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MEASURING THE DIRECT AND INDIRECT ECONOMIC BENEFITS OF COMMERCIAL ACTIVE SPACE DEBRIS REMOVAL SERVICES (ADRS) BASED ON THE UTILIZATION OF DISRUPTIVE FUTURE MODULAR SATELLITE SYSTEMS

Abstract

Recent space debris growth has become a major threat not only to operational satellites in Low Earth Orbit (LEO) and Geosynchronous Orbit (GSO), but also to the safe operations of the International Space Station (ISS). As of February 2020, more than 2,300 operational satellites with 34,000 pieces of space debris pieces larger than 10 cm and 900,000 pieces greater than 1 cm to 10 cm populate Earth's orbits. Envisaged commercial launches of constellations as OneWeb (648 satellites), Starlink (42,000 satellites) and Amazon's Kuiper System (3,236 satellites) will multiply the risk of catastrophic debris collision. Moreover, principles of traditional design, manufacturing, assembly and operations of satellites will be disrupted, all the way to on-orbit servicing (OOS), on-orbit-assembly (OOA), on-orbit manufacturing (OOM) and beyond. Traditional satellite operators are facing challenges due to falling capacity prices, aging satellites in GEO and on-going advancements of LEO mega constellation satellite technology and service propositions. All stakeholders, traditional satellite operators, NewSpace actors as well as space agencies will have to figure out new and economically viable ways regarding design, manufacturing, assembly and operations. ADRS, OOS, OOA, and OOM as well as other in-space logistics will become an integral part of it in the longer term. Hence, modular and plug-and-play (PnP) satellite concepts and the use of commercial off-the-shelfs (COTS) component will become enabling and integral elements of future space infrastructure, its operations and related business, with direct feedback and impact on manufacturing, assembly integration and testing (MAIT). However, uncertainties exist due to nascent markets and regarding competitive drivers and other yet to be determined influences.

The paper assesses direct/indirect economic benefits of disruptive future modular satellite systems during distinct phases of market evolution. In a first step a sample high level evaluation of such benefits will use the iBOSS modular building set as a case study. In a second step direct and indirect economic benefits will be scored based on effects in the stakeholder value chains. Measures of future direct economic benefits like cost savings, interoperability, responsiveness, flexibility as well as indirect benefits. The analysis and its benefit measures and trades-offs of future direct economic benefits (e.g. cost savings from satellite servicing, cost avoidance, interoperability, improved time to launch and market) as well as indirect economic benefits like technology innovation, space debris protection and reduction, and other spillovers associated with the utilization of modular satellite systems/services that will support stakeholders in the development of suitable business cases.

The authors and partners involved have longstanding experiences, background and visibility in the academic and global commercial space arena with involvement in multiple innovative new business endeavors, comprising dedicated expertise in space commercialization and innovation, new business creation and finance, international partnerships, commercial prototyping and series manufacturing.