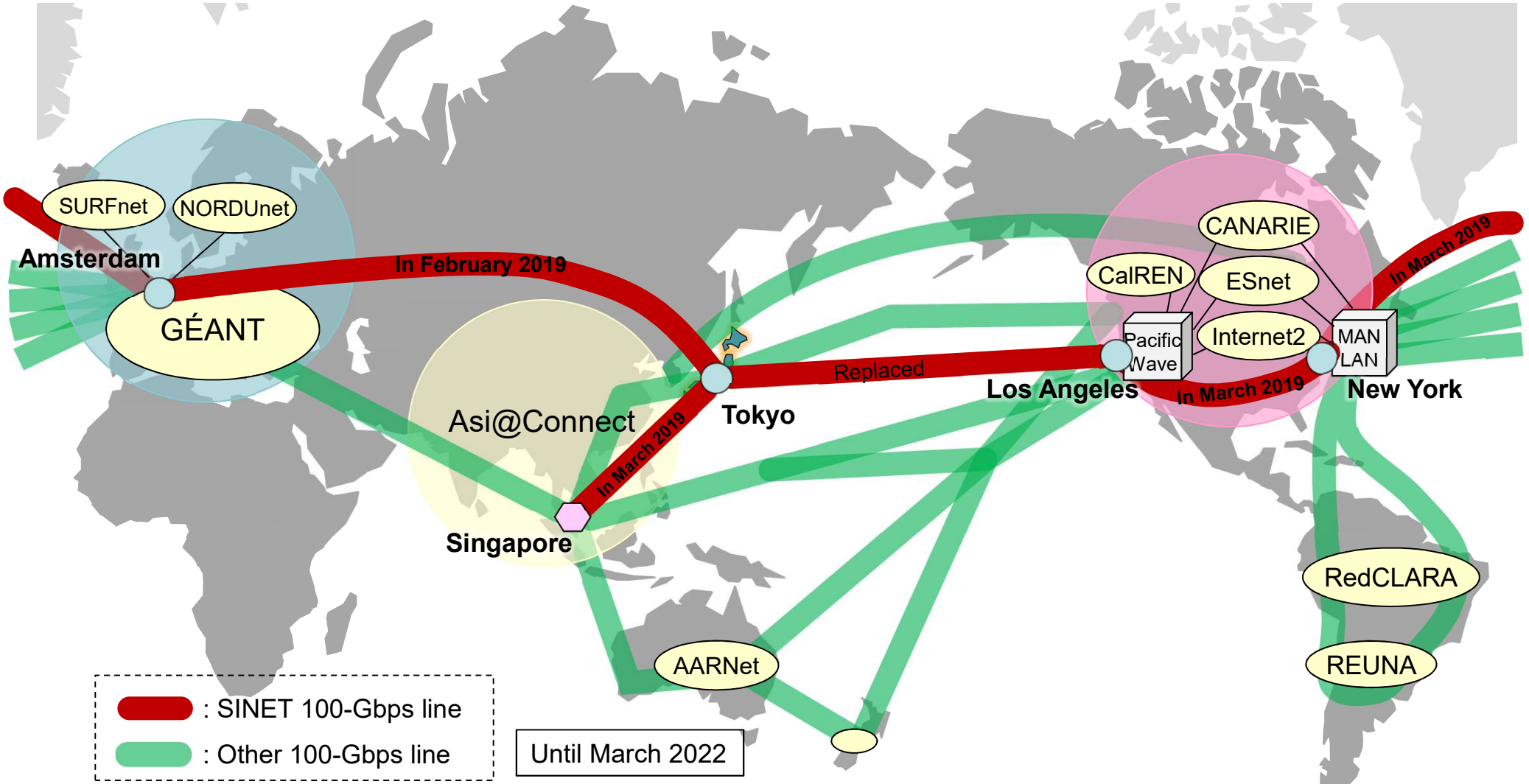
◆ SINET had two direct 10-Gbps lines to London for low latency and high-performance in 2016.
SINET also had a 100-Gbps line to Los Angeles in 2016.




© 2019 National Institute of Informatics

# International Lines of SINET5

- Japan-Europe line, Japan-New York line (via Los Angeles), and Japan-Singapore line were upgraded to 100 Gbps in February or March 2019.
- NII is seeking resilient circuit architecture in collaboration with other NRENs.

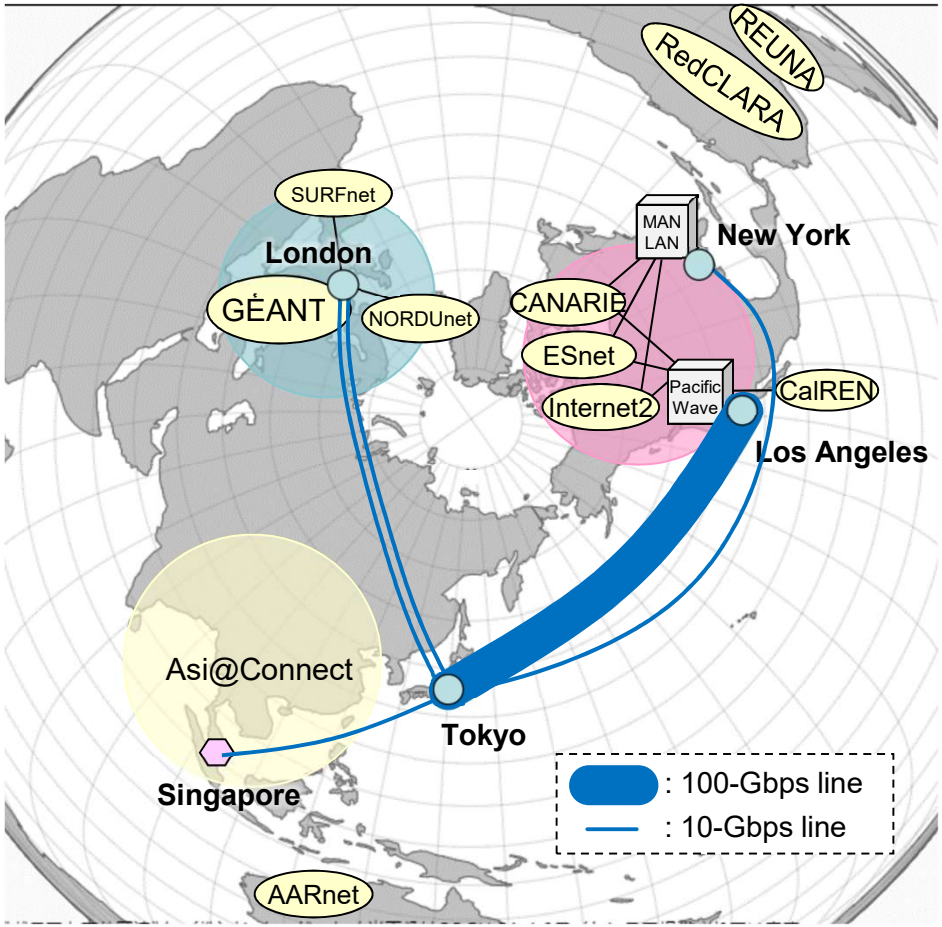



© 2019 National Institute of Informatics

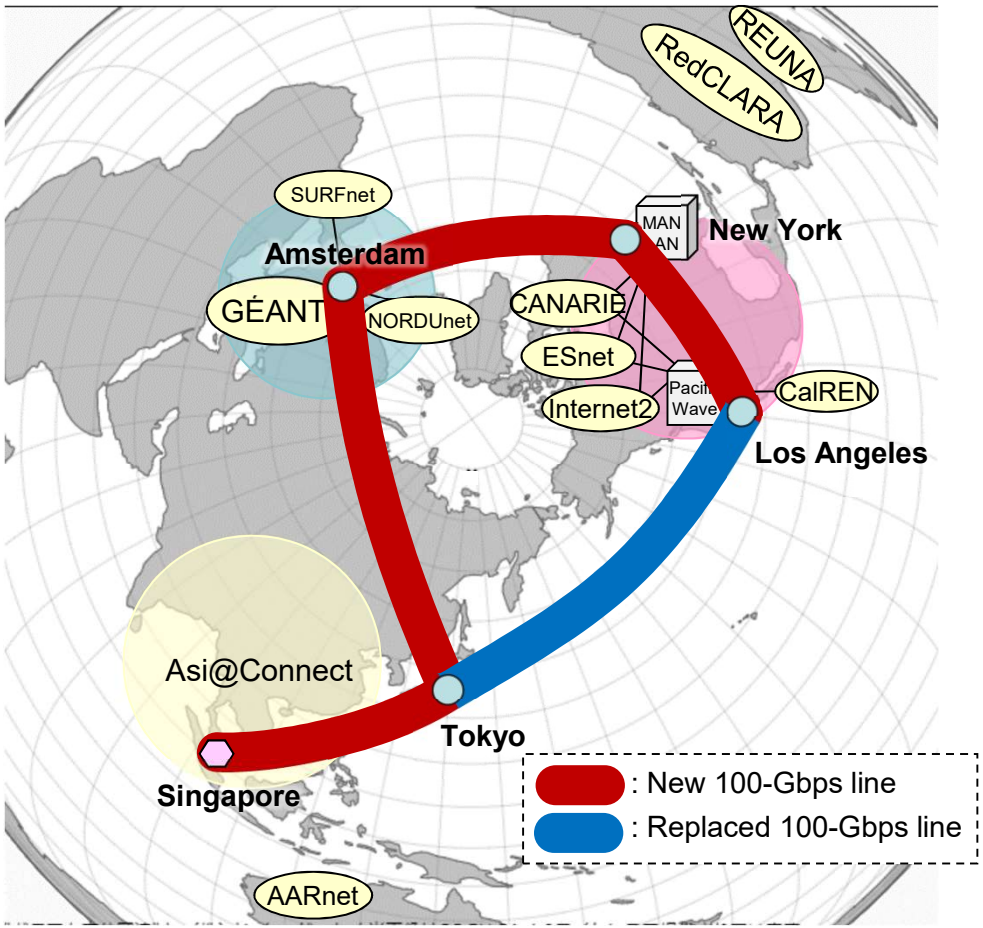
# International Lines (North Pole View)

◆ 100Gbps ring connection around the globe is expected to supercharge EU-Japanese science collaborations.

https://www.geant.org/News_and_Events/Pages/100Gbps-ring-connection-around-the-globe-supercharges.aspx



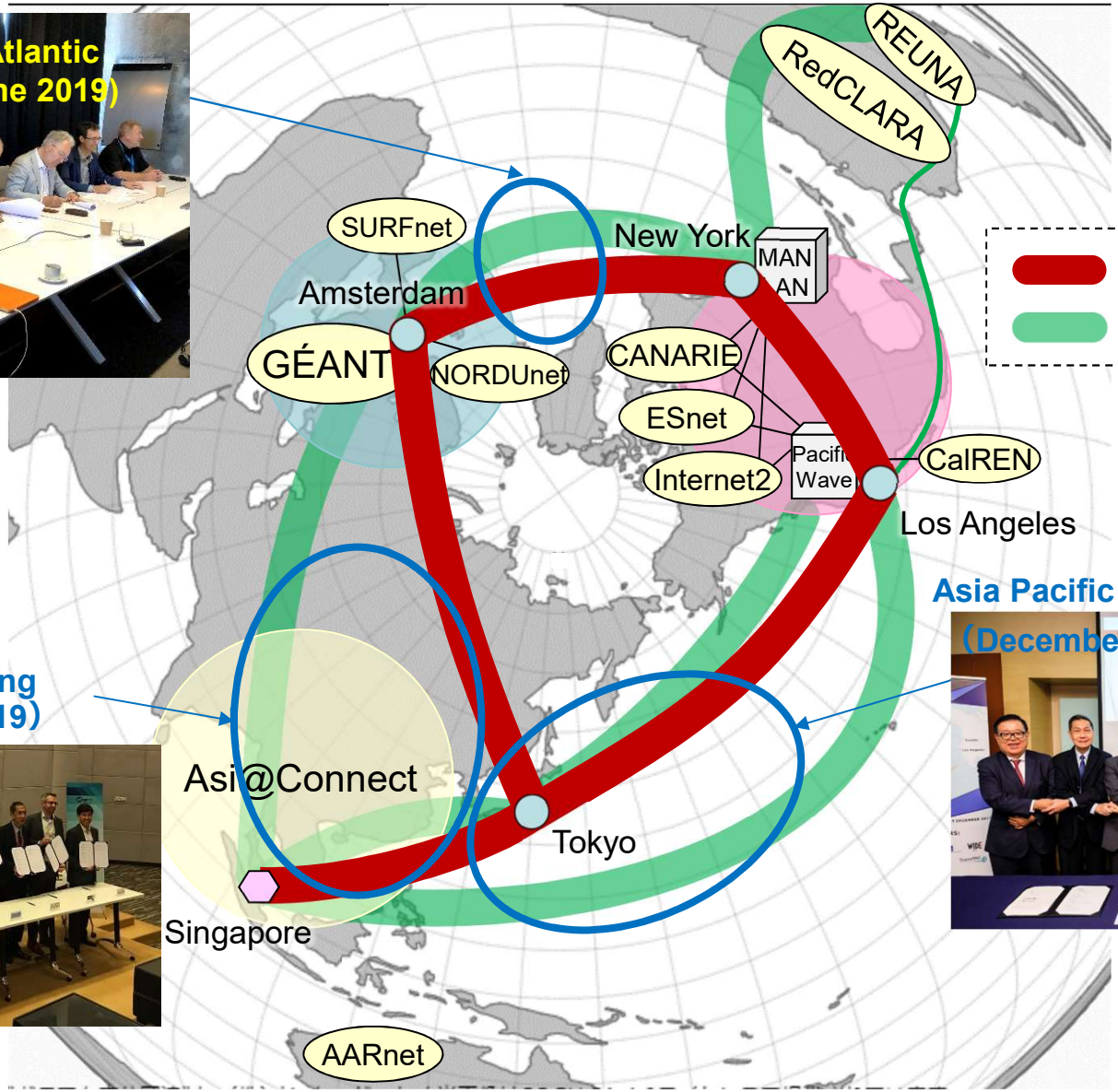

Until February 2019




From March 2019

© 2019 National Institute of Informatics

# Mutual Backup with other NRENs



© 2019 National Institute of Informatics

# Large-Volume Data Transfer Examples

## Belle II (Several 10Gbps)

Tsukuba - LA

USA

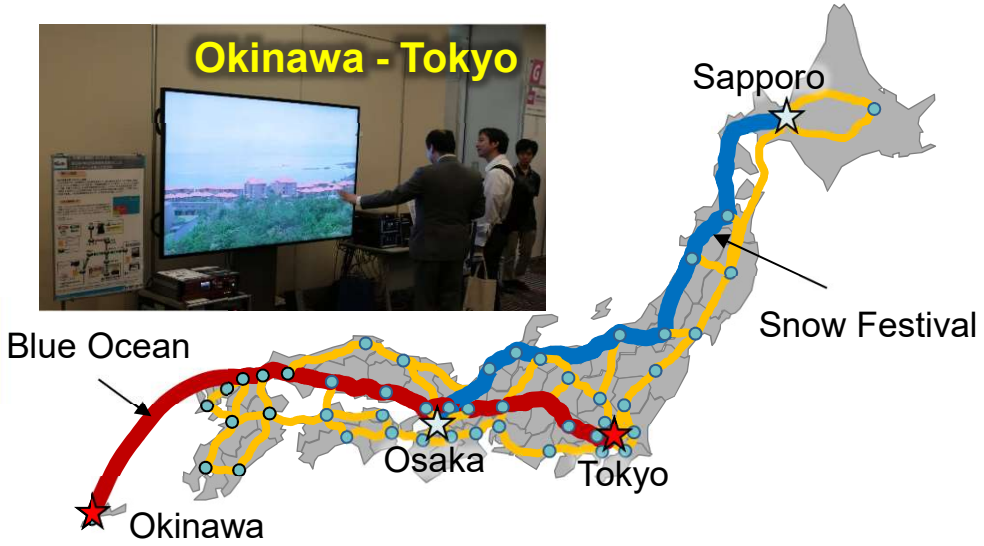
## HPC Data Backup (over 90Gbps)

Kobe - Kashiwa

Kashiwa

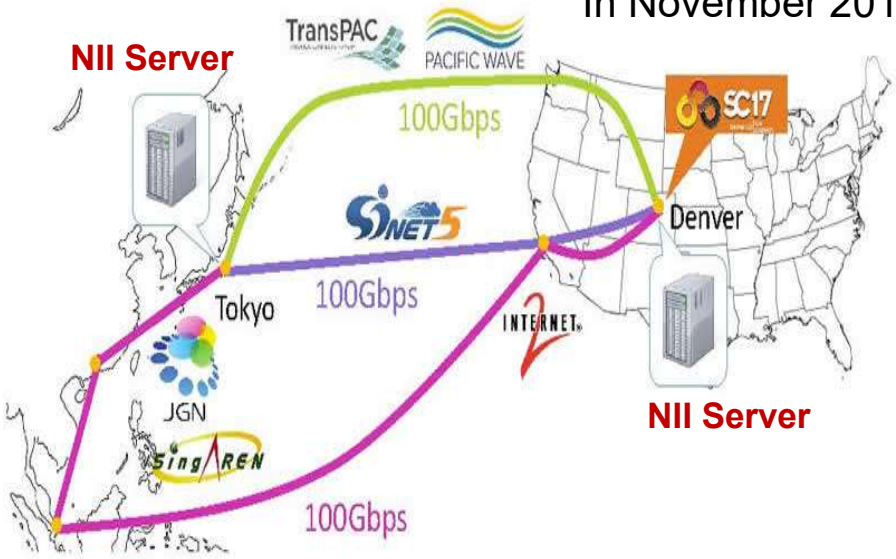
## 8K Video Transmission (25Gbps~50Gbps)




## 231Gbps-Speed File Transfer

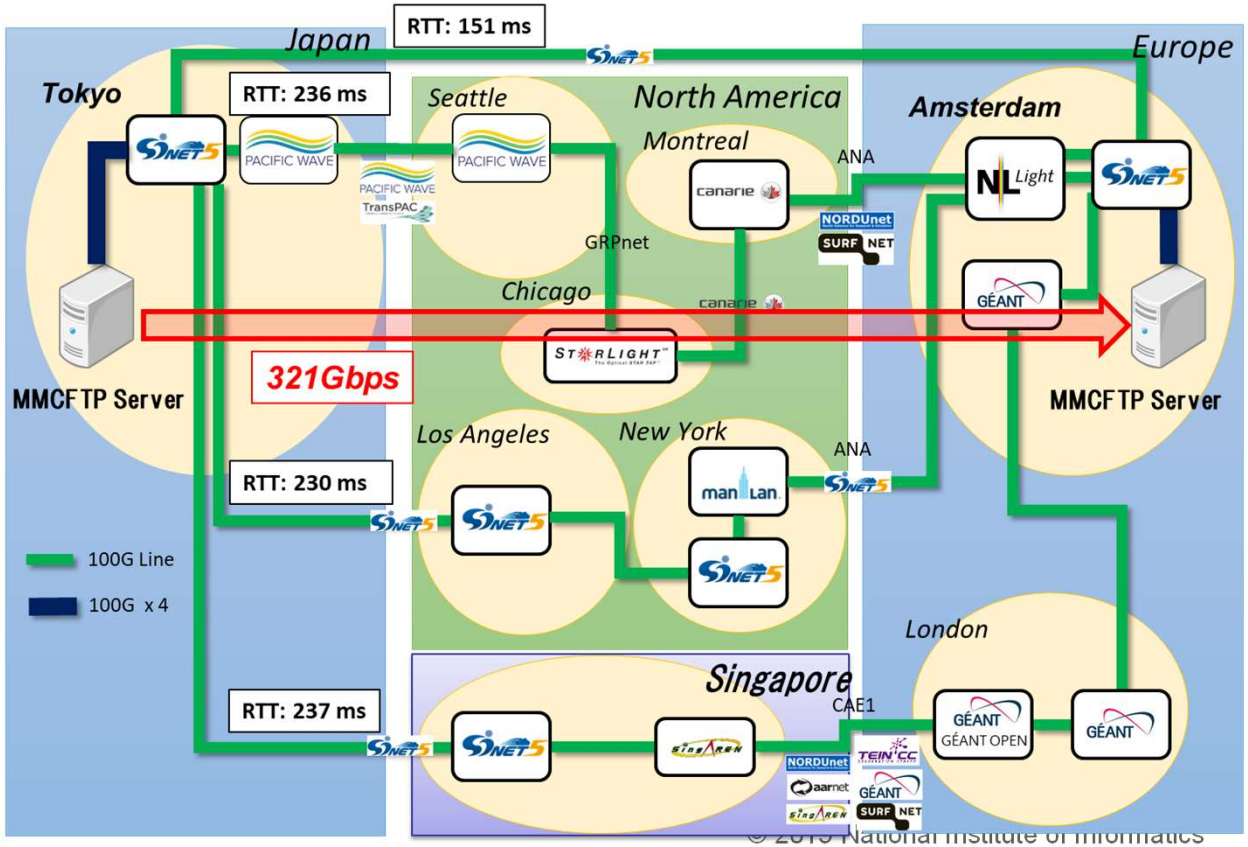
In November 2017




© 2018 National Institute of Informatics

# 321Gbps Data Transfer Experiment at TNC19

- Experiment using special protocol (MMCFTP) at TNC19@Estonia in June 2019.
- Attained 321Gbps data transfer rate between Japan and Estonia over the following four 100-Gbps lines.
  - Tokyo – Amsterdam – Estonia
  - Tokyo – Seattle – Chicago – Montreal – Amsterdam – Estonia
  - Tokyo – Los Angels – New York – Amsterdam – Estonia
  - Tokyo – Singapore – London – Estonia

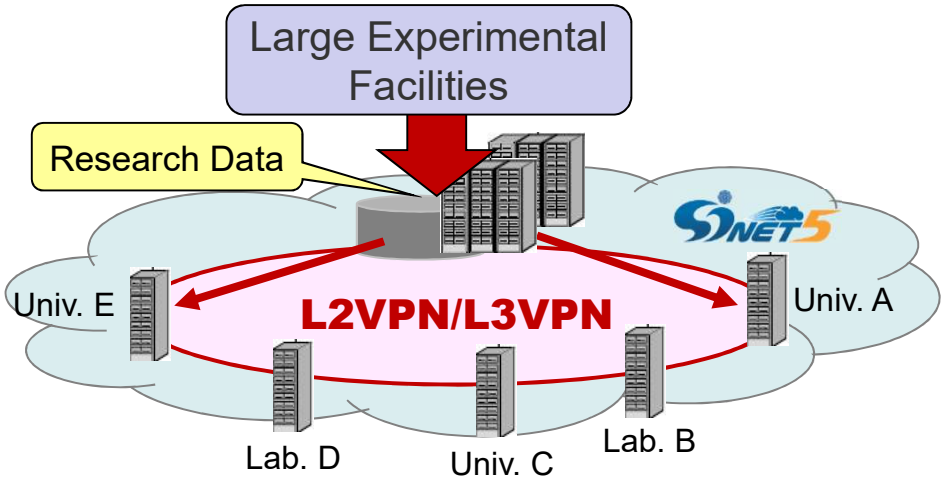



© 2019 National Institute of Informatics

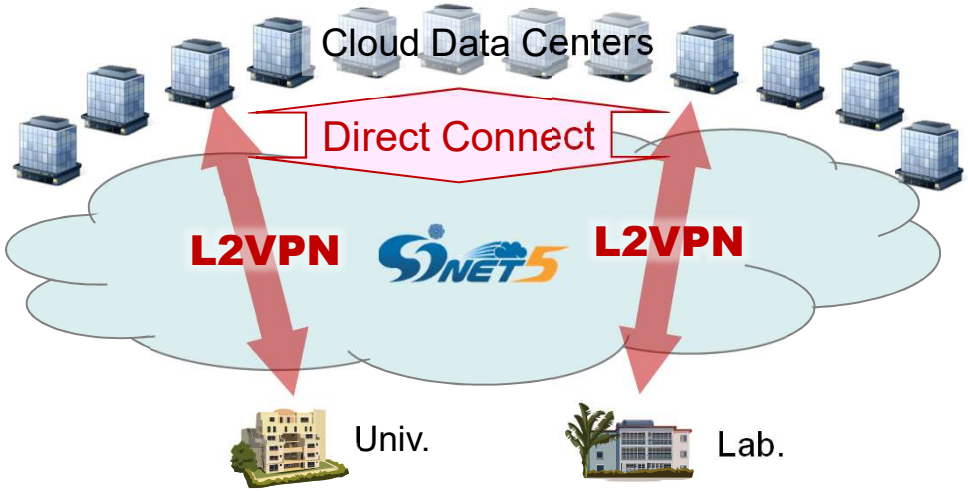
# Growing VPN Services

◆ Secure and high-performance VPN services have been growing, and the number of VPNs exceeds 2,700.

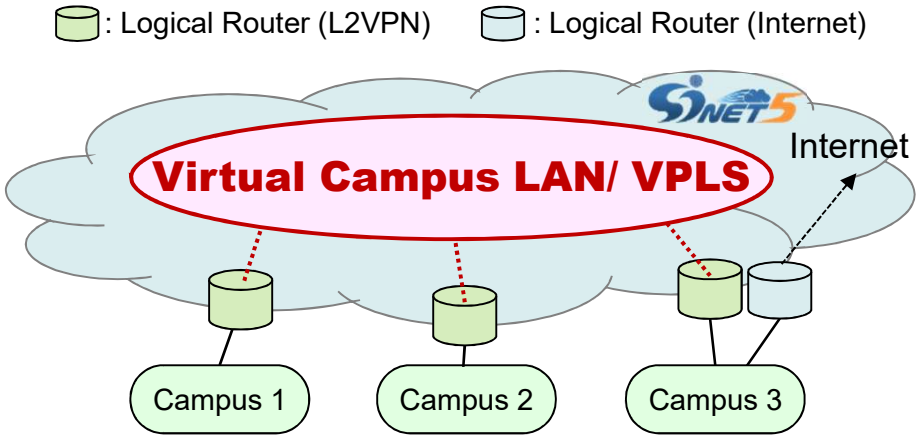
## Collaborative Research Environment




## Use of Cloud Computing

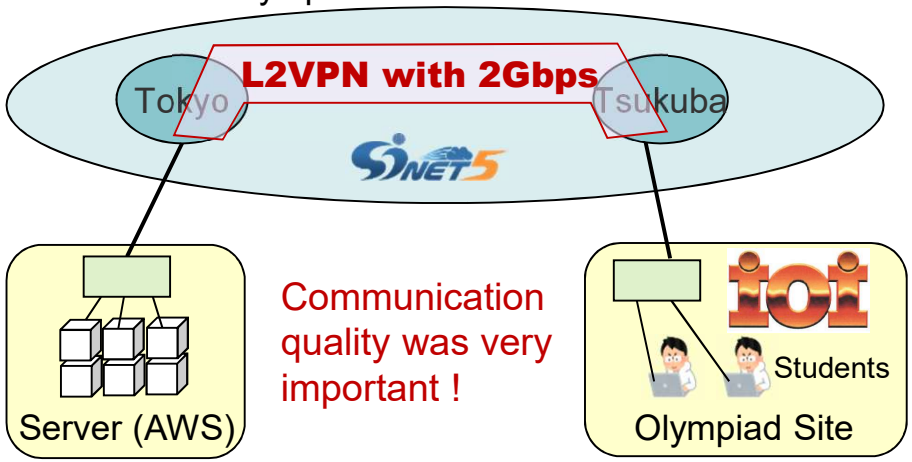



## Multiple Campus




## Bandwidth Guarantee

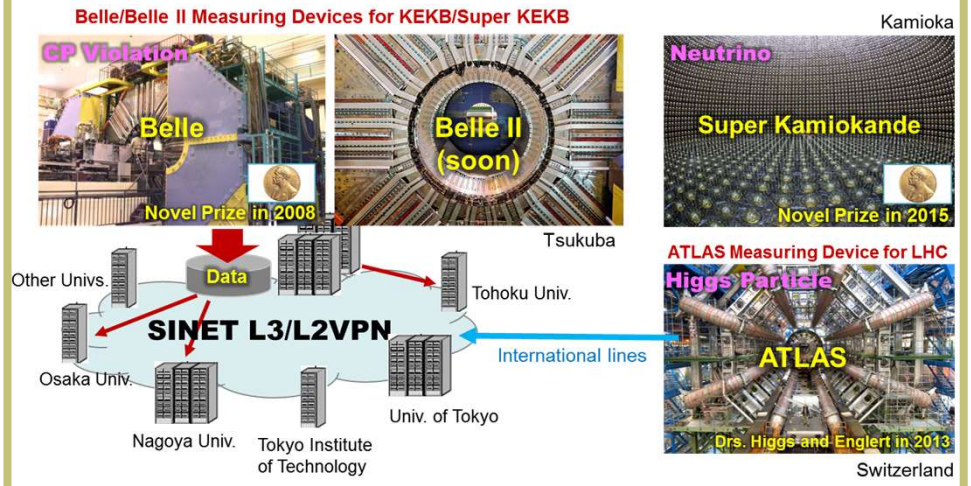
e.g. International Olympiad in Informatics 2018



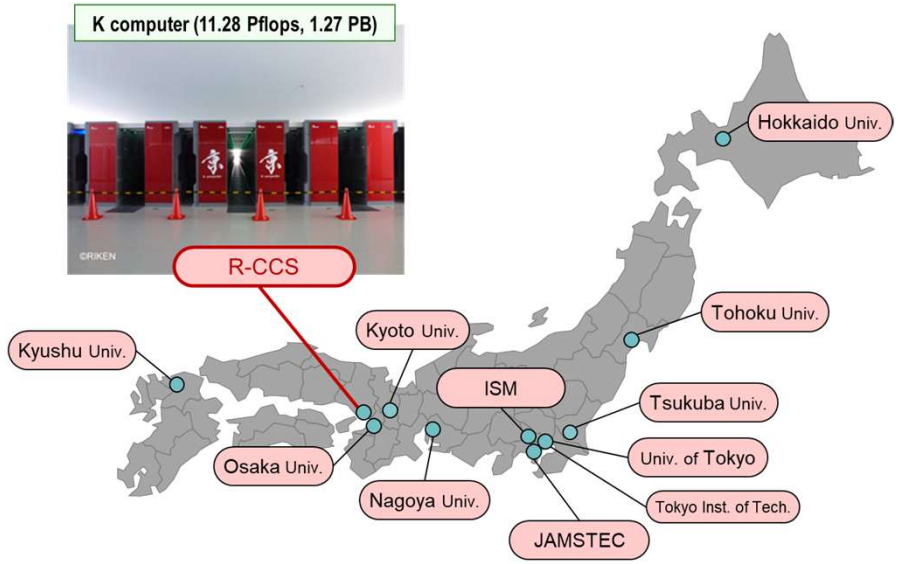

© 2019 National Institute of Informatics

# Usage Examples (1)

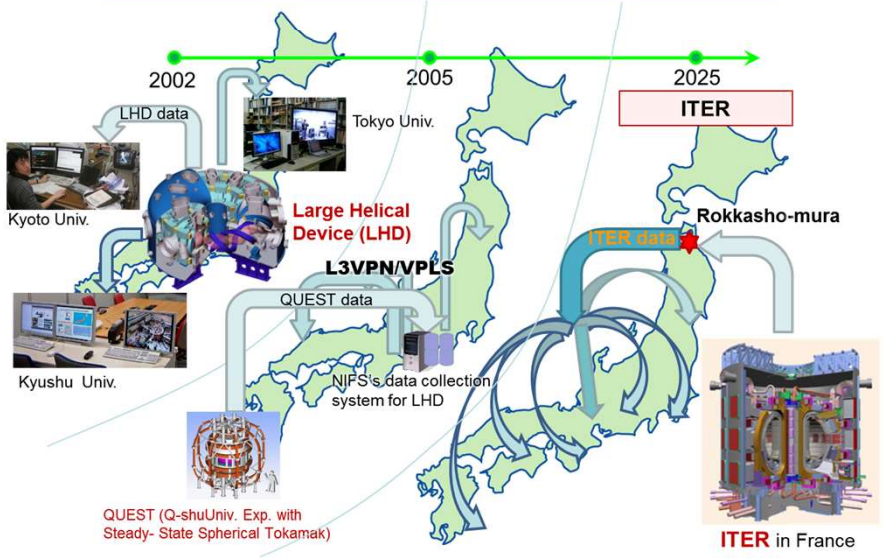
## 1) High-Energy Physics



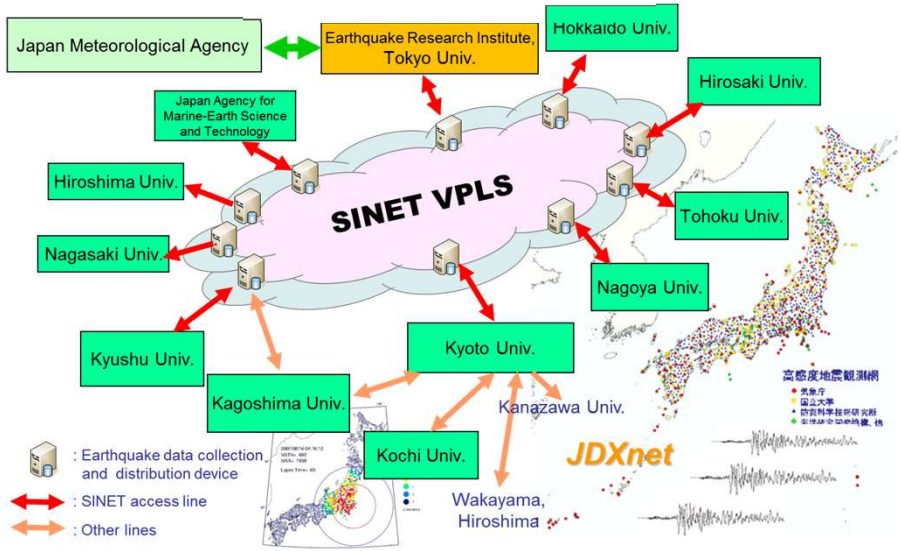

## 2) High-Performance Computing




## 3) Nuclear Fusion Science



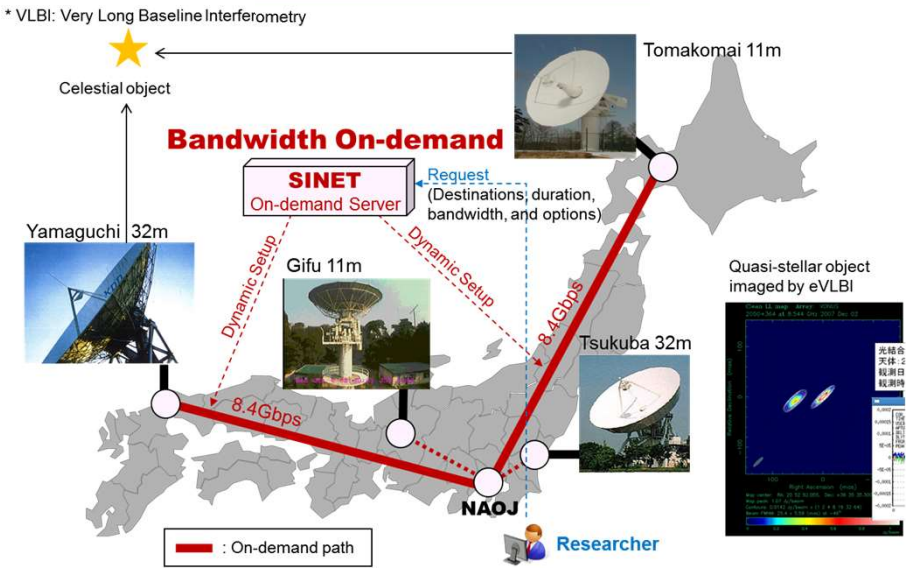

## 4) Seismology



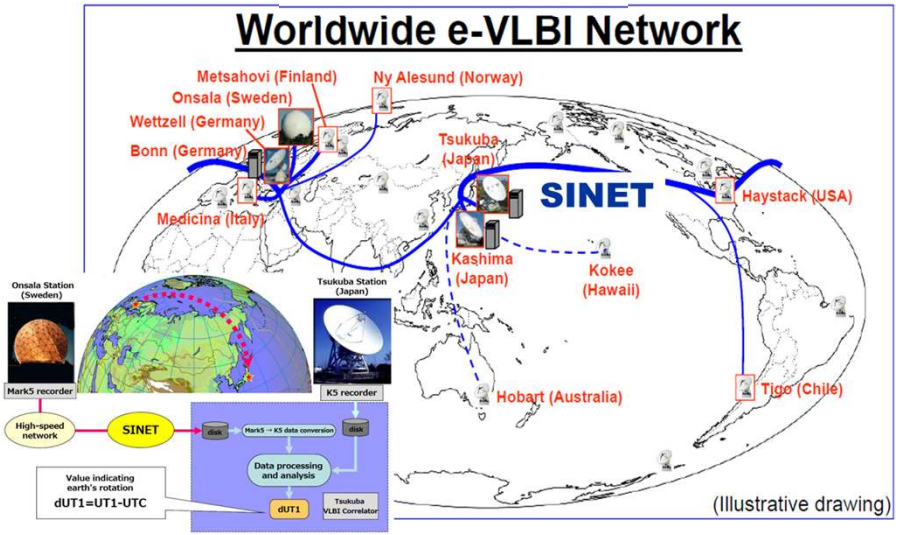

© 2019 National Institute of Informatics

# Usage Examples (2)

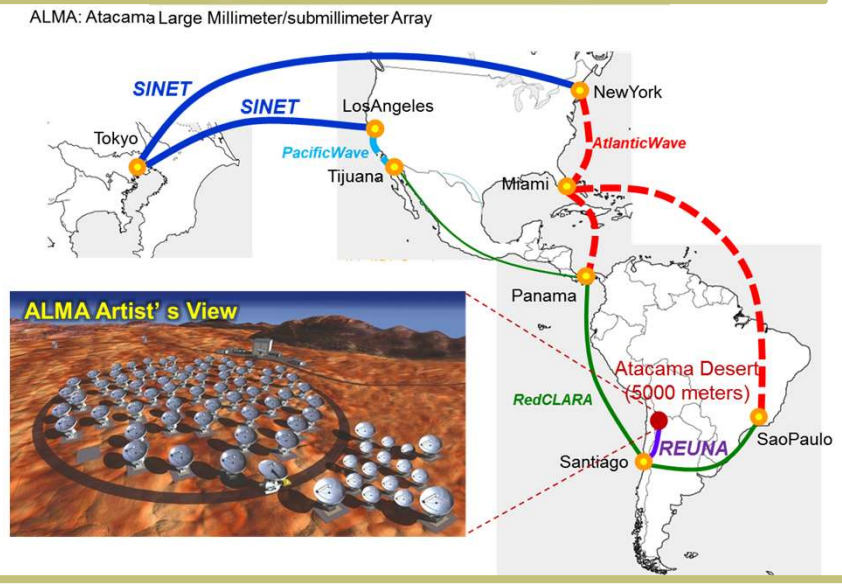
## 5) Astronomy



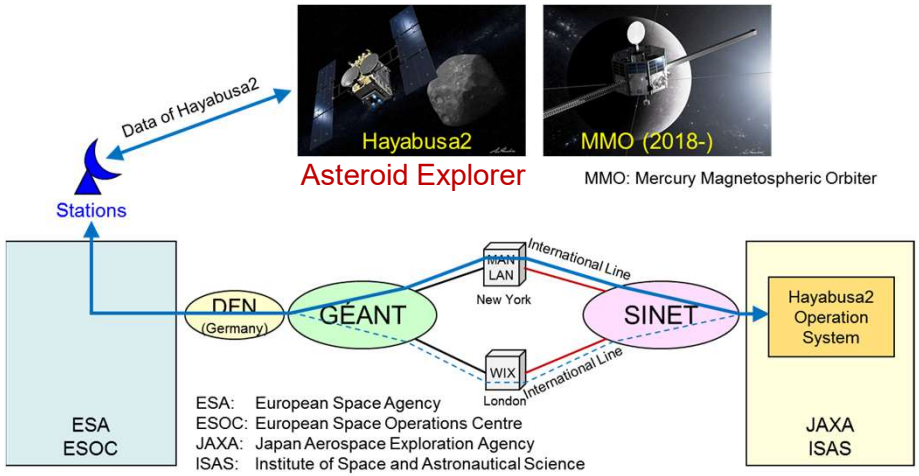

## 6) Geodesy




## 7) ALMA Telescope




## 8) Space Observation

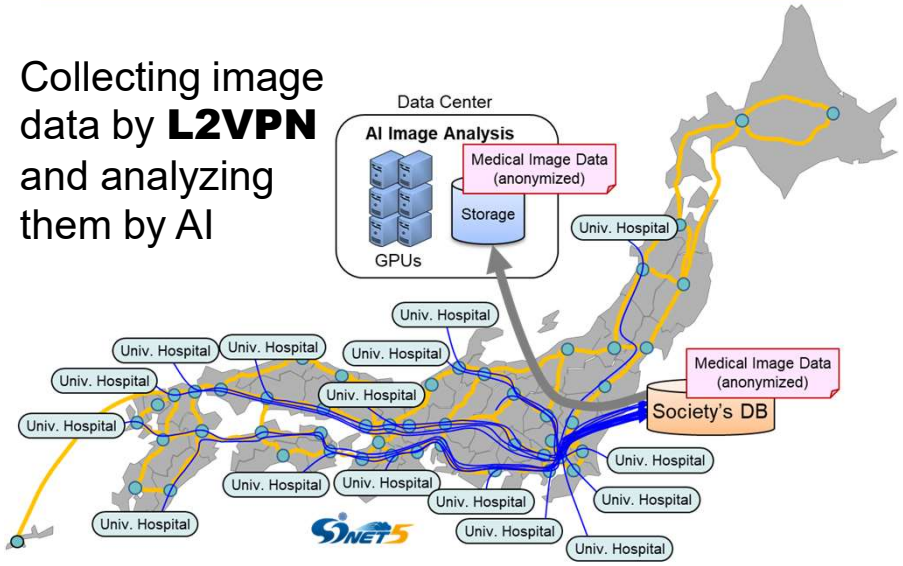



© 2019 National Institute of Informatics

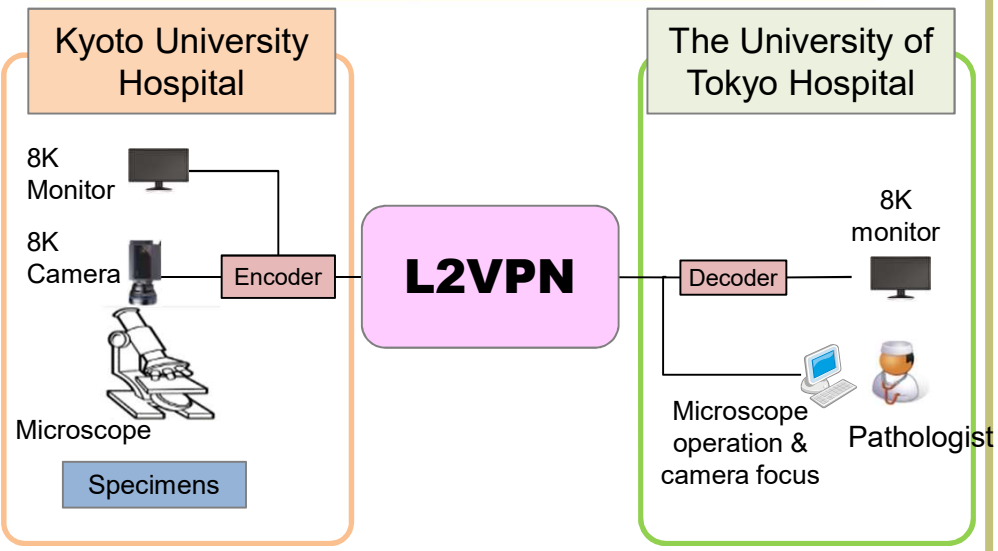
# Usage Examples in Medical Field

## 9) Medical Image Data Analysis

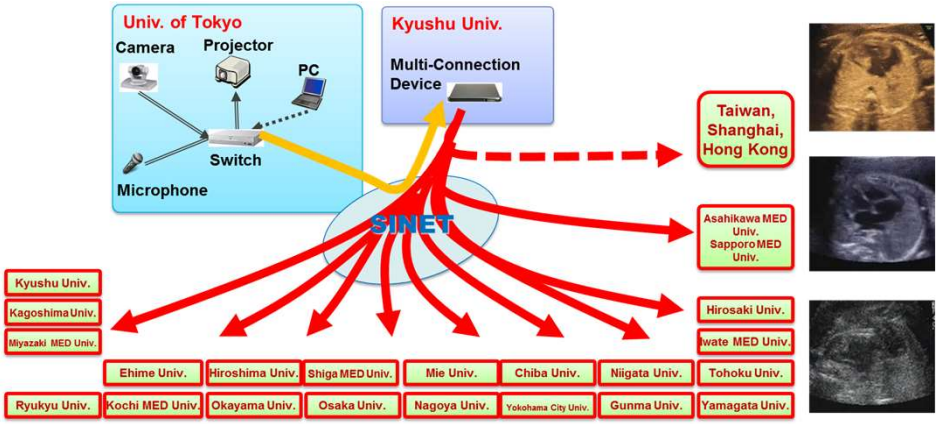
Collecting image data by **L2VPN** and analyzing them by AI




## 10) Remote Diagnosis by 8K Video




## 11) Remote Medical Education



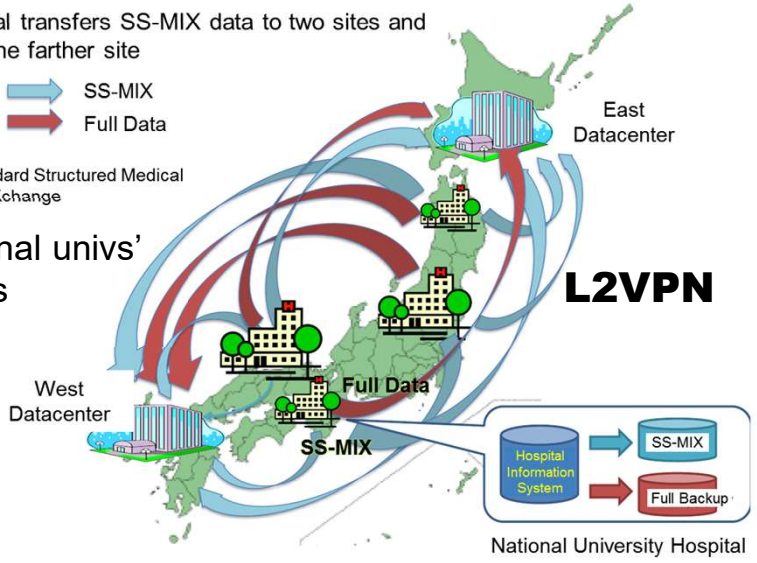

## 12) Medical Information Backup

Each hospital transfers SS-MIX data to two sites and full data to the farther site

SS-MIX
Full Data

SS-MIX: Standard Structured Medical Information eXchange

46 national univs' hospitals



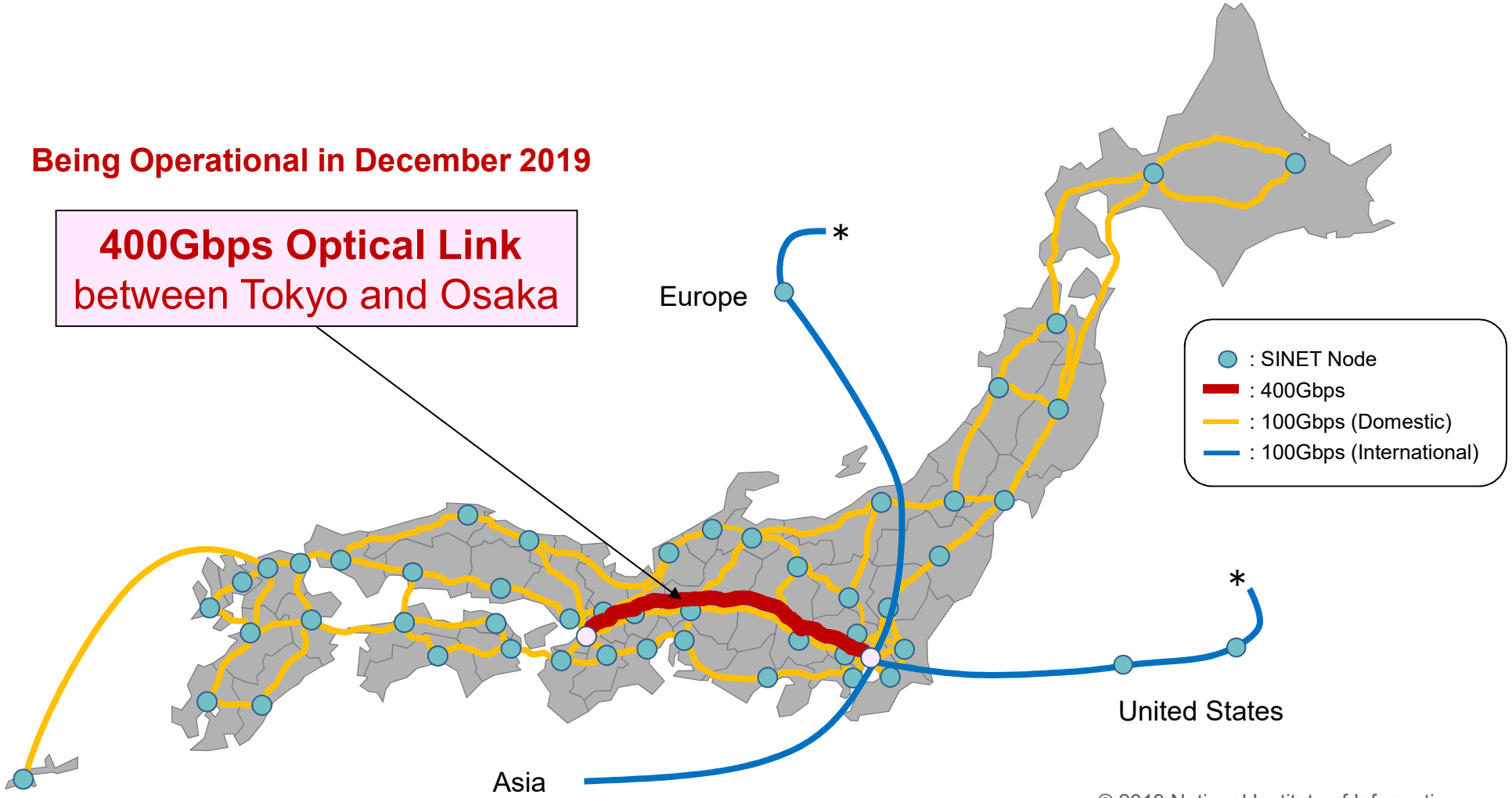

© 2019 National Institute of Informatics

# 400Gbps Optical Link Deployment

- Traffic amount between Tokyo and Osaka has been increasing due to encouraged traffic by upgraded internarial lines as well as ever-increasing traffic from existing applications.
- We plan to introduce a new 400Gbps optical link between Tokyo and Osaka.

**Being Operational in December 2019**

**400Gbps Optical Link**
between Tokyo and Osaka

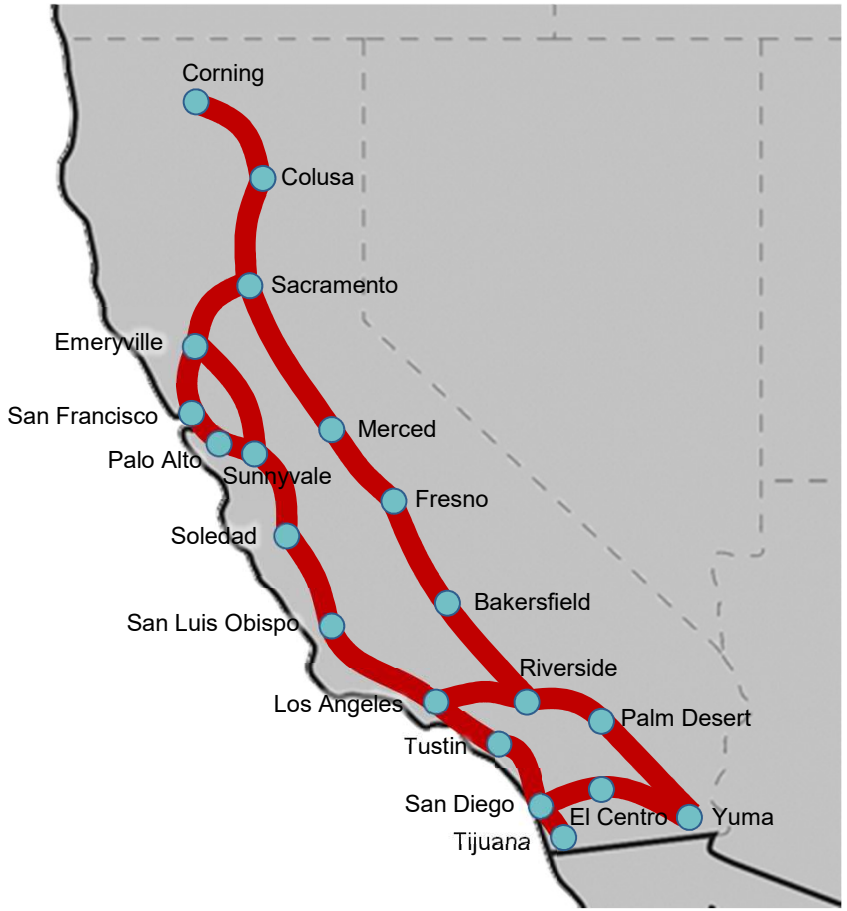



© 2019 National Institute of Informatics

# SINET “density”

Edited based on a slide provided by S. Urushidani @ NII

## Japan and California in the same scale



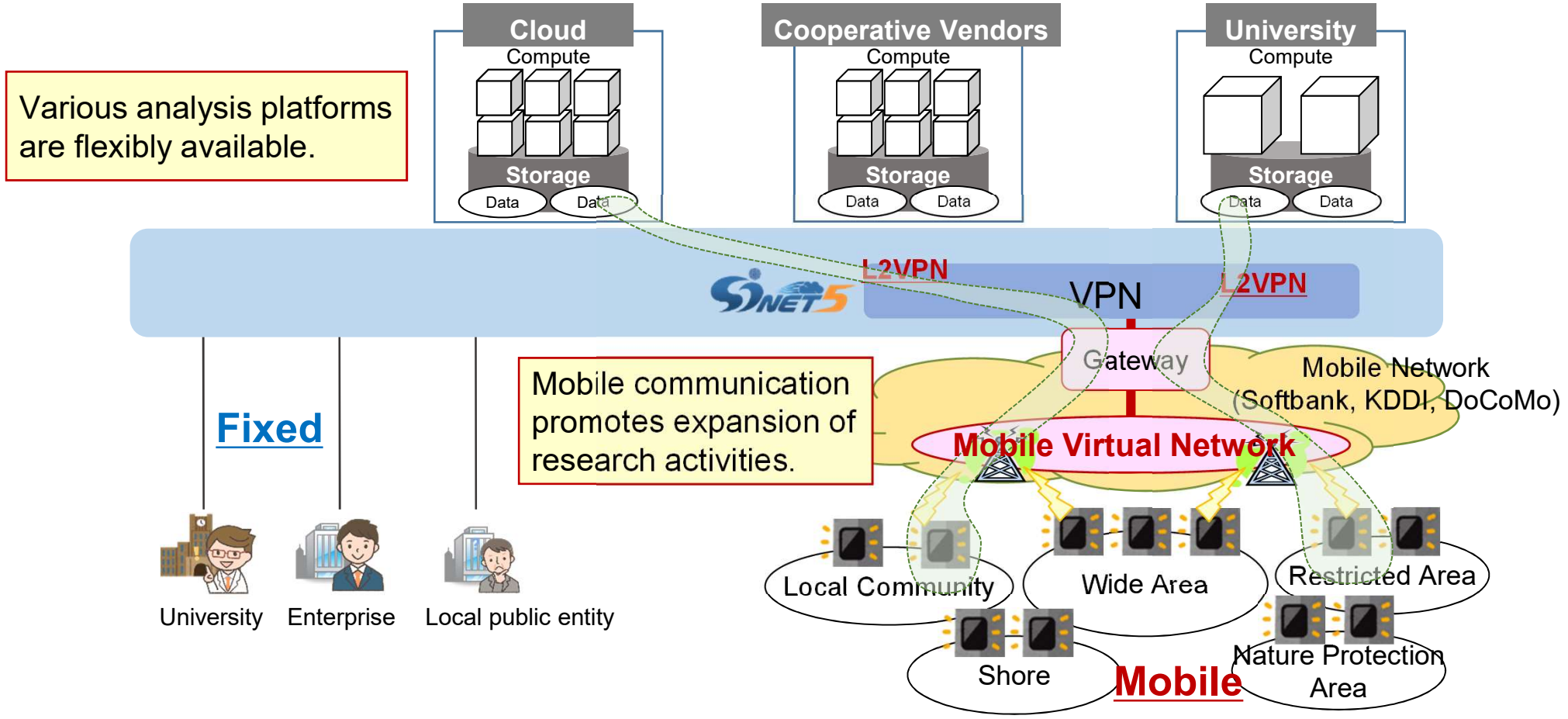
: nodes

: 100 Gbps connections

Source: https://cenic.org/network/network-overview

# Mobile Platform in SINET5

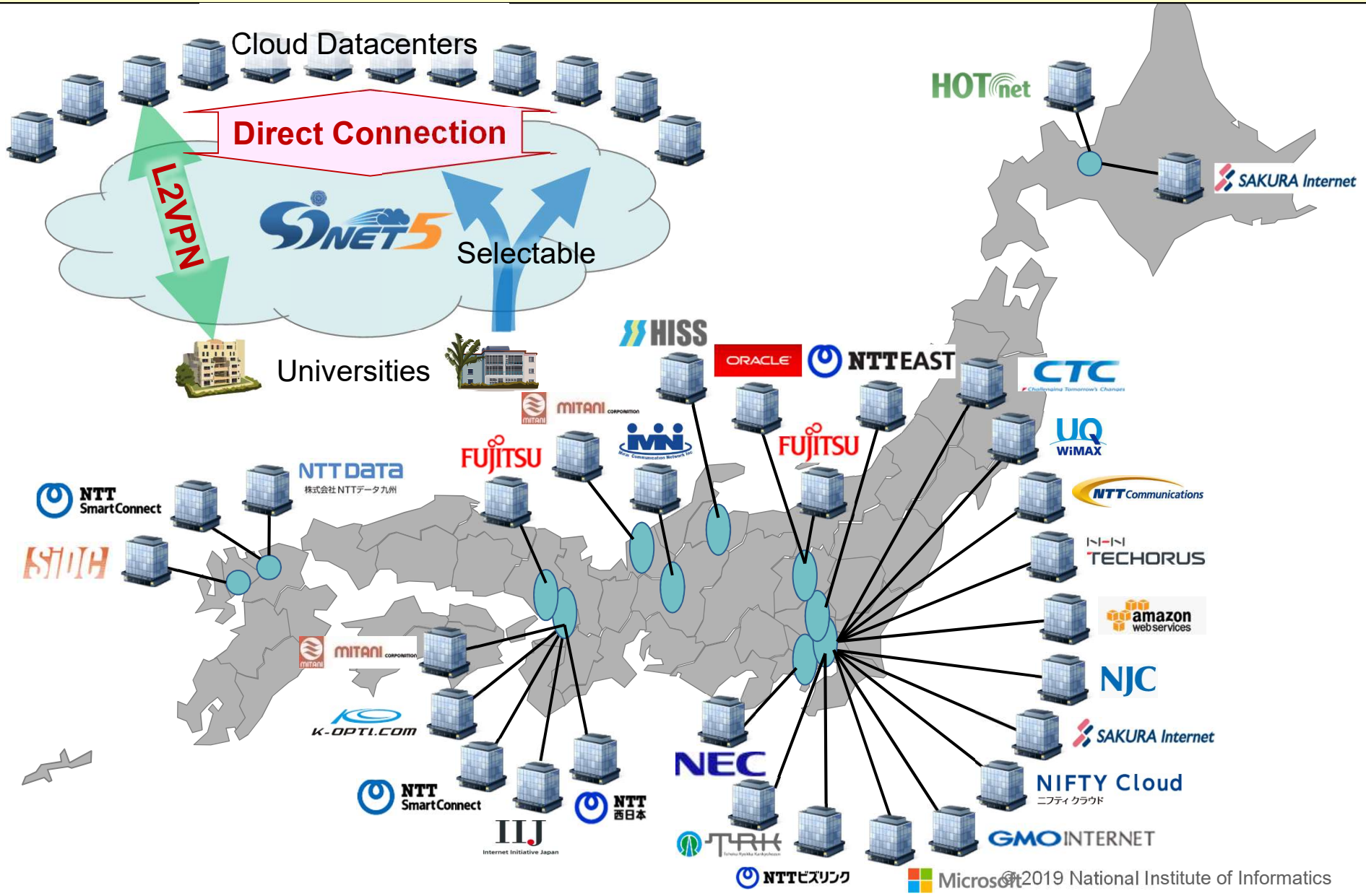
- NII started to introduce mobile capability into SINET in order to support IoT research and mobile-oriented applications toward 5G era in December 2018.
- Mobile virtual network created for SINET over commercial mobile network is directly combined with SINET VPN plane through gateways for secure communication.




© 2019 National Institute of Informatics

# Directly-Connected Cloud Services

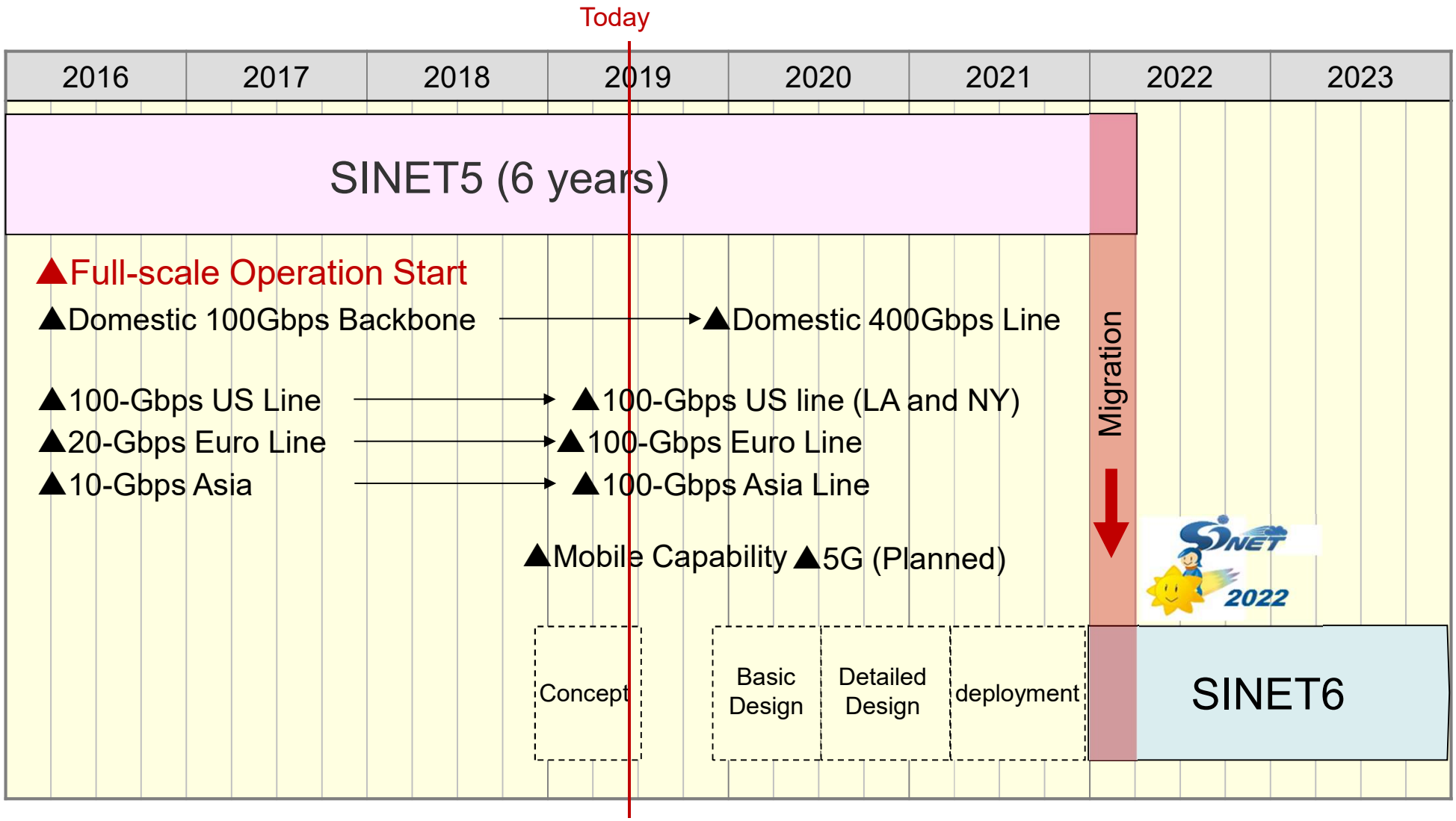
◆ 31 cloud datacenters (26 service providers) are directly-connected to SINET in order to provide high-performance and secure cloud services for more than 190 universities.




©2019 National Institute of Informatics

# Schedule for SINET6

◆NII plans to launch SINET6 in April 2022 and is now exploring its concept.




© 2019 National Institute of Informatics

# Data Exploitation Platform (tentative name) project



- **Will provide a rapid PoC environment for R&D data exploitation activities including industry-academia collaboration projects.**
  - Shared platform for various data exploitation activities
  - Combine SINET and high performance computing and storage infrastructure
- **Users can use wide bandwidth low latency “slices”**
  - Wide-area virtual infrastructure isolated from “the internet”
  - Connect edge devices with high performance computing and storage infrastructure and supports real-time data processing
- **Will host:**
  - Various data exploiting activities, especially in SMEs, local governments and agriculture / fishing
  - Key to solve the regional disparity problems
- **Will provide matching function of:**
  - Those who want to analyze their own data,
  - Various data and their owners
  - Researchers who have skills/tools to analyze data,
  - The data exploitation platform infrastructure

# To realize Knowledge Intensive Society: Platform for Data Exploitation

**Input：Events**

**Platform**

**Knowledge Distillation: Data Exploitation Platform**

- Mathematical Model
- Past Events
- Background Data （Topograpy, Population Etc.）

**Output：Knowledge**

Data exploitation is the key to realize highly productive knowledge intensive society.
Data exploitation opportunities should be provided to everyone / every region.

→ SINET is a great infrastructure to provide such opportunities to all over the country.

# Core Pillars of the Data Exploitation platform

## 1 Dynamic provisioning of real-time data collection / storage / analysis infrastructure leveraged by SINET

On-demand construction of virtual infrastructure (slices) including remote censors, storage and compute resources
Using the provided virtual infrastructure, users can process data and get analysis result in real-time.

## 2 Fusion of Data Science and Computational Science

First-rate computing infrastructure for both data science and computing science enables highly accurate data analysis

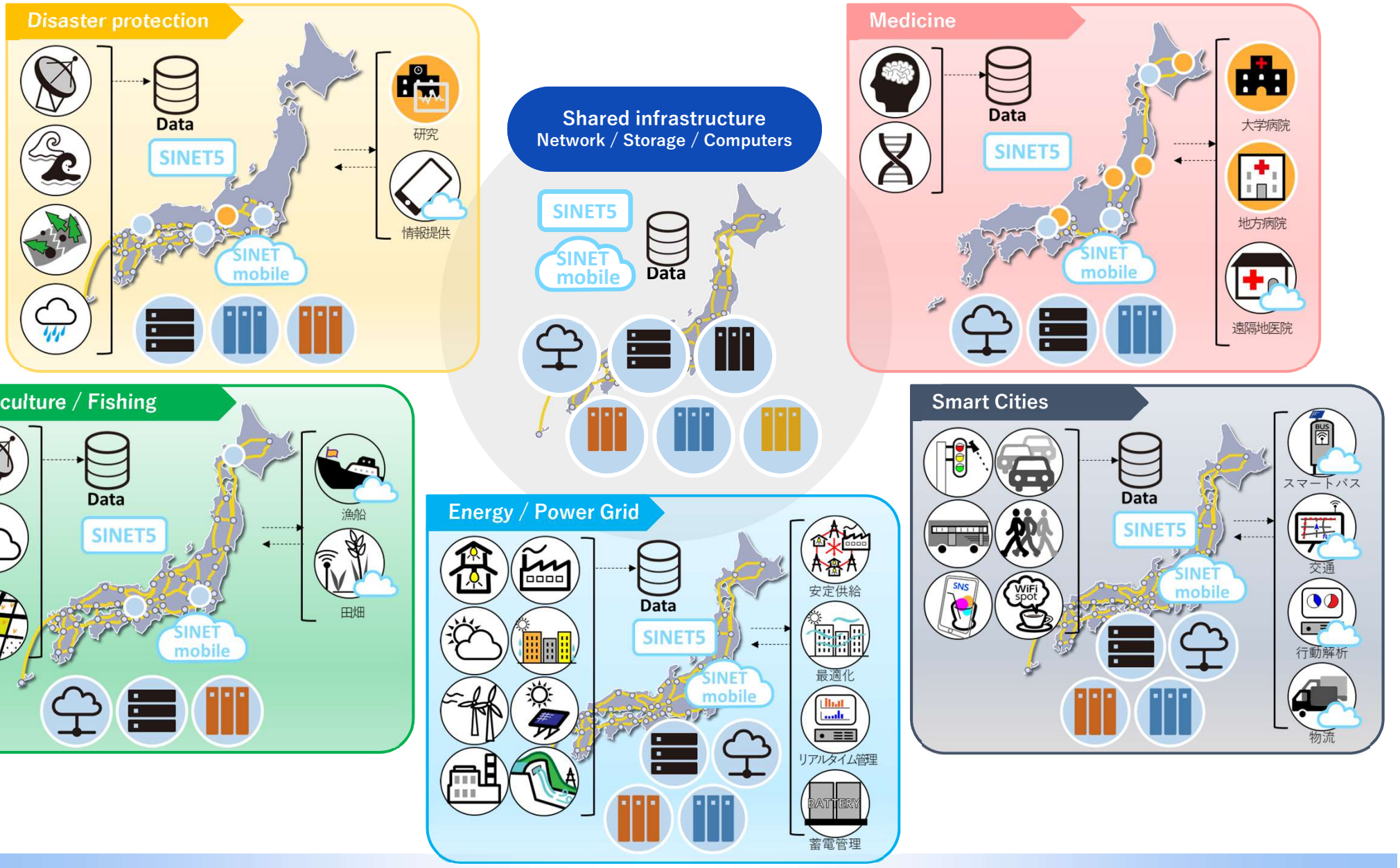
## 3 Promote combined use of various kinds of data and knowledge by matching and consulting

Build a cross academia / industry community of data owners, data analysis specialists and those who want to utilize data so as to accelerate data exploitation in various area

# On-demand platform



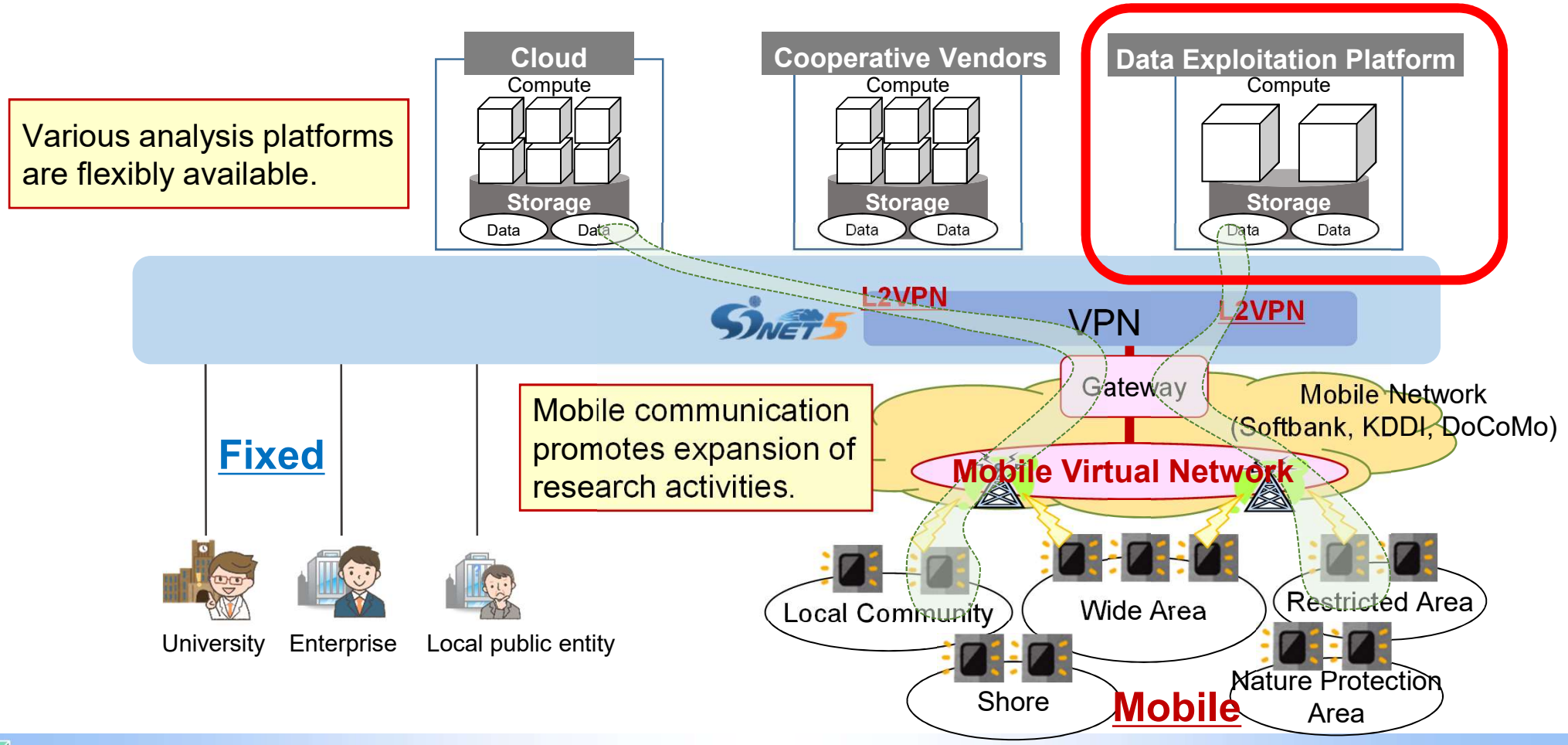
## Geographically distributed IaaS including network



# SINET mobile infrastructure



- SINET mobile infrastructure to support data collection and analysis
- IoT devices can be connected to SINET L2VPN
- Secure: a virtual SINET network is constructed in mobile networks. Closed application designated network isolated from the internet connects edge devices and compute & storage infrastructure

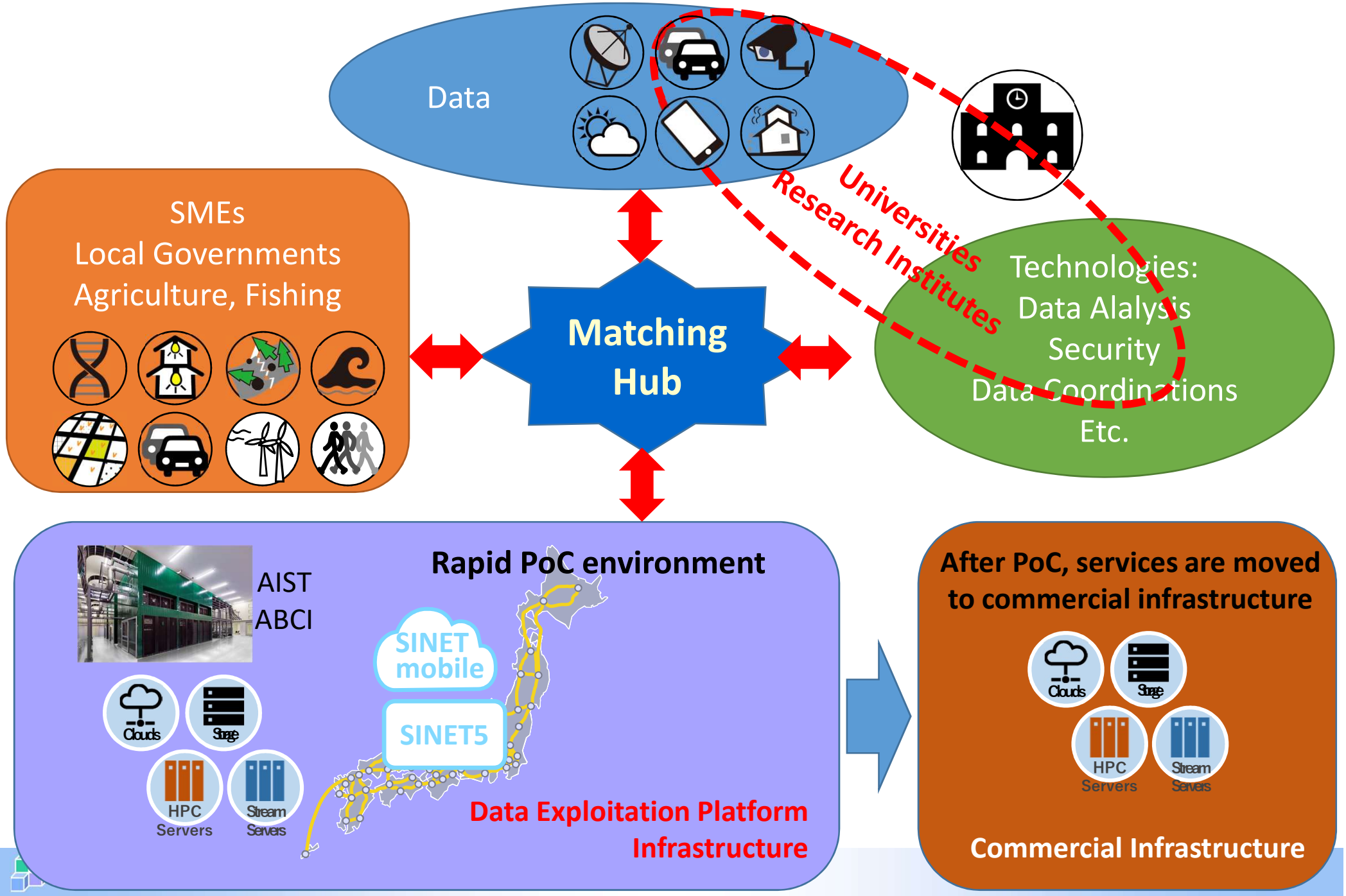



Data Exploitation Platform

Edited based on a slide provided by NII

# Overview of the Data Exploitation Platform





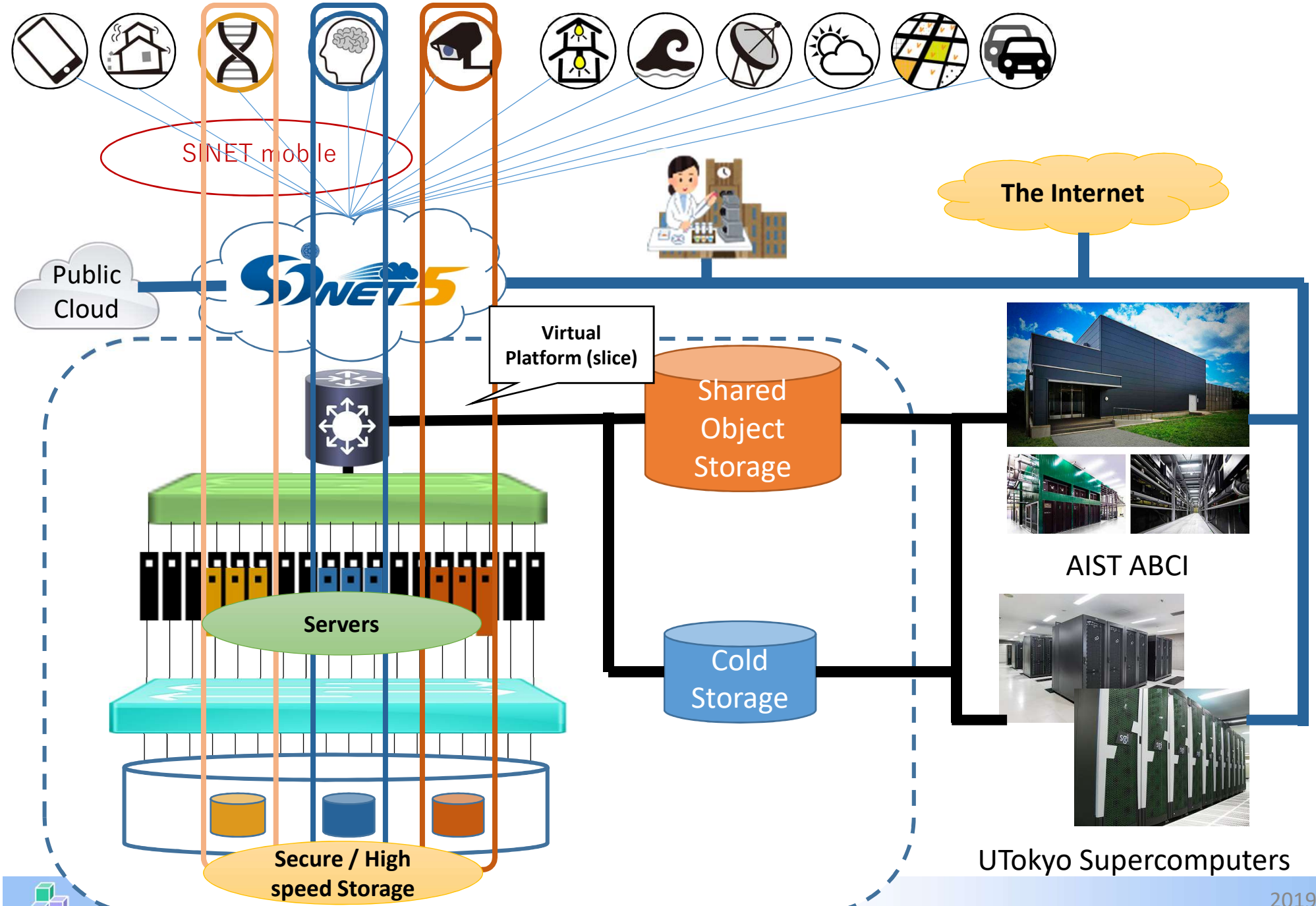
# Deployment and operation plan



- **Small scale testbed will be available in FY2019**
- **First deployment system will be operational by the end of FY2020**
  - Computer & storage will be installed in Kashiwa II campus of the University of Tokyo
- **AIST's ABCI (AI bridging infrastructure) will also participate in the program**
  - Japan's fastest supercomputer for AI
- **The platform will be jointly operated by :**
  - Universities in Japan
  - NII (National Institute of Informatics)
  - AIST (National Institute of Advanced Industrial Science and Technology)

# Infrastructure of the Data Exploitation Platform





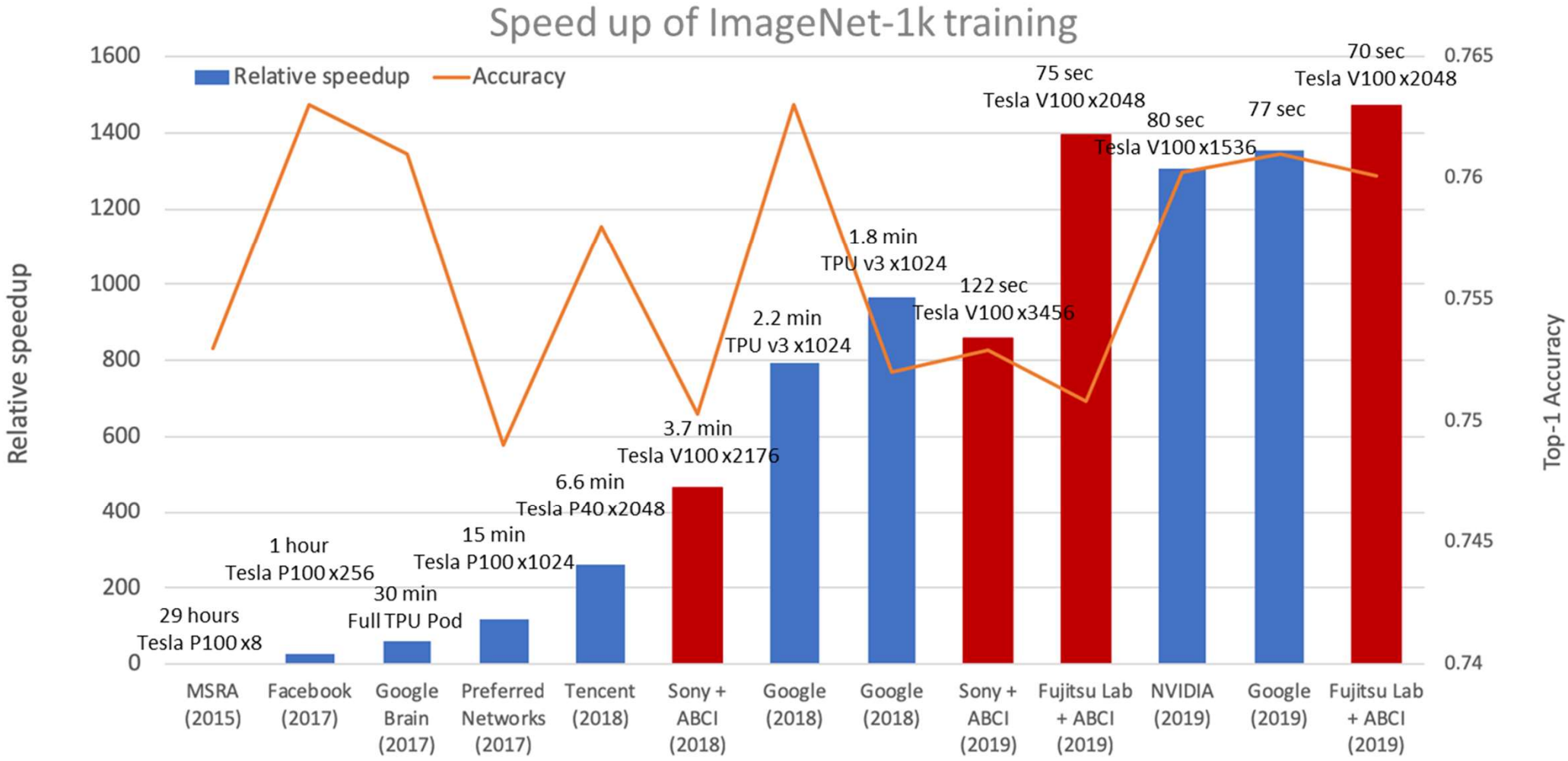
# ABCI: The World's First Large-Scale Open AI Infrastructure

**ABCI** AI Bridging Cloud Infrastructure

- World Top-Level compute and data process capability
- **Open, Public, and Dedicated** infrastructure for AI & Big Data Algorithms, Software, and Applications
- **Open Innovation Platform** to accelerate joint academic-industry R&D for AI

**Peak Performance:**
550 PFlops (FP16)
37 PFlops (FP64)
**Effective Performance:**
19.88 PFlops (#8 in TOP500)
14.423 GFlops/W (#3 in GREEN500)
509 GFlops (#5 in HPCG)
**Power Usage:** < 2.3 MW
**Average PUE:** < 1.1 (Estimated)

# ABCI is a powerful infrastructure to compete with hyper giants for AI R&D



# Two-level Isolation for Security Sensitive Applications



- **The platform will host security sensitive applications such as medical data, personal data**
  - Those applications require higher security level. Cloud-like environment may not be sufficient
- **The platform will be used by many different kind of users, and not all of them can be trusted.**
- **Number of IoT devices may be large, and hard to manage. Some IoT devices do not have enough computing power for secure encryption.**
- **In addition to software based security (authentication, authorization and encryption), the data exploitation platform will provide isolation by the network (VLAN)**
  - VLAN are controlled by the resource manager (port-based VLAN)
  - Even if the hypervisor is compromised, a user on a slice cannot access data of another slice

# Summary



- **The Data Exploitation Platform is “more for every day applications than big sciences”**
  - Data Exploitation for everyone: SMEs, local governments, agricultures, fishing etc.
  - Provide PoC environment for commercial applications
- **A real-time data processing environment.**
  - It is a geographically distributed IaaS, directly connectable to edge devices.
- **It can work as a streaming data gathering infrastructure for super computers such as ABCI**
  - Leveraging the SINET mobile infrastructure
- **Supports Two-level isolation (software level and network level) for security sensitive applications**
  - In combination with the SINET VPN (VLAN) service, can support