WE LOOK AFTER THE EARTH BEAT

Application of MBSE to avionics and software development: achievements and future goals

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Outline

- Introduction
  - Industrial context
- Arcadia and Capella
- MBSE strategy in TAS
- Application of MBSE at system, avionics, software level
  - What is already working
  - What is under development
  - Future work
- Conclusions

Introduction

- Model-based system and software engineering
  - A very long story with a way full of pitfalls
  - A process which is factually deployed through a set of bottom-up approaches
  - A major change of process with no simple demonstration of the effective return of investment
  - A process which must be supported by a convenient toolset: not easy to get consensus (cf SAVOIR REX)

→ Overall many initiatives and prototypes but how to adopt it embedded in our programs?

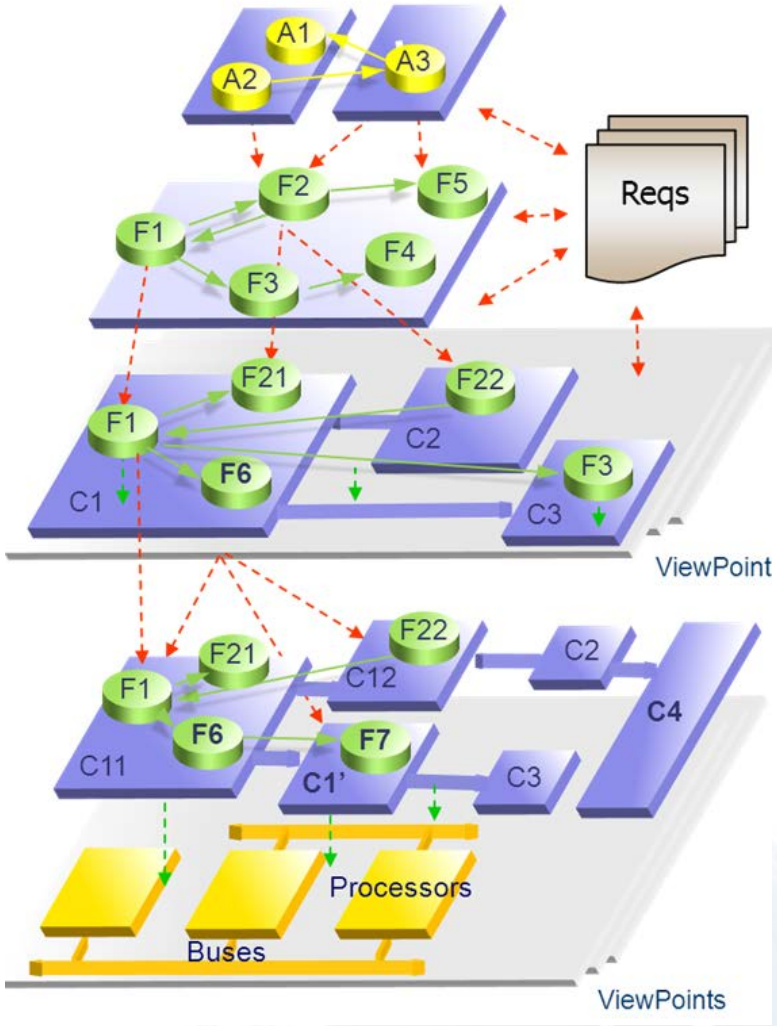
- A long story also in TAS-F
  - More than 7 years of modelling in operational projects mainly for OBSW
  - Some benefits already acknowledged but there is a need to increase the scope and relationship with additional domains
  - An innovative process to be adopted in a rapidly changing domain context

Industrial context

- Internal practices are evolving rapidly
  - Co-engineering practices
    - Promote team work
    - involving all stakeholders
    - Extend CDF approach to C/D phases
  - Deployment of Lean Engineering and Agile methodologies
  - Voice of the customer / user-centric approach
  - Visual management/ know-how management
- MBSE deployment at every level
  - Covering Process / methods / tools
- Deployment of homogeneous Engineering Environments
  - In terms of technological stack and base methodology

ARCADIA and Capella

- Open method and open source tool originally developed by Thales
- Focus on operational analysis, functional analysis and architecture
- Why do we adopted Capella?
  - Both a method (Arcadia) and a tool (Capella)
  - Adapted for complex system design
  - Inspired by best practices and experience of domain engineers
  - Inspired by SysML (with improvements)
  - Easily extensible
  - Open source, with powerful ecosystem
- Give it a try ! Go to polarsys.org/capella



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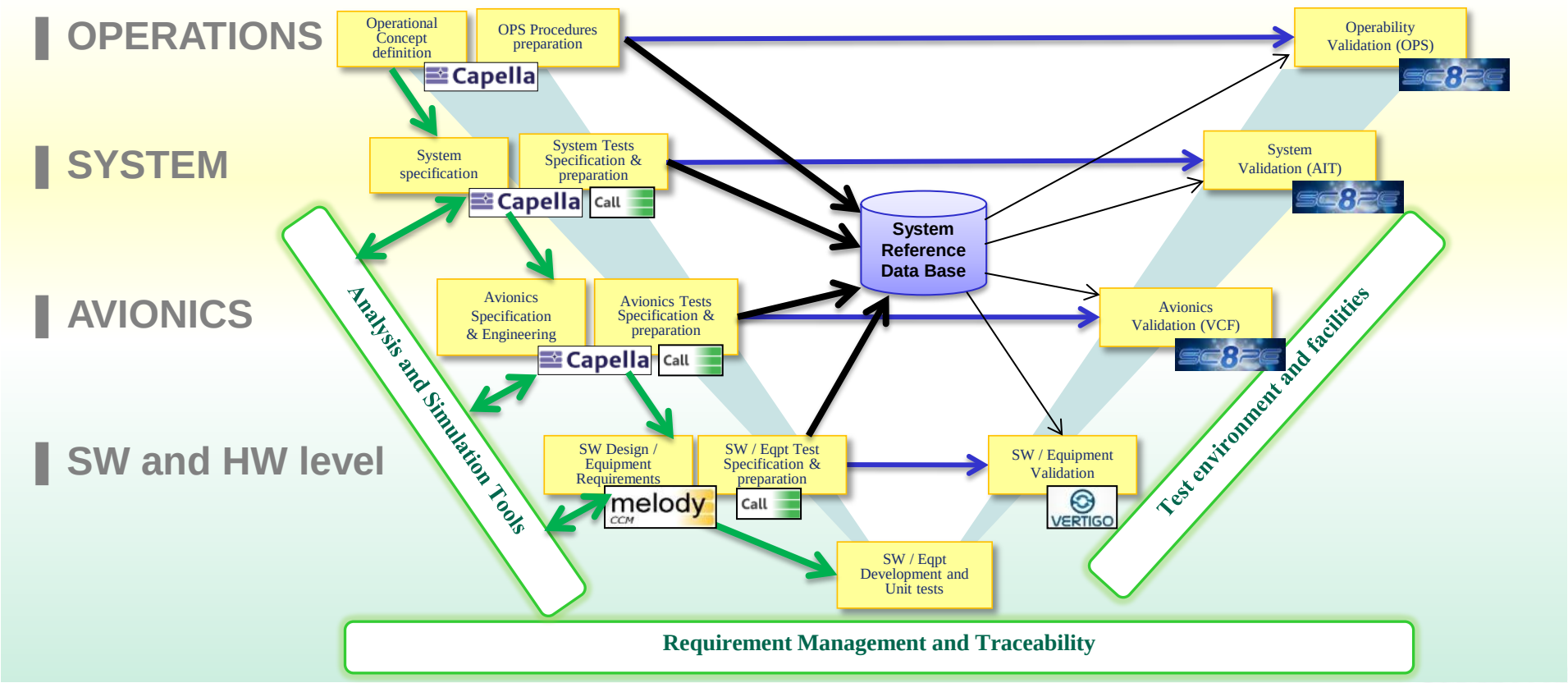
MBSE stategy in Thales Alenia Space – Our vision



Model Based Design engineering process accross different abstraction levels.

Model based data management process accross different abstraction levels.

Model Based V&V engineering process accross different abstraction levels.

Capella is the backbone of the System/Software Factory !

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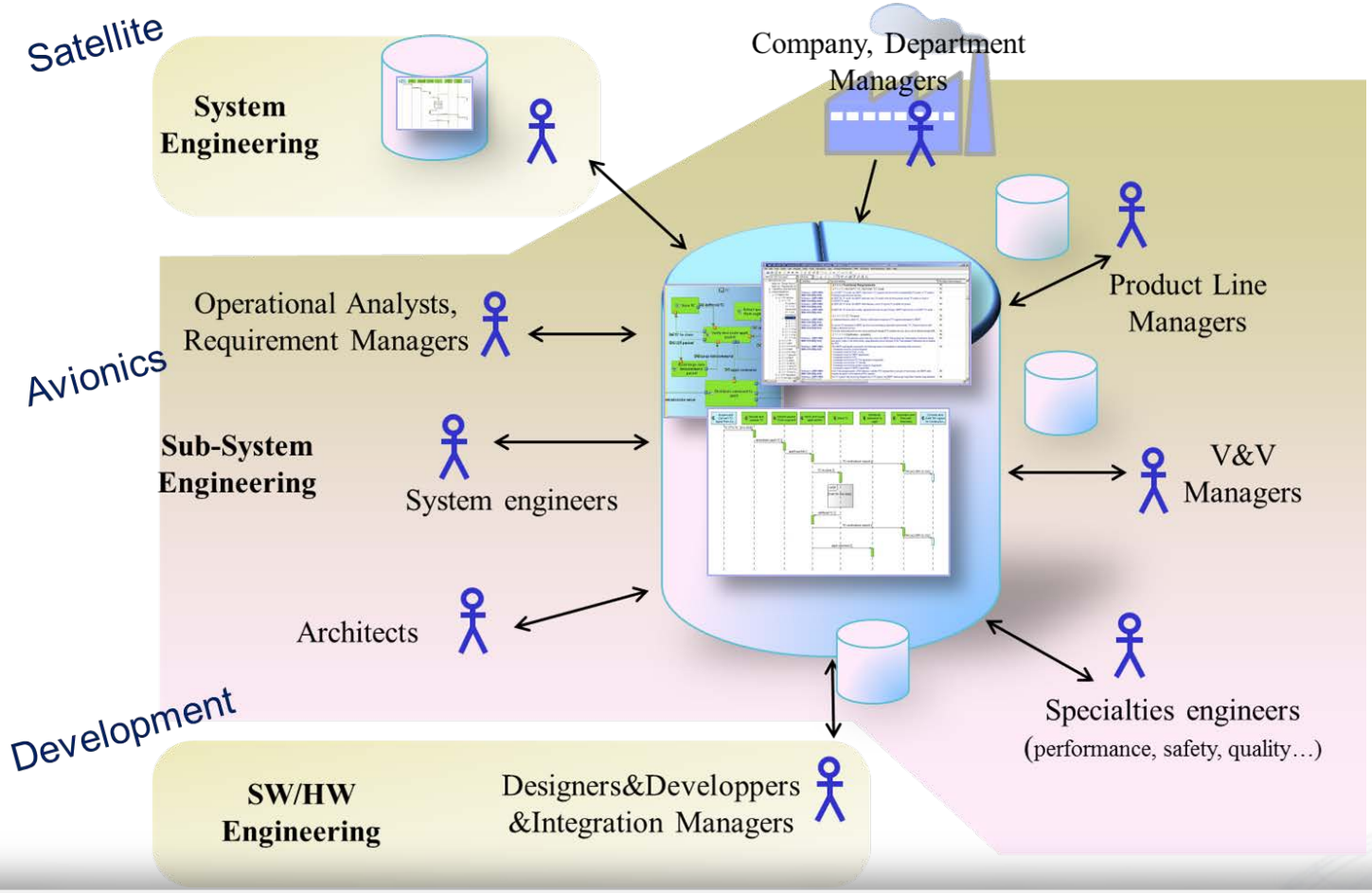
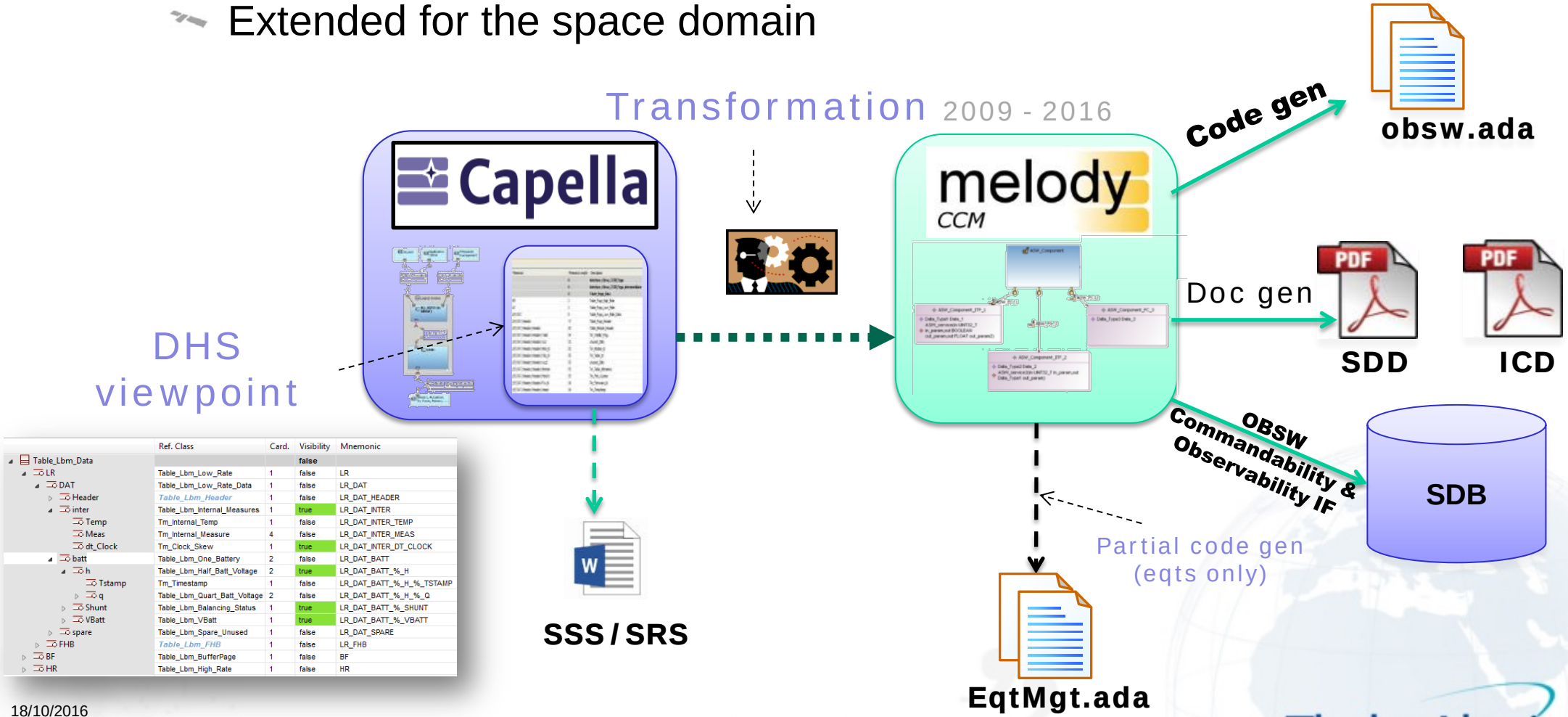
Focus on avionics



MBSE to improve co-engineering & transition between 3 engineering levels
=> Reduce development costs & risks

From avionics models to SW models: automated transformation

- From avionics models to SW Models
  - Automated transformation by Thales
  - Extended for the space domain



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What is it already working for us? Some examples…

- Design of ground/board interface
  - Operational scenarios co-engineering (ground, sat system, avionics, equipments)
  - Definitions of the functional exchanges supporting these scenarios
  - Support for ground/board allocation trade-offs
  - Production of ground/board IRD
- Transformation between avionics models and software models
  - Automated transformation from Capella to software component model (CCM ≈ OSRA Component Model)
- Production from a single avionics model of
  - Software SSS
  - Simulation SSS
  - On-board communication protocol IRD (i.e., 1553)

What is currently under development? Some examples…

- Model-based validation for OBSW
  - Definition of test sequences at component-model level
  - Automated derivation of executable test scripts from the model
- Support for product lines
  - Definition of a feature model for generic avionics
  - Link between feature model of the avionics and the Capella model

Strands of future work (I)

- FDIR
  - Introducing FDIR viewpoints for early analysis (leveraging on external dedicated tools such as COMPASS)
- Behavioural modelling
  - Analysing ways to express in a consistent and semantically adequate manner behaviour at different abstraction levels
  - Relationship with simulation tools
  - Relationship with EDS
- Code generation from sub-systems / avionics models
  - Cohabitation of code generated automatically from Matlab / Simulink and Software Architecture Models
  - Exploitation of information from equipment EDS and relationship with avionics models

Strands of future work (II)

- SDB workflow in an MBSE context
  - Relationships between models of various levels and SDB (EGS-CC CDM)
- End-to-end Test / procedure modelling
  - From tests of operational concepts models down to OBSW test models
    - Ensure coherence between levels
    - Adapt to the specificities of V&V objectives of each level (SW V&V / FCV / AIV / OPS)
- Early avionics analysis
  - Increase the perimeter of early analysis based on avionics models
    - i.e., continue the work inspired by the ESA AAML study
    - Creation of suitable viewpoints for specification and analysis
  - Combine several analysis to perform multi-criteria architectural tradeoffs

Strands of future work (III)

- Digital continuum from phase 0 to E
  - Continous models across phases
    - From early system definition phases to operations
  - Larger scope than avionics, covering all the engineering disciplines
    - Including mechanical, electrical, …
  - A system reference database as a central cross-discipline repository
  - Concepts becoming feasible thanks to emerging of new technologies (e.g., big data, big analytics)

Conclusions

- A sound and consolidated heritage of Model-based practices for OBSW
- Major change from last years: transition from localised experimental applications of MBSE at system and avionics, to consistent and operational application
  - Focus from « feasibility evaluation » to continuous improvement of the process
  - Benefits earned from local application expected to have increased payoff with consistent end-to-end application
  - The foundations are solid, we are building on them!
- Capella / Arcadia is the backbone of the approach for avionics- and system-level application
  - An interesting candidate methodology and tool to federate efforts of the community
    - A number of R&D studies and case studies on-going with agencies and industrial stakeholders
- A roadmap that is becoming clear and with promising potential results
  - Consistent use of EDS and models, model-based FDIR, multi-criteria analysis, EGS-CC