Infrastructure and system to promote data exploitation

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Data Exploitation Platform (tentative name) project

- **Target is to leverage data utilization at all over Japan making full use of high performance R&E network "SINET"**
  - SINET is an R&E network of Japan operated by NII (National Institute of Informatics)
- **Project supported by Japanese Government**
- **Currently jointly being designed by:**
  - 8 National Universities (Tokyo, Hokkaido, Tohoku, Tokyo Tech, Nagoya, Kyoto, Osaka, Kyushu)
  - NII (National Institute of Informatics)
  - AIST (National Institute of Advanced Industrial Science and Technology)
- **Will invite universities and public research institutes of all over Japan to use the platform for industry-academia and local government-academia collaboration activities.**
- **Starting Operation in January 2021 (or later)**

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.）

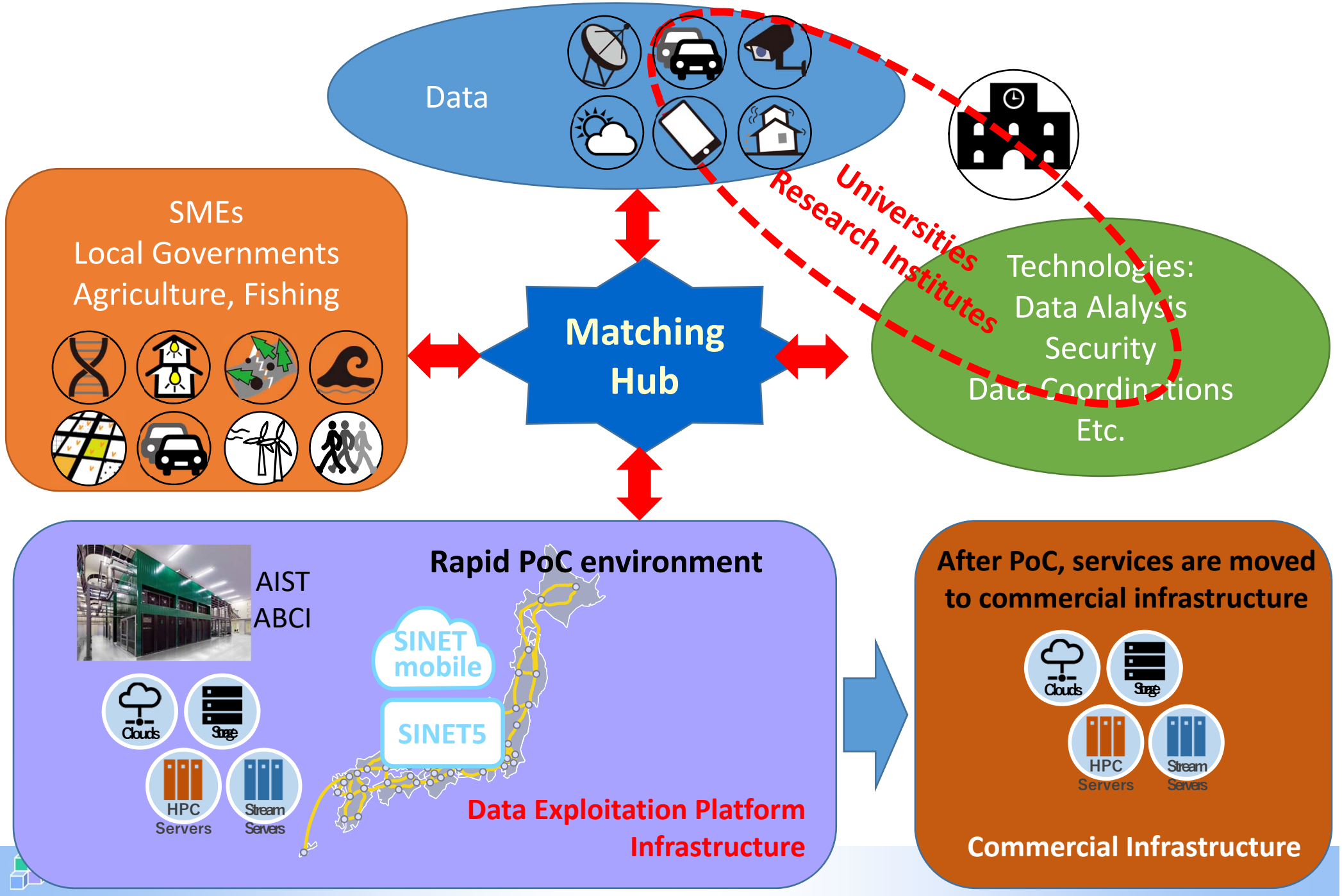
Output：Knowledge

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.

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

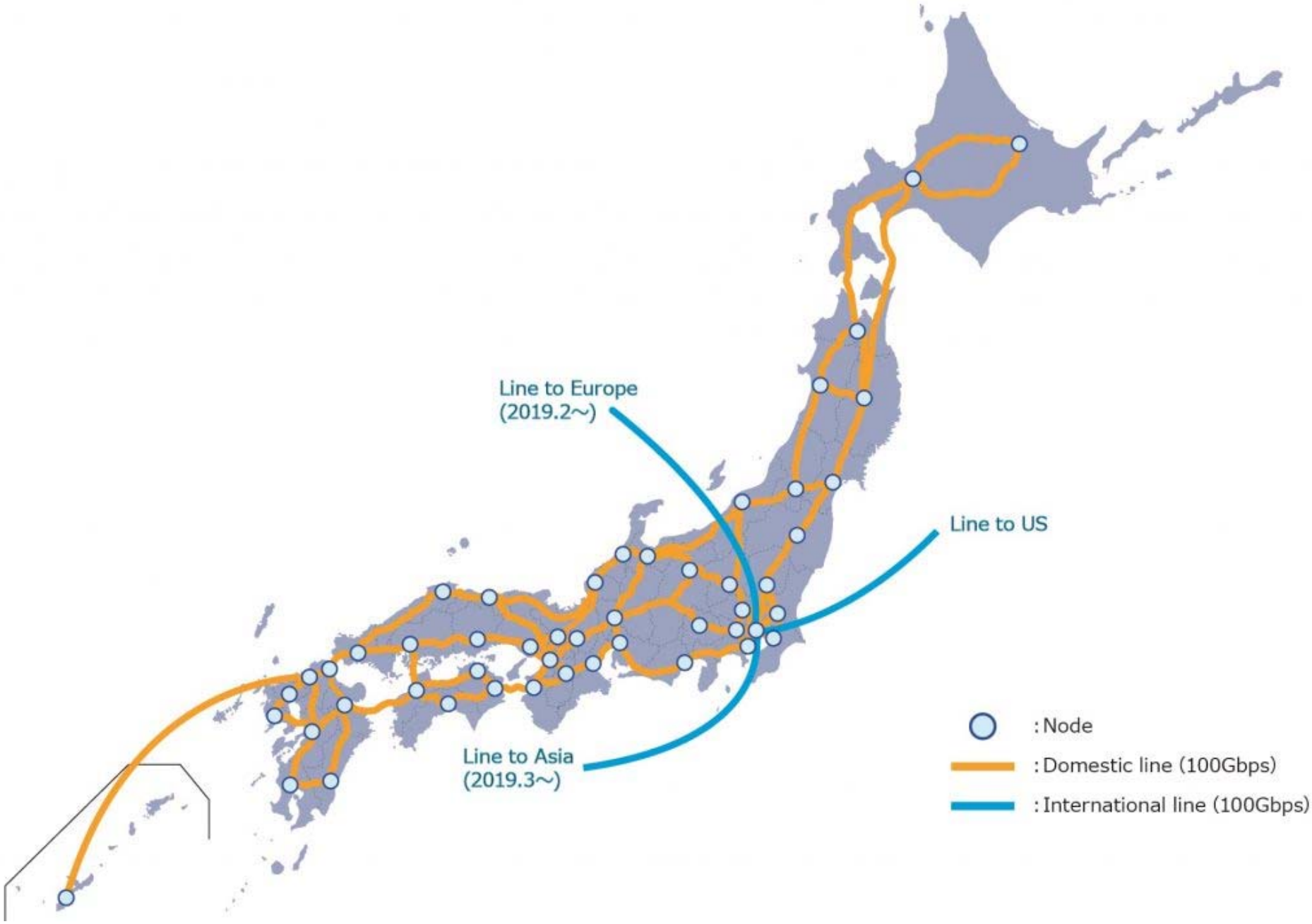
Overview of the Data Exploitation Platform



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**

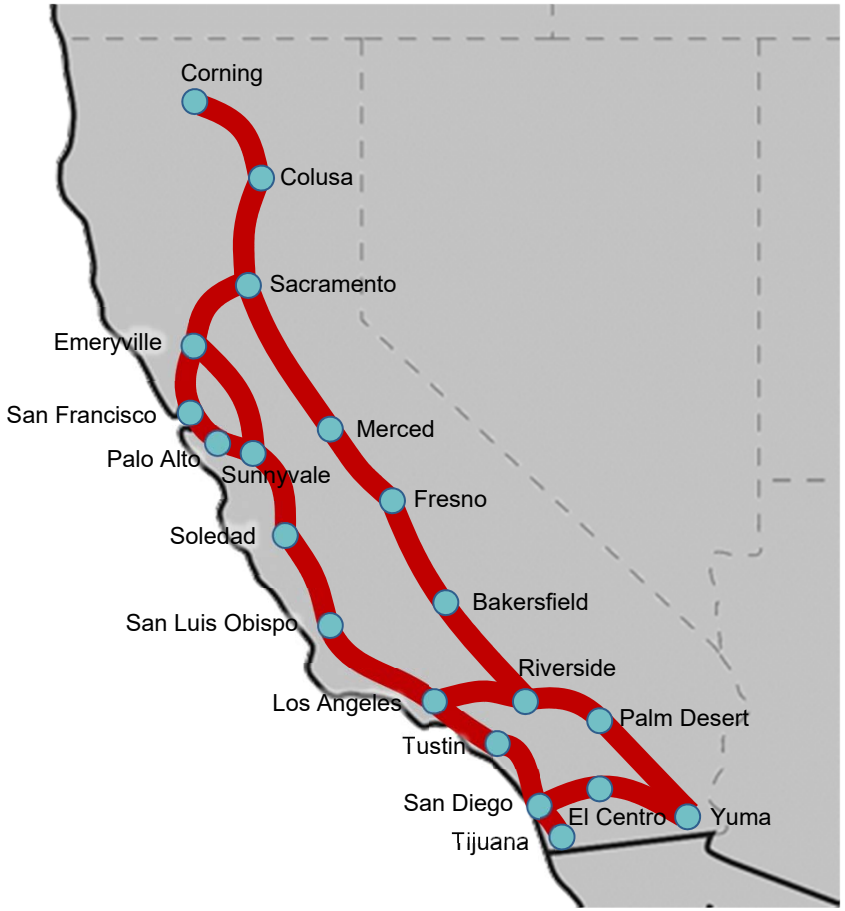
SINET domestic network

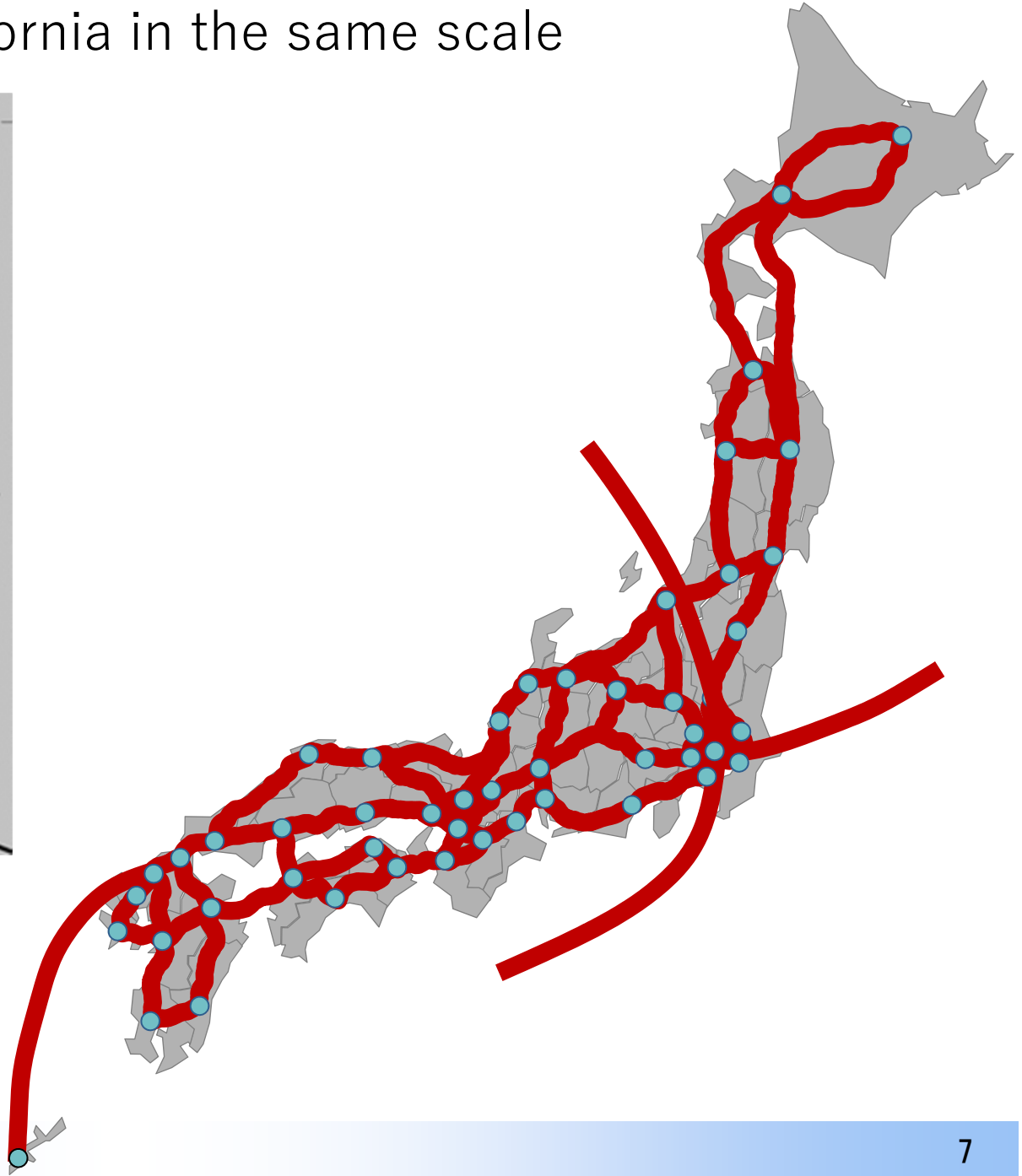


SINET “density”

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

Japan and California in the same scale





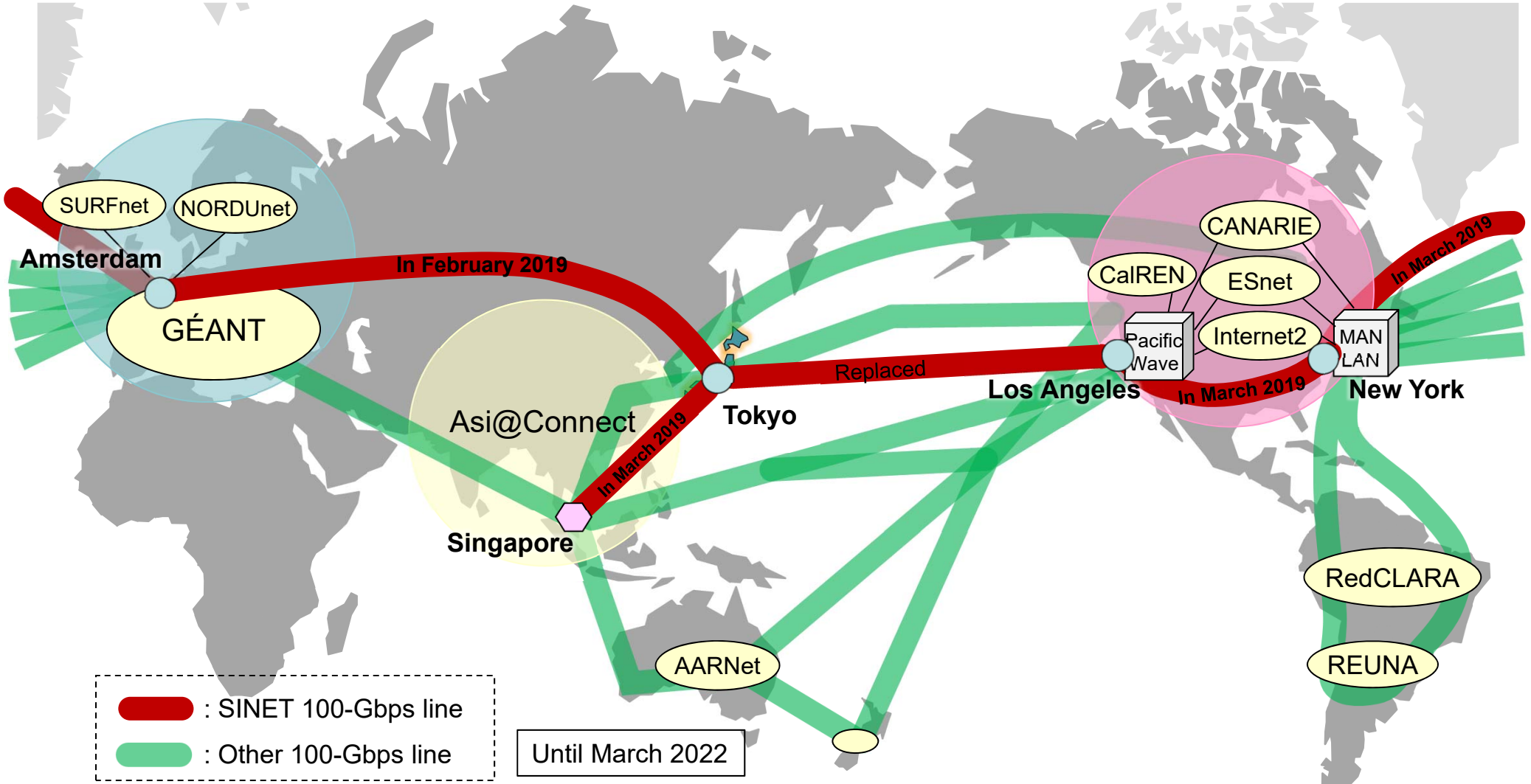
: nodes

: 100 Gbps connections

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

International Lines of SINET5

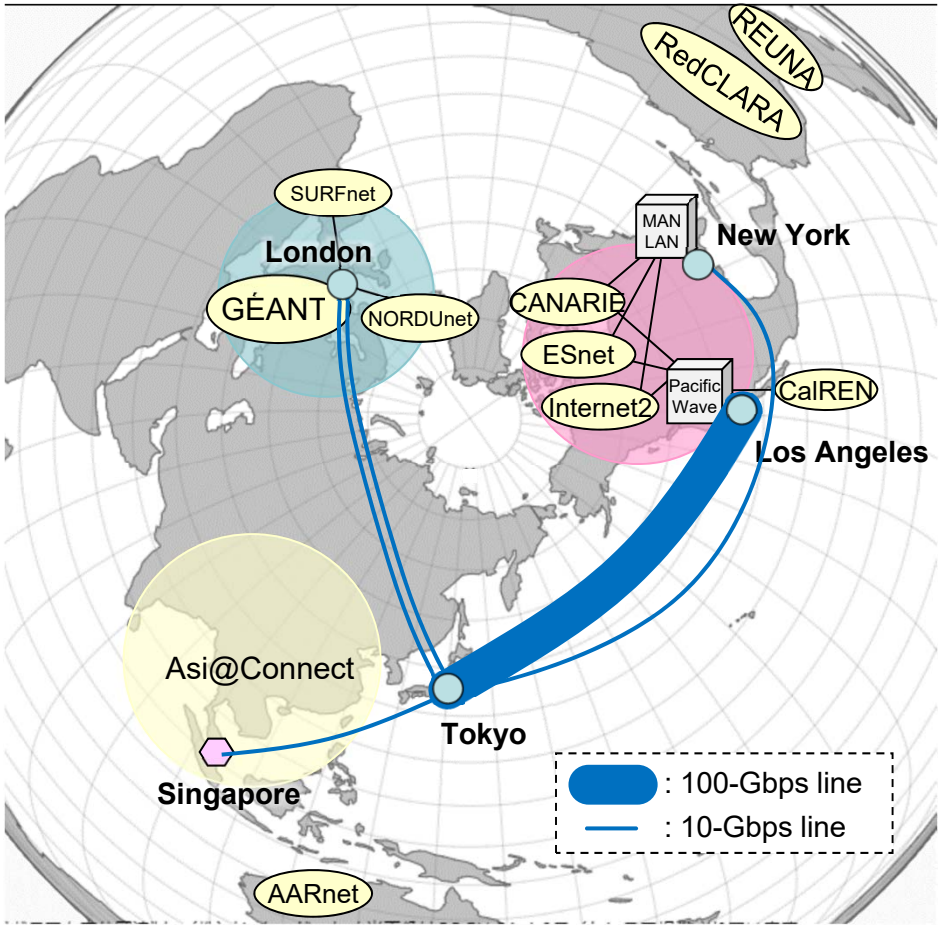
- Japan-Europe line, Japan-New York line (via Los Angeles), and Japan-Singapore line were upgraded to 100 Gbps in February or March 2019.
- NII is seeking resilient circuit architecture in collaboration with other NRENs.



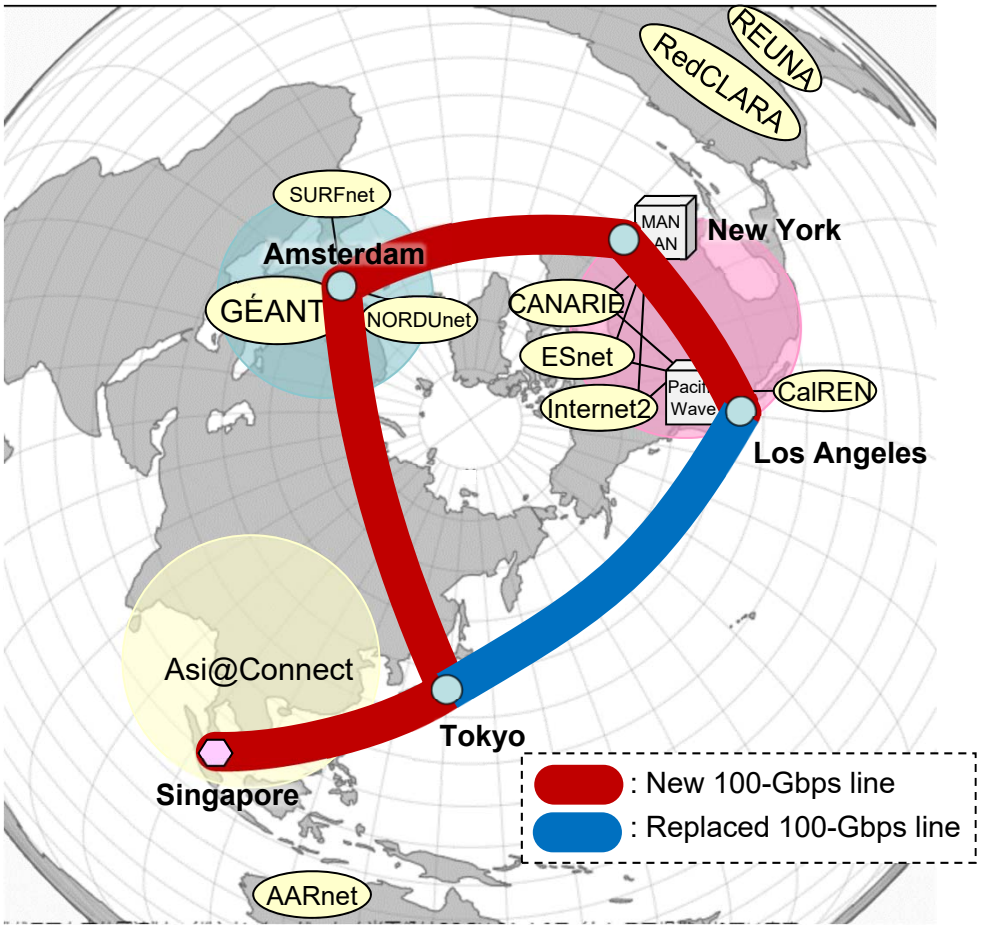
International Lines (North Pole View)

◆ 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

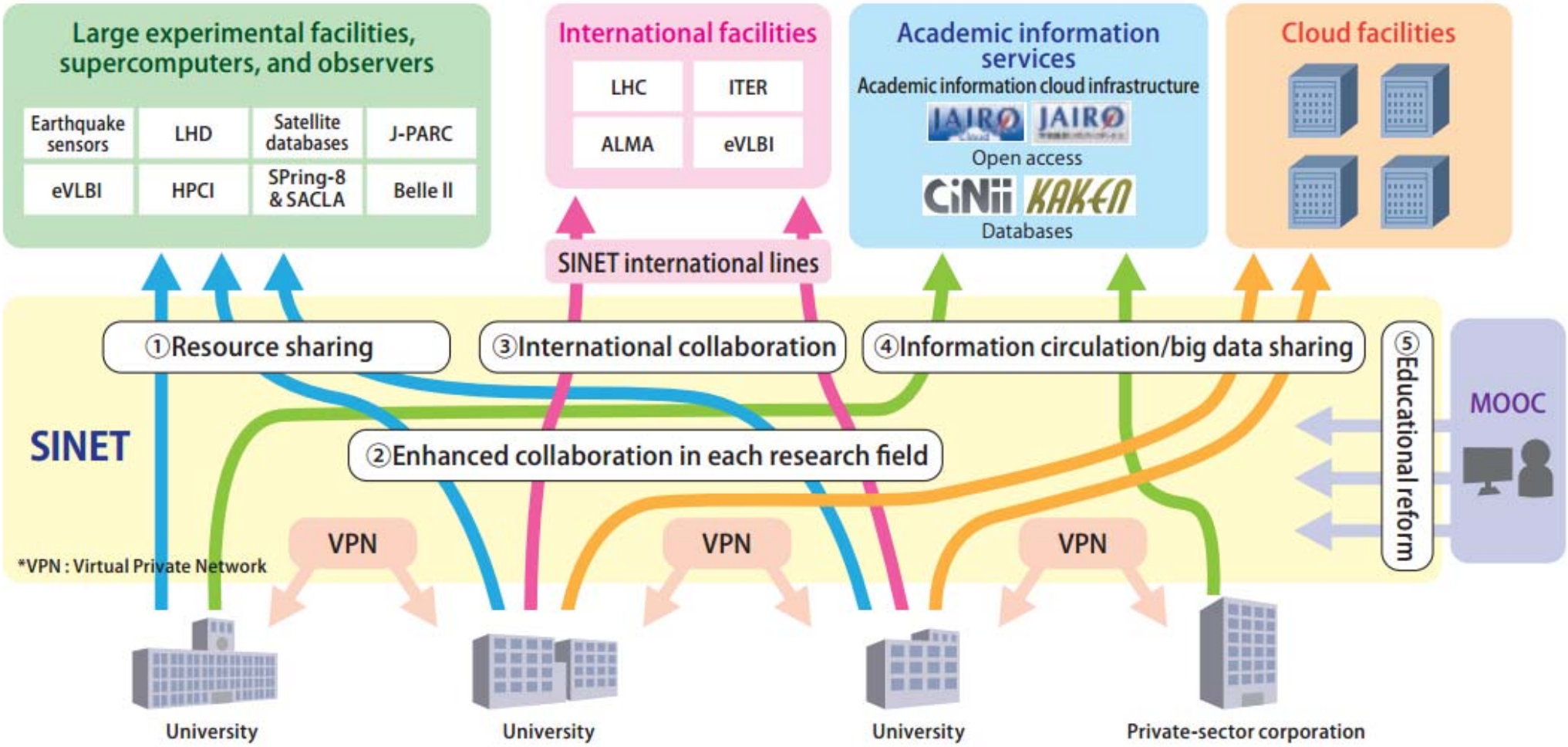


Until February 2019



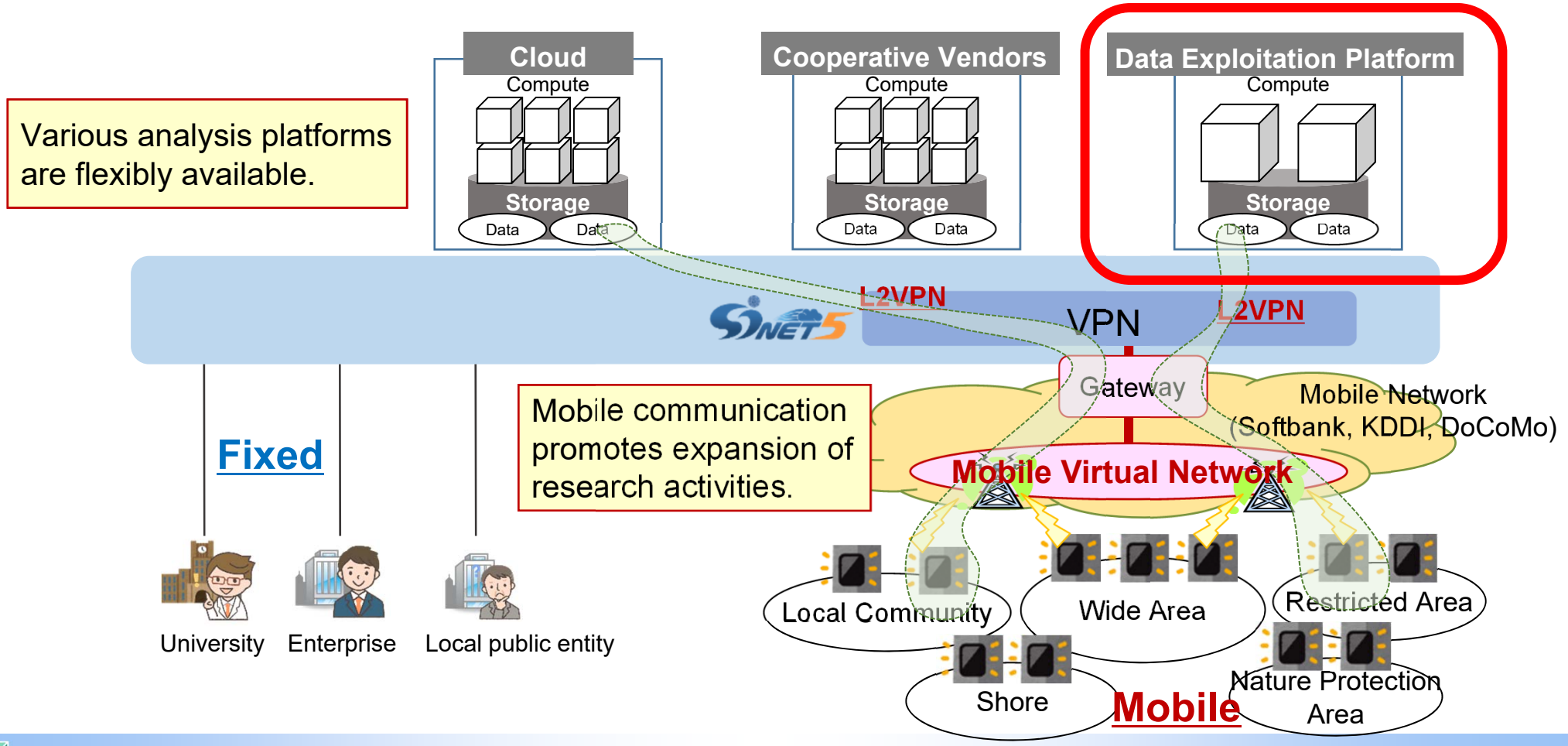
From March 2019

SINET and services



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



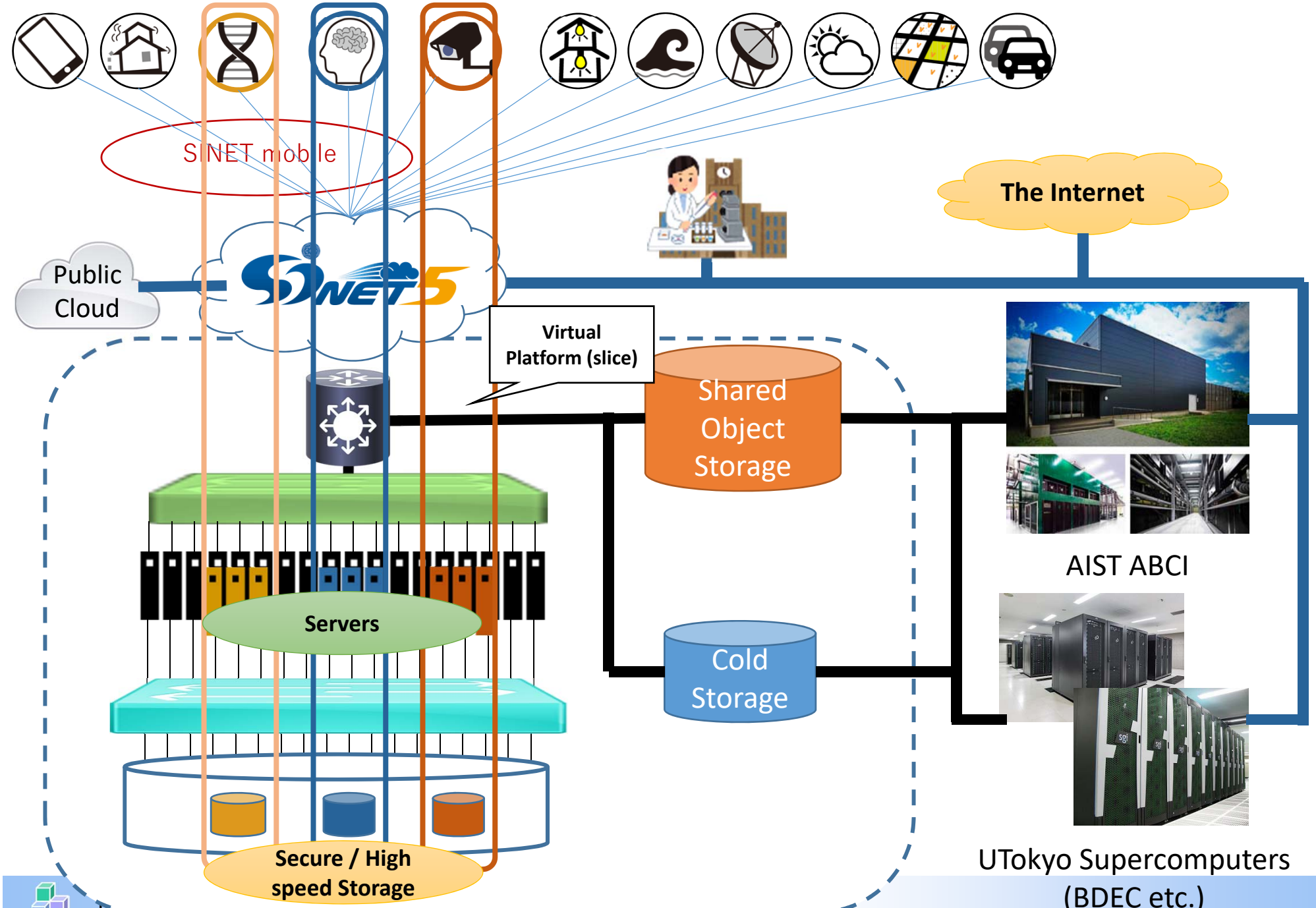
Data Exploitation Platform

Edited based on a slide provided by NII

Infrastructure of the Data Exploitation Platform

- **The infrastructure of the Data Exploitation Platform is more like a cloud (IaaS) spreading over wide area**
  - Network connecting data and IoT devices can be provisioned with compute and storage resources
- **The platform provides virtual infrastructure (slices) to users**
  - Users can use the provided infrastructure (slice) as if it is a dedicated infrastructure for the user.
  - A slice is isolated from the internet or other slices.
    - User can provision gateway(s) to outside on a slice

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)

UTokyo BDEC System

Apr. 2021 (or later)

40+ PF, 3.5-4.5 MW including Cooling

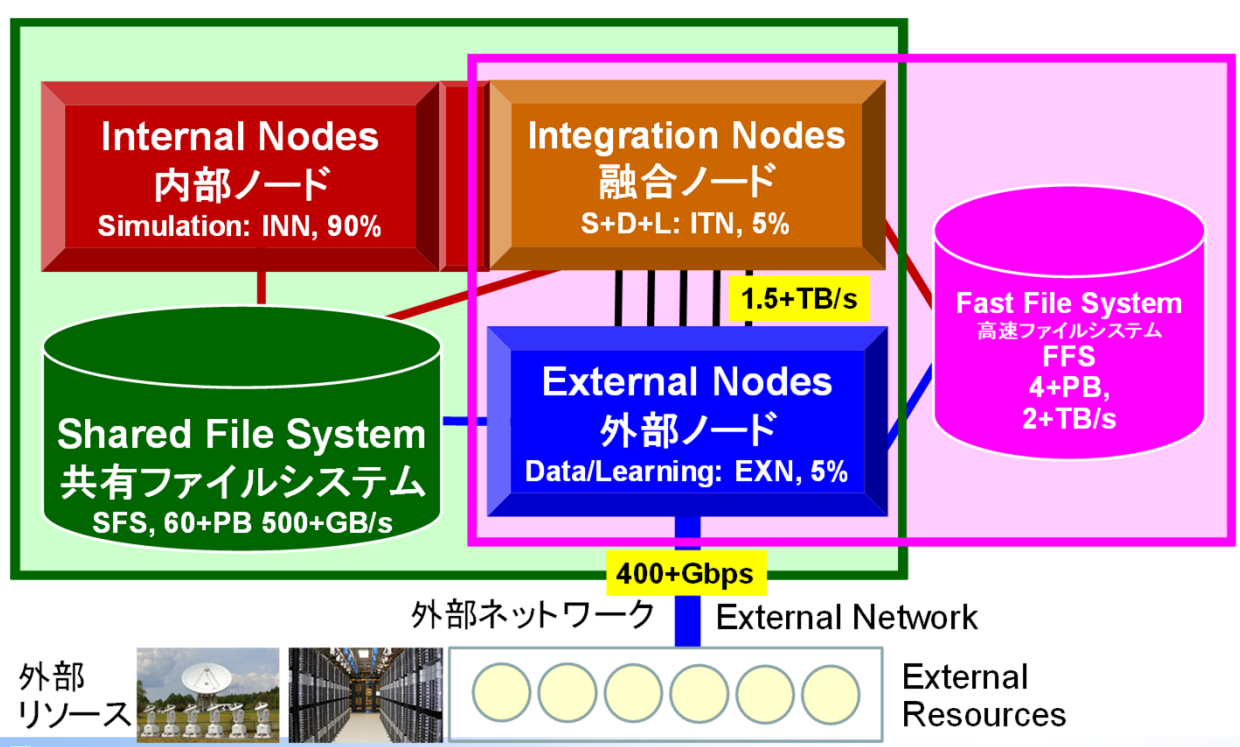
External Nodes for (Data + Learing) (EXN)

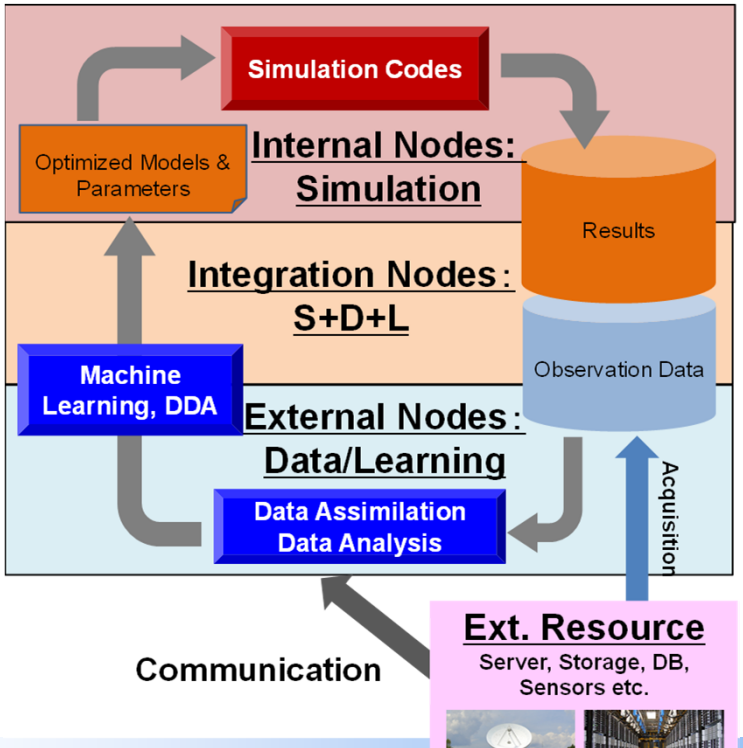
Internal Nodes for (Simulation) (INN) 50+PF, 6.3+PB/s

Integration Node for (S+D+L) (ITN)

Architecture of EXN could be different from that of (INN+ITN))

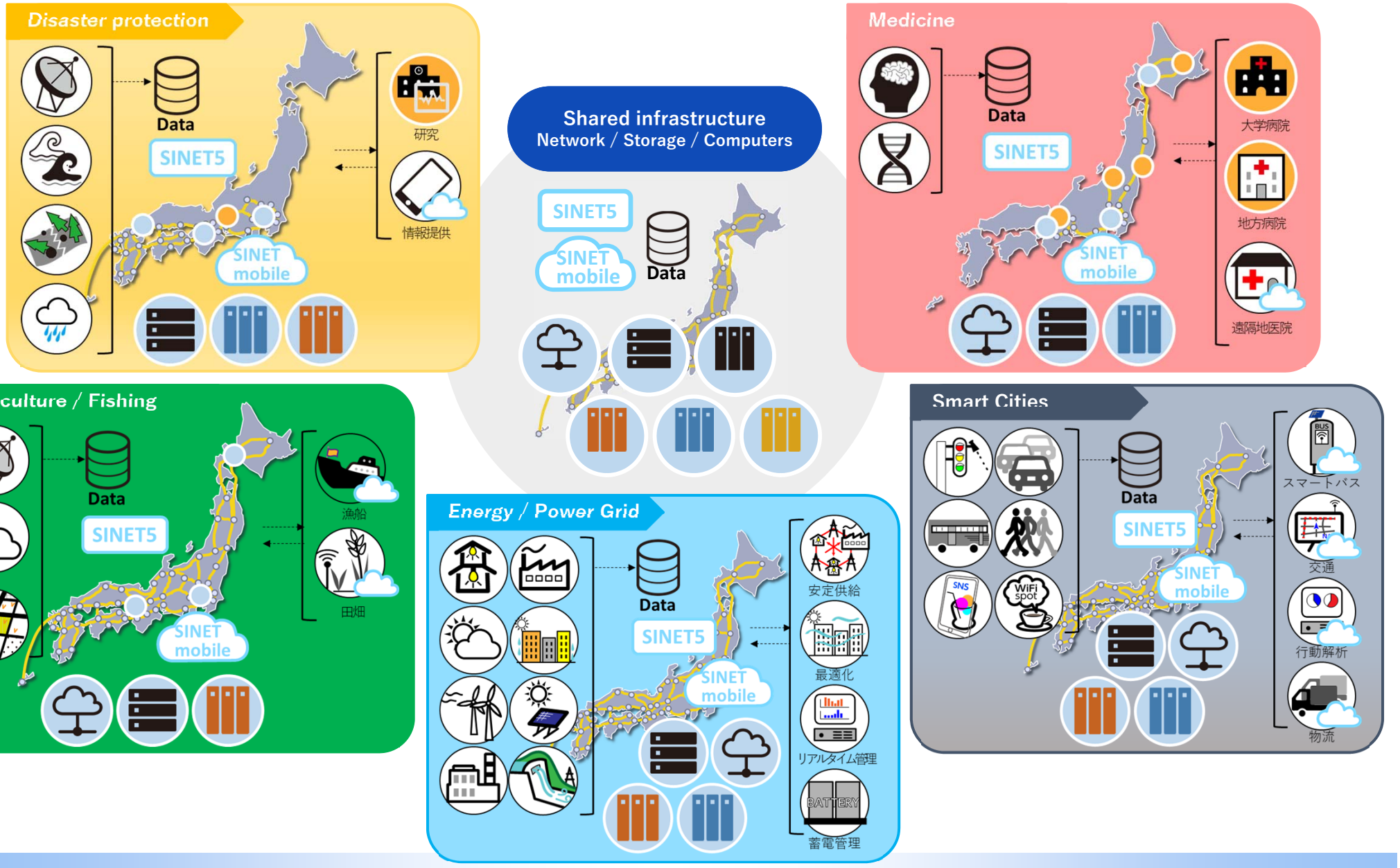
Shared File System (SFS) + Fast File System (FFS)





On-demand platform

Geographically distributed IaaS including network



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 kinds 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. Some not updated adequately.
- **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

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
- **Will be connected with UTokyo supercomputers such as BDEC**
- **The platform will be jointly operated by :**
  - Universities in Japan
  - NII (National Institute of Informatics)
  - AIST (National Institute of Advanced Industrial Science and Technology)

Overview of the infrastructure (1)

- **Compute Nodes**
  - the general purpose nodes (GP)
    - general purpose CPU nodes
  - the computation accelerator nodes (ACC)
    - FP64 focused accelerator nodes
  - the data analysis nodes (DA)
    - FP32/FP16 focused accelerator nodes
  - Virtual Machines (VM) and/or containers on all compute nodes
    - Users can run Linux or an Windows on VM/containers

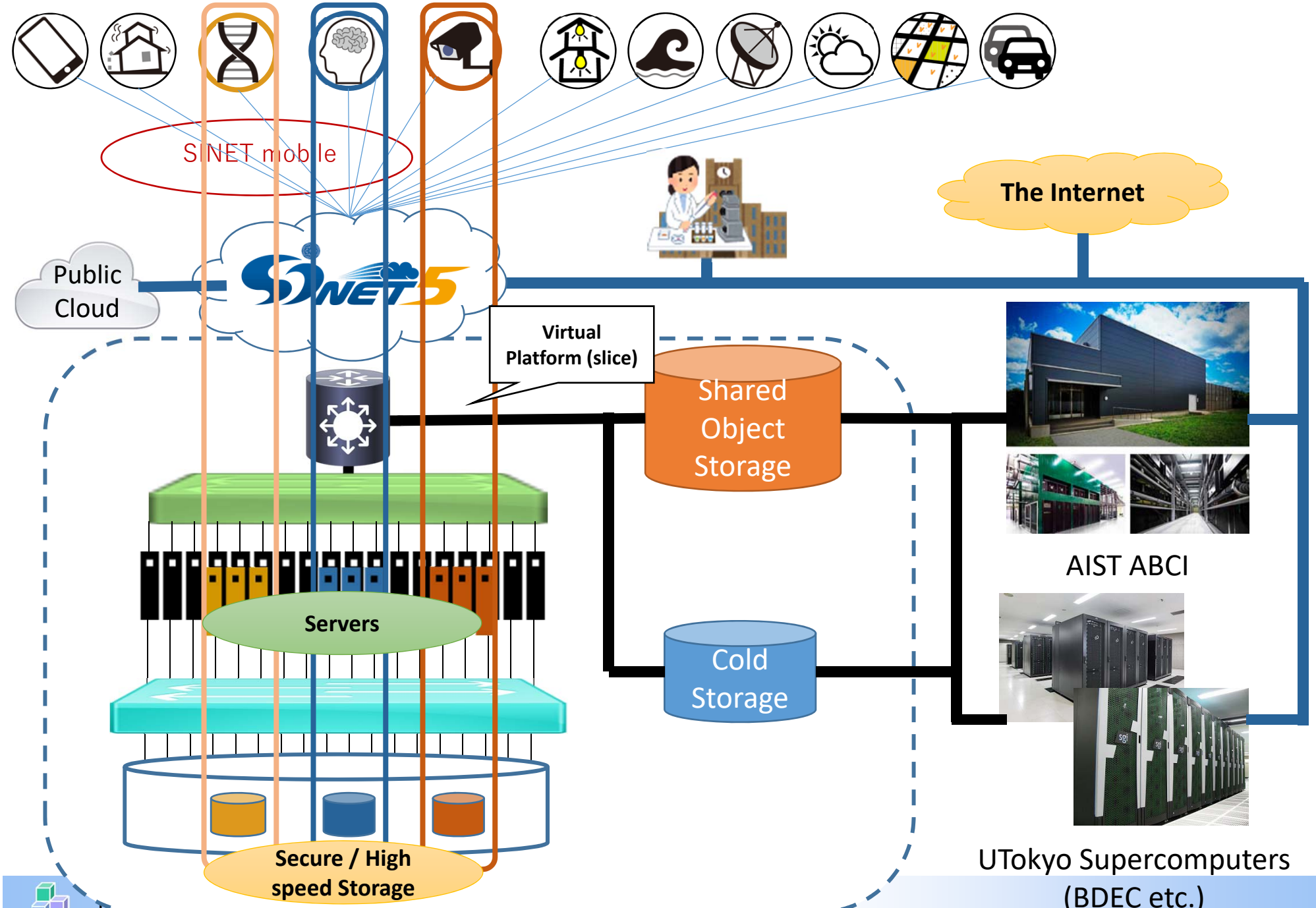
Overview of the infrastructure (2)

- **Storages**
  - High-speed internal storage
    - A set of high-speed internal storage nodes including NVMe SSD
    - Can restrict accesses from compute nodes. i.e. only specific computing nodes can access certain storage nodes.
  - Large-capacity internal storage
    - A set of large-capacity internal storage nodes
    - Also can restrict the access
  - Shared storage
    - An object storage compatible with Amazon S3
  - Cold storage
    - Magnetic tapes or optical disks. Provides storage service like Amazon Glacier to users.

Overview of the infrastructure (3)

- **Internal Network**
  - Spine-Leaf type Ethernet-based IP network.
  - The network can be configured to provide separate (isolated) networks
    - The switches are configured by (and only by) the management system.
- **Management software**
  - Resource management software which manages not only computing nodes but also storages and network
  - Should support isolation (separation) of slices by the network

Infrastructure of the Data Exploitation Platform



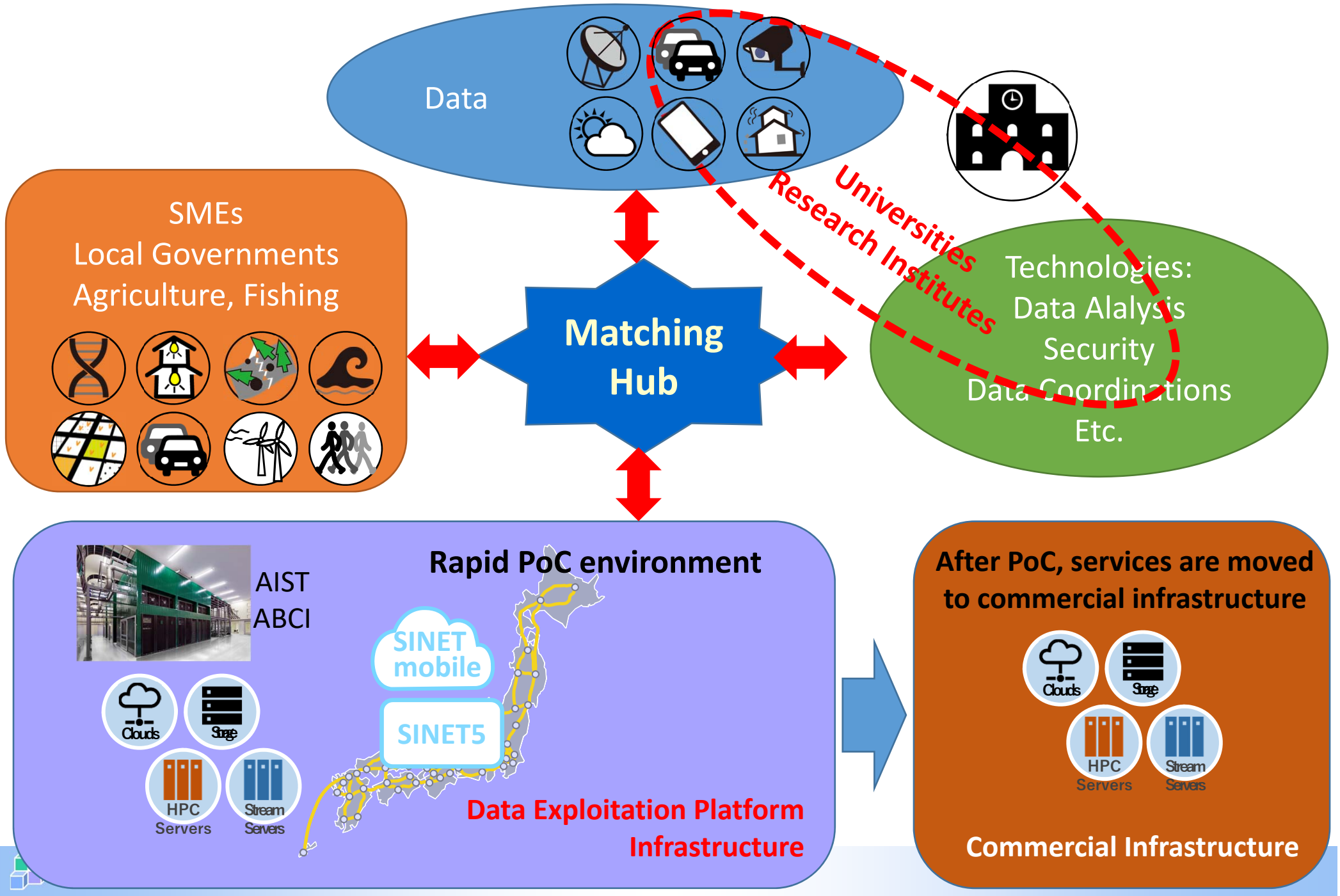
Challenges (1)

- **Support of real time (stream) processing**
  - Will be connected to a huge number of IoT devices directly
  - Receive all data and process immediately without loosing data is a challenge
- **Job scheduling**
  - Batch scheduling cannot be used for nodes which receive/send real time data
  - Batch scheduling is efficient for machine utilization
  - Need to combine long term assigned nodes/VMs with batch scheduled nodes to support jobs

Challenges (2)

- **Management software**
  - Wide area network, internal network, computing nodes, storages should be managed in a unified way.
  - Separation among slices should be supported.
  - Existing cloud management software (such as VMware, OpenStack, Kubernetes, etc. cannot satisfy all the requirements.
- **Operation**
  - Should be available when required.
    - Many AI people thinks it is hassle to use supercomputers.
- **Matching function**
  - So many challenges to implement ….
  - Need cooperation of researchers, universities' managements and data owners.

Overview of the Data Exploitation Platform



Core Pillars of the Data Exploitation platform

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.

Fusion of Data Science and Computational Science

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

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

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.
- **The platform can work as a “streaming data gathering infrastructure” for super computers such as ABCI or BDEC**
  - 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