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ANALYSIS ON LONG TERM ORBITAL EVOLUTION OF GEOSYNCHRONOUS TRANSFER ORBITS

Abstract

Most of the geosynchronous satellites are first launched in a geosynchronous transfer orbits (GTO) and then subsequently their perigee is raised to geosynchronous altitude. The spend stage of the launch vehicle is left to GTO orbits, which will be crossing GEO belt many times during its lifetime. This can be a major threat to operational spacecraft in GEO. Also these GTO objects pass through all the altitude ranges from LEO to GEO, 3 -4 times a day, throughout their lifetime. This also can increase the conjunction probability of the operational spacecraft in all the regions. Hence it is very essential to study the orbital evolution of GTO objects, the estimation of lifetime and also explore the ways and means to minimize the lifetime of these spent bodies in GTO. Objects in GTO are on one hand experience high drag at perigee and on the other hand affected by gravitational perturbation due to Sun and Moon at apogee. The coupling of these two perturbations combined with the effects of the Earth potential (secular drifts mainly) makes the orbit's evolution particularly sensitive to initial conditions and modeling errors.In particular, Sun's position at the time of injection into GTO dictates the evolution of the orbit. The lifetime of objects in GTO can vary from few months to hundreds of years. The lifetime of the spent stage in GTO can hence be controlled by adjusting the lift off time. The Lifetime of objects in GTO can be limited to comply with IADC and UNCOPOUS guidelines by proper selection of launch time. But the selection of launch time may be constrained by mission requirements such as eclipse conditions, sun angle, power requirements and the launch opportunities for interplanetary missions. In such cases the lifetime of spent stage can be restricted by increasing its A/M (area-to-mass) ratio. The higher A/M ratio at perigee will increase the drag effect allowing shorter lifetime. This will also increase solar radiation pressure at apogee which can either increase or decrease the lifetime depending on orbital geometry. Higher A/M can be achieved by having deploying mechanism. In this study sensitivity analysis of high A/M and satellite injection time on orbital life is carried out for various launch dates and orbital geometries.