Space Security: Capabilities and Limits of Technical Solutions

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Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

War and Poverty, Peace and Prosperity, May 31, 2007
How is space used now?
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Communication: 66%
Navigation: 7%
Earth observation/remote sensing: 5%
Military surveillance: 6%
Astrophysics/space physics: 5%
Earth Science/meteorology: 5%
Other: 5%
How is space used now?

- LEO: 46%
- GEO: 43%
- MEO: 6%
- Molniya: 2%
- Other: 3%
UCS Database of Active Satellites

- Available at www.ucsusa.org/global_security/
- Data on over 800 satellites, updated quarterly
Government spending on space

US military space spending is 95% of worldwide total
The Physics of Space Security

A Reference Manual

David Wright, Laura Grego, and Lisbeth Gronlund

Published by:
American Academy of Arts and Sciences (May 2005)
Roughly half of current space debris is in LEO (<2,000 km altitude).
## Current Orbital Debris Population in Low Earth Orbit (LEO)

<table>
<thead>
<tr>
<th>Debris size</th>
<th>1 mm to 1 cm</th>
<th>1 cm to 10 cm</th>
<th>&gt; 10 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total debris in LEO before Chinese test</td>
<td>140 million</td>
<td>180,000</td>
<td>9,700</td>
</tr>
</tbody>
</table>
Orbital Debris Created by the Breakup of a 10-ton Satellite

<table>
<thead>
<tr>
<th>Debris category</th>
<th>Debris size</th>
</tr>
</thead>
<tbody>
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<td>Total debris in LEO before Chinese test</td>
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<td>Debris from the breakup of a 10-ton satellite</td>
<td>14 million</td>
</tr>
</tbody>
</table>

The catastrophic breakup of even a single massive satellite would dramatically increase the amount of debris currently in orbit.
Debris Evolution from ASAT

Figure 2. Cloud of debris of size greater than 10 cm after 15 minutes.

Figure 3. Debris cloud after 10 days.

Figure 4: Debris cloud after 6 months.

Figure 5: Debris cloud after 3 years.

Includes “J2” and “J4” terms to describe nonsphericity of earth.
200-year Debris Evolution in 900-1,000 km band

The red zone. Effective number of objects, 10 cm and larger, between 900- and 1000-km altitudes from the LEGEND simulation.

(Liou-Johnson, Science, Jan 2006)
Proposed New Military Missions for Space

- Attacks on ground targets
- Ballistic missile defense
- Defense of satellites
- Attacks on satellites
Space-based ground attacks

• Performs “Global Strike” mission outlined in Nuclear Posture Review

• Fast response time requires a constellation of satellites; orbital period in LEO is ~90 min

• For an attack that requires a response time of under an hour, need tens of satellites

• Ground-based alternatives many tens of times less expensive
Ballistic Missile Defense

• Response time required is ten times shorter than ground attack

• Requires hundreds to thousands of satellites in constellation

• Can be locally overwhelmed by launch of several ICBMs, or can have a “hole” punched through by shorter range missiles, rendering the defense ineffective.