Space Debris Related Activities
-Japanese Case-

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Notable Features – Japan –

1. No significant fragmentation in orbit, yet Collisions without long lasting objects (1969, 79)
2. Very early warning of collision hazard possibility Nagatomo paper, 1971*
3. Nation-wide study by academic society JSASS, 1990-1993
4. Early adoption of launch vehicle passivation NASDA, ~1985
5. IADC founding member Japan=NASDA+ISAS+NAL+Academic organizations
7. Leading role in IADC Mitigation Guideline drafting NASDA, ~late 1990’s

Space Debris Study Group Report, 1993
Japan Society for Aeronautical & Space Sciences (JSASS)

Contents

1. Background
2. Space Debris Environment
3. Current Status
   Observation, Sources, Modeling, Social/Economic/Legal, Protection
4. Orbital Environment Preservation
   Development of Technical Standards
   Technology Consideration
   Orbit for early re-entry
   Removal from GEO
   Policy Establishment
   Large object removal technology and cost consideration
   Organization structure for object removal program
Technology background toward Active Debris Removal

1. Conceptual study on GEO object servicing and disposal
   Geostationary Service Vehicle (GSV), 1989, 92

2. On orbit robotic rendezvous/docking demonstration
   ETS-VII, 1996
ADR Activities, Overview

Technology Development
- EDT For LEO
- Plasma For GEO

Space Object Observation
Impact Tests
Environment Model and Simulation

Implementation Plan

Policy to come!

Government

University

Industry

JAXA

General Public

General tendency to support debris removal
Scenarios for debris removal

- Technologies to realize ADR have been studied and key technologies to be demonstrated identified

Scenarios for debris removal in final operation

- Start rendezvous
- Motion estimation
- Attachment of tether end
- Proximity operations
- To the next debris object
- Approach to debris (non-cooperative rendezvous)
- Debris objects in a crowded region
- Debris de-orbit with EDT
- Reenter with EDT

Roadmap for debris removal

**Space Environment Preservation**

**Current Situation**

- Mitigation guidelines were enacted
- Reentry within 25 years is required
- Collisional cascading started
- Removal of existing debris is needed

**International Cooperation with IADC, IAA, etc.**

- Proximity Operations
- Enlargement of EDT
- Non-cooperative rendezvous
- Flight Experiment of EDT

**Removal of One Debris Demonstration**

- EDT for Small Sat.
- EDT for Large S/C
- Micro Remover to remove one debris

**Removal of Multiple Debris**

- EDT Demo

**Satisfy 25-year-rule**

- De-orbit Device for New S/C

**Prevent Collisional Cascading**

- Removal of one debris

**Debris Removal System**

- 5-10km EDT
- Attachment of EDT
- Demonstration of <1km EDT

**Year**

- 2008
- 2013
- 2018
Population Growth

ASSUMPTIONS:
No launch
No explosion
During 200 years

Ariyoshi, Hanada, Kawamoto, “How Can We Identify Colliding Objects to be Removed”. IAC-12-A6.5.1
ASSUMPTIONS:
No launch
No explosion
During 200 years
Business Model for Orbital Debris Removal
- SJAC proposal 2008-


- Fund Raising:
  (Plan 1) Fund depending on the level of responsibility for generating debris in the past
  (Plan 2) Space environment utilization tax
    2.1 (Allocation simply depending on the volume)
    2.2 (Allocation based on debris index)

- Implementation body:
  International public company
  International coordination body

From report of “Committee for Next Generation Space Projects”, SJAC
( Society of Japanese Aerospace Companies)

Mine, “Promoting the Active Debris Removal Project on Business”, 5th Space debris Workshop, JAXA, Jan, 2013
Kitazawa, “Organizational and Operational Requirements for Space Debris Remediation”, International Interdisciplinary Congress on Space Debris Remediation, 2011, McGill University
What are done, what are to come.

Fragmentations due to Explosions, ASATs, Collision of new and operational satellites will be suppressed by Mitigation practices.

Collisions among orbiting old objects are our future concern. This could only be suppressed by Remediation practices where the ADR is the main issue.

Needed are: technology development and demonstration, cost and money flow for implementation, organizational consideration, legal consideration.

Above all, have the government establish a policy toward ADR which ensures internationally coordinated action.
Conclusions

• Actions toward Active Orbital Debris Removal are prevailing at wide levels
• Technology is ready with a possible demonstration in near future
• A coherent strategy not yet established
• An international consensus first to drive national level policy establishment
• Understanding and PUSH by general public could be a key to national consensus
References and Contact address


“Space Debris Study Group Report”, Japan Society for Aeronautics and Space Sciences, 1993


Ariyoshi, Hanada, Kawamoto, “How Can We Identify Colliding Objects to be Removed”. IAC-12-A6.5.1, Naples, 2012

Mine, “Promoting the Active Debris Removal Project on Business”, 5th Space debris Workshop, JAXA, Jan, 2013


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