



CubeSat-Based Low-Cost Communication Network and its Utilisation for Capacity Building in Developing Countries

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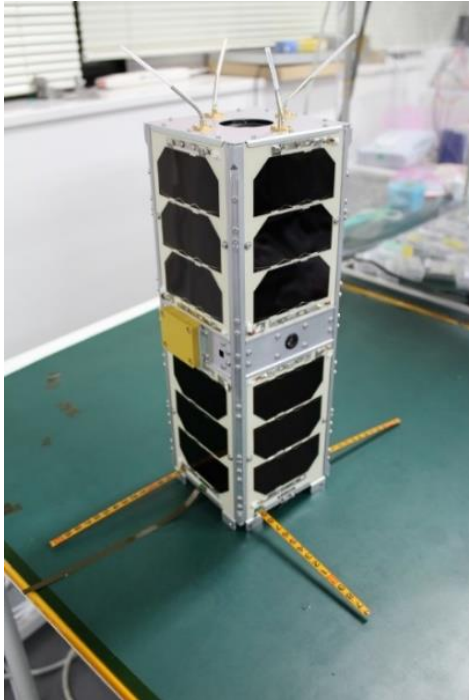
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Intelligent Space Systems Laboratory, Department of Aeronautics and Astronautics, The University of
Tokyo, Japan

Back Ground: Forester, Conservation & Rural Development Projects



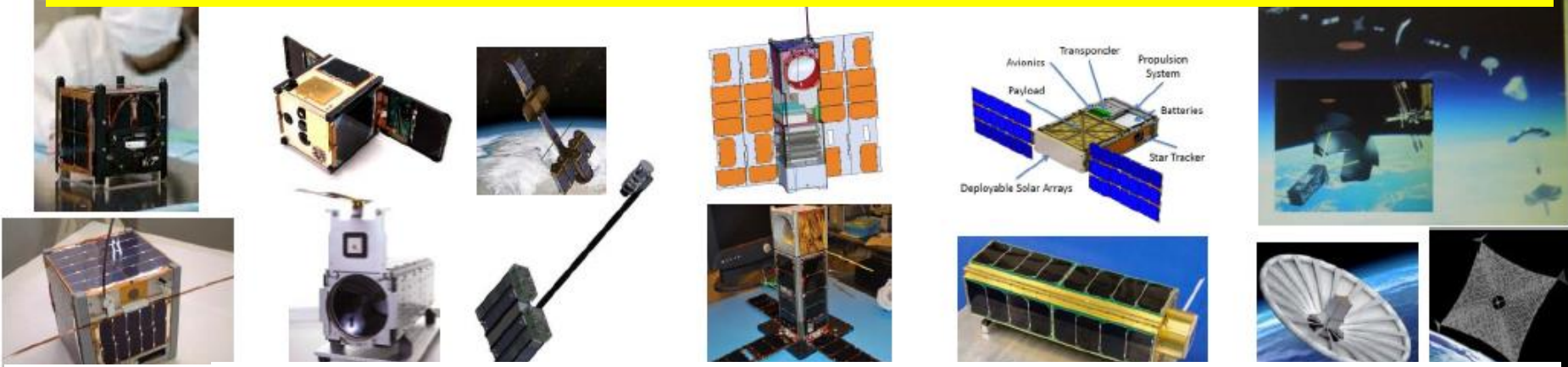
LEAN SPACE technologies and Spatial Information Science make it possible for all developing countries to LEAPFROG towards the accomplishment of SDGs.



▶ LEAN SATELLITE / CUBESAT

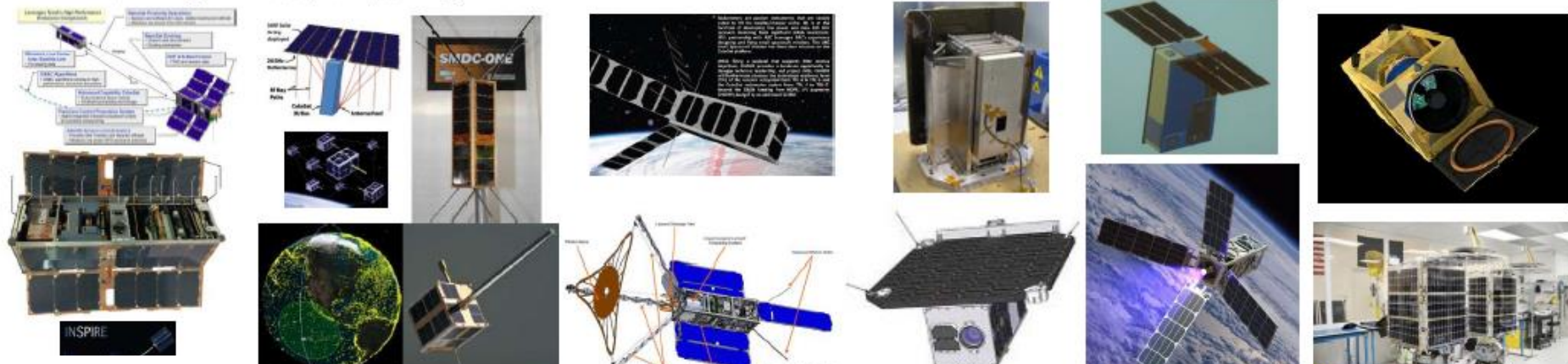


Innovative utilizations of Micro/nano/pico satellites(<100kg)



Education Remote sensing Telescope Weather Bio-engineering Re-entry

OPUSAT (1U: 1kg) AeroCube(1.5U: 2kg) AAReST MiRaTA (3U) BioSentinel計画案(6U) 再突入回収(3U)
 XI-IV (1U: 1kg) Dove,Flock(3U: 4kg) SPORESAT (3U: 5.5kg) Sunjammer

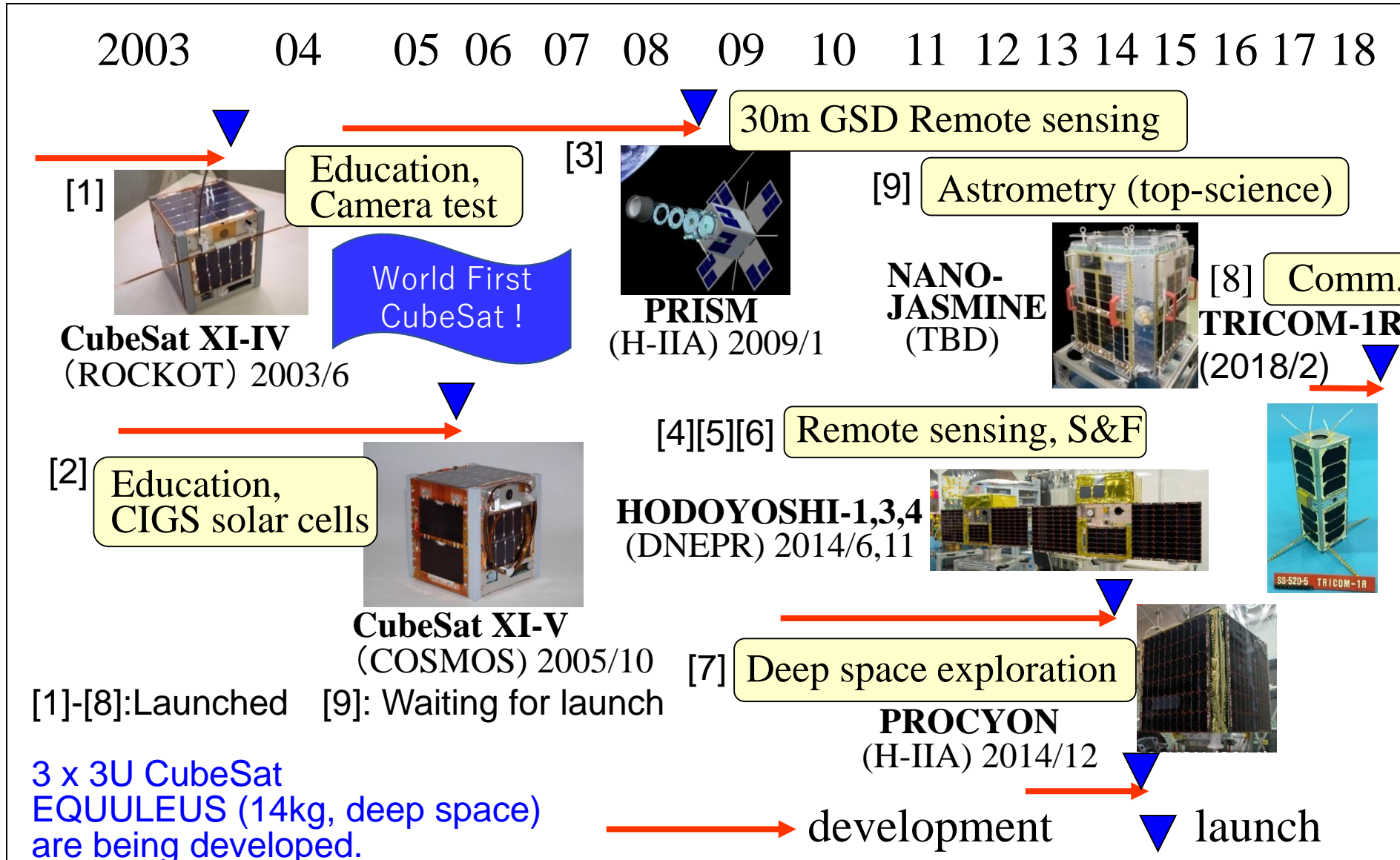


Rendezvous/docking Communication Space Science Atmosphere Exploration High Resolution.

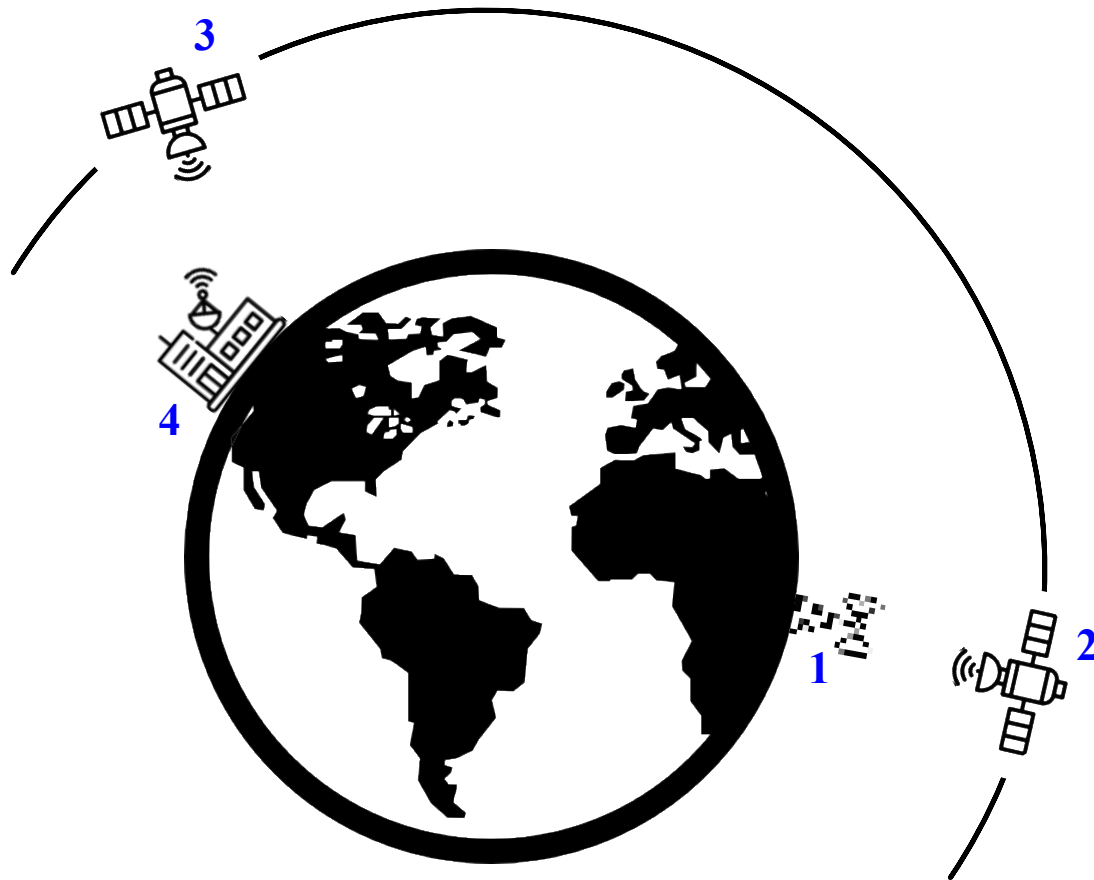
INSPIRE (3U) 高速通信・ISARA (3U) RACE (3U) (可視・近赤外) LWaDi (6U) SCOUT (50kg)
 低速通信・AISSAT-1 (6kg) FS-7 (3U) NEMO-AM (15kg) CAT (3U) Skysat (120kg)

Primarily by university/venture companies, but governmental projects are also appearing, which begin to replace mid-large sized satellites.

University of Tokyo's (UT's) History - 10 satellites developed (8 launched) -

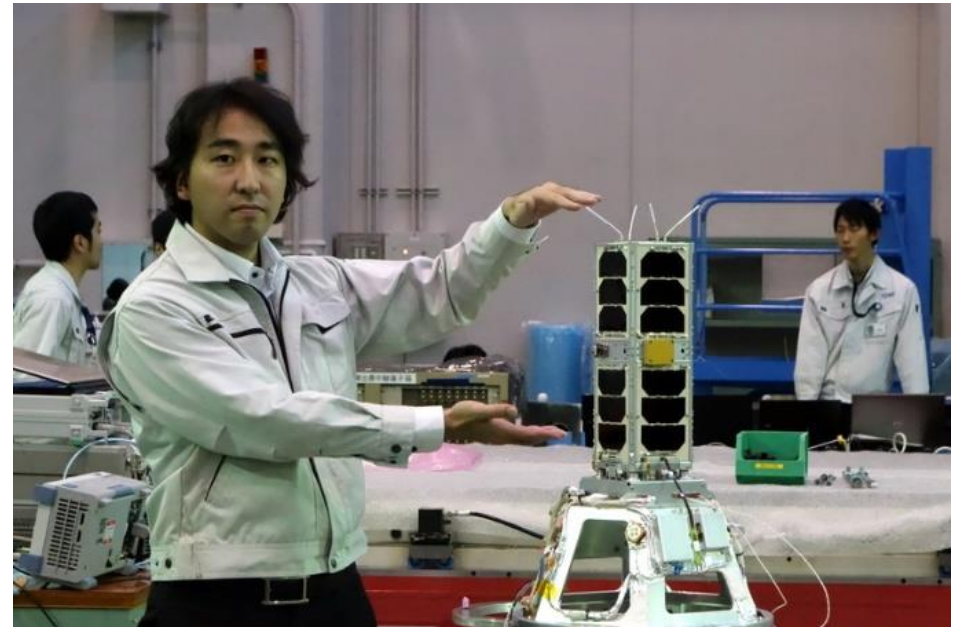


“Store & Forward” collects ground information



1. Measurements by ground stations
2. Data stored in satellite
3. Data forwarded by satellite
4. Data analyzed in headquarters

**8mW low RF power(LoRA),
low data rate (300bps) transmission
is tested in TRICOM-1R.**

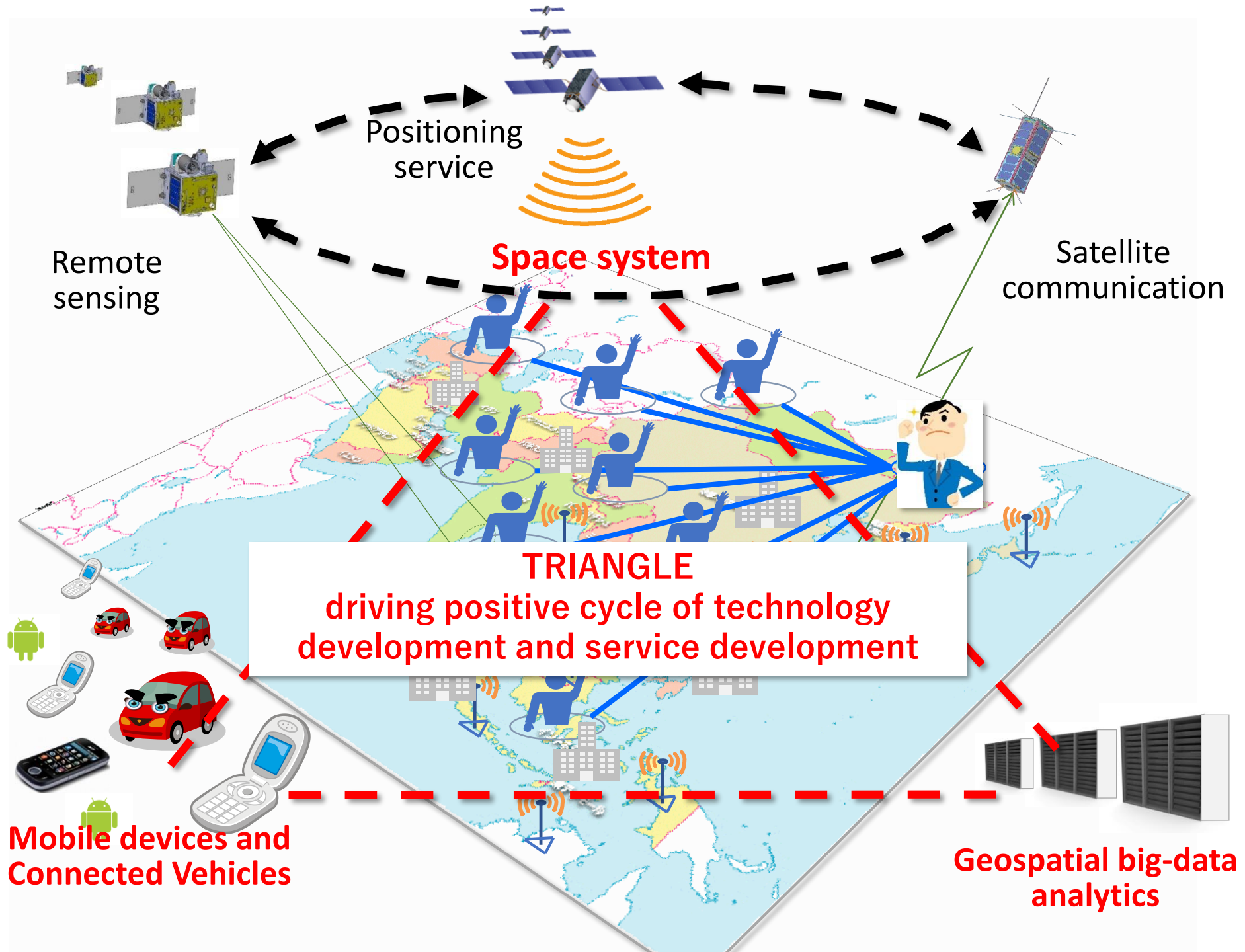


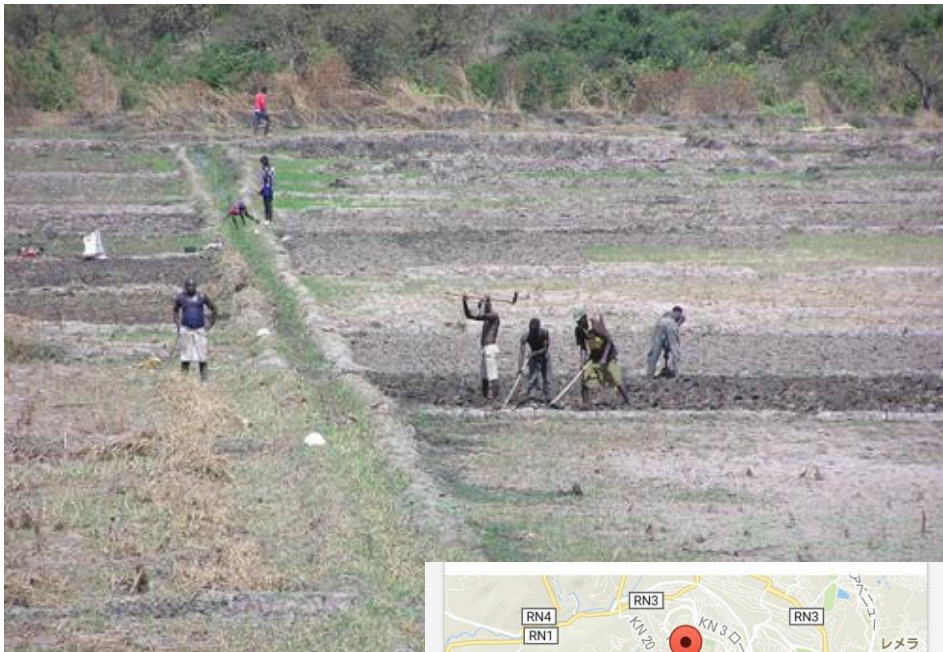
3kg TRICOM-1R

Launch of TRICOM-1R by SS-520-5

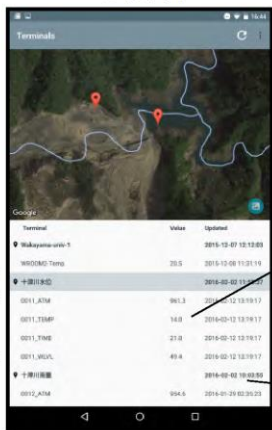
- Launched on **3/2/2018** by the world smallest orbital rocket by JAXA/ISAS
- S&F and camera experiments successful
 - **8mW transmission from Japan, RWANDA, etc**
- Plan to develop **low cost/quick development version to support foreign countries**







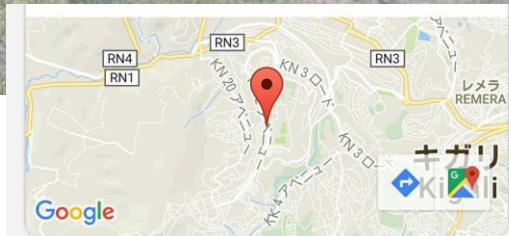
メイン画面



端末情報
センサ情報

その他の機能

- テータ共有機能
- 写真データとセンサ端末データの紐づけ機能
- アンドロイド端末でのインターバル撮影、位置

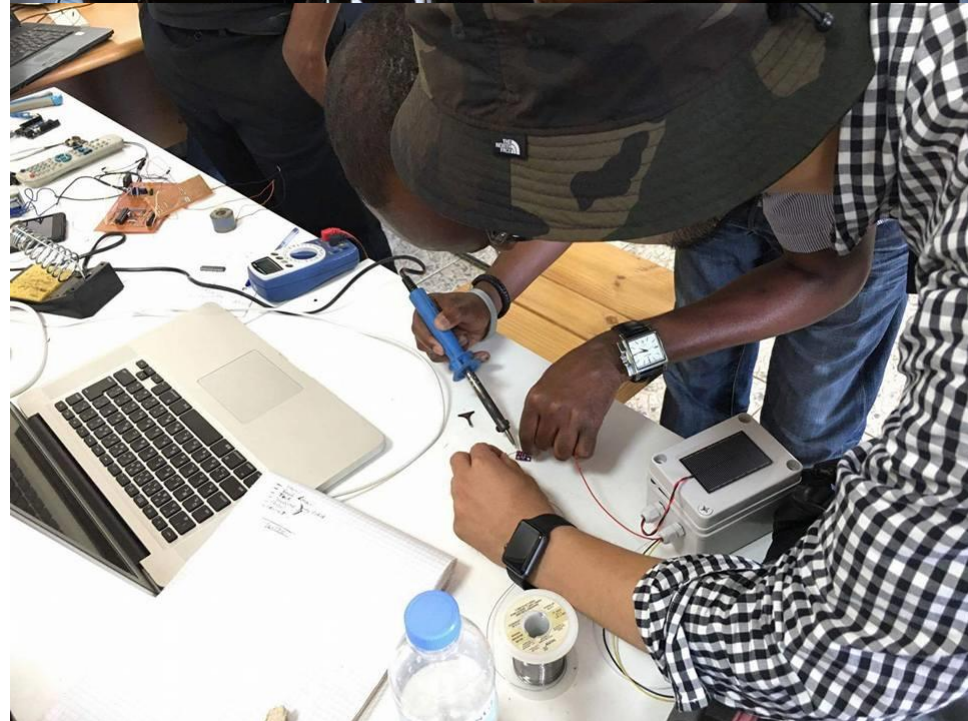


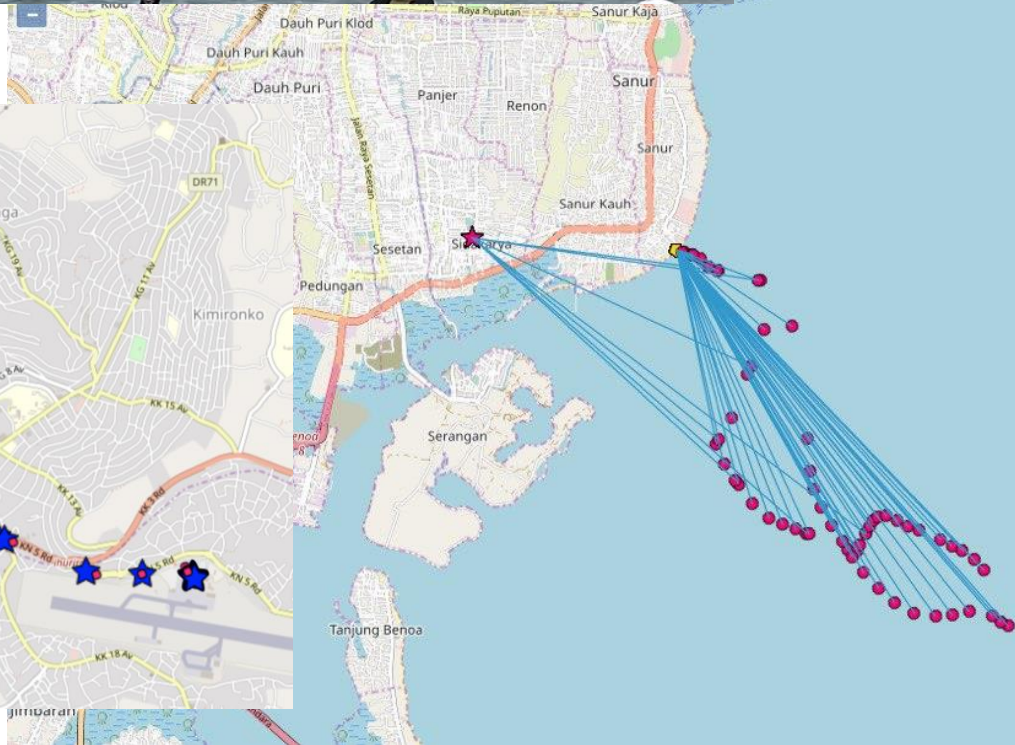
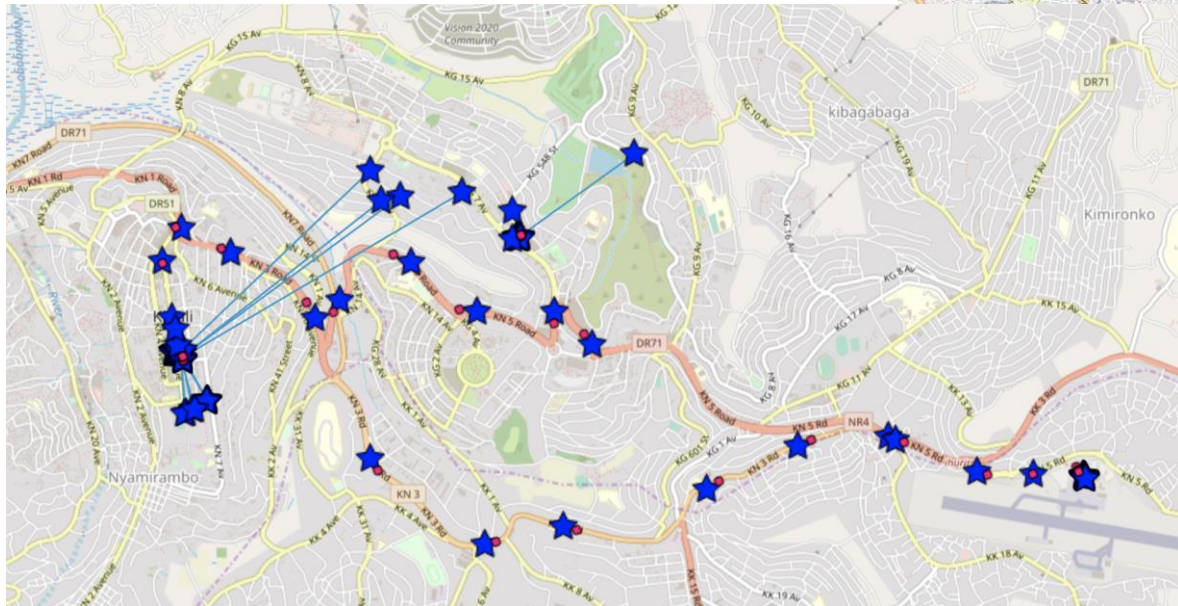
meteo rwanda

soil moisture sensor

2017-08-13 02:46:32 更新

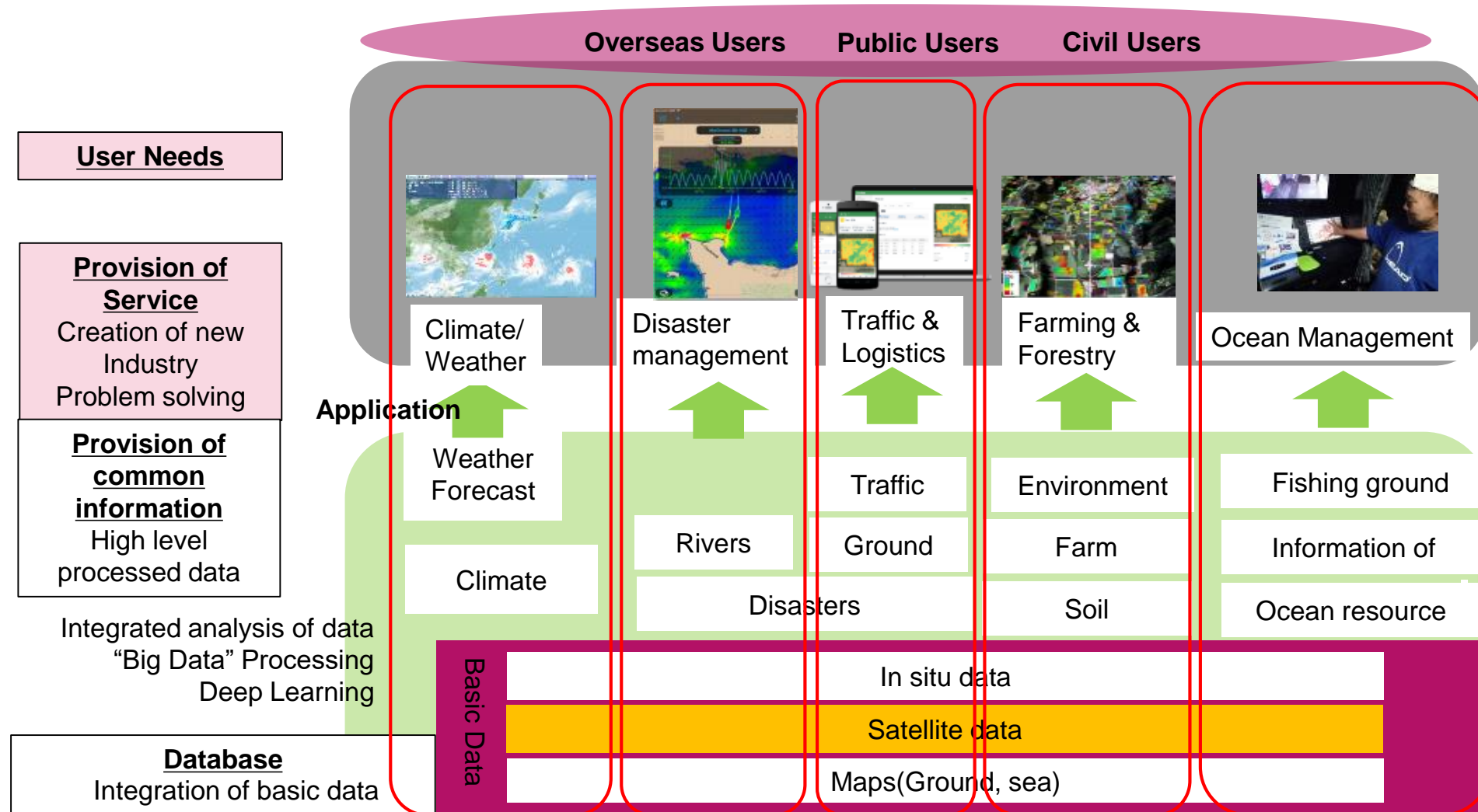
temperature	26.3
soil moisture	358.0
lux	433.0
battery(v)	3.87





Expansion of Space Utilization

“High level data processing” using Satellite data and in situ data is necessary.





Geostationary
Communication
Satellite:

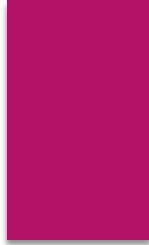
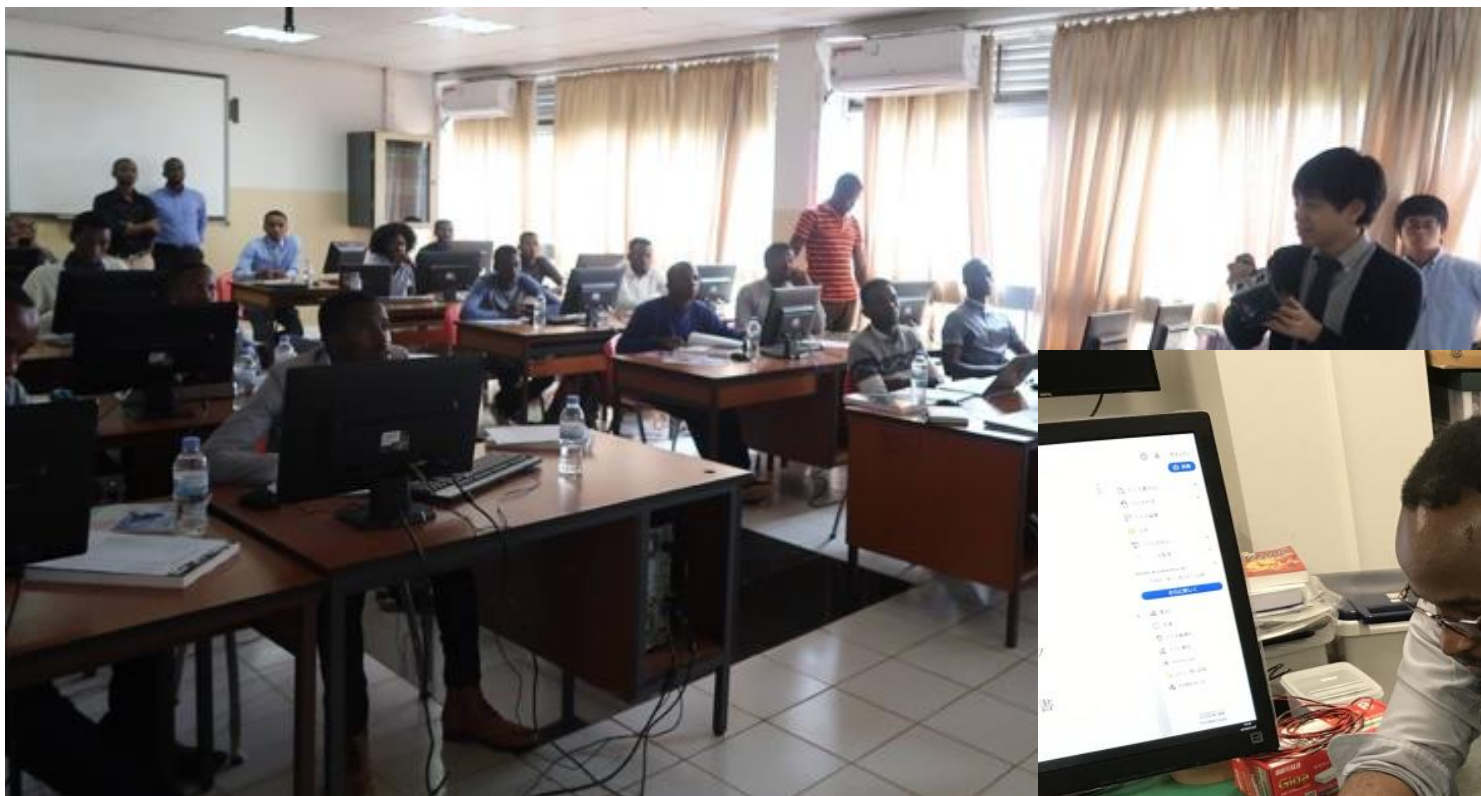
Low Earth Orbit
Small Satellite:

Space Inclusion



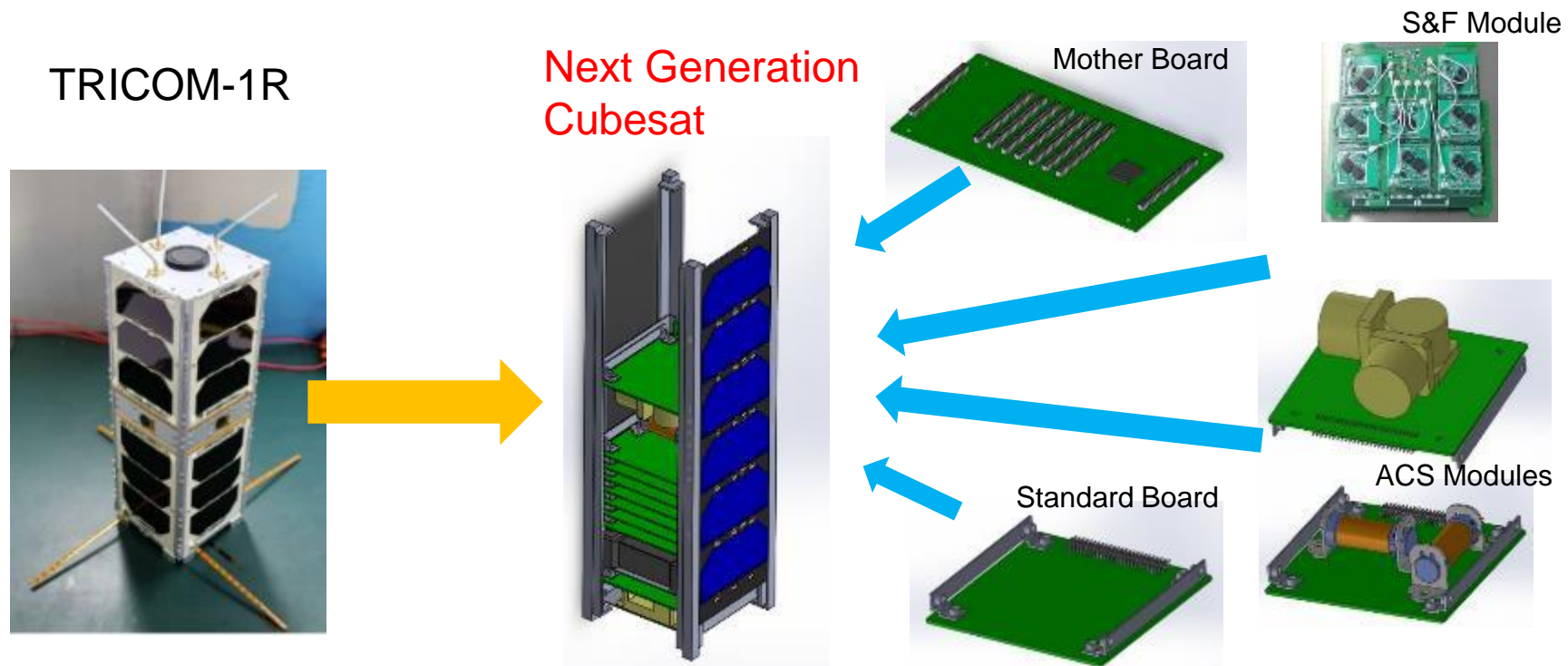
Boot Camp



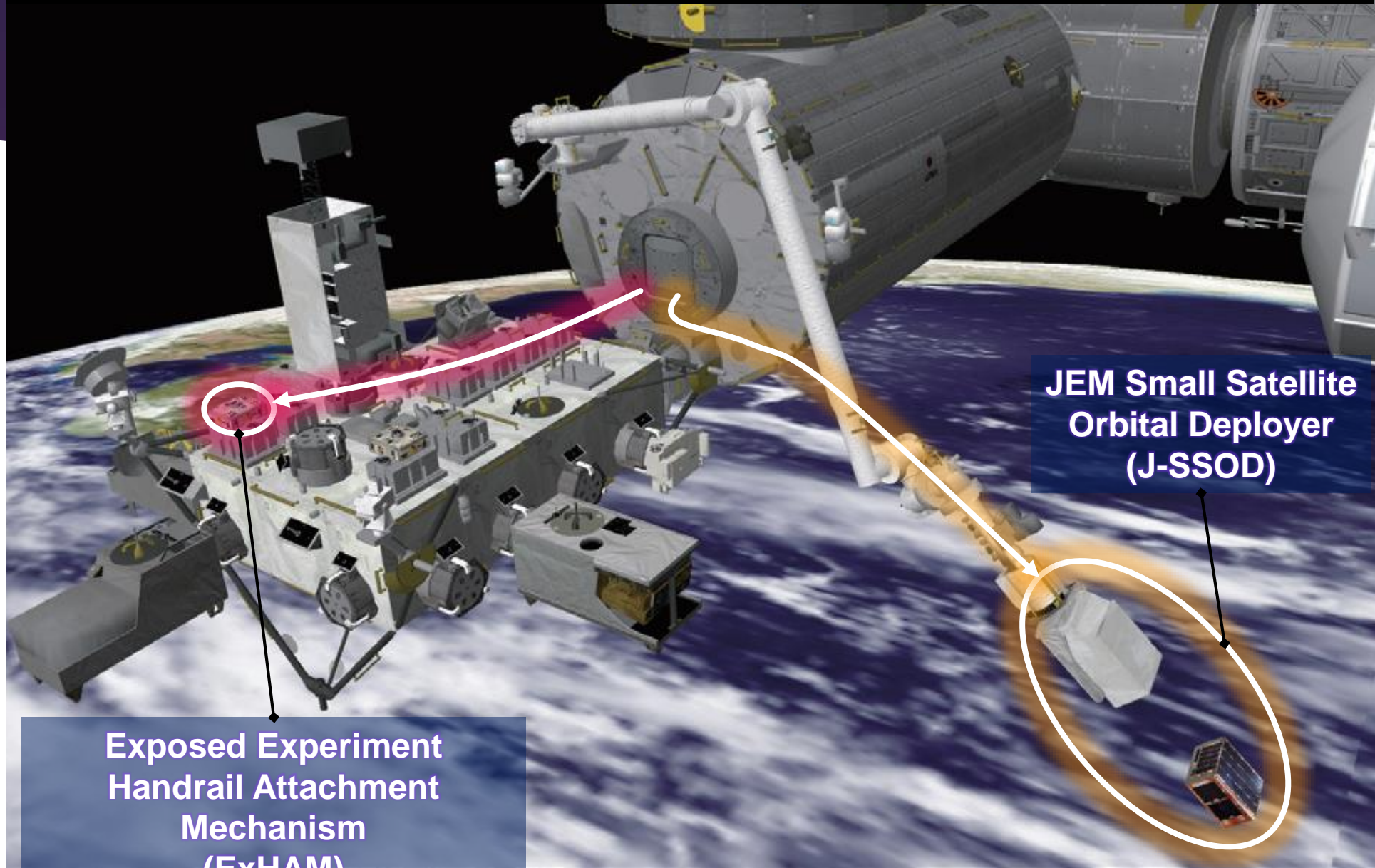


Next Generation of Cubesat

- Towards the constellation of cubesats
 - Based on heritage design and experience
 - Renewed architecture **to easy build and test**
 - **Industry partnership for better quality and mass production**
- 1st Deployment of two satellites will be 20th **Nov. 2019**



Launch (deployment) from ISS with **Kibo** Unique Exposed Facility



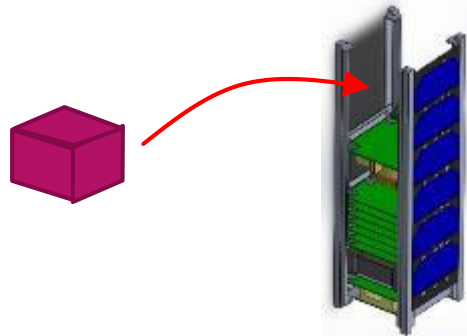
Exposed Experiment
Handrail Attachment
Mechanism
(ExHAM)

JEM Small Satellite
Orbital Deployer
(J-SSOD)

Collaboration Options

- Any Collaboration : Your Idea ✗ Our Experience
- All options can include **capability building** programs

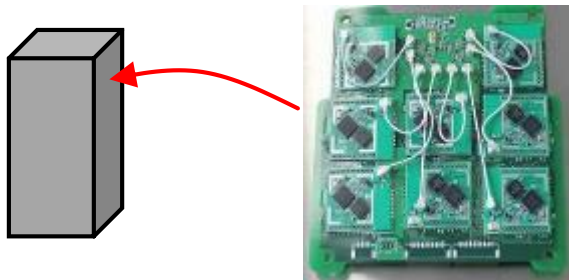
Your Mission ✗ Our 2U/1U S&F BUS



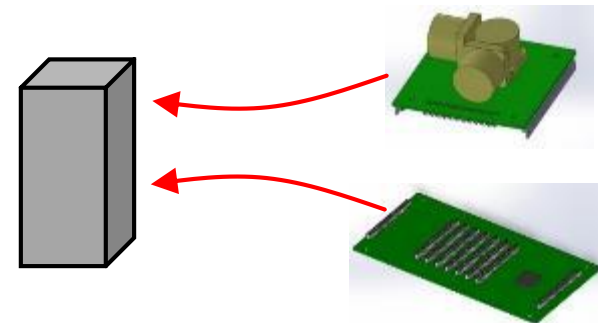
Your Members ✗ Our 3U/2U S&F Cubesat
(build **Together!**)



Your Bus ✗ Our S&F Mission Board

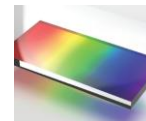
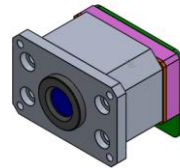
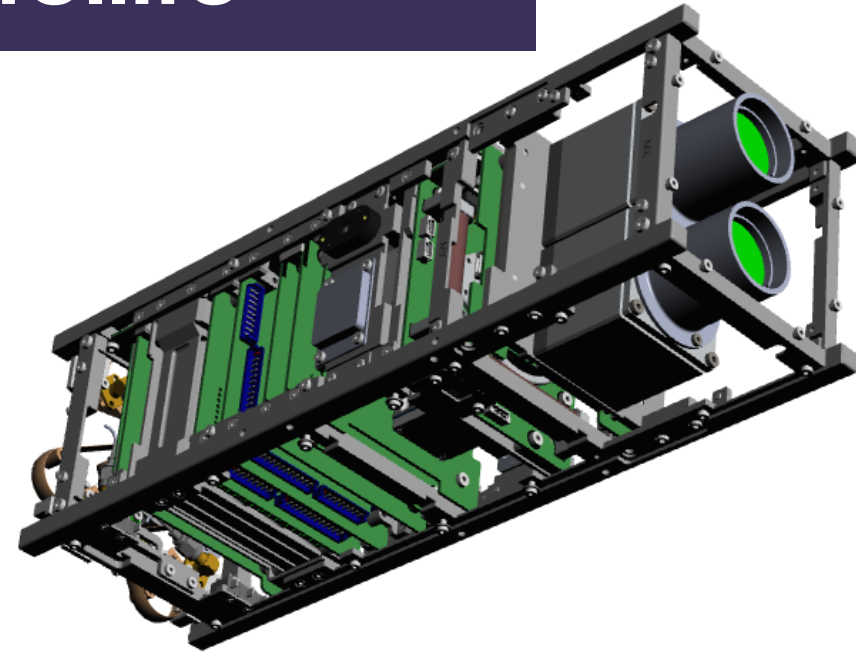
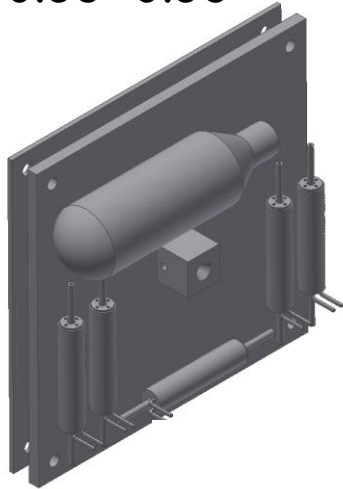


Your Bus ✗ Our Heritage Components

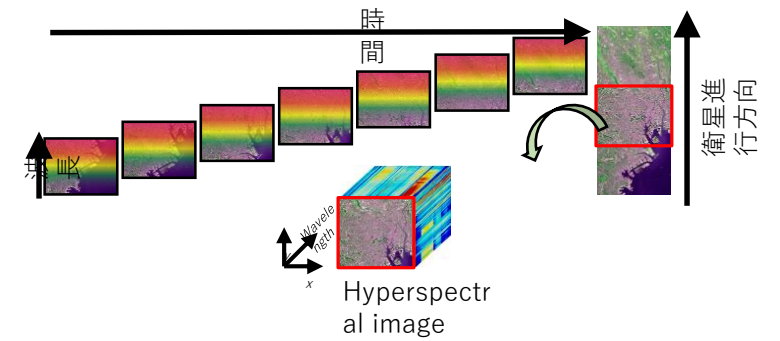
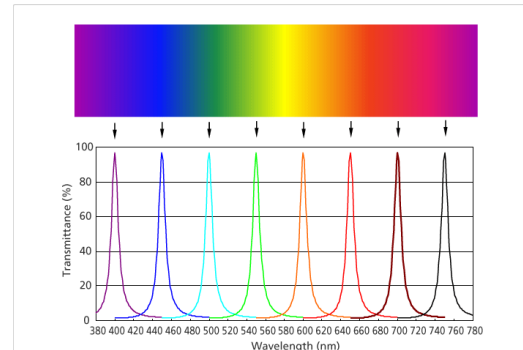


New Tricom : 3U-Satellite

Nano Thruster
0.3U- 0.5U



Onboard Deep
Machine
Learning





MOU to develop 3U CubeSat to be launched in 2019

News from Africa (09/05/2018)

**Smart Africa, Rwanda Sign Deal With
Tokyo University For Satellite Technology**



Today: 22 Smart Africa Member States



- 22 Member States have joined the alliance
- Market: 560+ Millions people



Member States:

- Angola
- Benin
- Burkina Faso
- Cameroon
- Chad
- Congo (D.R. of)
- Côte d'Ivoire
- Djibouti
- Egypt
- Gabon
- Guinea
- Kenya
- Mali
- Niger
- Rwanda
- Sao Tome & Principe
- Senegal
- South Africa
- South Sudan
- Togo.
- Tunisia
- Uganda



Keynote Address by Mr. Shinzo Abe, Prime Minister of Japan

「Let us raise our eyes now to a place beyond the earth. Soon, up there, a small-sized satellite built by Rwanda together with the University of Tokyo will emerge. From space, the satellite will observe crop harvests and the state of water resources in Rwanda. -snip-

And so I will say it again: the Japanese government - New TICAD -- will do its utmost to support Japanese enterprises that are betting on the future of Africa.」



Signing Ceremony of LOI between Egyptian Minister and Univ.Tokyo for African Space Activities

Yokohama Action Plan-TICAD7(2019) AU flagship initiatives: Africa Outer Space Strategy

Support human capital development and harness STI to achieve the SDGs

-Capacity building through development, operation and utilization of small satellites, including small satellites deployment from the Japanese Experiment Module "Kibo" of ISS and satellite data utilization to solve social issues.

Capacity building for emerging countries

Capacity Building

- ◆ E-learning system available for overseas universities in space emerging countries
- ◆ Education program with cansat/model rocket composition and its launch for invited foreign university students
- ◆ Training program on remote sensing technology for senior engineers in space emerging countries



▲ E-learning system



▲ Cansat/model rocket program

Utilization of ISS "KIBO" Module

- ◆ Exposure test of components developed by emerging countries using JAXA's KIBO module of ISS
- ◆ Deployment of cubesat developed by emerging countries from robot arm of JAXA's KIBO module of ISS



▲ Cubesats to be released from ISS "KIBO" module

Application of QZSS

- ◆ Demonstration experiments of commercial GNSS applications in Asia-Pacific region where QZSS signals is available



▲ Demonstration of i-Construction in Thailand



Tire : 30cm

Strip : 40cm

▼ Autonomous driving of a tractor in Australia

Dispatch of Japanese experts

- ◆ Overseas dispatch of Japanese experts to give a lecture in seminar/workshops and/or university classes



▲ JASTIP symposium in Thailand



▲ Space technology seminar in UAE

Capacity building programs using Japan's assets

【Cansat/Model Rocket Hands-on】

- Provide foreign students with opportunity to manufacture and launch can-size satellites and model rockets



【Space Experiment Ideathon】

- Divide students into several groups, and then each group comes up with ideas and present the outcomes for experiment in space environment.
- Japanese experts may advise when necessary.



【Parabolic Flight】

- Invite the winner of Space Experiment Ideathon to the real experience of zero gravity by parabolic flight.



“UNISEC-Global” activities

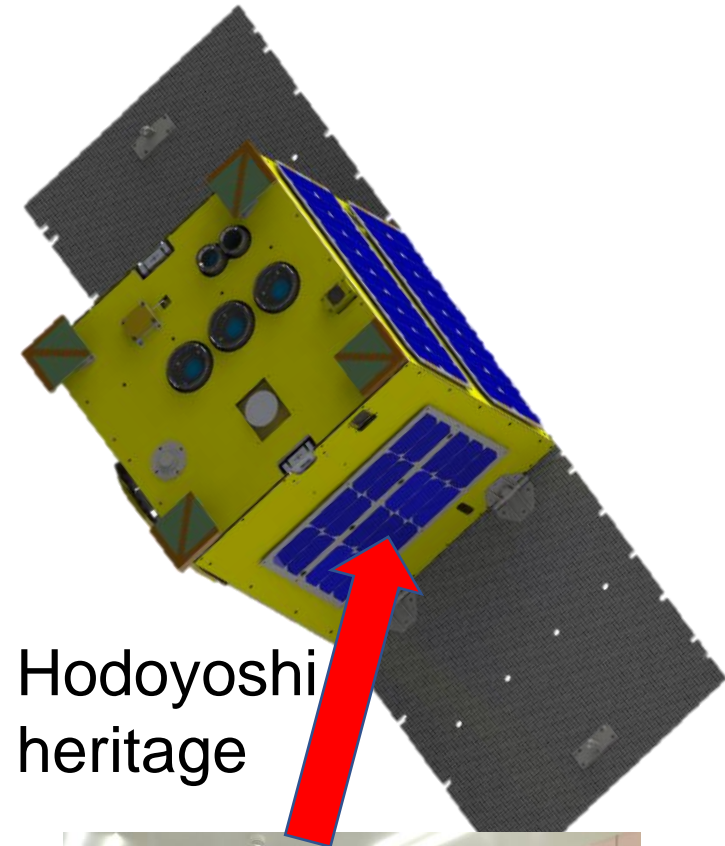
40+ regions/countries are interested to start UNISEC in their countries: **South Africa**, Angola, Namibia, **Egypt**, Ghana, Kenya, **Nigeria**, **Tunisia**, **Bangladesh**, Korea, Mongolia, the Philippines, Singapore, Taiwan, Thailand, **Turkey**, Australia, Indonesia, Saudi Arabia, Canada, USA, Guatemala, **Mexico**, **Peru**, Brazil, **Bulgaria**, **Italy**, **Samara (Russia)**, Switzerland, **India**, **Germany**, Slovenia, **Lithuania** and **Japan**.



15 Local Chapters and 1 Association of Local Chapters have been acknowledged. (red part)

“MicroDragon” for Vietnam

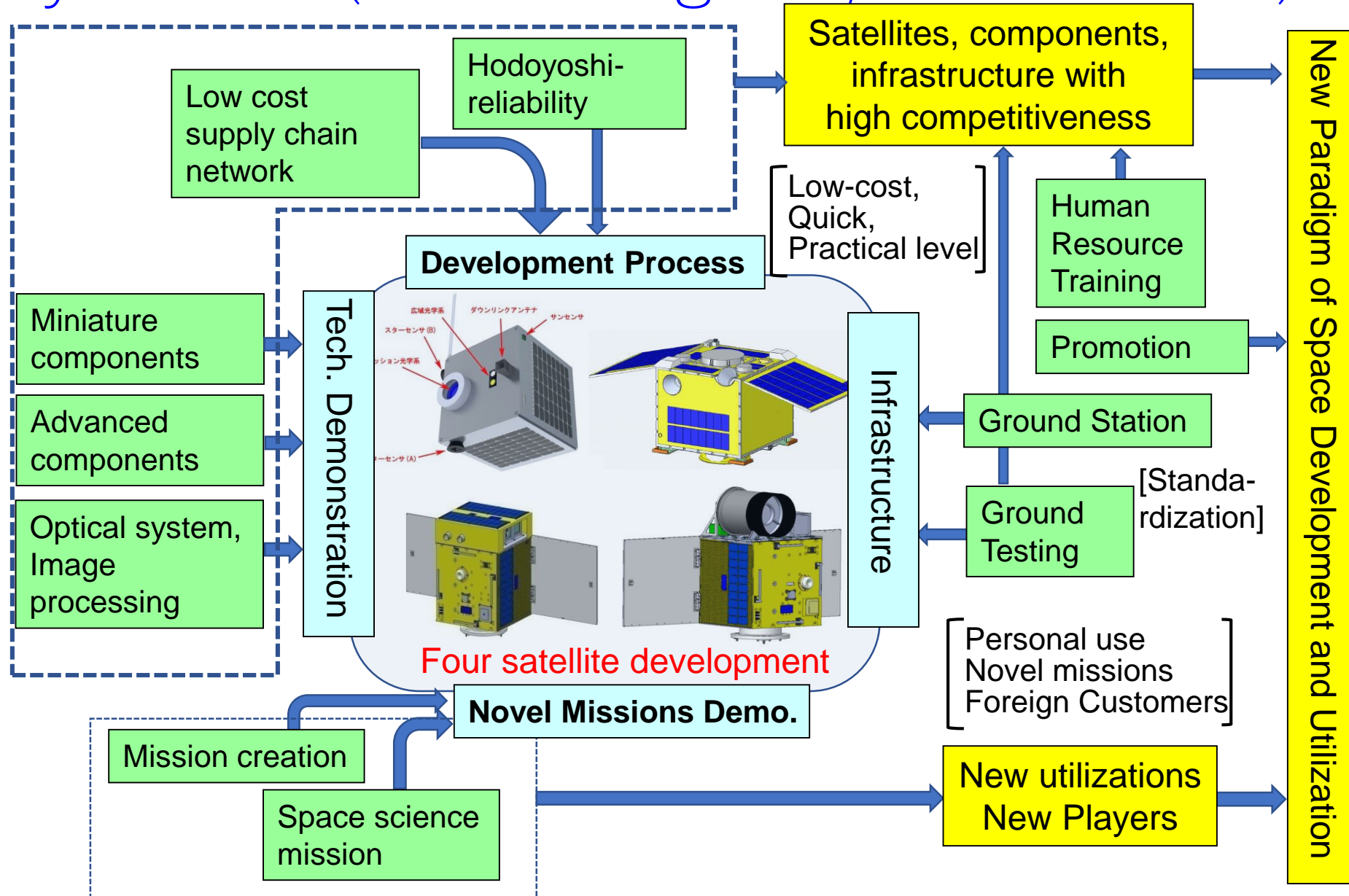
Size	approx. 0.5 m × 0.5 m × 0.5 m (stowed) approx. 1.4 m (SAP delopoyed)
Mass	approx. 50 kg
Orbit (Planned)	SSO 500 km LTDN 9:30
ADCS	Three-axis Earth Pointing
EPS	Solar Cells 2x Solar Array Paddles (SAPs) + 5x Body Mount Cells
	Generation 100 W (max) Consumption 50 W (avg) Bus Voltage 28V (unreg) + 5V (reg) Battery 5.8AH Li-ion
COM	S-band 4kbps (CMD) S-band 4/32/64kbps (TLM) X-band 10Mbps (Mission)



Hodoyoshi
heritage



Hodoyoshi PJ (“First Program,” 2010-2014)



Hodoyoshi-3 (left) and Hodoyoshi-4 before Shipment (April, 2014)

Target: 50kg class satellite to be developed within \$3M and 2 years

Size: 50x50x80cm 60kg Downlink: 10Mbps Power: max 100W average 50W

Attitude Control Capability:

- Stability 0.08 deg/s (Roll, Pitch) 0.8 deg/s (Yaw)
- Pointing accuracy 0.2 deg 2 deg
- Determination accuracy 0.0048 deg 0.048 deg

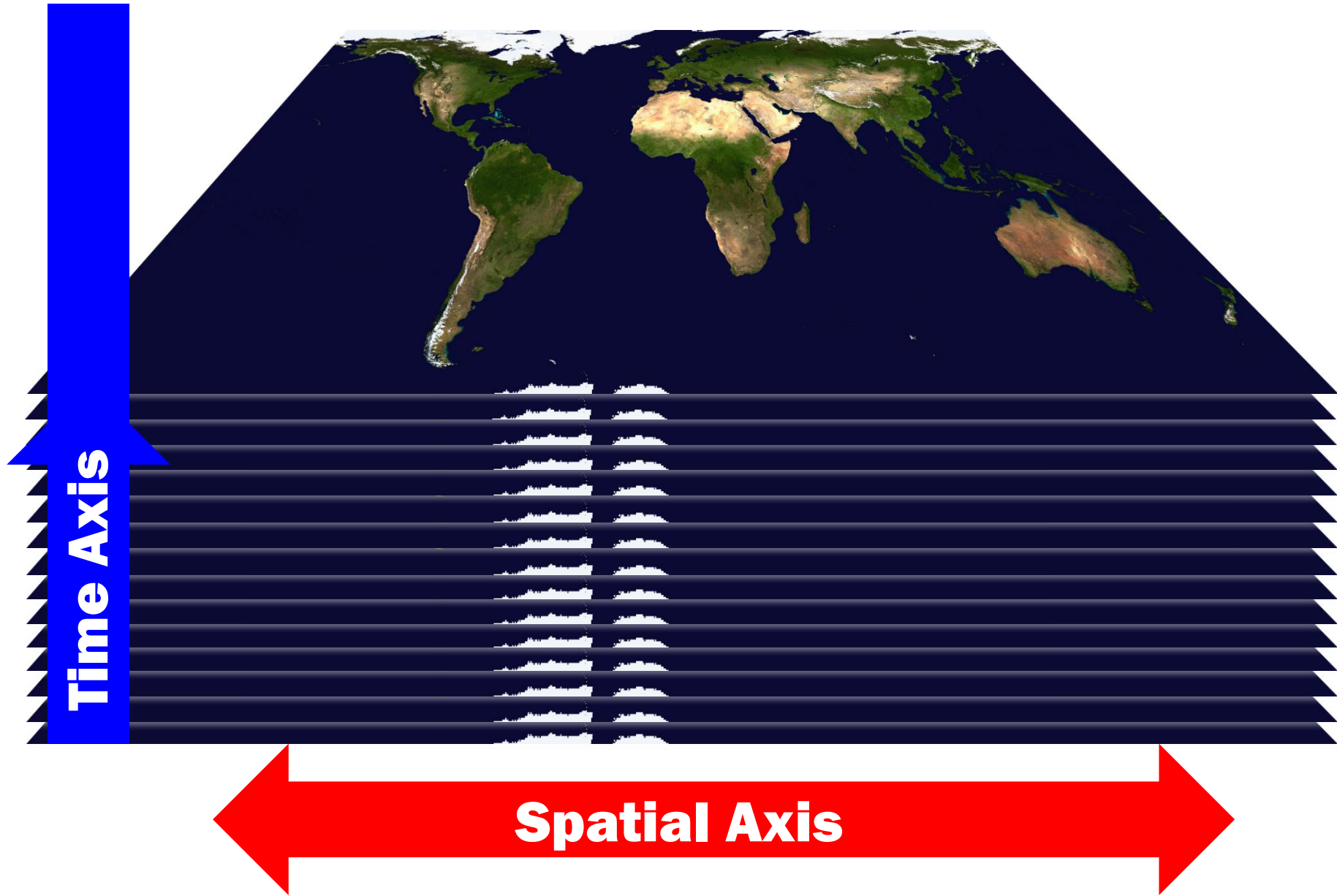


Chiba
(6m GSD)



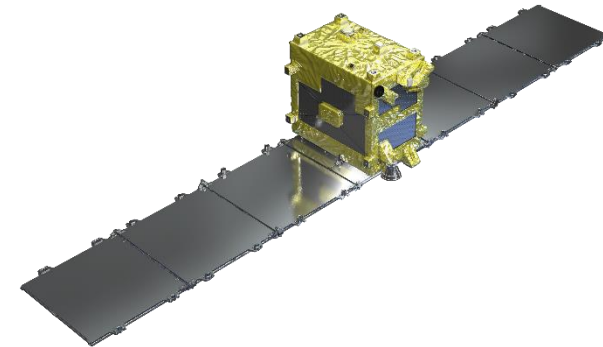
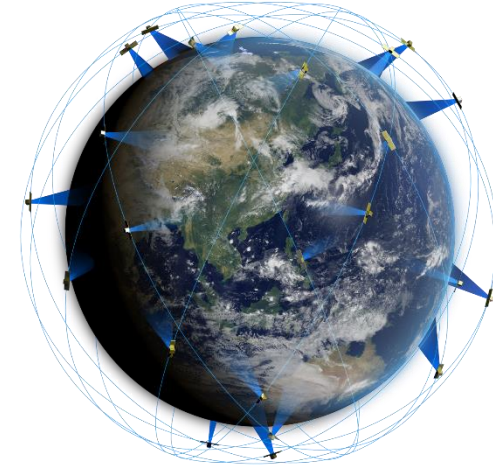
**microsats
constellation**

**Monitoring
whole world,
every day**



Small SAR Satellite Constellation

- Small SAR(Synthetic Aperture Radar) satellite constellation for **frequent and persistent information gathering from Earth**
- **Six** satellite constellation **until 2021**, **20** sats are the goal to achieve **daily to hourly** revisit
- The launch of the first demo satellite will be in **late 2019** and now in EM development phase
 - Demo satellite: **3m ground resolution**, 140kg, 0.7m cubic size, designed based on Hodoyoshi outcomes
- The mission part is developed in ImPACT (Impulsing Paradigm Change through Disruptive Technologies) program, funded by Cabinet Office, Government of Japan



STOP

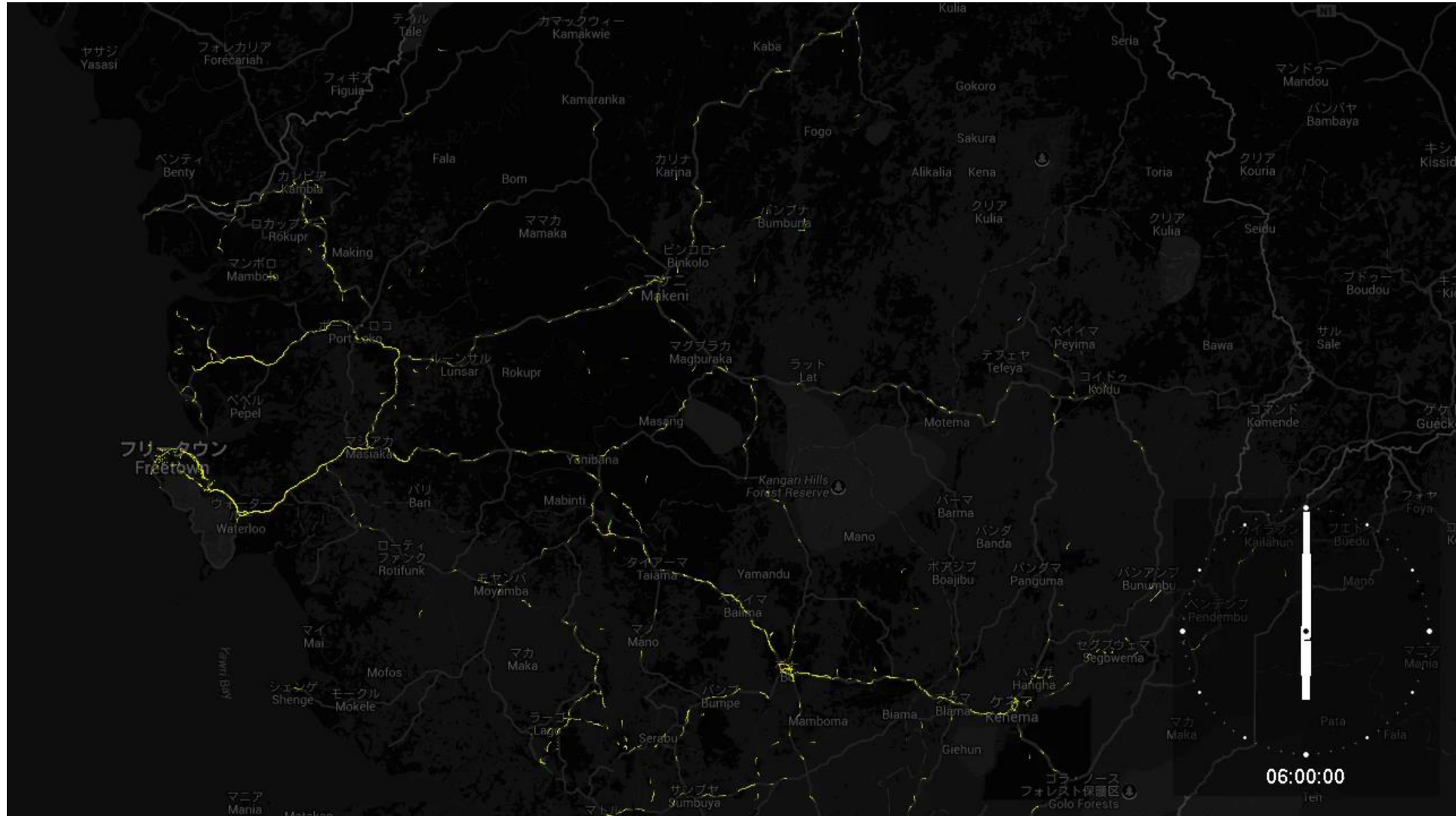
EBOLA

EBOLA PREVENTION

NO KISSING AVOID MUGGING

WASH HANDS





Layers Data Analysis

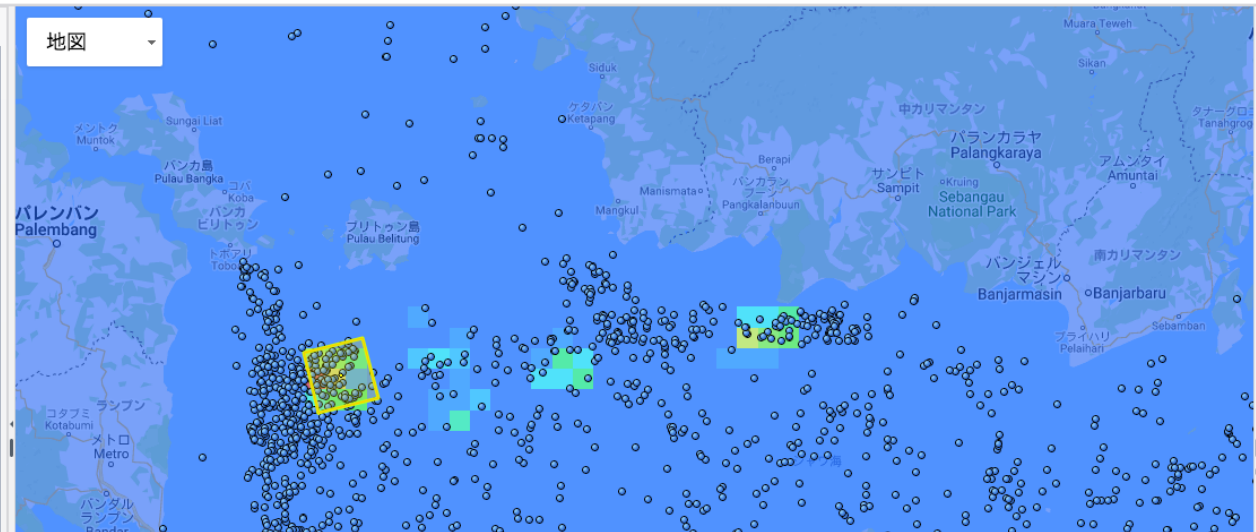
GlobalFish-combined.csv
3568 moving objects

New layer
Grid (20500 cells)

Value max: 17 Auto

Color scheme

Spacing



Vessel observation

Preview type

No
 All
 Live

Radarsat-2
2018-01-05 14:48:30 UTC
Reg:46 / Noreg:0 / *SUS*0

Radarsat-2
2018-01-30 14:16:40 UTC
Reg:14 / Noreg:0 / *SUS*0

Radarsat-2
2018-02-07 22:57:30 UTC
Reg:9 / Noreg:0 / *SUS*0

Radarsat-2
2018-02-08 00:38:10 UTC
Reg:77 / Noreg:0 / *SUS*0

Radarsat-2
2018-03-04 09:01:40 UTC
Reg:4 / Noreg:0 / *SUS*0

Radarsat-2
2018-03-27 21:16:40 UTC
Reg:23 / Noreg:0 / *SUS*0

Radarsat-2
2018-04-11 23:10:00 UTC
Reg:7 / Noreg:0 / *SUS*0

Radarsat-2
2018-04-20 22:57:20 UTC
Reg:11 / Noreg:0 / *SUS*0

show grid Capture vessels

Selection Gate dock Plug-ins Clock Theater mode Timeline viz

2018-02-08 09:38:10

Jan. 2018 Feb. 2018 Mar. 2018 Apr. 2018

Layers Data Analysis

GlobalFish-combined.csv
3568 moving objects

New layer
Grid (20500 cells)

Label
Value max: 17 Auto

Color scheme

Spacing

地図

Map showing vessel observations (black dots) and a heatmap overlay (yellow and green) in the Java Sea region of Southeast Asia. Labels include Palembang, Banjarmasin, and Palangkaraya.

Vessel observation

Preview type

No
 All
 Live

Radarsat-2
2018-01-05 14:48:30 UTC
Reg:46 / Noreg:0 / *SUS*0

Radarsat-2
2018-01-30 14:16:40 UTC
Reg:14 / Noreg:0 / *SUS*0

Radarsat-2
2018-02-07 22:57:30 UTC
Reg:9 / Noreg:0 / *SUS*0

Radarsat-2
2018-02-08 00:38:10 UTC
Reg:77 / Noreg:0 / *SUS*0

Radarsat-2
2018-03-04 09:01:40 UTC
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Radarsat-2
2018-03-27 21:16:40 UTC
Reg:23 / Noreg:0 / *SUS*0

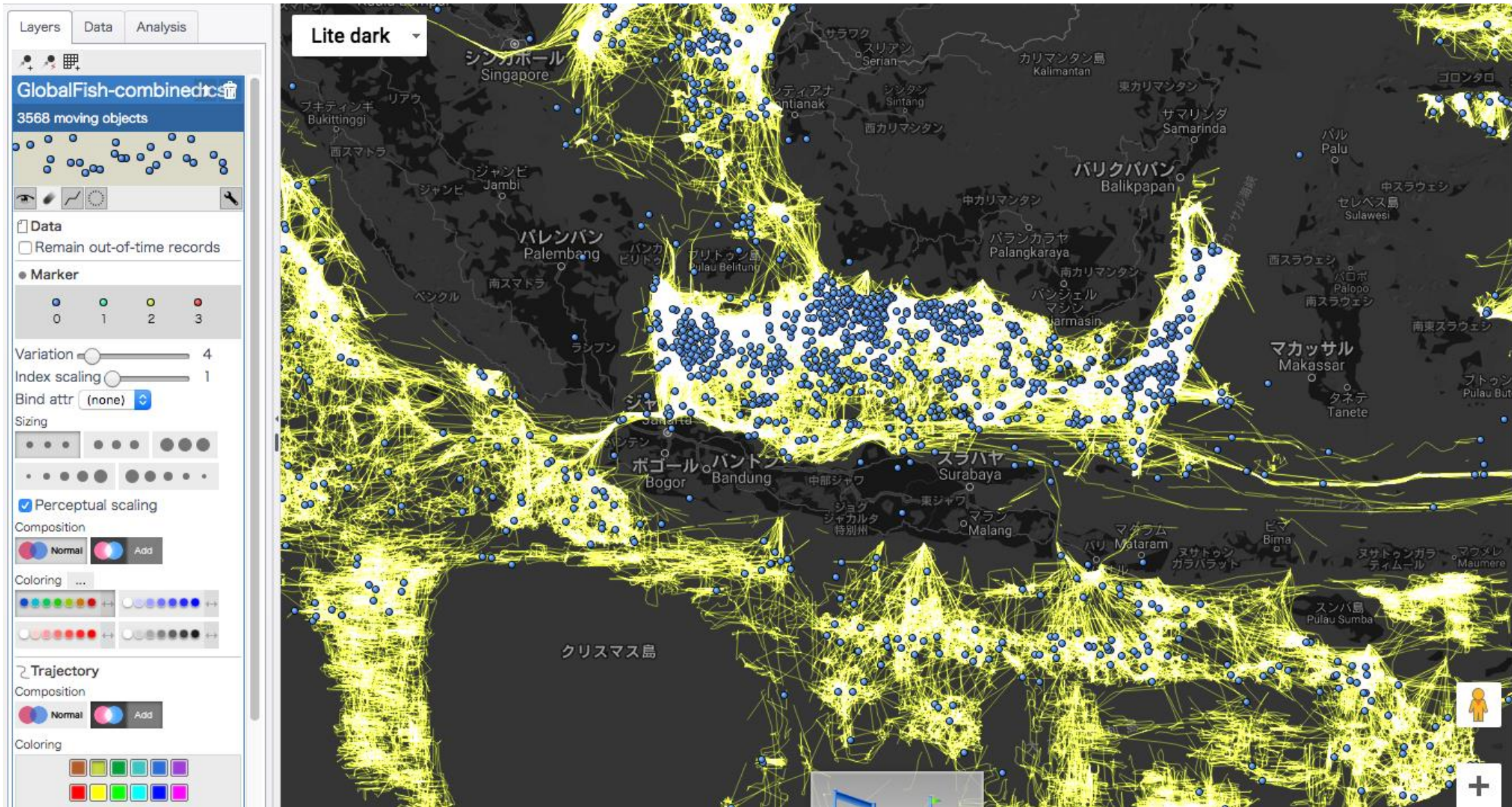
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2018-04-11 23:10:00 UTC
Reg:7 / Noreg:0 / *SUS*0

Radarsat-2
2018-04-20 22:57:20 UTC
Reg:11 / Noreg:0 / *SUS*0

show grid Capture vessels



show grid



キャプションを入力してください。