An ESA Project Perspective

By
D. Maeusli
EarthCARE Mission &
System Manager
EOP-PXM

GeSOR-ADCSS 2010
Noordwijk / NL

3. November 2010

INTRODUCTION

"The author"

1986-2001 Data Handling Engineer in the Technical Directorate (project support & standardisation)

2001-2007 GOCE DHS, TTC & GPS engineer

2007-today EarthCARE Mission & System Manager

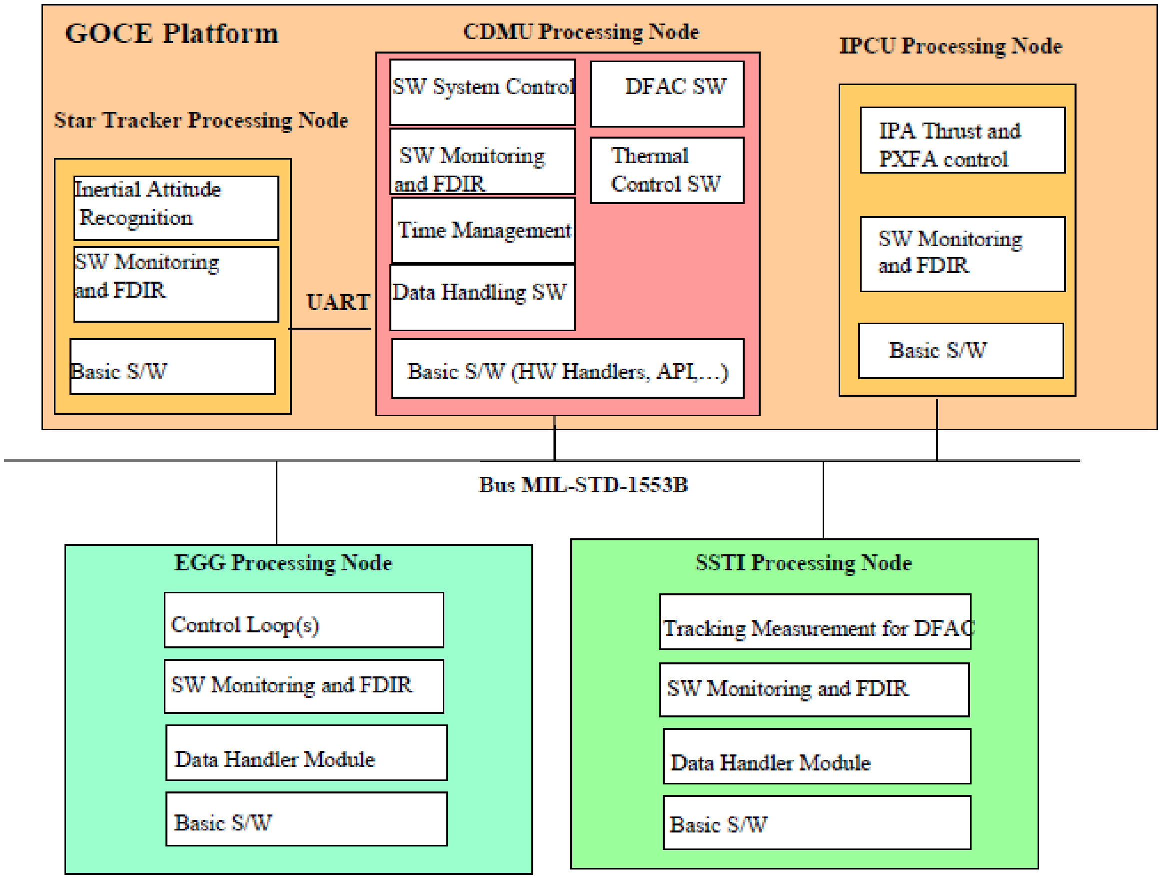
➔ ***Following slides reflect more a personal opinion rather than an official position from ESA programmes***

GOCE – DHS In Few Words

- **Basic DHS topology** built around an OBC / RTU and Mil-Bus 1553B
  - Low data rate (< 14kbps overall)
  - Standard autonomy (MTL, OBCPs, 1GS) & 8-day survival needs
- **2 intelligent payloads**
- Challenging requirements in terms of synchronisation and micro-vibrations
  - Extremely sensitive gradiometer
  - Very precise gradiometer geo-location determination (<200nsec)
  - Drag-free mode with payload in the AOCS Control Loop (resulting in a tricky ad-hoc data block transfer protocol on Mil-bus 1553B)
  - No duplication of TM packets (incl. re-dump for filling in initial gaps)
  - CPU load (mass memory dump)
- **CDMU** implements both OBC (ERC-32) and RTU functions in a same box

  ➔ ***cost benefit > mass saving***

GOCE – Processing

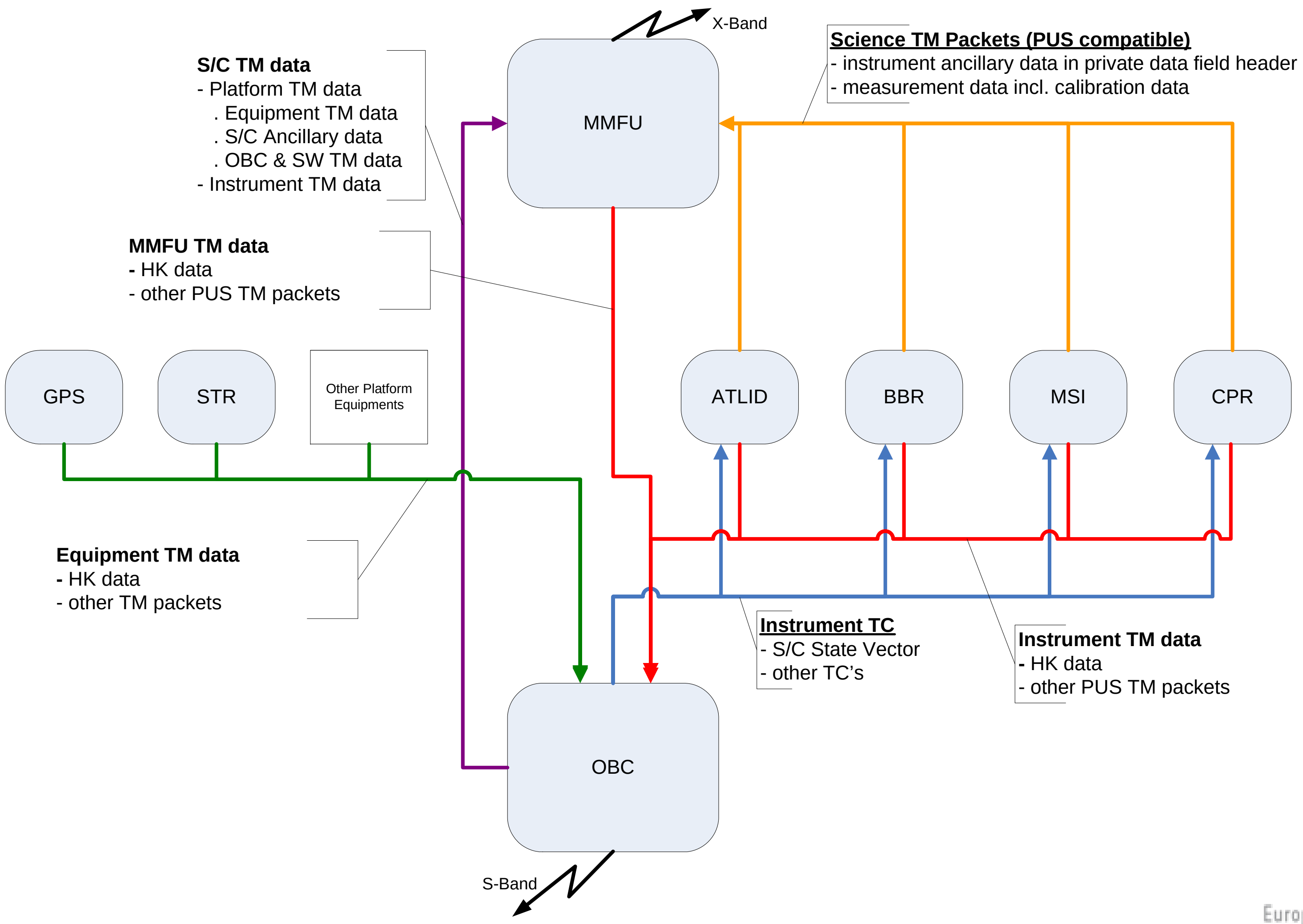


EarthCARE – DHS In Few Words

- **"Improved" basic DHS topology** built around the PCDU/OBC/RIU equipment set
  - Low data rates (12.5 kbps HKTM & 2 Mbps Science)
  - **Separate P/F and Payload 1553B Mil-busses** towards simplifying integration & testing
  - Standard autonomy (MTL & OPS, OBCPs) & survival requirements

- **4 intelligent instruments** towards simplified electrical and operational I/Fs
  - Instrument Control Unit & PUS (unloading OBC CPU)
    - Same ATLID/BBR/MSI ICU supplier
  - Point-to-point links from Instruments to MMFU (RS-422)

EarthCARE – Data Flows



EarthCARE – DHS In Few Words

- DHS-related issues (currently) requiring particular monitoring are:
  - Instrument I/F – P/F compatibility (JAXA CPR CFI) using the **Platform I/F Simulator Assembly (PISA)** EGSE for risk mitigation
  - OBC ERC-32 CPU load
  - DHS reconfiguration time during **Sun Escape Manoeuvre** & CPR antenna deployment
  - **MMFU operational concept** versus 60% NRT (<3-hour latency, via 1 GS)

EarthCARE – DHS In Few Words

- **Separate OBC / RIU implementation** has been preferred by EC Prime
  - standard OBC unit / building block for multi-programme application
  - early availability of OBC as S/W test bed
  - possibility of a later release of RIU specification and procurement

OBC & RTU - Modularity

- **RTU's have been precursors** for modularity via an early standardisation of the discrete I/Fs in the 70's thanks to the famous TTC-B-001 std, superseded by ECSS-E-ST-50-14C S/C Discrete I/F
  - Cost-effective solution are already in place at RTU suppliers via a modular design (I/O board/modules/groups)

- Similarly, **OBC suppliers** have also adopted cost-effective solutions by developing sets of standard boards (TC Decoder & RM, PM, TM Encoder)

- Recent examples are GOCE/Cryosat-1/2 CDMUs, EarthCARE/S2 OBCs and EarthCARE/S2 RIUs

Requirements & Traceability

- Two “schools” exist for generation of equipment specifications:
    1) **Unit specifications complemented by separate support specifications** (Electrical I/F, Mech., Thermal, Radiation,…)

       E.g. GOCE

       => thin unit specs with physical separation per engineering responsibilities

    2) **Self-standing unit specifications including all requirements** , i.e. unit specific functionality plus ‘generic’ requirements from a central requirement data base **E.g. EarthCARE**

       => stand-alone but bulky unit specs which implies the updates of many large documents in case of amendment of a common requirement

Requirements & Traceability

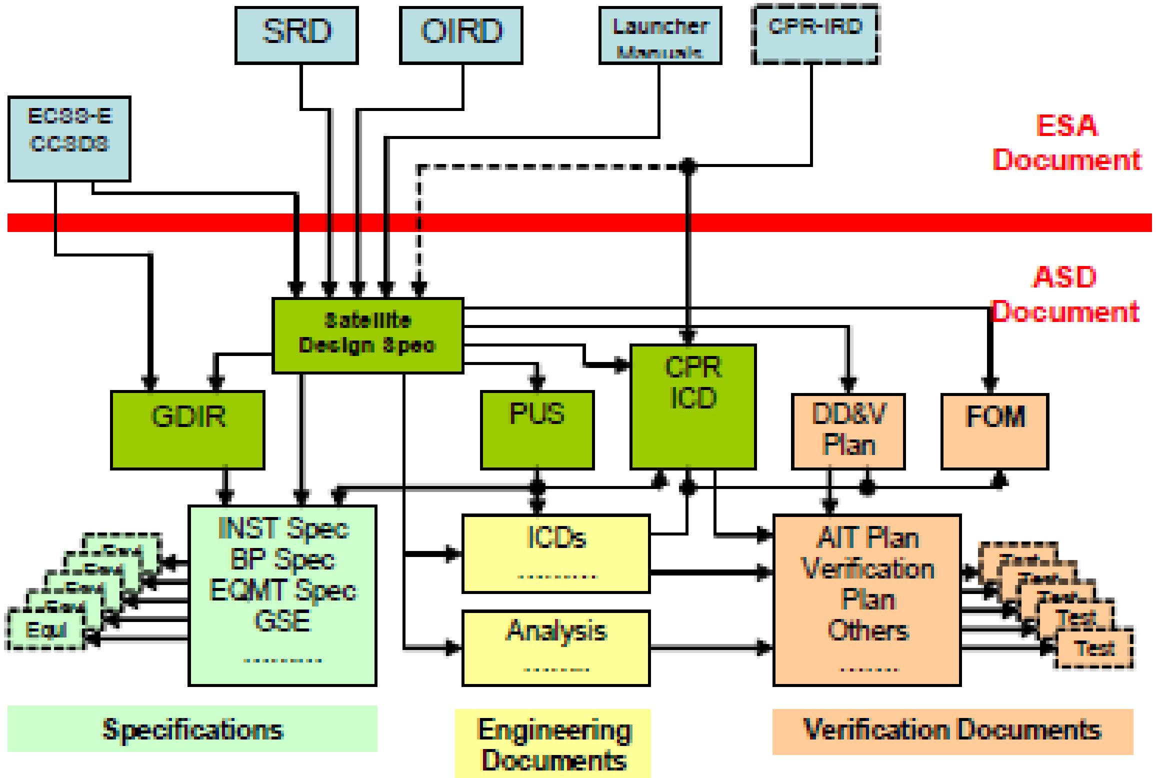


Figure 1.2-1: EarthCARE Top Level Document Hierarchy for Technical Requirements

Requirements & Traceability

- Achieving **effective generic specifications** for OBC and RTU will:
  - need to tackle the "problem" at the root, i.e. at the top and since the preparation of the **S/C SRD and ITT**
  - need of **tool(s)** in order to support a **"controlled tailoring"** of e.g. ECSS requirements.
  - OBC and RIU specifications however fall under the responsibility of the **S/C Prime**:
    - can only be achieved with S/C Prime concurrency.
    - generic OBC & RTU specs make only sense in case a reference DHS (sub-) system is endorsed/supported by Primes

Cautions versus ESA Best practices

➔ **Generic specification <-> standardization**

Potential DHS Improvements

- A number of recurrent weaknesses continue to exist:
  - **No tool(s) available to support the DHS development cycle**.
    - Only gross analyses are provided for DHS, compared to other subsystem analyses (e.g. mechanical, thermal)
    - availability of **simulation tools** and equipment simulation model libraries could have **major impacts on promotion of generic specification**.
  - No standard **block transfer protocol over Mil-bus 1553B** is widely enforced.
  - No harmonised **equipment operational approach** (TBC)
  - No **validation plans / test cases** (TBC).

Potential DHS Improvements

- Other remarks about DHS evolution:
  - Potential for use/deployment of **fieldbus / sensor bus** towards acquiring e.g. thermistor information (more for less mass)
  - **Projects are otherwise conservative on DHS side**
    - + Generic specifications
    - - SpW for both science data management and S/C control.

➔ **For sure, ALL Projects wants more performance, for less mass and power**

ERC-32 -> LEON processor

Summary

- GOCE and EarthCARE examples are based on **well-proven DHS topology** built around modular & recurrent design OBC and RTU equipment

- **(Cost-)effectiveness – and potential - of using recurrent design/commonalities** have already been shown despite e.g. the small space market, its low volume and the component obsolescence

  - **Procurement cost**
  - **Delivery time**
    > Time is money
    > Essential for OBC which is key element in **SW development & AIT programme**
  - **Build up on acquired experience**
    > Continuity, efficiency and quality

- **Generic specifications** would somewhat formalize this streamlined approach.
  - Tools are missing

EarthCARE