FAST KINETIC IMPACTOR.

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The number of Near Earth Asteroids (NEA) that are monitored by the scientific community has increased exponentially in the recent years thanks to a large increase in observations and investigation. Some of these asteroids have a very low probability of impact with the Earth in the following decades and they are therefore catalogued as Potentially Hazardous Asteroids (PHA). Planetary Defense studies are aimed at the development of techniques to respond to the possibility of such a threat in the future.

In this context, the European Space Agency has promoted a study to analyse the current capability to achieve the deflection of a real target asteroid with a very short warning time. The target object has been chosen in the class of 50m diameter asteroids, which is considered to be relevant in terms of number of existing objects and potential threat. The chosen approach for the asteroid deflection focuses on the adoption of a kinetic impactor, that is the exploitation of a (massive enough) spacecraft to enter in collision with the asteroid with a high relative velocity in order to deflect its trajectory and remove the threat.

Such mission profile imposes very important challenges that need to be tackled in order to ensure success, two of which are of special relevance:

1. The short warning time (only few years) since the PHA discovery to its close approach with Earth. This requirement poses strong limitations both in terms of spacecraft development and mission profile.
2. The complex GNC system required to impact the target at a very high speed has a strong impact on the choice of the platform to be used.

The consortium was constituted by Airbus Defence and Space (main contractor) and Deimos. While Airbus was in charge of the platform definition and analysis, Deimos has been in charge of the trajectory design. A large number of objects, particularly those included in the list of Potentially Hazardous Asteroids, has been taken into account as potential threats.

The search and optimization of trajectories are constrained by different mission and operational parameters, such us warning time, maximum transfer time, Sun Phase Angle at impact, or the arrival velocity at the target body. The methodology followed during the trajectory design procedure is presented in the paper. In brief, a catalogue of a few hundreds of asteroids has been collected. For each body, given the epoch of closest approach to the Earth, a large number of trajectories (in the order of thousands per body) has been taken into account through a tool that computes trajectories from a certain body to another at a given time grid (both for departure and arrival) with a search-and-prune approach. Each trajectory reaching the asteroid imposes a deflection on the object, by altering its velocity vector. The asteroid trajectory is propagated forward in time (for each of the impacting trajectories) in order to assess the deflection obtained at the epoch of the potential collision with the Earth.

The main outputs of the analysis are a set of maps that report the deflection capabilities depending on the asteroid, the spacecraft design and the mission characteristics. This outcome is a relevant input for the platform choice, which also includes a timeline analysis in order to ensure that the short warning time requirement is fulfilled both in terms of trajectory profile and in terms of platform design and development.

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