Naval Research Laboratory

The Corporate Laboratory for the Navy and Marine Corps

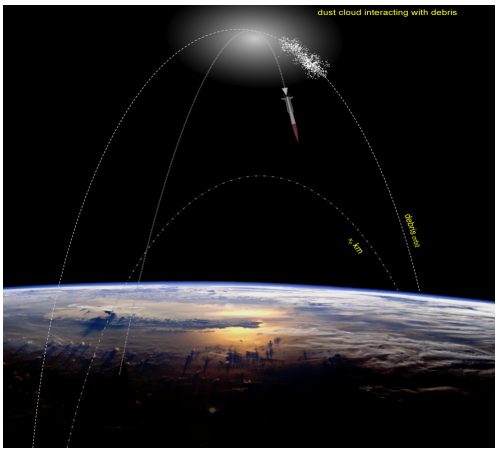
Mitigation Concept of Low Earth Orbit

Physicist and Engineers at the U.S. Naval Research Laboratory Plasma Physics Division and Naval Center for Space Technology have researched a technique to 'sweep' Low Earth Orbit (LEO) debris from space using an Active Debris Removal (ADR) system of deployed micron-scale dust.

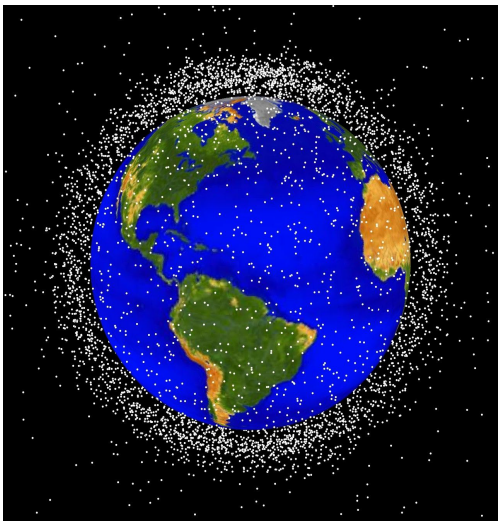
The essential idea is that dust, if artificially deployed on orbit in opposite direction to the debris trajectory, can induce an enhanced drag on the debris. The novelty is that by choosing the dust characteristics, for instance, mass density, size, etc., it is possible to synchronize the rate of dust and debris descent. This offers the possibility to clear a very large volume of small debris by deploying a modest amount of dust in a narrow layer and "sweeping" of the debris volume by the dust layer.

It is well known that the natural drag due to neutral atmosphere decays satellite orbits. However, the magnitude of the drag is too small on the orbital debris above 600-700 km but significant on the micron-scale dust grains. The method would use the natural atmospheric drag to decay the deployed dust orbits and simultaneously use the descending dust layer to induce enhanced drag on the orbital debris. Like the natural dust, most of the deployed dust as well as the small orbital debris will incinerate while reentering the Earth's dense atmosphere. So the environmental effect of releasing the dust is expected to be benign. Research indicates that the dust based ADR system can be a cost effective means to clear deadly untrackable small orbital debris with manageable risks to existing space assets and can be developed with off-the-shelf type technologies in the near term. This same concept can be utilized for removing larger debris with a suborbital dust deployment. Preliminary analysis suggests tungsten be a prime candidate for the dust because of its high density, relative abundance, availability in powder form and modest cost, all contributing factors to the efficiency and economy of the system.

(Lower Image) Low Earth orbit is the region of space within 2,000 kilometers of the Earth's surface. It is the most concentrated area for orbital debris.



(Above)Schematic Illustration of the suborbital dust deployment. A ballistic rocked is used to release dust in the path of debris fragments. The debris population is engulfed by the dust cloud, experiencing enhanced drag and results in the loss of debris altitude. The debris population descends to an altitude of X0 kilometers, within one debris revolution time, below which Earth's natural drag is sufficient to force reentry within a desired time. The dust cloud also descends under gravity and re-enters the atmosphere.



Technology Status

The technology is Technology Readiness Level 2, technology concept and/or characteristic proof of concept.

Licensing or Collaboration Opportunity

US Patent Nos. 8,469,374 and 8,579,235 are available for License so companies with commercial interest. Collaborative research and development is available under a Cooperative Research and Development Agreement (CRADA).

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