SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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MISSION, SYSTEM AND ARCHITECTURE DESIGN OF A GENERIC ASTEROID DEFLECTION SYSTEM

Abstract

The Near Earth Asteroid Apophis passes Earth within a few thousands of kilometers in the year 2029. If the asteroid passes through the so called keyhole at this occasion, the asteroid's orbit will be modified by the Earth gravitational field leading to an impact on Earth in the year 2036. An impact of this 300 m asteroid could lead to massive destructions and high number of casualties. Although such impact of Apophis on Earth is very unlikely, it demonstrates the threat imposed by asteroids to Earth and mankind in particular. Hence, Astrium performs several in house activities to develop concepts for asteroid deflection.

This study aims to develop a concept for the deflection of a generic asteroid threatening Earth impact. Therefore, the asteroid's orbit has to be modified to achieve a deflection of at least the Earth's diameter to avoid the impact. As a first design case of such a deflection system, the short Earth fly by distance of Apophis in 2029 is neglected in comparison to solar system dimensions and an impact is assumed. The asteroid deflection system, developed in this study, has then to protect Earth from this hypothetical impact.

Reviewing possible deflection strategies, kinetic impactors have been chosen as baseline. To enable a rapid development of the deflection system, the utilization of new technologies should be avoided as much as possible. Furthermore, the mission architecture should only use already existing and operational launch vehicles as well as competences of ongoing projects as ATV and Ariane 5.

The study conducted first a mission analysis to determine possible launch windows for impactors. It considered impulsive direct and swing by transfer trajectories to Apophis, which have been optimized with respect to their deflection performance. In conclusion, Venus swing by trajectories with launch dates in the years 2017, 2018 and 2020 have been found as favorable. Based on that a system architecture assessment has been performed leading to a decentralized system consisting of several impactors, launched independently, minimizing the severity of a launch vehicle or impactor failure. For such an impactor, a phase 0 system design has been performed addressing especially guidance system for asteroid final approach as well as propulsion, power, communications and thermal control.

This paper will outline the major results of the conducted mission analysis, the mission architecture as well as its justification and the impactor system design.