S4D (Space for Development); Current achievements and Future Prospect

Ryosuke Shibasaki (CSIS, UT)

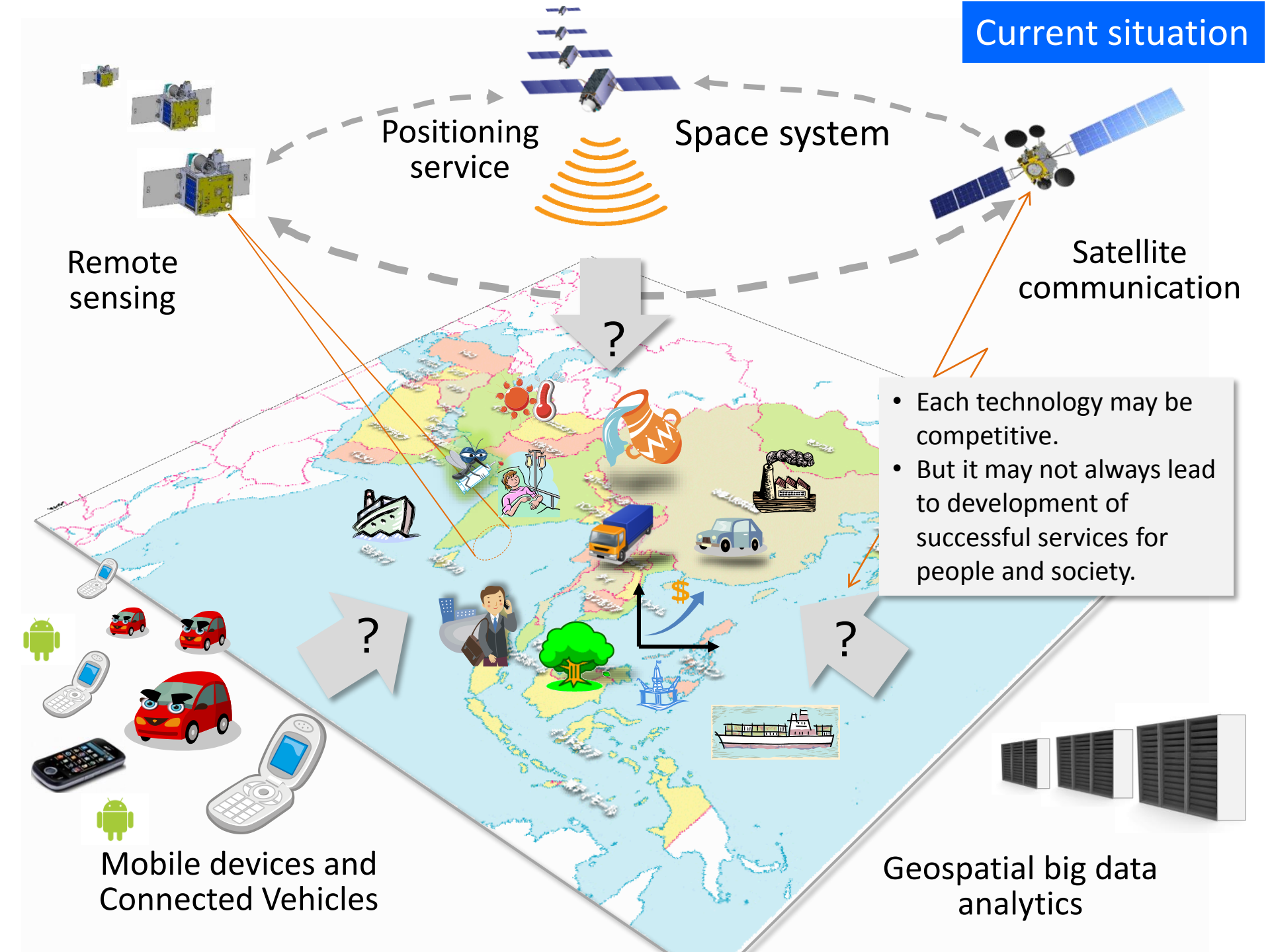
Outline of S4D Project

- Driving research and development of space and geospatial technology to contribute to social problem solving at global scale, by combining 1) infrastructure development of space information and geospatial services and 2) PPAP development.

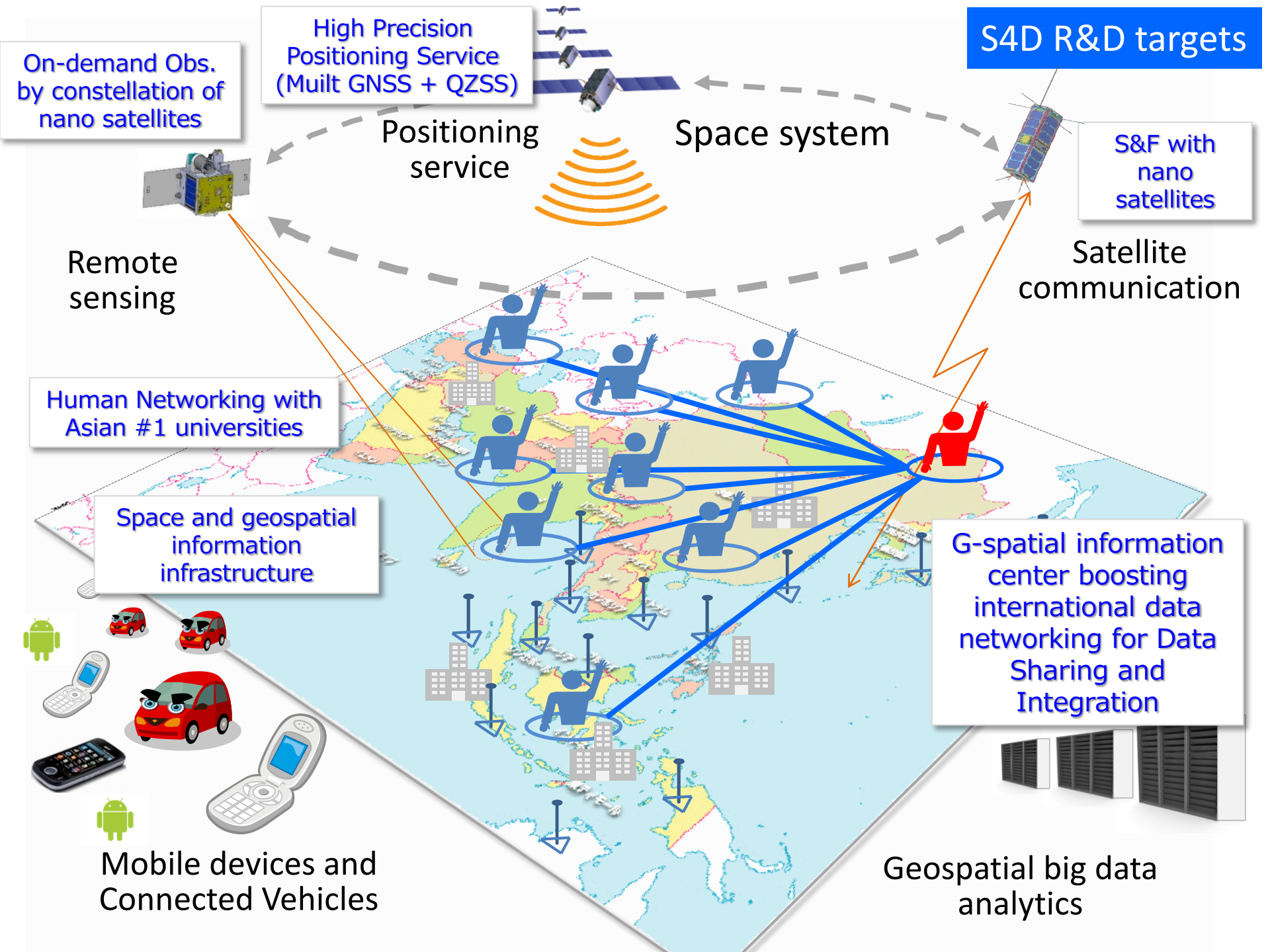
S4D project team
- Space technology group
  Prof.S. Nakasuka (Dept of Eng. UT)
- Geospatial techonology group
  Prof. R. Shibasaki (CSIS, UT)
- GNSS positioning service group
  A. Prof. N. Kubo (TUMST)

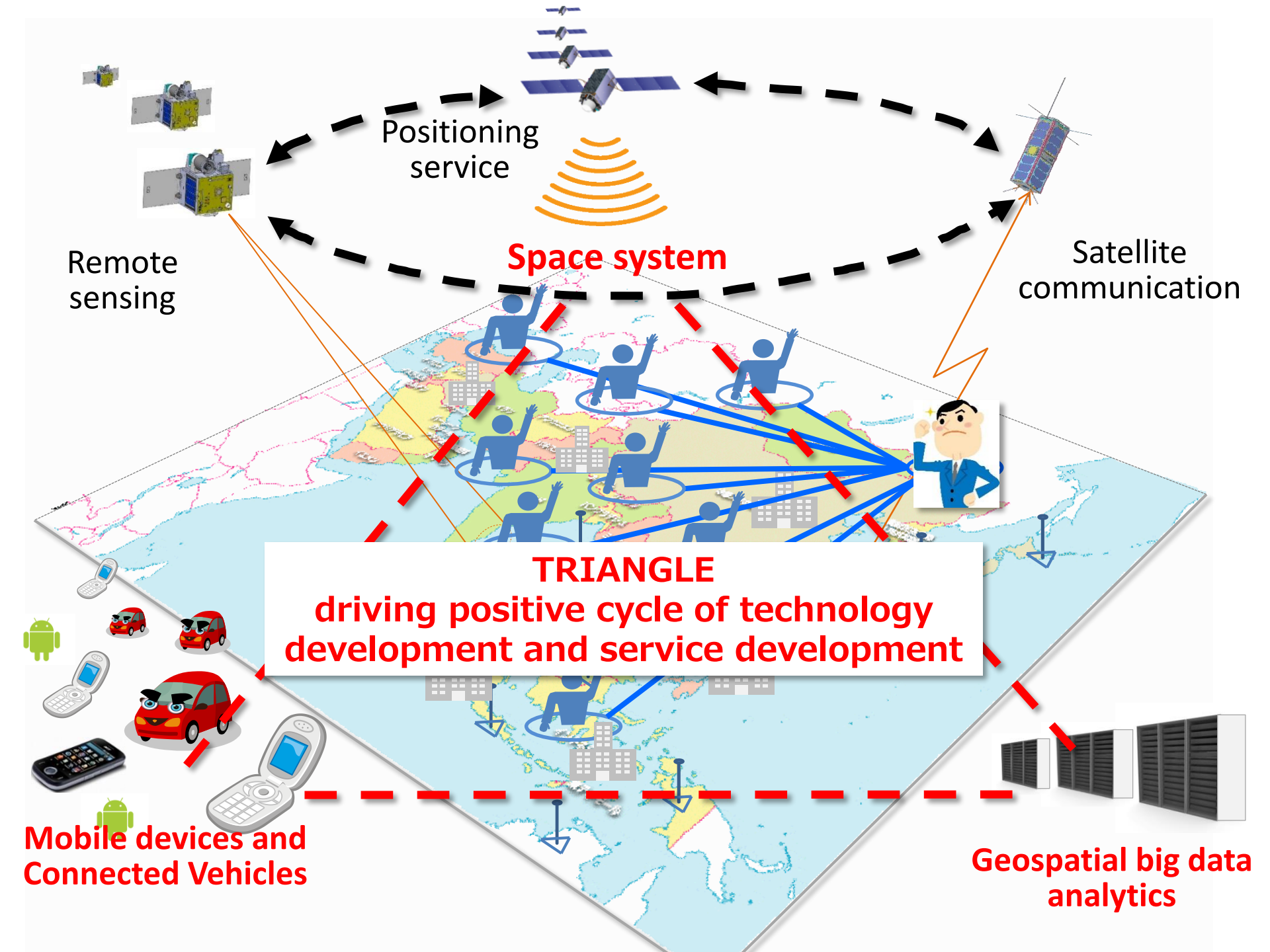
Collaboration with
- Cabinet Office
- Min. Land, Infrastructure and Transport
- Min. of Communication
- Min. of Economy, Trade and Industry
- Min of Education, Science and Technology
- Min. of Foreign Affairs etc

Current situation



- Each technology may be competitive.
- But it may not always lead to development of successful services for people and society.

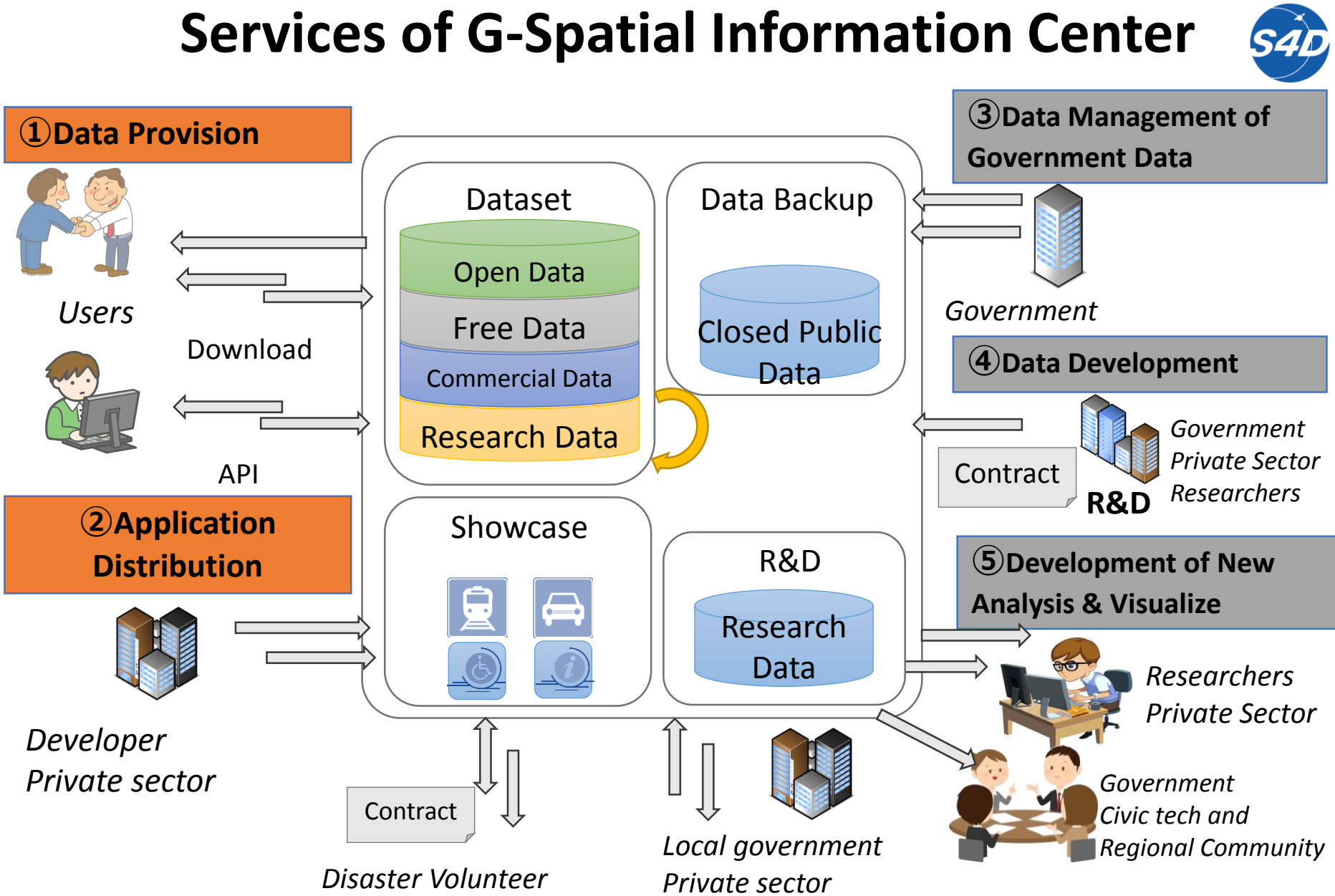

S4D R&D targets
High Precision Positioning Service (Muilt GNSS + QZSS)
On-demand Obs. by constellation of nano satellites
Positioning service
Space system
S&F with nano satellites
Remote sensing
Satellite communication
Human Networking with Asian #1 universities
Space and geospatial information infrastructure
G-spatial information center boosting international data networking for Data Sharing and Integration
Mobile devices and Connected Vehicles
Geospatial big data analytics


Positioning service
Space system
Remote sensing
Satellite communication
TRIANGLE
driving positive cycle of technology development and service development
Mobile devices and Connected Vehicles
Geospatial big data analytics

In Summary, we aim to ・・・

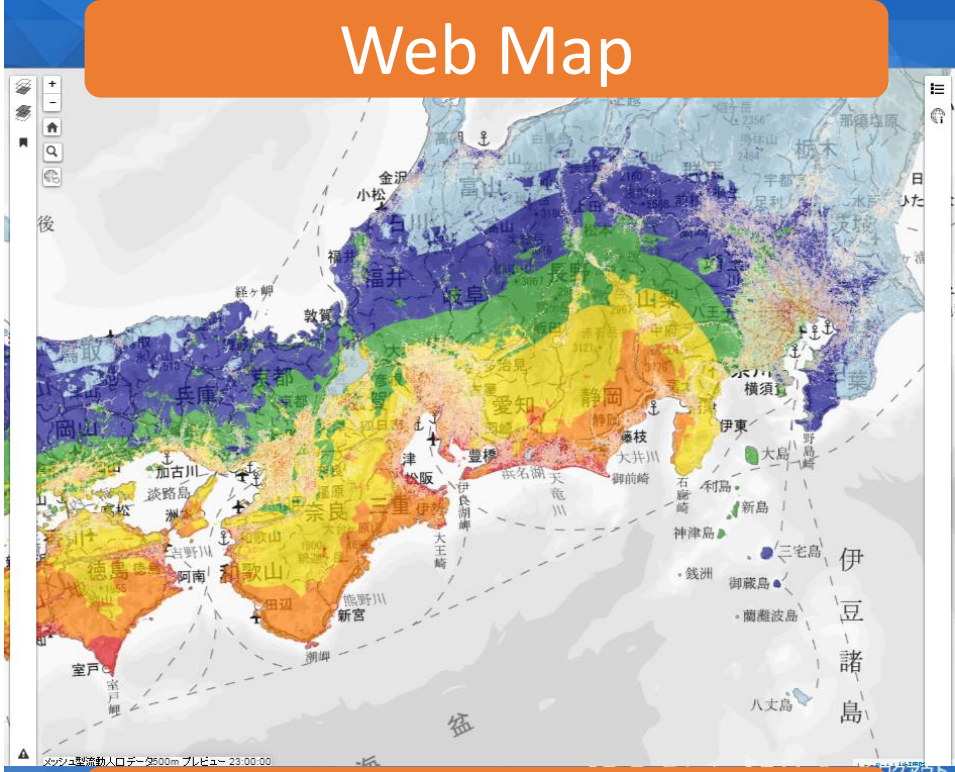
1. Provide information/data and platforms related to Space as an open community, e.g.
   - ✓Satellite monitoring and communication services through nano-satellites
   - ✓Positioning services
   - ✓Data analysis services and GIS data development as supplement data for the data analysis
2. Build global networks and communities to link Japan and Asian countries
3. Facilitate the creation of new business opportunities
4. Strengthen technical competitiveness through technology development and R&D projects

Services of G-Spatial Information Center

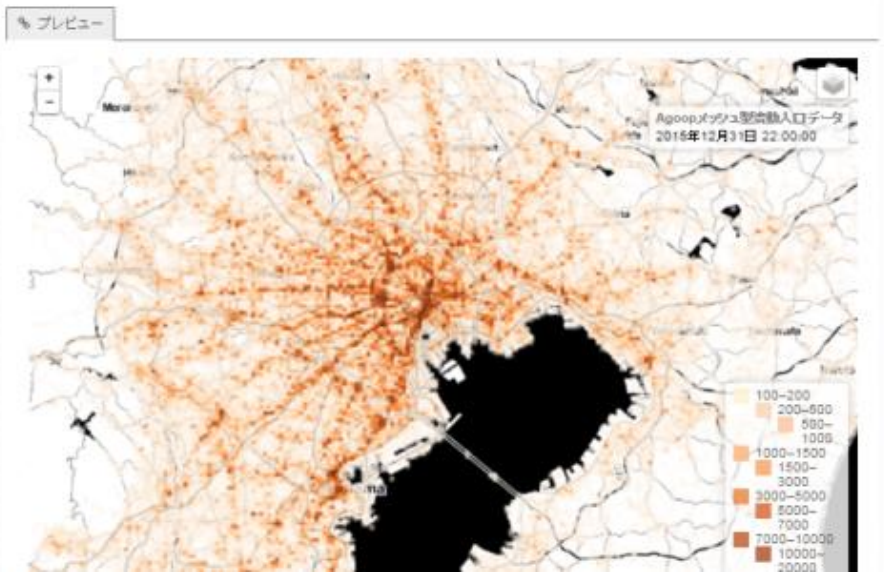


Data Search

Web Map



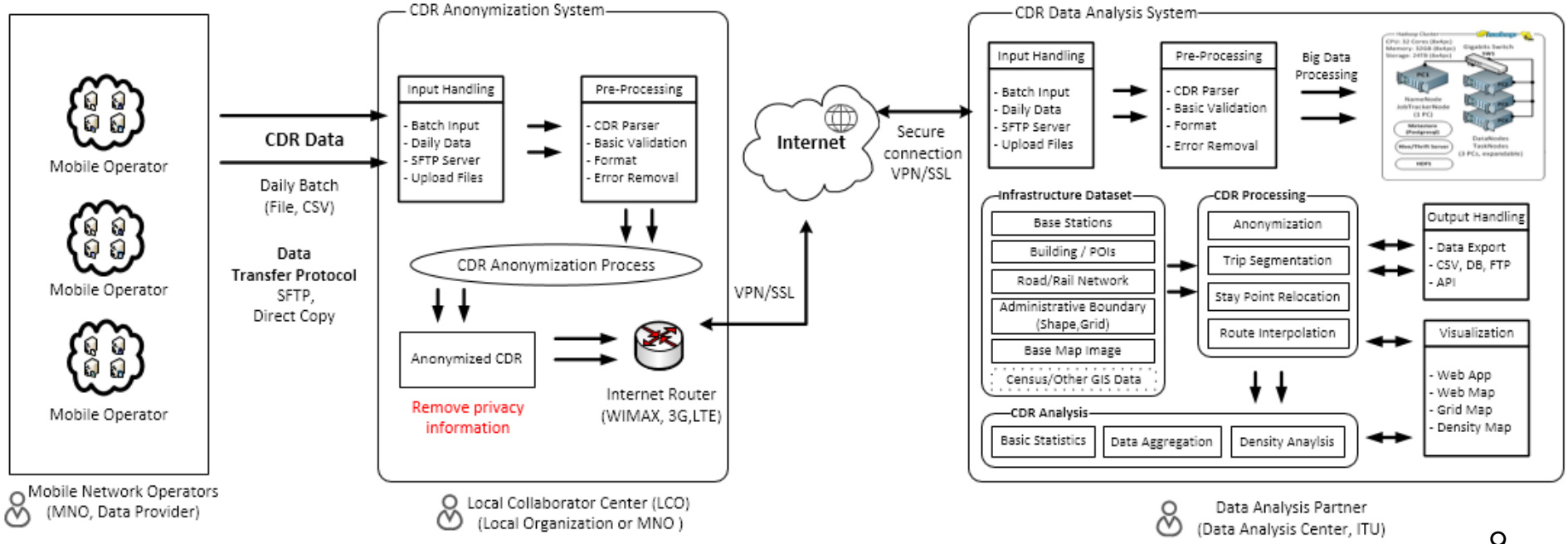
Time-Space Data Preview



Data Purchase

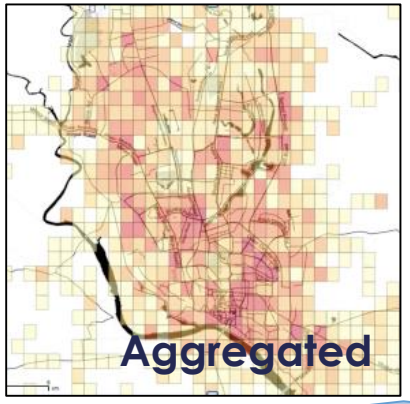
CDR (Call Detail Record) data analysis system

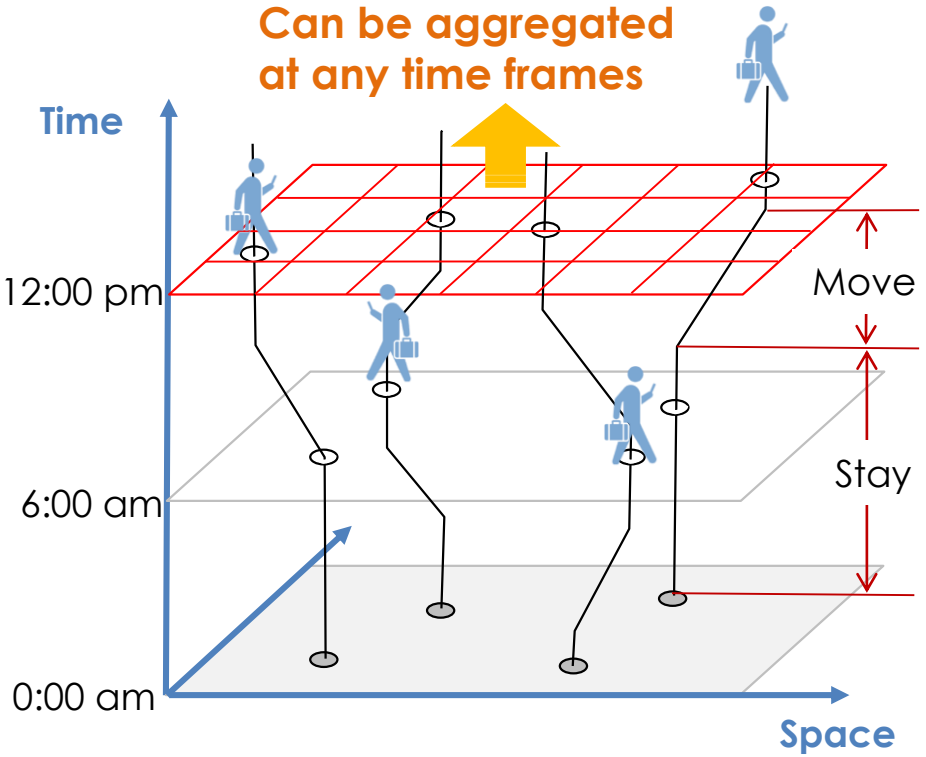
- System has already been developed and a cloud system is being developed
- Input data are CDR data and some others, which depend on the output requirement
- The system structure is flexible for adding data analysis modules upon the output requirement



Use case: Dynamic Census

Human mobility dataset of actual nationwide population labeled with demographic attributes

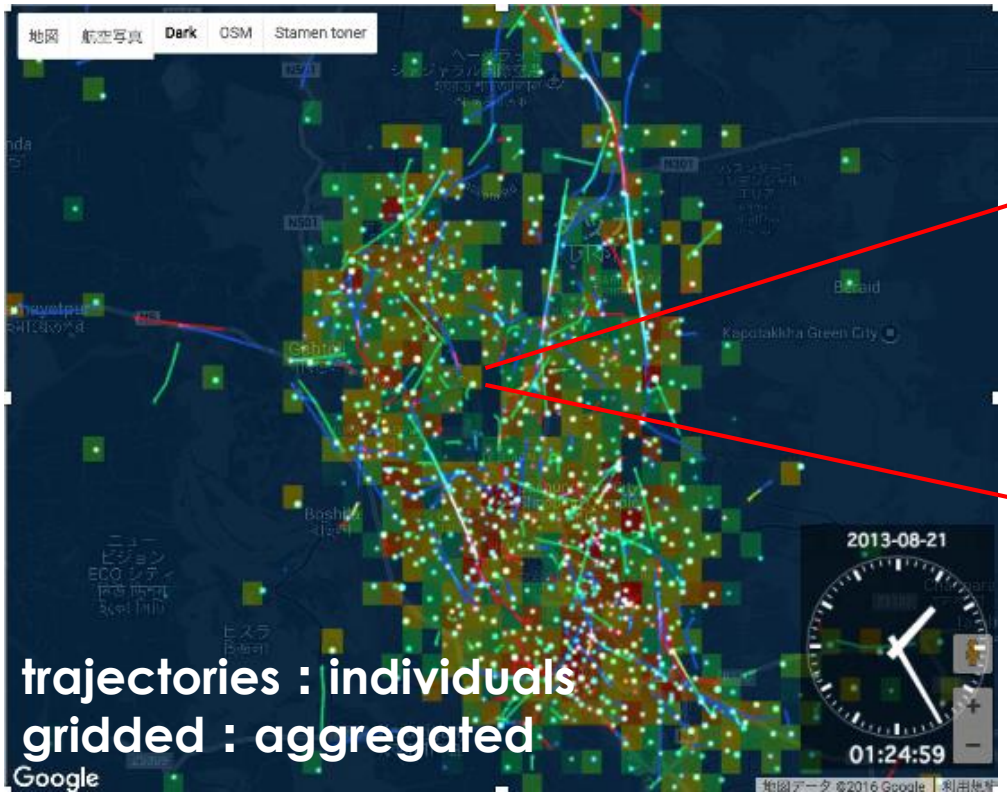




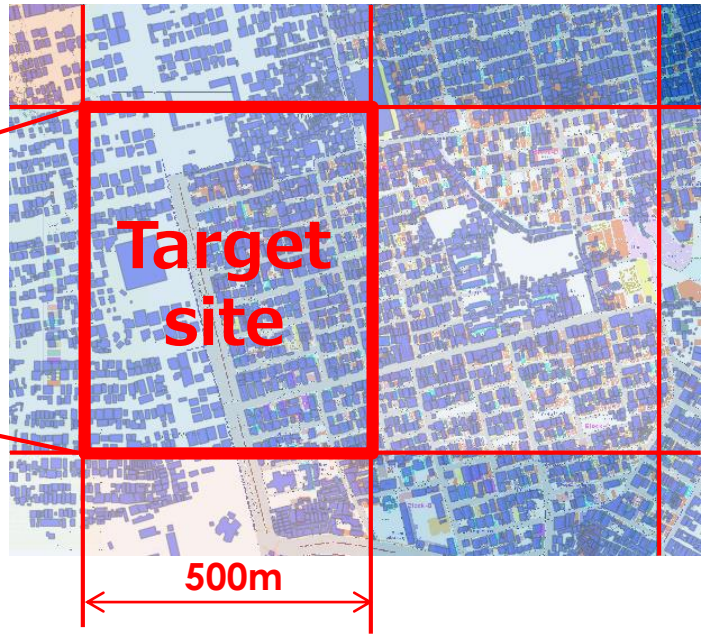
Minimum data inputs

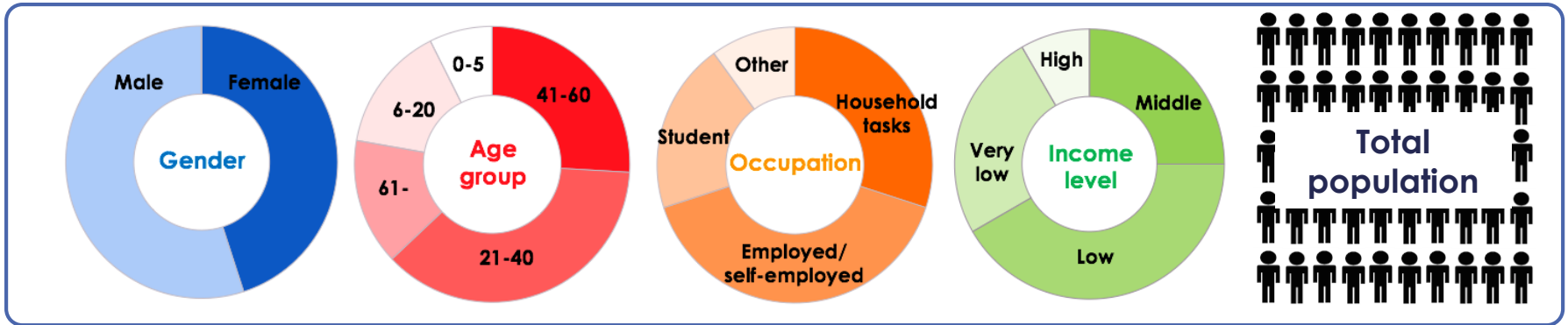
Strong advantage under data scarce environment

STATISTICAL DATA EXTRACTED FROM DYNAMIC CENSUS



※ Validated using transportation survey data





What Dynamic Census can contribute to

Goal 11: Make cities inclusive, safe, resilient and sustainable

To be funded by GPSDD (WB, UNF. etc.) as a pilot project for monitoring achievements of SDGs' Goal 11.1 and 11.2

CDR projects in next years

Bangladesh

Local partner: BUET

Establishing CDR data analysis center in Dhaka

Sri Lanka*

Local partner: LIRNEasia (think tank)

Engaged in collaborative research

Mozambique*

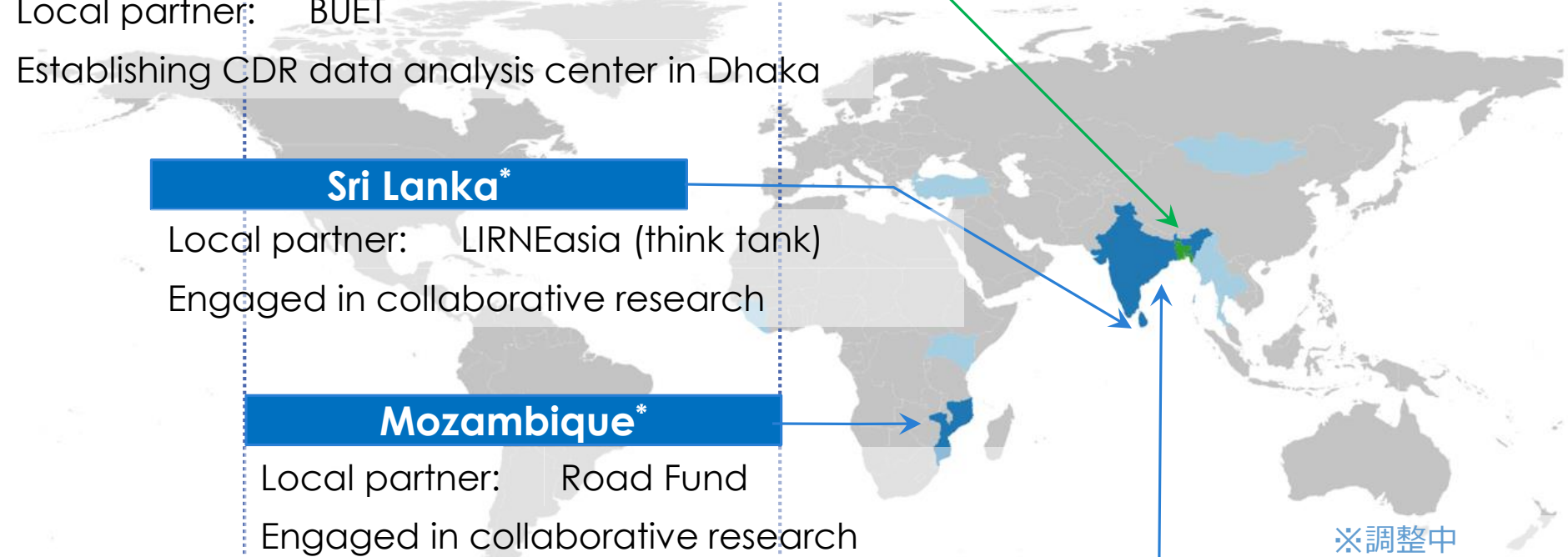
Local partner: Road Fund

Engaged in collaborative research

India

Local partner: OneForAll Labs Co.,Ltd.

Preparing for collaborative research



※調整中

West Africa
Myanmar
Turkey
Thailand
Mongolia
Uganda
Kenya

FY2016 FY2017 FY2018

Development of Automated Mapping Systems

High-res. images from Google/Bing Maps

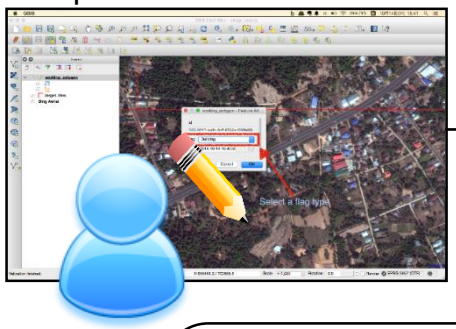
Georeferenced image management

Process by 256 x 256 image tile

Automated building extraction using deep learning

High-Performance Computing Systems (CPU/GPU)

Visual interpretation of buildings on WebGIS/QGIS for sampled extents



Training data for sampled extents

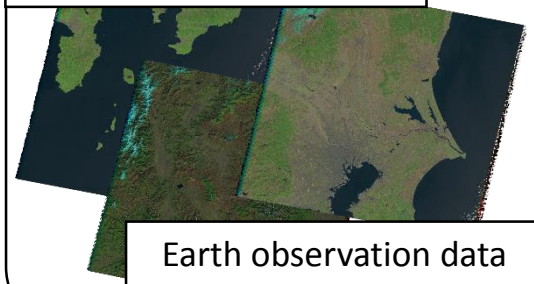
Automated mapping

Next Steps:

1. On-demand system supporting **global coverage**.
2. **Quality assessment** methodology and systems for better data products.
3. Extension to other ground features, e.g. **roads, cars**, etc.

Development of Time-Series Human Settlement Mapping System

Landsat archives @USGS



Earth observation data of 30-m res. since 1984

Coarse-scale data

Data Processing on DIAS

Automated mapping by machine learning

Settlement maps

1990

2000

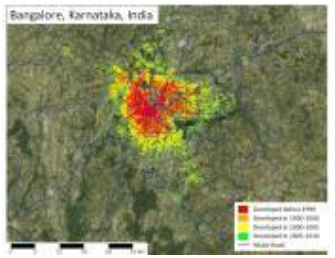
2005

2010

… and more on demand!

Data Products on demand

Guanzhou City, Guangdong Province, PRC



Next Steps:

1. Web-based on-demand data processing system.
2. Applications for ADB's projects and operations.
3. Integration with other satellite data archives, e.g. ASTER, Hodoyoshi satellites.

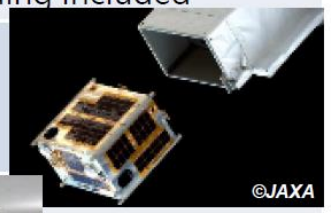
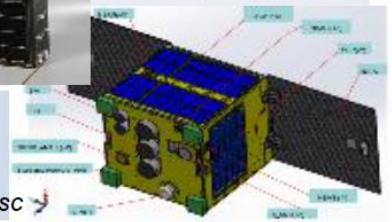
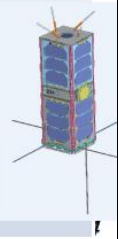
Data Users

The World Bank

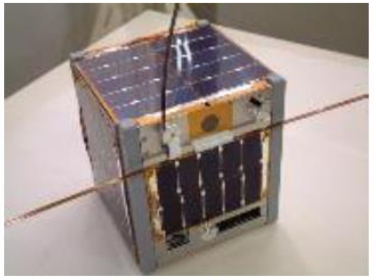
Asian Development Bank (ADB)

Example of Collaborations and Capability Building

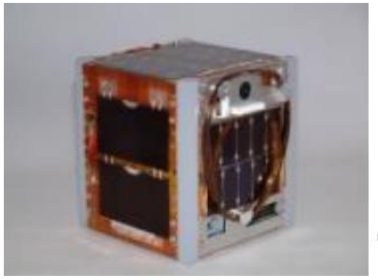
- Many Countries collaborate with Japanese government, agencies, universities and industries and building capabilities

	Country	Japanese Partner	Launch	
PicoDragon	Vietnam (Vietnam National Satellite Center)	JAXA,IHI, Univ. of Tokyo	2013	 ©VNSC  ©MELCO
Turksat-4	Turkey (Turksat)	JAXA, MELCO	2014,15	Capability Building Included
Diwata-1	Philippines (Department of Science and Tech., Philippine Univ)	Tohoku Univ. Hokkaido Univ.	2016	 ©JAXA
UBAKUSAT	Turkey (Istanbul Technical University)	JSF, Kyushu Institute of Technology	2017	 ©DIRECTORATE GENERAL OF AERONAUTICS AND SPACE TECHNOLOGIES, Turkey
Micro Dragon	Vietnam (Vietnam National Satellite Center)	Univ. of Tokyo Keio Univ. etc.	2018	 ©VNSC
UNISEC-Global	Many (14 authorized, 34 prepared)	UNISEC	Under discussion	Store & Forward or other collaborative missions 
Lotus-1/2	Vietnam (Vietnam National Satellite Center)	METI	Planned	 ©VNSC

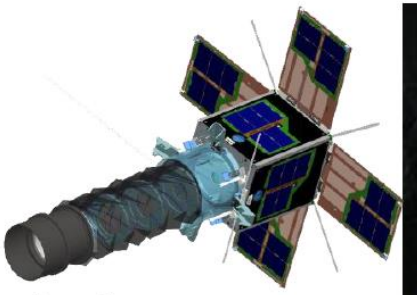
Univ. of Tokyo Small Sats (9 Developed, 8 Launched)



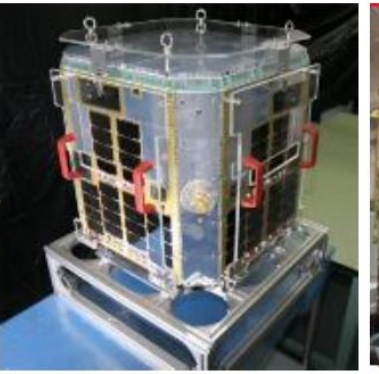
World 1st 1kg Sat
XI-IV(2003)



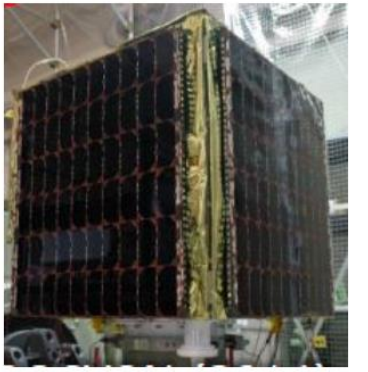
Tech Demo
XI-V(2005)



8kg for 30m GSD
PRISM(2009)



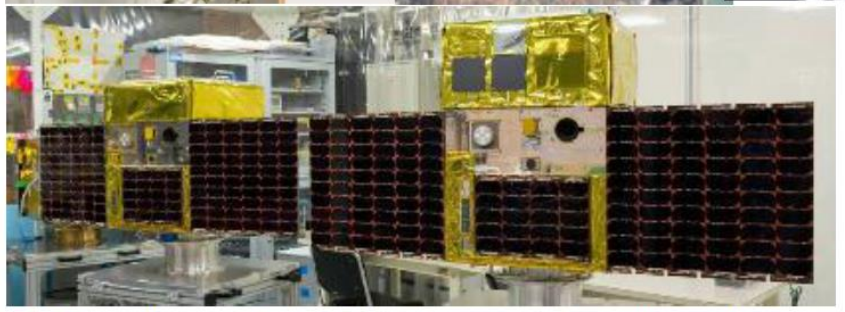
State of the Art
Space Science
Nano-JASMINE
(Waiting for launch)



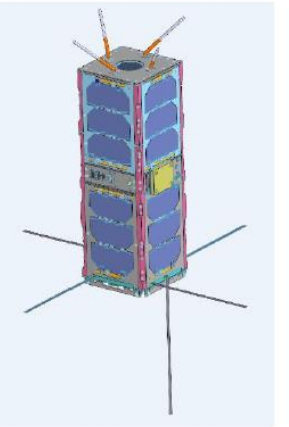
World 1st Deep
Space Small Sat
PROCYON(2014)

6mGSD
(Chiba JPN)

Wide
(Sri Lanka)

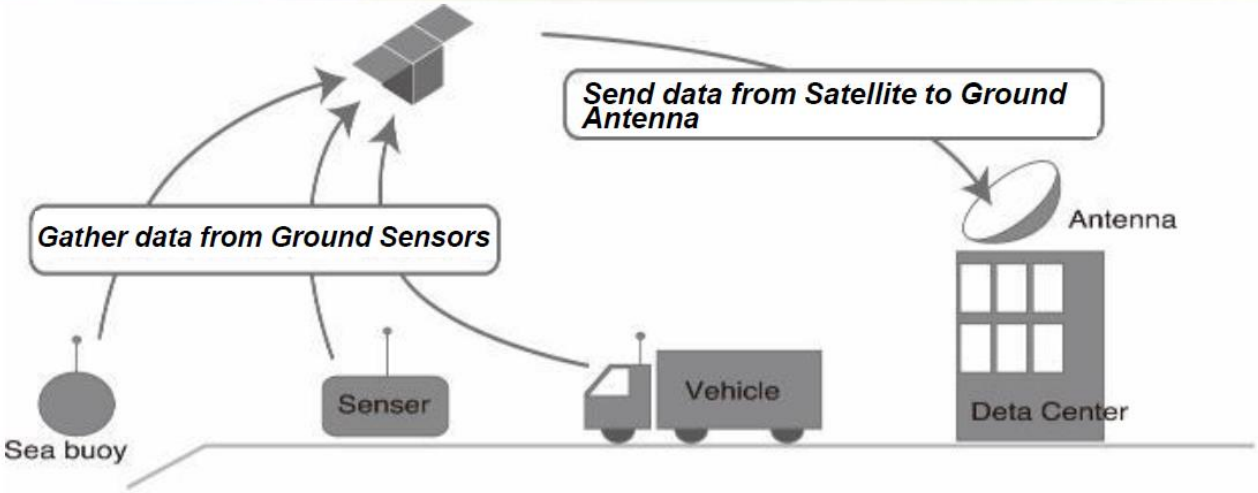


60kg class 6mGSD (2years for development)
Hodoyoshi-1 Hodoyoshi 3/4(launched in 2014)



S&F satellite TRICOM-1 (Jan 2017)

Stored & Forward



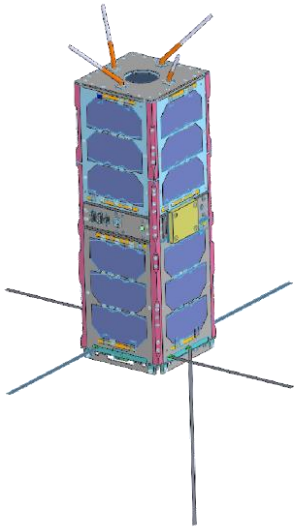
- Ground or buy sensors to measure, satellites to collect data that downlinked to ground stations at low bit rate
- UNISEC-Global is now proposing to build a constellation of cubesats for the mission. Each country/university can contribute with their own satellite and get frequent access of sensor data through the constellation
- Key is 'what to measure'
  - Water quality, water level, soil, environment(CO2, gas), car velocity(traffic jam), ship route(oceanic current), ground movement(earthquake)
  - Competitive where no mobile infrastructure, dangerous areas, etc.

Utilization of Nano Satellite

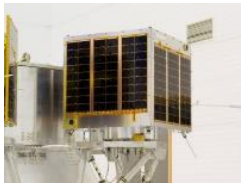
- **Store & Forward**
  - TriCOM-1, 3U CubeSat (University of Tokyo) to be launched in January 2017
  - Weak signal reception is tested within 1 month life time
  - Data transmission test from Laos is planned
- **Earth Observation by Nano-Satellites**
  - Hodoyoshi-1/3/4 is be used
  - Taking images for Laos

Receiver Module

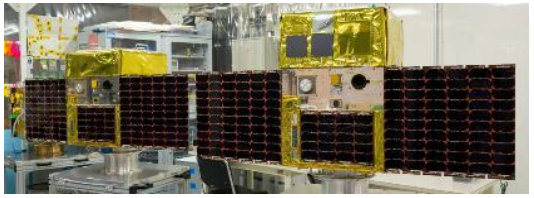
Transmitter on the Ground



TriCom-1



Hodoyoshi-1



Hodoyoshi-3&4

Obtained Images by Hodoyoshi-1 (6.7mGSD)

Epidemic Area of Malaria 12/26/'16

Example of Urban Area (Canberra) 12/13/'16

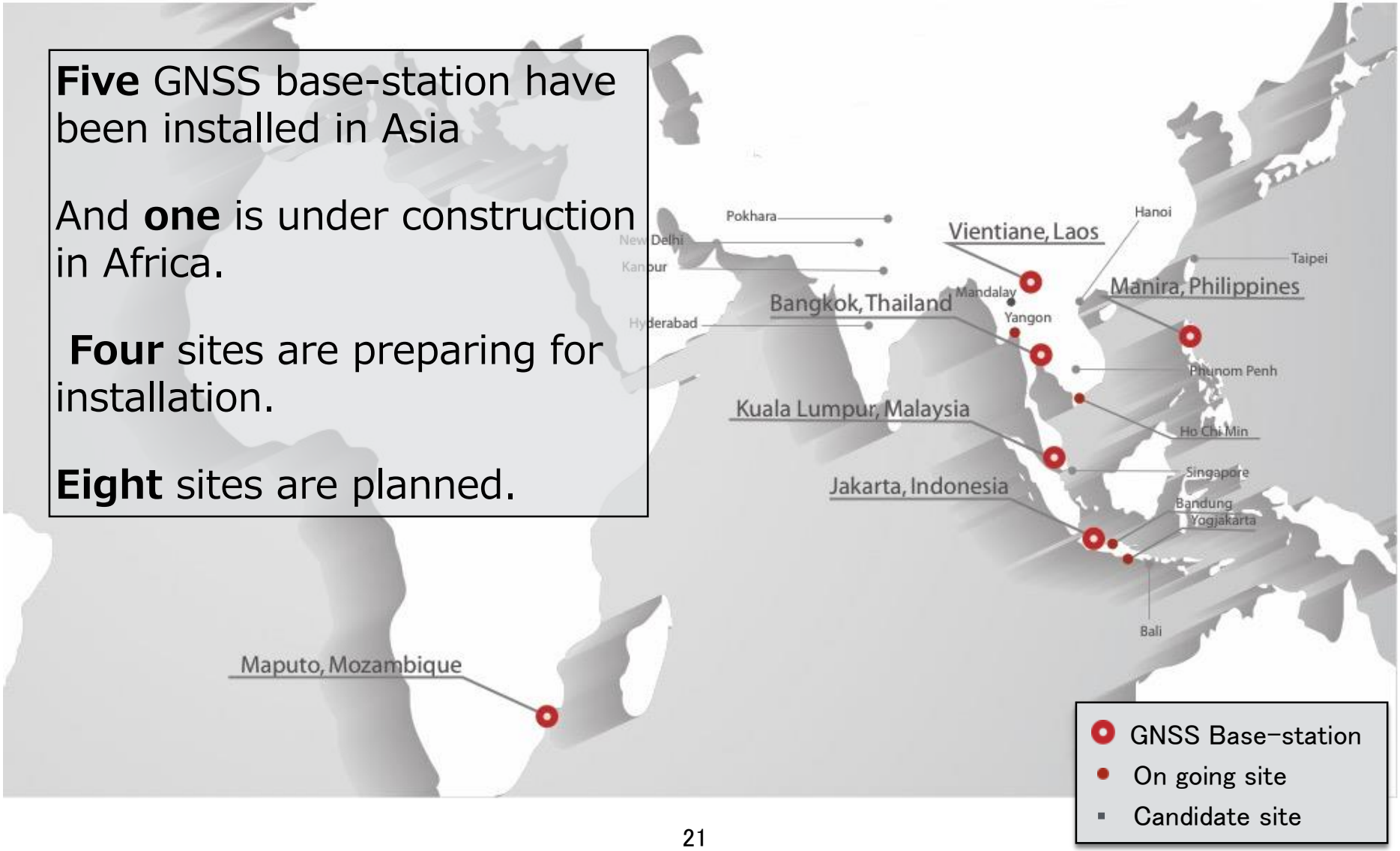
GNSS base station network expanding!

Five GNSS base-station have been installed in Asia

And **one** is under construction in Africa.

Four sites are preparing for installation.

Eight sites are planned.



もちろん、国内も・・・・

Very-Cheap RTK GNSS Receiver

- GNSS Receiver: u-blox M8T US $80
- GNSS Antenna US $30
- RaspberryPi Computer US $50
- Battery Pack US $50
- Data Modem As per use base

Internal seminars

- Held every two to three weeks (9 seminars, 18 speakers)
- 15 to 25 participants per seminar from 26 partners
- Topics are on technologies, policies, practices, and international trend in GIS, remote sensing, positioning systems, space systems, etc.