SPACE DEBRIS SYMPOSIUM (A6)
Mitigation and Standards (4)

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# SPACE MISSION PROTECTION, IMPROVEMENTS AGAINST SPACE-DEBRIS HAZARDS

**Abstract**

Space-debris around Earth is becoming a more and more significant threat to the proper functioning of our satellites in orbit. To cope with this increasing problem, different strategies to enhance mission protection are being established by a European consortium composed in a multi-disciplinary manner, involving research organizations and academia on the one side and industrial companies and SME on the other. The work is being performed within the EC's 7th Framework Programme as a collaborative project in the activity "Strengthening of space foundations" called P2ROTECT (Prediction, Protection Reduction of Orbital Exposure Collision Threats).

Within the proposed paper and presentation, based on current understanding of post-structural penetration kinematics, current regulations in place in order to mitigate debris generation and existing space debris/meteoroids protection technology, the current work will be presented in the following fields:

- Methods to calculate the vulnerability index of spacecrafts;
- Improvement of spacecraft protection by enhanced redundancy and design;
- Spacecraft self-protection;
- Fractionated mission design.

As the space-debris environment around Earth is not constant and changes significantly from orbit to orbit, it was decided to orientate the proposed strategies around three representative missions:

- Sentinel-1 (Earth radar Observation mission in LEO – SSO 693 km altitude)
- Galileo in MEO (Navigation mission in MEO – around 23000 km altitude)
- MTG in GEO (Meteosat mission in GEO)

A traditional approach to evaluate damages caused by debris and meteoroids on S/C components has been combined with a FTA (Fault Tree Analysis) methodology. The purpose of this exercise is to evaluate S/C functional impairment starting from components failure probability. This approach allows

accounting for functional dependencies and redundancies avoiding the overestimation of damages caused by Micrometeoroids and Orbital Debris (MMOD) impacts.

The paper will provide recommendations for improving space mission survivability by improving space debris knowledge and improving mission and spacecraft design. The recommendations will be based on the calculated vulnerability of the baseline spacecraft constellation designs and current debris detection knowledge. Together with the assessment of the technologies investigated, also the predicted increased performance as well as related costs will be addressed.

Improvements will be analyzed in the areas of:

- Internal accommodation
- Minimizing cross-sections
- Mechanisms  shadow baffles
- Redundancy aspects