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GROUND-BASED LASER FOR TRACKING AND REMEDIATION – AN ARCHITECTURAL VIEW

Abstract

Laser tracking of orbital targets is a well established technology in the scientific community (geodesy, space radar/optical imagery) with precision ranging to operational satellites equipped with retro-reflectors as well as to the Moon. Since a few years, the use of this technology was pioneered also for the tracking of defunct objects, e.g. in order to identify its attitude motion from range residual analysis. After introduction of more sensitive receivers, more powerful transmission systems and improvement of track initialisation techniques, it became possible to receive and process echoes from uncooperative targets. Still, accurate a-priori pointing information is required and tight constraints on the observation conditions must be met to be successful.

Presently, a new generation of pulsed lasers is being deployed with the prospect of achieving a power density at target that is by several factors higher than before. This will allow to track even smaller uncooperative targets, while challenges to initialise tracks will grow and require further maturing in the area of tracking in daylight, stare and chase, and networking technology.

The application of laser tracking in this domain will most likely be limited to the tracking of 'known' targets. Hence, the size of the tracked objects will always be limited by the supporting (radar-based) surveillance system. As such, laser tracking will eventually develop as a cost-efficient alternative method for all target sizes in a catalogue, e.g. providing orbit refinement prior to conjunctions to a level which reduces false alerts dramatically.

With the next evolution step of power (by another order of magnitude), which is within reach of larger aperture telescopes and adaptive optics technology, target orbits may also be slightly influenced. This opens the door to the prevention of collisions among uncontrolled objects. The occurrence of such collisions at altitudes of ¿800km are the most feared events from an environment perspective. The application of a small delta-v from ground could prevent such collisions. The small influence of the atmosphere in this altitude, allows a better predictability of a laser pass. Any successful laser pass will improve the prediction and lower the false alerts and also lower the required delta-v.

This paper provides a first overview of the inter-relation between prediction accuracy, collision probability and manoeuvre size as a starting point for the optimisation of a network of tracking and nudging lasers focussing on high-altitude LEO targets.