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AUTONOMY AND SAFETY CONSIDERATIONS FOR SATELLITE MEGA-CONSTELLATIONS

Abstract

Due to the on-going trend of deploying hundreds to thousands of small satellites in the form of so-called mega-constellations into Low Earth Orbit (LEO) by commercial space actors like SpaceX, Amazon and OneWeb the number of satellites in orbit is drastically increasing. This rising number is viewed critically by numerous experts and organisations around the world as this increase poses a thread towards the space environment, activities carried out in LEO and the long-term access to space. The large amount of satellites in orbit lead to a higher risk of collisions between functioning satellites as well as existing space debris which is as a result increasing the amount of space debris in orbit. Autonomous operations and safety concepts have to be implemented to ease operations and to keep the near-Earth orbits safe and accessible. Methods from the domain of Artificial Intelligence (AI) have been extensively researched and developed in recent years for system autonomy purposes for diverse applications in the terrestrial industry. In the field of spacecraft operations such methods can support the processes onboard as well as on ground when it comes to autonomy of system monitoring, anomaly detection, decision making and constellation or formation management of a large fleet of cooperating spacecraft.
This study presents an overview of established and planned mega-constellations and their autonomy concepts. A concise outlook on autonomous constellation management based on Artificial Intelligence together with considerations on safe and autonomous operations of a large fleet of spacecraft is given. Such autonomy and safety concepts can serve as building blocks for Space Traffic Management (STM) from a technology point of view.