Focus Issue: Conducting a National Active Debris Removal Mission

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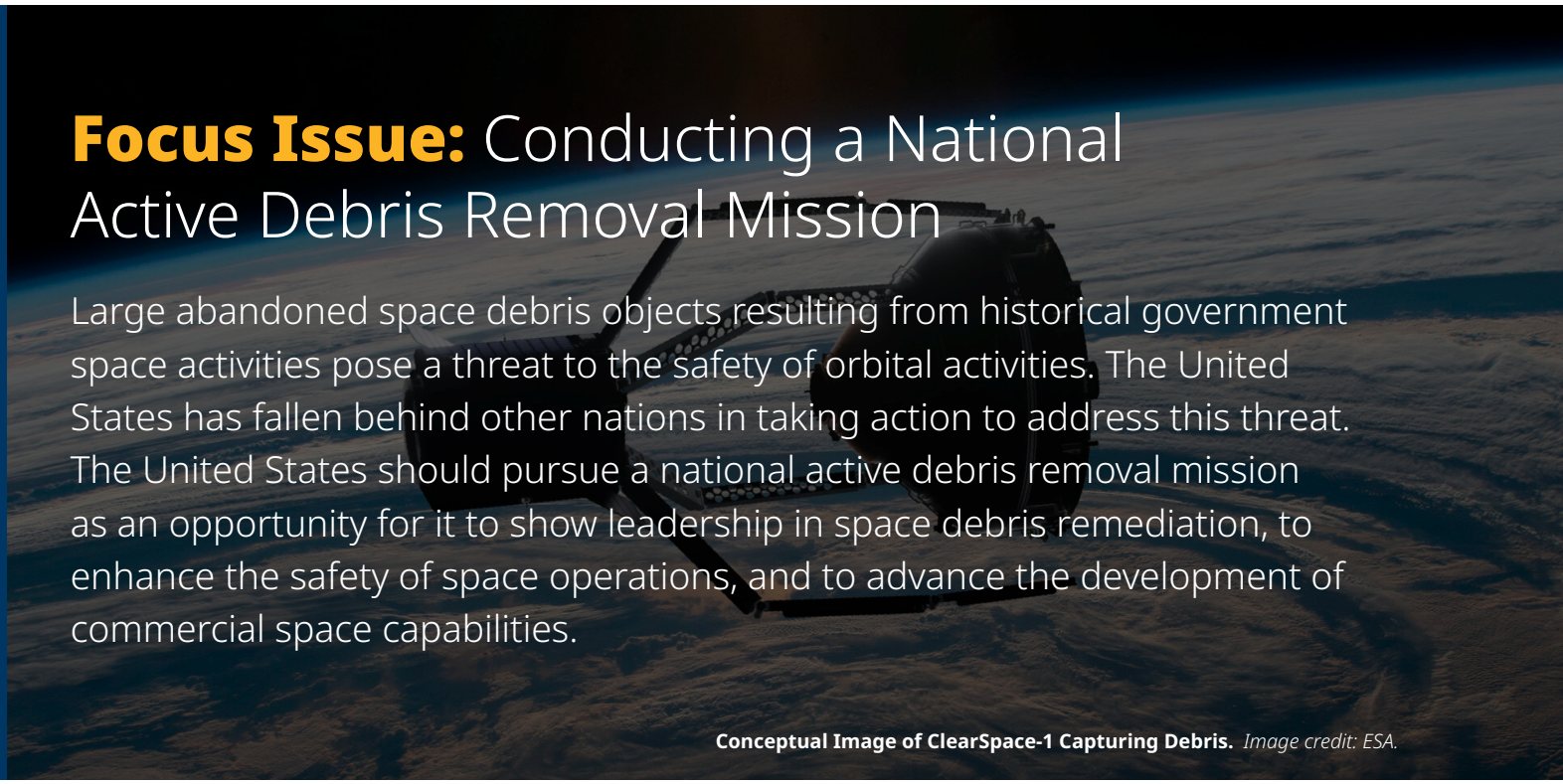

Focus Issue: Conducting a National Active Debris Removal Mission

Large abandoned space debris objects resulting from historical government space activities pose a threat to the safety of orbital activities. The United States has fallen behind other nations in taking action to address this threat. The United States should pursue a national active debris removal mission as an opportunity for it to show leadership in space debris remediation, to enhance the safety of space operations, and to advance the development of commercial space capabilities.

Conceptual Image of ClearSpace-1 Capturing Debris. *Image credit: ESA.*

Background

Maintaining and expanding national security, economic, and societal benefits that the United States derives from space services and capabilities depends on an operating environment that remains safe and conducive to continued operations. There are several risks to this stability, including the risk from collision between active spacecraft and space debris objects.

In particular regions of low Earth orbit (LEO), where historical activity has been high due to the economic and scientific utility of these orbits, there are a significant number of massive derelict space objects, primarily upper stages of rockets abandoned from prior space missions. For the most part, these large debris objects are part of the legacy of the past space activities of the United States, Russia (including historical Soviet objects), and China. These massive objects are uncontrolled and at risk of colliding or exploding—events that would foul these orbital regions with a large amount of debris, significantly increasing risks to operators in the environment. Action to remove these objects from orbit (e.g., active debris removal[ADR]) would provide stability and safety benefits to all actors in the space environment.

Active debris removal has been, and remains, a difficult technical, political, and business challenge to solve. There is no current commercial market for removing these objects and geopolitical considerations have limited government-to-government cooperation. Technical challenges associated with developing and maturing technology for the removal of unprepared debris objects (i.e., objects not designed for or actively participating in a removal operation, such as defunct rocket bodies or satellites) also have been a high barrier.

However, a number of trends and activities are reducing the technical challenges with debris remediation and ADR concepts. Development of adjacent capabilities, with potential commercial viability for in-space servicing, assembly, and manufacturing (ISAM) is helping to advance ADR-related technologies in commercially relevant rendezvous and proximity operations as well as in spacecraft grappling, berthing, and docking capabilities. Commercial space situational awareness

and space-to-space imaging capabilities and services enhance the ability to conduct characterization of debris objects and inform safe rendezvous operations. Further, companies are investing in novel debris remediation concepts, such as laser-based ablation and in-space recycling.

Most significant, however, are a number of ADR or debris remediation pilot and technology development programs underway in Europe, Japan, and the United Kingdom. The European Space Agency has funded the ClearSpace-1 mission which will remove the defunct European PROBA-1 satellite, with a target date in 2026. The United Kingdom Space Agency is funding the National Active Debris Removal Mission to remove a pair of defunct UK satellites, also planned in 2026. In Japan, the Japan Aerospace Exploration Agency (JAXA) has funded the Commercial Removal of Debris Demonstration (CRD2) program, which aims to cooperate with private Japanese companies to remove an unprepared Japanese upper-stage rocket body from LEO. Additionally, in January 2022, China's Shijian-21 spacecraft docked with and towed a defunct BeiDou navigation satellite to a graveyard orbit above geostationary orbit; as a capability demonstration. These capabilities advance national interest in these countries and support the development of industry capabilities, enhancing the competitiveness of their national space industry in the ISAM segment.

Current Policy and Gaps or Shortcomings

Notwithstanding the pilot and technology demonstration ADR missions described above, there is little public progress on large-scale debris remediation from the governments associated with the largest source risk from legacy objects (United States, China, and Russia). The United States has largely fallen behind other countries in both capability and action related to ADR capabilities.

Most of the pilot programs for debris remediation are in Europe, the United Kingdom, and Japan, although there have been a few other countries supporting minimal programs along these lines. In the United States, the Space Force's Orbital Prime program has awarded a number of small research and development contracts to U.S. firms for the development of ADR-related technologies, and the long-term objectives of the program include conducting an on-orbit demonstration of ADR. These programs are useful but have largely been limited to low-dollar studies of low-technology readiness level (TRL) concepts. It is important to advance the TRL of ADR concepts through hardware demos and on-orbit demos for civil space purposes.

Overall, the U.S. government has invested little in research and development (R&D) of remediation capabilities—despite high-level policy direction to do so—and currently lacks both follow-through on the existing implementation execution strategy and a broader vision to advance space debris remediation capabilities. In January 2021, the first Trump administration released the *National Orbital Debris Research and Development Plan*,[1] which sought to provide a coordinated plan to support research and development efforts related to orbital debris risk management across the federal government. In July 2022, the Biden administration issued the *National Orbital Debris Implementation Plan*, which sought to outline tangible implementation actions

1 National Science and Technology Council, National Orbital Debris Research and Development Plan (Washington, DC: Executive Office of the President, January 2021), https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/National-Orbital-Debris-RD-Plan-2021.pdf.

to build upon the 2021 R&D plan. Both plans have resulted in some increased activity in technology funding and studies, but only at a limited scale. There has also been bipartisan interest in Congress in enhancing national capabilities to conduct ADR missions. In September 2022, Senators Hickenlooper, Lummis, Cantwell, and Wicker introduced the Orbital Sustainability (ORBITS) Act, which would have established a program at NASA for actively removing debris from space, among other provisions. This bill was unanimously passed by the Senate in October 2023 but was not acted on by the House.[2]

The United States should pursue a national active debris removal mission as an opportunity for it to show leadership in space debris remediation.

Policy Recommendations

→ The U.S. government—through NASA—should establish a program to fund and conduct the removal of a U.S.-government-owned space debris object, preferably a large rocket body.

This mission should be conducted as a public-private partnership through NASA and would leverage existing NASA technical capability and investment related to ISAM, as well as emerging industry capabilities related to satellite servicing and in-space logistics. Such a mission would help to establish U.S. leadership in orbital debris remediation and set an example of responsibility in the importance of taking responsible action in support of the space economy. It would also deepen U.S. industry capabilities related to commercial markets in ISAM.

2 U.S. Congress, Senate, ORBITS Act of 2023, 118th Cong., 1st sess., introduced in Senate February 15, 2023, https://www.congress.gov/bill/118th-congress/senate-bill/447.