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Cross-Scale Technology Reference Study

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Technology Reference Studies (TRS) have been introduced in the ESA Science Directorate to focus the development of strategically important technologies that are of likely relevance to potential future science missions. This is accomplished through the study of several technologically demanding and scientifically meaningful mission concepts. The TRSs are selected to cover a wide range of different scientific topics ranging from astrophysics, fundamental physics to solar system exploration, with an even wider range of strategic important technologies.

The Cross-Scale Technology Reference Study (CS TRS) is a mission concept study for the investigation of fundamental space plasma processes that involve dynamical non-linear coupling across multiple length scales. In order to achieve this, a constellation of spacecraft is required, flying in formation around the Earth sampling three characteristic plasma scale distances simultaneously: electrons ($\sim$10 km), ions ($\sim$100-1,000 km), magnetospheric fluid ($\sim$3,000 – 15,000 km). The near-equatorial orbit with an apogee of 25 Earth radii crosses the bow-shock region, the magnetopause and visits the magnetotail each year.

The mission concept study is in progress, with the selection of the baseline mission architecture recently concluded. The key mission drivers that have been identified are the transfer and deployment strategy, the spacecraft and payload design philosophy, inter-spacecraft localization and synchronization as well as mission operations. The baseline solution is a single launch with a Soyuz-Fregat 2-1b by means of a dispenser-like transfer vehicle that brings 8 – 10 S/C to the operational orbit where they will be deployed. A common transfer allows mass and volume minimization of the spinning science satellite platforms and has a reduced mission operations complexity compared to individual transfer to the operational orbit. To maximize use of available Euro-

pean heritage, the structure of the transfer vehicle is based on an existing light-weight carbon-fibre reinforced plastic central tube used for the SpaceBus 4000. The propellant tanks for the transfer, which have the same SpaceBus heritage, are accommodated inside the central tube. As there is sufficient volume available for the tanks, the mass and number of science spacecraft can be traded against propellant mass (operational orbit) without impacting the overall design. For cost-efficiency, simple identical spinners have been baselined with a platform dry mass of $\sim$100 kg, which can accommodate 20 – 40 kg of plasma instruments. To allow flexibility in payload instrumentation, the spacecraft have a number of standard slots and interfaces that can accommodate several different categories of payload instruments. The key technology requirements identified so far are an inter-spacecraft localization/synchronization system and a European low-resource X-band transponder and amplifier.