GUIDELINES FOR CCDB MAPPING TO GS FILES

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DISTRIBUTION

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1. INTRODUCTION

This TN describes guidelines based on lessons learned in the context of ESA Earth Observation Missions regarding the approach to :

- handle the so-called **CCDB** (Satellite/Space Segment) Calibration and Characterisation Data Base, logical split and format definitions.

- facilitate the management and exchange of this information between the Space Segment and the Ground Segment while maintaining a strict and separate configuration management.

CONCLUSION: It is recommended to define 2 physically separated and decoupled CCDB representations (with the same parameters):

a) one used within the **Space Segment activities** (the deliverables from Space Segment to Ground Segment)

b) the second being the set of AUX (Auxiliary) files ingested by the Data Processors and managed by the **Ground Segment** orchestration.

Note1: the GS data processor orchestration function uses as input-output and data repository only the **files** (generally XML, NetCDF) with standard naming and formatting and **not a databases management system** of parameters (like for example SQL, Oracle or MS Access).

Note2: the standard GS nomenclature distinguishes between calibration (CAL) and auxiliary (AUX) data: CAL refers to files obtained dynamically through a calibration process and automatically used, while AUX refers to files input to processors and used for anything else static or quasi static (instrument characteristics, alignment matrices, trends, drifts, etc) or externally generated (IERS bulletin, data from other missions). (See Fig. 1 below)

Note3: it is considered that online calibration files (CAL) produced during the mission data processing are not part of the CCDB although they can be post-processed into AUX data, which then becomes part of the CCDB. (See Fig. 1 below)

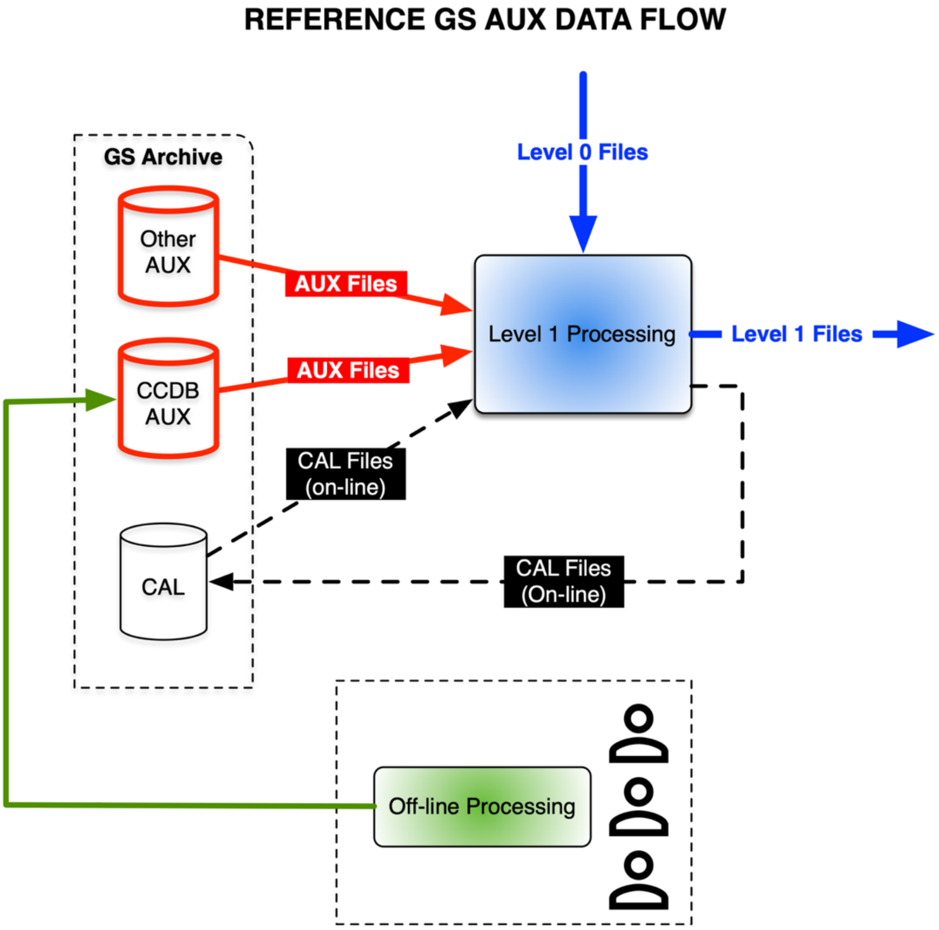

Fig. 1 Reference Data flow of AUX and CCDB related files

2. CONTENT AND STRUCTURE

The CCDB (also called Calibration Key Data (CKD) in some missions) used within the Space Segment activities can contain, mixed together and in a not distinguishable way (in standard GS sense), multiple versions of identical parameters e.g. design values, measured values, in-flight calibration values.

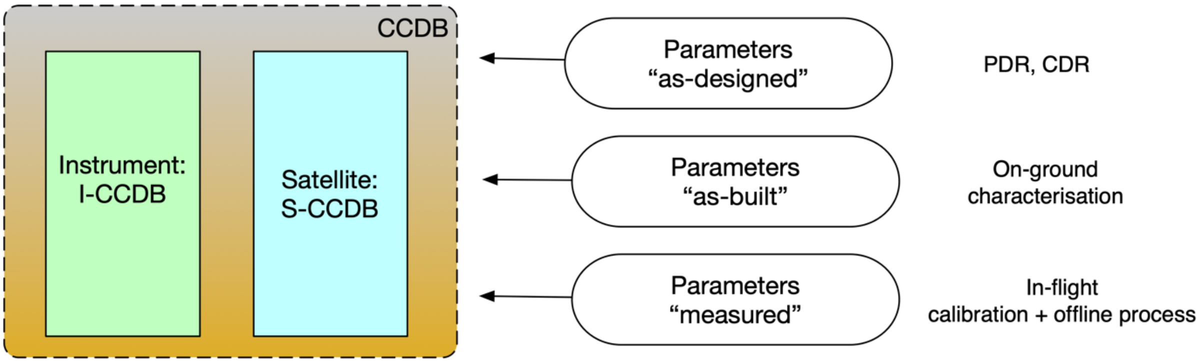

Fig. 2 Relation between CCDB and I-CCDB and S-CCDB and parameters

Although this might not be a problem for the Space Segment internal activities and specific tools, it is not adequate for E2E mission performance and Ground Segment development/activities since it does not match the structured, file-based, configuration-controlled system in which the ground data is organized and that is used by the orchestration and processors, furthermore it introduces a direct dependency between Space Segment and Ground Segment low level implementation.

The management of the CCDB as a single configuration management item is also problematic as even individual parameter changes result in the definition of a completely new versioned baseline for the whole parameter set.

A first step to address the problem above is to perform a **logical** and physical split with a defined structure, having in mind the various classes of parameters that are used differently:

1) parameters related/used for each specific algorithm/correction/processing step
2) design parameters (instrument-as-designed)
3) on-ground measured data/parameters (instrument as-built)
4) parameter timeliness (i.e., frequency of update, some data are static and other data can instead be frequently updated).

The two main criteria to perform the splitting and grouping are:

1) physically separate and in differently named AUX files in following categories:

a. instrument design/model parameter values,
b. instrument measured parameter values (from on-ground calibration)
c. fast changing parameters that are computed continuously during systematic processing
d. slow changing parameters derived infrequently from the mission data to update quasi-static data

2) split data per subsystem/algo

3. CHRONOLOGICAL ASPECTS

The CCDB used within the Space Segment activities is generally used as a generic historical repository of all the design and calibration data generated on-ground at different times in many cases even with the same name. This is not recommended since it creates ambiguity, duplication of data, cannot be used with standard GS orchestration selection rules and is not needed by the GS.

It is recommended that the CCDB is delivered to the GS containing only one copy of each calibration coefficient/parameter (either as designed or as ground calibrated) and not the historical archive of all the values coming from pre-launch activities performed by the Space Segment.
If there is the need at GS Processor level to use both (e.g. to allow for degraded processing to reverting to the *as-design* values) this is then managed in the Ground segment with definition of separate files of different type and therefore unique naming per time and data type must be ensured for any file containing these parameters.

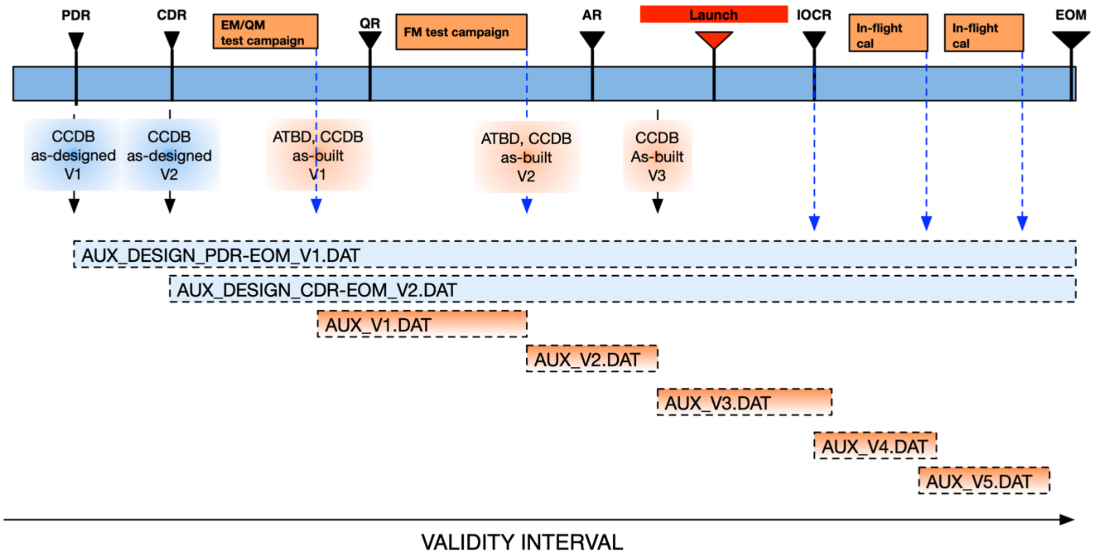

Fig. 3 Timeline of updates of AUX files containing CCDB parameters

The AUX files are used in the GS for data processing based on their validity interval in relation to the observation data to be processed. A definition of a validity based concept for AUX file contained in metadata and in the filename is mandatory for example:

```
FLX_OPER_AUX_DNGAIN_<yyyymmddThhmmss>_<yyyymmddThhmmss>_<yyyymmddThhmmss>__<ooooo>
```

Where the 2 red fields are validity start and stop (see also the EOP File Format Standard PE-TN-ESA-GS-0001).

4. EXAMPLES

Table 1. Example of parameter matching between Space Segment and Ground Segment.

A parameter X is a 3x3 matrix of coefficients. Its value can be measured on ground or computed by use of calibration after launch. It is expected its' value will regularly change.

Within the Space segment and CCDB the following parameters instances

XD1	Design value of X at PDR
XD2	Design value of X at CDR
XC1	The measured value on ground after the first characterisation
XC2	The measured value on-ground after the second characterisation
XC3	The value of X after third characterization measurements and specific statistical processing (which is defined pre-launch as "the best knowledge of this parameter)
XF1	The value that is derived in Flight using some specific mission data (observation or CAL) during **commissioning** at **time T0**
XF2	The value that is derived in Flight Phase E2 using mission data (observation or CAL) at **time T1**
XF3	The value that is derived in Flight Phase E2 using mission data (observation or CAL) at **time T2**

Within the GS the values and associated files would be

XD1	AUX file containing design values at PDR	AUX_X_DES_X_001
XD2	AUX file containing design values at CDR	AUX_X_DES_X_002
XC1	AUX file containing first set of result on-ground campaign.	AUX_X_GC_001
XC2	AUX file containing second set of result on-ground campaign.	AUX_X_GC_002
XC3	AUX file containing third set of result on-ground campaign.	AUX_X_GC_003
XF1	AUX file containing the value that is derived in Flight using some specific mission data (observation or CAL) during **commissioning** at **time T0**	AUX_X_OPER _T0
XF2	AUX file containing the value that is derived in Flight Phase E2 using mission data (observation or CAL) at **time T1**	AUX_X_OPER _T1
XF2	AUX file containing the value that is derived in Flight Phase E2 using mission data (observation or CAL) at **time T2**	AUX_X_OPER _T2

5. FORMATS

The CCDB used within the Space Segment activities can be (and generally is) physically formatted in a way that is not directly/easily usable in the GS software (Simulator, Processors, etc) without extensive rework and with ambiguities.
In the past ESA has received from the Space Segment CCDBs made as: excel sheet, CSV files, directory tree structure with semantic value containing parameters files, on-line database accessed via web, etc.

The best approach at system level is to **define and maintain a separate decoupled instantiation of the parameters from the CCDB as a set of AUX Ground Segment files** defined by Level 1 developer and GS engineers. These files will follow the GS format standards/naming and match the standard processor orchestration approach at Level 1. The development of a tool that automatically converts the CCDB format into the GS format is the best way to maintain physical decoupling and parameter alignment.

In addition, in the context of the E2E Mission Performance Simulators, it is desirable to keep the files/parameters required for Instrument Simulator Module (ISM) physically defined as different files (IDS-CCDB) from the one required by Level 1 Processor (GS-CCDB) to avoid cross use mistakes.

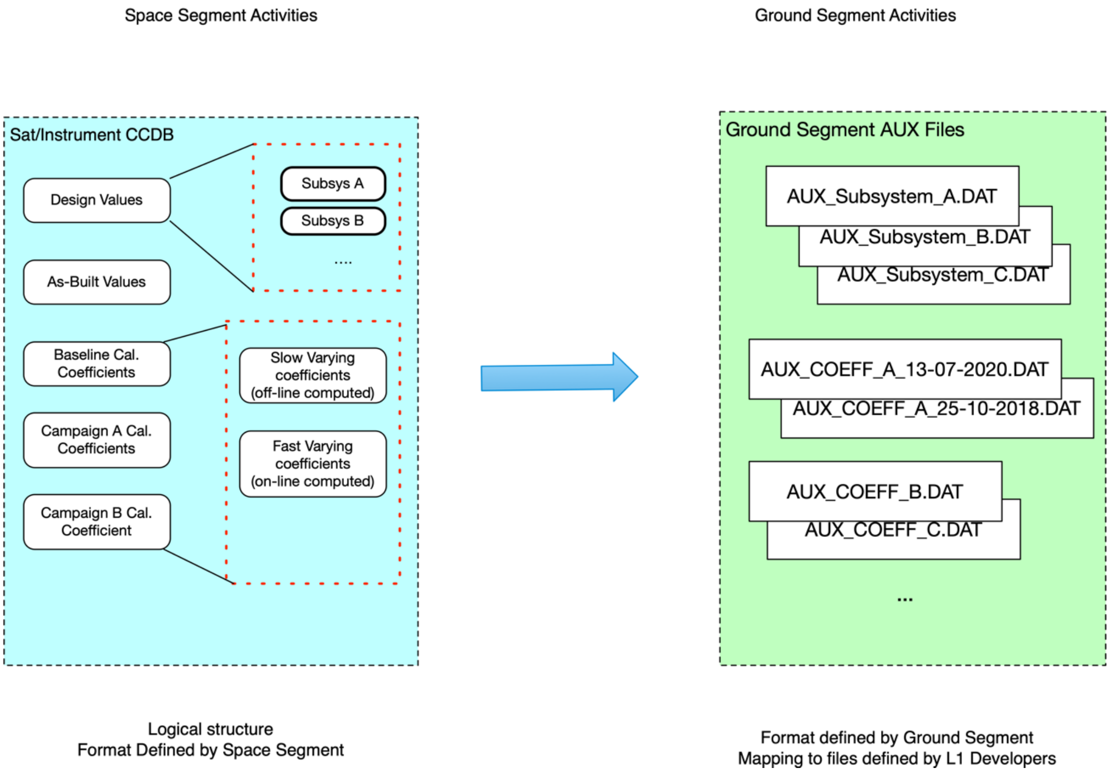
Space Segment Activities
Ground Segment Activities
Sat/Instrument CCDB
Design Values
As-Built Values
Baseline Cal. Coefficients
Campaign A Cal. Coefficients
Campaign B Cal. Coefficient
Subsys A
Subsys B
....
Slow Varying coefficients (off-line computed)
Fast Varying coefficients (on-line computed)
Ground Segment AUX Files
AUX_Subsystem_A.DAT
AUX_Subsystem_B.DAT
AUX_Subsystem_C.DAT
AUX_COEFF_A_13-07-2020.DAT
AUX_COEFF_A_25-10-2018.DAT
AUX_COEFF_B.DAT
AUX_COEFF_C.DAT
...
Logical structure
Format Defined by Space Segment
Format defined by Ground Segment
Mapping to files defined by L1 Developers

Fig. 4. Mapping from CCDB parameters to GS files

6. OTHER MISCELLANEA RECOMMENDATIONS:

Recommended to avoid in the E2ES (e.g. as input to ISM) a single config file containing thousands of parameters.

7. REQUIREMENTS

7.1. CCDB Representation and Separation

REQ-CCDB-001
The Contractor shall implement two physically separated representations of calibration and characterisation parameters:

- a **Space Segment CCDB** representation used for Space Segment activities, and
- a **Ground Segment representation** consisting of AUX files used by Ground Segment processors and orchestration.

REQ-CCDB-002
The Ground Segment representation shall consist exclusively of file-based AUX data products, and shall not require a database management system for operational use.

7.2. Parameter Classification and Structuring

REQ-CCDB-003
The Contractor shall logically classify calibration and characterisation parameters according to their nature, including at minimum:

- instrument design parameters (“as-designed”),
- on-ground measured parameters (“as-built”),
- in-flight calibration parameters,
- parameters derived during operations.

REQ-CCDB-004
Parameters shall be organised according to the algorithm, correction, or processing step that uses them.

REQ-CCDB-005
Parameters shall be grouped according to their update frequency, distinguishing at minimum:

- static parameters,
- slowly varying parameters,
- frequently updated parameters.

7.3. Physical Data Organisation

REQ-CCDB-006
Ground Segment parameters shall be physically separated into different AUX files according to parameter class, including at minimum:

- instrument design/model parameters,
- on-ground measured parameters,
- frequently changing parameters generated during systematic processing,
- slowly varying parameters derived from mission data.

REQ-CCDB-007
Ground Segment parameter files shall be organised by subsystem or algorithm to minimise cross-dependencies between processing components.

7.4. Chronological and Version Management

REQ-CCDB-008
The CCDB delivered to the Ground Segment shall contain only the current valid value of each parameter and shall not include the historical archive of parameter values.

REQ-CCDB-009
Historical values required for Ground Segment processing shall be handled through separate AUX files with explicit versioning and validity intervals.

REQ-CCDB-010
Each AUX file shall include metadata defining a validity time interval associated with the observation data to which it applies.

REQ-CCDB-011
The validity interval shall be encoded both:

- in the AUX file metadata, and
- in the AUX filename following Ground Segment file format standards.

7.5. File Naming and Identification

REQ-CCDB-012
All AUX files shall follow the Ground Segment file naming conventions defined in the EOP File Format Standard (PE-TN-ESA-GS-0001) tailoring applicable to the mission.

REQ-CCDB-013
The filename shall uniquely identify:

- parameter type,
- validity start time,
- validity stop time,
- version or instance identifier.

7.6. Format and Data Exchange

REQ-CCDB-014
The Contractor shall deliver Ground Segment parameter data in formats compatible with GS processors, such as XML or NetCDF files compliant with Ground Segment standards.

REQ-CCDB-015
The Contractor shall provide a conversion mechanism or tool capable of automatically mapping Space Segment CCDB data structures into the Ground Segment AUX file structure.

REQ-CCDB-016
The conversion mechanism shall ensure parameter consistency and alignment between the Space Segment CCDB and Ground Segment AUX files.

7.7. Separation Between Processing Environments

REQ-CCDB-017
Parameter files used by instrument simulation modules shall be maintained separately from those used by Ground Segment processing algorithms.

REQ-CCDB-018
The Contractor shall ensure that simulator parameter files and operational processor parameter files are stored and managed as distinct datasets to prevent accidental cross-use.

7.8. Configuration Management

REQ-CCDB-019
The configuration management of parameters shall be performed at file level rather than at the level of a monolithic CCDB dataset, allowing individual parameter sets to evolve independently.

REQ-CCDB-020
The Contractor shall avoid delivering parameter sets as a single configuration file containing a large number of parameters, unless explicitly justified.