

Red Team Policy Proposal for Applied Physics Seminar E4903 – Professor Michael Mauel

Dear Mr. President,

In 2012, a panel at the World Economic Forum concluded that “a day without satellites” would spell global economic disaster. Modern living is increasingly dependent on space, from telecommunications to disaster relief to climate change data to national security, not to mention the clear benefits for our nation’s progress in pure science. But man-made space debris threatens the secure use of these infrastructures for the international community, including our country. Because of high speeds in orbit, even a small piece of debris can cause serious damage to spacecraft, and due to the nature of orbital mechanics, one debris collision can generate multitudes of additional debris, which produce further collisions and yet more debris, in a dangerous cascade effect. This is called the Kessler Syndrome.

In this context, this proposal calls for initiatives to: 1) assign a branch of the U.S. government to manage debris by accelerating research and development funding for projects to remove existing debris with new technologies (remediation) and prevent the future creation of debris through stronger standards (mitigation); 2) develop international policies reconciling national and commercial interests with the need to limit debris creation; and 3) foster effective means of international cooperation on debris issues.

1. a Remediation: The U.S. must take an active role to remediate (remove) debris. The Kessler Syndrome has reached a point of no return such that even if launches stopped today, debris production from collisions would continue to increase. The focus for the long run should be on removing large objects. Mr. President, your 2010 National Space Policy called for our government to remove debris, but no agency has been assigned the task. While the Naval Research Lab and NASA’s Orbital Debris Program Office are developing new technologies, a *branch of the U.S. government* must be assigned to direct these efforts and be given funding to accelerate them through the R&D process. Remediation research can be implemented in the following technological areas, each of which slows debris down such that it burns up in the atmosphere. (Should debris not burn up entirely, the probability of damage on land is 10^{-4}):

- *Electrodynamic tethers*: current in tethers reduces speeds of satellites and debris
- *Slingshot mechanisms*: push debris into the atmosphere while propelling themselves to the next piece of debris in the process
- *Solar sails*: drag pushes debris into LEO
- *Drag enhancement*: high altitude balloons that release air, dust, crystals, or other nanomaterials into Low Earth Orbit, inducing drag and forcing satellites or debris into atmospheric burn

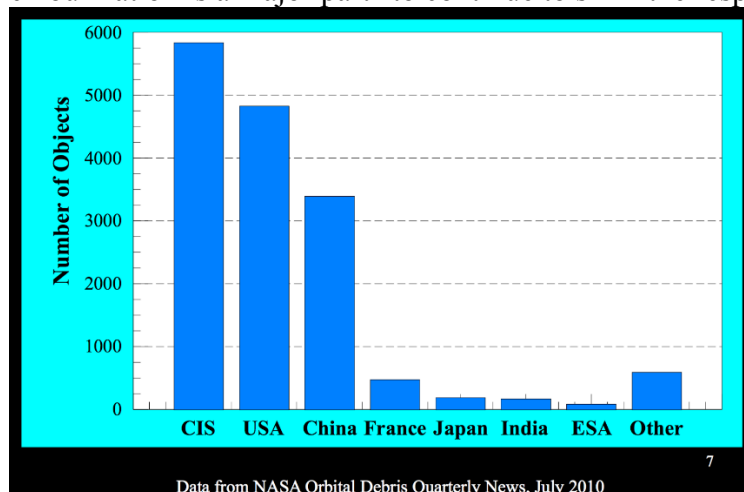
1.b Mitigation: Further creation of debris must be mitigated (prevented) by imposing strict guidelines on the construction and operation of spacecraft launched into orbit. Debris from launches must fall into atmospheric burn, and satellites must have basic capabilities to avoid collisions forecast on the ground. While there are “soft law” international guidelines developed from NASA’s standards, our proposed branch of the U.S. government which dedicated to debris should push for these guidelines to be implemented as hard law, domestically and internationally.

2. Limit commercial and national space activity: We recommend that the United States work closely with other nations, especially Russia and China, to ensure that space is a zone accessible and safe to all nations. Within this international framework, we have a set of recommendations that we think are important for the United States to achieve the goals set out by your 2010 National Space Policy:

First, we urge the United States to accept the United Nations resolution calling for the prevention of an arms race in outer space, even though the United States voted against it. It is significant that the only two countries to vote against the resolution are the United States and Israel. This resolution, which is effective and needed in the context of space debris, cannot achieve its mission without the involvement of the United States. An international agreement to prevent an arms race in outer space protects the United States' satellites and makes military activity in space unneeded. It allows for securing US infrastructure in space, while at the same time saving money that could be used to expand research activities in space.

Secondly, we urge the United States to work with other countries to regulate access to space as a market. With the current level of debris, space cannot remain an open arena where any company or corporation can launch missions. National research interests should be prioritized in light of how important research in space is for the entirety of humanity. Thus, it is imperative that the United States works with other countries, most importantly Russia and China, to ensure an international agreement on a framework for regulating commercial activities in space and ensuring a balance where commercial activities in space are regulated so as to limit space debris.

3. Foster international cooperation: One of the major concerns with debris is a “tragedy of the commons”--that absent of mutually-agreed-upon standards, the many national entities working in space will fall into conflict over this common territory in which no nation has legal claim (as stated by the U.N. Outer Space Treaty of 1967). No nation alone, including the U.S., would be willing to spend money and human resources to clean up the space for the common good of the world. Indeed, the problem is imminent and there is no time to waste for the international community--of which our nation is a major part--to continue to shirk the responsibility.

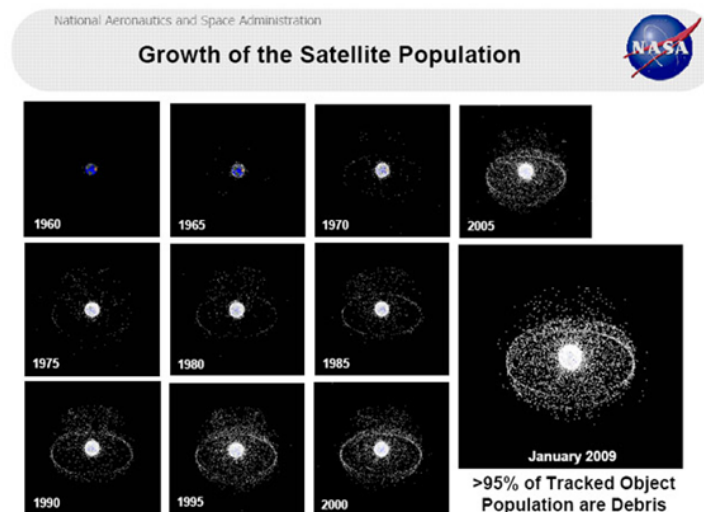


To get around the “tragedy of commons” and resolve the orbital debris issue, the United States should work with the U.N. Office of Outer Space Affairs to establish an international organization in which participating nations can share up-to-date space data, distribute financial remediation burdens together, and mediate possible space-related political issues. Especially, the

three nations (Russia, China, and the U.S.) which have created the most debris in recent years would be obliged to be part of the organization and fulfill their responsibilities in proportion to their debris production (see figure above).

One advantage of this international organization is that orbital debris research can become more efficient. For example, one of the promising orbital remediation technologies is “drag enhancement,” by which viscous nanomaterials intersect the pathways of major debris (drag force) to make them spiral down closer to Earth and eventually combust in Earth’s atmosphere. The project may require two very different fields of research: (1) building a spacecraft customized for releasing nanomaterials exactly on a desired orbit and (2) synthesizing viscous but volatile nanomaterials that drag debris without producing more debris in the process. In the proposed international organization, nations can divide the necessary tasks and cooperate with each other rather than one nation handling all the tasks, with the proposed branch of U.S. government from Part 1 working in tandem. Some nations can take the aerospace engineering research, while some others can focus on nanotechnology research.

This organization will also be a good place to mediate potential space-related political issues. For example, another highly effective remediation technique is to use “high power ground-based lasers” to slow debris down into atmospheric burn. However, there has always been a concern that possession and usage of lasers with such high power by one nation would upset others (the same reason that possession of nuclear weapons heightens tension). To take full advantage of the existing technology and resolve the orbital debris problem quickly, nations can conduct laser-research together in this international organization and make sure that the laser technology is not used for the military purpose of any one nation.



In conclusion, this proposal advocates for the U.S. to 1) assign and fund a branch of government to direct and accelerate remediation projects and harden mitigation regulations; 2) place strict regulations on the militarization and commercialization of outer space that severely limit the consequences for producing more debris in these activities; and 3) establish an international framework by which to tackle these issues with global consensus.

Sincerely,

The Red Team

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Works Cited

- "Fact Sheet: The National Space Policy." The White House. Accessed December 6, 2014.
<http://www.whitehouse.gov/the-press-office/fact-sheet-national-space-policy>
- "General Assembly Adopts 63 Drafts on First Committee's Recommendation with Nuclear Disarmament at Core of Several Recorded Votes," United Nations, December 2, 2014. Accessed December 14, 2014. <http://www.un.org/press/en/2014/ga11593.doc.htm>
- Johnson, Ray, Geraldine Naja, Michel de Rosen, Brian Weeden, and Ram Jakhu. "Open Forum 2012: A Day without Satellites." Lecture presented at World Economic Forum, Davos-Klostern, Switzerland, January 27, 2012. Video file. Youtube. Posted February 6, 2012. Accessed December 15, 2014. <https://www.youtube.com/watch?v=Po2ww6oiLmc>.
- NASA Orbital Debris Program Office. Accessed December 14, 2014.
<http://orbitaldebris.jsc.nasa.gov/>
- "National Space Policy," The White House, June 28, 2010. Accessed December 14, 2014.
http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf
- "National Security Space Strategy," U.S. Department of Defense,
http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf, accessed December 14, 2014.
- "National Space Transportation Policy," accessed December 14, 2014.
http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_space_transportation_policy_11212013.pdf
- "NRL Scientists Propose Mitigation Concept of LEO Debris," Naval Research Lab, June 20, 2012. Accessed December 14, 2014. <http://www.nrl.navy.mil/media/news-releases/2012/nrl-scientists-propose-mitigation-concept-of-leo-debris>
- Office of Space Commercialization. Accessed December 14, 2014.
<http://www.space.commerce.gov/>
- Liou, J.-C. and Johnson, N. L. "Risks in Space From Orbital Debris," *Science* (2006): 340-41. *Science Mag*. Accessed December 15, 2014.
<http://www.sciencemag.org/content/311/5759/340.full.pdf>
- "Space Junk Cleanup: 7 Wild Ways to Destroy Orbital Debris," space.com, accessed December 7, 2014, <http://www.space.com/24895-space-junk-wild-clean-up-concepts.html>
- "United Nations Official Document." UN News Center. November 12, 2014. Accessed December 6, 2014. http://www.un.org/ga/search/view_doc.asp?symbol=A/69/438.