# Chapter 3
# Exploring New Approaches and Solutions to the Orbital Space Debris Problem

## Introduction

The legal definition and status of orbital space debris is problematic in a variety of ways. As already noted, all human crafted items launched into space are known as "space objects" as specifically defined in the Liability Convention and generally conceived in the Outer Space Treaty. [Treaty on Principles] But orbital space debris, in contrast, has no agreed international definition. Nevertheless "defunct space objects no longer in use" is a practical definition that is often used. Such a legally agreed definition becomes quite important in such circumstances as when the provisions of the "Liability Convention" come into play. [Convention on International Liability]

The collision of the Iridium 33 and the Kosmos 2251 spacecraft is a specific case in point. If the Kosmos 2251 satellite had been clearly and unambiguously defined as orbital space debris that was officially designated as defunct and uncontrolled while the Iridium 33 had been designated an active and operational space object, then the collection of liability damages from this collision would have been much easier to resolve if formal claims had been made.

There is a further definitional problem under the "Outer Space Treaty" and the "Liability Convention" that places the responsibility for any accident that occurs as a result of a space collision not with the offending "space object" nor even the "operator or owner of the spacecraft". The responsibility for paying liability claims, under these ratified UN agreements only go to the "Launching State"—and exclusively so. Yet, there is ambiguity here in that there can be more than one "Launching State". The language that defines the Launching State sets forth a threefold definition in Article VII of the Outer Space Treaty and Article I (c) of the Liability Convention. The Launching State is defined as a State that launches or procures the launching of an object into outer space, or from whose territory or facility an object is launched. In some cases the "Launching State" can be a single nation, but it is possible for four or more countries to be somehow involved. France for instance



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operates a launch facility in Guyana and launches Russian launch vehicles from this facility for many different customers from different countries that procure services to place their spacecraft into orbit. Sea Launch that operates out of the United States Long Beach California launches from the High Seas in the Pacific Ocean near Kiribati. The Sea Launch consortium is owned by four companies from Norway, Russia, Ukraine, and the United States but is incorporated in the Cayman Islands. [Sea Launch]

There is now a Registration Convention that sets forth the requirement for registration of all launches into outer space and identifies what the process is when more than one Launching State is involved. This is specified in Article II of the "Convention on the Registration of Objects Launched into Outer Space" as follows:

> "2. Where there are two or more Launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article, bearing in mind the provisions of article VIII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and without prejudice to appropriate agreements concluded or to be concluded among the Launching States on jurisdiction and control over the space object and over any personnel thereof.
> 3. The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned." [Registration of Objects]

With this background in mind, it should be clear that the active removal of space debris has a number of challenges. The legal issues that are involved are addressed in detail in Chap. 6.

This chapter is more specifically concerned about what incentives can be given to nation states, satellite owners and operators, and those who launch spacecraft to minimize orbital space debris at the time of launch and to remove debris from orbit at the end of life or when a spacecraft or upper stage launch vehicle becomes defunct.

Launching States currently take a risk of incurring a large liability when undertaking active removal of a spacecraft or deorbiting an upper stage launcher. According to Article III of the Liability Convention, in the event of damage being caused elsewhere than on the surface of the Earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable if the damage is due to its fault or the fault of persons for whom it is responsible. If there is a collision while these removal processes are under way the "Launching State" may be held liable for the crash. If on the other hand, they simply leave their satellites in orbit, once it is successfully launched, it is difficult to prove that any collision that may occur is due to their fault, hence holding them liable. The current Guidelines for the Mitigation of Space Debris under Guideline 6 urges all concerned that they: "Limit the long-term presence of spacecraft and launch vehicle orbital stages in the Low-Earth orbit (LEO) region after the end of their mission". But these guidelines are non-binding and the incentives "to do the right thing" either on the part of private satellite operators or even the Launching State are currently simply not present. Since it does not seem likely that the current provisions of the Outer

Space Treaty or the Liability Convention will soon be amended, the question becomes what can be done instead to encourage active orbital debris removal. [Space Debris Mitigation]

## Current Problems with Space Debris and Creating New Incentives to Facilitate Debris Removal

The classic case in economics is the problem of the light house. All ships at seas benefit from light houses. These facilities help ships to avoid running aground or perhaps even risking a puncture and sinking into the ocean. Yet no one ship owner wants to pay for a lighthouse individually. Thus governments build lighthouses and pay for them through taxes and usage fees imposed on ship owners. Air and water pollution is much the same. No individual wishes to pay for the clean-up of air and water pollution all on their own. Instead governmental regulations are created and enforced by taxes and clean-up fees. There are also fees, and fines against offenders. The case of orbital space debris pollution is even more difficult because outer space surrounding Earth is in the global commons and not under the control of any one nation and not subject to taxing authorities. Clearly if there were a way to collect revenues to pay for active orbital debris prevention or removal this would assist a great deal. The problem of space debris is clearly complicated by the lack of enforceable regulations, the lack of a revenue source to cope with the problem and lack of an entity that is globally accepted to impose sanctions, fees, or enforce other remedial actions. Yet the problem of mounting orbital space debris remains along with the cascading effect which means that high velocity debris will continue to generate additional orbital debris. Nor is any treaty or convention-mandated solution to this issue on the horizon. Thus, the question becomes what can be done?

## Transparency and Confidence Building Measures

The issue of orbital debris has been actively on the agenda of the UN Committee on the Peaceful Uses of Outer Space for essentially two decades—starting in 1994. Cooperation with the Inter-Agency Space Debris Coordination Committee (IADC) has produced the Guidelines on Space Debris Mitigation adopted by the UN General Assembly in 2007. This is, however, not the only UN initiative in this area. The UN Office of Disarmament Affairs (UNODA) has set up a Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities as directed by the UN General Assembly. This GGE was asked to address space-related issues in terms of disarmament and coping with space issues in terms of national defense issues.

The GGE in its report of July 29, 2013 identified six explicit areas where the development of Transparency and Confidence Building Measures would be

desirable and should be pursued. The fifth recommended area suggested that efforts should be made to establish "norms of behavior for promoting spaceflight safety such as launch notifications and consultations that aim at avoiding potentially harmful interference, limiting orbital debris and minimizing the risk of collisions with other space objects." [Report of the Group of Governmental Experts]

It is sometimes assumed that consultations related to civil space activities are much less contentious and difficult than negotiations related to defense-related matters. This is simply because of the highly sensitive and strategic nature of military and national defense issues. In this area, for instance, experts have rather universally recognized the mounting problem of space situational awareness and the dangers that space debris or re-entering space craft could be mistaken for a missile attack with tragic consequences. In this case, the concern about such consequences works in favor of initiatives to clean up orbital debris. The logical thought process is that if leading space faring nations (who are also typically those with space missile defense systems) could agree on a norm of behavior related to minimizing space debris, space collision avoidance, and active space debris removal this would also assist with improved missile defense. Military officials certainly wish to avoid false perceptions of missile attacks. From this perspective, "best practices with regard to debris removal" would be a benefit to everyone concerned. If for starters there could be an agreed "norm" with regard to space debris (and its active removal) this would be a net positive rather than some sort of zero sum game. In short it is generally agreed among the military space practitioners in the U.S., Russian, Europe, China, India and Japan, as reflected in the GGE Report, that progress on the orbital debris problem and space collisions is highly desirable. From this perspective, if a norm of behavior could be developed and broadly observed over a period of time, it would almost be as good as a new space treaty to this effect. Certainly it appears highly desirable if the UN Working Group on the Long Term Sustainability of Space Activities would stay in touch with the UNODA and the GGE recommended initiatives to devise possible steps forward. These could, in fact, be based simply on "Transparency and Confidence Building Measures" as agreed by key space faring nations. These agreements or norms would presumably apply to space debris minimization, launch notifications, and even plans for active debris removal. Joint discussions that involve both civil and defense space agencies in moving forward on orbital space debris could prove helpful in a number of ways.

## Expanded Recognition of the Role of Private Entities in the Outer Space Arena and New Approaches that Transcends the "Launching Nation" Conundrum

Today the world of space activities is dramatically different from the time that the Outer Space Treaty and the Liability Convention were agreed. In the early days of space it was only governments in terms of Defense Ministries or civil space agencies that launched spacecraft or missiles. Private enterprise was not a

part of the equation. In almost a half century the world of space activities has dramatically changed.

Today about half of all launches and spacecraft are related to commercial activities, student or university projects, or private international institutions. Organizations like Bigelow Aerospace are deploying private space stations. Private aerospace companies are developing launch systems to ferry astronauts to and from the International Space Station (ISS). There are ventures such as the SpaceShip Corporation and XCOR pursuing private suborbital flights, and other ventures such as Launch One, Stratolauncher and Reaction Engines are developing commercial launch systems that are able to lift different classes of satellites to orbit at ever decreasing costs. [Joseph N. Pelton and Peter Marshall]

Companies not only arrange to buy and launch satellite systems, but they also buy and sell in-orbit satellites and trade space systems freely around the world. The initial Outer Space Treaty and the Liability Convention that held (and still holds) that the "Launching State" was responsible for a spacecraft even after it has been bought and sold commercially by companies from entirely different regions of the world does not seem to make sense, yet this indeed reflects the current realities in terms of space-based activities and associated liability provisions.

The problem is far clearer than the solution. One approach would be for Launching States to not agree to launch until there was binding contract to cover not only due diligence, related to orbital space debris at launch, but also strict contractual terms and conditions that cover the right to sign off on any subsequent sale of satellites and provisions for end of life disposal arrangements. There could also be a separate deorbit system installed on satellites that would remain under the control of the Launching State, regardless of any sale of the satellite and would be exercisable at a prescribed time unless formally agreed to by the Launching State. The bottom line is that the division of responsibilities between private commercial concerns on one hand and governmental entities on the other needs to be reappraised. This is true with regard to all space transportation and on-orbit systems in general and orbital debris mitigation provisions in particular. As there is continued movement toward "New Space" commercial activities the urgency only increases. The increasing risks related to space debris only increases with time. The importance of this reappraisal will thus become more and more apparent.

## Financial Incentives and Funds to Address Orbital Debris Issues

There have been a number of proposals made as to improved ways to address space debris issues. These include the creation of a new international agency, perhaps modeled on the initial incarnation of the Intelsat Consortium, or a new international convention or agreement devoted to orbital debris. Ultimately, as is the case with many international problems and issues, the key to the orbital debris problem is closely related to money and the need for funds to address this issue.

It has been suggested that one solution would be for all space missions, in addition to the purchasing launch and mission insurance, should be required, under national or regional regulation, to put a small percentage of the project into a debris mitigation fund. This fund would compensate innovative space entities that develop the needed new technology that could remove defunct spacecraft and upper stage launch vehicles from working orbits. It has been calculated that for a much smaller percentage of the mission costs than is currently devoted to launch insurance, it would be possible to create a financial mechanism that could reverse the process of debris build up and also generate a range of new and innovative technologies that could spur new types of space applications. [J. N. Pelton, A Global Fund]

By using the space insurance model and financial incentives it is believed that many new response mechanisms would be developed and that they would prove more efficient and cost effective than other approaches. Such an approach would be lower in cost, faster, and more effective than the creation of a new international agency. It certainly could be accomplished much faster than through a process of negotiation of a new treaty or convention that requires near unanimous international consensus. Indeed the "financial insurance model" can be implemented on a national or regional basis and grow as more and more countries agree to sign on to this process. Indeed just one country passing a "model national space law" could change space history. This law would only need to mandate an "orbital space debris insurance fund" going forward. Such a bold step, if joined by other forward looking countries could usher in a new era in space safety and allow human society reclaim its long term ability to leave this planet and use the heavens for science, exploration, and a wide range of essential applications.

## The Way Forward

In the short term it seems apparent that individual countries will need to utilize technology currently developed (as outlined in Chap. 2) to remove the largest and most dangerous space debris in low earth orbit on a one at a time basis. Currently only the Launching State can remove its own defunct satellites from orbit unless it is going to be accused of deploying a Weapon of Mass Destruction and committing an act that would likely be deemed an act of war. Likewise using a directed energy system to change the orbit of a satellite of some other country would also be seen as an act of aggression. It has been suggested that a country that is the Launching State for a particular defunct satellite might be given access to another countries technical capacity to divert the orbit of this satellite in order to avoid a collision and also in this manner avert an international incident.

It has been suggested that if the ten most dangerous debris elements were removed each year, even if employing technology that removes only large defunct spacecraft at a time, that progress on proliferation of space debris could at least be

initiated. But this is just an interim step. The new approaches that are discussed in Chap. 5 can develop much more efficient and cost effective ways to remove a much larger volume of space debris. Clearly there is also a need to address the institutional, regulatory and legal issues that are initially presented in this chapter and discussed in more detail in Chap. 6.

## Conclusions

The intricacies of the orbital space debris issues are enormously complex. There are difficulties everywhere. The current guidelines for mitigation are modest, incomplete, and non-binding. The problem of debris build-up continues to grow worse due to the cascading effect that comes with the 6 tons of debris, with tens of thousands of these debris elements being in sizable chunks, that are constantly colliding and creating yet other new debris elements. One collision involving large objects can generate thousands of new debris elements. Efforts just to remove ten large debris elements, using current technology are quite expensive. And yet even this minimal effort can help stabilize the ongoing build-up of debris elements. All of the players in this ongoing play entitled something like: "The Rise of Orbital Space Debris", need to continue to work to find new solutions. This means a concentrated effort to address these issues by all of the space agencies, the military and defense space programs, the Inter-Agency Space Debris Coordination Committee (IADC), the UN Committee on the Peaceful Uses of Outer Space, the Working Group on the Long-Term Sustainability of Space Activities, the UN Office of Disarmament Affairs and the Group of Governmental Experts on Transparency and Confidence Building Measures. The interesting new dimension would be if others such as the space insurance agencies, satellite and launch vehicle manufacturers, and the scientific and astronautics community should join into these discussions with innovative new ideas and suggestions. The stakes of not solving the problem of space debris are sufficiently high that a crash effort (pun intended) to solve this problem is now imperative.

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