TDE 2020 - Implementation of Attitude and Orbit Control Interface Commonalities

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New TDE to be issued in 2020

TDE proposal
STAT form

‘Implementation of Attitude and Orbit Control Interface Commonalities’

- **12 months** duration, **300keuros**
- Target for **ITT is Q1 of 2020**
- Proposed in collaboration of

  Bénédicte Girouart, AOCS & Pointing System Section in ESTEC.
  Michael Müller, Science Mission Support Section in ESOC.

- Objective: **To assess commonalities of on-board AOCS functions interfacing with ground segment algorithms and to prototype common versions**

- The study is a step towards consolidating commonality of some building blocks in the domain of AOCS functions with the **ultimate goal to establish corresponding ECSS standards applicable for ESA operated missions for these common functions**.

Motivation

- The current diversity in the implementation of the same AOCS functions strongly limits the re-use of ground implementations.

- It appears that some AOCS functions are re-designed for almost every mission whereas functional commonality would allow re-use

- Standardization of these common AOCS functions would allow **implementations to be re-used in the ground as well as the space segment**.
  → Gain in cost and Schedule in both segments

Note: these common functions would be a specific subset of the overall AOCS functions

Input: Draft Handbook for AOCS functionalities

- Functions that are planned to be covered are:
  - Guidance functions
  - Thruster modulators
  - Reaction wheel management
- Based on experience with the following missions:
  - Rosetta, Mars-Express & Venus Express
  - Smart-1
  - Gaia
  - Lisa-Pathfinder
  - Bepi-Colombo
  - Exo-Mars
  - Solar Orbiter
  - Juice
  - Plato

Envisaged Scope of an AOCS Function Standard

The scope covers:

- The used Parameters of the AOCS function
- Unambiguous definition of the AOCS function input/output/behavior
- Possible (and if possible unified) AOCS function implementation
- On-ground processing input and requirements
- Ground constraints (including acceptance criteria)

The scope does not cover:

- The numerical representation of parameters and order of parameters in TCs.
- Handling in case of an acceptance criteria is not met.

An Example explaining the Envisaged Scope:
Attitude Quaternion Guidance based Chebyshev Polynomials

- The parameters are

  t_{ini} , t_{fin}, t_{act}: a segment initial and final time and a segment activation time

  c_{ij}: i=0,…,3 and j = 0,…,N-1 with N the order of the approximation

- The function is evaluated such that $q_i(t) = \sum_{j=0}^{N-1} c_{ij} T_j(x)$ with $x = \frac{2t - t_{ini} - t_{fin}}{(t_{fin} - t_{ini})}$

- On-ground processing input/requirements:
  - an maximum off-pointing wrt. an ideal attitude profile (possibly dependent on mission phase).
  - at segment transitions an attitude discontinuity of twice the maximum off-pointing is allowed.
  - at segment transition a change in the quaternion sign may occur
- Acceptance Criteria: $t_{ini} < t_{fin}$ to be checked before the first use of a segment

  $t_{ini} \leq t \leq t_{fin}$ to be checked in every time step

Steps of the Study

This activity would encompass the following tasks:

1. review and, if required, iterate on the proposed AOCS functions standard
2. identification of missions that serve as reference for validation
3. analyze and validate whether the specific mission requirements can be fulfilled using the proposed standards.
4. based on identified non-compliances, an improved set of standards shall be proposed.

Summary

- An new TDE will be issued in 2020:

‘Implementation of Attitude and Orbit Control Interface Commonalities’

- The study serves as step towards establishing standards for some AOCS functions applicable to future ESA operated missions.

- ESA is presently compiling a draft-handbook proposing standards for selected functions.

- Regular information at SAVOIR meetings (contact in SAVOIR: B. Girouart).

- Any Feedback/Input/Recommendations welcome!!!
  Contact: Bénédicte Girouart or Michael Mueller