Development of a Standardised Power Module for Thermal Control Software Packages

Optimising Power Efficiency from a Thermal Point of View

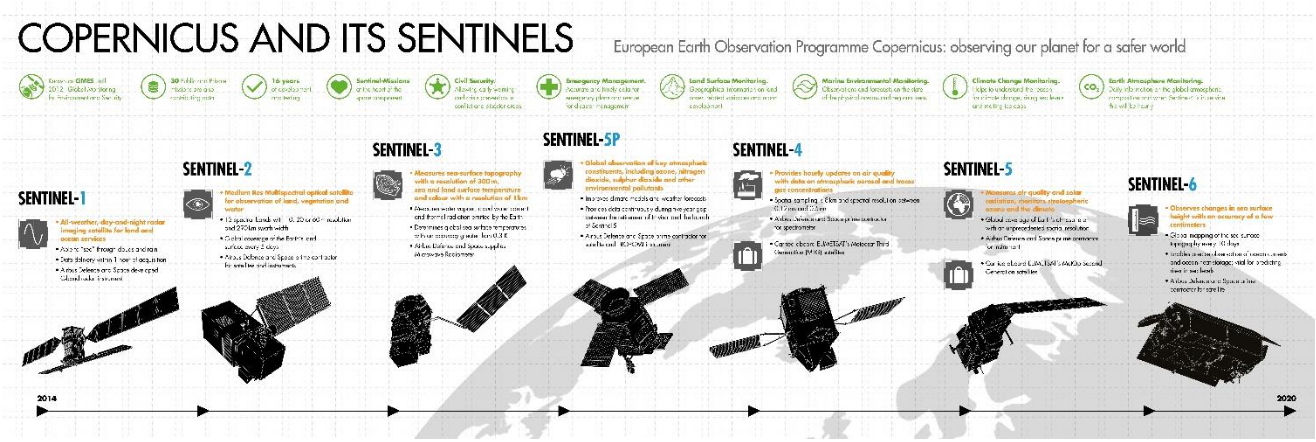

Figure illustrates various satellite configurations using the example of the Copernicus Sentinels, which have different requirements for their electrical power system.

Introduction:

In spacecraft design, thermal analysis plays a crucial role in ensuring optimal performance and mission success. Spacecrafts, instruments and other payloads are operating in a harsh environment with extreme temperatures, fluctuations, and under vacuum conditions. Accurately predicting their thermal behaviour is essential for managing heat dissipation, power efficiency, and structural integrity.

Power generation by usage of solar arrays and battery charging/discharging processes are directly related to the thermal behaviour of the electrical power system as well as on the thermal control of the spacecraft as whole.

This thesis aims to conduct a comprehensive analysis of thermal behaviour based on implemented electrical power systems in spacecraft thermal analysis. Focusing on the optimisation of charging/discharging effects, degradation, varying bus voltages, orbit effects (e.g., sunlit or eclipse phases) and different spacecraft modes will enhance the thermal analysis quality and thus contribute to the overall mission success.

Tasks/Methodology:

The thesis methodology will/can involve the following key phases:

1) Review:
    - Review existing spacecraft thermal control systems, electrical power generation methods, and thermal-power system integrations. Study relevant mission designs, spacecraft materials and current challenges.

2) Thermal System Modelling:
    - Use thermal simulation software (e.g., ESATAN TMS, SYSTEMA and/or Thermal Desktop) to develop models of spacecraft thermal systems and integrate electrical power system models. This will include the consideration of solar irradiance variations, spacecraft orientation, and power consumption profiles.

3) Power System Simulation:
    - Analyse spacecraft electrical power systems (e.g., solar arrays, batteries) for performance under varying thermal conditions. Investigate the impact of temperature fluctuations on efficiency, lifetime, and charge/discharge cycles, partial solar array failure.

4) Optimisation of Thermal-Power Simulation:
    - Implement standardised power models/libraries/functions for solar arrays and batteries to ensure correct thermal behaviour on spacecraft level

The thermal analysis and design process always results in exciting tasks for students of the following disciplines, among others: **mechanical engineering, aerospace engineering, automation engineering or computer science**. Basic thermodynamic and engineering knowledge is helpful.

Framework:

The thesis/internship is planned for a six-month period, and shall be performed in the "Thermal Systems & Space Physics Germany" department of Airbus Defence and Space GmbH, Friedrichshafen, Germany.

The student is responsible for supervision and acceptance of his work by the university. Circulation of results of the work to other institutions than the university needs permission of Airbus Defence and Space GmbH.

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