Survey of IAA Space Debris Studies

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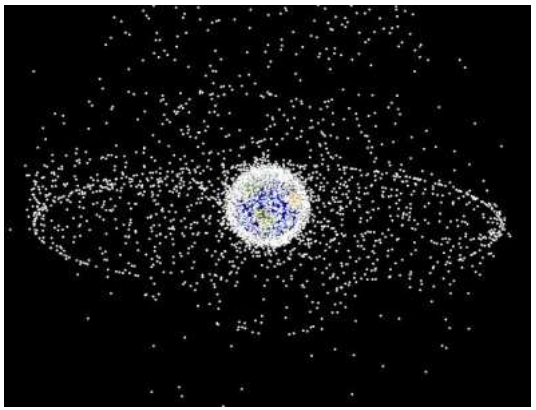
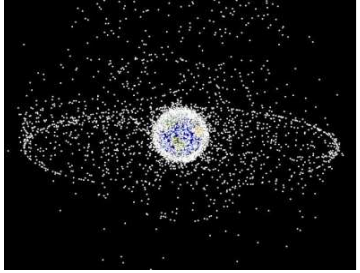
IAA Space Debris Committee



September 28, 2014

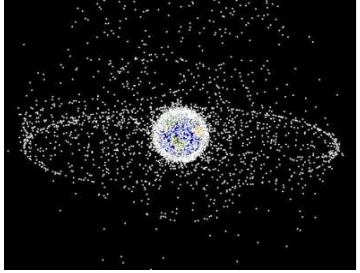
Plenary Session, Academy Day

IAA Space Debris Committee



- Scope
  - Coordination of all activities related to space debris within the Academy
    - Symposium A6 of IAC has consistently been one of the top three symposia in attendance and papers presented
  - Coordination of the Academy participation in conferences dedicated to Space Debris
    - For example, ESA Darmstadt Conference
  - Dissemination of information among the members of the Technical Committee
- Membership
  - 43 members from 12 countries

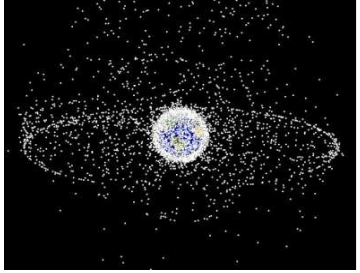
ABSTRACT



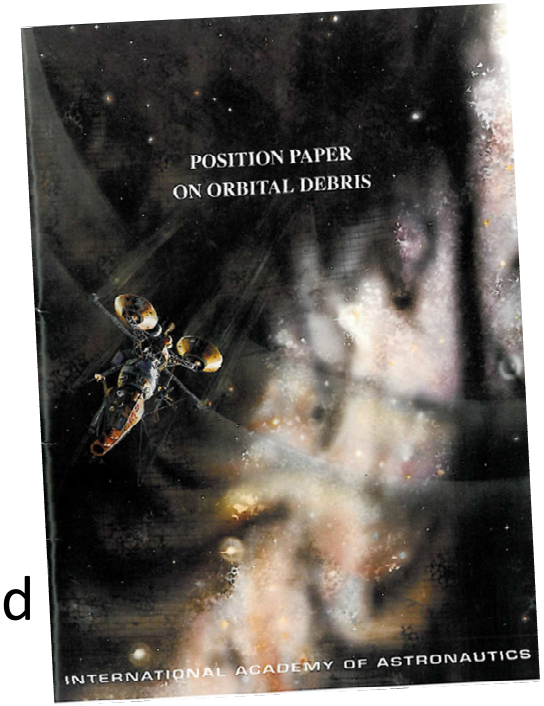
- Orbital debris (OD) is an increasing concern to…
  - Satellite operators, aerospace engineers, space lawyers, insurance underwriters, scientists, and policymakers worldwide.
- Events over the last 20 years have amplified concerns that this environmental hazard
  - Central issue in the decades to come.
- Four documents accelerated technical and policy constructs to deal with the orbital debris problem.
  - Each study provided a timely chronicle of evolving space environmental hazard
  - **Recognition → Characterization → Mitigation → Remediation**
- **Two ongoing report efforts highlight multi-disciplinary foundation of orbital debris debate**

1993 IAA Position Paper

Recognition

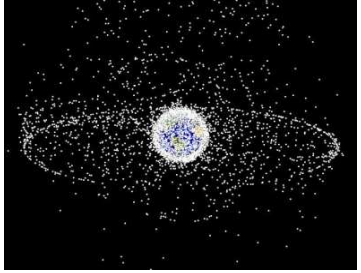


- Compiled by the Ad Hoc Expert Group of the IAA
  - Component of IAC Safety, Rescue, and Quality Committee
- ***Debris scorecard at time of this report:***
  - ***~7,700 cataloged objects in orbit***
  - ***~120 breakups on orbit to date***
  - ***Author statistics: 13 authors - 6 countries***
- Precursor to…
  - Inter-Agency Space Debris Coordination Committee (IADC) formed (1993)
  - NASA Safety Standard 1740.14 – Guidelines and Assessment Procedures for Limiting OD (1995)
  - NASDA STD-18, Space Debris Mitigation Standard (1996)
  - CNES Space Debris Mitigation Standard (1999)



1993 IAA Position Paper

Recommended Actions

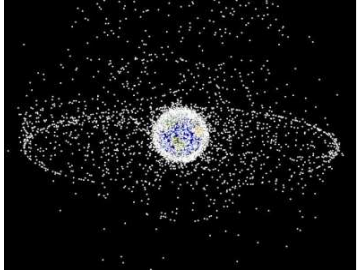


- Three families of options:
  - Category I: should do immediately - require minimal technology development or cost
  - Category II: consider later - require moderate technology development and/or cost
  - Category III: consider later - require significant technology and cost
    - Technical feasibility and cost-effectiveness were unclear.

	Category I Immediate Low $/Little Technology Development Needed	**Category II** Secondary Mod $/Some Development Needed	**Category III** Long-Term High $/Significantly Technology Development Needed
ACTIONS	1.No deliberate breakups 2.Minimize operational debris 3.Vent LEO rocket bodies (R/B) 4.Minimize GTO lifetimes 5.Reorbit dead GEO payloads (P/L) 6.Separate kick motors into super-synchronous orbit (SSO) 7.Vent GEO rocket bodies and move to SSO	1.Removal within 3 months of all R/B's and defunct P/L's in LEO if lifetime exceeds 10 years 2.Removal of all R/B's and P/L's in GTO and highly elliptical orbits within 10 years 3.Reorbit R/B's and P/L's outside of LEO into a disposal orbit 4.Deorbit hardware into oceans to reduce ground hazard	1.Develop propulsive deorbit capability 2.Develop drag augmentation systems for removal 3.Develop grappling and detumbling devices plus tethers for removal 4.Develop laser removal 5.Develop effective sweepers that can avoid collisions

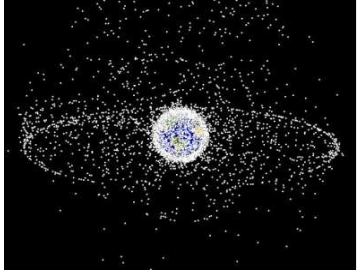
2001 IAA Position Paper

Characterization



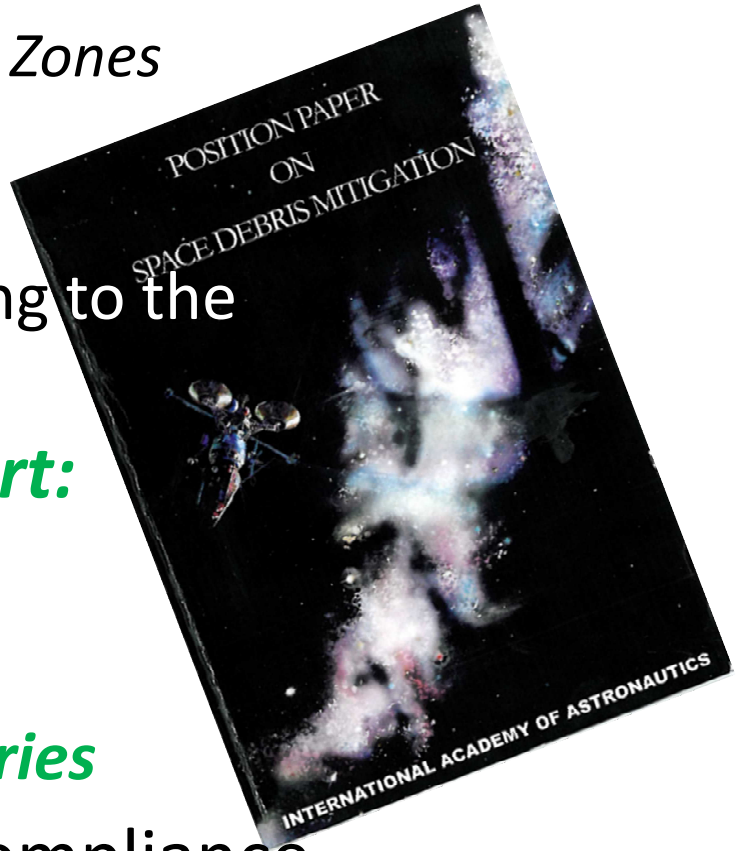
- Update of 1993 IAA Position Paper
  - Updated by Space Debris Subcommittee of the IAA
- ***Debris scorecard at time of this report:***
  - ***~8,700 cataloged objects in orbit***
  - ***~160 breakups on orbit to date***
  - ***Author statistics: 26 authors - 9 countries***
- Update takes into account:
  - New results of space debris research
  - Evolving space debris environment
  - International policy developments

2005 IAA Position Paper SG 5.1 on Space Debris



Mitigation

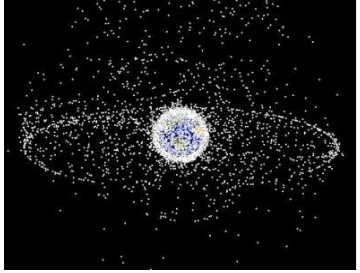
Implementing Zero Debris Creation Zones



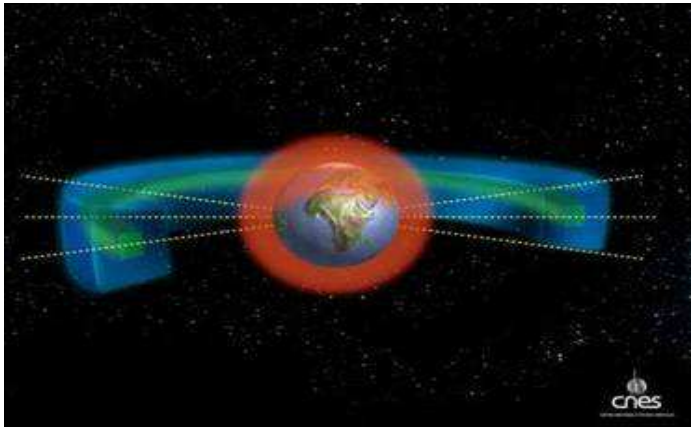
- Focus on debris mitigation
  - Aerospace community must stop adding to the existing debris population
- ***Debris scorecard at time of this report:***
  - ***~10,300 cataloged objects in orbit***
  - ***~180 breakups on orbit to date***
  - ***Author statistics: 22 authors - 8 countries***
- Outline operational procedures for compliance with evolving space debris mitigation guidelines

2005 IAA Position Paper

Recommendations



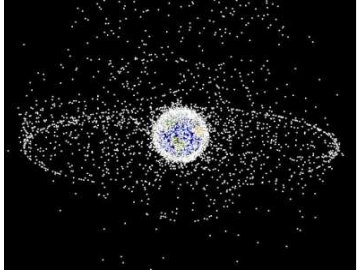
- Proposed two space regimes to protect through zero debris creation mandates
  - LEO: Up to 2000km
  - GEO: ± 200km altitude and ± 15° latitude



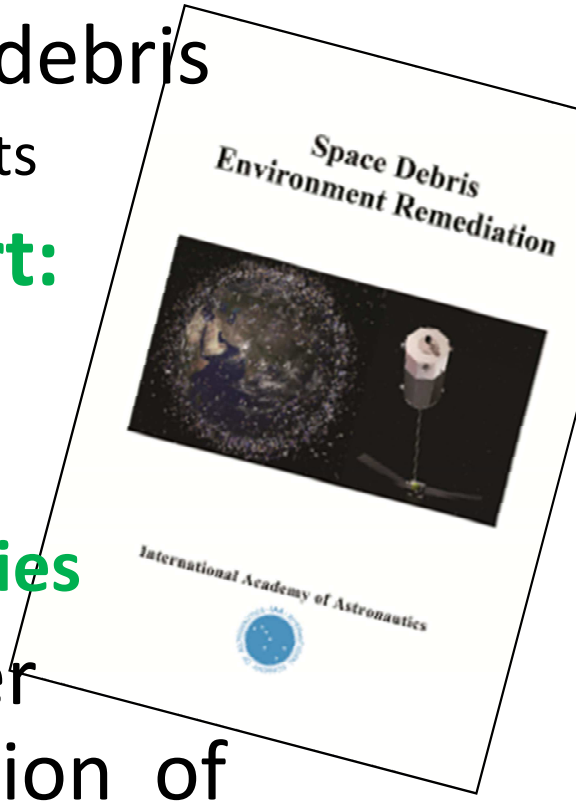
Debris Mitigation Guidelines	Hardware Design	Mission Operations
Spacecraft	*Minimize debris releases* *Eliminate energy sources (after use)* *Remove from orbit*	
Launchers		

2013 IAA Cosmic Study SG 5.5 on Space Debris Environment

Remediation

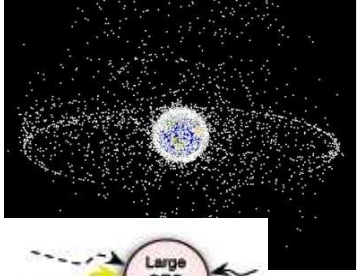


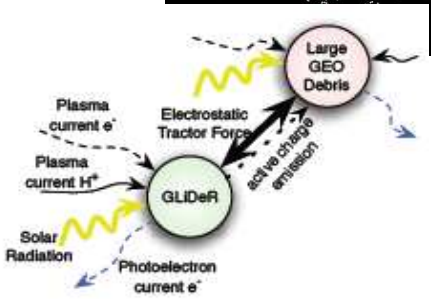
- Debris mitigation guidelines will not be sufficient to control growth of orbital debris
  - Must actively remove massive derelict objects
- **Debris scorecard at time of this report:**
  - **~16,600 cataloged objects in orbit**
  - **~210 breakups on orbit to date**
  - **Author statistics: 26 authors - 11 countries**
- Wide variety of technologies are under consideration for the challenging mission of active debris removal (ADR)

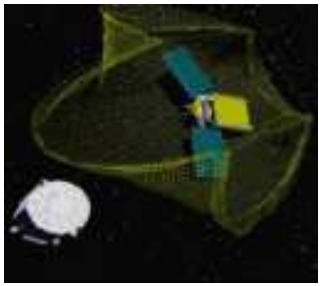


2013 IAA Cosmic Study

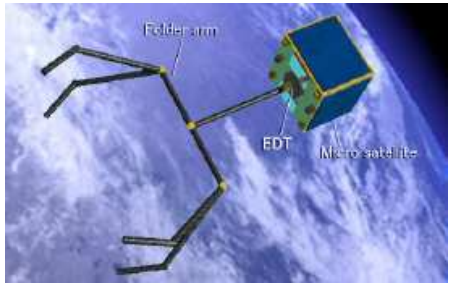
Key Findings

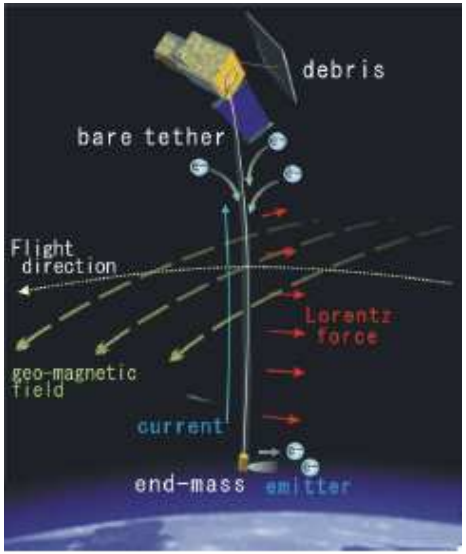






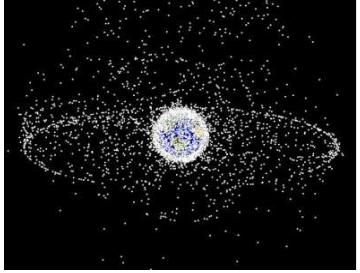
- Remove massive objects in cluttered orbits
- LEO – removal; GEO – move up
  - Must grapple, (possibly) despin, and move/remove
- Propulsive tug is only proven removal technology
  - Many other promising options in research and development





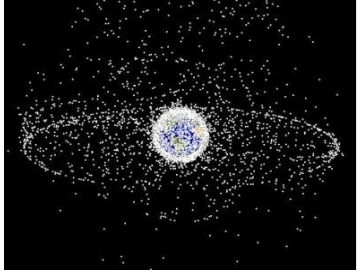
Two New Reports Ongoing

Drafts assembled in Toronto IAA this week



- 1. Inter-Disciplinary Cosmic Study
  - Policy, legal, economic, and technical
- 2. IAA Status Report
  - Comprehensive treatise
    - Creation to re-entry
- *International Challenges*
  - Actively catalyze cooperation
    - Will not 'just happen'
  - Involve newcomers at IADC and UN COPUOS
  - Same rules
    - Avoid 'flags of convenience' in space

2014 IAA SG 5.10 on OD Removal: Policy, Legal, and Economic Considerations

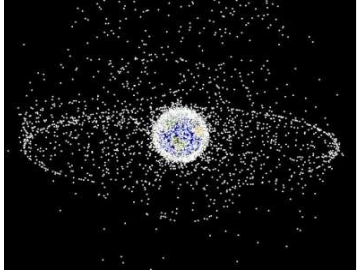


Ongoing Development

- Build upon technical framework of the 2013 IAA Cosmic Study on Space Debris Environment Remediation to determine operational issues to fielding ADR options
  - Policy: Is it a space commons or alternative venue for international politics?
  - Legal: What is debris and who defines remaining utility of an object?
  - Economic: Is active debris removal cost-effective?

Situation Report on Space Debris SG5.14
By IAA Space Debris Commitee

Ongoing Development



- Context
  - Present Status
  - Measurements
  - Space Surveillance
- Reduce Effects
  - Collision Risk Management
  - Protection
  - Reentering Space Objects
- Reduce Environment
  - Debris Mitigation
  - Debris Remediation
- Legal Issues
  - Ownership
  - Liability
- Future Environment