# General overview of the situation of the space debris population

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**Résumé**

Since the beginning of the space age, in 1957, almost 5400 successful launches and more than 300 on-orbit breakups have led to nearly 44,000 manmade objects tracked in space. Of these, about 24,000 are currently in orbit, and more than 19,000 are included in the official catalog of the US Space Surveillance Network (SSN). More than 1800 satellites are operational (Satellite Database of the Union of Concerned Scientists), corresponding to just less than 8% of the on-orbit tracked objects. The remaining are non-functional intact objects (_˜28%) and debris (_˜64%). Most of the latter were generated by more than 260 on-orbit fragmentation events recorded since the explosion of the Transit 4A rocket body, on 29 June 1961. Among these, the majority were explosions and only a few were collisions, accounting for less than 10 accidental and intentional events. So far, four accidental hypervelocity collisions among cataloged objects have been recorded in Low Earth Orbit (LEO). Three were debris-intact impacts, generating very few cataloged fragments, while one involved the collision, in February 2009, between two intact spacecraft (Cosmos 2251 and Iridium 33), one of which maneuverable, with the consequent production of more than 2290 cataloged fragments. The intentional breakup of the Chinese spacecraft Fengyun-1C, in January 2007, led instead to the generation of approximately 3440 cataloged fragments. At present, the outcomes of both collisional events account for nearly 35% of the on-orbit cataloged fragments and boost by about 22% the cataloged population. On-orbit fragmentation events generated the highest number of particles larger than 1 cm: on the order of 750,000, according to the ESA's MASTER model. Other sources of space debris, in the centimeter range, have been the slag particles from solid rocket motors, and the sodium-potassium droplets released from Soviet orbital nuclear reactors. The mass in orbit around the Earth is currently approximately 8140 metric tons. Most of the orbiting mass (_˜98%) is concentrated in intact payloads and upper stages, and nearly 32% resides in LEO (ESA's DISCOS Database). Among the intact objects, nearly 80% are abandoned and more than 90% cannot be maneuvered. Those left above around 650 km, i.e. with a typical residual lifetime of more than 25 years, represent the main potential mass reservoir for the generation of new detrimental orbital debris in case of mutual collisions with the existing debris environment.
Since the 1980's several mitigation measures were promoted and agreed internationally in order to prevent the occurrence of new breakups in space and put under control the accumulation of the mass abandoned in orbit, but unfortunately the level of compliance with such guidelines, requirements or standards is still far from satisfactory. Moreover, space debris mitigation alone cannot stabilize the environment, but it must be probably complemented by space debris remediation measures.

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The purpose of this presentation is to give a state-of-the-art representation of the population of manmade space objects orbiting around the Earth, from LEO to GEO (geosynchronous orbit), by highlighting as well the main sources of orbital debris, together with the principal natural mechanisms (sinks) affecting their orbital evolution. Finally, after a short overview of some recent results concerning the debris environment forecast, the proposed mitigation and remediation measures will be presented, and their effectiveness on the long-term stabilization of the environment will be discussed.