Debris Removal/Rendezvous and Proximity Operations: Looking at Policy Implications

- Rendezvous and proximity operations (RPO) are not new to space activities. They have been a part of human spaceflight since the very beginning of the Space Age. RPO activities involve the manoeuvring of two or more space objects close to each other, opening up the opportunity for interactions between those objects. Lunar orbit rendezvous was critical to enabling the Apollo astronauts to land on the Moon. Rendezvous and docking is necessary to transfer astronauts to and from space stations and space labs, and was used to construct the International Space Station. Dozens of such RPO activities have been conducted by several spacefaring countries over the last sixty years.

- However, over the last decade these classical RPO activities have been joined by a new category of RPO that does not involve humans. These new activities include satellite formation flying, on orbit satellite servicing and refuelling, and some of the proposed methods for actively removing space debris from orbit.

- The Swiss Space Center is exploring an ADR programme called Clean-mE. It currently receives a small amount of funding to develop CleanSpaceOne, which will remove SwissCube, a satellite launched by Swiss students that does not comply with space debris mitigation guidelines. The project now aims to increase awareness and responsibility regarding orbital debris, demonstrate ADR technologies and de-orbit a known piece of debris. Partnership among various institutions drives the five-year project, which is open to further international cooperation. All of these efforts demonstrate a commitment to a cleaner future for space, one that utilizes SSA and other technologies to make space more secure and recognizes that no one entity can achieve this alone.

- However, there are challenges to cooperation and collaboration on these technical solutions to space security threats. ADR, if not conducted transparently, may lead some actors to perceive additional threats to space security. Since CleanSpaceOne is a project conducted transparently and has the potential to contribute to ADR research, development and deployment. Even still, the political, security and legal implications of ADR, which is inherently dual-use, will need to be addressed before it can become widely used.

- Objectives of ADR
    - Short-term objective: to reduce the collision threat for active satellites, in other words to remove the ‘bullets’(space debris of category I with high probability of collision with large objects)
    - Long-term objective: to stabilize the long-term growth in the debris population, in other words to remove the ‘cars’(debris objects with the highest value of Mass x Probability of Collision).
    - Innovation: the ability to remove orbital debris can help drive innovative uses of space and create new possibilities.
    - Safety: Ensure the long-term sustainability of Earth orbit and minimize the threats.

- Hurdles :
    - Technical:
        - No appropriate technology;
        - Natural constraints of spatial environment;
        - Physical characteristics of some space debris (thousands of pounds);
        - Find a consensus on objective/priority for ADR (small or large objects) and a
        - metric for determining which objects to go after;
        - Controlling atmospheric re-entry of large objects to prevent potential damage to humans/property on Earth;
        - Etc…
    - Non-technical:
        - What is a "space debris" as legally distinct from a functional satellite?
        - Who makes this determination?
        - Who has the reference catalogue of space objects to determine which objects should be removed?
        - A country cannot remove the debris launched from a second country without that second country's permission but source of spatial debris come from every space-faring nations, so no nation shall or can solve the problem alone.
        - Launching State retains jurisdiction over their objects in perpetuity, but what about the 6,000+ tracked objects that have no assigned Launching State
        - The concerns on close proximity and rendezvous - if you can remove space debris you can attack a satellite
- Technical suggestions:
    - *Implementing several concepts together might help remove a large array of space debris of different sizes, retaining safety to many orbits.*
    - Solar sail: an option for disposal of objects in very high orbits; require no propellant storage or engines; hard to deployment and control
    - Drag augmentation device: a balloon deployed on space debris such as useless satellites; no need to maintain any specific orientation; no attitude control system needed
    - Laser: a feasible way to remove space debris of Category I from LEO. Two options: ground-and-air based laser and space-based laser, more expensive and technologically challenging.

- CONCLUSION
    - ADR is a necessary part of managing debris, protecting satellites, and ensuring the long-term sustainability of Earth orbit.
    - Technical community needs to do more research on feasible ADR techniques, especially on metrics for determining objectives and priorities.
    - Non-technical community needs to work closely with the technical community on legal and policy issues involved.
    - An international, cooperative technology demonstration mission could promote progress on both the technical and non-technical fronts
    - In addition to legal hurdles however, key linkages between international security implications and the civil rollout of this technology remain unclear