COMMENT

Rules of the Road for Space?: Satellite Collisions and the Inadequacy of Current Space Law

by Robert P. Merges and Glenn H. Reynolds

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The February 2009 collision of a dead Russian satellite with an Iridium communications satellite left a cloud of debris in orbit and a number of questions on earth as to why and how it happened and who was responsible.[1] Contrary to some popular impressions, outer space is not a lawless region, but an area governed by international law (and, in the case of U.S. spacecrafts and the U.S. parts of the International Space Station, by American law).[2] Unfortunately, existing space law is inadequate to deal with the growing problem of space collisions and space debris. In this brief essay, we will note some of these problems and suggest some steps toward a solution, while drawing a few more general lessons regarding the state of international space law today.

I. Current Space Law

Damage to and by spacecraft is governed by the 1972 Convention on International Liability for Damage Caused by Space Objects.[3] Under that treaty, liability for damage caused to people or property on the ground is "absolute"—meaning that the country that launched the spacecraft is liable for damages, even if there was no negligence. The same strict liability applies if a crashing space object strikes an aircraft. Defenses, such as due care or contributory negligence, are unavailable to the owner of the spacecraft—or, more precisely, to the "launching state" on whose registry the spacecraft is carried. This approach makes sense. Anyone operating a spacecraft must know that it can do damage wherever it crashes, whereas expecting people on the ground to be on guard against crashing satellites is unrealistic; the likelihood that any particular person or building will be struck is too low to justify taking precautions.

Though far from perfect, the strict liability regime governing damages on earth is straightforward and sensible.[4] In space, however, matters are less so. When one spacecraft collides with another, the Liability Convention provides for liability only if the spacecraft operator is at fault—that is, negligent in some way. But the Liability Convention provides no guidance on what constitutes negligence in this context.

Operating a spacecraft in a way that poses a substantial foreseeable risk to others is probably negligent, but in the case of the February 2009 collision, the Russian Kosmos military satellite was described as "defunct," meaning that it had either broken down or run out of maneuvering fuel.[5] Many defunct satellites in orbit exist, and although good practice calls for their operators to either deorbit them or boost them into harmless parking orbits before control is lost, this is not always possible. Even if it were, it would be hard to argue that failure to do so constitutes negligence. While we may one day develop standards of practice or "rules of the road" for space, standards affirmatively requiring space operators to ensure that satellites vacate high-traffic orbits at the end of their lives are not in force at present.[6] Thus, merely leaving inoperable spacecraft in earth orbit is unlikely to rise to the level of negligence. Unfortunately, the number of inoperable spacecraft in orbit is climbing, with predictable results.

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1. *See* Paul Rincon, *Sat Collision Highlights Growing Threat*, BBC News, Feb. 12, 2009, http://news.bbc.co.uk/2/hi/science/nature/7885750.stm.
2. *See generally* Glenn H. Reynolds & Robert P. Merges, Outer Space: Problems of Law and Policy (2d ed. 1997) (describing international and American space law).
3. 28 U.S.T. 2389, T.I.A.S. 7762.
4. Alexander Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 Yale J. Int'l L. 78 (1984) (describing negotiations over liability for crashed Soviet satellite). Since most launching states tend to launch many satellites, a strict liability regime allows for "spreading" accident costs over a number of launches. *See* Guido Calabresi, The Cost of Accidents 39-67 (1970). Imposition of fault-based liability as between space objects also makes sense from a "spreading" standpoint. Reynolds & Merges, *supra* note 2, at 186-89. Note that this regime, with strict liability regarding those on the ground, but fault-based liability among those off of it, mirrors that of American tort law. *See* Restatement (Second) of Torts, §520A.
5. *Satellite Collision Produces Dangerous Debris*, Nat'l Geographic News, Feb. 12, 2009, http://news.nationalgeographic.com/news/2009/02/photogalleries/satellite-collision-pictures/.
6. *See generally* Kendra Webb, *To Infinity and Beyond: The Adequacy of Current Space Law to Cover Torts Committed in Outer Space*, 16 Tul. J. Int'l & Comp. L. 295, 310-12 (2007) (describing problems with Chinese liability for missile-test debris).

II. The Growing Debris Problem

The amount of debris in space is rising, and fast. Space debris expert Nicholas Johnson estimates that there are about 19,000 man-made objects in orbit around the earth. Roughly 900 of those are satellites. What is left is mostly junk, ranging from pieces of spacecraft to wrenches dropped by astronauts and even paint chips that have flaked off spacecraft.[7] Depending on how high the orbit is, fragments may persist for days, months, years, or even millennia.[8] Worse still, if enough debris accumulates, we are at risk of a chain reaction—called the Kessler effect[9]—in which satellite fragments damage more satellites, fragmenting them and producing still more debris. Potentially, this could lead to a "debris belt" in orbit that would make access to space much more dangerous and expensive.[10]

From a legal standpoint, things are even worse. While intact satellites can be traced back to their countries of origin, debris fragments—which, because of the tremendous velocities involved, can wreck a spacecraft even when they are smaller than a golf ball—will often be from unidentifiable sources. Nor does current space law allow one possible solution to the space-junk problem: salvage. Under the 1967 Outer Space Treaty,[11] nations retain "jurisdiction and control" over their spacecraft, even when they are inoperable,[12] meaning that a salvage operator would not be able to take title or claim an award for recovering a defunct craft as is done on earth.[13]

In light of these difficulties, it would be wise to address the debris problem as much as possible now, lest it become substantially worse in the not too distant future.

III. Possible Solutions

Space lawyers have been arguing for years that the proliferation of space junk makes some sort of salvage law necessary, but there has been little progress.[14] While expensive, the technology for recovering defunct satellites—returning them to earth or placing them in an orbit where they will burn up safely, for example—is well within current technology. Cleaning up smaller debris fragments, however, will prove more difficult. You can not rendezvous with a paint speck or a lug nut. Some have proposed burning up small bits with lasers or capturing them with large blobs of orbiting aerogel, but many of these solutions risk producing more debris from collisions, and all would be expensive and controversial.[15]

Another approach is to prevent space collisions in the first place through better traffic control. Today, satellite operators do not have precise orbital parameters for other satellites that might pose a risk of collision. Only a few countries—chiefly the United States, and to some degree China, Europe, and Russia—have access to precise tracking data, and that information is kept secret, lest it reveal details about the sophisticated instrumentation used to gather it. Military planners have long talked about the need for "space situational awareness," and the military tracks satellites for its own purposes.[16] But the increasingly crowded nature of near-earth orbits, plus the threat posed by collision debris, has led many to argue that we need similar tracking capabilities for the civilian sector. The cheap way to do this is to make some of the military data public; the expensive way would be to build a separate, purely civilian tracking system.[17]

Planners in the United States and other militaries have good reason to want to keep adversaries guessing about their surveillance capabilities.[18] But they also have good reason not to want to see space filled with debris that is as deadly to their own satellites as to civilian craft. The European Space Agency is working on a plan to track 1,000 satellites in order to prevent collision; this is a good start.[19]

While valuable, these approaches serve more to reduce the problem than to resolve it. Over time, especially beyond the lowest level orbits, debris will tend to accumulate. This calls for more far-reaching approaches.

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7. Tariq Malik, *Space Junk Around Earth on the Rise, Experts Say*, Space.com, Apr. 29, 2009, http://www.space.com/news/ 090429-space-debris-safety.html.
8. Below 300-400 miles, orbits decay in years, above 600 miles or so they can last for centuries, and above a few thousand miles, orbits are virtually eternal for human purposes. NASA Orbital Debris Office, Orbital Debris Frequently Asked Questions, July 2009, http://orbitaldebris.jsc.nasa.gov/faqs.html# 12.
9. *See* Donald Kessler & Burton Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. Geophys. Res. 2637 (1978).
10. We may be approaching the Kessler effect now; debris hazards are certainly growing, at any rate. *See* Michael Bradford, *Space Becomes More Risky as Debris Collects*, Crain's Bus. Ins., Apr. 13, 2009, at 12, *available at* 2009 WL 7207997.
11. 18 U.S.T. 2410, 610 U.N.T.S. 205 (entered into force Oct. 10, 1967).
12. *Id.* art. 8.
13. Grant Gilmore & Charles L. Black, The Law of Admiralty 532 (New York: Found. Press, 1975).
14. *See, e.g.*, Nandasiri Jasentuliyana, *Regulation of Space Salvage Operations: Possibilities for the Future*, 22 J. Space L. 5 (1994).
15. *See* Chrissy Kadleck, *Approaching Carrying Capacity: The Fast-Growing Amount of Orbital Debris Is Making Space a Dangerous Place*, Waste & Recycling News, June 8, 2009, *available at* 2009 WL 11168639; *Official: Space Faring Nations Must Work Together to Mitigate Debris*, Inside the Air Force, June 12, 2009, *available at* 2009 WL 11279373; Barbara Miller, *Space Debris Close to Critical Density*, World Today, Mar. 18, 2009, *available at* 2009 WL 6006700.
16. *See* Amy Butler, *Cause and Effect: Satellite Collision Prompts More Oversight of Space Traffic From the Pentagon*, Aviation Wk. & Space Tech., Apr. 6, 2009, at 27-28.
17. *See* Secure World Foundation, *Satellite Collisions: Plan Outlined for Civil Space Traffic Control System*, NewsWise, Feb. 12, 2009, http://www.newswise.com/articles/view/549274/.
18. *See generally* Robert P. Merges & Glenn H. Reynolds, *News Media Satellites and the First Amendment: A Case Study in the Treatment of New Technologies*, 3 High Tech. L.J. 1 (1988) (describing issues with national security regulation of space-based information).
19. Melissa Eddy, *European Space Agency Hopes to Clean Up Space Junk,* Breitbart, Feb. 16, 2009, http://www.breitbart.com/article.php?id=D96COB0G0&show_article=1. *DOD Wants Revamped Data-Sharing With Industry on Satellite Moves*, Inside The Pentagon, May 21, 2990, *available at* 2009 WL 9654554.

At present, the space-debris problem is a classic tragedy of the commons.[20] Earth orbital space is a common resource, with the benefit of any particular satellite launch going to the user and the cost of space debris being spread across numerous others. As such scenarios go, however, it is comparatively manageable. The number of participants is not especially large, and most of the behavior involved, e.g., the launching and management of satellites, is easily observed by others. This suggests that a negotiated agreement may suffice.

Such an agreement might proceed in three stages. Nations should first address mitigation and traffic control/collision avoidance measures. More effort should be devoted to ensuring that spacecrafts' initial orbits are chosen with an eye toward reducing the risk of collision and reducing the production of debris should a collision occur.

Second, space powers might agree to particular standards regarding what conduct is negligent for purposes of compensation under the Liability Convention. At the very least, space powers might join together to agree on what conduct is clearly not negligent. A set of "best practices," including boosting expiring satellites into safe orbits, might be a good place to start. Even today, satellites can be, and sometimes are, made to vent residual propellant or use such propellant to boost them into safer orbits at the end of their lifetimes.[21] Creating a "safe harbor" under the Liability Convention through the use of best practices might encourage launching states to voluntarily adopt such practices without requiring the time-consuming process of hammering out matters on a case-by-case basis.

Finally, the agreement could provide a legal framework for space salvage. Under such a framework, international organizations or for-profit enterprises might be empowered to recover debris in exchange for financial awards. For inactive satellites and large debris fragments, space powers might even take a cue from the 1977 TV series *Quark,* a sci-fi comedy about a space garbage scow and its crew, and allow governments or insurance companies to pay private operators a bounty for eliminating space junk.[22] Some scholars, including the present authors, have also proposed an international regime that would "tax" countries for debris cleanup based on the amount of material left in orbit.[23] Under this scenario, a country might pay so many millions of dollars per ton left in orbit, with the money earmarked for cleanup or for compensation to those harmed. While such proposals remain purely academic, such an approach could prove quite successful.[24]

IV. Conclusion

The liability provisions of the Outer Space Treaty and the Liability Convention have not been adequate to address the space debris problem. This suggests several responses.

In the short term, greater attention to questions of debris-mitigation and collision-avoidance is essential. Happily, the relatively small number of active space powers means that many of these questions can be addressed through informal discussion. All space powers have an interest in preventing damage from debris, and many of the changes—such as designing spacecraft to produce less debris in the form of paint chips, or deorbiting or "parking" satellites at the end of their lifetimes—are relatively inexpensive. Likewise, better coordination of satellite trajectories and sharing of traffic data, though fraught in some cases with national security implications, should nonetheless prove feasible.

But it appears that the growth of the space-debris problem is outpacing any sort of organic development of good-conduct norms. While the maritime industry had many centuries to develop its norms of negligence and appropriate conduct before the oceans reached their current stage of congestion, the space industry is already facing significant obstacles. International law should therefore provide guidance as to what constitutes negligence in space. The space powers should also establish best practices standards for avoiding and reducing space debris. Altering current space law to allow for salvage is another recommended step toward solving the debris problem.

Though such efforts would be expensive, they would likely cost less than the potential tort liability that might flow from frequent space collisions in the long term. Moreover, while the future of space law remains unsettled, what is clear is that this is a problem that urgently needs attention from all the spacefaring nations, lest we find ourselves earthbound under a blanket of orbiting trash.

20. Garrett Hardin, *The Tragedy of the Commons*, 162 Sci. 1243 (1968). *See also* Glenn Reynolds & Robert Merges, *Space Resources, Common Property, and the Collective Action Problem*, 6 N.Y.U. Envtl. L.J. 1 (1997).
21. *See* Jennifer Seymour, *Curbing the Cosmic Crisis: A Proposal for Curbing the Perils of Space Debris*, 10 Geo. Int'l Envtl. L. Rev. 891, 904-12 (describing debris removal and mitigation techniques).
22. The show was created by Buck Henry and starred Richard Benjamin. A description can be found at http://www.imdb.com/title/tt0459662/.
23. Reynolds & Merges, *supra* note 2, at 188-89.
24. *See, e.g.*, Mark Sandahl, *Unidentified Orbital Debris: The Case for a Market-Share Liability Regime*, 24 Hastings Int'l & Comp. L. Rev. 125 (2000).