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SUSTAINABILITY OF COMMERCIAL SPACE OPERATIONS AND THE INTEGRATION OF SPACE AND AIR TRAFFIC MANAGEMENT

Abstract

Space sustainability has become a pillar for space operations and exploration. However, gaps in legal frameworks and technical guidelines leave critical activities, such as space debris mitigation, unregulated, generating legal uncertainty and raising concerns about public safety, environmental impacts, and infrastructure reliability. The context is aggravated by the booming of commercial space activities within the NewSpace economy. To ensure the sustainability of the space economy, it is fundamental to develop a regulatory environment tailored to NewSpace activities. Standards should align with performance safety goals while maintaining flexibility for agile prototyping and cost efficiency, typical of a product lifecycle in the NewSpace. The use of specific technical standards is usually recommended by regional guidelines or national regulations. The Zero Debris Charter from ESA, for example, offers a revision of ESA's space debris mitigation requirements. Although this is a non-legally binding document, licensing authorities for space activities often require their applicants to provide space debris mitigation plans. Implementation of mitigations is not specifically provided for by the applicable law, but without such implementation there is uncertainty whether the respective space activity will be licensed. The core result of this investigation is based on the observation that both standards and regulations are trying to keep pace with emergent technologies already in use. A comparison with a non-space sector shows that regulations are made in the first place, and then standards to oblige to the regulation are created. In the space sector, technical and policy standards are often adapted from existing standards developed for other sectors. Unlike in aviation, in the space domain regulations or guidelines to endorse the selected standards often come afterwards. This approach can be detrimental in the long term, since it increases risk exposure. The observations are supported by the authors using the integration of commercial space activities with aviation in Europe as practical example. In fact, the European scenario includes the complexity of integrating airspace operations among the 42 States members of Eurocontrol. An example to show how commercial space operations could be integrated with Air Traffic Management (ATM) is discussed. The integration of space traffic management with ATM also touches upon space debris mitigation and space situational awareness through the mission. The analysis shows that collaboration between public and private sectors is essential to address challenges related to space sustainability, not only during the phase of defining new standards or adapting existing ones, but also during space operations.