Innovative Satellite Technology Demonstration Program

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Innovative Satellite Technology Demonstration Program

Purpose

This program is part of the basic plan for space policy to realize a comprehensive industrial base in outer space to provide opportunities to demonstrate equipment, parts, microsatellites and CubeSats developed by private companies, universities, research institutions, etc.

JAXA is aiming to realize the following through this program.

[1] We will look forward to the future and demonstrate technologies and ideas that will lead to the creation of new uses and industrial competitive systems/subsystems while responding to the challenges of the country and industry.

[2] Although the risk is high, we will preferentially take “innovative” technologies that are expected to achieve high results in the development of Japanese space technology and securing the international competitiveness of the space industry and demonstrate.

Outline of the Public Recruitment System

JAXA is offering proposals for “Innovative Satellite Technology Demonstration Program” throughout the year. For details of application conditions etc, please see the following website.

https://www.kenkai.jaxa.jp/kakushin/index.html

Previous Projects

Innovative Satellite Technology Demonstration-1

Innovative Satellite Technology Demonstration-2
Innovative Satellite Technology Demostracion-3

Outline

The "Innovative Satellite Technology Demonstration-3" is the third demonstration opportunity of the "Innovative Satellite Technology Demonstration Program" to publicly invite universities, research institutions, private companies, etc., equipped with 15 selected themes. It consists of 9 satellites, "RAapid Innovative payload demonstration SatellitE-3" developed by JAXA entrusted to Mitsubishi Heavy Industries, Ltd. (with 7 demonstration themes) and 8 microsatellites / CubeSats.
Mission and Features of
“RApid Innovative payload demonstration SatellitE-3 (RAISE-3)”

Mission

RAISE-3 (RApid Innovative payload demonstration SatellitE-3) is a satellite for seven on-orbit demonstration themes selected in the “Innovative Satellite Technology Demonstration Program”. RAISE-3 will be operated at the request of the proposers of each theme and provide them with opportunity to demonstrate their essential parts and new innovative technologies on orbit.

Features

1. Low-cost and Short-term development

“Innovative Satellite Technology Demonstration Program” provides demonstration opportunities about once every two years, and the RAISE satellite is required to be developed in less than two years and at a low cost. On the other hand, the RAISE satellite needs to be reliable enough to acquire demonstration data from each device. Achieving both short-term, low-cost development and ensuring reliability are important development issues for the RAISE satellite.
To challenge this development,
- RAISE-3 consists of almost flight-proven components and little modified components from flight-proven components to shorten the design and verification period, reduce development costs, and development risks.
- On-Board Computer (OBC) of RAISE-3, which is the key to satellite system control, has many small satellite heritages. This OBC is equipped with a highly radiation-resistant CPU, ensuring high reliability.

2. Development by MBSE

In the development of RAISE-3, MBSE (Model Based Systems Engineering) is attempted to improve the efficiency of satellite development through digital development.
MBSE is partially applied to environment construction, system modeling, design, traceability and review.
Satellite Systems

**Integrated Satellite Control System**

The Integrated Satellite Control (ICS) subsystem has the core functions of the satellite system such as data handling of telemetry commands, satellite management, and mission data processing. These ICS functions are provided by the On-Board Computer (OBC). RAISE-3 OBC is based on the flight-proven OBC and ensures reliability with main/slave-redundant configuration.

**Communication System**

The communication subsystem consists of S-band and X-band. S-band is telemetry command lines for satellite control, and X-band is a telemetry downlink line that transmits experiment data of each theme, etc. from the satellite to the ground system. The S-band communication components are flight-proven with a redundant configuration to improve reliability. The X-band has sufficient downlink data rate to transmit the experiment data of all themes stored in the satellite system to the ground system.

**Electrical Power System**

The Electrical Power Subsystem generates, stores, and supplies the power required for demonstration theme components, satellite bus system components, and heaters. On RAISE-3, solar panels are attached to the four sides of the satellite, and in the sunlight, one or more solar panels continue to generate power enough to each experiment. Li-ion battery with high volumetric and mass efficiency is used to store electric power.

**Attitude Control System**

The Attitude Control Subsystem (ACS) controls the satellite attitude with the three-axis attitude control. ACS has an attitude change maneuver function which enables attitude control necessary for satellite operation and experiments of each demonstration theme. If the ACS component fails partially, the remaining components enable to continue attitude control. That improves the robustness of the satellite system.

**RAISE-3 Configuration**
## Main Characteristics

<table>
<thead>
<tr>
<th>Launch</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Launch Vehicle</td>
<td>Epsilon Launch Vehicle</td>
</tr>
<tr>
<td>Launch Site</td>
<td>Uchinoura Space Center</td>
</tr>
<tr>
<td>Launch Year</td>
<td>JFY 2022</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sun-synchronous orbit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>560km</td>
</tr>
<tr>
<td>Inclination</td>
<td>97.6 degree</td>
</tr>
<tr>
<td>Local Sun Time at Descending Node</td>
<td>9:30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Box-shape with body mounted solar array panels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>1m × 0.8m × 1m (Payload Adapter Fitting not included)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight</th>
<th>110 kg</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Three-axis control (Earth-pointing, Sun-pointing, etc.)</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Solar Array</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average during sunlight BOL: &gt; 250 W, EOL: &gt; 230 W</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mission system</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BOL: max105Wh, EOL: max62 Wh</td>
<td></td>
</tr>
</tbody>
</table>

| Initial Operation 1 month and Nominal Operation 13 months |  |
RAISE-3

Dimensions: 1m × 0.8m × 1m (Payload Adapter Fitting not included)
Weight: 110kg

01 LEOMI
Low Earth Orbit satellite MIMO for 920MHz band IoT platform

02 SDRX
Software Defined Receiver

03 GEMINI
cots GPU based Edge-computing for mission systems utilizing model based systems engineering

04 KIR
Kakushin-3 water Ion-thruster and Resistojet-thruster

05 TMU-PPT
Tokyo Metropolitan University Pulsed-Plasma Thruster

06 D-SAIL
Membrane deployment deorbit mechanism

07 HELIOS
Harvesting Energy with Lightweight Integrated Origami Structure
1-4

Theme of on-orbit demonstration

01
Low Earth Orbit satellite MIMO for 920MHz band IoT platform “LEOMI”

Theme name
On-orbit demonstration of 920 MHz band IoT platform that uses satellite MIMO technology

Proposing organization
Nippon Telegraph and Telephone Corporation

Outline of mission
To demonstrate a satellite MIMO technology to improve the spectral efficiency of satellite links. In addition, this project demonstrates a satellite IoT platform concept realizing ultra-wide area and protocol-free IoT services as a use case for expanding the high-capacity downlink channel by MIMO technology.

Dimensions
LEOMI-TRX: 150mm×150mm×150mm
LEOMI-LANT: 172mm×172mm×42mm
LEOMI-XANT: 71mm×71mm×22mm

Weight
Set: 4.0kg

Person responsible for implementation
Fumihiro Yamashita
Nippon Telegraph and Telephone Corporation

Collaborators
JAXA

02
Software Defined Receiver “SDRX”

Theme name
Software-defined radio that enables flexible satellite development

Proposing organization
NEC Space Technologies, Ltd.

Outline of mission
Demonstrate a method for developing sophisticated and complex satellite systems in a short time and at low cost, as well as on-board rewrite/dynamic reconfiguration techniques in orbit, utilizing digital data related to the design and related processes.

Dimensions
150mm×150mm×150mm

Weight
1.4kg

Person responsible for implementation
Masaharu Tsuchiya
NEC Space Technologies, Ltd.
03  cots GPU based Edge-computing for mission systems utilizing model based systems engineering “GEMINI”

Theme name  On-orbit evaluation and model-based development of a commercial GPU
Proposing organization  Mitsubishi Electric Corporation
Outline of mission  On-orbit demonstration of a consumer GPU capable of ultra-high-speed computation to enable high-speed signal processing such as AI processing and SAR regeneration processing. In addition, the software development for the GPU will be model-based, aiming to shorten the development period and improve quality.
Dimensions  143mm×143mm×45mm
Weight  0.7kg
Person responsible for implementation  Shinya Hirakuri  Mitsubishi Electric Corporation

04  Kakushin-3 water Ion-thruster and Resistojet-thruster “KIR”

Theme name  On-orbit demonstration of an ultra-compact integrated propulsion system that uses water as a propellant
Proposing organization  Pale Blue Inc.
Outline of mission  Aim to enhance competitiveness through on-orbit demonstration of an ultra-compact integrated propulsion system that integrates two types of propulsion systems, resist jet thrusters and ion thrusters using water as the propellant, into a single component.
Dimensions  123mm×123mm×90mm
Weight  1.8kg
Person responsible for implementation  Jun Asakawa  Pale Blue Inc.

05  Tokyo Metropolitan University Pulsed-Plasma Thruster “TMU-PPT”

Theme name  On-orbit demonstration and performance evaluation of a pulsed plasma thruster (PPT) for small satellites
Proposing organization  Advanced Technology Institute, LLC
Outline of mission  To conduct an on-orbit demonstration and performance evaluation of an electric propulsion system that is low-power, compact, and low-cost as a propulsion system for nano-satellites and small satellites.
Dimensions  160mm×130mm×100mm
Weight  1.4kg
Person responsible for implementation  Mitsuteru Sugiki  Advanced Technology Institute, LLC
Collaborators  Tokyo Metropolitan University, University of Yamanashi, Takahashi Denki Seisakusho Corp
06 Membrane deployment deorbit mechanism “D-SAIL”

Theme name: On-orbit demonstration of membrane deployment deorbit mechanism for microsatellites

Proposing organization: Axelspace Corporation

Outline of mission:
To further reduce the period of time that the satellite remains in orbit after the end of operations, the system of deorbit mechanisms will be validated.

Dimensions: 2249mm×2080mm×73mm (when deployed)

Weight: 1.9kg

Person responsible for implementation: Tomohiro Kawamura

Collaborators: SAKASE ADTECH CO., LTD.

07 Harvesting Energy with Lightweight Integrated Origami Structure “HELIOS”

Theme name: Demonstration of a lightweight, membrane deployment structure with power generation and antenna functions for Society 5.0

Proposing organization: SAKASE ADTECH CO., LTD.

Outline of mission:
In order to achieve high performance (high power / high capacity 5G communication / high resolution observation by interferometry) of low-cost small satellites, on-orbit demonstration of a lightweight, high-delivery membrane structure with power generation and antenna functions will be performed.

Dimensions:
- Electric box: 130mm×110mm×110mm
- Membrane structure (when deployed): 1000mm×1000mm×230mm

Weight: Set: 2.3kg

Person responsible for implementation: Yoshiharu Sakai

Collaborators: SAKASE ADTECH CO., LTD.
Each demonstration theme proposer makes an experiment request to the ground system via a web browser. In the ground system, based on the experiment request input and the experiment plan, satellite operation plan is created, and stored-command plan is generated.

The generated stored commands are uploaded to the satellite from the ground station, and the satellite conducts experiments on each demonstration theme according to the stored commands and accumulates the experimental data in the onboard data recorder.

Accumulated experimental data is transmitted from the satellite to the ground system using the X-band telemetry downlink line. The ground system sorts the acquired telemetry data for each demonstration theme, and then generates and stores them as data that can be distributed together with the satellite House Keeping data required for experimental data evaluation. The demonstration theme proposer acquires experimental data via a web browser.

As described above, the demonstration theme proposer can obtain the convenience of being able to input the experiment request and acquire the experiment data all via the WEB browser.
RAISE-3 System Overview

RAISE-3 Total System
- Satellite System

Ground System
- Ground Station
  - S-band Telemetry
  - X-band Telemetry

Satellite Control System
- Satellite control
- Planning
- Data-processing / storing
- Distribution

Experiment request / Experiment plan
- Experiment Data

Demonstration Theme Proposer

RAISE-3 Flight Model

Epsilon Launch Vehicle

Microsatellite | CubeSat
Innovative Satellites
Microsatellite
Launch vehicle is under adjusting

01 KOYOH

**Theme name**: Development of a micro-satellite system for space science and engineering, and X-ray observation of gravitational wave sources

**Proposing organization**: Kanazawa University

**Outline of mission**: The satellite, KOYOH, has a wide field X-ray monitor, and will identify the time and direction of gamma-ray bursts and X-ray transient phenomena associated with gravitational wave radiation. It will share the observed information to ground/space observatories in whole over the world within quasi-real time.

**Dimensions**: 493mm×450mm×488mm  
**Weight**: 43kg

**Person responsible for implementation**: Satoshi Yagitani  
Kanazawa University

02 Platform for Extra and Terrestrial Remote Examination with LCTF “PETREL”

**Theme name**: Demonstration of multi-spectral ocean observation technology that uses an ultra-low cost high-accuracy attitude control bus system

**Proposing organization**: Tokyo Institute of Technology

**Outline of mission**: An innovative multispectral camera will be mounted on a low-cost but high-performance microsatellite. This project including mission operation and providing data application services is conducted by a quite unique academic-industrial consortium in which members contribute via their own professionalities free of charge. This project will open up a new space business utilizing spectral data, and a new research style of space science.

**Dimensions**: 467mm×530mm×512mm  
**Weight**: 62kg

**Person responsible for implementation**: Yoichi Yatsu  
Tokyo Institute of Technology

**Collaborators**: Team Umitsubame
03 Space Tethered Autonomous Robotic Satellite “STARS-X”

Theme name  Demonstration of space tether technology for debris capture

Proposing organization  Shizuoka University

Outline of mission  A tether is extended 1km in space, and a robot (climber) moves on the tether to conduct a debris capture experiment with a net.

Dimensions  540mm×588mm×576mm  Weight  60kg

Person responsible for implementation  Masahiro Nohmi
Shizuoka University

Interview People involved in “Innovative Satellite Technology Demonstration-3”

Interview articles with each organization are on the following website.

©Nagoya University  ©Waseda University  ©SAKASE ADTECH CO., LTD.  ©Kanazawa University  ©Advanced Technology Institute, LLC  ©Kanazawa University
# CubeSat

To be launched by Epsilon Launch Vehicle No.6

## MAGnetically separating NAno-satellite with Rotation for Orbit control “MAGNARO”

**01**

<table>
<thead>
<tr>
<th>Theme name</th>
<th>Rotation and separation of microsatellites to deploy their constellation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposing organization</td>
<td>Nagoya University</td>
</tr>
<tr>
<td>Outline of mission</td>
<td>We aim to establish a method to achieve resource saving, high accuracy, and formation by rotating and separating connected nano-satellites to form a formation, and to achieve multi-point simultaneous observation and continuous earth observation with nano-satellites.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>111mm×111mm×340mm</td>
</tr>
<tr>
<td>Weight</td>
<td>4.4kg</td>
</tr>
<tr>
<td>Person responsible for implementation</td>
<td>Takaya Inamori Nagoya University</td>
</tr>
</tbody>
</table>

## MITSUBA

**02**

<table>
<thead>
<tr>
<th>Theme name</th>
<th>On-orbit demonstration aimed at expanding space application of commercial semiconductor devices and general-purpose equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposing organization</td>
<td>Kyushu Institute of Technology</td>
</tr>
<tr>
<td>Outline of mission</td>
<td>On-orbit degradation observation of COTS semi conductor for adding value to COTS data base and On orbit demonstration of general USB device.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>105mm×100mm×227mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.7kg</td>
</tr>
<tr>
<td>Person responsible for implementation</td>
<td>Hirokazu Masui Kyushu Institute of Technology</td>
</tr>
</tbody>
</table>
03 KOSEN-2

Theme name  Demonstration of technology for a marine observation data collection satellite equipped with a directional antenna with ultra-high precision attitude control, Sustainable space engineer development; and Demonstration of a network-based satellite development scheme

Proposing organization  National Institute of Technology (KOSEN), Yonago College

Outline of mission  The project will collect observation data of seafloor crustal deformation by combining a LPWA (LoRa) receiver and a directional antenna, demonstrate the high-precision attitude control using a dual reaction wheel that integrates fish-eye cameras and magnetic sensors, and demonstrate satellite communications using a satellite data collection protocol specialized for multi-point reception.

Dimensions  111mm x 111mm x 227mm
Weight  2.7kg

Person responsible for implementation  Masahiro Tokumitsu

Collaborators  National Institute of Technology (KOSEN), Gunma College

04 WASEDA-SAT-ZERO

Theme name  Demonstration of integral molding technology for satellite housing

Proposing organization  Waseda University

Outline of mission  Aiming for zero screws, zero mechanical parts, and zero debris by using 3D printer technology to mold the satellite chassis in one piece. Using this satellite chassis, we will conduct deployment experiments of a membrane surface composed of flat elements (like origami).

Dimensions  113mm x 113mm x 113mm
Weight  1.2kg

Person responsible for implementation  Tomoyuki Miyashita

05 FSI-SAT

Theme name  Demonstration of technology for a multi-spectral camera for CubeSat

Proposing organization  Future Science Institute

Outline of mission  A 1U size multispectral camera including data processing system will be developed at low cost to demonstrate basic operation in orbit.

Dimensions  110mm x 110mm x 113mm
Weight  1.4kg

Person responsible for implementation  Mitsuharu Shiwa
Innovative Satellite Technology Demonstration-1

RAPID Innovative payload demonstration Satellite-1
RAIPS-1
JAXA

MicroDragon
Kawasaki University

Rapid International Scientific Experiment Satellite
RISESAT
Tohoku University

Man-made meteor shower Demonstration Satellite
ALE-1
ALE Co. Ltd

Innovative Satellite Technology Demonstration-2

RAPID Innovative payload demonstration Satellite-2
RAISE-2
JAXA

Variable Shape Attitude Control Demonstration Microsatellite
HIBARI
Tokyo Institute of Technology

The multi-wavelength infrared observation microsatellite
Z-Sat
Mitsubishi Heavy Industries, Ltd.

Debris Removal Unprecedented Micro-Satellite
DRUMS
Kawasaki Heavy Industries, Ltd

Innovative Satellite Technology Demonstration-3

RAPID Innovative payload demonstration Satellite-3
RAISE-3
JAXA

KOYOH
Kanazawa University

Platform for Extra and Terrestrial Remote Examination with LCTF
PETREL
Tokyo Institute of Technology

Space Tethered Autonomous Robotic Satellite
STARS-X
Shizuoka University

MAGnetically separating NANO-satellite with Rotation for Orbit control
MAGNARO
Nagoya University

Innovative Satellite Technology Demonstration-4

Coming soon!