### ADR CP vs Space Assets Aff

#### The United States federal government should transparently develop, deploy, and demonstrate a debris removal system, with external non-military verification, through government contracts to the private sector funded by charging fees and service fees that removes US debris and the debris of other nations upon their request.

#### Solves trust and debris

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International cooperation in space has rarely resulted in cost-effective or expedient solutions, especially in politically-charged areas of uncertain technological feasibility. The International Space Station, because of both political and technical setbacks, has taken over two decades to deploy and cost many billions of dollars—far more time and money than was originally intended. Space debris mitigation has also encountered aversion in international forums. The topic was brought up in COPUOS as early as 1980, yet a policy failed to develop despite a steady flow of documents on the increasing danger of space debris (Perek 1991). In fact, COPUOS did not adopt debris mitigation guidelines until 2007 and, even then, they were legally non-binding.

Space debris removal systems could take decades to develop and deploy through international partnerships due to the many interdisciplinary challenges they face. Given the need to start actively removing space debris sooner rather than later to ensure the continued benefits of satellite services, international cooperation may not be the most appropriate mechanism for instigating the first space debris removal system. Instead, one country should take a leadership role by establishing a national space debris removal program. This would accelerate technology development and demonstration, which would, in turn, build-up trust and hasten international participation in space debris removal.

Possibilities of Leadership

As previously discussed, a recent NASA study found that annually removing as little as five massive pieces of debris in critical orbits could significantly stabilize the long-term space debris environment (Liou and Johnson 2007). This suggests that it is feasible for one nation to unilaterally develop and deploy an effective debris removal system. As the United States is responsible for creating much of the debris in Earth’s orbit, it is a candidate for taking a leadership role in removing it, along with other heavy polluters of the space environment such as China and Russia.

There are several reasons why the United States should take this leadership role, rather than China or Russia. First and foremost, the United States would be hardest hit by the loss of satellites services. It owns about half of the roughly 800 operating satellites in orbit and its military is significantly more dependent upon them than any other entity (Moore 2008). For example, GPS precision-guided munitions are a key component of the “new American way of war” (Dolman 2006, 163-165), which allows the United States to remain a globally dominant military power while also waging war in accordance with its political and ethical values by enabling faster, less costly war fighting with minimal collateral damage (Sheldon 2005). The U.S. Department of Defense recognized the need to protect U.S. satellite systems over ten years ago when it stated in its 1999 Space Policy that, “the ability to access and utilize space is a vital national interest because many of the activities conducted in the medium are critical to U.S. national security and economic well-being” (U.S. Department of Defense 1999, 6). Clearly, the United States has a vested interest in keeping the near-Earth space environment free from threats like space debris and thus assuring U.S. access to space.

Moreover, current U.S. National Space Policy asserts that the United States will take a “leadership role” in space debris minimization. This could include the development, deployment, and demonstration of an effective space debris removal system to remove U.S. debris as well as that of other nations, upon their request. There could also be international political and economic advantages associated with being the first country to develop this revolutionary technology. However, there is always the danger of other nations simply benefiting from U.S. investment of its resources in this area. Thus, mechanisms should also be created to avoid a classic “free rider” situation. For example, techniques could be employed to ensure other countries either join in the effort later on or pay appropriate fees to the United States for removal services.

Recommendations for Leadership in Space Debris Removal

Going forward, the U.S. government should engage the commercial sector in space debris removal. Government contracts with several commercial firms would create a competitive environment, encouraging innovation and cost minimization. Having several companies working on the problem at the same time would also accelerate remediation as several critical orbits could be addressed at once. Furthermore, early investments in a domestic space debris removal industry would give the United States a head start in what may become a critical industry over the coming decades.

The aforementioned 2009 International Conference on Orbital Debris Removal, co-hosted by DARPA and NASA, suggests that these two agencies could lead U.S. government efforts in space debris removal. However, it is important to recognize that DARPA and NASA are driven by very different motives: one is a civilian space agency, while the other is a defense research agency. Failure to appreciate these differences when establishing mission requirements could lead to a situation like that of the National Polar Environmental Satellite System (NPOESS), where the attempt to combine civil and military requirements into a single satellite resulted in doubling project costs, a launch delay of five years, and ultimately splitting the project into two separate programs (Clark 2010). Furthermore, any system developed through a joint NASA-DARPA partnership would need to be transferred to an operational agency, as both NASA and DARPA are research and development entities. The U.S. Air Force, as it is the primary agency responsible for national security space operations, is a possible option.

Funding the development of a national space debris removal system carries risks because, due to the nascent state of the field, detailed cost-benefit estimates have not yet been carried out. The Space Frontier Foundation, however, proposes that the government should establish special funds at the expense of parties who generate debris (Dunstan and Werb 2009). Suggested mechanisms for raising the funds include charging fees for U.S. launches based on the debris potential of the mission, with the size of the fee determined by relevant factors such as the mass of the anticipated debris resulting from the mission and the congestion of the orbit into which the space object is being launched. Satellite manufacturers, operators, and service providers could all share responsibility for payment into such funds. Once debris removal systems are in operation, additional funds could also come from service fees. For example, entities that created debris could pay a specified amount to removal providers in return for the service rendered.

Any national space debris removal program must also be kept transparent with ongoing international dialogue in forums such as COPUOS so that other nations can build-up trust in the effectiveness and efficiency of the program. A proven debris removal program will result in more productive discussions in these international forums.

VII. Conclusion

If the United States and other powerful governments do not take steps now to avert the potentially devastating effects of space debris, the issue risks becoming stalemated in a manner similar to climate change. Given the past hesitation of international forums in addressing the space debris issue, unilateral action is the most appropriate means of instigating space debris removal within the needed timeframe. The United States is well poised for a leadership role in space debris removal.

Going forward, the U.S. government should work closely with the commercial sector in this endeavor, focusing on removing pieces of U.S. debris with the greatest potential to contribute to future collisions. It should also keep its space debris removal system as open and transparent as possible to allow for future international cooperation in this field.

Although leadership in space debris removal will entail certain risks, investing early in preserving the near-Earth space environment is necessary to protect the satellite technology that is so vital to the U.S. military and day-to-day operations of the global economy. By instituting global space debris removal measures, a critical opportunity exists to mitigate and minimize the potential damage of space debris and ensure the sustainable development of the near-Earth space environment.

#### ADR needed to remove Russian rocket bodies – key to avoid Kessler.

Shaub 19 – (Professor in Aerospace engineering at UC Boulder. “Active Debris Dynamics and Removal” <https://hanspeterschaub.info/research-ADR.html>)

The low Earth orbit debris environment continues to be a concern for the space community. While debris mitigation is an important component of reducing on-orbit clutter, active debris removal methods are likely to be necessary in the future. The AVS Lab is studying a debris removal concept which aims to deorbit existing defunct large rocket bodies by considering small modifications to existing launch vehicles. The following concept is being proposed by Dr. V. Trushlyakov of Omsk State Technical University. Post-mission fuel reserves from the second stage of a heavy launch vehicle are used to rendezvous with an existing rocket body debris object. Upon tethering to this debris, a Delta-v maneuver is performed with the remaining fuel reserves to lower both objects' periapses. Specifically, in current study, a Soyuz-like rocket-body is considered the thrusting tug craft, while a Cosmos-3M rocket-body is considered the debris object. To deorbit a Cosmos-3M in 25 years from an 800 km orbit only requires a combined Delta-v of 120 m/s. This is within the fuel reserve budget of the Soyuz upper stage, illustrating the feasibility of this approach. In [order](https://hanspeterschaub.info/research-ADR.html) to avoid collision between the two craft, deep-space dynamics reveal that the thrust can be throttled in synchronization with the relative motion so that, at the end of a burn, zero relative velocity between the two craft is achieved. The on-orbit dynamics reveal that the orbital motion helps keep both craft separated. Our research [group](https://hanspeterschaub.info/research-ADR.html) is collaborating with Omsk State University by investigating the complex relative dynamics once the two large, rigid bodies are tethered to each other, and the deorbiting burns are engaged. Studying the dynamics, and the thruster control solutions, methods are being investigated to ensure the robustness of this ADR system.