

IAF SYMPOSIUM ON SECURITY, STABILITY AND SUSTAINABILITY OF SPACE ACTIVITIES
(E9)Interactive Presentations - IAF SYMPOSIUM ON SECURITY, STABILITY AND SUSTAINABILITY
OF SPACE ACTIVITIES (IP)

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TOWARDS A SUSTAINABLE FUTURE: BALANCING INNOVATION, REGULATION AND
TECHNOLOGY FOR SUSTAINING SATELLITE MEGA-CONSTELLATIONS**Abstract**

The advancement of satellite mega-constellations in Low Earth Orbit (LEO) demonstrates a pivotal moment in space technology development. While providing unparalleled opportunities for global communication, mega-constellations also present significant challenges for space traffic management, collision risks, and space debris proliferation. This study evaluates the critical balance between the rapid expansion of satellite constellations and the sustainability of LEO. Significantly, this requires a harmonized approach in establishing innovative regulatory frameworks. Emerging technologies also require adaptation to mitigate adverse impacts and ensure the long-term viability of satellite operations. In fact, both industry and scholars already acknowledge the urgency of addressing these challenges. For example, in ... (year) a near-collision event occurred between x and y satellites, exemplifying existing operational risks in LEO and the need for more adequate mitigation measures. Selected case studies involving leading satellite operators are also raised here to highlight the practical difficulties in implementing regulatory compliance and operational management in space. This paper will evaluate current regulatory policies for efficacy in regard to cutting-edge space technologies. This includes automated collision avoidance systems and end-of-life deorbiting strategies. Inputs from key stakeholders also offer insights into the complexities of global space governance. One approach calls for an integrated regulatory strategy that adequately addresses orbital slot allocation, debris mitigation standards, and coordinated satellite operations. Preliminary analysis reveals, however, substantial gaps in existing regulatory mechanisms with rapid technological advancements and the expansion of constellation deployments. Consequently, this paper identifies innovative technological solutions and emphasizes the inherent need for developing a joint technology and policy approach for ensuring the sustainable use of satellite constellations and addressing the growing concern of orbital congestion. Given the need for a harmonized global approach, this paper identifies the need for a strategic framework and practical insights for informing policymakers, industry stakeholders and international regulatory bodies. Inherently, a collaborative solution is required to ensure the safe and sustainable use of space. Furthermore, integrating space sustainability priorities are vital for effectuating a forward leaning and proactive sense of stewardship of LEO as a shared global resource for future generations.