U.S. SPACE TRAFFIC MANAGEMENT AND ORBITAL DEBRIS POLICY

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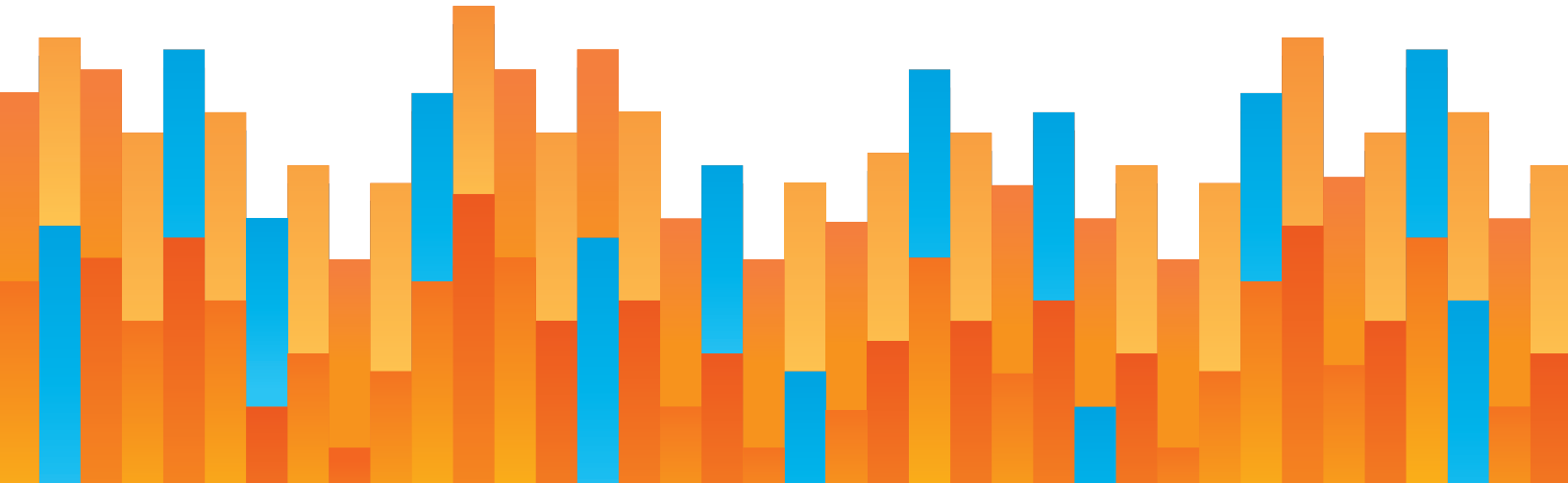

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EXECUTIVE SUMMARY

Orbital debris is a significant space sustainability problem. Debris particles can cause severe harm if they collide with spacecraft like the International Space Station (ISS) and satellites functioning in orbit. In-orbit collisions jeopardize billions of dollars' worth of space technology for public and private ventures in space. The National Aeronautics and Space Administration (NASA) estimates the population of space debris particles between 1 and 10 cm in diameter to be at least 500,000. Space debris will only increase as more actors get involved in space. Due to the real risk space debris generates, it is in this country's best interest to work toward better tracking of space debris and its removal through improved space traffic management. To do this, the Biden administration must work to consolidate space traffic management regulatory authority into one federal agency and work with the commercial space industry. This will expand space situational awareness policy to encourage responsible and sustainable practices by both government and commercial space actors.

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GLOSSARY

ASAP: Aerospace Safety Advisory Panel
ASAT: Anti-satellite, in reference to anti-satellite weapons/missiles
COPUOS: Committee on the Peaceful Uses of Outer Space
DoD: Department of Defense
ESA: European Space Agency
FAA: Federal Aviation Administration
FCC: Federal Communications Commission
GEO: Geosynchronous equatorial orbit
IADC: Inter-Agency Space Debris Coordination Committee
ISS: International Space Station
JAXA: Japan Aerospace Exploration Agency
LEO: Low earth orbit
NASA: National Aeronautics and Space Administration
NOAA: National Oceanic and Atmospheric Administration
NSpC: National Space Council
OADR: Open Architecture Data Repository
ODMSP: Orbital Debris Mitigation Standard Practices
OIG: Office of Inspector General
ODPO: Orbital Debris Program Office
OSC: Office of Space Commerce
R&D: Research and Development
SPD-3: Space Policy Directive 3
SSA: Space Situational Awareness
STM: Space Traffic Management

PART 1

WHAT IS ORBITAL DEBRIS AND WHAT ARE ITS DANGERS?

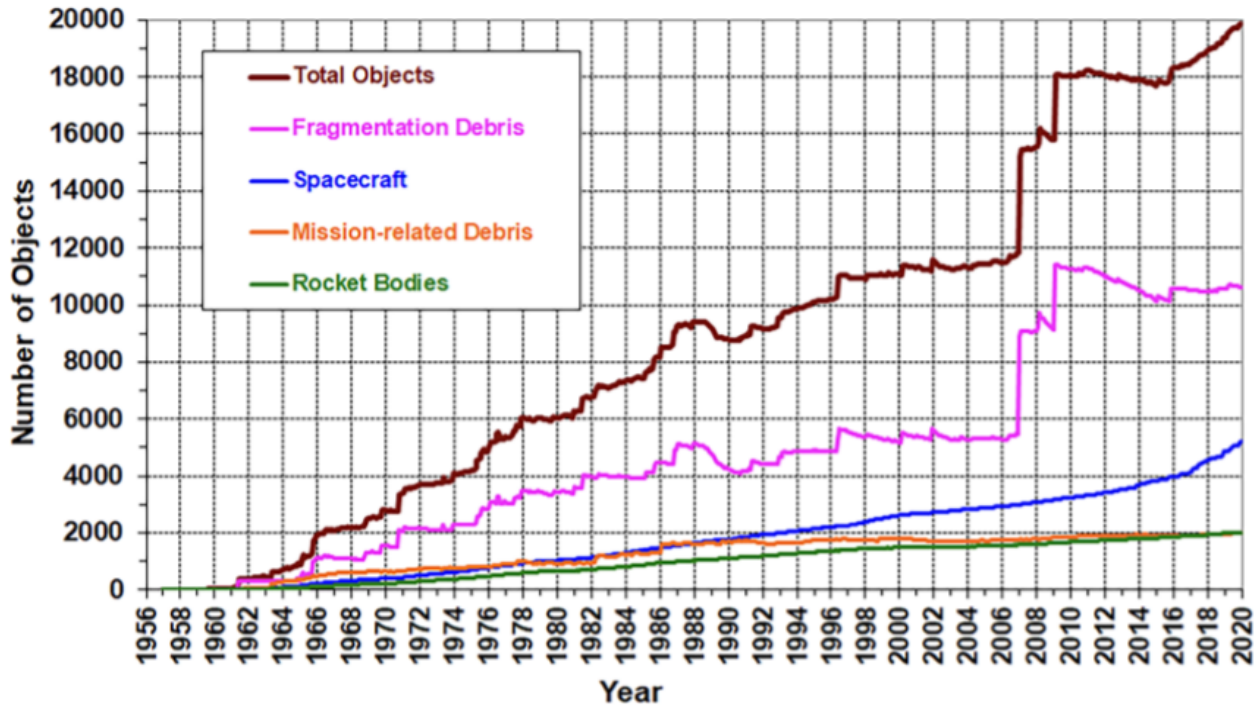
Orbital debris is no-longer-useful man-made objects in orbit such as used spacecraft, retired satellites, and debris caused by the fragmentation of space objects.[1] Fragmentation can either be caused by a collision of objects in orbit, other debris hitting objects in orbit, or by anti-satellite (ASAT) weapons that destroy satellites in tests. When space debris collides with a functioning craft in orbit, it can seriously damage the object or render it unusable. The more colloquial term for orbital debris is "space junk." The National Aeronautics and Space Administration (NASA) estimates the population of space debris particles between 1 and 10 cm in diameter to be at least 500,000, and over 23,000 particles larger than 10 cm.[2] Space debris will only increase as more actors get involved in space.

1 "Orbital Debris Program Office: FAQ," *NASA.gov*, NASA. https://orbitaldebris.jsc.nasa.gov/faq/ (February 19, 2021).

2 Ibid.

> *When space debris collides with a functioning craft in orbit, it can seriously damage the object or render it unusable.… Space debris will only increase as more actors get involved in space.*

FIGURE 1: NUMBER OF ORBITAL DEBRIS OBJECTS (LARGER THAN 10 CM): 1956-2020



Source: Aerospace Safety Advisory Panel's Annual Report—2020

With more satellites being launched into orbit, and constellations like Starlink webbing across low earth orbit (LEO), orbital debris is concerning. In LEO, space debris "circles the Earth at speeds of between 4 and 5 miles per second (7 to 8 km/s). [and] the average impact speed of orbital debris with another space object will be approximately 6 miles per second (10 km/s)."[3] Although a 10 cm piece of debris may seem insignificant to us on Earth, at these speeds, orbital debris can incapacitate a satellite. And cascading collisions of orbital debris (called a Kessler Effect) could render a number of satellites useless.

[3] "NASA: India's satellite destruction could endanger ISS," BBC News, BBC.

While launch has created orbital debris, such as when rockets discard their upper stages in orbit, orbital debris can also cause many problems for the launch industry. When launching a rocket, the launch provider must be cautious of where the flight path may intersect with orbital debris and additionally make sure the materials used to construct its rockets can withstand the effects of smaller debris. This can get expensive and tedious. With debris increasing, debris-resistant materials will only be more of a concern for launch engineers. For instance, back when the U.S. Space Shuttle was flying, NASA had to constantly replace rockets' windows because of the damage from orbital debris collision impact on the spacecraft.[4] While orbital debris tracking has allowed for launch providers to map out their flight paths to avoid debris more easily, it is still very much a concern when designing the rockets.

When launching a rocket, the launch provider must be cautious of where the flight path may intersect with orbital debris and additionally make sure the materials used to construct its rockets can withstand the effects of smaller debris. This can get expensive and tedious.

The ISS has maneuvered 25 times between 1999 and 2018 to avoid space debris.[5] In 2020, ISS astronauts administered avoidance maneuvers three times.[6] This is extremely concerning compared to the prior average of one avoidance maneuver a year.[7] Orbital debris has been so abundant in the past, that astronauts have had to hide in the Russian Soyuz capsule to wait out orbital debris collisions with the station.[8] A recent exposure to

4 Fraser Cain, "How do Astonauts Avoid Debris?" *Universe Today,* July 2, 2015, https://www.universetoday.com/121067/how-do-astronauts-avoid-debris/ (February 19, 2021).

5 "ISS moves to avoid space debris," *AFP*, msn News, September 22, 2020. https://www.msn.com/en-us/news/technology/iss-initiates-move-to-avoid-space-debris/ar-BB19jWGN (February 19, 2021).

6 Ibid.

7 "Orbital Debris Program Office: FAQ," *NASA.gov*, NASA.

8 "Astronauts take emergency shelter after junk threatens space station," Associated Press, *The Guardian*, July 16, 2015. https://www.theguardian.com/science/2015/jul/17/astronauts-take-emergency-shelter-after-junk-threatens-space-station (February 19, 2021).

orbital debris to the ISS was reported by the Canadian Space Agency to its Canadarm2, an 18-meter-long arm on the station that helps maintain tasks. While the robotic arm was unaffected this has created significant and worry for those in space.[9]

[9] Anusuya Datta, "Op-Ed: Damage to Canadarm2 on ISS Once Again Highlights Space Debris Problem," SpaceNews, June 4, 2021, https://spacenews.com/op-ed-damage-to-canadarm2-on-iss-once-again-highlights-space-debris-problem/.

PART 2

DEALING WITH ORBITAL DEBRIS

Orbital debris has historically been something we have allowed to deorbit naturally. The closer the piece of debris is to Earth, the faster it will deorbit into Earth's atmosphere and normally burn up upon reentry.[10] It is unusual for a piece of debris to not burn up during reentry, but in the event it doesn't, the majority of debris will land in mostly uninhabited areas like the oceans and locations like the Australian Outback, Canadian tundra, and Siberia due to the common path of orbits.[11] We have yet to see debris cause injury to anyone upon re-entry, or cause serious property damage.[12] NASA's analysis says that "debris left in orbits below 370 miles (600 km) normally falls back to Earth within several years.[13] At altitudes of 500 miles (800 km), the time for orbital decay is often measured in decades. Above 620 miles (1,000 km), orbital debris normally will continue circling Earth for a century or more."

However, given the long times before much debris deorbits and the increased launch of payloads into space, some governments are taking a more proactive stance on debris. Space debris removal is a whole new technological area for innovation. Using

10 "Nasa: India's satellite destruction could endanger ISS," *BBC News*, BBC.

11 Ibid.

12 Ibid.

13 Ibid.

maneuverable and propulsion-based satellites, ideas for disposing of orbital debris range from: capturing debris with nets, pushing debris to lower orbits, employing electrodynamic tethers to slow down debris, using slingshot maneuvers, deploying robotic arms, and using lasers to move debris into the atmosphere to burn up.[14]

Using maneuverable and propulsion-based satellites, ideas for disposing of orbital debris range from: capturing debris with nets, pushing debris to lower orbits, employing electrodynamic tethers to slow down debris, using slingshot maneuvers, deploying robotic arms, and using lasers to move debris into the atmosphere to burn up.

More-tangible projects under way include Japan's space agency JAXA (Japan Aerospace Exploration Agency) contracting out orbital debris removal operations to a Japanese commercial company, Astroscale.[15] Astroscale is a pioneer company for orbital debris removal and end of life servicing.[16] JAXA's contract, under its Commercial Removal of Debris Demonstration 2 program, requires Astroscale to launch a spacecraft to inspect a Japanese second stage rocket in orbit by 2023 and de-orbit it by 2026.[17] Astroscale also has a U.S. branch focused on restoring older GEO (geosynchronous equatorial orbit) satellites in orbit to prolong their lives and lessen orbital debris impacts created by retired satellites.

The European Space Agency (ESA) has also partnered with Astroscale recently. With the help of the U.K. Space Agency, Europe has awarded Astroscale, in tandem with newly

14 Elizabeth Howell, "Space Junk Clean Up: 7 Wild Ways to Destroy Orbital Debris," *Space.com*, March 3, 2014. https://www.space.com/24895-space-junk-wild-clean-up-concepts.html (February 19, 2021).

15 Caleb Henry, "Astroscale wins first half of JAXA debris-removal mission," *SpaceNews*, February 12, 2020. https://spacenews.com/astroscale-wins-first-half-of-jaxa-debris-removal-mission/ (February 19, 2021).

16 "Active Debris Removal (ADR)," *Services*, Astroscale. https://astroscale.com/services/active-debris-removal-adr/ (February 19, 2021). "End of Life (EOL)," *Services*, Astroscale. https://astroscale.com/services/end-of-life-eol/ (February 19, 2021).

17 Japan Aerospace Exploration Agency, "JAXA concludes partnership-type contract for Phase I of its Commercial Removal of Debris Demonstration (CRD2)," JAXA Press Release, March 23, 2020. https://global.jaxa.jp/press/2020/03/20200323-1_e.html. Accessed February 19, 2021.

resurrected satellite company OneWeb, funds to develop full-service active debris removal offerings by 2024.[18] ESA has been a pro-active leader in space debris management recently as it has also contracted with a Swiss company, ClearSpace, to clean up orbital debris.[19] Launching by 2025, ClearSpace will use robotic arms to target larger debris like the Vespa (Vega Secondary Payload Adapter). The Vespa's upper stage was left in LEO (low earth orbit) in an 800-km-by-660-km orbit after the ESA's Vega launcher took its second flight in 2013. ClearSpace will de-orbit the Vespa by directing it toward Earth's atmosphere to burn up in reentry. After the Vespa's removal, ClearSpace should have the means and skills to target other space debris crowding our orbital system.[20]

> *"… sometimes these larger pieces of space debris can be repurposed."*

However, sometimes these larger pieces of space debris can be repurposed. Nanoracks, a company that hosts commercial payloads on the ISS, is currently working on its Outpost project, which takes the upper stages of used rockets and reshapes them into miniature space laboratories in orbit.[21] These upper stages have many qualities necessary to make space stations. They are: 1) already in orbit 2) able to hold pressure, and 3) large enough to hold functioning technology and humans. With the help of robotic technology, Nanoracks is looking to remove remaining rocket fuel, shape metal, attach solar panels, and use propulsion technology to control the orbit of the stations. While Nanoracks faces many challenges, such as figuring out how to cut metal in the vacuum of space, such trouble-shooting is forging innovation to meet the cutting-edge needs of commercial space.

18 "Astroscale UK Signs £2.5 Million Agreement to Develop Space Debris Removal Technology Innovations with OneWeb," Astroscale, June 4, 2021. https://astroscale.com/astroscale-uk-signs-2-5-million-agreement-to-develop-space-debris-removal-technology-innovations-with-oneweb/.

19 "ESA commissions world's first space debris removal," *Safety and Security*, ESA, September 9, 2019. https://www.esa.int/Safety_Security/Clean_Space/ESA_commissions_world_s_first_space_debris_removal (February 19, 2021).

20 Ibid.

21 Daniel Oberhaus, "The Plan to Turn Scrapped Rockets Into Space Stations," Science, *Wired*, November 11, 2020. https://www.wired.com/story/the-plan-to-turn-scrapped-rockets-into-space-stations/ (February 19, 2021). "OUTPOST: Customer-driven destinations in space," *Outpost*, Nanoracks. https://nanoracks.com/outpost/ (February 19, 2021).

PART 3

POTENTIAL DAMAGE DUE TO ORBITAL DEBRIS AND ITS REMOVAL

3.1 GLOBAL AND U.S. COMMERCIAL DAMAGE RISK

In 2019, the global space economy amounted to about $366 billion. Of this, $271 billion was in the satellite industry, and $123 billion was directly in satellite services.[22] U.S. companies gained $49.9 billion in revenue from satellite services in 2019, which amounts to 41% of that year's global satellite services revenue. Of the U.S. operational satellites in 2019, 27% are for commercial communications, 27% for remote sensing, 8% in government communications, and 7% in military surveillance. As COVID-19 has spurred more reliance on satellites, the final numbers for 2020 will likely show similar to larger revenue for the U.S. commercial space industry.[23] As the world increasingly becoming reliant on satellites, U.S. and global satellite business—and the global industries that depend on it—will bear the brunt of failure to track and remove orbital debris.

22 "State of the Satellite Industry Report" *Satellite Industry Association*, Bryce, June 2020, https://brycetech.com/download.php?f=SIA_SSIR_2020.pdf (February 19, 2021).

23 Miriam Kramer, "The space industry comes of age," *Science*, Axios, December 22, 2020, https://www.axios.com/space-industry-comes-of-age-fd83b551-1f41-412b-ab78-b0022c152527.html (February 19, 2021).

3.2 RISK TO GLOBAL GOVERNMENTS AND MILITARY

Purposeful creation of debris from ASAT tests is becoming more of a concern internationally as more countries gain this military capability. ASAT weapons are a useful enhancement to space military capabilities and for terrestrial-based missions. They are technically within international legal bounds, as a ground-based weapon and not an illegal space-based weapon, making their development a very real threat. When an ASAT weapon hits a satellite, it can knock out communications and satellite imagery for reconnaissance and tracking purposes that military satellites relay to ground management.[24] This makes ASAT weapons not only a risk for military, but for public communications as well.

> *India's first ASAT test created around 400 pieces of trackable debris when it destroyed an Indian satellite. This major influx of debris raised alarm for many with space interests as well as for international collaboration.*

As of 2019, India joined the list of ASAT-capable nations that includes the U.S., Russia, and China.[25] India's first ASAT test created around 400 pieces of trackable debris when it destroyed an Indian satellite.[26] This major influx of debris raised alarm for many with space interests as well as for international collaboration. NASA's retired chief, Jim Bridenstine, cited a 44% increase in risk of debris collision with the ISS due to the Indian ASAT test debris.[27] India's ASAT debris is not the only debris hanging around in orbit. India's test pales in comparison to China's test in 2007. That intercept is theorized to be responsible for a third

[24] Doris Elin Urrutia, "India's Anti-Satellite Missile Test Is a Big Deal. Here's Why.," *Space.com*, March 30, 2019. https://www.space.com/india-anti-satellite-test-significance.html (February 19, 2021).

[25] Rajaram Nagappa, Mrunalini Deshpande, and S. Chandrashekar, "India's ASAT Test," *ISSSP Reflections,* No.58 (March 28, 2019). http://isssp.in/indias-asat-test/ (February 19, 2021).

[26] "ASAT: India's Shooting down of Satellite Created 400 Pieces of Debris, Put ISS at Risk: NASA," *Economic Times*, April 2, 2019. https://economictimes.indiatimes.com/news/defence/indias-shooting-down-of-satellite-created-400-pieces-of-debris-put-iss-at-risk-nasa/articleshow/68682165.cms (February 19, 2021).

[27] "Nasa: India's satellite destruction could endanger ISS," *BBC News*, BBC, April 2, 2019. https://www.bbc.com/news/world-asia-india-47783137 (February 19, 2021).

of all the debris now in orbit.[28] We will see an increasing trend of more countries (such as Iran and North Korea) expressing substantial interest and serious development effort toward ASAT weapons in coming years.[29]

Despite orbital debris being a national security concern for military reconnaissance and communications satellites, it can also be hijacked for clandestine missions. It is a common practice for militaries around the world to disguise reconnaissance satellites and counter-space weapons as orbital debris.[30] This makes orbital debris a particularly challenging problem for both civil and military space agencies.

> *Developing orbital debris technologies like lasers, nets, magnets, tethers, robotic arms, or co-orbiting service satellites can open the door for less-friendly space actors to threaten U.S. space assets.*

Yet, orbital debris removal technologies themselves come with risks. Developing orbital debris technologies like lasers, nets, magnets, tethers, robotic arms, or co-orbiting service satellites can open the door for less-friendly space actors to threaten U.S. space assets. Countries can easily create technologies that look like space debris removal systems or hijack technologies already in orbit through cyber-attacks to create counter-space threats.[31] Using a satellite with a laser on it, actors that wish to harm U.S. intelligence could easily choose to use these maneuvering technologies to harm our satellites in orbit instead of removing debris.

28 Ibid.

29 Todd Harrison et al, "Space Threat Assessment 2020," *Aerospace Security Project*, CSIS, March 2020. https://aerospace.csis.org/wp-content/uploads/2020/03/Harrison_SpaceThreatAssessment20_WEB_FINAL-min.pdf (February 19, 2021).

30 Peter Spinella, "Spy Satellites Spotted 'Disguised as Space Junk," *The Moscow Times*, April 12, 2015. https://www.themoscowtimes.com/2015/04/12/spy-satellites-spotted-disguised-as-space-junk-a45660#:~:text=Nighttime%20view%20of%20Moscow%20from,a%20television%20report%20on%20Sunday. (February 19, 2021).

31 Saadia Pekkanen, "Why space debris cleanup might be a national security threat," *Science + Technology*, The Conversation, November 18, 2018. https://theconversation.com/why-space-debris-cleanup-might-be-a-national-security-threat-105816 (February 19, 2021).

PART 4

ORBITAL DEBRIS AND U.S. POLICY

The U.S. has a history of being conscious of orbital debris and the dangers it holds for future space travel and commerce. In 1995, NASA was the first national space agency to issue a comprehensive set of orbital debris mitigation guidelines. In 2001, the U.S. government developed a set of *Orbital Debris Mitigation Standard Practices* (ODMSP) based on NASA's guidelines.[32] However, both these standards were not centered around the removal of debris, but just proactive actions to minimize the creation of new orbital debris.

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[32] "Debris Mitigation," *Orbital Debris Program Office*, NASA, https://orbitaldebris.jsc.nasa.gov/mitigation/ (February 19, 2021).

As debris gained attention, in 2002, the U.S. led 10 countries and the European Space Agency (ESA) to form the Inter-Agency Space Debris Coordination Committee (IADC) to adopt a consensus set of guidelines to mitigate orbital debris proliferation.[33] The IADC to this day meets regularly to address ongoing space debris problems and advises the United Nations' Committee on the Peaceful Uses of Outer Space (COPUOS) on international debris concerns.[34]

COPUOS also has a Working Group on the Long-Term Sustainability of Outer Space, established in 2010 under the Scientific and Technical Subcommittee. This group identifies areas of concern for the long-term sustainability of outer space activities, proposes measurements that could enhance sustainability, and produces voluntary guidelines to reduce risks to the long-term sustainability of outer space activities. Some of its work centers around orbital debris, SSA, as well as international regulatory recommendations for STM.[35]

The Working Group on the Long-Term Sustainability of Outer Space's most recent development was in 2019 when the group's *Guidelines for the Long-term Sustainability of Outer Space Activities* were adopted by COPUOS as voluntary guidelines for countries to follow. The recommendations included the collective sharing and dissemination of orbital debris monitoring information, better end-of-life standards for satellite and mission designs to ensure appropriate de-orbiting, the measurement of orbital debris' population long-term, and international partnership in research, development, and regulations moving forward. [36]

Another international mechanism for understanding orbital debris policy is through the Outer Space Treaty. Under the Outer Space Treaty's Article VI, government entities require authorization and continued supervision of objects launched into orbit from their country, but this is entirely up to the country's discretion.[37] National governments are only asked to keep

33 Ibid.

34 Ibid.

35 "United Nations Office for Outer Space Affairs," Working Groups of the Committee and its Subcommittees. Accessed July 7, 2021. https://www.unoosa.org/oosa/en/ourwork/copuos/working-groups.html.

36 United Nations Working Group on the Long-Term Sustainability of Outer Space Activities, *Guidelines for the Long-term Sustainability of Outer Space Activities*, Vienna, Austria, 2018.

37 "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," *Office for Outer Space Affairs*, United Nations, October 1967, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html (February 19, 2021).

in mind that under Article VII they are internationally liable for any damage that a space object causes. However, this section of the Outer Space Treaty has yet to be enforced because the U.S., Russia, China, and India have still not paid for their ASAT damages caused to the foreign satellites they have shot down, nor the damages caused by debris it created.[38]

Orbital debris work resurfaced in the Obama administration's 2010 National Space Policy.[39] However, this policy just emphasized the importance of ODMSP. While continuing to endorse NASA and DoD efforts to research and develop technologies to mitigate and potentially remove on-orbit debris, reduce its hazards through collision warning systems, and understand effects of future debris, it accomplished little actual debris interdiction.

It was not until 2018, when the Trump administration revived the National Space Council (NSpC), that we saw the U.S. begin to seriously put orbital debris on the map as a larger policy issue. The NSpC Space Policy Directive 3 (SPD-3) pushed for U.S. government work on space traffic management (STM), space situational awareness (SSA), and the review of the ODMSP periodically.[40] With added space traffic management (STM) protocols, the U.S. government and the DoD will be better prepared for counter-space threats. STM is more than just managing actors like commercial space companies. It is about working with them to carry out their missions safely, while also keeping U.S. national security in mind. Since the U.S. government remains a giant customer of the commercial space industry, foreign threats can harm its assets and be economically damaging. Hence, STM regulatory partnerships would benefit public and private sectors alike and should be approached as a partnership.

STM is more than just managing actors like commercial space companies. It is about working with them to carry out their missions safely, while also keeping U.S. national security in mind.

38 Doris Elin Urrutia, "India's Anti-Satellite Missile Test Is a Big Deal. Here's Why."

39 White House, *National Space Policy of the United States of America*, (Washington, DC: White House, 2010), https://history.nasa.gov/national_space_policy_6-28-10.pdf.

40 National Space Council, *Space Policy Directive-3, National Space Traffic Management Policy*, (Washington, DC: National Space Council, June 18, 2018), https://aerospace.org/sites/default/files/policy_archives/Space%20Policy%20Directive%203%20-%20STM%2018Jun18.pdf.

Similarly, SPD-3 was a direct reaction to the increased national security concerns orbital debris poses to civil assets, but also the U.S. government's focus on building up the commercial space industry. SPD-3 makes clear government understanding of orbital debris' potential to harm new commercial technologies in space. The ODMSP was updated in 2019 under SPD-3 to reflect these directive reviews and consider new technologies like satellite constellations being set up in space in relation to debris. Some of the newer policies promoted by the SPD-3 included making STM services available for free to direct users in accordance with national security standards, improving SSA interoperability and data sharing of debris, making SSA and STM a priority for pre-launch risk assessments, beefing up debris tracking programs, and including commercial leadership in SSA and STM work.

To change the ODMSP as well embrace more robust SSA/STM standards, the SPD-3 instructed government entities like NASA, Departments of State, Defense, Commerce, and Transportation, the director of National Intelligence, and the Federal Communications Commission (FCC) to work together to analyze these issues. Through multi-agency analysis, the SPD-3 wanted to see concrete changes in regulations to include SSA/STM standards through the ODMSP in Department of Transportation and FCC licensing, as well as creating a repository of debris tracking data.

Days before President Biden's inauguration, the Trump White House released a report by an interagency working group under the National Science and Technology Council on a National Orbital Debris Research and Development Plan.[41] This report presents a national plan to support three essential elements of orbital debris risk management: 1) limit debris generation by design, 2) track and characterize debris, and 3) remediate or repurpose debris. While the plan for research and development might be clear, the authority of STM is still opaque.

Since Trump's departure from office, we have seen a recommitment to orbital debris management and mitigation internationally that aligns with U.S. space policies. Most recently, G7 2020 summit delegates from Canada, France, Germany, Italy, Japan, the U.S., the U.K., and the E.U. pledged to take action to tackle orbital debris and the growing challenge it poses.[42] In their statement they welcomed the U.N.'s Long-Term Sustainability

41 National Science & Technology Council, *National Orbital Debris Research and Development Plan*, (Washington, DC: National Science & Technology Council, January 2021), https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/National-Orbital-Debris-RD-Plan-2021.pdf .

42 UK Space Agency, "G7 Nations Commit to the Safe and Sustainable Use of Space," GOV.UK, June 13, 2021, https://www.gov.uk/government/news/g7-nations-commit-to-the-safe-and-sustainable-use-of-space.

Guidelines on orbital debris research and development as well as addressed the U.N. COPUOS, the International Organization for Standardization, and the IADC to support developing common international standards on STM.[43] Signing onto the guidelines made by COPUOS' Working Group on Long-Term Sustainability of Outer Space is a step in the right direction in our international community taking orbital debris work seriously.

[43] Ibid.

PART 5

REGULATION ON ORBITAL DEBRIS

5.1 WHICH U.S. AGENCY OVERSEES REGULATION ON ORBITAL DEBRIS POLICY?

Since SPD-3, creating both better domestic regulations in concert with SSA/STM standards and a repository full of orbital debris information for general consumption has not been easy. There are no clear lines as to which government authority oversees regulating orbital debris risks. Instead, we have several different agencies touching on the debris problem all at once.

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DoD and NASA may be attempting to keep track of objects in space, but these operations are executed as more of a space collision warning process and do not act as a “space traffic

cop."[44] NASA and DoD do not have regulatory authority over space debris, but act more as a resource for SSA policies. This differs from authority like the Federal Aviation Administration (FAA) has for licensing commercial launches and reentries and radio broadcasts from space, or that the National Oceanic and Atmospheric Administration (NOAA) has for licensing space remote-sensing operations.

STM regulatory authority in the U.S. over orbital debris would realistically just grant an agency authority to tell satellite operators they have to move their spacecraft like air traffic control and give real collision warnings for orbital debris issues.[45] It may eventually extend to helping organize orbit more effectively, given traffic patterns.

Right now, academics, government agencies, and commercial companies around the world are launching a multitude of objects into space. With worries of overcrowding and creating an unsustainable space environment, Congress directed the Office of Space Commerce (OSC), a part of NOAA within the Commerce Department, to contract with the National Academy of Public Administration to do a study. This study, issued in August 2020, concluded that the OSC was the best government organization to assume the mission of non-military STM.[46] It also recommended the OSC be elevated to its own office instead of just being a part of NOAA. Looking forward, the U.S. needs to consolidate STM authority into a singular federal agency with the best connections to commercial space users.

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44 "Aerospace Safety Advisory Panel Annual Report: 2020," *Aerospace Safety Advisory Panel*, NASA, January 1, 2021. https://oiir.hq.nasa.gov/asap/documents/2020_ASAP_Report-TAGGED.pdf (February 1, 2021).

45 Marcia Smith, "NAPA ENDORSES OFFICE OF SPACE COMMERCE FOR SPACE TRAFFIC MANAGEMENT ROLE," Spacepolicyonline.com, August 20, 2020. https://spacepolicyonline.com/news/napa-endorses-office-of-space-commerce-for-space-traffic-management-role/ (February 19, 2021).

46 "Space Traffic Management," Panel of the National Academy of Public Administration, August 2020. https://www.napawash.org/uploads/NAPA_OSC_Final_Report.pdf (February 19, 2021).

5.2 WHY THE OSC?

Currently, DoD is the agency with the most responsibility over SSA reporting of orbital debris. DoD currently does this for military and non-military objects. Since it needs to track all orbital debris to analyze if it is a national security concern or not, publishing its already processed data of unclassified debris into a publicly available catalog makes logical sense. DoD should be excited at the idea of relinquishing any responsibility for STM collision warnings and handing authority over regulations to another agency. This would allow DoD to get back to what it does best: military-specific operations.

If DoD were to be relieved of these responsibilities, the natural choice should be an office under the Commerce Department, such as the OSC. DoD and NASA are not the only entities tracking and calculating the risk of orbital debris collisions. Traffic management and situational awareness are necessary to businesses operating satellites and orbiting objects in space, leading commercial space companies to compile their own database. Because of this the government should be tapping into and organizing commercial space companies' data in conjunction with DoD records to create a more comprehensive traffic management process.

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The OSC is well positioned to work with the private sector. It was created solely to support commercial space growth in the U.S. economy and has excellent existing relationships with industry actors. Instead of pushing another agency to build out its connections with commercial space, using the OSC's position allows the government to efficiently utilize private space data to protect and promote both civil and commercial space growth and assets.

However, months later the OSC is still not being utilized correctly. In October 2020, it hosted an event to solicit input from commercial space actors on information technology issues like the Open Architecture Data Repository (OADR).[47] The OADR would be through the OSC, using NOAA resources, as a program that would collect information from satellite operators to create better situational awareness overall and develop possible traffic management programs if the OSC gains responsibility over STM. This request for information attracted more than 250 participants offering services across the industry to add to our understanding of space safety.[48] Input from the industry showcased the U.S. commercial space sector's readiness to provide space data, storage, and services immediately. This immediacy comes with much better services than what we have access to today federally. Constellations of satellites like Starlink, Kuiper, and OneWeb dominate the private sources of data with precision that not even U.S. Space Command has access to.[49] Companies already have their own satellite tracking networks and, if an OADR is properly formed, the OSC could gain access to these commercial capabilities and combine them with data from different agencies like the DoD and NASA to create the most up-to-date services in history for STM and SSA.

We have not taken advantage of this overwhelming support from the private sector yet. Instead of jumping at the chance to develop the OADR, the OSC now hits a roadblock with the Department of Commerce's fiscal year 2022 budget request.[50] Scott Pace, former executive secretary of the National Space Council, recently pointed out that this budget request does not spend the $10 million-$15 million for commercial space data and services that the NAPA study advocated for, but continues to fund the entire OSC with $10 million with no funds for commercial data.[51] Even less efficiently, the rest of the OSC fiscal year 2021 is proposed to fund and review topics the NAPA study already analyzed.[52]

47 "Industry Day for SPD-3: Open Architecture Data Repository," *Business with Government*, Office of Space Commerce, October 27, 2020, https://www.space.commerce.gov/industry-day-for-spd-3-open-architecture-data-repository/ (February 19, 2021).

48 Scott Pace, "Op-Ed: NOAA Is Stalling U.S. Space Traffic Management," *SpaceNews*, June 18, 2021, https://spacenews.com/op-ed-noaa-is-stalling-u-s-space-traffic-management/.

49 Ibid.

50 "Op-Ed: NOAA Is Stalling U.S. Space Traffic Management," *SpaceNews.*

51 National Oceanic and Atmospheric Administration (U.S.), 2022, *Congressional budget justification*, Washington, D.C., https://www.commerce.gov/sites/default/files/2021-06/fy2022_noaa_congressional_budget_justification.pdf.

52 "Op-Ed: NOAA Is Stalling U.S. Space Traffic Management," *SpaceNews.*

OADR, in an appropriate role, would work with not only U.S. government agencies and commercial companies, but also international space partners.[53] This would promote a more international commitment to SSA and hopefully lead to more international engagement in STM. Maintaining U.S. leadership is vital in this environment. If the U.S. creates the standard and quality for these regulatory environments, then the regulatory norms remain a friendly place for U.S. commercial services, especially if these norms are adopted by other international partners. These international conversations about STM and SSA are already within the purview of the OSC. Back in August 2020, the OSC participated in talks with Japan about commercial space developments in the U.S. and the importance of STM/SSA moving forward.[54] Maintaining this leadership within OSC will be necessary as actors like China and Russia continue their less-than-U.S.-friendly developments in space.

5.3 WHAT ABOUT NASA?

Recently, the Aerospace Safety Advisory Panel (ASAP) submitted its analysis of NASA's operations and decision-making to Congress (Annual Report for 2020).[55] Within this report the ASAP has carefully laid out an assessment of orbital debris and the dangerous environment it creates for NASA assets in space, as well as for the private and international communities.

The report also speaks to the increase in congestion and less-traditional space assets being launched into orbit, like huge broadband satellite constellations and the possibility of space tourism, bringing about a need to revisit regulatory issues on STM. With past space assets typically being linked to civil agencies, STM regulations have been less of an issue, but with the increase in commercial actors using space assets for commercial ventures without ties to a government project, the regulatory environment has changed. ASAP draws attention to the lack of STM regulatory authority agencies have, and it assesses the new need to clarify this issue. With NASA space projects in mind and the threat orbital debris poses to them, ASAP's report also calls for support of the NAPA report findings that designate the OSC as the civil agency to handle STM/SSA.

53 Wilbur Ross, "Remarks by Commerce Secretary Wilbur Ross at the Eighth Meeting of the National Space Council" (speech, December 9, 2021), U.S Department of Commerce, https://www.commerce.gov/news/speeches/2020/12/remarks-commerce-secretary-wilbur-ross-eighth- meeting-national-space-council.

54 "Commerce Participates in U.S.-Japan Space Dialogue," *International Cooperation*, U.S. Department of Commerce, August 27, 2020. https://www.space.commerce.gov/commerce-participates-in-u-s-japan-space-dialogue (February 19, 2021).

55 "Aerospace Safety Advisory Panel Annual Report: 2020," Aerospace Safety Advisory Panel, NASA.

Assuming STM/SSA responsibilities are shifted from DoD and find themselves more within the OSC's wheelhouse, there is a question as to where NASA fits in the equation. NASA's new Administrator Bill Nelson has recently spoken with many committees in Congress about the importance of NASA moving forward and has noted that NASA will always be a part of the conversation on orbital debris management. This is because it is NASA's astronauts up in the ISS being affected by orbital debris and NASA's projects being damaged by debris.[56] However, NASA need not be an entity that tracks and warns our space community about debris, but rather can explore how to go beyond warning systems and data repositories. NASA should shift its orbital debris work toward research and development (R&D) that focuses on either the removal of debris or developing ways to repurpose it.

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Bhavya Lal, senior adviser to the NASA administrator for budget and finance, recently disclosed that she led a NASA team to help assess how the agency could be more effective in space sustainability.[57] While the public disclosure of these findings will still take months, Lal has described tackling the orbital debris problem with a three-pronged approach similar to the National Orbital Debris Research and Development Plan laid out by the Trump administration prior to his departure from office. These approaches include limiting the creation of debris, tracking and characterizing debris, and remediating or repurposing debris.

56 *A Review of the President's Fiscal Year 2022 Budget Proposal for NASA*, *Before the U.S. House of Representatives Committee on Science, Space, & Technology*, 117th Congress, (2021) (Bill Nelson, NASA Administrator).

57 Jeff Foust, "NASA Team to Study New Roles for the Agency in Addressing Orbital Debris," *SpaceNews,* June 28, 2021, https://spacenews.com/nasa-team-to-study-new-roles-for-the-agency-in-addressing-orbital-debris/.

Lal's comments are in tune with the NASA Office of Inspector General (OIG)'s report out on January 21, 2021, assessing *NASA's Efforts to Mitigate the Risks Posed by Orbital Debris*.[58] This report found that mitigation strategies for orbital debris now need to go beyond just prevention. Due to the increase in debris, the OIG urges NASA to retire its prevention strategy as the only way to mitigate orbital debris problems and stresses the need for remediation technology development. The report notes that, despite multiple presidential and congressional directives over the years to focus on R&D for debris removal technologies, NASA has yet to produce anything substantial.[59]

Additionally, the OIG report reviews NASA's tracking of orbital debris under its Orbital Debris Program Office (ODPO) and its understanding of the debris environment. The OIG concludes that NASA lacks sufficient data. This puts NASA at risk of either putting assets in danger or of wasting government funds on extra unnecessary precautions. The ODPO has also been unsuccessful in securing a source of measurement data on debris 3 mm and smaller in the 400 to 1,000 km range of LEO and cannot track debris smaller than 10 cm in the range of LEO where the ISS is located.[60] Realistically, it seems the ODPO can be replaced by just relying on the DoD and OSC's more comprehensive orbital debris tracking catalogues moving forward. If NASA did rely on these data, it would be better equipped to design its exploratory spacecraft against orbital debris risk due to better accuracy.

58 Office of Inspector General, *NASA's Efforts to Mitigate the Risks Posed by Orbital Debris,* Report No. IG-21- 011 (Washington, DC: NASA Office of Inspector General, January 27, 2021), https://oig.nasa.gov/docs/IG- 21-011.pdf?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosspace&stream=science (February 19, 2021).

59 Ibid.

60 Ibid.

PART 6

HOW DO WE MAKE MEANINGFUL POLICY CHANGES IN ORBITAL DEBRIS POLICY?

With the new Biden administration and a political change in Congress, space policy must remain a serious policy issue. Not only does the U.S. have billions in government technology in orbit and national security concerns with various other space-faring nations, but the commercial space industry is projected to exceed a trillion dollars by 2040. The U.S. should have policies to support this growth.[61] One such policy should be protecting assets in space from orbital debris.

With Administrator Nelson at the helm of NASA, we are seeing that the recommitment to Earth Sciences is NASA's outward facing policy. Additional pressure from Congress has led to every agency's reassessment of its environmental programs. Commercial space has taken note and offers more and more services to develop more satellite and remote sensing technologies to provide the U.S. with valuable research and tracking tools to assess

61 "Space: Investing in the Final Frontier," *Research*, Morgan Stanley, July 20, 2020. https://www.morganstanley.com/ideas/investing-in-space#:~:text=The%20Global%20Space%20Economy&text=Morgan%20Stanley%20estimates%20that%20the,from%20satellite%20broadband%20Internet%20access (February 19, 2021).

problems like Earth's climate change. Orbital debris poses a real and fatal threat to these technologies in space and this threat should be addressed via pro-active policy changes.

Administrator Nelson's talks with Congress cannot be the only space policy guidance we have in the U.S., no matter how powerful his statements are. It is time for the National Space Council (NSpC) to come out of hibernation and begin engaging in space policy. President Biden has recently assured the space community that the NSpC will be revitalized under Vice President Harris.[62] The NSpC not only provides meaningful and effective directives for national space policy, but also engages all parties in space including the military, civil, international, and commercial communities. With space policy experts on the council already having experience in different sectors of space, working and advisory groups can provide ongoing feedback on national objectives. The NSpC role in advising the White House and Congress on how to organize responsibilities in different agencies effectively and how to assess our growth as a spacefaring nation will be critical moving forward. An example of this is working with agencies like the Office of Space Commerce to help develop their directive and how they should approach STM and SSA programs, while also serving as a liaison point for other agencies to understand these developments.

The National Space Council's SPD-3 has done more for orbital debris review than most U.S. policies. This includes helping push Congress and agency management offices to take a hard look at space development.

The National Space Council's SPD-3 has done more for orbital debris review than most U.S. policies. This includes helping push Congress and agency management offices to take a hard look at space development. Without SPD-3, many investigatory reports would not have happened in the last few years to truly review how the U.S. could do better in space. SPD-3 has led to recommendations like the OSC taking over space traffic management. With further directives specifically made by the NSpC, agencies can effectively reassess and

62 Sandra Erwin, "Biden Administration to Continue the National Space Council," *SpaceNews*, March 29, 2021, https://spacenews.com/biden-administration-to-continue-the-national-space-council/.

analyze orbital debris. With a new NSpC, orbital debris could be the major point of national concern that it should be. Orbital debris is increasingly concerning for U.S. assets, as well as a tool for geopolitical space diplomacy as we see heightened space developments from both Russia and China, countries less committed to our U.S. STM and SSA standards.

In regard to the reorganization of STM, the DoD must be relieved of commercial and civil STM responsibilities and these responsibilities should be given over to OSC. Instead, DoD should publish unclassified data that it already collects during its military reviews of orbital debris and be free of the added pressures of maintaining collision warning systems and possible regulations of STM. This would allow the DoD to get back to what it does best: defense work.

The OSC is best equipped to handle STM due to its close relationship with commercial actors who also have excellent databases full of orbital debris information. By drawing on existing close relationships with commercial partners, the OSC would not only provide better STM, but would also facilitate commercial space industry growth, which would include orbital debris measurements.

To fulfil its intended purposes, OSC needs to be properly staffed again under this new administration. The Trump administration's Kevin O'Connell was an excellent director, but the new administration is without a director. OSC has typically been a nonpolitical office and therefore potential staffers and a director for this office must be above all committed to empowering the office to work effectively with both private industry and the White House to promote U.S. National Space Policy. Focusing on filling these roles is one way of kickstarting the work the U.S. space community is looking for. However, progress should not stop here. The OSC should realistically be made a separate entity within the Department of Commerce, with capabilities expanded beyond its position under NOAA. While it has previously been understood that NOAA is heavily involved in remote sensing and the OADR portion of OSC's mission, today the independence of OSC would create capacity and increased resources to meet our ever-growing commercial industry while it works with government to develop services like STM.

> *By drawing on existing close relationships with commercial partners, the OSC would not only provide better STM, but also facilitate commercial space industry growth by offering even better analysis and warnings about orbital debris risks.*

Additionally, as international businesses continue to work in orbital debris removal and wish to market their services in the U.S., the OSC will be a vital government agency. The OSC already has the means to speak with international actors, and adding STM/SSA issues to its roster is a natural progression. With G7 leaders announcing their dedication to solving the orbital debris problems we see internationally, the U.S. is going to need OSC to properly follow through with its international commitment to long-term sustainability goals in space.[63] OSC's industry perspective will be a helpful tool for Vice President Harris and the National Space Council as it continues these talks on orbital debris standards internationally as well as domestically.

However, to do this, NOAA's budget for the fiscal year of 2022 must properly fund the OSC and its developments for OADR. OSC is being held back by funding allocations when it has the perfect opportunity to work with industry to use commercial services today. The private space industry has already developed what the U.S. government needs to create a real OADR system, making this an efficient opportunity for the U.S. both with time and funding in mind. Taking advantage of this opportunity now with the proper funding will save the government resources in the future.

Funding for space is a hot topic at the moment, with the U.S. Innovation and Competition Act (USICA) passing the Senate with a provision called the Space Preservation and Conjunction Emergency (SPACE) Act.[64] The SPACE Act, introduced by Senator Wicker, codifies the Department of Commerce's role in SSA and creates a $20 million grant program to fund Centers of Excellence to advance research specifically on SSA. The act also

[63] G7 Nations Commit to the Safe and Sustainable Use of Space," GOV.UK.

[64] Congress.gov. "S.1260 – 117th Congress (2021-2022): United States Innovation and Competition Act of 2021." June 8, 2021, https://www.congress.gov/bill/117th-congress/senate-bill/1260/text.

authorizes $15 million for OSC.[65] However, it is still uncertain what a House of Representative's version of USICA will look like and if it will contain the SPACE Act or its OSC provisions. Congress should either be ready to allocate real and proper funding to the OSC through a jointly passed USICA Act or develop these funding needs and allocation directives through the Department of Commerce's federal budget for 2022.

As we look forward to more future-facing policies, we must reassess our current orbital debris policies. One policy in particular is that NASA must trust DoD and OSC information over its own ODPO orbital debris work. ODPO does not have the capability to track or assess orbital debris to meet NASA's needs to properly inform its space mission operations. Instead, NASA should be focusing, as presidential and congressional directives have instructed for years, more on research and development for the removal and repurposing of orbital debris. Projects like NASA's development of the on-orbit servicing, assembly, and manufacturing (OSAM) 1 mission are a perfect example of types of initiatives NASA should focus on.[66] These satellite servicing technologies to remove debris will be key to solving our orbital debris population issue. To effectively continue this type of innovative work, NASA must continue working with companies that have made strides to ensure a less-congested LEO. Companies are starting to create matured orbital debris mitigation designs, and NASA is in a unique and appropriate place to help guide their strategies and development. By working with these commercial actors, NASA would also save money through public-private partnerships and help spur future innovation in this sector.

NASA is about exploring space and not about regulating or documenting it. With a new, innovative administrator leading NASA to meet U.S. space policy needs, like Earth Science research and deep space exploration, it is time to redirect NASA to relinquish STM/SSA responsibilities to another agency.

65 Marcia Smith, "Senate Commerce Committee Again Approves SPACE Act," Space Policy Online – News, SpacePolicyOnline.com, May 21, 2021, https://spacepolicyonline.com/news/senate-commerce-committee-again-approves-space-act/.

66 "NASA Team to Study New Roles for the Agency in Addressing Orbital Debris," *SpaceNews*.

PART 7

CONCLUSION

Orbital debris must not remain a tragedy of the commons. Without responsibilities being taken by international actors as well as the U.S., orbital debris will increase, creating an ever more dangerous space environment. By implementing these changes to space traffic management and space situational awareness, there is hope for LEO. By putting in the debris removal work now, more developments will get their shot at safely orbiting our systems. Without the development of LEO we will not see further progress into deep space exploration where we ultimately must go. The reorganization of space traffic management to a singular entity will continue this progress.

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