DEFENCE AND SPACE

Applying ECSS-E-TM-10-23 – lessons learnt

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ESA Ontology Workshop

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Applying ECSS-E-TM-10-23 – lessons learnt: Overview

Applying ECSS E-TM-10-23

Chapter 1:
The Journey from „New Concepts“ to operational realization

Chapter 2:
Operational status of „Digital Continuity“ reached

Chapter 3:
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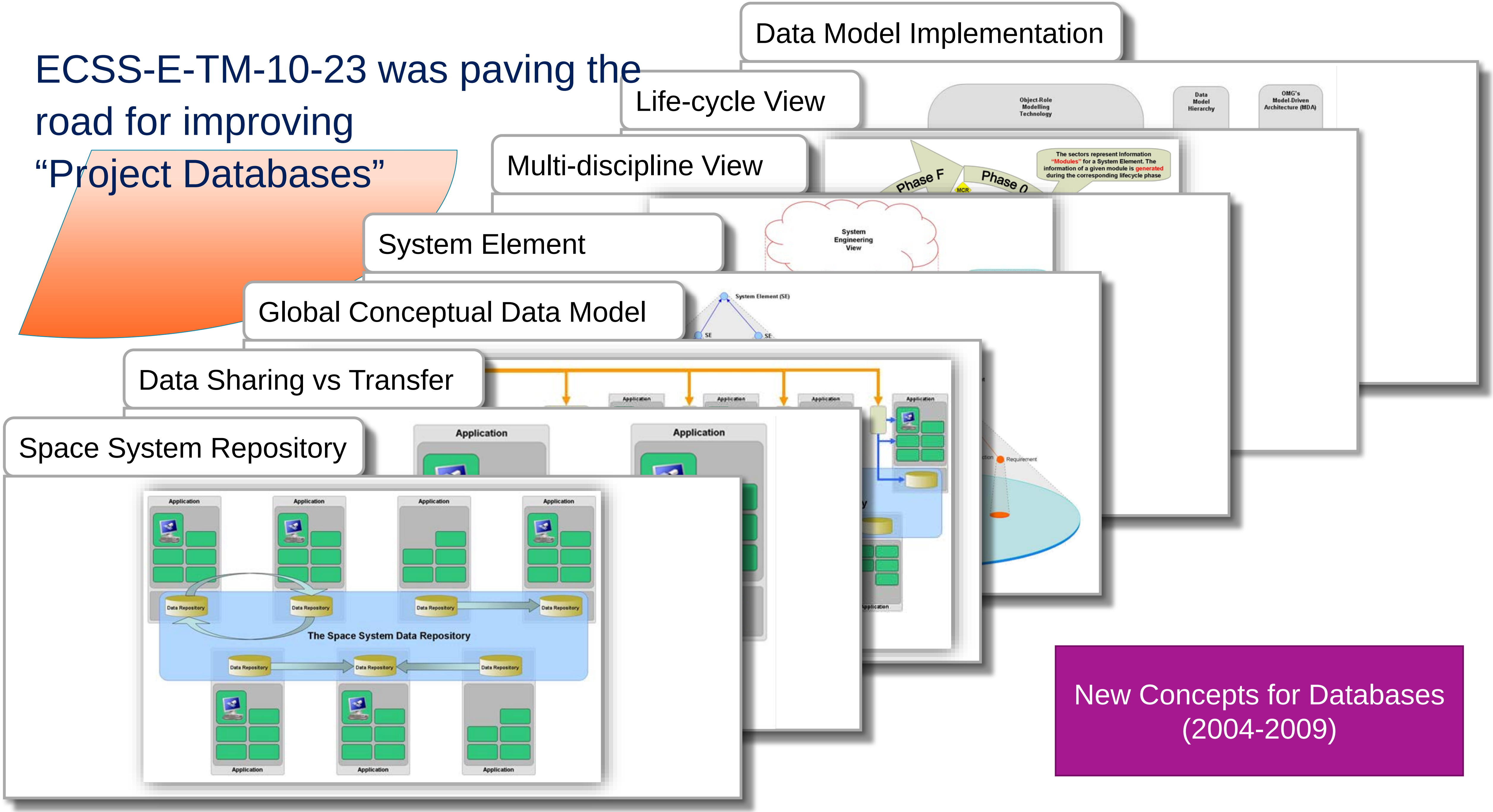
ECSS-E-TM-10-23 was paving the road for improving "Project Databases"



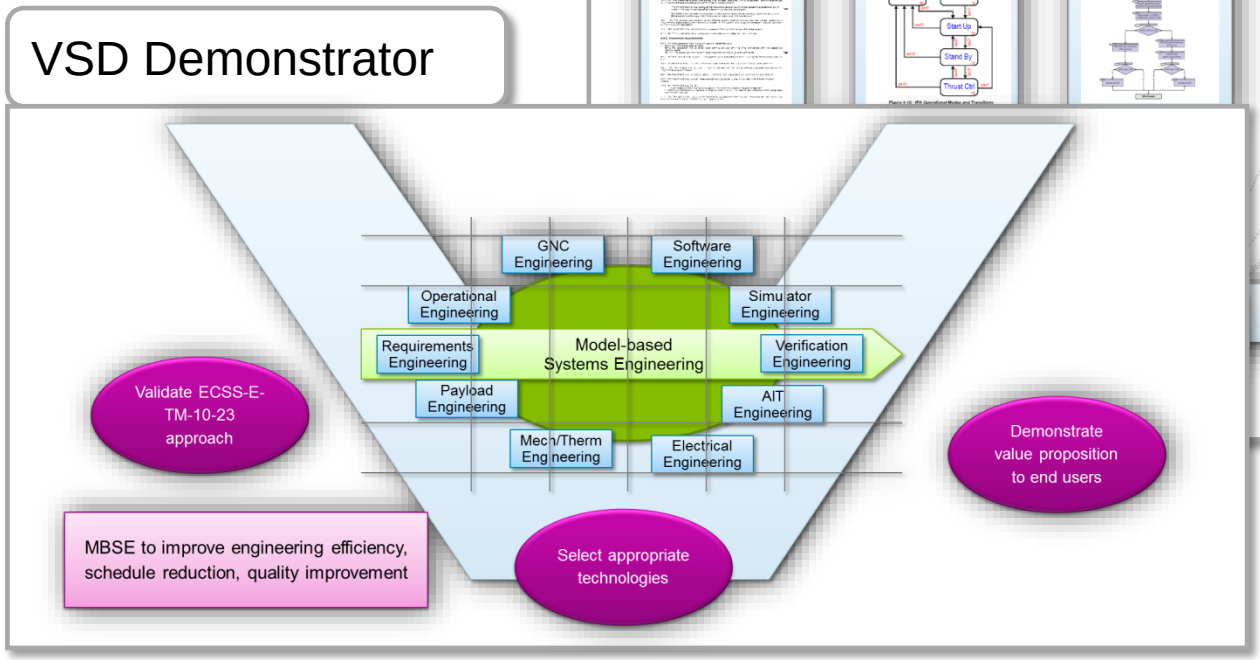
New Concepts for Databases (2004-2009)

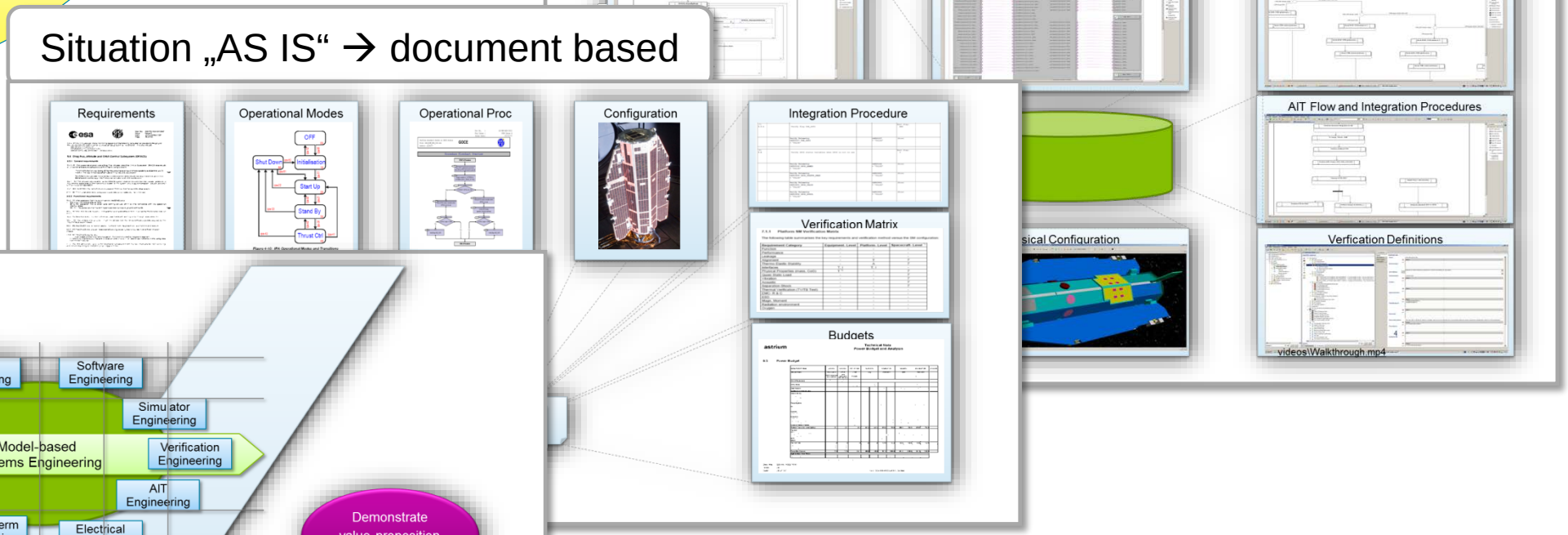
ESA “Virtual Spacecraft Design” (VSD) was do demonstrate / validate the beneficial use of ECSS-E-TM-10-23 for Systems Engineering

Demonstrated „TO BE“ → model-based

Situation „AS IS“ → document based

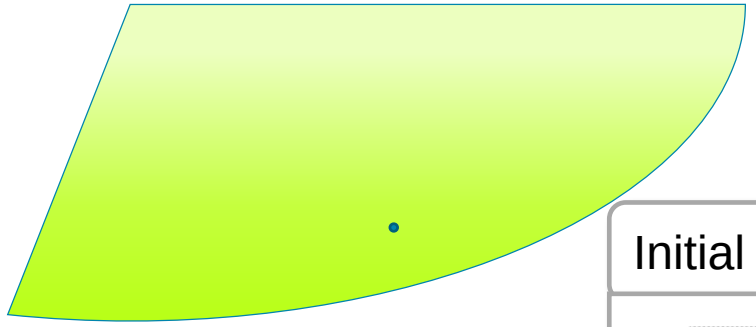
VSD Demonstrator



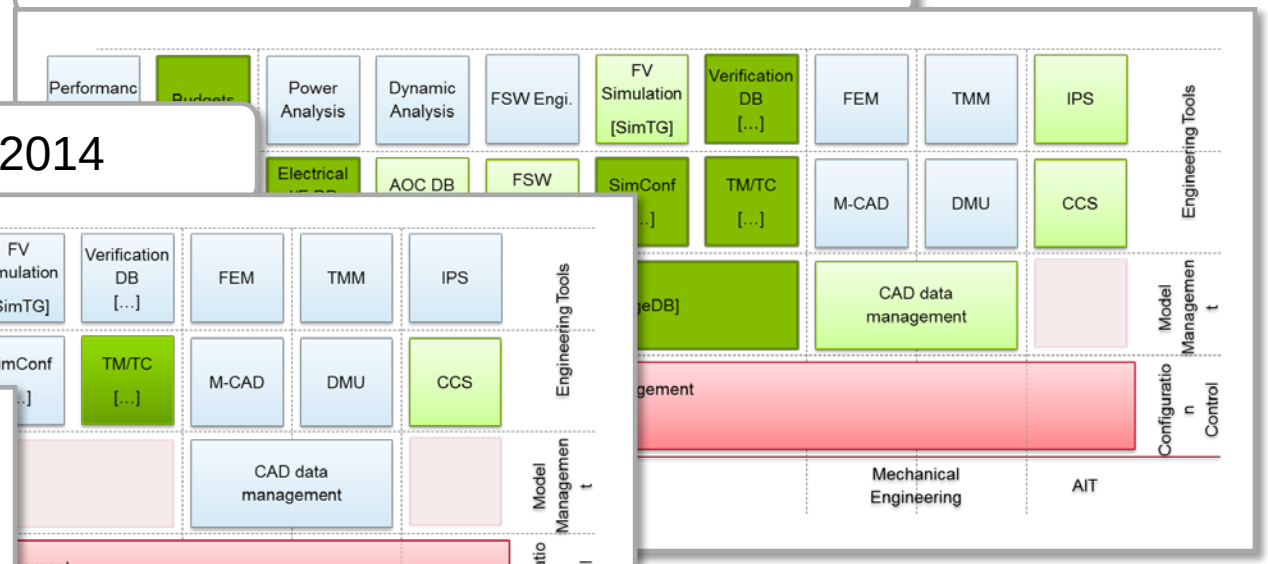


Demonstrating Feasibility (2008-2011)

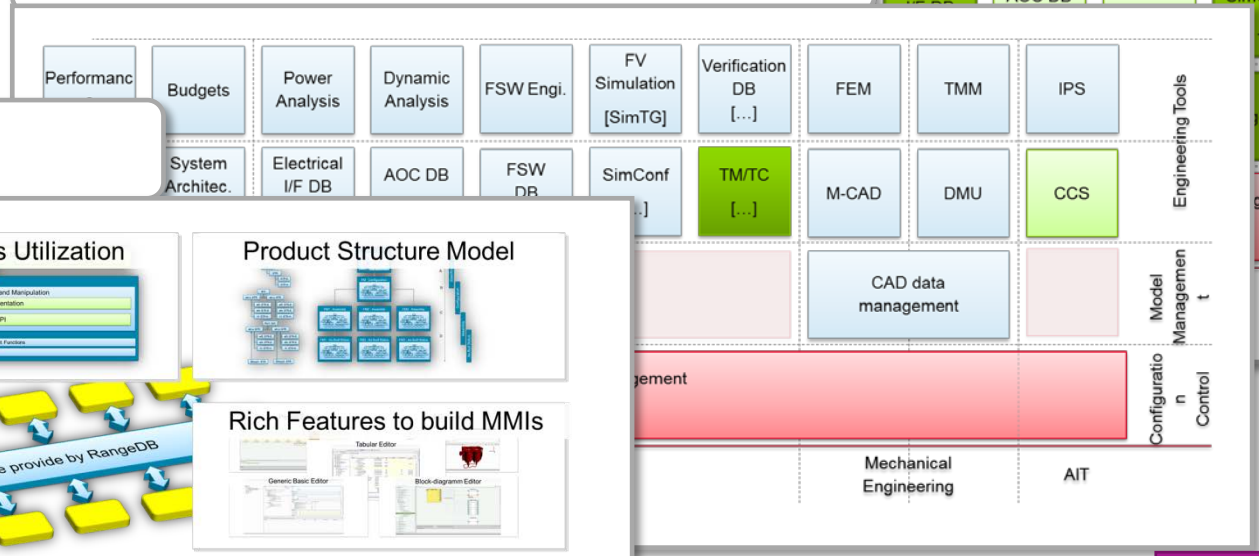
Adopting the VSD principles for Functional Avionics (→ SRDB): RangeDB



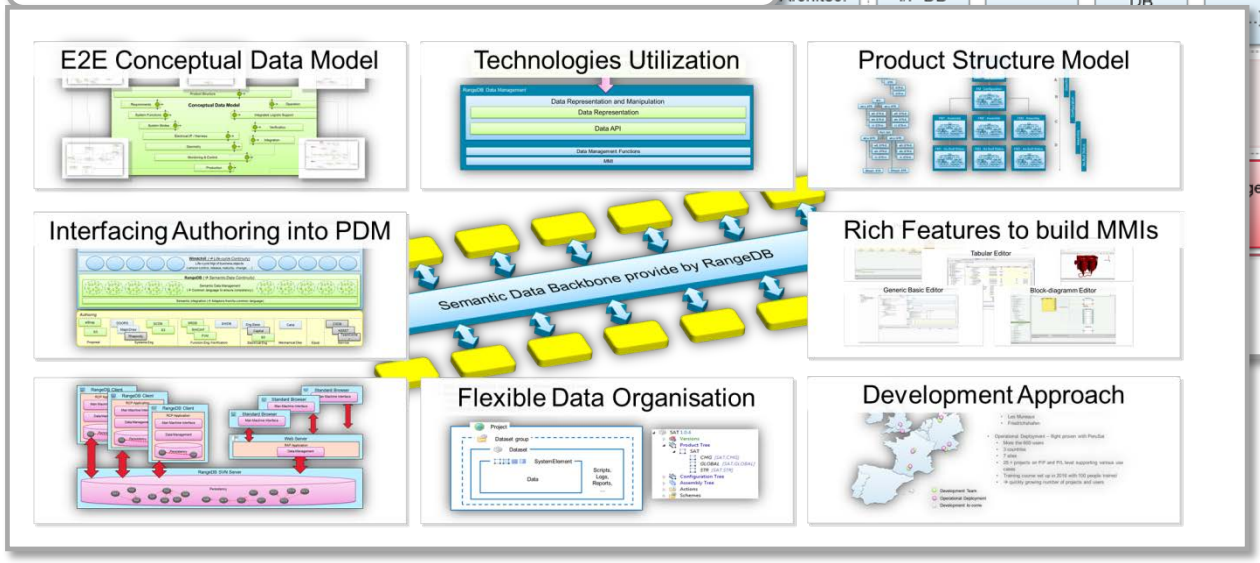
Evolution up to 2016



Initial Development Focus 2014



Framework principles



Devevelopment for operational use 2011-2014, operational use since.

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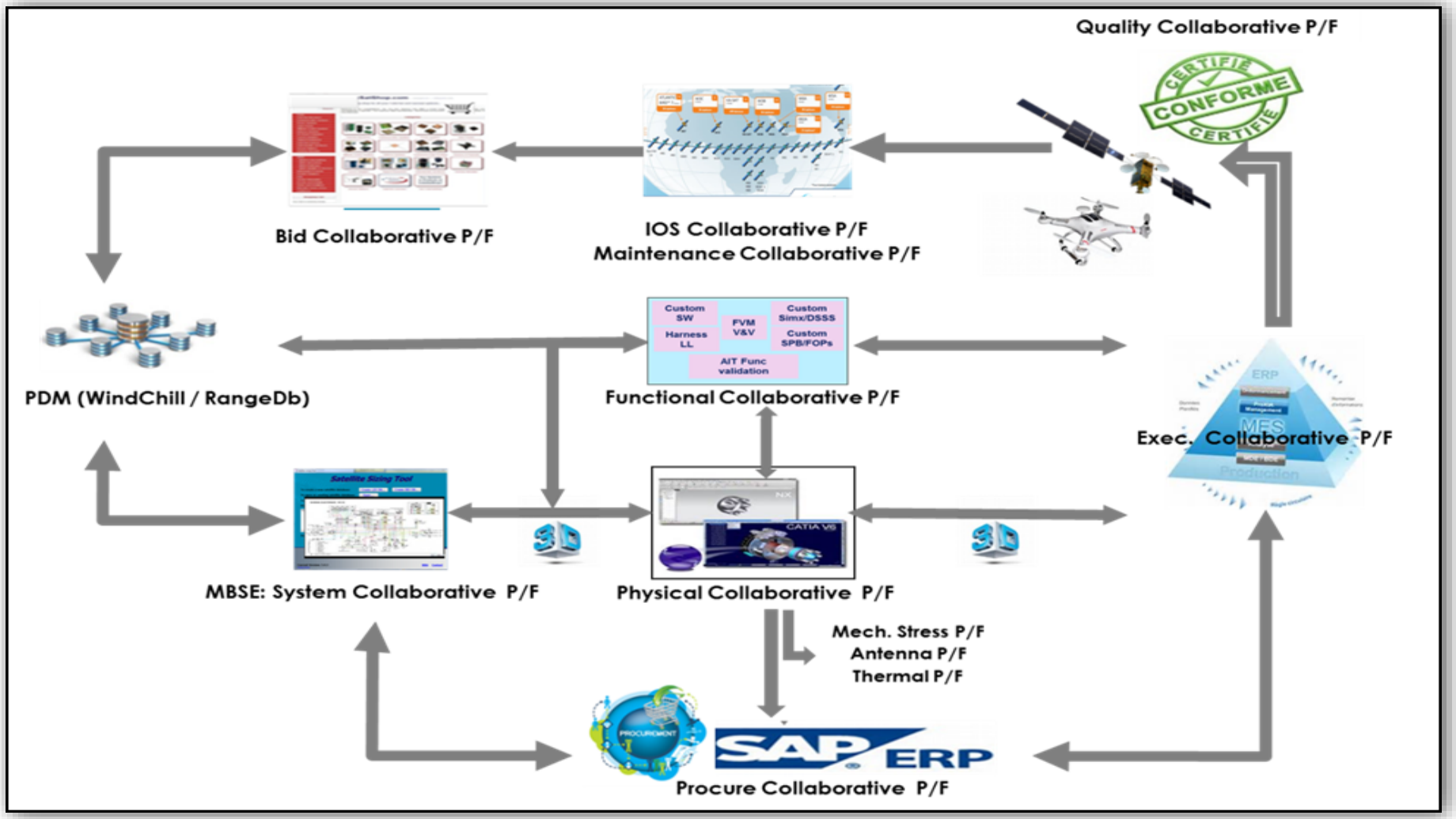
Digitalization Space System - DDMS Space System EuroStar NEO - Overview



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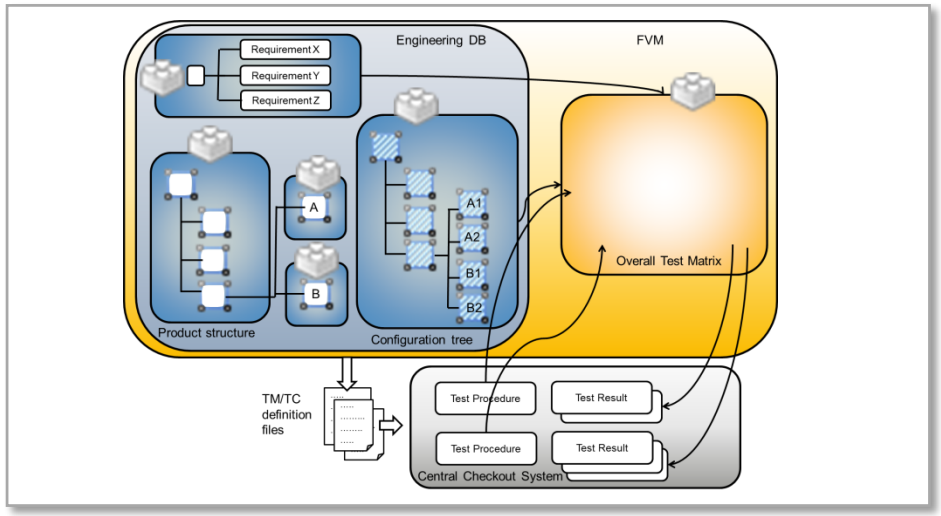
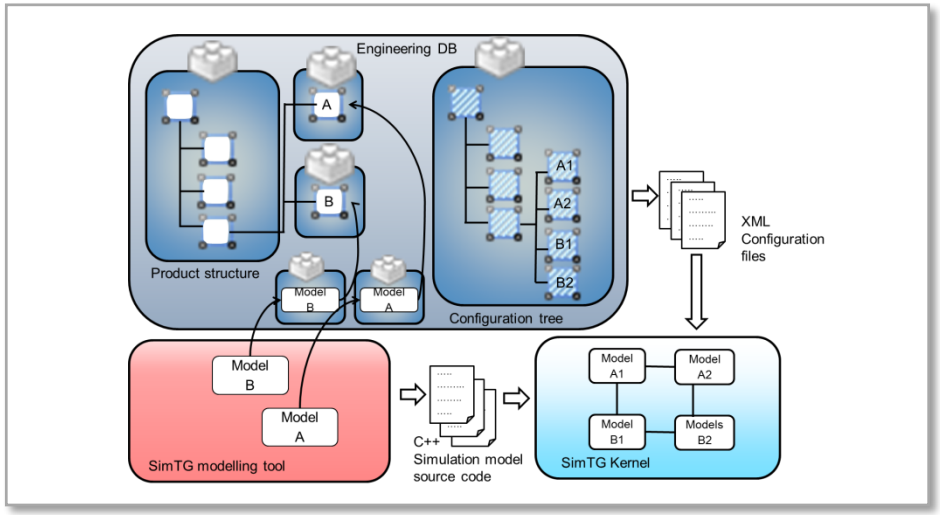
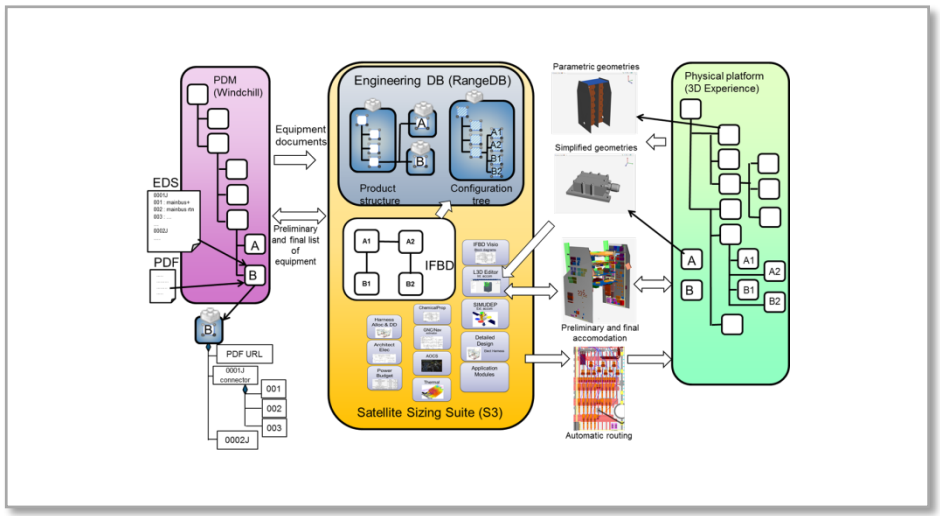
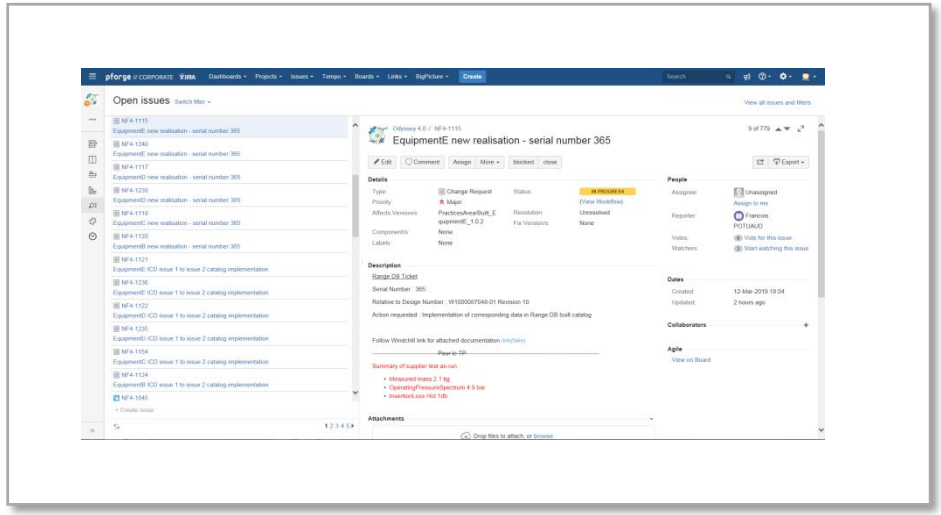
Key objective is to improve the E2E Digital Flow of Information – some examples









But there is more
- From product to project
- Multi-disciplinary engineering in early phases
- From SE into disciplines
- From disciplines into manufacturing
- Effective Co-engineering
- Overall agile working
- …

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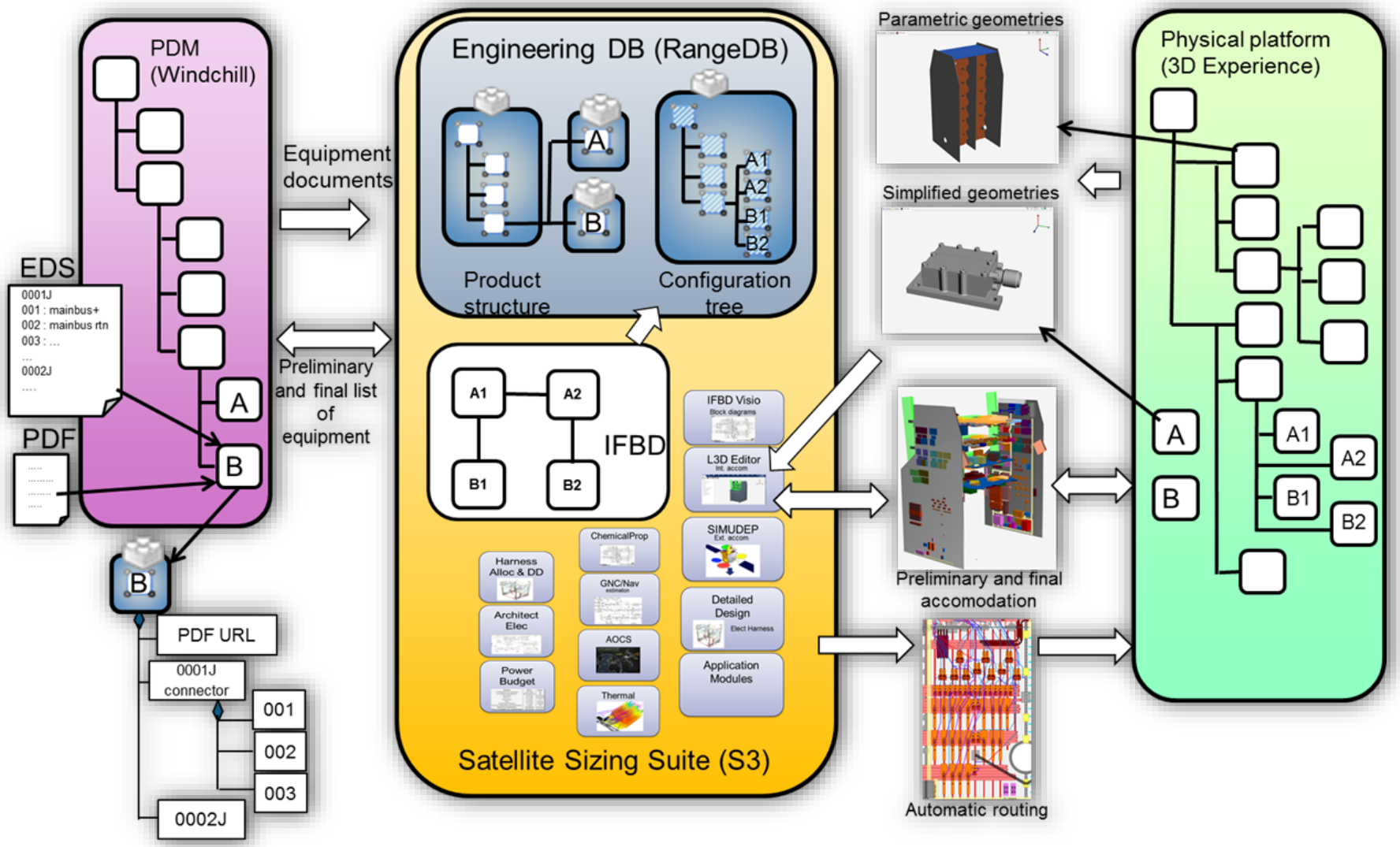
Digital integration of Key Backbone Platforms



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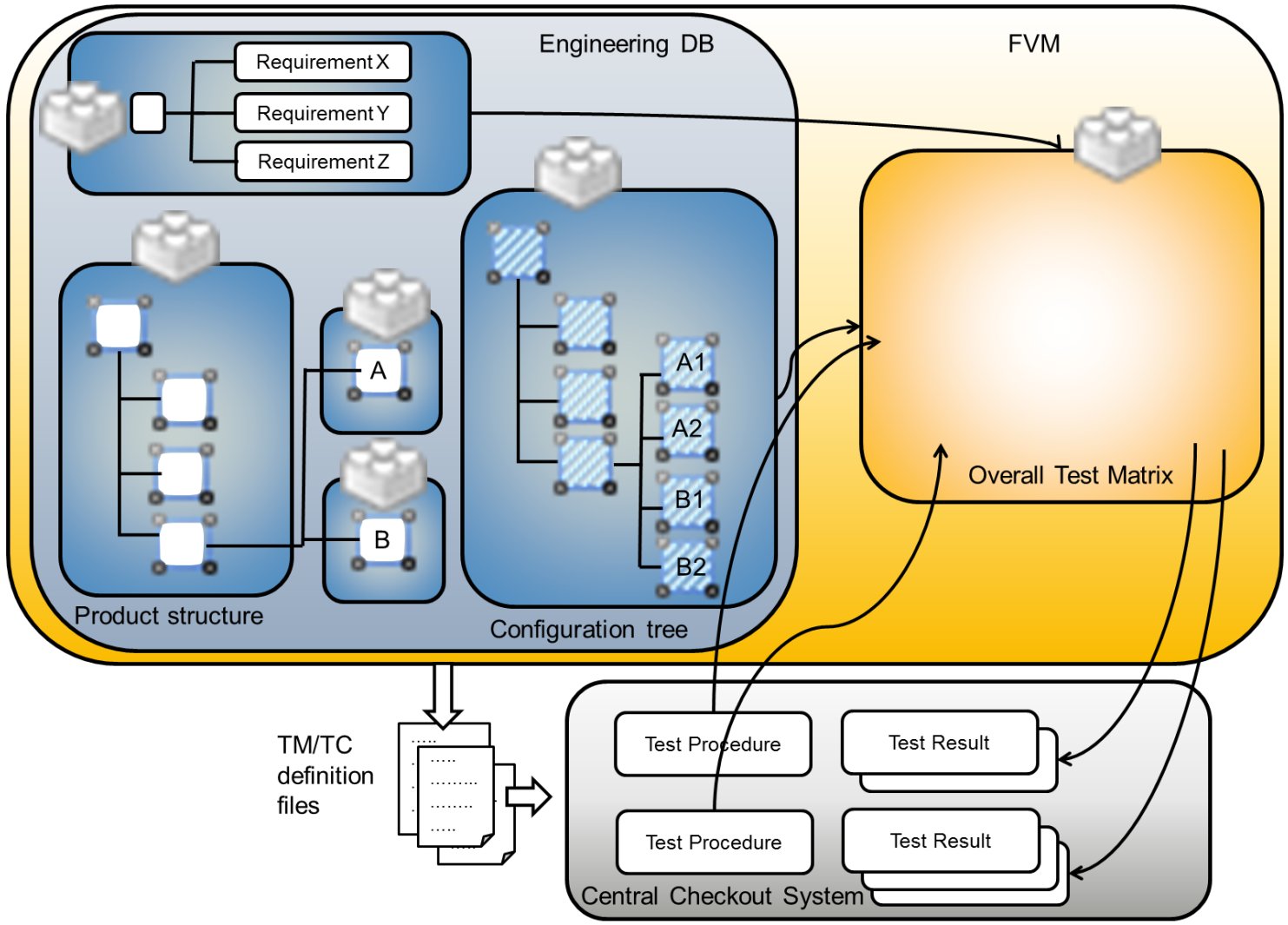
Integration of Engineering, Test Engineering and Testing



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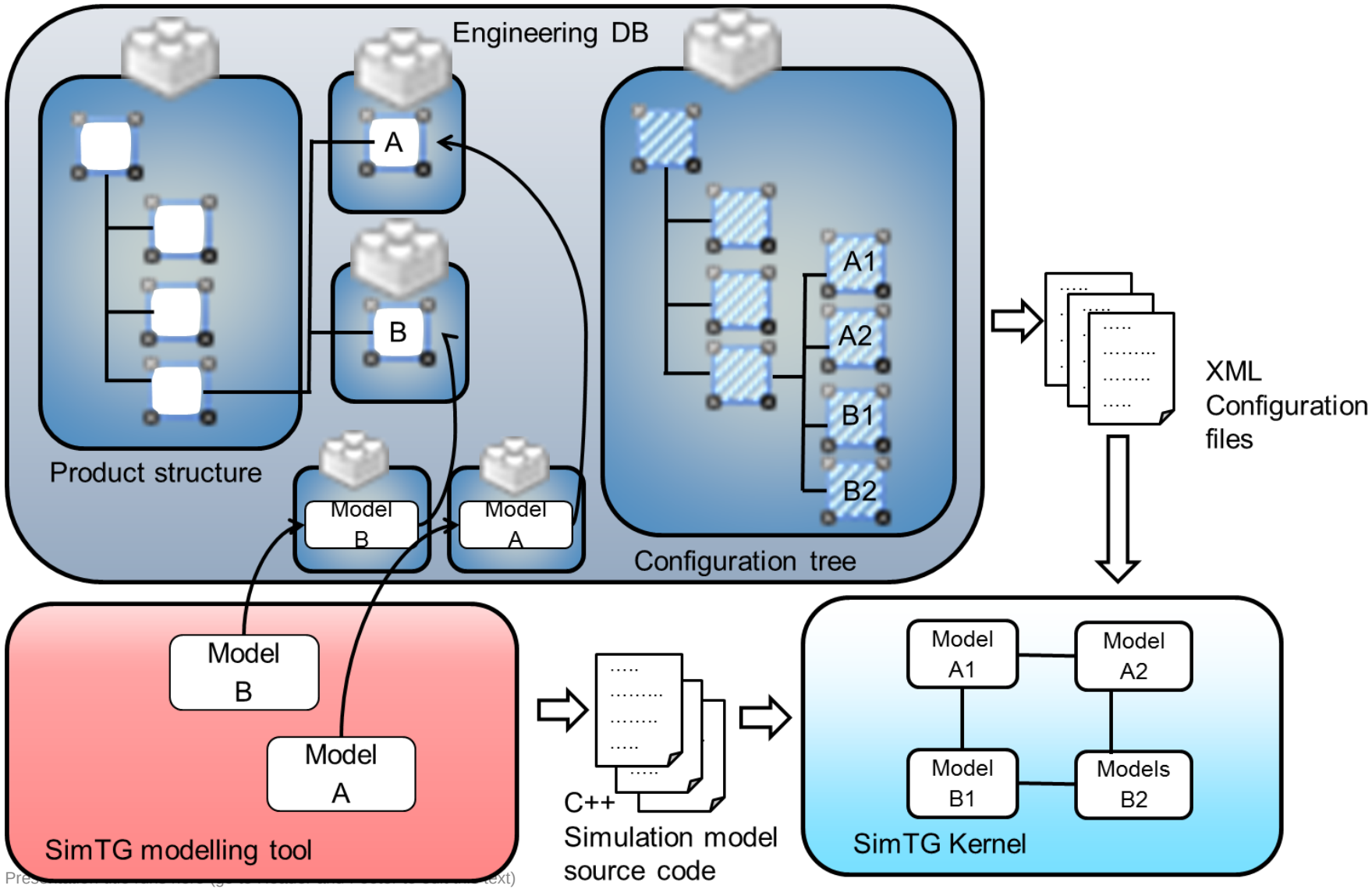
Integration of Engineering and Simulation Configuration



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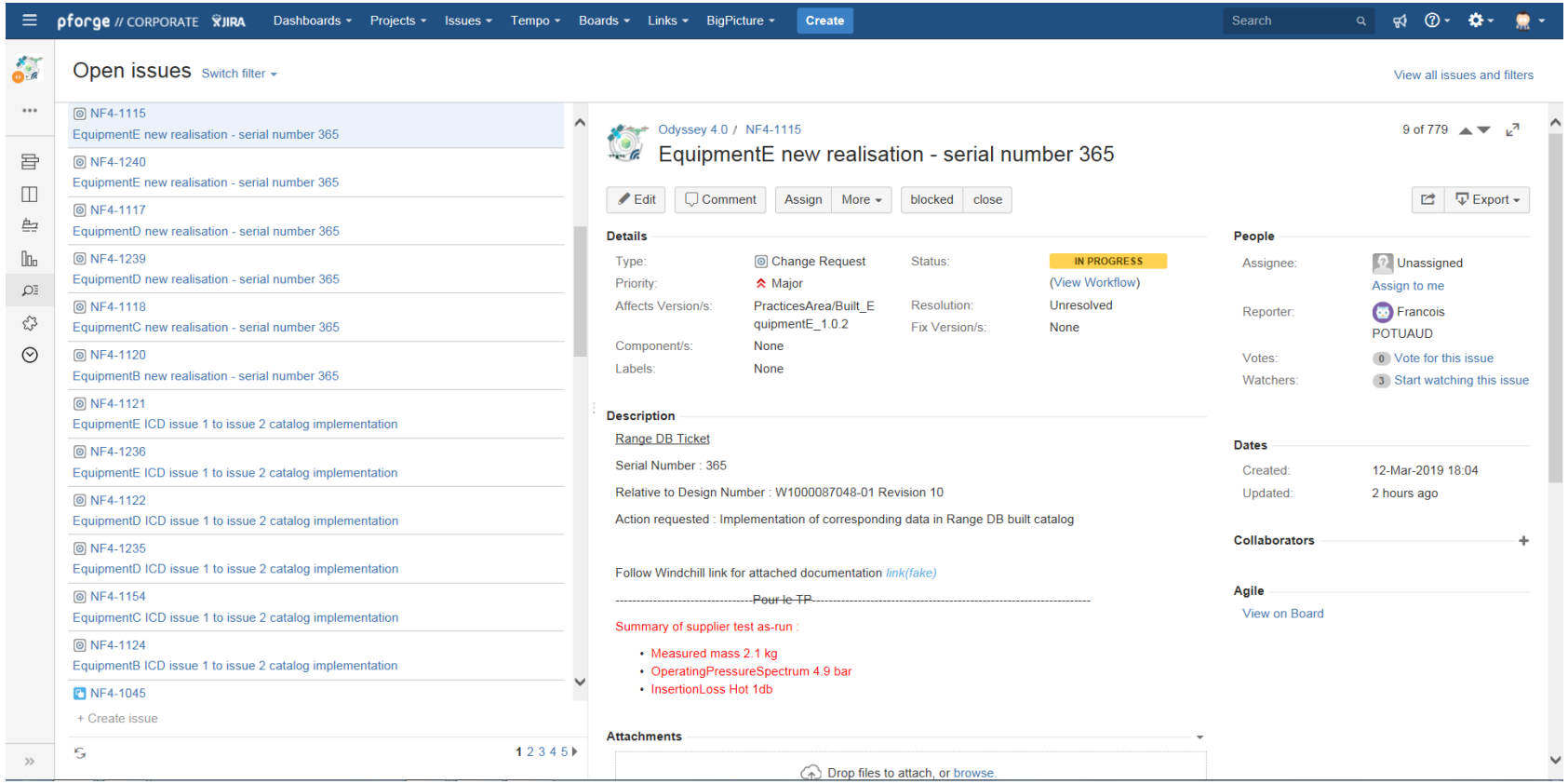
Integration to obtain “overall agile workflow”



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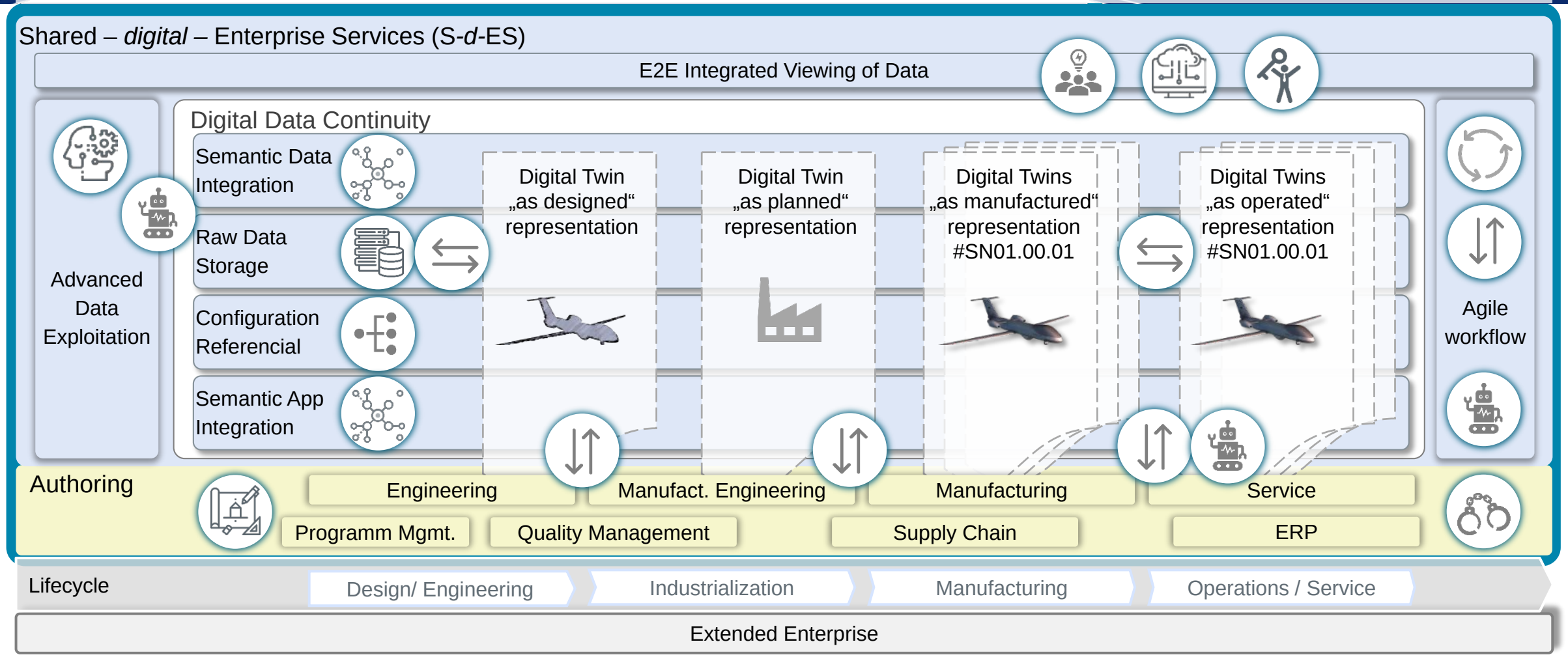
Space System Data Repository is part of Shared -*digital*- Enterprise (S-*d*-ES) Services



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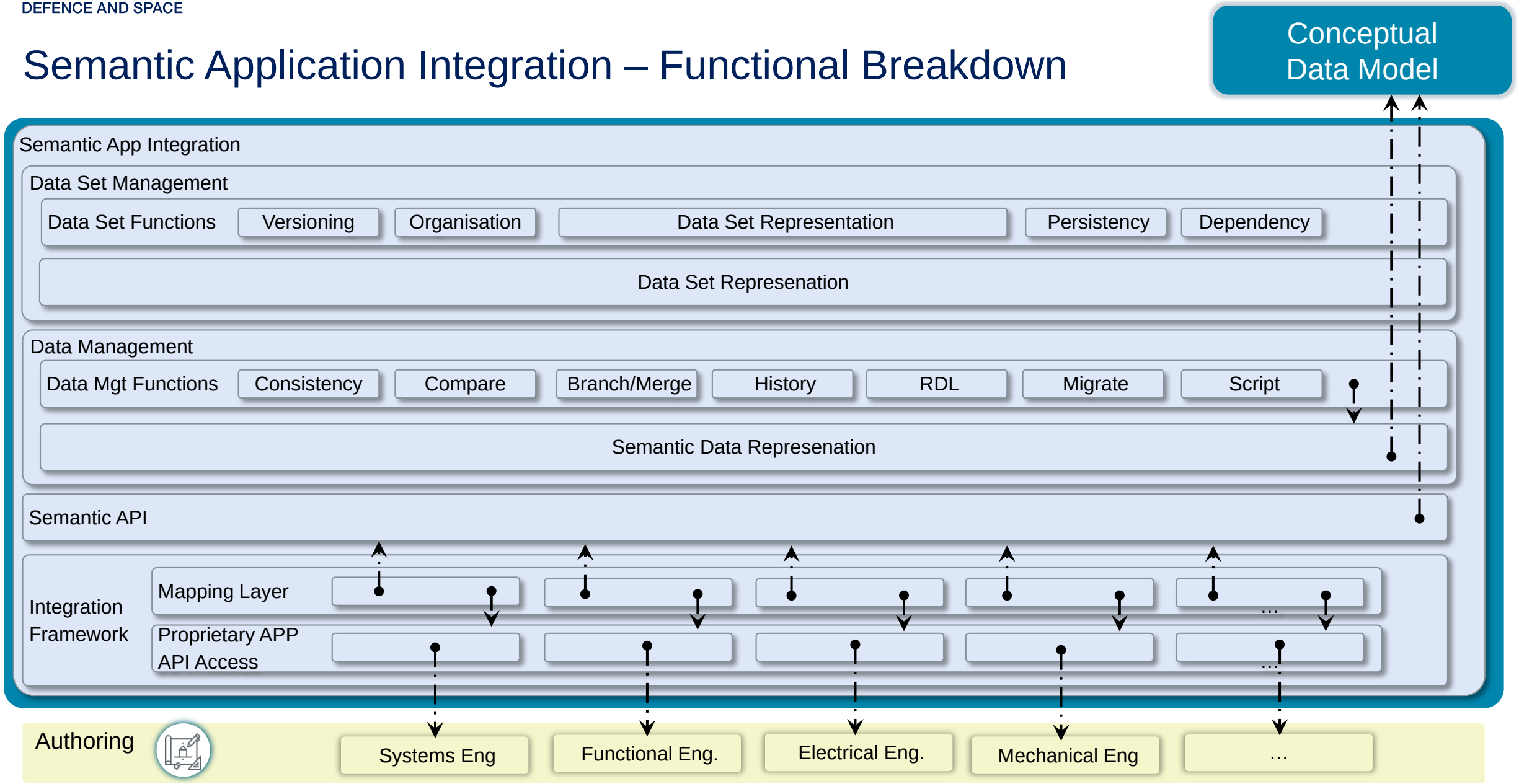
Semantic Application Integration – Functional Breakdown



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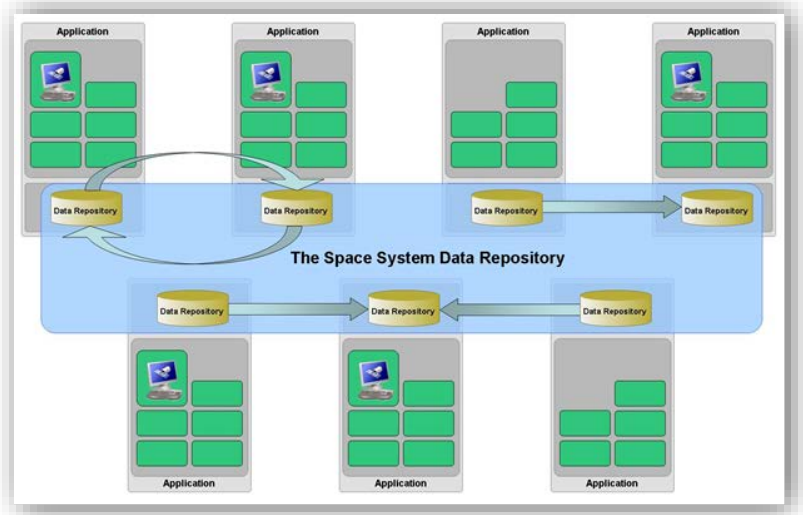
Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - Space System Repository

[→ Space System Data Repository] was addressing the need to enable interoperability across different applications

- Applications are driven by the individual stakeholder, with the result – that the overall environment is still very diverse
- Commonly shared digital services are needed to enable sharing and exchange of data
- Shared digital services comprise of data management functions based semantic representation - derived from a [→ Conceptual Data Model]

Space System Repository



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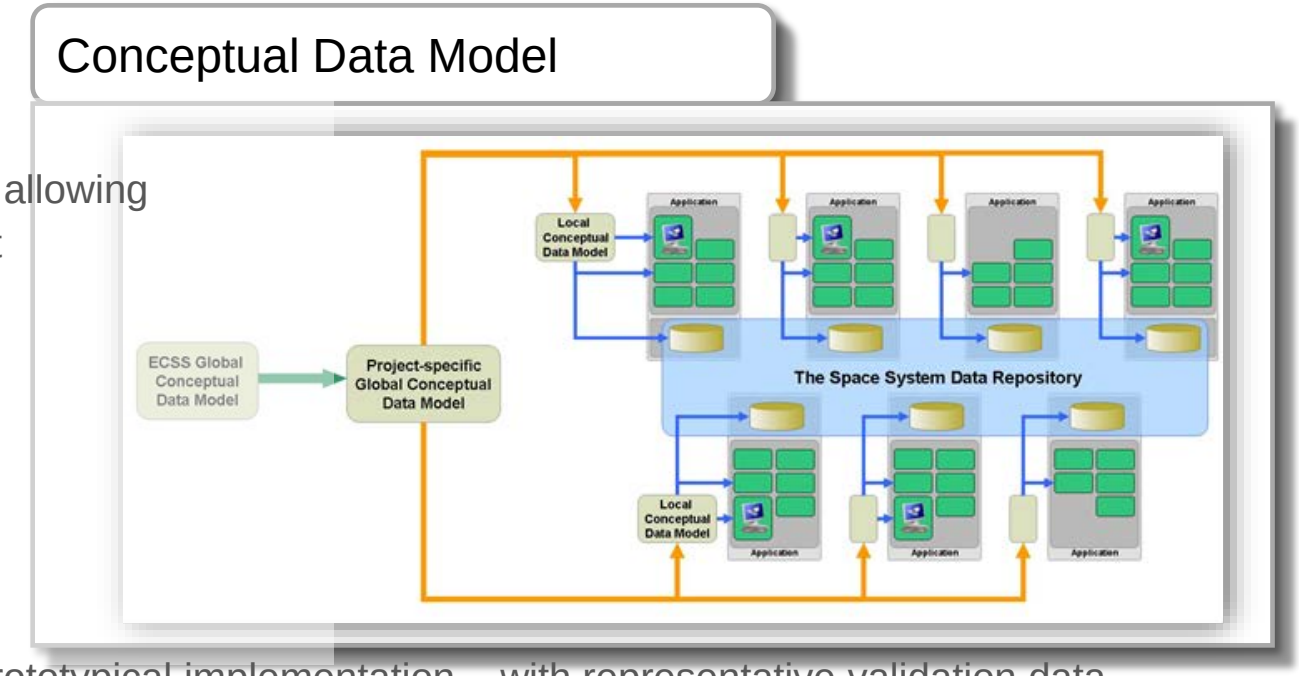
Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - Conceptual Data Model

Conceptual Data Model is to specify the common semantic representation to provide a common E2E language



- [→ Conceptual Data Model] turned out to be the key element allowing to formally specify the data – outside the development context
- But the meaning is little if not backed with a concrete physical implementation – while closely preserving the semantics
- Setting up a common language across domains/phases is possible, enabled by close consideration of user terminology
- Data model engineering needs to be closely supported with prototypical implementation – with representative validation data
- The data model has 2 parts – one which is directly used for development – the other “categories” allow tailoring at runtime
- [→ Conceptual Data Model] will evolve since new integrated stakeholder will introduce their constraints (process chains)

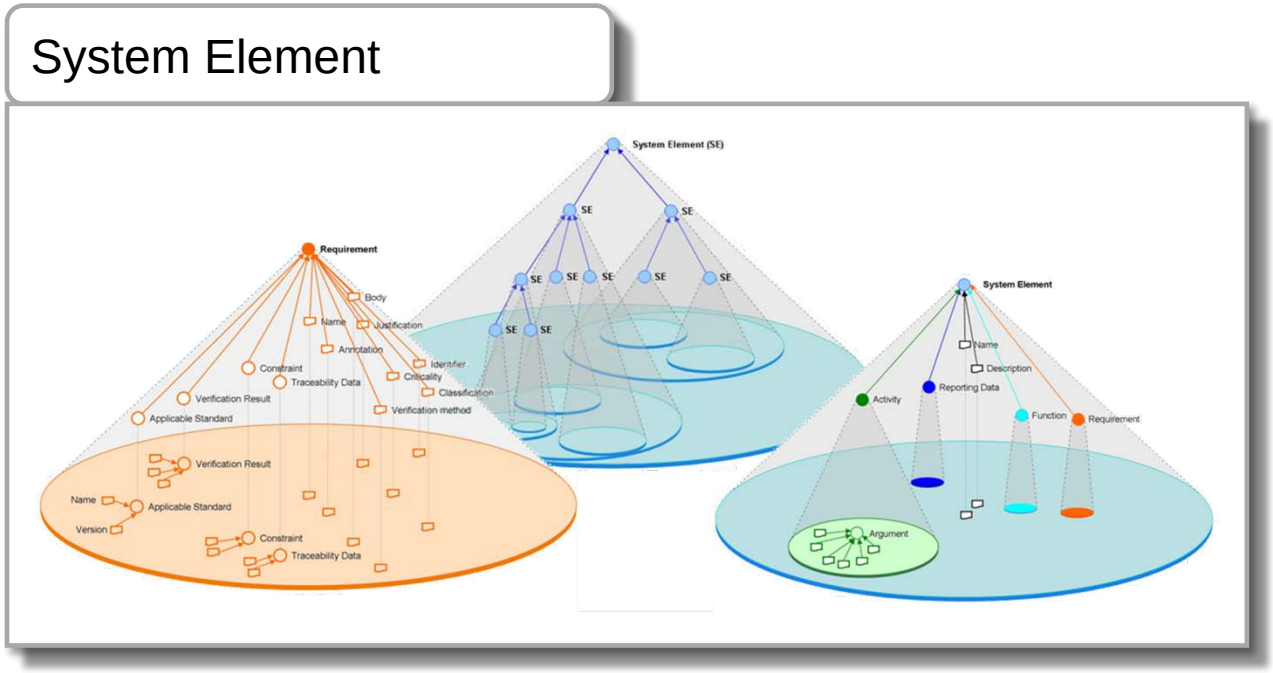
Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - System Element

[→ System Element]is a key element aggregate knowledge on system hierarchy, life-cycle or domain

- System element turned out to be a “strong concept” in the [→ Conceptual Data Model] to describe different notions
  - System breakdown structure
  - Considering evolution along [→ Life-Cycle] : Definition, Configuration Occurrence, Realization
  - Across different domains to obtain [→Multi-disciplinary views]
  - Individual properties to capture equipment characteristics

- [→ System Element] is a key enabling element towards “Digital Twin”

- System Element aspect is also close to versioning of data



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Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - Multi-discipline View

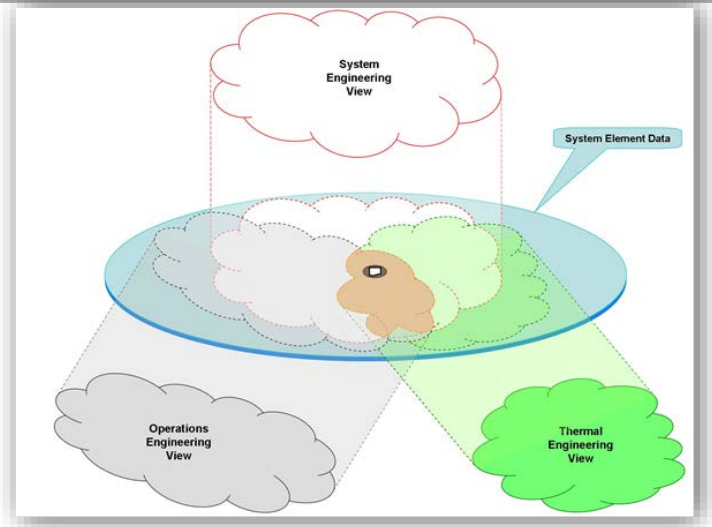
Multi-disciplinary views are needed to respect the different views on [→ System Elements] from different domains

- Notion of System Element has been enhanced with “aspects” to enable individual – but linked compartments

- The aspects comprise areas such as
  - Electrical: connector, pin, func channel / net, channel, …
  - Monitoring & Control: Packet, parameter, calibration…
  - Mechanical: position, orientation, …

- Aspects do represent different hierarchy level of data across the life-cycle

Multi-discipline View



Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - Life-cycle View

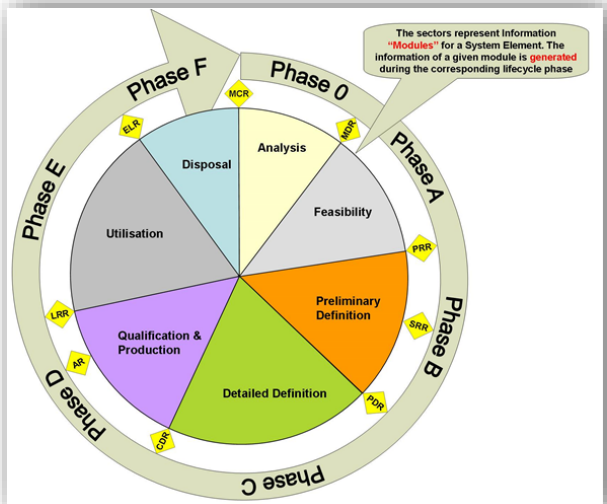
- *Life-cycle consideration to ensure that all data created along the life-cycle can be captured in the [→ Space System Data Repository]*

- [→ Conceptual Data Model] is defined to capture all data from requirements, design into FV and operation

- However for full life-cycle representation of data the following needs to be considered – and linked - as well
  - Data managed in the context of configuration / PLM
  - Data needed to manage Agility
  - Extended enterprise

- For extended enterprise good experience has been made with EDS for “simple data” only – for more complex data more appropriate ways need to be *agreed* !

Life-cycle View



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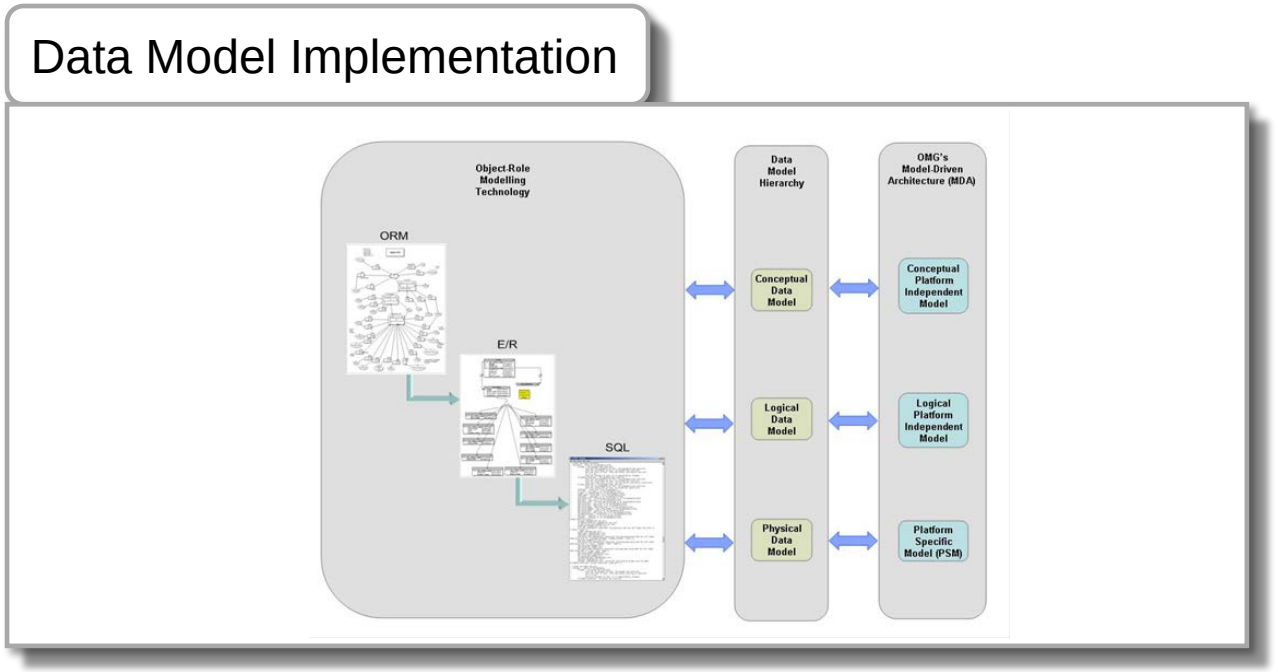
Lessons learnt – along the initial key concepts of ECSS-E-TM-10-23 - Data Model Implementation

Implementation view is important to ensure that [→ Conceptual Data Model] can be properly mapped into the implementation

- Overall data model structured with the aim to clearly separate the different concerns
  - [→ Conceptual Data Model] (domain concepts)
  - Technical data model (enriched with technology mapping, performance, …)
  - Physical data model (actual resulting source code)

- Support of “state or the art” is supporting the conceptual data model engineering – with early and continuous prototyping

- UML turned out to be a good choice, mainstream technology, many tools, knowledge widely spread



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Wrapping up

- Having a formal conceptual data model is an essential foundation – but the actual truth is in the physical model !
- Therefore Ontology / Conceptual Data Model is not a purpose on its own: it has to support the efficient provision of solutions, which effectively improve the envisaged processes
- For this early and continuous prototypes are enabling the validation of on data model – and consequences at run time !
- Use of main stream technologies is key to involve different parties, engineering domains, tool vendor, development, IM, domain
- Digital transformation is an ongoing effort – in general data model is converging – however continuous updates needed – even in operation
- Solutions within organizations are in place (and where not, emerging) – collaboration across enterprises are needed, to effectively enable collaboration across organizations
  - EDS is a start for simple structured data
  - There is much more to be tackled for operational exchange of data