

# Reaching for Planets and Comets – ESA’s Challenges of Operating Deep Space Missions

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Interplanetary or so-called deep space missions certainly belong to the most interesting and exciting missions – not only from a scientific point of view but also for the engineers developing, building and operating such satellites. These missions leave the familiar environment of the Earth expanding into partially unknown and little explored territory. Most of them are highly complex and ambitious first of its kind spacecraft with very limited synergies with other missions. Because of the uniqueness and high cost of each spacecraft, the overall mission risk level acceptable is very low. As a consequence, very high levels of technology robustness and redundancy as well as huge verification and validation efforts are required. Satellites for deep space missions are literally handcrafted and tested by hundreds of engineers.

However, the success of interplanetary space missions is not only dependent on a properly designed and built spacecraft and its successful launch. It also depends on successful mission operations, which is a collaborative endeavour.

In this talk, examples from the missions Rosetta - ESA’s comet chaser, and BepiColombo - Europe's first mission to Mercury, are presented to illustrate the main challenges of operating interplanetary missions, namely: the interplanetary trajectory, long cruise phases that can exceed a decade, the inhospitable and harsh environment driving the design and temperature control, long signal travel times of up to 100 minutes, communication and energy generation. Both Rosetta and BepiColombo travel through deep space for about a decade with delicate and spectacular manoeuvres before reaching their actual targets. Sophisticated and reliable computer models provide high precision interplanetary trajectories from launch to the comet rendezvous and Mercury insertion respectively and make these long journeys possible. Once close to the target, optical navigation techniques are used. The mission operations concepts of such non-routine deep space missions are primarily based on operations automation and off-line control as well as on-board autonomy.

There is nothing routine about deep space endeavours and these daring missions demand that world-class ambition is matched with the required technological developments.