Author: C. COLOMBO
Politecnico di Milano (Italy)
Title: *"Orbit manoeuvring enhancing natural perturbations"*

Abstract. Natural orbit perturbations are responsible for the trajectory divergence from the nominal two-body problem, increasing the requirements for orbit control; whereas, in space situation awareness, they influence the orbit evolution of space debris that could cause hazard to operational spacecraft. However, the dynamics of natural orbit perturbations can be leveraged to significantly reduce extreme high mission cost and create new opportunities for space exploration. Alternatives to high fidelity models of the dynamics to predict the actual orbit evolution are semi-analytical techniques, based on averaging of the disturbing potential function (Brouwer 1959, Deprit 1981), which separate the constant, short-period and long-period effects, thus reducing the computational time for long-term analysis. In an era of unlimited computational resources, when the burden of high-fidelity numerical propagation is not anymore a problem, a recent trend emerged in resorting to semi-analytical propagation techniques for Earth-centred orbits and to apply them to new space engineering problems. In this work semi analytical techniques and Hamiltonian dynamics are used first as a tool for understanding the underlying dynamics of orbit perturbations. Then, an optimiser is proposed that progressively explores the phase space and, through spacecraft propulsion manoeuvres, governs the effect of perturbations to reach the desired orbit. Within the optimisation, the dynamics model is progressively improved so that the final optimal result reflect the actual orbit evolution. Two mission applications are presented: the end-of-life design of the ESA INTEGRAL mission, enhancing the effect of luni-solar perturbation through delta-v manoeuvres and the use of variable geometry solar sail for the end-of-life of nano-satellites in medium earth orbit. In the first case the manoeuvre is computed in the eccentricity-inclination-anomaly-of-perigee map, first introduced by Kozai (1962), in the second case the effect of solar radiation pressure is modulated to achieve a long term grow of the orbit eccentricity.