Engineering Data in the MBSE life-cycle

Joachim Fuchs
ESA

This presentation exposes the context of the data sharing problem – from the level of system engineering to monitoring and control data. The difference in scope between the system engineering dimension (primarily relevant in the system integrator context) vs. the problem of data interchange in a multi-tier setup (multiple stakeholders) and the resulting problem of semantic interoperability will be highlighted. On-going ESA activities will be put in this context.

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EGS-CC in the System Context

Jakob Livschitz
ESA

The European Ground Systems ¡V Common Core (EGS-CC) is a European initiative to develop a common infrastructure to support space systems monitoring and control in pre- and post-launch phases for all mission types. This will bring a number of benefits, such as the seamless transition from spacecraft Assembly, Integration and Testing (AIT) to mission operations, reduce cost and risk, support the modernisation of legacy systems and promote the exchange of ancillary implementations across organizations. The initiative is being undertaken as a collaboration of ESA, European National Agencies and European Prime Industry. In this paper we describe the main objectives of the EGS-CC initiative, the overall system concept and the features it will provide.

The prime objective of the EGS-CC is to provide a core system which can be adapted and extended for the Monitoring and Control of both EGSE and Mission Operations and enables synergies in the validation of software and operational aspects (spacecraft databases, procedures, etc.) throughout the complete project life-cycle. Achieving this objective is very ambitious and the main features of the system include:

- Support of all mission types and phases
- An open, component based, service oriented architecture
- Generic and extensible functionality
- Binary compatibility of components
- Layered implementation
- Clear separation between generic M&C functions (kernel) and specific features of the controlled system (adaptation layer)
- Configurable level of operations abstraction
- Standardised interfaces (as far as possible)
- Technology isolation (as far as possible)
- Long term maintainability
- High performance, scalability and reliability

The EGS-CC defines a Reference Architecture which addresses the system decomposition, internal and external interfaces. The architecture consists of a number of layers, the core of which includes a kernel providing the system backbone. The use of the kernel is mandatory and non-replaceable, but its

implementation can be extended by user developed adaptations. The Monitoring and Control (M&C) kernel is the functional heart of the EGS-CC and:

- • Provides capability to model the complete space system from a monitoring and control standpoint according to the principles of the space system model as defined in the ECSS-E-70-31
- • Encapsulates the main monitoring and control functions (e.g. parameter processor, activities handler, events processor)
- • Provides access to all data of M&C relevance (static and dynamic)
- • Acts as an abstraction layer for monitoring and control operations
- • Supports the provision of M&C services to external components
- • Interacts with the engineering data archive to store all generated data of operational relevance

In addition to the kernel, a Reference Implementation layer offers system periphery components, which are replaceable by user's own implementation depending on mission or organisation requirements and the end usage context (e.g. EGSE or Mission Operations). A Reference Test Facilities layer provides additional components used to validate the full system.

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Conceptual Modelling and ECSS
Serge Valera
ESA

In 2010 the ECSS has issued the new technical memorandum ECSS-E-TM-10-23A (Space System Data Repository), describing how semantic interoperability should be addressed in the future. This presentation will describe the current status of this Technical Memorandum, as well as a number of related standards in the E-70 branch, addressing ground segment and operations / monitoring and control issues.

On-going R&D activities to provide a solution to the E-10-23 global conceptual modelling will be presented.

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eCascade, Flexible, incremental, holistic PLM during concept phases
G. Chevalier
Airbus Operations SAS, Engineering, Architecture M&T

During A/C Concept Phases, Airbus needs to manage lots of evaluations of a lot of configurations. It is needed to trace theses evaluations & their respective configurations for the history of the choices done thru the concept phase. And still be flexible in the evolutions. The Holistic aspect is that the evaluation of the A/C need a lot of different views of the A/C and need contributions from different engineering expertise.

eCascade is an internal project where the basic principle is to create a virtual object that helps to decouple-but-still-keep-a-link of the different aspects of data management in these concept phases: Configuration, Formats, Data Structrure/PDMs, and analysis/calculations. The 3oundation of the methods and some illustrative results will be presented.

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A snapshot of systems engineering data management in the automotive industry

Achim Seibertz
Prostep

Systems Engineering is currently adopted in the automotive industry. The presentation will cover the history, status and current challenges. Besides the applied methods, tools and data management systems the collaboration between OEM and suppliers by means of standards will be discussed. The presentation shall trigger information exchange between the industries and identify fields for potential joint activities.

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Perspective on system database management at CNES

Marie-Claire Charmeau
CNES

At CNES, system data management is evolving from a situation where each mission had their own data model and data management tool to a situation where missions share the same conceptual data model, based on ECSS standards and defined in the context of the ISIS project, and generic data management tools with exchange formats used by all missions. This method may be extended to other data than monitoring and control data. A new modelling tool has been prototyped to explore applications at system engineering level.

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System Engineering Data Repository:
Return of Experience and Recommendation for the Future

A.Provost-Grellier, E.Chaix-Conte
Thales Alenia Space

Thales Alenia space has been the Prime contractor for many different missions and is under contract for several on-going programs and future projects.

The differences of practice in the exchanges of data results as well from system and operational requirements of the mission, industrial organizations constraints as habits acquired by the various partners and customers. Unfortunately this last driver, stressed by the re-use of existing systems can bypass the first ones and is also a source of specific practices and have potentials at all levels of the mission development : on-board software development, EGSE and validation, operations.

The first part of the presentation will describe the main characteristics of system engineering Data Repository for the missions in which Thales Alenia Space has been involved : this will cover Science,

Exploration, Earth observation and commercial both for GEO Telecom and LEO constellation projects. For the main missions with relevant experiences, a summary of the main obstacles on data exchange and interoperability and re-use will be provided (e.g data volume, existing formats, EGSE concepts, needs of flexibility, …).

The second part of the presentation will address the future development and the trends on system engineering data requirements as perceived by Thales Alenia Space (e.g XTCE, On Board Software Exchanges, …). Then suggestions and recommendations for the System Engineering Data Repository standardization will be proposed.

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Realizing the ideas of Space System Data Repository

Harald Eisenmann, Michel Janvier
Astrium Satellites

The trend of model-based engineering started in the 80s with mechanical CAD (M-CAD) tools. Enabled by the increased computation power and improved S/W technologies, nowadays highly sophisticated model-based solutions are available. Those solutions do cover most of the different engineering steps for all disciplines. Based on this, an continuous application of model-based solutions in the projects can be observed.

However those improvements did not yet reach the systems engineering processes. Although the idea of MBSE (model-based systems engineering) is around for years, an adoption and application of the ideas in the programs cannot be observed. The basic reason for that is, that there is no sufficient SE-CAD tools are available, providing the sufficient integration of engineering discipline models, to obtain the "system model" - the commonly shared model between the disciplines.

Over the past years considerable progress has been made allowing to overcome the situation, realizing solutions which do allow the application of MBSE. Those comprise e.g.:

- Definition of conceptual data models, which are to specify the scope of the system models
- Large scale validation of the application of conceptual data models e.g. in the frame of ESA Virtual Spacecraft Design
- Emerging systems modeling tools like SysML which cover a part of the MBSE problem
- Understanding of the co-existence of the PDM systems and a interdisciplinary system engineering database

This allows the beneficially application of space systems repositories in the programs. However, there is still work to be done, in order to further improve the technologies to be applied. But in order to secure the investments required, a very close coordination is required in order to synchronize operational applications, technology activities and standardization.