The EUSO Science Operations and Data Centre

M. Catarina Espirito Santo, Jorge Gomes, Mário Pimenta (EUSO Collaboration)
LIP-Lisbon, Portugal

Abstract

The EUSO Science Operations and Data Centre (SODC) constitutes the EUSO scientific ground segment. The SODC ensures the scientific mission control and planning and addresses the issues of data collection, monitoring, distribution and archiving. EUSO will operate in different modes collecting several types of scientific data. The need to characterize the atmosphere may lead to important volumes of ancillary data. In the SODC, telemetry is received, processed and monitored. Mission activity planning is carried out and leads to the generation of command sequences for uplink, which are prepared and verified. Autonomous operations imply a particular care with ground based test and validation facilities for software and commands. The mission archive and user interface are maintained. The SODC lifecycle will accompany the mission lifecycle. The SODC should in all phases provide adequate support to the user community.

1. Introduction

The EUSO [1] Science Operations and Data Centre (SODC) constitute the EUSO scientific ground segment. The SODC ensures the scientific mission control and planning and addresses the issues of data collection, monitoring, distribution and archiving. Its objectives, lifecycle, functionalities and components are discussed below.

2. SODC Objectives and Lifecycle

The SODC lifecycle will accompany the mission lifecycle and can be generically divided into the following phases: definition, design, implementation, validation, commissioning, in-flight operations and post-operation. The SODC must in all phases provide adequate support to the user community. During the mission definition phase, the constraints, concepts and requirements are defined and the feasibility is assessed. The preliminary design, detailed design to the element level and implementation follow. The validation phase includes the technical verification and validation of each SODC element and the operational validation of the full system. The commissioning of the SODC, corresponding to the installation

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and first orbits of EUSO on board of the ISS, will precede the routine operations phase, when the scientific data will be acquired. During the operations execution phase, the SODC will receive telemetry data, generate EUSO specific commands, monitor the instrument health, functional status, performance and trend. The SODC will also be responsible for the scientific operations planning, on-board software (SW) maintenance and calibration of the EUSO instrument. Furthermore, it will establish the EUSO archive and provide the mission products to the users. The user community will evolve with the different phases of the mission: from the EUSO instrument teams and expert users in the beginning of the operations, to the whole EUSO collaboration during the mission operations phase, and to the scientific community at large one year after the end of operations. Mission archive and user support functionalities will have to be provided and maintained for several years in the post-operations phase. The design of the SODC depends critically on all the aspects that influence the types and the volumes of data.

3. Functionalities and Components

The basic SODC functionalities can be organised in three units:
Unit 1 - Telecommand (TC) generation, mission planning & system maintenance;
Unit 2 - Telemetry (TM) reception, processing and monitoring;
Unit 3 - Archive, database and user support.
Each units contains several functionalities, detailed below.

3.1. Unit 1 - TC generation, mission planning and system maintenance

This functional block of the SODC is sketched in figure 1. It contains three modules with different types of functions connected to the uplink part of ground operations: TC generation (TCG), mission activity planning (MAP) and test, validation and on-board and on-ground SW maintenance facility (TFV/SWM). The SODC performs different types of commanding actions upon the payload. All these actions correspond to more or less complex sets of telecommands. During routine operations all configuration parameters and operation procedures are completely defined on the on-board SW. In this case ground operations consist basically on the preparation of the mission schedules, on shorter (orbit by orbit) or longer term. This is handled by the MAP. In practice, and specially at the beginning of the operations, configurations changes will be needed. Those changes can be dictated by the operation conditions or by the instrument status. A configuration change corresponds to the update of specific configuration files. Finally, deeper interventions might be needed if SW modules need to be replaced. This is part of the SW maintenance commanding activities, handled by the TVF/SWM. In all cases, TC or TC sequences will have to be generated, verified and prepared for uplink. This is the basic role of the TCG.

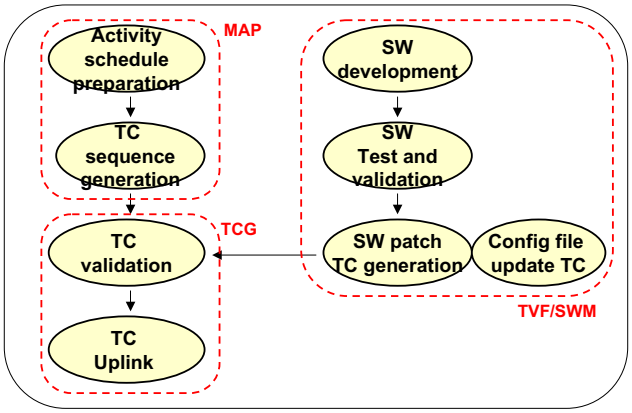

Fig. 1. The SODC TC generation,mission planning & system maintenance unit.

3.2. Unit 2 - TM reception, processing and monitoring

This functional block of the SODC is sketched in figure 2. It includes the functions mainly related to mission data handling, corresponding to two modules: TM handling (TMH) and data processing and monitoring (DPM). DPM involves data monitoring and data processing and calibration. Science and housekeeping telemetry are received from EUSO via the Columbus Control Centre. They are then pre-processed and streamed according to their type and to the instrument operation mode. Scientific data are pipeline-processed within the SODC. They are pre-selected, the raw signals are calibrated, pattern reconstruction algorithms and event calibration parameters are applied. They are finally validated, archived and distributed. More sophisticated analyses algorithms may then be applied by the EUSO analysis teams and users.

The monitoring of scientific data is performed at the raw data level and at different stages of the processing, using dedicated SW and graphic interfaces. This allows the monitoring of the instrument health, the control of the quality of the scientific data collected and of the pipeline processing procedures. The housekeeping parameters are downlinked and monitored in order to check the instrument health and status. Together with the monitoring of the scientific data, they allow to follow its evolution and the trend analysis of its performance. The log files from the on-board control activities are also received and checked. Monitoring activities have to be constantly performed by dedicated operators.

Calibration data might be an important share of the EUSO telemetry. In the SODC, preliminary values of the calibration parameters must be extracted from these data, used in the pipeline processing, and archived. Dedicated calibration teams will re-process these data in order to obtain the best possible scientific results. The updated calibration SW will then be used within the SODC, and the updated results stored in the mission archive. Atmospheric data processing

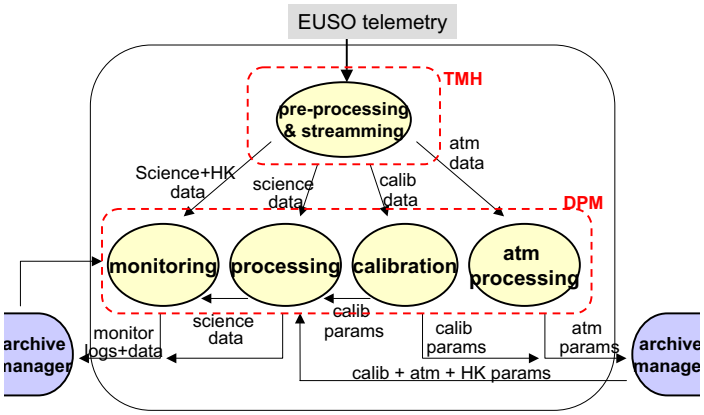

Fig. 2. The SODC TM reception, processing and monitoring unit.

should allow the extraction of the atmospheric parameters relevant for EUSO. More detailed analysis procedures may be carried out by the atmospheric science community.

3.3. Unit 3 - Mission archive and database maintenance

This functional block of the SODC includes mission archive and database management (MADB) and the interface to both external databases (EDBIF) and to the user community (UIF). The archiving system and in particular its user interface should take into account the different phases of the mission lifecycle and the different types of users, keeping in mind that all the relevant mission data will eventually be of public domain. Thus, both the archive contents and the interface design should be kept flexible, extensible and modular. The interface to the data archive should be on-line, user friendly and providing enough flexibility for the expert users. The EUSO scientific archive should include, organise and give access to different sets of information: scientific data, atmospheric data, calibration matrices and energy/position calibration files, analysis SW, quick-look analysis tools, monitoring logbooks, housekeeping parameters, instrument users manuals, and, in general all relevant documentation and SW tools. The existence of a backup site where significant parts of the SODC are kept for redundancy is also foreseen.

4. References

1. see in these Proceedings O. Catalano, et al., “The EUSO instrument” and M. Teshima et al. “Physics with EUSO”
2. see in these Proceedings M.C. Espirito Santo et al., “The EUSO SODC”