Abstract for EUCASS

Munich, July 2013

Title: Astrium perspective on space debris mitigation & remediation

Authors: P. Voigt, D. Alary, C. Cougnet, M. Oswald, J. Utzmann (Astrium GmbH)

Abstract

The density of space debris has been increasing for decades, with the rising number of satellites, rocket bodies and mission-related debris, and with the fragmentation events. The situation is critical especially in LEO. The destruction of one object yields an additional set of debris, and hence a significant increase of the collision probability for many other objects finally resulting in a chain reaction. Experts predict one large collision every 5 years in 2050 and an acceleration of the chain reaction. This would have a severe impact to the LEO domain as useful regime for satellite operations. Already today space debris is a serious problem which is visible through the regular avoidance maneuvers of the ISS, the threat for sun-synchronous orbits due to the potential destruction of de-functional large Earth observation satellites but also the risk on the safety of ground population due to uncontrolled re-entries (Rosat).

Astrium is aware of this problem and proposes a four-pillar debris mitigation approach. There is a long-term experience in all these four pillars of mitigation as well as on system and architecture level.

First pillar: **Prevention**. Further debris generation shall be prevented by Post Mission Disposals (PMD) of satellites and launchers to reduce the maximum lifetime in operational orbits to 25 years after the end of operations, by transferring them into graveyard orbits according to the IADC guidelines or by re-entering into the earth atmosphere. The PMD can be ensured by on-board capabilities. This has an impact on the system itself. It may also be provided by a special de-orbit kit attached into the satellite by an external removal service. In all the cases the cost of the solutions is a strong driver. So it has to be required by regulation and license issues.

Second pillar: **Avoidance**. Currently LEO-objects larger than ca. 10 cm are tracked by the US SSN so that avoidance maneuvers can be carried out by operational satellites. Also national means (German TIRA or French GRAVES) exist for Surveillance and Tracking, however additional sensors are needed with improved capabilities in order to tackle the debris problem. In the future, debris location could be known better through a European Space Situation Awareness system. Astrium has been and is involved in several ESA system studies in this regard, e.g. the current "CO-II SSA Architectural Design" and the "Assessment Study for Space Based Space Surveillance Demonstration Mission".

Third pillar: **Survivability**. The vulnerability of satellites for untracked debris between 1 mm and 10 cm can be reduced to survive an impact. Different solutions are considered to reduce the vulnerability of satellites in LEO, both at system and satellite architecture levels. In particular, new concepts of shielding are proposed to protect critical equipment against particles of up to 4 mm size. Indeed, it appears that the particles of 2 to 4 mm size are the

most significant group contributing to damage of satellites as shown in the EC FP7 study ReVuS currently led by Astrium Satellites.

Fourth pillar: **Remediation**. The challenge is to remove 5 to 10 large debris per year in order to stabilize the debris situation. To achieve that goal a wide range of different concepts is analyzed for single- and multi-target missions, based on new technologies such as sensors to detect the target and evaluate the tumbling rate, systems for capture and stabilization of targets and systems for de-orbiting. The aim is to develop a vehicle able to remove several debris objects and thus hosting several capture systems and de-orbit packs (Debritor). Such a vehicle should be made of off-the-shelf subsystems or equipment in order to lower the development cost at maximum and thus the cost of a mission. In addition concepts to remove small debris (e.g. by laser) are analyzed.

The paper will describe the overall mitigation strategy and the different technical approaches in the four pillars to avoid further debris.