JAXA's Activities on Ensuring Stable Use of Outer Space

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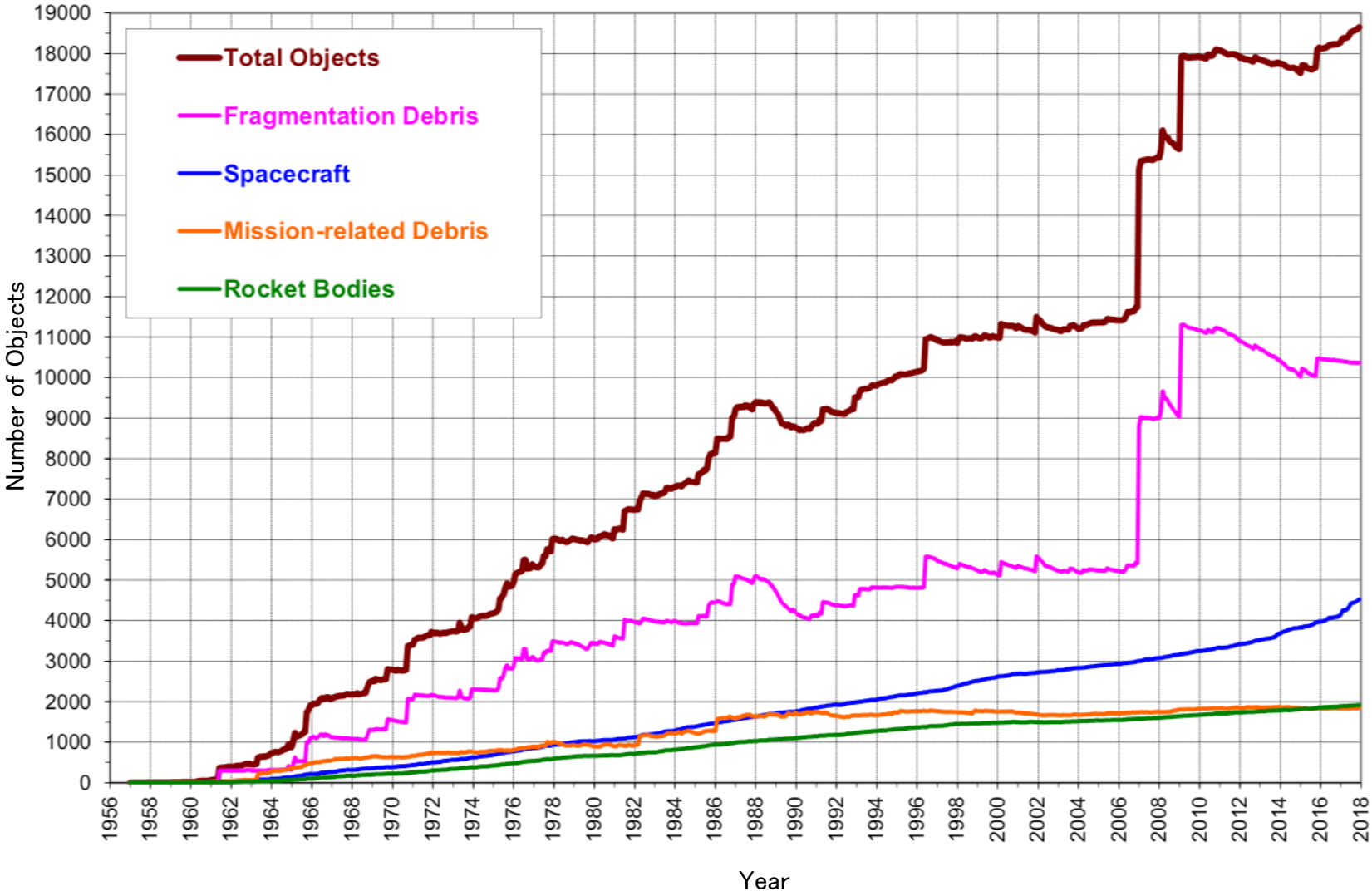
Increase of Number of Objects in Earth Orbit



NASA Orbital Debris Quarterly News, Volume 20, Issues 1&2, April 2016

Basic Plan on Space Policy (April 1, 2016)

☐ "Ensuring Stable Use of Outer Space" (§ 4.1.1.1)

- ✓ "establish the Space Situational Awareness (SSA) system in Japan and enhance its capacity for the avoidance of space debris, promote SSA information sharing with allies etc., and develop the capacity for our space systems to avoid collisions with space debris, etc."

- ✓ "work closely together with international partners for realizing and strengthening rule of law"

- ✓ "take measures for the development of space debris removal technology etc., and improve the utilization environment in outer space"

JAXA's activities on ensuring stable use of outer space

JAXA has been contributing to ensure stable use of outer space based on Basic Plan through the following main pillars, pursuant to the "plan for achieving the Medium to Long-term Objectives" (JFY 2018-2024):

1. Contribution to Space Situational Awareness (SSA)

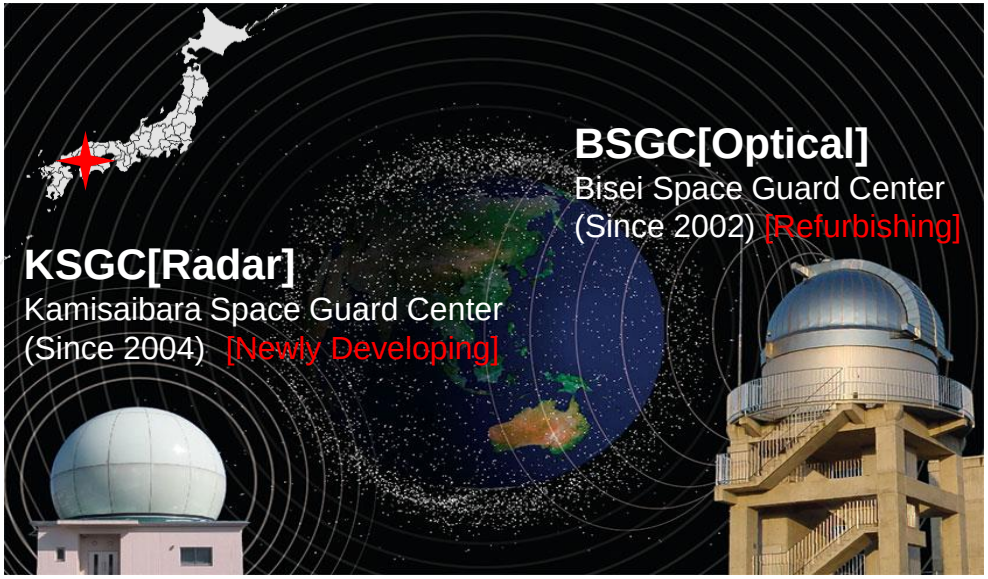
2. Efforts for making international standards and regulations on space utilization

3. R&D for Space debris threats and risks

JAXA's Activities on Space debris (1)

1. Contribution to Space Situational Awareness (SSA)

- Develop and Operate JAXA's SSA-related facilities and conduct R&D activities to advance our SSA abilities.
- Upgrade our SSA-related facilities and contribute to the intergovernmental operational framework by 2023.
  - ✓Integrated with MOD and other Japanese governmental institutions.



JAXA's SSA System and National Framework

JAXA's SSA system

KSGC[Radar]
Kamisaibara Space Guard Center

BSGC[Optical]
Bisei Space Guard Center

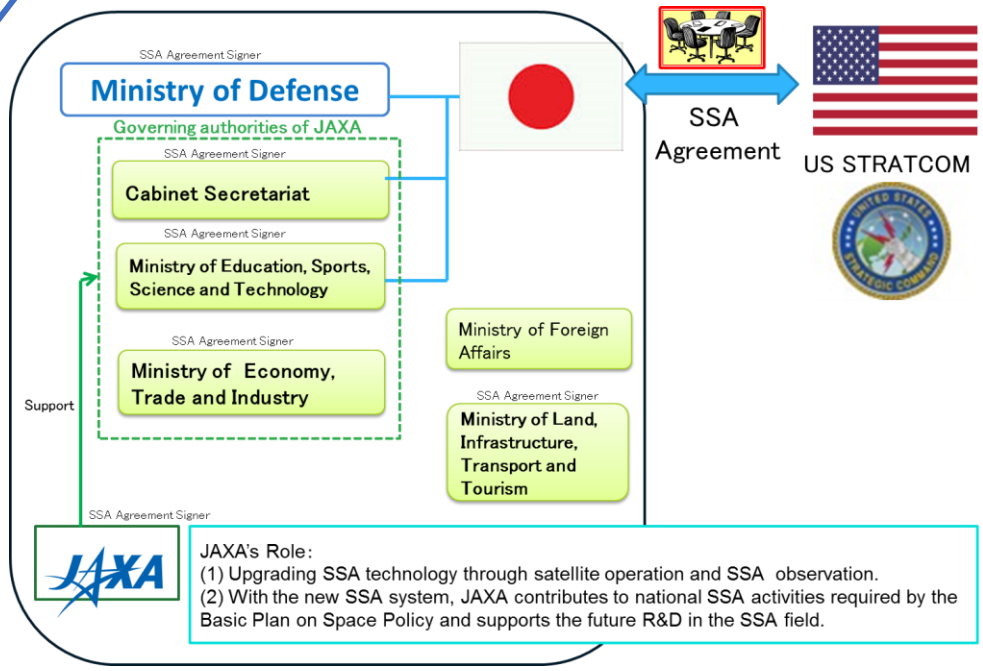
Radar: Newly Developing

1.6m⇒10cm

Telescope: Refurbishing

Japanese SSA framework

JAXA cooperates with Ministry of Defense and other national institutions.



JAXA's Activities on Space debris (2)

2. Efforts for making international standards and regulations on space utilization

- JAXA leads Japan delegation for Japan in Inter-Agency Space Debris Coordination Committee(IADC).
  - ✓ Hosted the annual meeting 2018 in Tsukuba.
  - ✓ IADC space debris mitigation guidelines was based on NASA Safety STD and NASDA's debris STD (1996).
- Based on R&D and the international technical trend, JAXA will continue to contribute to IADC as well as other international committee, UN/COPUOS, ISO and so on.

Appendix. Framework of IADC

IADC (Inter-Agency Space Debris Coordination Committee)

Japan delegation: JAXA

Other participate members: Universities and CAO

※Inter-Agency Space Debris Coordination Committee

IADC's objective is to exchange information and facilitate opportunities for cooperation on space debris research activities and identify debris mitigation options.

※13 IADC member agencies

NASA、ROSKOSMOS、CNES、JAXA、ASI、CNSA、UKSA、DLR、ESA、ISRO、NSAU、CSA、KARI

SG(Steering Group)

- **WG1: Measurements**
- **WG2: Environment and Database**
- **WG3: Protection**
- **WG4: Mitigation (Remediation)**

Inter-Agency Space Debris Coordination Committee

Appendix. IADC Annual Meeting 36

The 36th IADC Annual Meeting (June 5 – June 8, 2018, Tsukuba)

- Participation : 150 members from 11 agencies.
- Key note speech at opening plenary from Cabinet Office, private companies (Astroscale and KHI) and JAXA.
  - ✓ Shared Japan's concerns for space debris issues by introducing Japan's space policy and regulations, cooperation with private sectors and plan for creating new market on ADR/EOL service.

Main Topic:

- Considering Large satellite Constellation activities and newly planned space activities, revisions of "IADC Space Debris Mitigation Guidelines(since 2007)" and "IADC Statement on Large Constellations in LEO(since 2015)" were discussed.
- Discussion on future prediction concerning Large Satellite Constellation.

Appendix. Joint research with Keio University

JFY 2018 Programs:

(1) Research on formulation of global norms in outer space
- issues addressed in COPUOS (LTS guidelines, etc.)
- Space Traffic Management (STM), etc.

(2) Research on legal issues arising out from advanced space activities (ADR, etc.)

(3) Study on how to evolve our cooperation and develop our space law community



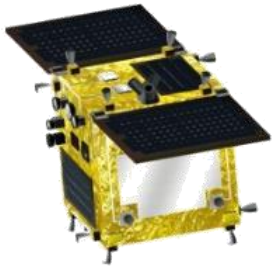
Space Law Symposium for 10th Anniversary of Keio University Center for Space Law (Feb 25, 2019)

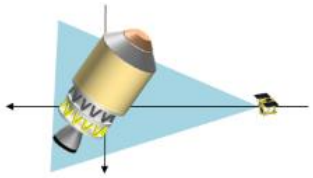
JAXA's Activities on Space debris (3)

3. R&D for Mitigating Space Debris threats and risks

- Continue researches for observation, collision avoidance, protection and ADR.
- Make space debris removal service into a new market and demonstrate the world's first active debris removal at low cost.
  - ✓Partner with private sectors; by joint programs including research, ground testing, demonstration in orbit and so on.

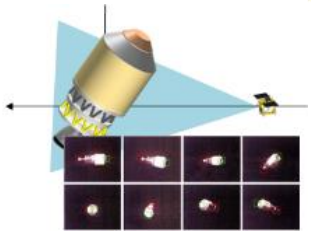
Phase I
ADR demonstration





On-orbit and in-situ measurement

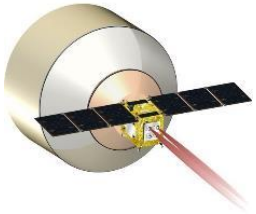
Rendezvous technology to non-cooperative space debris



Robust onboard real-time navigation

Phase II
ADR project

Target: Upper stage of JAXA's launch vehicle

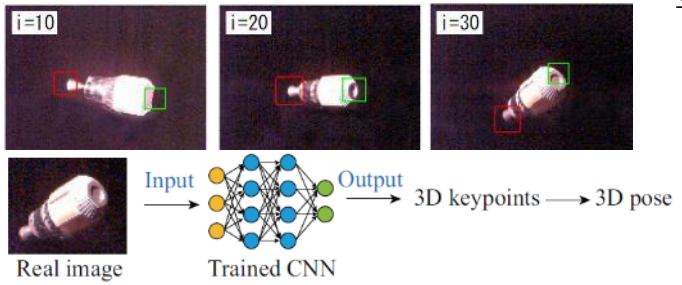


Researches on Active Debris Removal technology development

① Rendezvous technology to non-cooperative space debris

- Onboard real-time image navigation
  - ✓ Robust onboard real-time navigation using deep learning based pose estimation.
  - ✓ High fidelity ground test environment for onboard image navigation.

Deep learning based pose estimation

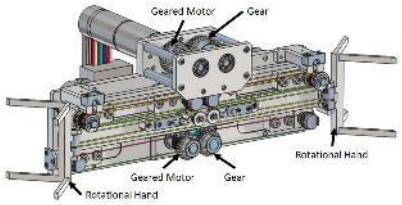


Mission Concept

② Capture technology for non-cooperative large intact space debris

- Dedicated capture mechanism
  - ✓ Mechanism to capture slowly rotating rocket upper stage.
  - ✓ High fidelity ground test facility.

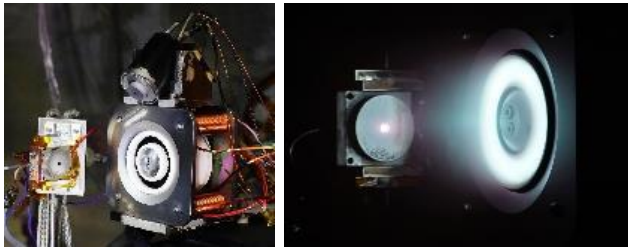
Mechanism to capture payload attachment Fitting(PAF) of upper stages

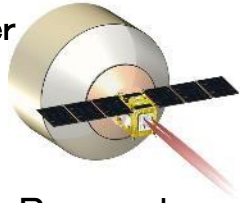


③ Efficient propulsion system to remove large intact space debris

- Efficient electric propulsion
  - ✓ Novel efficient electric propulsion to transfer large intact space debris into graveyard or reentry orbits.

Electrodynamic tether and hall effect thruster

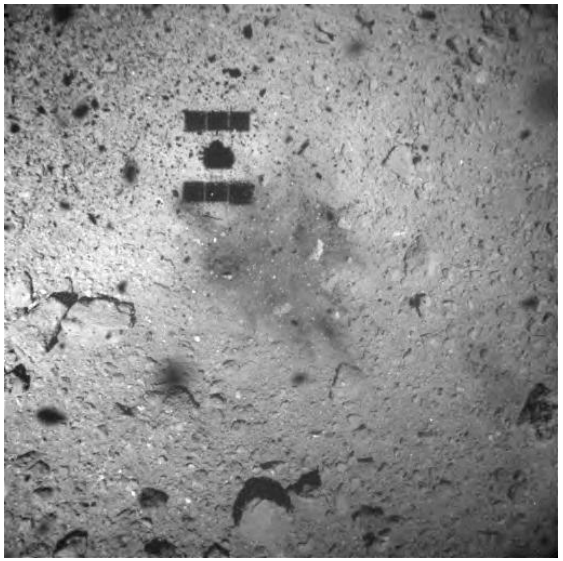




Latest information on HAYABUSA2

The Successful First Touchdown on asteroid Ryugu
Feb 22, 2019

- Successfully conducted the touchdown operation of Hayabusa2 on the surface of asteroid Ryugu.



←Image taken with the Optical Navigation Camera. (altitude of about 25m)
Spacecrafts shadows and discolored area by the touchdown.

Thank you for your kind attention.

Backup Chart

About JAXA -Structure of Space Activities in Japan-

Government structure in relation to space

Strategic Headquarters for Space Policy
(Chairman; the Prime Minister)

Request for advice

➡ Basic Plan on Space Policy

Secretariat

Space Policy Committee
(9 committees from industry, academia etc.)

Cabinet Office
National Space Policy Secretariat
(NSPS)

Management of QZSS

[Cooperation among ministries]

Cabinet Satellite Intelligence Center (CSICE)	MLIT	MOE	MOD	MIC	MEXT	METI	MOFA NPA MAFF etc...
Intelligence	Meteorological Satellite	Greenhouse Gases Observing	National Defense	Communications and Broadcast	Science and Technology Development	Space Industry Promotion	

➡ Mid to Long term Objectives

Incorporated Administrative Agency ➡ JAXA Japan Aerospace Exploration Agency

➡ Mid to Long term Plan

MLIT: Ministry of Land, Infrastructure and Transport
MOE: Ministry of the Environment
MOD: Ministry of Defense

MIC: Ministry of Internal Affairs and Communications
MEXT: Ministry of Education, Culture, Sports, Science and Technology
METI: Ministry of Economy, Trade and Industry

MOFA: Ministry of Foreign Affairs of Japan
NPA: National Police Agency
MAFF: Ministry of Agriculture, Forestry and Fisheries of Japan