On-Orbit Satellite Servicing Standards Are a Necessity for the Private Space Industry

By Danielle Miller and Elsbeth Magilton

It is axiomatic that failure to regulate is de facto regulation. Without appropriate structure and predictability, it is difficult to build a new and innovative industry that requires significant private investment. Investors are skeptical of high-risk endeavors that lack consistent government oversight because (in addition to the commercial risks involved) government may react to events in unpredictable ways. The private space industry epitomizes these concerns, particularly with regard to market readiness for on-orbit satellite servicing.

The technology for on-orbit satellite servicing has existed for several years, but organizations have hesitated to develop it because satellite servicing is highly risky, both operationally and as a business venture. However, experts contend that the time for on-orbit servicing to fully come to market has arrived and that the risks are worth it.[1] Among the many remarkable emerging space industry projects, satellite servicing may seem relatively mundane. Yet, on-orbit servicing is fundamental to future space projects. Therefore, as a high-risk proposition, the satellite industry requires regulatory support for these new and highly critical projects.

This article first describes on-orbit servicing and the technology's potential, including how on-orbit servicing is critical to the continued growth of the space industry. We also address how the technology is currently regulated by the federal government. Next, we argue that the current regulatory scheme is insufficient, and explain why it should be changed to provide servicers legal certainty—and why that matters to their business. The article concludes by addressing why a clear and structured set of rules for governmental licensure or approval of on-orbit space activities is essential to the industry's development.

What Is On-Orbit Satellite Servicing?

On-orbit servicing generally refers to a space-based vehicle that approaches and docks (or attaches itself to) a satellite, then assumes control of the satellite's maneuvering and positioning (or "stationkeeping").[2] The National Aeronautics and Space Administration (NASA) has been using robotic tools for this purpose on the International Space Station and for the Hubble Space Telescope for several years,[3] including running trials of inspection and cryogen replenishment of nearby satellites.[4] Companies intend to use this technology for similar reasons: to extend the life of existing space systems by repairing, retooling, and refueling satellites while the satellite remains in orbit. Most recently, Orbital ATK, before its acquisition by Northrop Grumman Innovation Systems, unveiled its latest version of a satellite servicing vehicle, aimed at developing a new version of the company's "Mission Extension Vehicle." The project is called the "Mission Robotic Vehicle and Mission Extension Pods" and would handle maintenance for geostationary satellites nearing the end of their fuel life. The Mission Extension Vehicle could extend the life of a satellite by five years.[5] This technology will relieve companies of the need to replace billion-dollar projects in space, thereby achieving a giant leap forward in the financial sustainability of new-space ventures.

Why On-Orbit Servicing Is Vital to Future Space Projects

As the main potential customer for satellite servicers, satellite operators with assets in geostationary orbit are keenly interested in the ability to repair their aging assets. Launching and placing a satellite in geostationary orbit, approximately 22,236 miles above Earth's surface, is an extraordinarily expensive proposition.[6] These satellites are often very large and expensive to launch, particularly given the additional weight of robust anti-radiation shielding. Replacing a satellite due to instrument failure—even a small instrument—would cost millions if not billions of dollars. Even if nothing fails and the satellite simply runs out of fuel at the expected end of life, the cost of replacing the satellite rather than refueling is prohibitive. If a company were able to repair or refuel the satellite, replacement and launch costs could be avoided, particularly if the satellite then remains in orbit for longer than originally anticipated. Satellites could even be periodically upgraded to take

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advantage of technological improvements (e.g., a new camera unit).

In addition to saving companies billions of dollars in launch costs, fixing rather than replacing satellites will help to solve a host of other issues. Space is extremely overcrowded. As a practical matter, there is a limited amount of area in the immediate vicinity to Earth that is usable due to Earth's gravity and orbit. In the 1950s, this was not an issue because only two nations (the United States and the Soviet Union) were space-capable, and they placed less than 50 satellites into orbit combined. However, today there are over 60 nations (with over 1,600 active satellites) competing for room in low Earth and geostationary orbits.[7] The number of space-faring nations is growing steadily, and experts estimate that the number of satellites in orbit will grow exponentially in the next few years.[8] The competition for usable orbital slots is becoming fierce, and latecomers to the space race are unsure whether there will be room for their use of space in the coming years.

Moreover, while states argue over where they can park their satellites in this congested arena, there is another pressing concern. Space debris, or the leftovers from old space missions, including launching equipment, broken satellites, or tiny pieces that have fallen off space objects, is a critical issue in the free and fair use of outer space. Recently, U.S. Strategic Command (USSTRATCOM), the U.S. government entity that was charged with tracking space objects until that responsibility transferred to the U.S. Department of Commerce in June 2018 under Space Policy Directive-3 (SPD-3),[9] estimated that there are 23,000 human-made objects larger than a softball in orbit. USSTRATCOM also estimates there are 650,000 softball-to-dime-sized objects, and 170 million bits of tiny debris (like flecks of paint and fragments of bolts or screws).[10] If those pieces of debris, traveling at over 17,000 mph, collide with another space object, it can cause catastrophic failure in important space systems. This problem causes the International Space Station to change course several times per year to avoid larger pieces of debris that threaten the safety of the astronauts or the station. The debris largely comes from old or derelict satellites breaking down and often breaking apart. Those satellites and pieces of debris are also likely to strike other pieces of debris, with the collision creating more debris and perpetuating the problem.

In sum, the ability to repair satellites nearing the end of their life (or to move defunct and inoperable satellites into graveyard or disintegration orbits) would mean less congestion and debris in space—a more sustainable space environment. The current regulatory uncertainty relating to on-orbit servicing, however, is an obstacle to achieving this objective.

The Current Status of Satellite Servicing Regulation

Counterintuitively, market actors are not necessarily averse to regulation of their activities. Appropriate regulation can provide organizations certainty that their activities are lawful and not vulnerable to arbitrary government intervention. For instance, in an area of utmost concern for lawyers, government regulation can assign liability to various actors, a critically important factor for high-risk ventures like satellite servicing. Satellite servicers would prefer to know whether they can be adequately indemnified against potential harm done to the serviced asset (in this context, a robot attached to a satellite traveling at 17,000 mph) before they commence the servicing. The U.S. government currently indemnifies launch companies against losses over a statutorily established liability cap in the event of a catastrophic occurrence during launch.[11] However, the current U.S. regulatory framework leaves unaddressed similar issues in the field of on-orbit servicing. In fact, on-orbit activities are not subject to comprehensive regulation following launch and before reentry. Rather, a patchwork of regulations governs some, but not all, space activities. Multiple government agencies have overlapping (even competing) regulatory authority, which frustrates industry and raises national security concerns.

The problem begins with the current U.S. approach to implementing its obligations under the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty).[12] The Outer Space Treaty requires that states authorize and supervise their space activities and those of their nationals. Pursuant to this requirement, the United States currently oversees space activity through a number of government entities with differing yet overlapping areas of responsibility. The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) governs remote sensing satellites, the Federal Communications Commission (FCC) regulates the use of communication spectrum, and the Federal Aviation Administration (FAA) oversees the launch and reentry process. The Department of Defense (DOD) is also heavily involved in the process, conducting security reviews of proposed payloads and sensing equipment.

Although every satellite in space uses spectrum and thus to some extent is subject to FCC regulation, the U.S. government's lack of regulation of actual satellite operations following launch and before reentry is a glaring omission. While NOAA currently requires approval of any satellite carrying a camera that is technically capable of sensing the planet (even if not intended for that purpose), that mandate will eventually become unsustainable as the number of satellites in space grows exponentially. Eventually NOAA, should it retain this authority, may have to focus on those systems that intend to take images of the planet, and leave other actors alone. Satellite servicers, while almost certainly carrying cameras of some variety necessary to perform their function, would not

be primarily tasked with sensing the planet. Thus, no particular U.S. government entity would regulate their operations. This lack of regulation and oversight poses a serious problem for potential satellite servicing entities.

Important international law considerations also apply. Under article VI of the Outer Space Treaty, states are responsible for the actions of their nationals in space and must authorize and supervise those actions. Therefore, in the event of an issue between two operators, their governments must become involved.[13] The 1972 Convention on the International Liability for Damage Caused by Space Objects (Space Liability Convention),[14] unlike the Outer Space Treaty, provides for resolution of disputes arising from the use of space and issues caused by space assets on Earth. Such disputes are subject to diplomatic negotiations, adjudication by a commission assembled by the parties, or ultimately adjudication by the International Court of Justice.[15] Without knowing what activities the U.S. government considers acceptable, operators cannot be certain whether their government will defend them against the capricious (or valid) claims of foreign operators. Moreover, a consensus is emerging that the lack of U.S. regulation of on-orbit activities is a fundamental breach of the U.S. obligation to authorize and supervise the behavior of its nationals in space. Failure to uphold our international obligations could lead to international reprisals, including sanctions and other penalties imposed by other states whose industries are harmed by the U.S. government's failure to comply with its obligations under these space treaties.

This legal uncertainty makes it difficult for companies to develop on-orbit servicing, which is critically important for the sustainability of the space environment and the space industry's growth. Industry cannot determine what capabilities they may include in their designs and whether the government may subsequently intervene and declare their activities illegal, thereby wasting the investment of time and resources already incurred. Investors are uncertain whether the potentially substantial profits from such a venture could be erased by unindemnified losses from a single accident. They are hesitating to invest the billions of dollars necessary to fund the development of servicing systems in such a high-risk environment. Thus, regulation is essential, sooner rather than later.

Ongoing Development of a Regulatory Framework

The United States, through industry, academic, and government initiatives, is taking steps to address problems arising from the patchwork regulatory framework governing space activities. Section 108 of the U.S. Commercial Space Launch Competitiveness Act of 2015 mandates the executive branch to address the on-orbit authority issue by requiring the director of the White House Office of Science and Technology Policy to "assess current, and proposed near-term, commercial non-governmental activities conducted in space," and to "identify appropriate authorization and supervision authorities."[16] In April 2016, the Obama White House released a report, as required by the Act, which identified on-orbit activities as a category of activity covered by the Act and suggested an oversight framework called "Mission Authorization."[17] The report did not, however, propose any agency to create such regulation.

A new policy President Trump signed on May 24, 2018, calls for the implementation of a series of regulatory reforms to support commercial space, all recommended by the recently reinstated National Space Council earlier in 2018. Space Policy Directive-2 (SPD-2) aims to streamline launch, reentry, and remote sensing regulations, and calls for the creation of a "one-stop shopping" office for commercial space and for reviews of radiofrequency and export control policy.[18] The Secretary of Commerce has been assigned the task of creating this "one-stop shop." It remains to be seen whether this approach will succeed in adapting the current patchwork of regulations, with its glaring omission of on-orbit activities, into a more comprehensive and workable framework. Regardless of the Department of Commerce's approach, Congress must legislate to enable the Department of Commerce to proceed. The Department of Commerce is also working toward this goal during a period of significant transition in space organization, as exemplified by President Trump's announced "space force" and other proposed national security-focused restructuring initiatives.[19]

Think tanks, academics, and other government agencies also support the call for congressionally authorized standards for on-orbit servicing. The Defense Advanced Research Projects Agency (DARPA) has created a public-private consortium to address the safe operation of robotics in space. The Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) aims to "[c]reate an industry/government consortium to develop technical standards for safe on-orbit rendezvous and servicing operations."[20] According to Todd Master, Tactical Technology Office Program Manager at DARPA, CONFERS will

> leverage best practices from government and industry to research, develop, and publish non-binding, consensus-derived technical and safety standards that servicing providers and clients for on-orbit servicing operations would adopt. In doing so, the program would provide a clear technical basis for definitions and expectations of responsible behavior in outer space. The standards would be broad enough to allow individual companies to pursue their own implementations of these standards to suit their individual businesses, while assuring that the implementations adhere to best practices for operational safety.[21]

This project integrates research, academic and industry expertise, and government experience, while protecting commercial participants' financial and strategic interests. The goal is to provide investors, insurers, and potential customers with the confidence to engage in this new sector—which is exactly what a new regulatory framework must do. These standards may provide critical guidance to Congress and the Department of Commerce as they begin drafting and implementing new laws and regulations.

Conclusion

As with any unregulated activity, there is much debate and discussion over how best to regulate on-orbit activities. The alternative potential approaches range from a light-touch general authorization regime to more specific and detailed regulation. Regardless of differing views on the optimal approach to regulation, there is broad consensus about the need for congressional action regarding on-orbit servicing. First and foremost, legislation would promote U.S. compliance with its obligations to "authorize and supervise" outer space activities under article VI of the Outer Space Treaty. It also could ensure that national security concerns are addressed in a predictable and clear manner. This would inform industry operators about how security reviews and DOD interactions would be conducted, thereby providing greater certainty.

A clear and structured set of rules for licensure or approval of on-orbit space activities is essential. Without certainty, companies' operations will be constrained by ambiguity as to the legality of their activities. All stakeholders, including industry, think tanks, and academics, must play a role in influencing the structure and content of future of on-orbit satellite servicing legislation and regulation—and it cannot happen soon enough.

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