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The Role of Norms and Best Practices in Commercial Rendezvous and Proximity Operations (RPO) and On-Orbit Satellite Servicing (OOS)

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ABSTRACT

The modern space economy is organized and facilitated by a complex array of international treaties and principles, domestic legislation and initiatives, governmental and corporate policies and traditions, and the particulars of party-to-party cooperative agreements, memoranda of understanding, and contracts. Despite the diversification in range and number of commercial actors in space activities in the last two decades, overall, space law has been characterized by this insufficiency of legally binding written rules.

United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) operates on a basis of full consensus. As a result, the international treaties and principles of space governance contain legally vague language, so as to make unilateral consensus more plausible. They empower member States to pursue their own interpretations of their obligations to suit their domestic market, falling short of explicitly defining key terms. Consequently, the activities of potential commercial providers of on-orbit satellite Servicing (OOS) activities are dominated by the domestic regulatory framework and oversight of their respective nations, which are in turn highly dependent on "norms" and "best practices" that constitute non-legal industry standards.

Commercial providers of Rendezvous and Proximity Operations (RPO)-enabled OOS act as major players contributing to and directly influencing "best practice" standards of operation. Forums such as the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) provide a venue for developers, operators, investors, customers, government policymakers, and insurers to convene and engage in a norm-building process, fostering Transparency and Confidence-Building Measures (TCBMs) and working towards a collective set of industry standards that still protect commercial participants' financial and strategic interests.

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INTRODUCTION

Evolution of RPO & OOS Technologies

- Cooperative vs. Non- Cooperative RPO, and applications (see Table 1)
- RPO supporting human spaceflight is not new; robotic RPO supporting OOS is emerging, with several contracts already in play. Examples include DARPA cooperative RPO projects: 2007 Orbital Express, Robotic Servicing of Geosynchronous Satellites (RSGS): potential re-bid forthcoming.
- Global development: actively being explored by commercial firms, civil government organizations, and militaries.

Big Picture: Technologically, OOS is dependent on RPO capability, which itself hinges on high-fidelity, accurate space situational awareness SSA ("collaborative consortium" proposal). Without any of these three, Active Debris Removal (ADR) will be impossible. Governmental and commercial actors in in each will fall under varying licensing, regulatory, and contracting processes. This is where norms come in.

STATE OF PLAY

Definition of Norms and Their Role

- *Norms: Activities and conduct commonly practiced over time, and accepted by a community at large*. By definition, norms are **not legally binding—but** they are based on precedents from legal documents such as contracts.
- Individual governments may go on to legally codify norms within their own national activities and commercial licensing structures.
- Much of the existing international space governance framework is based on "soft law" norms of interpretation of "hard" documents like the Outer Space Treaty (OST).
  - With far more space actors than ever before, each have diverse interests and goals.
  - UNCOPUOS and other international legal entities face increasingly challenging odds to reach global consensus on new "hard law" mechanisms. (ICoC/LTSS example)
  - *Options for norm-setting: Private/State, Private/Private, State/State.*

Big Picture: Norms of practice are set by "case studies" of initial contracts, which lead to industry "best practices." The legal structures of the first few contracts in a field like OOS are likely to establish a basis for norm-formation in the industry, which remains the main mechanism to shape domestic regulatory frameworks and address emergent legal challenges in space. This means that the "big players" to watch in forming the future of OOS will be industry providers and their customers—not the UN or government regulators.

Figure 1. Crew Dragon Docking with ISS. Artist's Rendition.

Figure 2. Satellite Servicing (SSL). Artist's Rendition.

OOS: BENEFITS AND CHALLENGES

- Could greatly increase the viability and lifetime of space architectures. On-orbit refueling and modular upgrades will make it possible to work around some key obstacles: stringent maneuvering constraints, part failures, and technological obsolescence.
- **Essential for most ADR activities; debris remains a significant issue for all actors operating in the space domain. ADR would contribute to the long-term sustainability of orbital regimes and protection of US assets.**
- Advances in automation and machine learning could lead to increased efficiency in ability to diagnose malfunctions on-orbit.
- Potentially robust economic market if given regulatory room to grow.
- **Potential to act as a strategic deterrent, if shown to meet Nitze criteria (must be effective, must be self-defending, and must be cost effective at the margin).**
- Raises a number of diplomatic, legal, safety, operational, and policy challenges
- Government liability for civil applications: beyond contracts, **who will license/oversee nonmilitary use of OOS?** Mirrors current SSA debate: DO Transportation? Commerce?
- **Potential dual-use of OOS technology and dexterous robotics**. US focus: if indeed OOS are developed offensively (space weaponization under a Space Force, for example) how will OOS tech augment military operations when US lacks concrete offensive space doctrine? **"Strategic Restraint" (Woomera/MILAMOS efforts crucial.)**
- Norms for OOS will likely be set by whoever becomes the frontrunner(s): if a commercial actor, U.S. may not be able to "dictate" norm-setting beyond limiting public SSA data.
- **Here again, the significance of government involvement in norm-and consensus-building efforts with industry is paramount.**

Table 1. Example Applications of Varying Types of Rendezvous and Proximity Operations

	Non-Cooperative Information transfer (PNT data, velocity, health/status, etc.) between vehicles is one-way only	**Cooperative** Information transfer is two-way via crosslinks, ground contact, etc.
Non-Hostile	• Active Debris Removal (ADR) • Orbital Tugs/de-orbiting without data exchange • On-Orbit Additive manufacturing and assembly	• Cargo/Crew spacecraft docking with the International Space Station • Orbital Tugs with data exchange • Most OOS activities • Formation flying of a fleet/constellation of small satellites
Hostile	• Offensive ASAT spacecraft designed to degrade, disable, or destroy a satellite without information transfer, often ballistic in nature • ***Question: Is the disposal of unattributed space debris considered hostile? By whom? Why or why not?***	• Remote cyber corruption of a satellite to exchange data with a hostile spacecraft • Hacking or overtaking of a ground station to enact offensive maneuvers with data exchange

NOT JUST ECONOMICS

- RPO that involve **more than one** private actor, more than one State actor, or a mix of private and State actors **raise new questions** about issues of liability, contract structure, and responsibility.
  - From a **safety** standpoint, RPO undertaken without sufficient government oversight is more likely to result in accidents, mishaps, and anomalies that damage satellites or create large amounts of space debris, further degrading the orbital environment.
  - From a **security** standpoint, certain types of RPO undertaken without sufficient transparency could **create misperceptions or mistrust** that heighten tensions between States or commercial actors and lead to greater strategic instability.
- The role of **culture and perceptions** in assessing threats and opportunities; as well as interactions between technology, organizations, and bureaucratic politics all influence decision-makers and stakeholders.

Table 2. Current Actor Developing Commercial Activities in OOS

Satellite Inspection	Chandah
Life Extension	Effective Space, Orbital ATK
Satellite Refueling	AIRBUS DEFENCE & SPACE, SSL
Modular Satellite Assembly	NovaWurks, iBOSS
Deorbit/End of Life Services	D-ORBIT, Astroscale

THINKING AHEAD

- Remember lessons learned: any new domestic licensing scheme should **maintain obligations to international agreements** but also **reflect industry positions** in terms of oversight. (EO market evolution as an example, 'one-stop shop' platform of easily navigated bureaucracy ideal to stimulate.)
- Security aspect: **transparency and confidence-building** are paramount. **Just because norms are non-binding does not mean they are inherently non-legal.**
- Are norms enough? Should they be voluntary or mandatory? When does a norm become legal? Are the "major players" likely to change?

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