Paper ID: 76973
oral

30th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Access to Space for Small Satellite Missions (5)

Author: Dr. Francesco Barato
University of Padova - DII/CISAS, Italy, francesco.barato@unipd.it

Dr. Elena Toson
T4i, Italy, e.toson@t4innovation.com
Ms. Fabiana Milza
T4i, Italy, fabiana.milza@gmail.com
Prof. Daniele Pavarin
T4i, Italy, d.pavarin@t4innovation.com

INVESTIGATION OF DIFFERENT STRATEGIES FOR ACCESS TO SPACE OF SMALL SATELLITES ON A DEFINED LEO ORBIT

Abstract

In recent years small satellites have shifted from being secondary items to dominate the space market thanks to, but not only, the development of the large LEO constellations. For small satellites to be highly effective, particularly when arranged in such constellations, each satellite has to be placed in a specific orbital plane and orbital position. Currently, three main options are available to reach a specific orbit. The first, more straightforward solution is to employ a dedicated launch with a small launch vehicle. Plenty of small launchers are in development around the world (with few already operational); however, their cost per kilogram is predicted to be much higher than for large launchers. The second possibility is the exploitation of a rideshare option, where the satellite is transported by a large launcher together with other payloads on a general predetermined orbit. Afterwards the satellite needs to be transferred to its designed orbit. This can be done in two ways: through the use of a satellite carrier (also called self-propelled dispenser) or with the satellite own propulsion system. In both last cases, the mass transported by the launcher into the release orbit is higher than the final one necessary for the nominal mission, impacting total costs. In this paper these three possibilities are compared considering the need to reach various specific orbits, starting from a different release one in the case of the rideshare options. First of all, the change in velocity for different orbital parameters (altitude, inclination, RAAN, phase, argument of perigee) is computed. Afterwards the propulsion mass budget is calculated. Everything else being equal, it is demonstrated mathematically that a dispenser is inherently less efficient than a group of autonomous satellites, particularly for the RAAN change and a large number of carried satellites. However, it is not always possible or convenient to provide small satellites, particularly the smallest ones (nanosats/cubesats/microsats) with comparable propulsion capabilities of a larger dispenser, making the latter still an attractive option in several situations. A cost analysis also shows that, particularly for sophisticated small satellites, when the final orbit is far from the release one, a dedicated small launch vehicle can be cost competitive with the nominally much cheaper large launcher. However, this requires a sufficient flexibility in the launch azimuth and location, which must be fully taken into account in the design of the dedicated launch system/service.