



Promoting Cooperative Solutions for Space Sustainability

Workshop on Principles for Safe and Responsible Active Debris Removal

Summary Report

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**Secure World Foundation
www.swfound.org**

INTRODUCTION

Active debris removal (ADR) refers to a set of technical, engineering, and business approaches to actively remove space debris from orbit. As the development of ADR technology progresses and initial demonstration missions are being considered, there is need to facilitate discussion of initial principles for transparency in operations and approaches.

To explore these issues, SWF convened a workshop on April 21, 2017 as a side event to the 7th European Space Debris Conference in Darmstadt, Germany. In a small group gathering of technical experts from government, academia, and industry, the workshop provided a facilitated discussion of basic principles, key issues, and opportunities to be addressed in order to ensure that ADR activities develop in a safe responsible and transparent matter. This was the first in a series of related discussions that SWF plans to organize. ESA's Space Debris Office provided logistical support for the workshop, including the room in which the event was held. SWF expresses its thanks for this support.

This workshop was held under Chatham House Rule and was not for attribution. This report summarizes the key discussion themes and questions raised by the workshop. The views expressed in this summary report do not necessarily reflect those of Secure World Foundation, or of the individuals in attendance or their respective institutions, organizations, or governments.

WORKSHOP SUMMARY

The workshop was convened to provide a forum for discussion of transparency in active debris removal activities. Over an afternoon, the agenda (see Appendix) featured two interactive group discussion sessions, moderated by SWF Project Manager Ian Christensen, and began with two brief highlight presentations: one focusing on the challenges posed by spent rocket upper stages, and the other focusing on space debris modelling and communications challenges. The participants included representatives from several space agencies, commercial satellite end of life service providers, spacecraft manufacturers, and industry and academic representatives involved in space debris modelling and tracking activities. Participation included operators of ADR demonstration missions scheduled to occur in the next year(s).

As the subject of the workshop was transparency in operations, much of the discussion focused on questions related to information and communications needs for ADR activities, including characterization of risk, communication to policy makers and to the community, and approaches to and execution of actual ADR missions. These high-level questions included:

- What common approaches or procedures can the space community adopt to share information related to debris removal activities?

- What information is needed to safely perform rendezvous and proximity operations (RPO) as part of an ADR mission or service?
- What role exists for standards in satellite manufacturing and/or operations to facilitate debris removal operations and/or satellite end of life services in future spacecraft?
- What practices can/should ADR operators adopt as Transparency and Confidence-Building Measures (TCBMs) as capabilities are developed, demonstrated, and fielded?
- How can space debris risk – by object, by orbit, by constellation – be characterized and communicated in common and understandable terms?
- What are the target stakeholder groups to be reached in order to spur action on debris removal?

The workshop was largely conducted under the premise that ADR activities are becoming practical and likely in the relative near-term. As such, the discussion was not focused on the political and economic uncertainties associated with the concept of ADR, although these issues did arise at some points during the event.

DISCUSSION THEMES

Although not all of the above questions were addressed in depth during the workshop, a number of related themes emerged across the discussion session. These are summarized in the following sections.

Distinction Between Spacecraft End-of-Life Services and Active Debris Removal

At the onset of the workshop participants noted the importance of recognizing the distinction between ADR activities and spacecraft End-of-Life (EOL) services. These distinctions can be summarized as:¹

- Spacecraft End of Life services describes an offering in which a service provider offers de-orbiting, grave-yarding, or decommissioning services for spacecraft that have reached the end of their operational lives or suffered an on-orbit failure. It entails active cooperation and agreement between the target spacecraft operator and the service provider, and might commonly include interaction with a target spacecraft that is ‘cooperative’ (e.g. with well-characterized physical and orbital parameters, possibly maneuverable, possibly with on-board physical aids to assist in RPO).

¹ Uetsuhara, M., Fujimoto, K., and Okada, M. “*IDEA OSG 1: Prelaunch Status Report*,” Paper presented at the 7th European Conference on Space Debris, Darmstadt, Germany. April 18-21, 2017.

- Active Debris Removal services or activities generally refer to missions or services to de-orbit or otherwise remove objects that are not cooperative or under clear control of owner/operators. This might include objects which are not well-characterized and for which ownership and authority to engage might not be known.

It was also noted by some participants that EOL services represent a more likely near-term commercial market opportunity than does ADR, and that as a result it is more likely that these services will be operational prior to any commercial scale ADR services. It was also noted that certain technology and/or mission approaches might be shared between EOL and ADR services.

The majority of the discussion at the workshop focused on ADR, although there are of course areas of overlap.

Transparency Measures in Active Debris Removal Operations

Recognizing that ADR activities will necessarily involve rendezvous and proximity operations between space objects, raising concerns about both dual-use implications and of the potential to create additional debris through operations, participants were asked to discuss what measures ADR providers or operators could take to provide transparency in their operations. Participants' response focused on five initial tenants:

1. Provide a clear declaration of intent: the ADR operator/provider should state which object(s) they intend to approach and remove, and their purpose in doing so.
2. If possible, the ADR provider should identify the owner of the target object(s) and establish a relationship with that owner if one doesn't already exist. Under current law and practice, it is unlikely that specific ADR missions will proceed without ownership and permission relationships established.
3. Share top level description of the technology (e.g. harpoon, net, tether, etc.) to be used for ADR operations, at a minimum with the owner of the target object, ideally in a public media.
4. Share a public high level concept of operations, with steps and timing of operations, and as operations proceed, provide status updates.
5. Prior to ADR operations, the owner of the target object (and other sources) should share previous observations on the current state of the object with the ADR provider.

The need for verification of these steps was also discussed, as was the recognition that commercially sensitive information will be need to be protected.

Discussion of these tenants raised additional questions:

- What is the notification process at the international level? Is a public statement enough, or are more formal practices necessary?

- What level of risk assessment is needed prior to an ADR engagement? Are there standard measures which can be developed and adopted? To what degree (if at all) should mission-specific risk assessments be public?

As part of the discussion of transparency measures, several participants noted that as a result of International Space Station operations (and potentially the Chinese space station), some procedures for RPO activities have been developed. It was suggested that these may offer some best practices that can be leveraged in developing operations norms for ADR activities.

Risk Communication

A second major theme of discussion during the workshop centered around how risk related to space debris is characterized and communicated. It was recognized that there may be need to increase the political, and possibly public, visibility of the challenges posed by space debris in order to support the fielding of ADR technologies and missions. It was also discussed that along with this fielding comes the need to be able to communicate the risks associated with space debris in a consistent, relatable, and understandable manner.

Some participants stated the challenge of communicating risks starts with “it’s a problem with using lists.” The concern is that using lists of the ‘most hazardous’ or ‘dangerous’ space debris objects does not communicate risk in an objective or consistent manner that relates to understandable effects on society. Many participants felt that it is important to quantify and communicate the risks associated with space debris in terms that relate to how those risks affect the ability to achieve specific applications, benefits, and/or missions. Essentially the suggestion was that risk communication be tied to stakeholder groups and their ‘pain points.’ Some participants further suggested that it would be useful to quantify the economic value generated through the use of specific orbits (rather than the economic value generated by the space sector or by specific applications, as is traditional), which would then allow the impact of polluting those orbits to be postulated in economic terms. The participants also discussed the range of modeling techniques and approaches currently used to study risks associated with space debris. It was suggested that the community might look towards the disaster reliance field for best practices, where a small number of models have become the reference tools used throughout the field.

CONCLUSIONS

At the end of the workshop, most participants felt that the discussion was useful, but not complete. As technical development efforts in ADR and satellite EOL services continue, there is need for further discussion of the legal, political, commercial, and operational issues involved. Not surprisingly, the workshop raised a number of questions that were not answered during the event itself.

Further questions to consider:

- In order to increase the political support for ADR missions, who does the community need to target in communications and education efforts? Political decision makers? The public? The satellite operator community?
- Under what rules would removing space objects for which ownership or launching state is unknown be covered?
- How to deal with the challenge of knowing who to notify, or ask permission of, to remove an object, especially for small objects where ownership/origin of the object might be unclear?
- As large constellations are deployed, what is the best approach for deployment over multiple launches and into multiple orbital planes, to allow for satellite check-out? Would it be useful to designate orbital ‘zones’ that differentiate between deployment and operational altitudes?

For its part, Secure World Foundation views this workshop as part of a series of conversations we plan to convene around the topic of norms of activity in rendezvous and proximity operations in space. The themes and question raised during this discussion will be revisited and further explored in subsequent events.

APPENDIX: WORKSHOP AGENDA

Workshop on Principles for Safe and Responsible Active Debris Removal April 21, 2017: ESA/ESOC Darmstadt, Germany

Description:

The workshop will feature a facilitated interactive discussion among participants in order to begin to identify basic principles, key issues, and opportunities to be addressed in order to ensure that ADR activities develops in a safe responsible and transparent matter. In a small group setting, participants will be asked to discuss and respond to a set of questions and issues posed by the organizing team.

Agenda:

- 13:30 – 13:45: *Introduction to Workshop Purpose and Objectives*
- Mr. Ian Christensen, SWF
- 13:45 – 14:00: *Series of Short Talks from Invited Participants*
- Dr. Darren McKnight, IAI
 - Dr. Hugh Lewis, University of Southampton
- 14:00 – 15:00: Working Session 1: Information Needs for ADR
- Group Discussion
- 15:00 – 15:30 Coffee Break
- 15:30 – 16:30: Working Session 2: Risk Communication Principles
- Group Discussion
- 16:30: Wrap-up and Conclusion Mr. Ian Christensen, SWF

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