EMERGING ISSUES IN NEW SPACE SERVICES: TECHNOLOGY, LAW, AND REGULATORY OVERSIGHT

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Next-generation commercial on-orbit missions have started to include a variety of capabilities previously reserved only for governmental missions. These commercial endeavors range from radio-frequency collections and satellite servicing to planetary missions. Is the existing regulatory framework sufficient to provide oversight and compliance with our international obligations? This paper highlights some of the commercial missions starting to push the boundaries and looks at ways to address this exciting intersection between technology development, policy, and international treaties.

Overview and History

The commercial sector is developing a spectrum of on-orbit capabilities. Some of them are commercial versions of capabilities previously operated only by governments, but others are completely new. These capabilities will help to satisfy a range of needs, including inspection and maintenance of satellites, debris mitigation, science and exploration missions, and more. However, the government offices involved with regulating space are still working to update their processes and rules to better support these industries. The following section provides some examples of space activities that are starting to approach a fuzzy boundary of regulatory oversight and international obligations. The paper concludes with a list of actions that would ensure the U.S. space sector remains at the forefront by providing transparent regulation where needed, guidelines where regulation would be premature, use commercial capabilities for government missions, and invest in targeted R&D efforts.

Existing Regulatory Framework

Even as the commercial sector grows, it remains the job of governments to ensure safe and responsible behavior in space. Specifically, Article VI of the Outer Space Treaty of 1967 states, "The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."[1] The manner of any derived regulation is not directly determined in the Outer Space Treaty of 1967; it is up to individual states to determine how best to regulate their space industry while adhering to the treaty. In the United States, the regulatory authorities are within the Federal Communications Commission (FCC), the Federal Aviation Administration (FAA) of the Department of Transportation, and the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce.

FCC. The role of the FCC is to ensure communications and spectrum use in space do not interfere with terrestrial communications or other space-based communications; it also provides requirements for orbital debris mitigation in the licensing process.[2] The FCC is becoming increasingly important as more large satellite constellations in low Earth orbit (LEO) stress spectrum allocations. In some circumstances it has also become the "regulator of last resort" for novel commercial concepts that do not fit neatly into other agencies' jurisdiction, since nearly all satellite activity requires spectrum. The FCC issues licenses to operators and launch providers for the use of spectrum to communicate with their launch vehicles and satellites, as well as for any other use of spectrum such as ranging and broadcasting.

FAA. The FAA regulates commercial space transportation to ensure safety of launch and reentry. It does not have the responsibility to regulate U.S. government launches or commercial on-orbit activities; however, it *does* have the authority for integrating the launch and reentry of both government and commercial systems into the existing air traffic system. Around the time of a launch, the airspace must be restricted to ensure that there are no collisions with airplanes.[3]

NOAA. NOAA regulates space-based remote sensing operations. Prior to the May 2020 release of the *Rules on Private Remote Sensing Space Systems*, if a system were capable of imaging the Earth, it required a license; now there are exceptions to this rule, including imaging for the purpose of mission assurance.[4] Prior to the release of the May 2020 rules, NOAA had its own debris mitigation guidelines; however, NOAA now defers to the FCC on debris mitigation rules.

Fuzzy Regulatory Boundaries

Rendezvous and Proximity Operations with Satellite Servicing. The practice of rendezvous and proximity operations (RPO) has existed since the Gemini and Apollo programs, though it has mostly been employed by government spacecraft, not commercial systems. RPO generally refers to orbital maneuvers in which two spacecraft arrive at the same orbit and approach at a close distance. This rendezvous may or may not be followed by a docking procedure. On-orbit servicing is an activity that utilizes RPO and possibly docking maneuvers to employ a spectrum of capabilities. A widely agreed-upon definition of RPO does not exist, but the term generally includes non-contact support such as inspection, orbit modification and maintenance, refueling and commodities replenishment, upgrade, repair, assembly, and debris mitigation.[5]

No national or international policies explicitly regulate RPO. Article VI of the Outer Space Treaty of 1967 requires governments to provide authorization and continuing supervision of nontraditional activities, to include many proposed RPO activities. The treaty's Article VII establishes that a party that launches or procures the launching of an object into outer space is liable for the object or its "component parts" in air or in outer space.[6] The Liability Convention of 1972 expands upon the principles of liability for damage caused by space objects introduced in Article VII of the Outer Space Treaty of 1967.[7]

On-orbit activities such as communication, spectrum usage, and debris mitigation strategies require approval from the FCC. A couple of commercial companies pioneering the on-orbit servicing market are working to gain regulatory approval in a relatively ad hoc manner. Northrop Grumman's Mission Extension Vehicle (MEV) received approval from NOAA and the FCC to perform rendezvous, proximity operations, and docking with Intelsat-901 as a demonstration.[8]

Non-Earth Imaging. The scope of authority to regulate non-Earth imaging (NEI) is confusing and not easily spelled out. Some have even argued that the Department of Commerce does not have legislative authority to regulate NEI.[9] The language in the Land Remote Sensing Policy Act (51 U.S.C. 60121)[10] on regulatory authority refers to the ability to license private remote sensing space systems. In response to questions regarding this authority over NEI satellites, the Department of Commerce states, "the plain language of the Act requires a broader scope than simply intentional Earth imaging."[11] Referencing 15 CFR Part 960, NOAA defines the phrase *remote sensing space system* as "any device, instrument, or combination thereof, the space-borne platform upon which it is carried, and any related facilities capable of actively or passively sensing the Earth's surface."[12] The word *capable* is interpreted by the Department of Commerce as permitting the inclusion of NEI satellites; while their purpose is not Earth imaging, NEI systems have the capability to image the Earth.[13]

On May 20, 2020 a new rule was released by the Department of Commerce clarifying that instruments used primarily for mission assurance or other technical purposes were among the exceptions to the license requirements for Earth imaging and non-Earth imaging.[14] This would also specifically exclude the licensing of private remote sensing systems that are beyond Earth's orbit including the moon and Mars. Yet nation states are ultimately responsible for commercial activities through the Outer Space Treaty Article VI provision. If commercial space remote sensing activity extends beyond Earth orbit, some form of authorization will be required for the United States to remain consistent with our international obligations.

Space Object Ownership Issues for Active Debris Removal. Active debris removal (ADR) is the process of removing space objects ranging from small pieces of debris to large defunct satellites. The debris removal vehicle may dock with the object to retrieve it or deploy some other form of technology to guide the object out of orbit to burn up in the atmosphere. Studies conducted by The Aerospace Corporation, NASA, and the European Space Agency (ESA) revealed that the amount of debris, assuming no additional space objects are launched, will steadily rise assuming a collision rate of every ten years.[15] LEO continues to be the site of the most space traffic and thus, the location most at risk from debris collisions. Most models show[16] that efforts to mitigate the creation of debris are no longer enough and more active solutions are needed.

ADR must deal with legal issues related to the removal of debris that is not owned by the debris removal entity. At minimum, permission from the owner and the supervising nation would be required. Some questions include: can states remove debris of other states, or debris of unknown origin, without permission? How can we ensure that objects being removed are, in fact, debris and not active satellites? Should there be an international body charged with oversight of debris removal or a national clearing house to track debris removal permissions? Given those open questions, ADR will likely focus initially on intra-state activities.

Commercial Planetary Missions and Planetary Protection. Historically, only national and international space agencies have had the technological and monetary means to send satellites and probes to other planetary bodies. This is changing as companies like SpaceX develop their own Mars missions. The rise of commercial interplanetary missions will elevate the already-challenging issue of planetary protection with guidance provided through the COSPAR Planetary Protection Policy, an international, science-based guidance and standard framework. Planetary protection refers to "managing contact between terrestrial life forms and organic material from celestial bodies as it relates to adversely affecting the scientific study of these bodies, called forward contamination." Additionally, it refers to the opposite—protecting the Earth from outside contamination.[17] These issues will need to be properly accounted for as we look to send humans back to the moon and on to Mars. Eventually, they will return to Earth. However, astronauts cannot be doused in chemicals, baked at high temperatures, or irradiated to remove any foreign organism.[18]

Experts in this field have provided a number of recommendations to the U.S. government regarding planetary protection guidance for commercial companies involved in the development of interplanetary missions. Objectively the most important recommendation is the need to establish a regulatory authority for commercial companies with plans to visit other planets. This authority would be to ensure the proper planetary protection standards are maintained before and during the mission.[19] Diversifying the classifications of regions on the surfaces of celestial bodies would be important and would allow for areas of biological importance to be protected while others to be less so. For example, the poles of the lunar surface should be relatively protected due to the presence of water; however, the rest of the moon is barren and may not require as much, if any, protection.[20]

Going forward, it is important to create standards by which humans are held accountable, while also allowing for the exploration of space and search for life on other planets.

Space Flight Safety. In order for space tourism to become commonplace, there must be serious conversations about space flight safety. The FAA is currently under a congressionally initiated moratorium that prohibits the issuing of regulations to protect the health and safety of crew and space flight participants, which was intended to allow the infant industry of commercial space flight to develop prior to regulation. This moratorium is currently scheduled to end in October 2023, but Congress could adjust this date.

Since 2006, the FAA has had regulations in place to ensure that space flight participants are made aware of risks and that they are provided with the minimum safety standards to prevent death upon entry into space.[21] If space tourism is going to be a common occurrence in the future, spacecraft must be adapted for participants who do not meet the physical qualifications of a professional astronaut. Should an anomaly occur during a commercial space flight, it is likely that the FAA would be directed by congressional oversight committees or the administration to immediately assume regulatory responsibility.

Commercial Radio-Frequency Collection. Space-based commercial radio-frequency (RF) collection systems are designed to detect and geolocate a range of RF signals from emitters of interest, such as handheld radios, maritime radar systems, automated information system beacons, very small aperture terminals, and emergency beacons. The detected signals can also be processed and analyzed to produce information about spectrum use in a particular region or about the emitters themselves. Emerging commercial operators believe there is a market among governments, industry users, and nonprofits for the information they produce. Although these companies disclaim any interest in intercepting and examining the content of message traffic, the potential for such operations raises concerns in national security circles because these services represent the first wave of non-government entities conducting such collections from space on a global scale. For decades, the U.S. government operated on the assumption that uncooperative RF collection from space (as opposed to regular communication satellites) was a government-only activity. That assumption is simply no longer valid. In addition, the Department of Commerce has decided that commercial RF collections are not included under the definition of a commercial remote sensing regulatory framework. Thus, space companies pursuing such activities operate in space without a license requirement except for what is necessary to launch and to receive a spectrum allocation to communicate with the spacecraft.

Export. Satellite companies often have to deal with export control laws which are designed to prevent the spread of sensitive technologies to foreign actors. There are two sets of regulations: International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR). ITAR is under the jurisdiction of the Department of State and seeks to control items, information, or activities that could be used for military purposes; it operates under the assumption of denial. EAR is under the jurisdiction of the Department of Commerce and controls items and technologies that could be applicable to commercial or military use. RPO, for example, can include a mix of ITAR and EAR technologies and services. Given that spacecraft rendezvous and docking frequently utilize cameras for the terminal phase, it is possible that some imagery collected during this phase of a servicing mission could provide satellite design information to the servicer that would fall under export control regulations.

Ways Forward and Conclusion

This paper described several examples where space activities are likely approaching regulatory boundaries in the near future. Some may require further study, some may benefit from a regulatory framework, and some may call for guidelines and best practices. Following are several actions the U.S. government could take to help the emerging spectrum of on-orbit capabilities flourish, enable both industry and government to operate in space more efficiently and effectively, and fulfill the nation's international obligations.

- **Provide technically informed and enabling regulations.** The current uncertainty created by an ad hoc approval process for many of these activities makes it difficult for commercial companies to develop new business opportunities and get them funded. There is a tradeoff between industry's desire for clear regulations that provide certainty for potential investments versus those that can nimbly address emerging businesses, which would likely be broader. Given the pace with which new ideas are emerging for space business, it is likely that an approach that demands a separate regulatory framework for each type of capability would be too slow; instead, a framework that provides a reasonable level of regulatory certainty for all novel on-orbit activities would be best. The current lack of a clear path forward increases difficulty in closing business cases and securing investors.

- **Develop guidelines and best practices with broad participation.** Activities that are too premature for regulation would benefit from clear guidelines and norms of behavior. A mixture of precedents and industry consensus efforts helps to drive norms of behavior, leading to many important outcomes. It improves the interoperability of systems such that platforms owned by different stakeholders can all interface with each other. This in turn improves flight safety. If a spacecraft deviates from established norms, it will stand out—making it easier to identify bad actors. This will also help with issues related to space traffic management, and more.

- **Focus on commercial capabilities as a service to government missions.** The U.S. government should include the use of commercial on-orbit capabilities when designing its future space architecture. Historically, satellites were large, pristine platforms that were launched in their final form and expected to operate for ten years or more. Current discussions focus on switching to smaller, shorter-lived satellites to increase agility. However, there is also a range of options in between that could employ on-orbit capabilities. It is important to understand the range of capabilities to better assist both the government and the commercial market. When exploring the tradespace, there should be consideration for what capabilities should be government-owned and operated versus provided to the government as a service. The U.S. government should look to maximize its role as the customer.

- **Fund critical R&D investments.** The U.S. government should continue to fund research and development projects related to furthering on-orbit capabilities. Small business grants and R&D investments are a way to help small businesses with innovative ideas enter the market.[22]

These actions would help ensure that the United States will remain at the forefront of space activities, promote domestic businesses, and not only fulfill international obligations but, perhaps more importantly, provide leadership in an increasingly democratized, global domain.

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