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Impact-Induced Mission Effects and Risk Assessments (3)

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THE SHORT-TERM IMPACT OF THE COSMOS 1408 FRAGMENTATION ON NEIGHBORING SPACE REGIONS: FROM INHABITED SPACE STATIONS TO LARGE SATELLITE CONSTELLATIONS

Abstract

The Soviet Electronic Intelligence (ELINT) satellite Cosmos 1408, launched in low Earth orbit (LEO) on 16 September 1982, was destroyed in a Russian anti-satellite weapon test (ASAT) on 15 November 2021. The spacecraft, with a mass around 2 metric tons, was in a high inclination orbit and its intentional fragmentation, which occurred at an altitude of just under 500 km, led to the generation of a debris cloud of almost 1500 pieces of trackable debris, as well as hundreds of thousands of more difficult to track fragments, according to a preliminary report by the US 18th Space Control Squadron. The orbits of cataloged debris pieces are distributed between the heights of 200 and 1500 km, then crossing the most populated regions in LEO. Such ASAT test took place in a region of space hosting crewed assets, such as the International and Chinese space stations, as well as large constellations of satellites, like the SpaceX's Starlink around 550 km. As a matter of fact, the debris cloud immediately posed a threat to the International Space Station (ISS) and its crew, forcing astronauts and cosmonauts to undertake safety procedures in the first few days following the event. The threat also exists for the Chinese space station and its taikonauts, and also for the numerous satellites that orbit, or will be placed, in those regions of space crossed by the Cosmos 1408 debris cloud. The purpose of this paper is to assess how the average probability of collision increased at the heights of the International and Chinese space stations, as well as for several large constellations, e.g. Lemur, Flock and Starlink, operating below 600 km of altitude. For instance, just under 2.5 months after the event, on 28 January 2022, 1279 orbiting debris from Cosmos 1408 were available in the US catalog. Using these data, the spatial density around the altitude of the ISS roughly doubled. Around 500 km, on the other hand, the spatial density increased by just over 30% at the time considered. However, the availability of newly cataloged fragments, as well as the observed evolution of the debris cloud, might lead to appreciable changes in the collision probability through the altitudes crossed. These changes will be monitored in detail over the coming months, also comparing their effects with those from the 2007 and 2009 catastrophic collisions, numerous fragments of which are still crossing the altitudes of interest due to their natural orbital decay. Some considerations on the consequences of these adverse collisional events on the sustainability of the space environment, in order to preserve space for future generations, will conclude this analysis.