Virtual Spacecraft Design

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Where Did We Start From

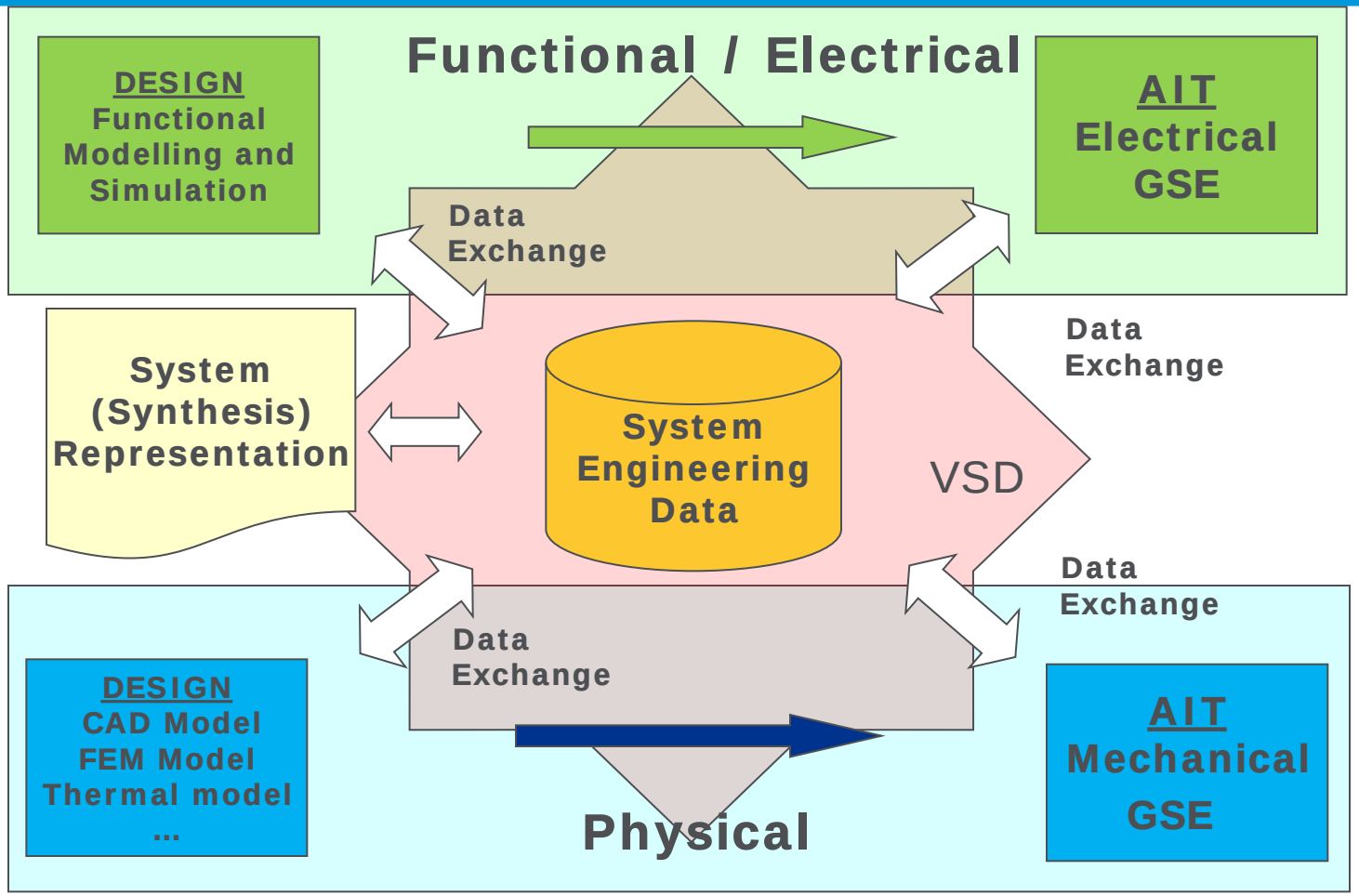
- Difficulties encountered today (Development pull)
  - Stovepipe design approaches
  - Inconsistent System Data
  - Bottlenecks in AIT / AIV
  - Late problem detection
  - Difficult handover between stakeholders (ESA / industry)

- Technology push
  - Model-Based System Engineering (MBSE)
  - Virtual Design / Testing capabilities
  - System modelling / standardisation

A Bit of History

- 2001: Space Technology Innovation Workshop, Copenhagen
  - First discussions (Agency / Industry / Delegations) on the interest to link different domains at system level together to consolidate first ideas
- 2004: Issue of an ITT
  - TRP study for 2 M€ (1 M€ earmarked for SMEs for development)
  - Objective to: increase the cost-effectiveness of the spacecraft development process, optimising the design at system level and increasing the coherence between analysis, design, testing and operations
- 2005: After long negotiations KO for the study
- 2008: End of phase 1 – Use Cases, Process, Specifications for supporting tools, selection of subcontractors
- 2012: Finalisation of development

The early ideas…

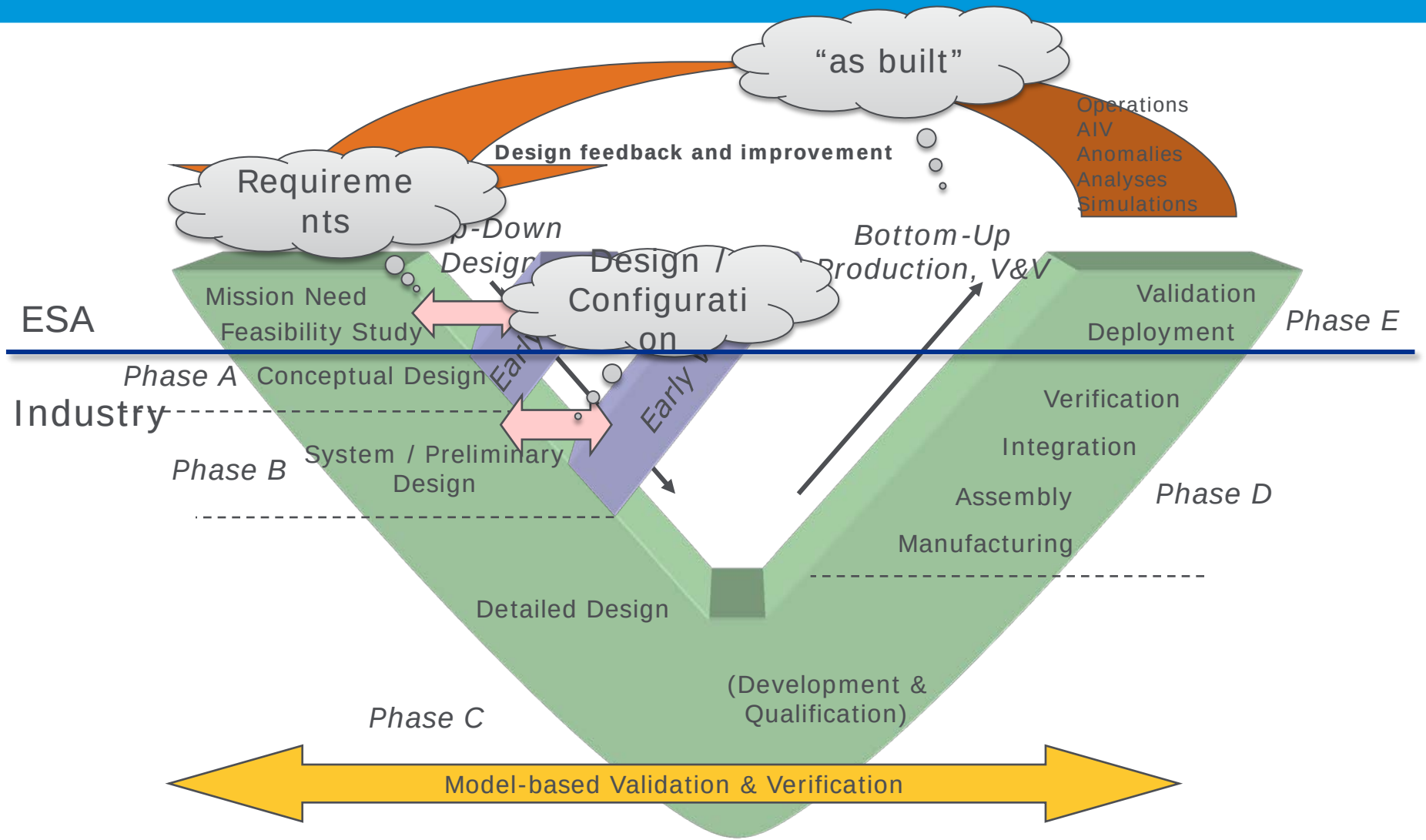


Concept

Product Life Cycle

Product

End-to-end SE Process



SE + MBE = MBSE

- Systems Engineering (SE) is well established in European Space Projects
  - Key success factor for European Space Projects
  - Mature standards for Space Systems Engineering (ECSS)
- Model Based Engineering (MBE) is already practice in specific domains, e.g.
  - Physical models (CAD) with sophisticated analysis tools
  - Functional models and tool chains for design and verification of SW
  - Other domain specific models…
- Improvement still required
  - Maintaining Quality with decreasing resources (efficiency)
  - Increased complexity of systems
  - Problem oriented approaches vs Product orientation
  - Increased need for interoperability of systems (in particular for cooperative developments)
  - Model-based, cross discipline collaboration

Why Virtual Spacecraft Design?

- Virtual Spacecraft Design aims to improve S/C system level design activities by
  - Strengthening multi-disciplinary aspects
  - Further integrating analysis, design and verification activities
- In order to
  - Improve consistency and completeness of the design definitions
  - Advancing some of the verification activities
  - Ease design iterations
  - Support design optimization and system level trades

What is our Virtual Spacecraft Model

- Virtual representation is the computer-based modelling of (elements of) a system, its environment or the required test equipment
  - Static (descriptive / design) vs.
  - Use (dynamic / analysis)
- Covered features in VSD include
  - Requirements
  - Functionality and Behaviour
  - Appearance
  - Design Definition Data
  - Analysis / test definitions and results
  - Links to Domain Specific tools and models
- Required enabling aspects
  - Consistent, comprehensive data management (i.e. versioning)
  - Multi-disciplinary Virtual S/C model
  - Advanced technologies for tool integration

Improvements

- Improvements are expected in the following areas:
  - Requirements management and verification
  - Design trade-offs at system level
  - Analysis of system operability issues
  - Assessment of engineering margins
  - Coherence between Analysis and Testing
  - Preparation and execution of AIT
  - Transition from AIT to operations
  - Model-Based data sharing

- VSD is prototyping an Engineering Environment for the validation of an improved SE process and the supporting datamodel and its link to domain specific data

Agenda (I)

- 9:00 **Introduction** (ESA)
- 9:30 **Overall presentation of VSD** (Astrium)
  - Context: System Engineering and MBSE
  - Model Integration
  - The Data Problem
  - Potential Solutions
- 10:45 Coffee Break
  - Key Values provided by VSD
  - Examples and Illustrations
  - Way Forward
- 12:00 **Open discussion**: So what - a user perspective
- 13:00 Lunch

Agenda (II)

- 14:00 **Detailed presentation**
- Introduction (ESA)

- Use Cases and Demonstration Scenario (TAS-I)
- Data Repository solution (GMV)

- 15:15 Coffee Break

- Model Editors (Scopeset)
- Integrated System Model Visualisation (Novabase)

- 16:30 Adjourn
- Free demonstration – as desired

Synthesis

- Not changing SE, but providing more formal approach and means (supporting tools)
- “Only” TRP, but Framework
  - Ready for pilot application
  - Allows adaptation to “proprietary” applications and process
  - Reduces dependency from tool supplier by industry
- Big primes have been working together
  - Open cooperation
- VSD Requires broad adoption, common support of underlying data representation

- The benefits of VSD approach should become visible in space projects by higher efficiency, better quality, risk reduction, optimising design

Consortium

- Thanks to the consortium of this study
- For the main concepts, use cases, model and demonstration development
  - Astrium (D)
  - TAS-I
- For the implementation of the prototype
  - Scopeset (D)
  - GMV (E)
  - Novabase (P)

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