International Perspectives on Rendezvous and Proximity Operations in Space and Space Sustainability

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Rendezvous and Proximity Operations (RPO)

- RPO have been part of human spaceflight space activities since the very beginning
  - Apollo Lunar orbit rendezvous
  - Transfer of astronauts/cosmonauts to Salyut, Mir, and Skylab
  - Assembly of the International Space Station

- Over the last decade, these traditional RPO activities have been joined by a new category not involving humans
  - Satellite formation flying disaggregated constellations
  - On-orbit satellite servicing (OOS)
  - Active Debris Removal (ADR)

"New" RPO Activities Over Last Decade

- 2005: NASA DART spacecraft
  - Autonomous rendezvous with dead MUBLCOM satellite, ended up "bumping" it on accident
- 2005: U.S. Air Force XSS-11
  - Autonomous rendezvous and inspection of "several US-owned space objects near its orbit"
- 2007: DARPA Orbital Express
  - Demonstration of on-orbit servicing and refueling technologies involving RPO
- 2010: Swedish Space Corporation PRISMA
  - Two microsatellites demonstrating formation flying & rendezvous
- 2010: Chinese SJ-12
  - Rendezvous with SJ-06F for unknown reasons (probably inspection)

Planned Future ADR and OOS Activities

- DARPA Phoenix
  - Robotic rendezvous with dead communications satellites in GEO graveyard & recycling of large apertures into new communications satellites
- Vivisat Mission Extension Vehicle (MEV)
  - Robotic rendezvous and docking with active satellites in GEO belt for life extension, maneuver, or disposal services
- StarTech ElectroDynamic Debris Eliminator (EDDE)
  - Robotic vehicle moving up and down in LEO removing large amounts of small debris over several years
- Swiss Space Center CleanSpace One
  - Cubesat designed to remove another cubesat from orbit

The Common Thread

- Three characteristics of these new activities
  - Involve two (or more) unmanned spacecraft
  - Occur in orbital regions above the traditional human spaceflight zone (below 500 km)
  - Include private sector actors instead of only governments

- They pose some significant legal and policy challenges
  - On-going national oversight of private sector activities
  - Liability, safety
  - Opportunity for mishaps, misperceptions, and mistakes
  - Will they be a positive or negative contribution to space sustainability?

Our Contribution

- SWF organized a series of events in 2012 and 2013 to further discussion and investigation of these issues
  - Focus on active debris removal (ADR) & on-orbit satellite servicing (OOS)
  - International and multi-stakeholder in nature
  - Mix of public conferences and private workshops
- Three main goals
  - Enhance public and international awareness of planned ADR and OOS activities
  - Engage stakeholders in a dialogue on addressing some of the main legal and policy challenges these activities pose
  - Bring together those in the private sector planning these activities with those in government creating policy and law

Events

- June 2012, Washington, DC
  - SWF participated in the satellite servicing conference and workshop organized by DARPA
  - International participation, broad examination of planned projects and key issues
- October 2012, Brussels Belgium
  - SWF and Ifri co-organized public conference on OOS and ADR
  - European perspectives, focus on ADR
- November 2012, Washington, DC
  - SWF organized scenario-based workshop
  - Brought together commercial sector with government regulators and policymakers
  - Identified several gaps between existing regulation/licensing and planned private sector activities

Events

- February 2013, Singapore
  - SWF and Singapore Space and Technology Association (SSTA) co-organized public conference and private workshop on OOS and ADR
  - Asia-Pacific perspectives, focus on security and TCBMs
- September, 2013, Beijing
  - Paper presentation at the 2013 International Astronautical Congress
- November 2013, Washington, DC
  - Capstone panel discussion

Major Themes

- Current international legal and policy framework does not forbid ADR or OOS, but does not specifically address several areas
  - ADR and OOS activities are in a legal/policy/regulatory "grey area" with lots of uncertainty
  - Uncertainty is an obstacle to investment and innovation

- Hypothetical discussions of the legal and policy challenges are only useful only to a point
  - Useful for framing issues and discovering gaps
  - Have limited value for figuring out how to address those gaps
  - Targeted discussions focused on specific, real-world examples or projects are more useful

Major Themes (2)

- Transparency and Confidence Building Measures (TCBMs) are crucial for safety, security, and sustainability
  - Need to improve Space Situational Awareness (SSA) for all space actors
  - Need to enhance coordination between space actors
- Important to develop norms of behavior
  - Improving safety (best practices, sharing of lessons learned)
  - Minimizing the opportunities for misperceptions, mishaps & mistrust
- Need to involve all the relevant stakeholders in developing national and international regulatory mechanisms, TCBMs, and norms

Recommendation

- Need to have one or more technical demonstration missions for ADR or OOS capabilities to serve as focusing exercises
  - Should involve more than one country
  - Should involve governments as well as private sector
  - Should be as open and transparent as possible

- Would force participants to solve specific legal and policy challenges
- Lay groundwork for establishing TCBMs, norms, and other crucial governance elements
- Remove the grey areas to enable more investment and private sector innovation

Thank you

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