MBSE Demonstrator CDF study

Quirien Wijnands

29/09/2020

Outline

- Objectives
- Study plan
- Preliminary Results
- Conclusions

Objectives (1/4)

3 main objectives:

- To obtain an **IPR-free representative multi-disciplinary space system reference mission,**

- To apply **Model-Based System Engineering process,**

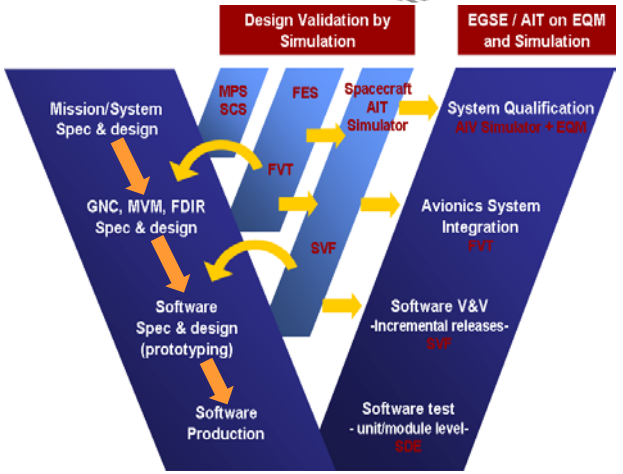
- To develop - and possibly integrate (3x) - the related **simulation models**, to build up simulators and test-facilities as input into the R&D activities.

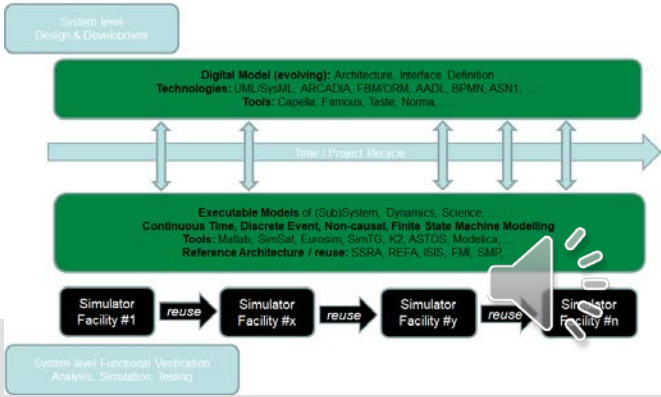
Note: *heritage models and lessons-learned from EagleEye Reference Mission, as used since 2005 in R&D (avionics–oriented and documentation-based)*

Modelling “Reminder”

For this CDF study (and this presentation) to distinguish between the:

- **Space system reference mission**, e.g. Mission Objectives, Mission and System specification and Design; *the “what”*,
- **MBSE models** for the space system reference mission; to capture and maintain the above mentioned information in tooling such as OCDT, Capella and/or Enterprise Architect, but also the domain-specific MBSE tooling (e.g. Catia),
- **Simulation models** for verification and validation of the space system reference mission; functional dynamic / behavioural models to be executed as part of simulators using tools like STK, Matlab/Simulink, EcosimPro, etc…





Objectives (2/4)

To obtain an **IPR-free representative multi-disciplinary space system reference mission**

- Definition of the SSRM mission to serve ESA future domain-specific R&D needs.
    - *This means that not only the "mission needs" are driving the design but also that the **"R&D needs" - coming from all interested domains** - must be considered in case they have an impact on the definition of the SSRM mission baseline.*
- *Could* be based on "definition and consolidation of the **EagleEye** mission baseline across non-avionics domains"

Objectives (3/4)

To apply **Model-Based System Engineering approach:**

- For the specification of the SSRM mission, systems and subsystems requirements.
- For the definition of the product tree and its implementation in OCDT (Phase 0)
- For the definition of an MBSE model in a Capella-like environment, to cover and support to later phases (Phase A/B1).
- For the development of MBSE models across the domains.
    - *Note that the **integration** of MBSE models and Simulation models is also part of the ongoing "Digital Engineering DataHub" activities.*

Objectives (4/4)

To develop - and possibly integrate - the corresponding **simulation models**

- **Identification**, **specification** and **implementation** of simulation models as needed to verify the “space system reference mission” baseline design in the CDF context. **This includes the alignment with the information as captured in the MBSE models**.

- **Identification** and **specification** of simulation models as needed to support the usage of the “space system reference mission” for future R&D activities in each domain.
    - This will serve as a starting point for work/efforts *after* the study.

- **Analysis** and **identification** of the simulation technologies and interfaces to “support continuous integration of simulation models” towards the concept of a **Digital Twin.**

Study Plan

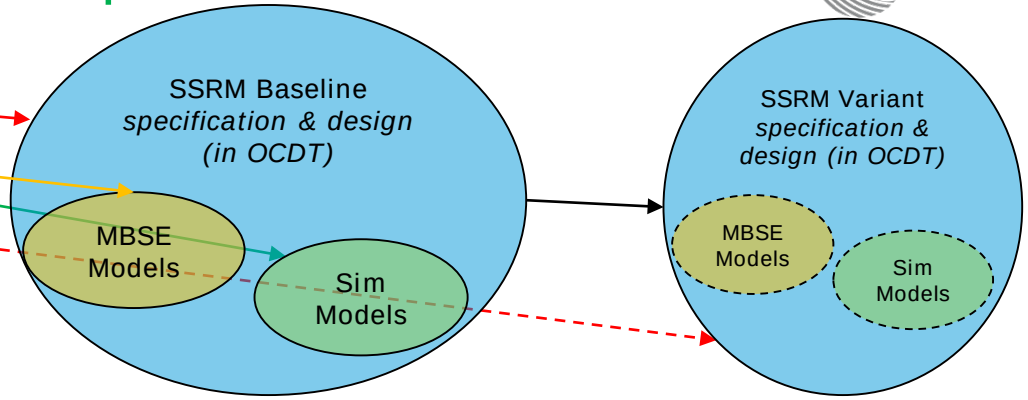
Session	Day	Date	Time	Objective
Session #1	Thursday	04/06/2020	09:30 – 13:30 CET	Kick Off
Offline				*Gathering of inputs*
Session #2	Thursday	11/06/2020	09:30 – 13:30 CET	Discussion on inputs
Session #3	Thursday	18/06/2020	09:30 – 13:30 CET	Discussion on inputs
Offline				*Preliminary definition of space system reference mission*
Session #4	Tuesday	07/07/2020	09:30 – 13:30 CET	Space system reference mission iteration
Session #5	Tuesday	01/09/2020	09:30 – 13:30 CET	Space system reference mission consolidation
Offline				*MBSE and Sim model work*
Session #6	Tuesday	06/10/2020	09:30 – 17:30 CET	MBSE and Sim model overview
IFP	Tuesday	12/11/2020	09:30 – 17:30 CET	Internal Final Presentation

Mission, System and “R&D” Specification

Part-1: Session #2 and #3 inputs:

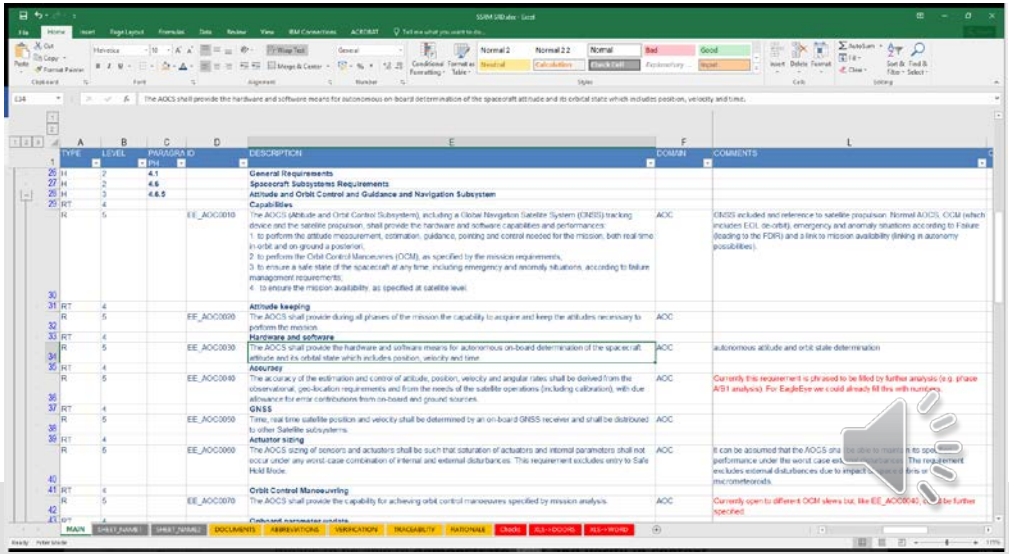
- RM requirements fitting a Baseline
- MBSE related requirements
- Sim Model related requirements
- RM requirements needing a variant
- *RM requirements **not** fitting*

(around 100 requirements)



Part-2: EagleEye Mission, System and Subsystem specifications

Part-3: EO Phase-A MRD and SRD as input in order to complete and further detail

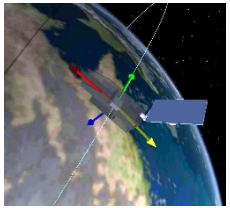


SSRM excell-based SRD model

SSRM Mission and System Design

1. "**Ocean Earth Watch**" Earth observation mission *(to speed up process)*

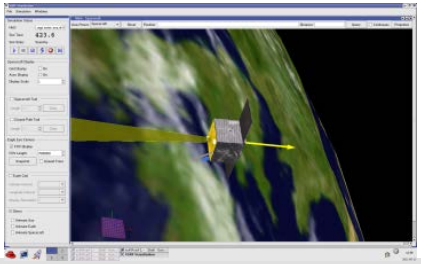
CDF study done in 2006, IDM, configuration and Final Report available

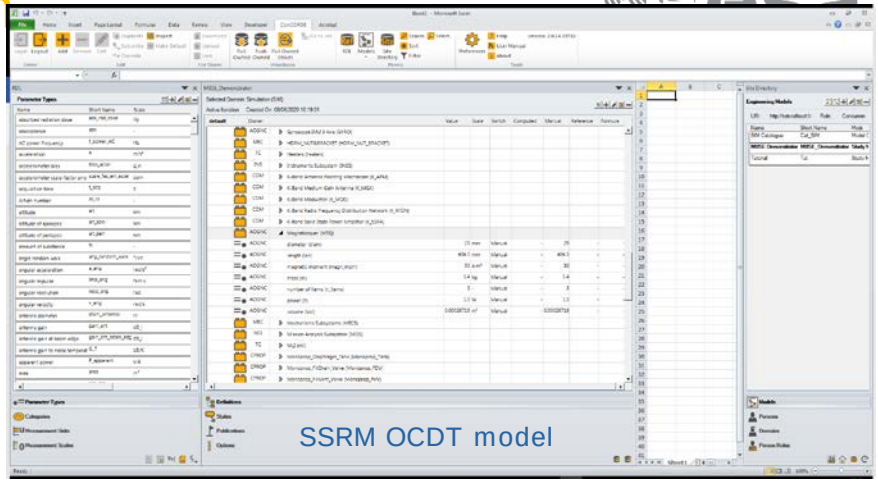


2. "**EagleEye**" Earth observation reference mission *(for availability of models)*

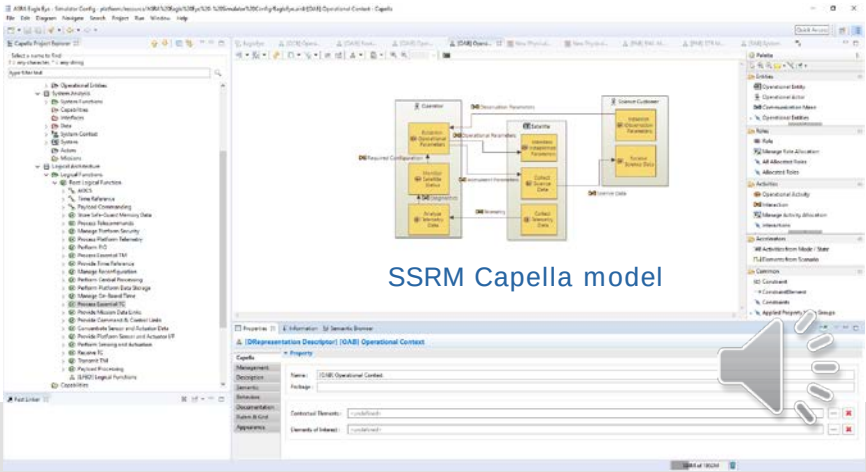
as captured in RAC Earth Observation Reference Mission requirements specification document.

as implemented by number of simulators and simulation models



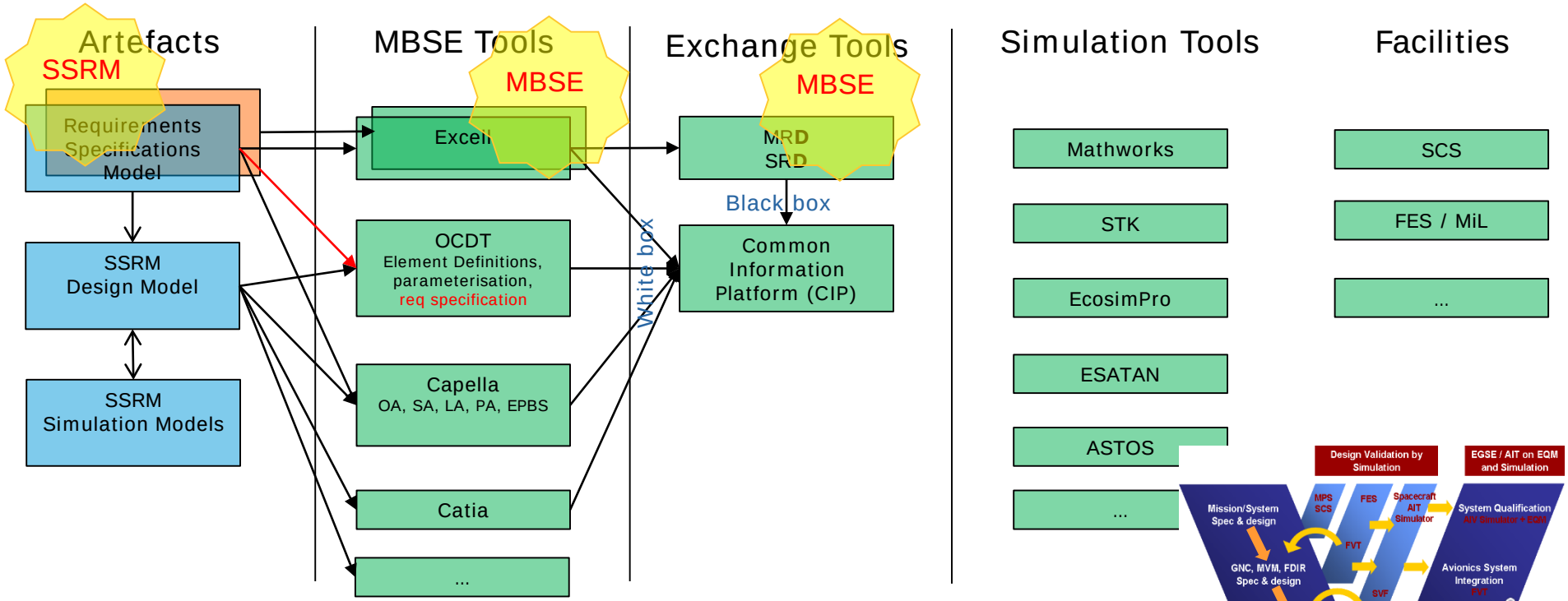


SSRM OCDT model

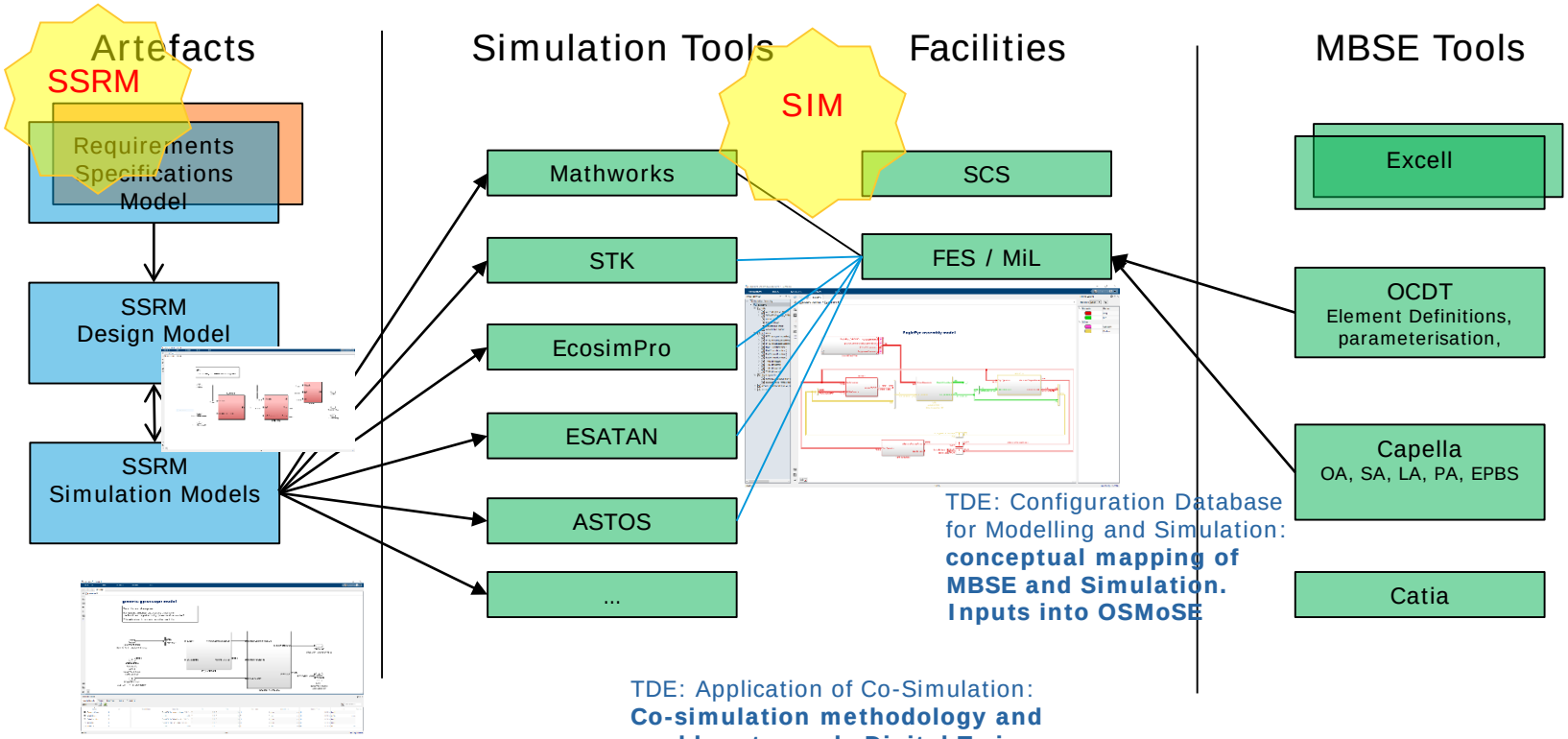


SSRM Capella model

Schematic: SSRM artefacts and MBSE tooling



Schematic: SSRM artefacts and Simulation tooling



TDE: Configuration Database for Modelling and Simulation: **conceptual mapping of MBSE and Simulation. Inputs into OSMoSE**

TDE: Application of Co-Simulation: **Co-simulation methodology and enablers towards Digital Twin**

(Preliminary) Conclusions

- MBSE Demonstrator Study is ongoing
  - “Nature of study” and “Off-site team” challenging
- Requirements Specifications phase was difficult:
  - *“Domains” **are** the users of the SSRM*
  - *Different nature of specifications*
  - *Scattered over Mission, System and Subsystem level*
  - *Gaps (to be filled)*
  - *Heritage inputs (OEW and EagleEye)*
  - *Phase 0 and Phase A/B1 “dynamics”*
- Preliminary SSRM design in OCDT and Capella; consolidation ongoing
- Simulation modelling is just starting
  - Co-Simulation V&V methodology is available
- Complete and consistent dataset (including MBSE / Sim Models) is required before starting new R&D activities using the SSRM (e.g. OSMoSE ontology skeleton)
  - Urge from starting/ongoing R&D activities ;-)

Questions?

For more information please contact:
quirien.wijnands@esa.int