IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (2)

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KEYNOTE: MISSION AND SPACECRAFT DESIGN CHALLENGES OF THE SUN-EARTH L5 POINT LAGRANGE SPACE WEATHER MONITORING MISSION

Abstract

As part of its Space Situational Awareness Programme (SSA), ESA has initiated a study to define an operational system to monitor, predict and disseminate space weather information. The system will reliably generate alerts to a wide user community in sectors like space-based communications, human spaceflight, broadcasting, and many others.

A key asset of ESA's operational space weather service will be a space-based observatory, to be placed at the Sun-Earth L5 point. This location allows observing the Sun and Earth with a fixed geometry, significantly improving the quality of the service by providing a unique vantage point. To investigate the feasibility of implementing this space segment, ESA has initiated the "Lagrange Mission" study in scope of its SSA programme. The spacecraft will cary both remote sensing, as well as in-situ instruments.

Based on the ongoing Phase B1 study, this paper will present an in-depth discussion of the mission and spacecraft design challenges of the Lagrange mission. A distinguishing feature of this mission is that it will be the first ever deep-space mission providing an operational service. This means that it has to fulfil stringent availability and latency requirements, while being located at L5 at 1 AU distance from the Earth. The resulting implications on the spacecraft design and autonomy will be highlighted in this paper.

Another unique mission requirement is to maintain operational capabilities even in extreme radiation environments that can occur during severe space weather events, e.g. when the spacecraft encounters a coronal mass ejection from the Sun. The spacecraft shall remain operational even in case it encounters a space weather event of a magnitude that statistically only occurs once every 1:1000 years. Under such conditions, most spacecraft would enter safe mode or possibly even fail. The ramifications of the required radiation tolerance will be discussed in this paper.

Apart from being an operational mission, the two primary drivers are its destination, *i.e.* the observation point at L5, and the instrument suite. From a mission point of view, a narrow orbit about the

L5 point needs to be established by means of a suitable transfer and manoeuvre strategy. This fixed geometry has several implications on the spacecraft and its subsystems, which will be elaborated in this paper. Particular challenges derived from the instruments are to fulfil stringent magnetic cleanliness requirements, as well as accurate pointing requirements. These will be discussed in the paper as well.