CENTER FOR SPACE POLICY AND STRATEGY

FEBRUARY 2018

ASSURANCE THROUGH INSURANCE AND ON-ORBIT SERVICING

REBECCA REESMAN
THE AEROSPACE CORPORATION

REBECCA REESMAN

Rebecca Reesman is a member of the technical staff in The Aerospace Corporation's Performance Modeling and Analysis Department, where she supports government customers in the national security community. Before joining Aerospace in 2017, she was an American Institute of Physics Congressional Fellow handling space, cybersecurity, and other technical issues for a member of Congress. Prior to the fellowship, she was a research scientist at the Center for Naval Analysis, providing technical and analytical support to the Department of Defense, with particular focus on developing and executing wargames. She holds a Ph.D. in physics from the Ohio State University.

ABOUT THE CENTER FOR SPACE POLICY AND STRATEGY

The Center for Space Policy and Strategy is a specialized research branch within The Aerospace Corporation, a nonprofit organization that operates a federally funded research and development center providing objective technical analysis for programs of national significance. Established in 2000 as a Center of Excellence for civil, commercial, and national security space and technology policy, the Center examines issues at the intersection of technology and policy and provides nonpartisan research for national decisionmakers.

Contact us at www.aerospace.org/policy or policy@aero.org

Abstract

On-orbit servicing is an emerging capability that can potentially revolutionize how satellites operate in space. The ability to fix anomalies or extend service life for aging satellites can change the way the industry views risk and develops mission plans. Direct beneficiaries of this enabling technology are the commercial companies providing the servicing, the insurance companies who can develop new markets and limit payouts, and the client satellites whose effective mission lifetime is extended. The government could also reap indirect benefits through greater industry stability and service predictability. Still, the technology carries inherent risks, and it will take time to build confidence among stakeholders. This paper introduces and examines some of the concepts and questions that will be important as this industry develops.

Background

Insurance is a form of risk management designed to protect against financial loss. Launching and operating a space system is inherently risky, and insurance is a necessary component of many space endeavors.

Space insurance provides coverage for satellite operators, manufacturers, and launch providers during production, launch, initial operations, and on-orbit operations. It includes virtually all the technical and financial risk, with few exclusions (e.g., war, terrorism). Insurance is the third largest program cost, after the satellite and launch services.[1,2]

Policy

Currently, no national or international policies explicitly regulate on-orbit servicing. Article VI of the Outer Space Treaty of 1967 requires governments to provide authorization and continuing supervision of nontraditional activities, which would include on-orbit servicing. 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." The Liability Convention of 1972 expands upon the principles of liability for damage caused by space objects introduced in Article VII.

Domestic regulations could also apply. The capabilities of satellite servicing vehicles could be harnessed for malicious behavior. Consequently, servicing companies must deal with U.S. export controls, which are designed to prevent the spread of sensitive technologies to foreign actors. There are two sets of relevant 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. EAR is under the jurisdiction of the Department of Commerce and controls items and technologies that could be applicable to commercial or military use. Satellite servicing will involve a mix of ITAR and EAR technologies and services. For example, spacecraft rendezvous and docking frequently uses cameras for the terminal phase; consequently, any imagery collected during this phase of a servicing mission would fall under export control regulations.[3] The FCC is the licensing body for launch, deployment, docking, and telemetry, tracking, and command; a NOAA license is required for the cameras.[4]

Current Insurance Market

The current satellite insurance market focuses on launch—the riskiest part of a satellite's life. Approximately two-thirds of insured satellites have coverage that encompasses launch plus one year; some are launch plus three or even five years. After the initial coverage period, additional on-orbit insurance can be purchased. If the satellite functioned properly during the initial period, the additional coverage is straightforward to obtain. In 2016, premiums were the lowest they had been in 15 years.[1] After approximately 10 years, the satellite value declines enough such that insurance no longer makes sense. Could on-orbit servicing extend this timeframe or even create an uptick in the value?

Smaller fleets carry more risk per satellite: if something goes wrong, a small fleet operator is more likely to lose a capability. Consequently, smaller fleets are more likely to get on-orbit insurance. This can be seen in geosynchronous orbit (GEO), where 23% of commercial operators buy little or no on-orbit insurance because they "self-insure" by depending upon the versatility of their large constellations to pick up the slack if necessary. For example, Intelsat carries on-orbit insurance only for a small portion of their entire satellite fleet and only for a short time following launch. Intelsat appears confident that they can protect their business using "in-orbit spare satellites, backup transponders, and self-insurance."[5]

Could on-orbit servicing extend this timeframe or even create an uptick in the value?

Almost half of the commercial on-orbit satellites are uninsured.[1] That means the insured half of satellites are under the control of three-quarters of the operators: smaller fleets are insured.

Future Insurance Market

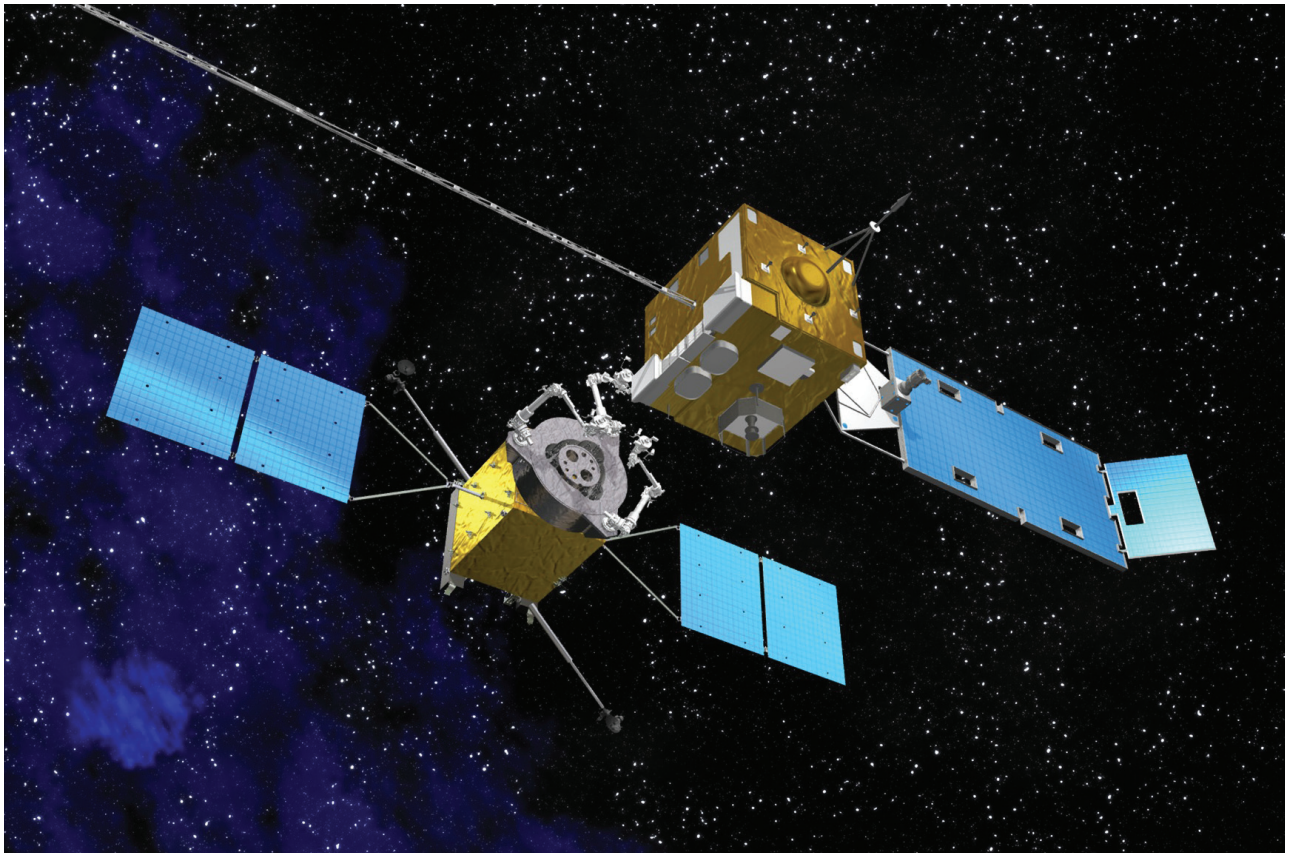
There are different aspects to insurance relevant for on-orbit servicing. The servicing vehicle may carry liability insurance, which would include launch and performance capabilities covering loss, damage, or failure. The satellite to be serviced may or may not be insured, but a contract with the servicer would outline expectations. Additionally, third-party liability insurance would cover damages imposed on an asset not involved in the servicing agreement.

The availability of on-orbit servicing could one day lower premiums for satellites. Currently, premiums for on-orbit coverage are the lowest they have been in years, making it less likely for underwriters to lower them further; however, that might not always be the case, and it could be useful for satellite designers and operators to know how insurers would compare satellites that have a conventional risk-mitigation profile to those that have a contract with an on-orbit servicer. But first, the technology needs to demonstrate it can be successful and readily available. As Richard Parker, president of the insurance company Assure Space, indicated, "There is no standing fleet of on-orbit servicing vehicles, so we can't consider lowering rates just yet."

The capabilities necessary to service a satellite would also be useful in assessing the status of the satellite. Assessment of a technology is a key component of underwriting, once again making on-orbit servicing vehicles a potentially helpful tool for insurance companies. Furthermore, servicing could be used as a risk-mitigation tactic. Servicing or repair of a satellite could help to avoid catastrophic loss and could prevent the need for an insurance payout.

Before such capabilities can be fully utilized, further demonstrations are required to buy down risk. Things to consider:

- Metrics should be developed and used to determine when the capabilities are sufficiently mature.
- Insurance companies will probably require a reliable and mature capability before allowing servicing to be considered part of a contractual mitigation strategy or used as an assessment tool.
- A broad and reliable capability means that a sufficient number of servicing vehicles can be readily employed. A small cadre of servicers, on the other hand, are more likely to be specialized for clients and thus less likely to affect the broader insurance market.



NASA/Goddard Space Flight Center

Figure 1: Artist's concept of a servicing spacecraft, left, approaching an orbiting satellite needing assistance.

Emerging Capabilities

While on-orbit servicing is not a new concept, a new era is emerging. Past examples include the assembly and servicing of the International Space Station, servicing of the Hubble Space Telescope, and DARPA's Orbital Express, which demonstrated key features required for autonomous on-orbit servicing. To date, all such missions have been conducted by governments, and most have involved astronauts. Future efforts will be industry-driven and more autonomous.

A few projects currently being developed include:[6]

- **DARPA/SSL RSGS.** DARPA selected Space Systems Loral (SSL) to help develop the Robotic Servicing of Geosynchronous Satellites (RSGS) program. RSGS will inspect, correct mechanical problems, install new payloads, and relocate and refuel a spacecraft.[7]
- **NASA/SSL Restore-L.** The Restore-L mission is planned for mid-2020 and will perform an autonomous rendezvous with Landsat-7 in low Earth orbit (LEO) for refueling and orbit relocation.[8]
- **Northrop Grumman/Orbital ATK MEV.** The first Mission Extension Vehicle (MEV-1) is scheduled to launch in late 2018 and will provide services for Intelsat. It will dock with a client satellite and perform orbit maintenance and attitude control activities before undocking and moving on to the next client.[9]
- **DLR DEOS.** Run by the German aerospace agency DLR, the Deutsche Orbitale Servicing (DEOS) mission aims to demonstrate servicing capabilities in 2018. This mission will demonstrate not only on-orbit servicing but also orbital debris disposal.[10]

Risk Assessment Criteria

With few established examples to assess, it is difficult to develop a complete framework for optimizing risk management and insurance for on-orbit servicing. Given that the future space environment will contain more rendezvous and proximity operations, including on-orbit servicing, it is constructive to engage in ongoing industry dialogue and observation to develop a basis for risk management.

New Technologies

Evaluating new technologies and assessing risk is what insurance companies do; representative criteria for the underwriting process is outlined in Table 1. The different metrics do not exist in isolation—they can influence each other and are affected by policies and other external forces. It is necessary to think through how these pieces interact in producing a capability and assessing the subsequent risk.

Given that the future space environment will contain more rendezvous and proximity operations, it is constructive to engage in dialogue to develop a basis for risk management…

When thinking through the risk associated with new technologies, it is important to consider both process and performance. That means considering the end capability (performance), while also understanding how that capability is achieved (process). For example, there is a difference in the way servicing companies are approaching refueling and orbital maintenance. MEV-1 will dock with a customer satellite and provide the necessary orbital maneuvers for as long as desired; there is no transfer of fuel or parts. Alternatively, RSGS, DEOS, and Restore-L are looking to directly transfer fuel and then separate. How does the risk of these different refueling and servicing methods compare? How might that affect insurance premiums?

New Designs and Mission Concepts

Traditional satellites were not designed to be serviced, but the introduction of successful servicing could influence future designs. The amount and type of design change would depend on the intended servicer. For example, Orbital ATK claims that its MEV can interface with more than 80% of the satellites presently on orbit, limiting the need for substantial design changes.

The past decade has seen an increase in the number of small satellites (especially CubeSats). This has helped foster the development of modular and standardized payload and vehicle designs. By charging more for satellites that are not service-friendly, insurance companies could encourage standardization. How can on-orbit servicing leverage this trend? How would interoperability affect insurance underwriting?

National security space will likely see changes to its satellite designs and concept of operations as well. While discussing the procurement of new satellites, General John Hyten, head of U.S. Strategic Command, stated, "I won't support the development any further of large, big, fat, juicy targets."[11] This indicates a shift from the status quo across multiple sectors. Whether that future explicitly includes on-orbit servicing remains to be seen.

New Financial Models

The insurance market, or any risk-management strategy, could potentially benefit from the proliferation of on-orbit servicing. Currently, the value of a satellite declines with time. Anomalies can occur throughout the lifetime of a satellite, and their impact on performance ranges from minor degradation to total loss of capability. Furthermore, 10% of anomalies occur within the first two months after launch—yet account for 36% of cases with full loss of capability.[1] Mechanical and electric power issues are the primary causes for loss—a likely area of focus for on-orbit servicing.

Could on-orbit servicing change this trend? Refueling alone could extend the life of a satellite, but is unlikely to increase its intrinsic value. The ability to do repairs or upgrades could conceivably improve upon the status quo, either by lessening the slope of the decline or by enhancing capability. If a satellite was built with a reliable bus, modular components, and the ability to get substantial software updates, the value could change with every servicing.

Conclusion

Assessing and mitigating risk are critical aspects of both the space industry and insurance sector. The emerging market of on-orbit servicing has the potential to play a novel role in simultaneously benefiting both types of business. This will require successful demonstrations on the part of servicers, but it will also require prospective satellite clients to commit to a concept of operations that includes servicing.

Table 1: Representative Underwriting Criteria[1,2]				
Design	**Experience**	**Contracts**	**Commercial**	**Pricing**
• Concept of operations • Operating environment • New technology • Redundancy • System architecture • Heritage • Mission requirements	• Operator • Manufacturer • Launch provider • Anomaly resolution	• Purchase agreement • Performance specifications • Test plan	• Business plan • Contractual obligation • Loss calculation • Asset valuation • Exposure analysis • Mission	• Value • Statistical analysis • Failure rates • Quantification of potential loss scenarios • Frequency vs. severity • Market conditions

The space industry attracts numerous innovative start-ups, but they do not all succeed. That could discourage the traditional satellite industry, which tends to be cautious. The opportunity for on-orbit servicing to have a unique symbiotic relationship with the insurance sector could provide ample assurance to this risk-averse base.

The good news is that everyone recognizes the magnitude of risk in the space industry. Consequently, there are aligned incentives between commercial space companies and their insurers to mitigate risk and optimize performance. The on-orbit servicing industry is still in the early stages, and a wide variety of approaches are just beginning to take shape. An open dialogue that communicates the utility of new concepts and considers the needs and concerns of the risk-adverse satellite community, while also working with the insurance sector to assess and mitigate risk, will help enable success for everyone.

References

[1] Kunstadter, C., "Space Insurance Update 2017," International Union of Aerospace Insurers; https://iuai.org/IUAI/Study_Groups/Space_Risks/Public/Study_Groups/Space_Risk.aspx.

[2] AON Risk Solutions, "Insuring Space Activities" (Oct. 2016); http://www.aon.com/russia/files/Insuring_Space_Activities_whitepaper.pdf.

[3] *Introduction to U.S. Export Controls for the Commercial Space Industry. 2nd Edition* (2017); http://www.space.commerce.gov/wp-content/uploads/2017-export-controls-guidebook.pdf.

[4] Henry, Caleb, "FCC begins approval of Orbital ATK satellite-servicing mission for Intelsat-901," *Space News* (2017); http://spacenews.com/fcc-begins-approval-of-orbital-atk-satellite-servicing-mission-for-intelsat-901/.

[5] Intelsat 2016 Annual Performance Summary; http://media.corporate-ir.net/media_files/IROL/13/131114/intelsat_performance_summary_2016/.

[6] D. Piskorz and K. Jones, "On-orbit Assembly of Space Assets: A Path to Affordable and Adaptable Space Infrastructure" (The Aerospace Corporation, Feb. 2018).

[7] "DARPA Selects SSL as Commercial Partner for Revolutionary Goal of Servicing Satellites in GEO," DARPA (2017); https://www.darpa.mil/news-events/2017-02-09.

[8] "Restore-L Robotic Servicing Mission," NASA; https://sspd.gsfc.nasa.gov/restore-l.html.

[9] "Orbital ATK Begins Assembly of Industry's First Commercial In-Space Satellite Servicing System," Orbital ATK (2017); https://www.orbitalatk.com/news-room/release.asp?prid=286.

[10] "Ongoing Space Robotics Missions," DLR; http://www.dlr.de/rmc/rm/en/desktopdefault.aspx/tabid-3825/5963_read-8759/.

[11] Erwin, Sandra, "STRATCOM chief Hyten: 'I will not support buying big satellites that make juicy targets,'" *Space News* (2017); http://spacenews.com/stratcom-chief-hyten-i-will-not-support-buying-big-satellites-that-make-juicy-targets/.