Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
fact sheet

Space Debris from Anti-Satellite Weapons

Space debris is any human-made object in orbit that no longer serves a useful purpose. It includes defunct satellites, discarded equipment and rocket stages, and fragments from the breakup of satellites and rocket stages.

Space debris is a concern because—due to its very high speed in orbit—even relatively small pieces can damage or destroy satellites in a collision. Since debris at high altitudes can stay in orbit for decades or longer, it accumulates as more is produced. As the amount grows, the risk of collisions with satellites also grows. If the amount of debris at some altitudes becomes sufficiently large, it could be difficult to use those regions for satellites.

Since there is currently no effective way to remove large amounts of debris from orbit, controlling the production of debris is essential for preserving the long-term use of space.

What's in Space

Since the beginning of the space age there have been some 4,500 space launches worldwide, and today there are 870 active satellites in orbit, supporting a wide range of civil and military uses. The United States owns and operates roughly half of those satellites. This space activity has resulted in millions of pieces of orbiting debris (see table).

	Debris Size		
	0.1 to 1 cm	**1 to 10 cm**	**> 10 cm**
Total debris at all altitudes	150 million	750,000	22,000
Debris in low earth orbit (LEO)	16 million	370,000	14,000
Debris from the destruction of a 10 ton satellite	8-14 million	250,000-750,000	5,000-15,000
Debris from Chinese ASAT test	2 million	150,000	2,500

The first two rows show the estimated debris at all altitudes and in low earth orbit (below 2,000 km altitude) in three size categories; the background of naturally occurring objects (meteoroids) adds significantly to these numbers in the 0.1 to 1 cm range. The third row shows estimates of the debris from a catastrophic breakup of a 5 to 10-ton satellite. The bottom row gives estimates of the debris created by the Chinese ASAT test in January 2007.

There are two main sources of orbital debris:
(1) Routine space activity and the accidental breakup of satellites and stages placed in orbit by such activity;
(2) The testing or use of destructive anti-satellite (ASAT) weapons that physically collide with satellites at high speed (also known as "kinetic energy ASATs").

The international community is attempting to reduce the first category by developing strict guidelines to limit the debris created as a result of routine space activities. These guidelines appear to be working and can, with strict adherence, significantly reduce the growth of this type of debris.

The destruction of satellites by ASAT weapons can produce tremendous amounts of orbital debris: the destruction of a *single* large satellite such as a U.S. spy satellite could by itself *double* the total amount of large debris currently in low earth orbit (LEO), where nearly half of current satellites reside. There are currently no international restrictions on the testing or use of military systems intended to destroy satellites. *(over)*

Development and Testing of Destructive ASAT Weapons

In principle there are many types of ASAT weapons a country could use to interfere with the operation of satellites. Unlike most of these, a successful attack by a kinetic energy ASAT weapon would likely cause damage that could be detected by sensors on the ground, and detecting severe physical damage would strongly imply that the satellite was no longer functioning. If such ASATs are seen as legitimate weapons, a country might therefore have a strong incentive to develop one for use against satellites that are deemed highly important militarily. U.S. spy satellites, with masses of about 10 tons, are frequently mentioned targets of such attacks.

Both the United States and Soviet Union developed and tested destructive ASAT weapons during the 1970s and 1980s. The Soviet system was designed to approach a satellite at low speed and destroy it with shrapnel; the system is not believed to have worked well in tests. These tests created more than 700 pieces of large debris, roughly 300 of which remain in orbit.

The U.S. ASAT was a kinetic energy weapon designed to home at high speeds and destroy the satellite in a collision. It was successfully tested in 1985, destroying a 1-ton satellite orbiting at 525 km altitude. This test created thousands of pieces of space debris larger than 1 cm, but because it took place at relatively low altitude atmospheric drag caused the vast majority of the large debris to decay from orbit within a decade.

Following the U.S. test in 1985, there was a de facto moratorium on such tests until China tested a kinetic energy ASAT weapon in January 2007 against a 1-ton satellite orbiting at 850 km altitude. Like the U.S. test, the Chinese ASAT test created thousands of large pieces of debris. However, because atmospheric drag is much lower at this higher altitude, a large fraction of this debris will remain in orbit for many decades. Moreover, this debris is concentrated in the most densely populated part of space.

Threat to Satellites

Debris in low Earth orbit travels 30 times faster than a commercial jet aircraft. At these speeds, pieces of debris larger than 1 cm (half an inch) can severely damage or destroy a satellite, and it is not possible to shield effectively against debris of this size.

The Chinese destruction of a relatively small satellite roughly doubled the debris threat to satellites in the most heavily used part of LEO. Fortunately, the debris threat to satellites is still relatively small, but continued testing of destructive ASAT weapons against satellites, or their use against several large satellites in a conflict, could result in a much higher risk.

ASAT weapons could therefore significantly increase the cost of using space, and could hinder using regions of space that today are widely used for a range of purposes. Beyond that, the sudden loss of a satellite due to debris during a crisis could remove important capabilities, or could lead to dangerous reactions and the escalation of the crisis, especially if the adversary was known to have an ASAT capability.

Policy Recommendation

Space is uniquely suited for a range of important uses, such as communication, earth observation, and navigation, and society has becoming highly dependent on satellites. The international community has taken steps to limit the debris from routine space activity, and developing international measures to prohibit the testing or use of destructive ASAT weapons should now be a high priority. As the country by far the most dependent on space, the United States should take steps to lead this effort.

For more information contact Dr. David Wright at 617-301-8060 or dwright@ucsusa.org, or see "Space Debris," Physics Today, October 2007, available at http://www.ucsusa.org/global_security/space_weapons/space-debris-from-anti-satellite-weapons.html

April 2008