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New Missions Enabled by New Propulsion Technology and Systems (6)

Author: Mr. Giacomo Bertolucci
University of Pisa, Italy

Dr. Francesco Barato
University of Padova - DII/CISAS, Italy
Dr. Elena Toson
T4i, Italy
Prof. Daniele Pavarin
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy

# IMPACT OF PROPULSION SYSTEM CHARACTERISTICS ON THE POTENTIAL FOR COST REDUCTION OF EARTH OBSERVATION MISSIONS AT VERY LOW ALTITUDES

**Abstract**

Earth observation is one of the most important satellites' applications. Past Earth observation systems have used traditional space technology to achieve the best possible performance, but have been very expensive. Recently, thanks to advancements in technology and modern microelectronics, small satellites have become more and more useful at much lower costs, even if with reduced performance. The resolution of the optical payload improves as the altitude is reduced. Space system mass is proportional to the cube of the linear dimensions. This means that by flying at lower altitudes, satellites can reduce their payload size and therefore the entire mass of the satellite, thus reducing the cost of the system dramatically. However, almost all the earth observation missions fly at the minimum altitude that provides a sufficient orbital life. The addition of a propulsion system capable of providing drag compensation for the entire satellite operative life provides the possibility to fly at very low earth orbit. In this way the same performance can be obtained with a smaller and cheaper system. To obtain the same coverage more units are needed to replace a larger unit at higher altitude. In this paper it is demonstrated that future smallsat observation systems, operating at a lower altitude than traditional systems, have the potential for comparable or better performance, much lower overall mission cost (by a significant factor), lower risk (both implementation and operations), shorter schedules, lower up-front development cost, more sustainable business model, to be more flexible and resilient, more responsive to both new technologies and changing needs, and to mitigate the problem of orbital debris. This paper focus in particular on the effect of the propulsion system parameters (performance and costs) on the cost model as a function of the altitude. It is demonstrated that affordable chemical propulsion systems provide already significant benefits with limited constraints, allowing a useful reduction of altitude and, consequently, costs. Electric propulsion systems have the potential to allow even lower altitudes or longer lifetimes, however, they have a stronger impact on the satellite design related to their power consumption, generally requiring extendable solar panels which can limit the flexibility in the orbit selection or the added weight and cost of batteries. The development of electric thrusters which have good performance and limited impact on the satellite architecture (particular at small scales) is fundamental to exploit their potential for reduced mission costs through very low altitude flight.