Orbital Debris: A Policy Perspective

Nicholas L. Johnson
Chief Scientist for Orbital Debris
NASA Johnson Space Center

12 October 2007

The Jefferson Society
University of Virginia
Voyage through near-Earth Space

(Animation)
What is Orbital Debris?

- Space debris encompasses both natural (meteoroid) and artificial (man-made) particles.
  - Meteoroids are in orbit about the Sun
  - Orbital debris are man-made and in orbit about the Earth

Non-operational Spacecraft

Fragmentation and Mission-related Debris

Derelict Launch Vehicle Stages
Orbital Debris Detectors and Damage Potential

Potential Shuttle Damage

- Window Replacement
- EVA Suit Penetration
- Radiator Penetration
- RCC Penetration
- TPS Tile Penetration
- Cabin Penetration
- Cargo Bay Damage

Debris Diameter in Centimeters

0.001 0.01 0.1 1 10 100 1000

Spacecraft Surface Inspections

Haystack Auxiliary Radar

Haystack Radar

Goldstone Radars

Space Surveillance Network
The Hubble Space Telescope suffered a significant impact in one high gain antenna during its first four years in space.
After 7 years in space the Hubble Space Telescope had been peppered with more than 500 craters on its aft shroud.
Mir Space Station Solar Array

- Sample impact from Mir solar array returned in 1998 by Space Shuttle.

Front of Panel

Rear of Panel
Space Shuttle
Satellite Explosions

- Nearly 200 satellite breakups identified since 1961
  - Primary source of orbital debris larger than 1 cm

Explosion of Russian Launch Vehicle Stage in February 2007
• Three accidental satellite collisions from different missions have already been identified.

• In the future, accidental collisions among derelict objects will be the greatest source of new debris.
Avoid the unnecessary release of orbital debris

Avoid accidental and deliberate satellite fragmentations

Properly dispose of spacecraft and launch vehicle orbital stages

Protect people and property on Earth from reentering debris
International Space Station Jettison Policy
International Space Station Jettison Policy

(Video)
Controlled Satellite Reentries

Compton Gamma Ray Observatory

Reentry 2000

6:12:26 AM

6:13:04 AM

6:13:27 AM
Controlled Satellite Reentries

Mir Space Station

Reentry 2001
Uncontrolled Satellite Reentries

- Georgetown, Texas, 1997
Return of Space Objects

- Nose cone launched in October 1998
- Washed ashore in Texas in Feb 2000
- Returned to France in 2004
Orbital Debris and U.S. National Space Policy

- Orbital debris has been addressed in all U.S. national space policies since 1988.

- New National Space Policy (signed 31 August 2006 by President Bush) states:

  “Orbital debris poses a risk to continued reliable use of space-based services and operations and to the safety of persons and property in space and on Earth. The United States shall seek to minimize the creation of orbital debris by government and non-government operations in space in order to preserve the space environment for future generations.”
Bankruptcy of the Iridium Satellite System

We'll be shutting down our global communications business and de-orbiting our satellites.

Question: Wouldn't that create dozens of deadly flame balls speeding toward Earth?

That's why we're aiming for cities that have lots of swimming pools.
Inter-Agency Space Debris Coordination Committee (IADC)
Orbital Debris at the United Nations
Chinese Anti-satellite System

- Test conducted 11 Jan 2007
- ~2500 large orbital debris
- Some debris will remain in orbit for > 100 years
• In the future accidental collisions will dominate the growth of debris population.
Failure to curtail the growth of orbital debris will eventually lead to potential loss or limitation of the practical use of portions of near-Earth space for economic, scientific, and national security purposes.

The challenge of orbital debris is to identify economically acceptable, but effective, mitigation practices which will be implemented by the majority of international space-faring community.

– The alternative is to bequeath a degraded space environment to future generations