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CHALLENGES OF OPERATING THE QB50 NANOSATELLITE SWARM

Abstract

Satellite swarms are an extremely interesting research topic thanks to the availability of small and highly capable satellite platforms: what could seem unaffordable with big size satellites now seems feasible with nanosatellite constellations and swarms, even if still challenging. QB50 is an international collaboration aiming at characterizing the high layers of the atmosphere using a swarm of Cubesats: instead of having an extremely complex, powerful and an expensive satellite, the problem was solved with a swarm of cheap satellites. For this project institutes around the world provide 50 nanosatellites to fly in a swarm in LEO.

Although there are many benefits of using this approach, there are quite some challenges related to designing, launching and operating a swarm of 50 nanosatellites with a very limited lifetime in LEO. This paper will focus on the operations for the QB50 mission, actually highlighting the main critical points and trying to propose some solutions. Next to discussing the design and verification challenges the paper will focus on providing insight into: - Swarm launch preparation, launch and LEOP - System level autonomy philosophy - Definition of the ground and space operational architecture - Radio communication issues and frequency coordination - Satellite tracking and data downlink and transfer - Satellite operations, with particular attention to scheduling and data transfer

Next to the obvious programmatic challenges in coordinating tens of different international institutes in building nanosatellites, there is a whole host of technical challenges. Data reception, for example, is quite challenging since all the 50 satellites will be launched together and will be orbiting near to each other for the first weeks. This will also generate trouble in terms of bandwidth usage since, with commonly used modulation schemes, the required bandwidth will be quite high making frequency assignment difficult. Furthermore proper ground station coordination is required to ensure that valuable data are collected in the short mission time. A ground station network will be needed to download mission data in the limited time available but data transmission from satellite to ground and from ground station to the mission control room will have to be carefully analysed to account for transport delays which may limit the actual data throughput.