

MODELLING THE SPACE DOMAIN: DOMAIN ENGINEERING FOR AVIONICS/EMBEDDED SYSTEMS

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ABSTRACT

Nowadays, when defining a new space system, single items or sub-system components can be reused, though the system definition usually does not consider pre-defined domain architecture as the starting point, reusing its defined assets when required. Given that reuse trend is continually evolving, there is a clear need for specialised and detailed guidelines on how these requirements have to be interpreted and how the relevant measures have to be taken into account in the projects.

Therefore it is important to define requirements related to the reuse of assets within an organization and projects' processes and activities. In the new ISO 12207 [ISO/IEC12207], three new organizational processes related to reuse are defined: Reuse Program Management Process, Domain Engineering process and Asset Management Process.

The domain engineering process defines and maintains a domain with their respective assets, which are also developed and maintained in this process. Reuse is a broader concept that deals with both producing reusable assets (domain engineering) and exploiting reusable assets (application engineering).

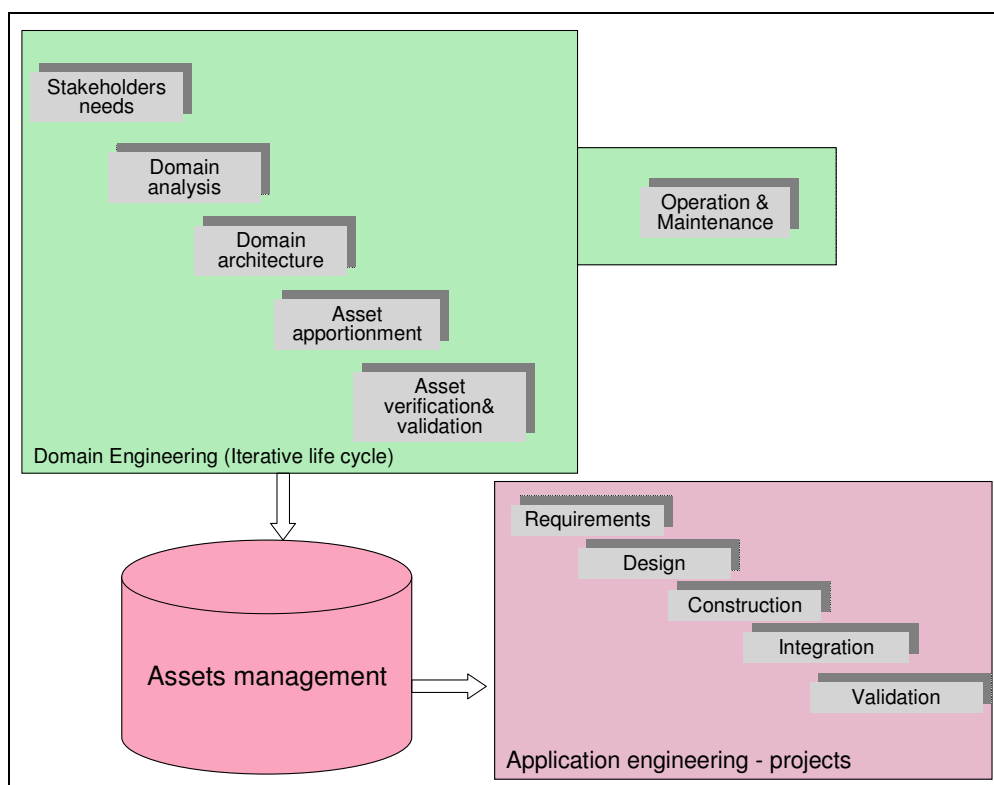
DOMENG project (Framework for DOMeng ENGINEERING, ESA Contract nr: 20001/06/NL/JD/jk) has aimed to use the Domain Engineering Process for the space domain (i.e., an 'space' domain engineering process) to establish the framework for the domain engineering for space systems. The ISO 12207, the ECSS Standards and the

IEEE Std. 1517 have constituted an adequate starting-point for establishing a framework for domain engineering in space.

Based on these standards the following tasks are identified:

- Process Implementation
- Stakeholder requirements gathering
- Domain Analysis
- Domain Design
- Domain Implementation
- Assets provision and Asset maintenance

In our view the Domain Engineering Process shown in next figure is a continuous process and the knowledge concerning the domain should be maintained and updated all the time according to new experience, new trends and feedbacks from application engineering processes.



Domain engineering and application engineering are complementary, interacting, parallel processes that comprise a model-based, reuse-oriented production system..

The first activities, belonging to the first overall Domain Engineering Process iteration, consist on Stakeholder requirements gathering (domain engineering plan, selection of methods and tools and gathering of information from stakeholders) to serve as input for the Avionics Embedded System domain analysis and design.

This paper will focus on the major outcomes of the Domain Analysis and Domain Design phases.

In Domain Analysis activity, GMV/SWC have analysed, abstracted, and modelled the characteristics of existing and envisioned software products within the Avionics Embedded System domain to determine what the products have in common (their commonality) and how they differ (their diversity).

Domain Design aims to produce the design specifications for the space domain architecture and space domain assets.

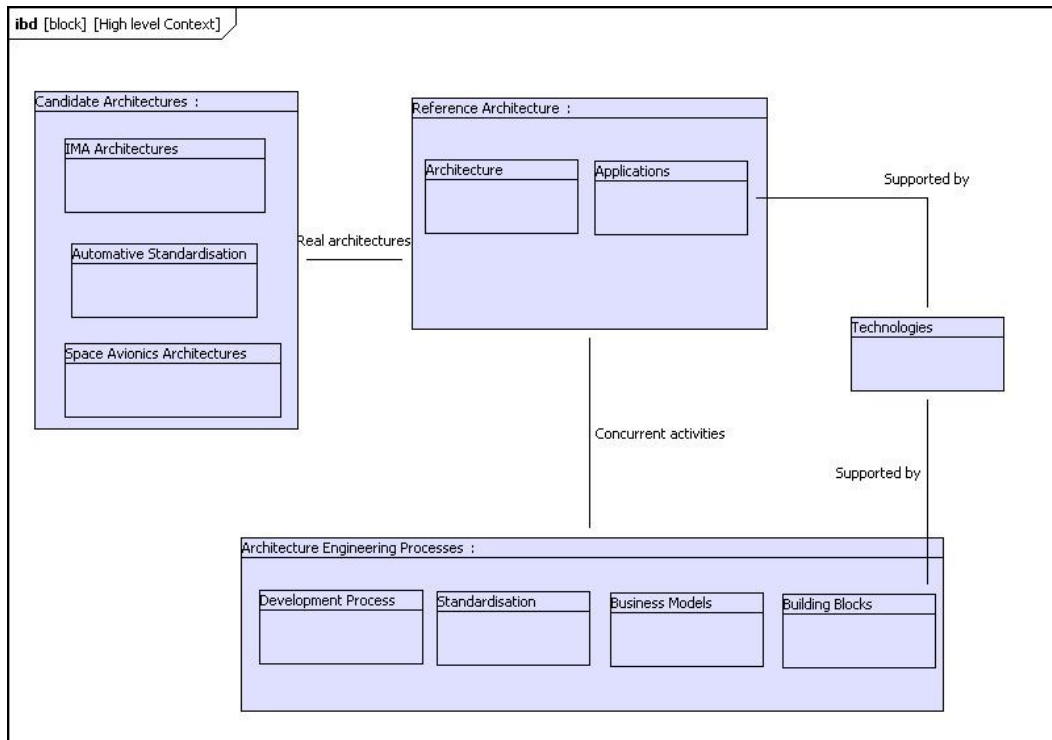
After having a first space domain architecture, existing reusable components will be gathered and their maintenance plan defined. A case study will be performed to validate the theoretical results of this project. A final workshop with stakeholders will be performed for a final validation of the results and a definition of the next steps.

In the DOMENG project, use case diagrams have been used to represent the capabilities of the domain and the relations of the stakeholders to the space domain engineering activities. Stakeholders are ESA, European National Space Agencies, Prime Industry, Avionics HW and SW suppliers, Universities and Academic Institutions, Technology Group and Steering Group. The activities to be performed by the stakeholders represent the high-level Functional Requirements:

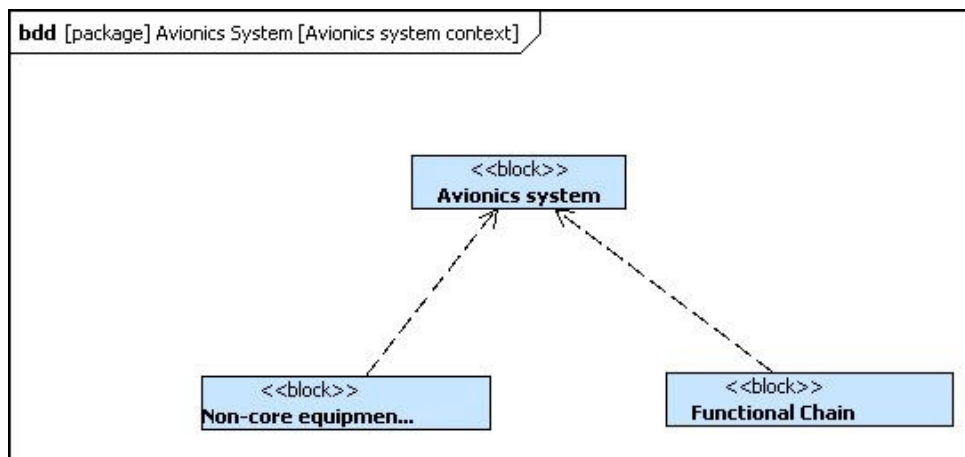
- HR-01 Create System Building Blocks (BB)
- HR-02 Create Avionics development process based on product lines, families, generic architectures and BB
- HR-03 Standardisation workflow (system-level architectures, BB definition and key technologies)
- HR-04 Acquire Technology and European independency
- HR-05 Implement Harmonization roadmaps and business models
- HR-06 Spin-in from non-space

The derived requirements are modelled with SysML requirements diagrams. The domain architecture will have to be traced to these requirements.

The Context Analysis establishes the bounds of the domain, the relationships with other domains (inputs and outputs) and the scope of the analysis. In DOMENG, the first step has been to describe the context for Domain Development within whole Avionics Development because there exist several entities participating in the space domain engineering process, that is Architecture, Applications, BB Definition, Standardisation, Technologies, Development Process and Business models.



Next in order to define the bounds of the Domain Analysis, the Avionics System is divided into Non-core Equipments and Avionics Core System. Avionics Core System is Avionics Embedded System and represents a Functional Chain: Thermal Control, Power Distribution, AOCS, DHMS, Communication Systems Payload Instruments Health Management System or Security System.



SysML block package diagrams are used to define a hierarchy for the identification of the SW Assets: Core Platform, the Mission-Independent part of the Functional chain and the Core Applications, the Mission-Dependent part composed of the Functional Applications specific to a particular S/C but which can be developed and executed independently of the underlying Core platform.