

MODEL BASED AVIONICS ESTABLISHES THE DIGITAL CONTINUITY BETWEEN SYSTEM AND HW/SW/CONTROL

ADCSS INQUIRY ABOUT MBSE OCTOBER 25TH 2022

Barthélémy ATTANASIO, Régis DE FERLUC, Brice DELLANDREA, Orion AZZIS

TABLE OF CONTENTS

1 Context

2 Q1- What is, in your own professional context, the specific benefits that we can expect from MBA?

3 Q2- What are the main obstacles which exist in your company to establish MBA?

4 Q3- What would you change in your company or in your customer/supplier relationship to enable MBA ?

5 Q4: We have seen presentations mainly related to the descending part of the V life cycle (requirements, design, implementation). How could we extend this part of MBA to (i) the rest of the life cycle and (ii) other disciplines?

CONTEXT

/// Model Based Avionics (MBA) establishes the digital continuity between system and HW/SW/Control

/ Model-based systems engineering (MBSE),

- **Wikipedia:** according to the International Council on Systems Engineering (INCOSE), is the formalized application of modelling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. MBSE is a technical approach to systems engineering that focuses on creating and exploiting domain models as the primary means of information exchange, rather than on document-based information exchange MBSE technical approaches are commonly applied to a wide range of industries with complex systems, such as aerospace, defense, rail, automotive, manufacturing, etc.
- **Frequent schematics:**
 - Operational/functional analysis
 - Exchange scenarios
 - Mode diagrams
 - System architecture/breakdown
 - Data/message structure
 - ...

/ Known tools:

-  Capella <https://www.eclipse.org/capella/>
-

Q1- WHAT IS, IN YOUR OWN PROFESSIONAL CONTEXT, THE SPECIFIC BENEFITS THAT WE CAN EXPECT FROM MBA?

(hints: automation, consistency verification, data flow verification, performance, resource usage, automatic generation of document/ICDs/configuration files, clear description of the avionics bus usage, clear software architecture, clear deployment view, requirement traceability, avionics validation, reuse, schedule, etc)

/// Answers:

- / Make the link between system need and avionics architecture. Then it enables to coordinates and manage implementation with several partners based on a common understanding.
- / Immediate benefits of Digital Continuity between Avionics Models and SW models is the increase of the productivity and the reduction of Non-Quality : Automatic generation of SW models and code saves a lot of manpower, and human error is prevented while correct by construction approach ensures that the implementation is aligned with the specification.
- / Documents are partially (export from the model for specification, design description or user manual purpose) or fully replaced (data model) by models, which simplifies the configuration and version management process. Traceability between Avionics models and SW artefacts is automatically created and maintained up-to-date by tooled transitions.

/// Notes/Remarks:

- / Avionics model may be dependent from the system model.
- / Transfer & Reuse of model is not an easy task

Q2- WHAT ARE THE MAIN OBSTACLES WHICH EXIST IN YOUR COMPANY TO ESTABLISH MBA? (1/2)

(hints: interoperability of tools, unclear process, lack of discipline synchronisation in schedule [means HW is early, SW is late, AOCS is in another time dimension <joking>],

/// Answers

- There is a Learning Curve for the acceptance of the tool. The engineers who have background in this space engineering field, does not necessarily see the advantage of having that. There are Early Adopters (<10%) in the same way than any innovation curve but it is hard to go to a common adoption.
- Modelling is sometimes seen by people as a nice to have, or as an optional activity that costs a lot and slows down the team work. When modelling activities are part of a “side-car” process, benefits are not there and it is rapidly abandoned.
- The natural solution is likely to be a kind of pedagogy, learning (general) and coaching (contextual) sessions. Not having a local and skilled team in charge of tool developments and day-to-day user support is also a frequent obstacle.
- It seems to be mandatory of an organization and set up which enable a shared Virtual Machine in which the model is shared and modifiable by anyone.

Q2- WHAT ARE THE MAIN OBSTACLES WHICH EXIST IN YOUR COMPANY TO ESTABLISH MBA? (2/2)

(hints: interoperability of tools, unclear process, lack of discipline synchronisation in schedule [means HW is early, SW is late, AOCS is in another time dimension <joking>],

/// Answers

MBSE is often perceived as an addendum to engineering tasks, and this is also due to Customer's DRL. If MBSE is to be produced on-top of usual documentation instead of replacing part of the DRL, MBSE will remain an extra work, i.e. extra cost, and will not be treated as a priority in programs in early phase, and it is harder afterwards to create a model late as support to IVV cycles. Initiatives are popping up for specific needs, but generalization of the process is stalled

/// Notes/Remarks:

- MBSE tools are not suitable for efficient brainstorming and trade-offing → prefer white board & snap shots
- MBSE do not provide efficient way to make easy reading, good looking, ergonomical figures → you need to train

Q3- WHAT WOULD YOU CHANGE IN YOUR COMPANY OR IN YOUR CUSTOMER/SUPPLIER RELATIONSHIP TO ENABLE MBA ?

(hints: organisation/merge hw and sw teams, process/define a MBA process, roles/define an avionics architect role, training)

/// Answers

- / Engineers would spend less time to write and review documents and would spend more time in the models. Sometimes documents are so long (could reach several hundreds of pages) than there are inconsistencies between the first pages and last pages.
- / Engineers from several departments would work on the same basis.
- / Definition of a MBA process in collaboration with system and HW/SW teams is the key of success. This process should come with a Modelling Plan (list of compatible tools, versions, and clear Modelling Guidelines).
- / Having a suitable infrastructure to exchange models instead of documents, and adapt reviews processes to include model review.

/// Notes/Remarks

- / Today even if models provide meaningful information, “paper like” documentation is the reference for contracts, reviews, specifications,... So documentation export capability is major requirement
- / Engineering Process and Tools responsible are already in the TAS organizations for the coordination of models, training and support in case of compatibility problems.

Q4: WE HAVE SEEN PRESENTATIONS MAINLY RELATED TO THE DESCENDING PART OF THE V LIFE CYCLE (REQUIREMENTS, DESIGN, IMPLEMENTATION). HOW COULD WE EXTEND THIS PART OF MBA TO (I) THE REST OF THE LIFE CYCLE AND (II) OTHER DISCIPLINES?

(hints: use Avionics and power models for simulation, executable systemC for tradeoff, Simulink for AOCS, OBC simulator , microchip emulator, and then flatsats, twins of equipments, contribution to spacecraft twin, Avionics validation; electrical design, PCB)

/// Answers

- / First, we are using tool for design and not necessarily for validation so this is normal that only the descending part is presented.
- / Models have started to be used for the ascending branch of the V cycle, what we call Model Based Validation
- / Models should also be used for consolidation of the Design (feasibility assessment, design exploration, design validation) either thanks to simulation (Ex: FDIR Simulator) or by model checking techniques (validation rules, ...).
- / It can also be useful for multi-disciplinary collaboration. For instance, using Capella viewpoints for FDIR, RAMS, Data Handling or AOCS purpose allows to keep all those activities aligned and coherent.

LOG OF CHANGES AND APPROVAL

Issue	Log of change - Description	Date
001		XX Jan 2020

Log of changes and approval
To suppress if this presentation is not a
configured document

Actors	Approval - Name and role	Date
Written by		XX Jan 2020
Verified by		
Approved by		