Mission Idea Contest:
“Orbit Change Without Using a Propulsion System”

As of February 25, 2026

UNISEC-Global

0. Background

In order to ensure the sustainability of outer space, the avoidance of collisions with other satellites and space debris is expected to become an increasingly critical requirement. In Europe, discussions are progressing toward rules under which satellites that do not possess the capability to maneuver away from a collision trajectory when debris approaches may not be permitted to launch.

On the other hand, the primary method of debris avoidance—“orbit change using a propulsion system”—is challenging. Not only is it difficult to equip a satellite with an appropriate propulsion system, but precise attitude control is also required to direct thrust in the desired direction. This makes installation particularly difficult for small satellites or satellites developed by emerging space nations whose technological capabilities are still maturing.

Here, a “propulsion system” is defined as a device that generates thrust through reaction force by ejecting some form of mass (such as propellant) in a fully separated state in a particular direction. Any device that does not fall under this definition may be used.

Accordingly, this Mission Idea Contest invites proposals for **methods and devices that enable orbital change without using a propulsion system**, as defined above.

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1. What Will Be Evaluated?

Participants shall assume a specific satellite size, mass, and orbit. Under the scenario that debris is predicted to collide with the satellite in X hours, teams shall propose a device capable of shifting the satellite’s orbit as much as possible before the X-hour deadline.

The proposed device must be appropriately sized relative to the satellite. Teams must:

- Rationally explain the concept,
- Model the magnitude and direction of the force that the device can generate,
- Submit the model in software form.

The submitted software will be integrated into a general-purpose orbital simulator prepared by the organizers. The resulting orbital deviation and the ability to restore the orbit will be visualized. The team whose device achieves the most effective results will be declared the winner.

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2. Specific Scenario Settings

(1) Satellite Specifications

- Satellite size: 50 cm × 50 cm × 50 cm
- Mass: 50 kg
- Attitude control: Three-axis stabilization
- Pointing accuracy: 1 degree maintained for an arbitrary duration

The proposed device must:

- Be no more than 20% of the total satellite size and mass
- Operate with a maximum power supply of 20 W from the satellite bus

Orbit:

- Typical Sun-Synchronous Orbit (same as ALOS-4)
- Altitude: 628 km
- Inclination: 97.9 degrees
- Circular orbit

Communication:

- Assume communication between the SSO satellite and a single ground station.

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(2) Debris Approach Assumption

It is assumed that information is received indicating that the satellite has entered a collision trajectory that will result in impact in X = 48 hours.
The approaching object is assumed to have no orbital maneuvering capability.

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(3) Post-Avoidance Recovery

After shifting the orbit to avoid debris, participants must propose methods or ideas for:

- Returning to the original orbit; or
- If full restoration is not possible, recover at least the altitude as close as possible to the original altitude in order to extend orbital lifetime before reentry.

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3. Evaluation Criteria

(1) Orbital Deviation After X Hours

The primary quantitative metric is the degree of deviation (in kilometers) from the original orbit after X hours.
The coordinate system shall be defined as follows:
Using the **Orbital Frame**:

- z-axis: Toward the center of the Earth
- x-axis: Along the direction of orbital motion

- y-axis: Normal to the orbital plane

Deviation in any direction will be evaluated. Participants must present calculation results indicating how far, and in which direction(s), the orbit can be shifted.

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(2) Design Documentation

Teams must submit a design document including:

- The device concept
- The physical principle by which force is generated
- Detailed calculations
- Detailed device design
- Integration with the satellite
- Ground command operation strategy during communication opportunities

Particular emphasis will be placed on the explanation of the force-generation principle and calculation methodology.

The design of the satellite bus itself will not be evaluated.

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(3) Software Submission

Participants must submit software (detailed specifications to be announced later) that calculates the force generated at each time step as a function of time and/or position (x, y, z), expressed in the Orbital Frame (x, y, z components).

The software will be incorporated into the organizer's general-purpose orbital simulator to:

- Visualize orbital changes,
- Evaluate the amount of deviation achieved,
- Assess the degree of orbital restoration.

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(4) Overall Judgment

Final evaluation will be based on a comprehensive assessment of:

- Quantitative performance (amount of orbital deviation and degree of recovery), and
- Qualitative factors including:
  - Novelty of the device concept
  - Feasibility
  - Compatibility with the given satellite size
  - Validity of force calculations
  - Effectiveness of the post-avoidance recovery strategy