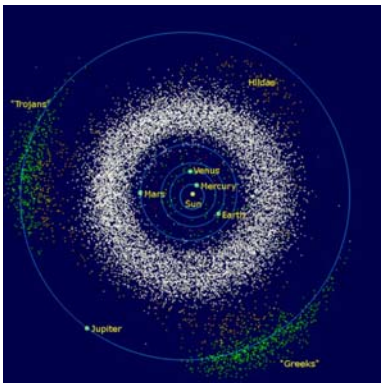
Project SEUSS: Save Earth Using Solar System Assets

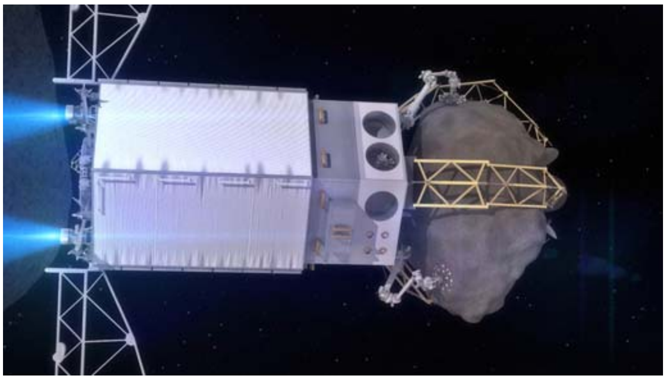
Madhu Thangavelu[(1)]

(1)Conductor, ASTE527 Graduate Space Concepts Studio, Dept. of Astronautical Engineering, USC Viterbi School of Engineering, University of Southern California, Los Angeles, CA 90089-1191, USA

ABSTRACT

Keywords: *asteroid belt, asteroid fragments, gravity assisted trajectories, intercept trajectories, ARM, AIDA-AIM MIssions*





The Earth continues to be bombarded by asteroids and less frequently by comets. The extinction of the dinosaurs over 65 million years ago was the result of an asteroid impact. While the probability of an extinction-class body colliding with the Earth is small, the consequences of such an impact are cataclysmic, as punctuated in Earth's geologic history. For the first time in history, the human species has the knowledge and means to observe, detect and mitigate the the threat of rogue bolides from outer space. Timely interception by an energetic weapon could cause sufficient deflection of a threatening body, just enough to alter the trajectory.

In the SEUSS concept, we propose the use of asteroid fragments as kinetic kill systems. Instead of trying to destroy an oncoming object, the goal is to deflect the body just enough to alter its trajectory to avert impact with Earth. This concept will utilize small (TBD diameter) suitable asteroid fragments to engage the target bolide. Pre-selected asteroid assets like Trojan fragments will be equipped with propulsion devices that, when activated, will propel the kinetic kill SEUSS-A system on an intercept course with the oncoming object. The kinetic energy transferred to the body will result in a small amount of change in velocity, which will in turn alter its course. One or many such pre-positioned Trojan "defenders" will be deployed depending on the size, attainable trajectory, location, and composition of the body. In addition, other factors such as orbital geometry and intercept trajectory as well as precise "Earth miss" transit window and distance analysis will be employed to determine the final deflection strategy.

Using the gravity assist principle that is thought to have flung asteroid fragments far out into the Oort cloud early in the evolution of our solar system, clearing the orbits of Jovian planets, the SEUSS-A concept proposes to use the Jovian giants as well as other planets to catapult asteroid fragments attached to propulsion units, transforming them into high energy kinetic-kill vehicles called defenders, precisely tailoring and aligning trajectories to intercept bolides like those potentially hazardous near Earth asteroids or comets.

Defenders are proposed to be commissioned with a very long operational life. The defender's propulsion device could utilize solid propellants because it is better(and safely) stored for long periods of time. Defenders will be fielded at TBD number per year with the goal of maintaining a TBD fleet of them distributed around strategic as well as opportune "armament rich" locations in our solar system at any given time. Adaptability of the SEUSS-A architecture to move the propulsion systems to various locations provides another dimension in architectural flexibility to align the best intercept trajectories with rogue bolide.

Lastly, additional areas for concept refinement and future studies include selection of the initial launch vehicle for of the defenders, identification of a range of asteroidal assets in strategic locations around the solar system including suitable, strategic Trojan defenders, extremely long-life, agile and reliable spacecraft systems, and a robust and secure communication architecture with the defenders.

Complex missions flown in the past including the Deep Impact mission to Tempel 1, Muses-C/Hayabusa to asteroid Itokawa, Stardust and various asteroid and comet rendezvous missions and the current New Horizons as well as the Rosetta mission that has been successfully turned back on and reassigned after nearly three years of deep space hibernation beyond the orbit of Jupiter to touchdown on Comet 67 P/Churyumov-Gerasimenko in June 2014 are all examples of architectures that allows insight into project SEUSS-A design and execution strategy. The NASA ARM mission and NASA- ESA collaboration on the AIDA-AIM mission proposes to study the feasibility and some aspects suggested in the SEUSS project.

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