ORBITAL DEBRIS: WHAT ARE THE BEST NEAR-TERM ACTIONS TO TAKE? A VIEW FROM THE FIELD.

2nd Manfred Lachs International Conference on Global Space Governance
30 May 2014
Dr. Mark A. Skinner
Agenda

- What are we trying to protect?
- So what's the problem?
  - Detritus of the Space Age
  - Debris begets debris: the Kessler syndrome
- So what can we do about it?
  - International cooperation
  - SSA
  - Data sharing
  - Debris removal
- Next best steps
- Conclusions
How to assure continued use of space for the future?
Man-made debris dominates Earth's near-space region

- Computer-generated images show objects currently tracked by US Space Command.
- 95% of objects in image are space debris.
- There exist additional debris populations at GEO that are not shown on this image.

Image courtesy of the NASA Orbital Debris Program Office.
How to create more space debris...
How is the amount changing over time?

Monthly Number of Objects in Earth Orbit by Object Type:

- **Total Objects**
- **Fragmentation Debris**
- **Spacecraft**
- **Mission-related Debris**
- **Rocket Bodies**

Monthly Number of Cataloged Objects in Earth Orbit by Object Type: This chart displays a summary of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. “Fragmentation debris” includes satellite breakup debris and anomalous event debris, while “mission-related debris” includes all objects dispensed, separated, or released as part of the planned mission.
The Kessler Syndrome: a run-away cascade of space debris...
What can we do about it?
Range of options, and their relative costs and time-scales

- **International cooperation**
  - Inexpensive, but medium-term
    - Not fixing existing problem, but for a better future

- **Data sharing**
  - Inexpensive, short-term
    - With some limitations

- **Additional SSA**
  - Inexpensive, short-term

- **Debris Removal**
  - Expensive, long-term
    - But needs to be researched now…
International Cooperation

UN (HQ, NYC)

UNIDIR* (GVA)
-Military/Disarmament issues
-Legal SC
-Outer Space Treaties
-Principles of use of NPS in space
-Capacity building in Space Law
-National mechanisms for space debris
-National legislation on peaceful uses of space

COPUOS (VIE)
-1959; 76 members
-Science & Tech SC
-Nuclear Power Systems
-SPIDER+ (disaster management)
-Space Debris
-Space Weather
-Use of GEO
-Long-term sustainability

Decisions are reached by absolute consensus

*United Nations Institute for Disarmament Research

+United Nations Platform for Space-based Information for Disaster Management and Emergency Response

*United Nations Office for Outer Space Affairs
The objective of the Working Group is to examine and propose measures to ensure the safe and sustainable use of outer space for peaceful purposes, for the benefit of all countries.
The output: guidelines under discussion...

The document gets translated into the five other UN languages
SSA & Space Surveillance

- Space Command maintains catalog of space objects
  - Utilizes ground-based optical & radar, space-based optical
- ISON has a network of small telescopes
- Emerging commercial SSA networks
The "Catalog"…

"TLE" for the ISS

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<th>NORAD CAT ID</th>
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<th>INTLDES</th>
<th>TYPE</th>
<th>COUNTRY</th>
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2 25544 051.6463 107.0810 0003978 337.2202 062.8076 15.50434083879826
Solving the problem - moving beyond the SSN
Data Sharing… for active space objects

SDA Current Participants

Multi-national, open to all space operators, in all orbital regimes

- 24 contributing operators
- 3 civil satellite operators

- inmarsat
- eutelsat communications
- INTELSAT
- SES
- Echostar Satellite Services
- EUMETSAT
- Skybox Imaging
- Airbus Defence & Space
- Star One
- NASA
- Avanti
- 3b Networks
- Thuraya
- AMOS
- ARABSAT
- NOAA
- DigitalGlobe
- OPTUS
- Iridium
- Iridium Everywhere
- ORBCOMM
- Telesat
- ISTDA
International space debris data sharing

No international public repository for space debris information...

- **The Model:**
  - Minor Planet Center
  - Associated with IAU
  - Located at SAO
  - Funded by NASA
    - 6 FTE's
    - Collates and associates observations of natural space objects

- **Proposal:**
  - Space Debris Data Center
  - Ties to UN COPUOS
  - Initial DARPA Demo
  - Funded by NASA
    - Orbital Debris Program Office
      - Located at MHPCC
        - UH- Pan-STARRS
        - Collates and associates observations of artificial space objects
Additional SSA for debris on a commercial/civil basis; telescope requirements* are modest…

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<td>BTA-6</td>
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<td>Galileo's 1609 telescope</td>
<td>1.5</td>
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*But need a sensitive camera
Active Debris Removal (ADR)

CleanSpace One
Size: 30 x 10 x 10 cm
Predicted launch: 2015-2016
Mission: De-orbit an obsolete satellite

1. Ejection
   Altitude: 500-750 km
2. Approach
   Speed: 28,000 km/h
3. Rendezvous phase
4. Grappling
5. Target orbit
6. and disintegration
   Temperature: more than 1000°C
One "hard" technical problem with ADR...

- Most defunct payloads, rocket bodies, and debris pieces are spinning/tumbling.
- "Non-cooperative"
- 0.33-20 RPM: ~30 km/hour
- Would require extraordinary amounts of energy ($\Delta v$) to capture and remove
ADR alternatives....

**JCA Operations:**
Prevent imminent orbital collision w/o going into orbit

1. **Identify:** Ground and orbital systems detect imminent collision.
2. **React:** Air-launch system is mobilized with JCA system on board.
3. **Deflect:** JCA system is deployed to induce a slight change in the orbit of one of the objects involved by deploying cloud of high density gas.
4. **Prevent:** If the object’s orbit is changed enough the collision will be prevented.

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** wenn Cahn:**

Original Orbit
Ground Detection
Aircraft Trajectory
Launch Vehicle Trajectory
New Orbit

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**Systems:**

1. **Identify**
   - Ground and orbital systems detect imminent collision.
2. **React**
   - Air-launch system is mobilized with JCA system on board.
3. **Deflect**
   - JCA system is deployed to induce a slight change in the orbit of one of the objects involved by deploying cloud of high density gas.
4. **Prevent**
   - If the object’s orbit is changed enough the collision will be prevented.
So where should we spend the next dollar?

- Additional SSA capabilities provide most efficient use of any additional funding
- Need to share data on debris internationally
  - New low-cost *Space Debris Data Center*
- Continue international discussions to develop best practices & guidance
- Research into how to accomplish collision avoidance
Space debris is caused by us
10,000's of objects
Danger to the near-Earth space environment and the long-term sustainable use of space
Danger to humans; astronauts and people on the ground
Studied by governments and industry
Under international discussion
Need to do something now and in the future-
multi-phased approaches
Need better knowledge of objects in space