

Leveraging Product Line Engineering (PLE) for Enhanced Digital Continuity in Systems Engineering



Capella Days
19/11/2025

**lgm / leading great
movements**

////////////////////

DIETER WAGNER

- 37 years of experience at MBDA Germany
- 25 years experience in MBSE
- 20 years expert for System Engineering
- 15 years lecturer at the University of German Arms in Neubiberg/Munich
- Head of NATO Working Group
- Member INCOSE/GfSE
- Member OSLC Working Group
- Member of the OMG PLE working group

SÉBASTIEN DUBÉ

- 25 years of experience on Systems Engineering, Software engineering and Project management
- Active member of AFIS/INCOSE communities on MBSE & PLE topics
- Part of an experienced team of 6 members for MBDA



MBDA Deutschland
Excellence at your side



With the support of



MANAGEMENT AND ENGINEERING OF COMPLEX PROJECTS AND SUPPORT
MAINTENANCE AND SUPPORT ENGINEERING

2023

1550

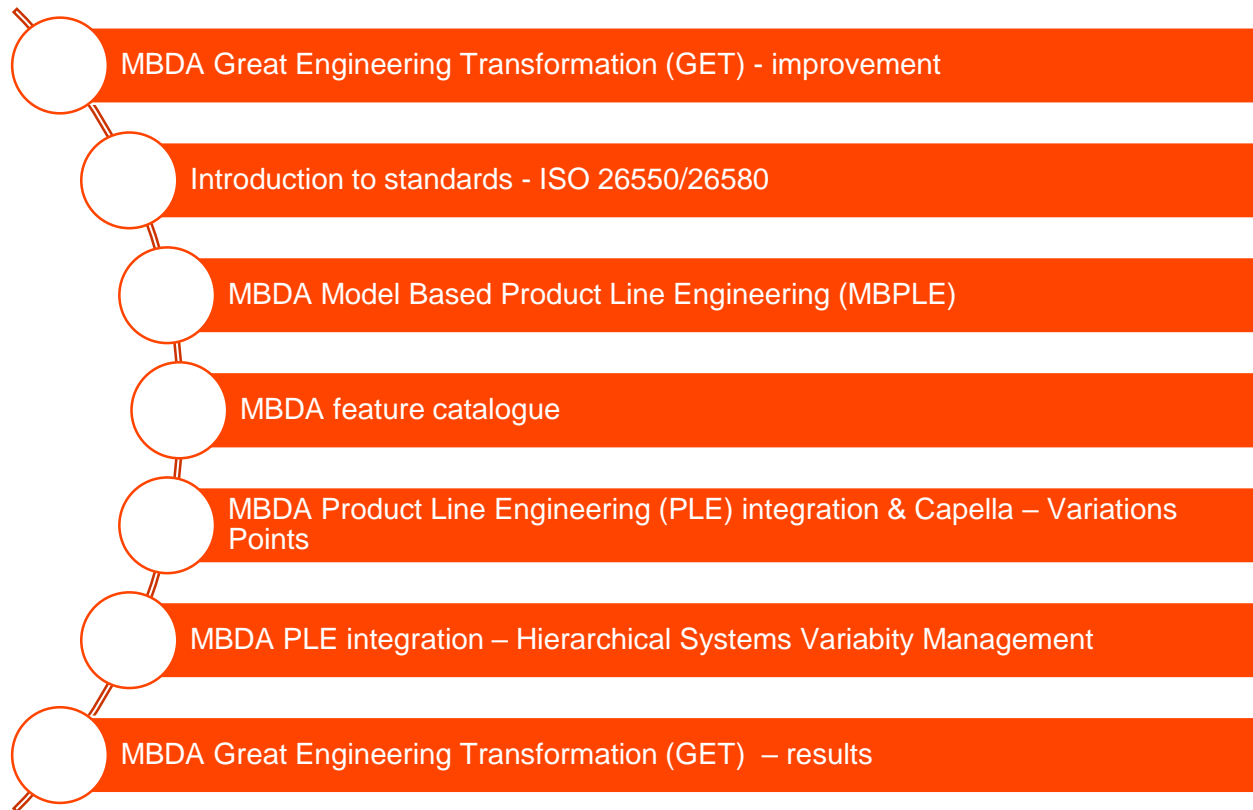
SYSTEMS ENGINEERING & RAMST (Reliability, Availability, Maintainability, Safety, Testability)

ORGANISATIONS AND PROGRAMME PERFORMANCE

DIGITALISATION, DATA & INFORMATION TECHNOLOGY


168

SYSTEM ENGINEERING METHODS & TOOLS SPECIALISTS



GET (MBDA NEXT) CONTEXT & OBJECTIVES

MBDA

lgm/

50% lead time reduction

- Customers do not accept anymore to wait many years to get their order
- Main competitors are organized to react quickly



25% Non recurrent cost reduction

- Customers are less willing to pay NRC
- Competitors seem having accepted this new constraint

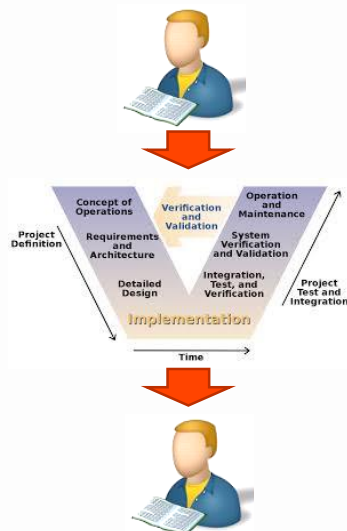


Reaching these objectives impose to change the way of working

Changing our product development strategy from Engineering to Order (ETO) to Configure to Order (CTO)

Engineering to Order (ETO)

Customer expresses his operational needs

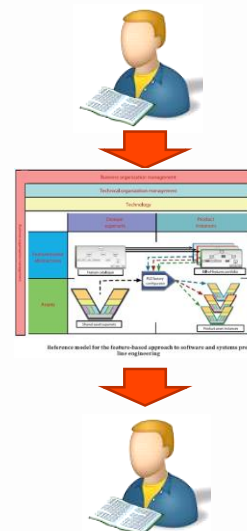


Custom-made development

Customer receives a product that satisfies his needs

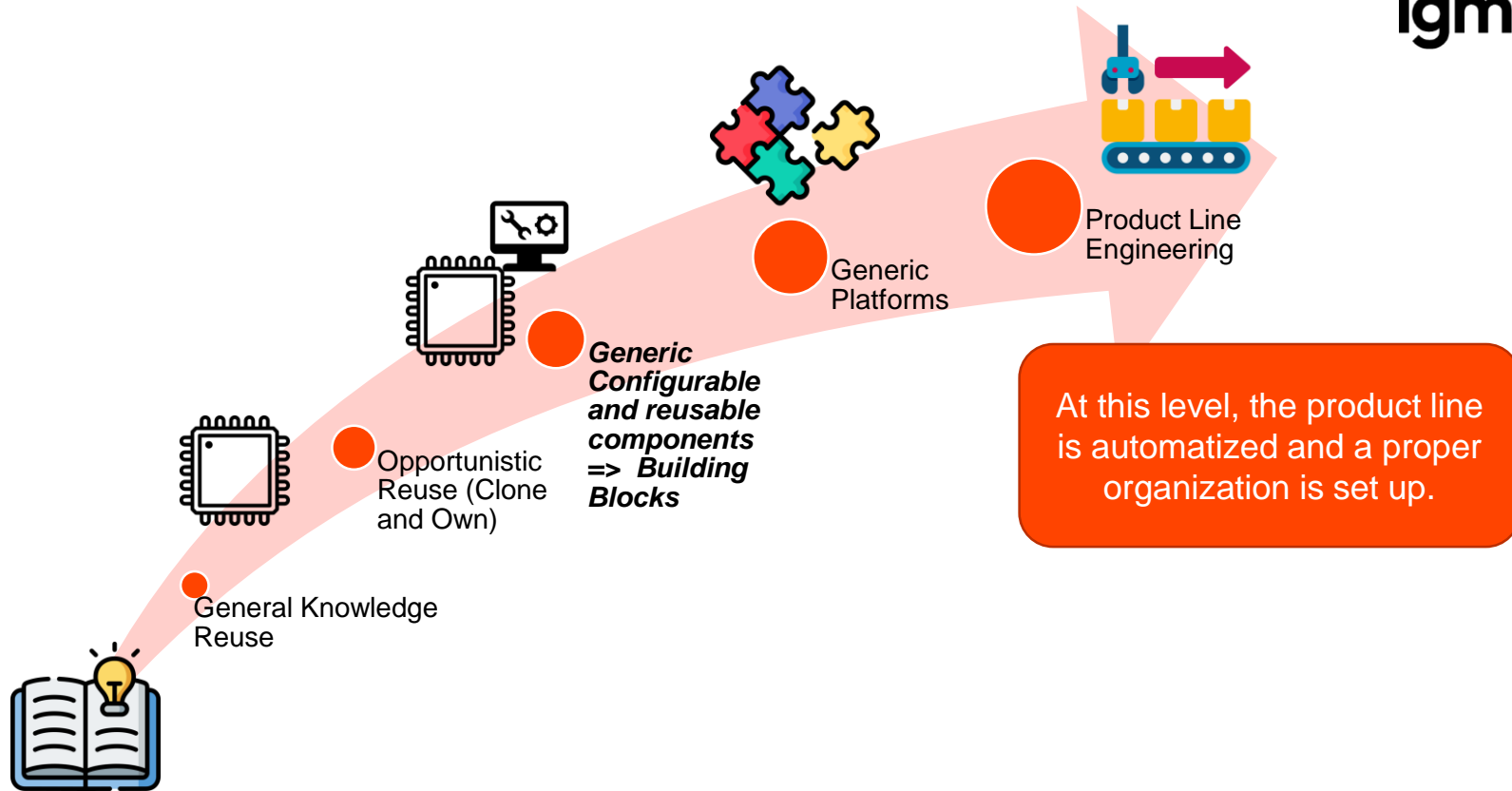
Customer configure the capabilities in a catalogue

Semi-automized development

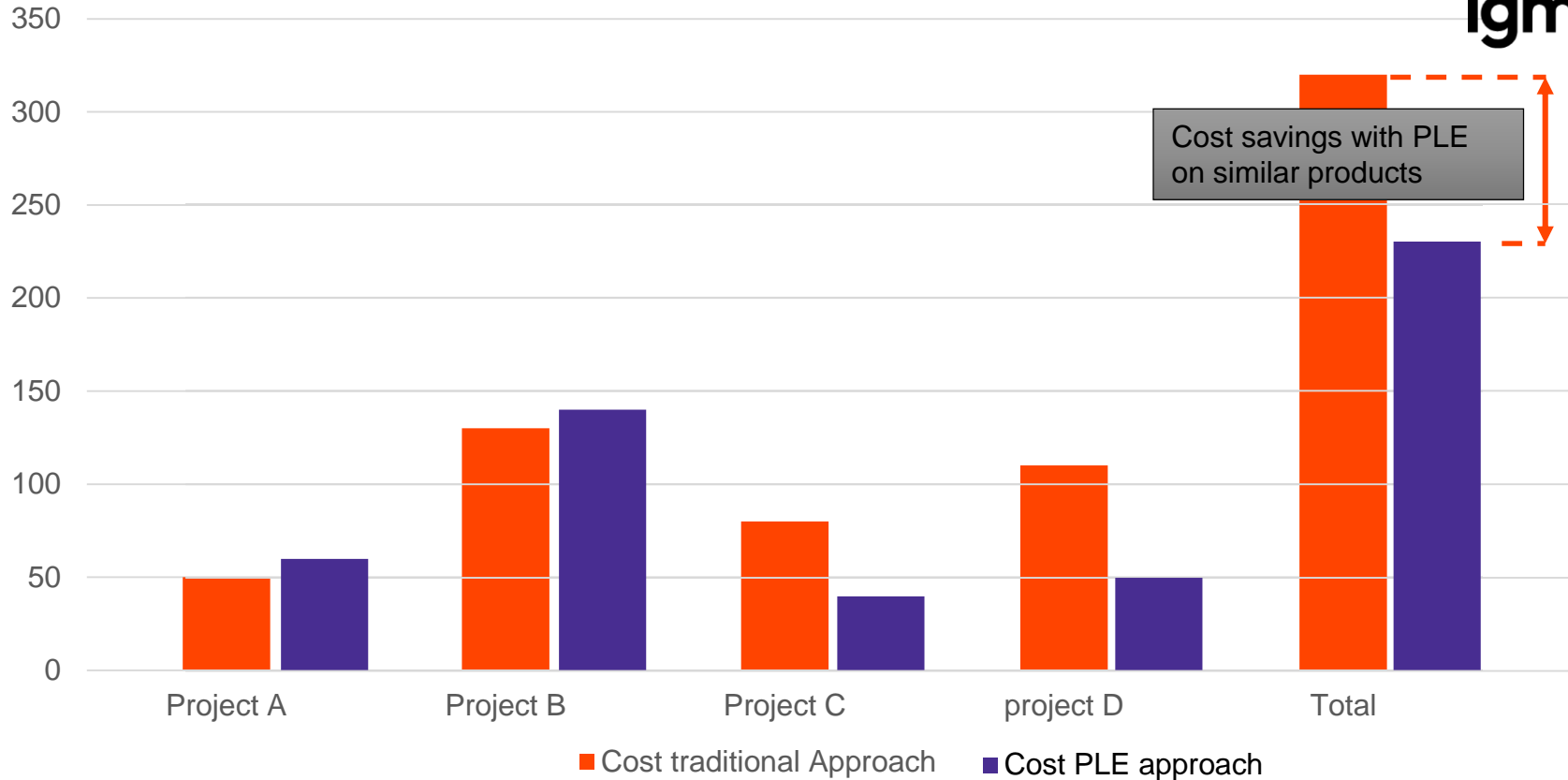


Configure to Order (CTO)

Customer receives a product that satisfies his needs



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/ Needs for Reuse Enhancement - vision

MBDA

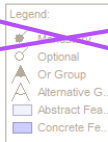
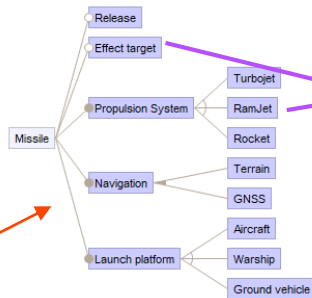
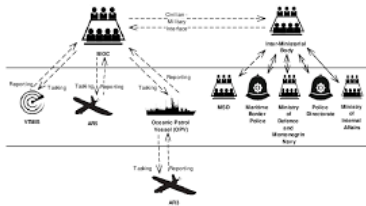
lgm/

How to reuse
efficiently existing
systems for the new
need ?

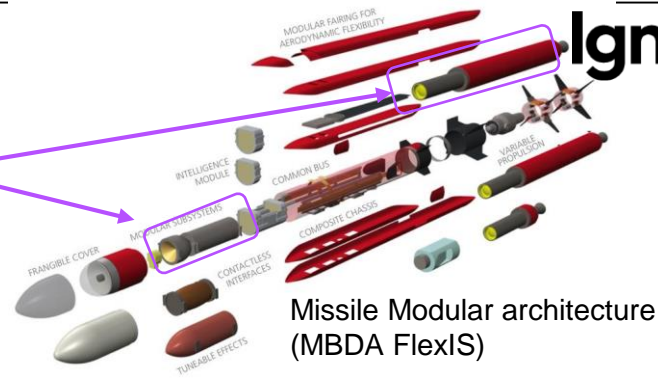


Select existing
features in
catalogue

Customer Needs
identification



Existing
Catalogue



Missile Modular architecture
(MBDA FlexIS)



Product A

Product B



Product C

1

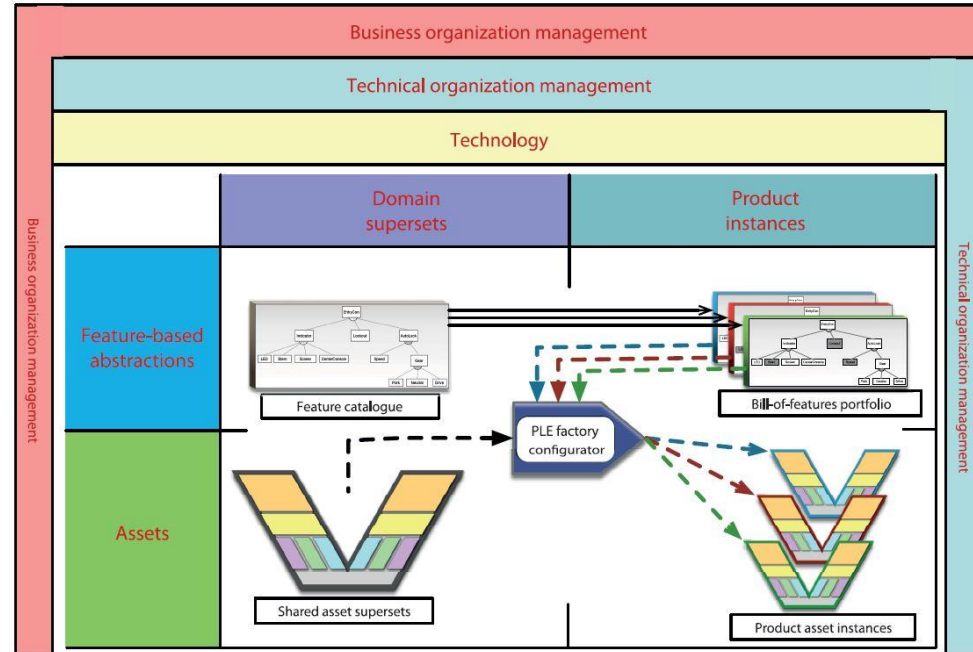
Business organization

2

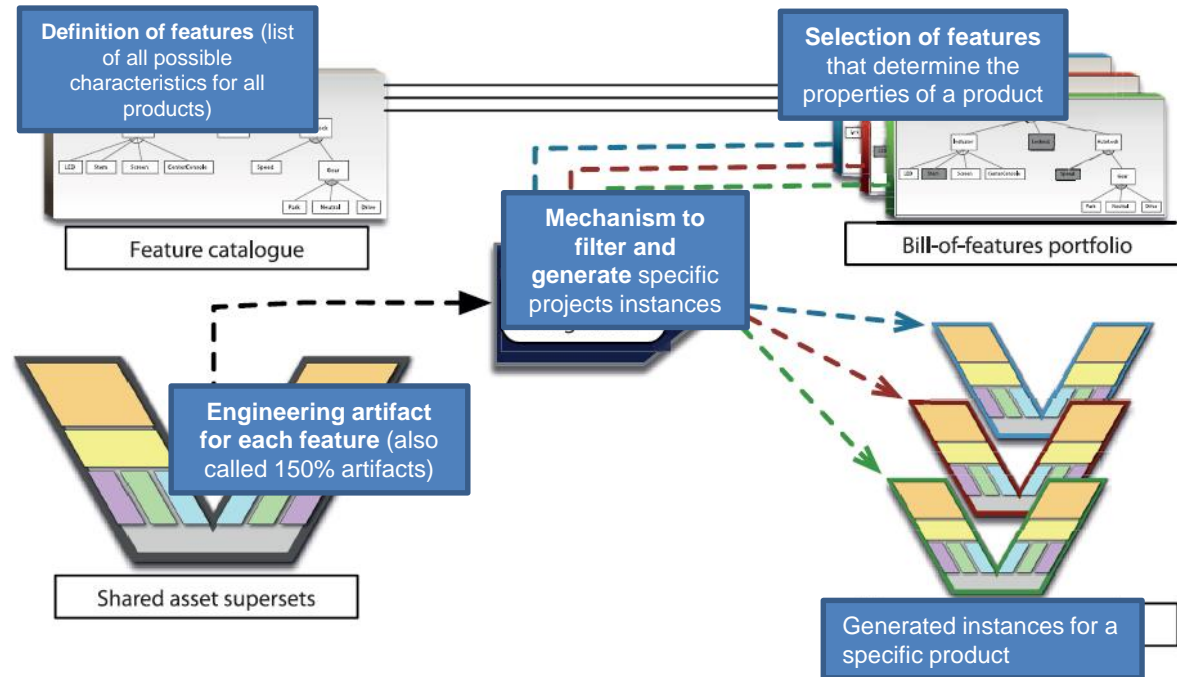
Technical organization management

3

Technology



Reference model for the feature-based approach to software and systems product line engineering





Working
Group PLE



Working
Group
MBPLE

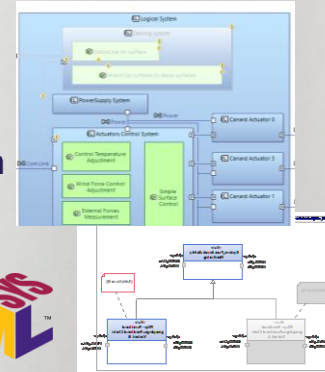
PLE
glossary
(EN-FR)

ISO
Standards
26581



PLE
metamodel
(tool
agnostic)

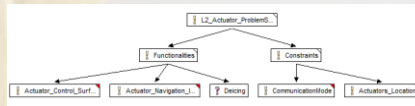




MBDA

End to End Model based engineering

Feature catalogue



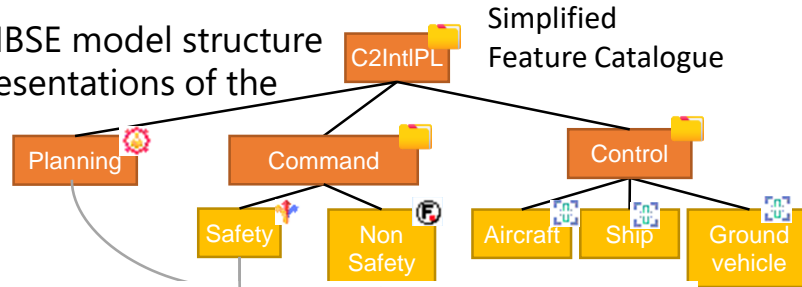
Bill Of Features Portfolio

Model Elements	Level	Complexity Measurement
12_Actuator_ProblemSpace		95
12_Actuator_ProblemSpace		
12_Constraints	2	✓
12_Actuation_Location	2.2	✓
12_Canards	2.2.1	✓
12_TailFin	2.2.2	✗
12_Wings	2.2.3	✗
12_CommunicationNode	2.1	✓
12_Functionalities	1	95
12_Actuator_Control_Surface	1.1	✓
12_Actuator_Navigation_Info	1.2	✓
12_Decision	1.3	✗

MBDA

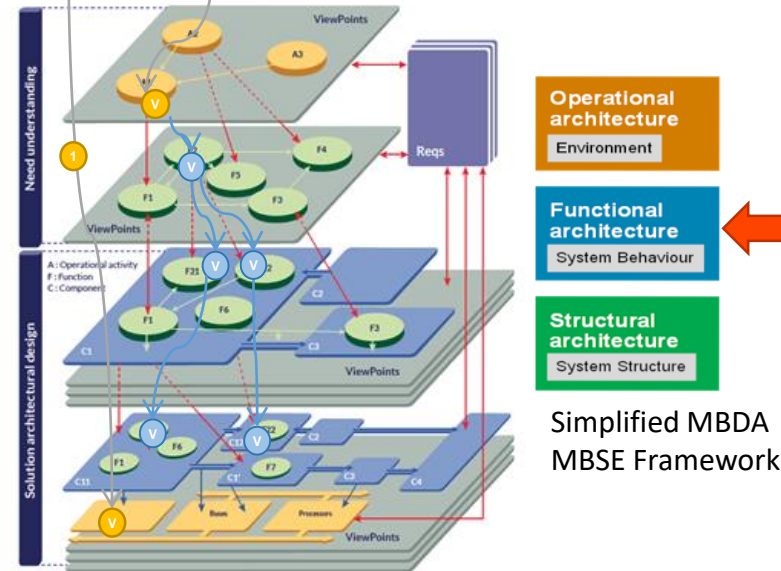
Product Line Engineering Model

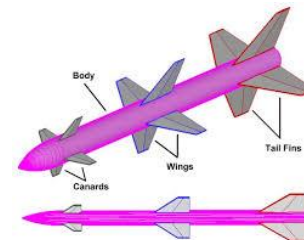
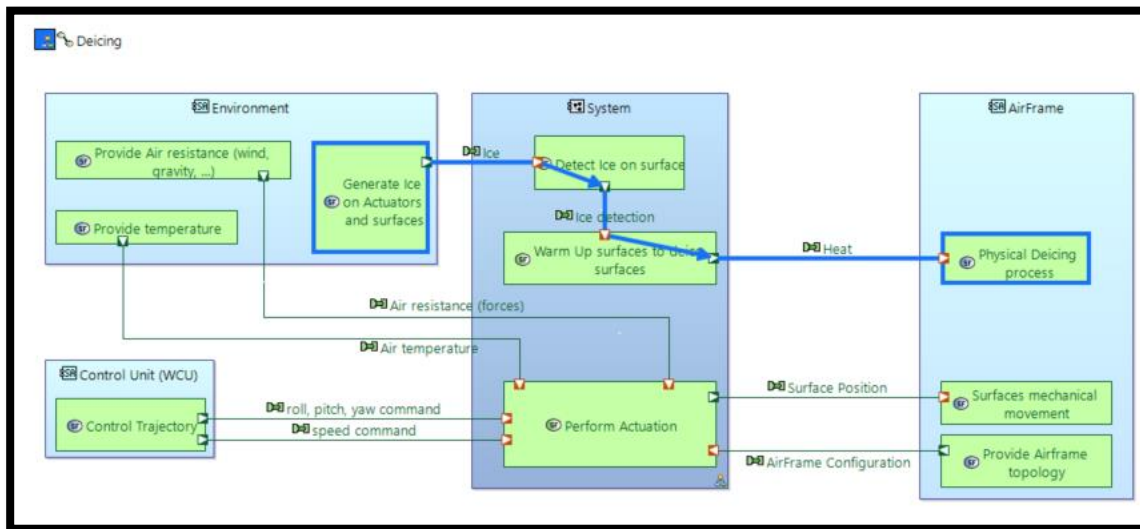
The feature catalogue shall mirror the MBSE model structure to allow an easy navigation in both representations of the 150% product line.



Variability:

- **Atomic Variation points** are assigned directly to a model element.
- **Starting Variation points** are used to minimize the engineering effort by automatic assignment features to a chain of MBSE model elements.





Variability sources

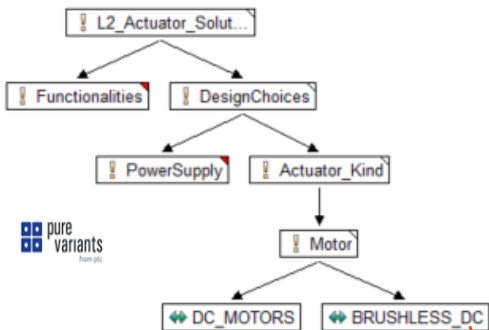
- Kind of actuators
- Nb of controlled surfaces
- Deicing

Equipment with a fictive feature « Deicing » in charge to warm up surfaces when ice appears

Feature Catalogue

Igm/

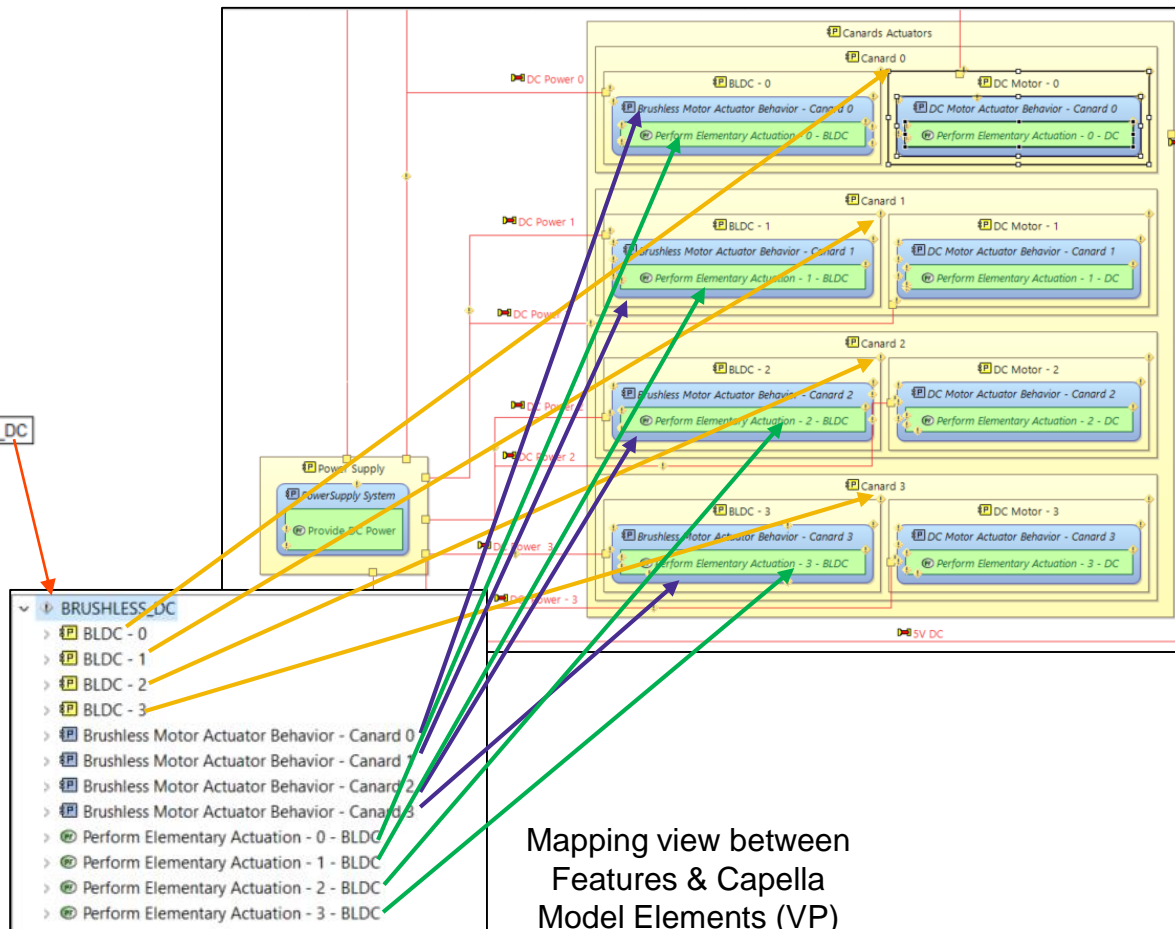
Capella



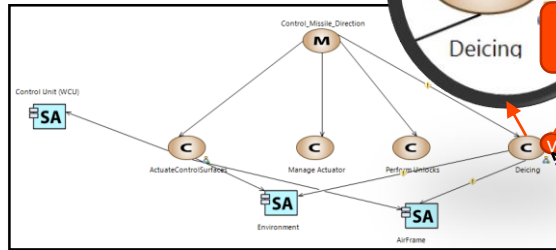
pure
variants
from plc

Capella

pure
variants
from plc

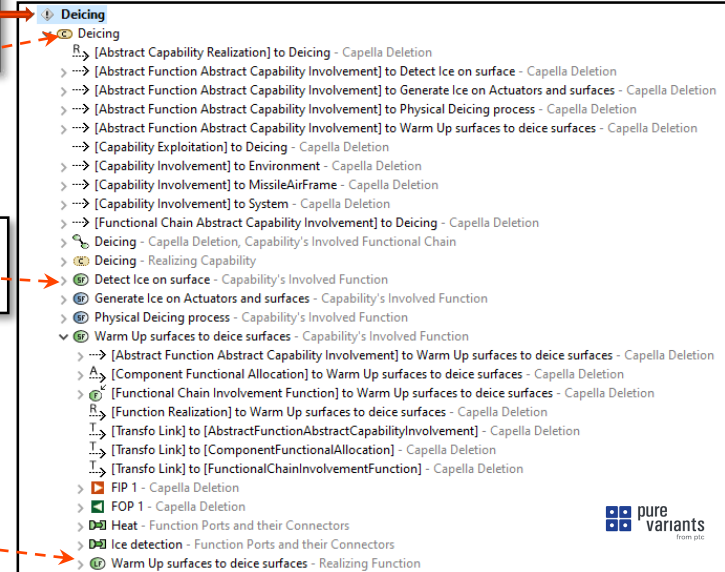
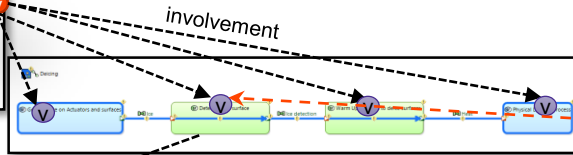
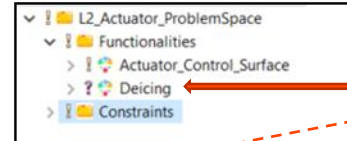


Feature catalogue

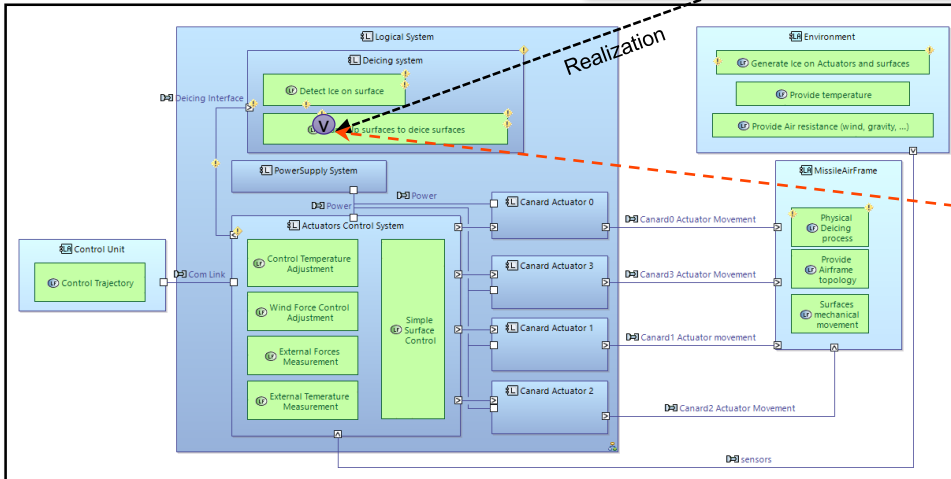


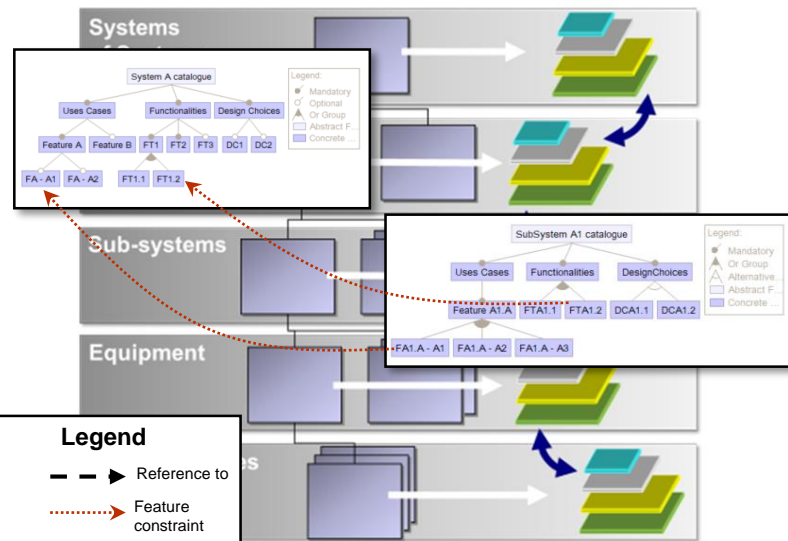
Starting
Variation Point

Feature Catalogue

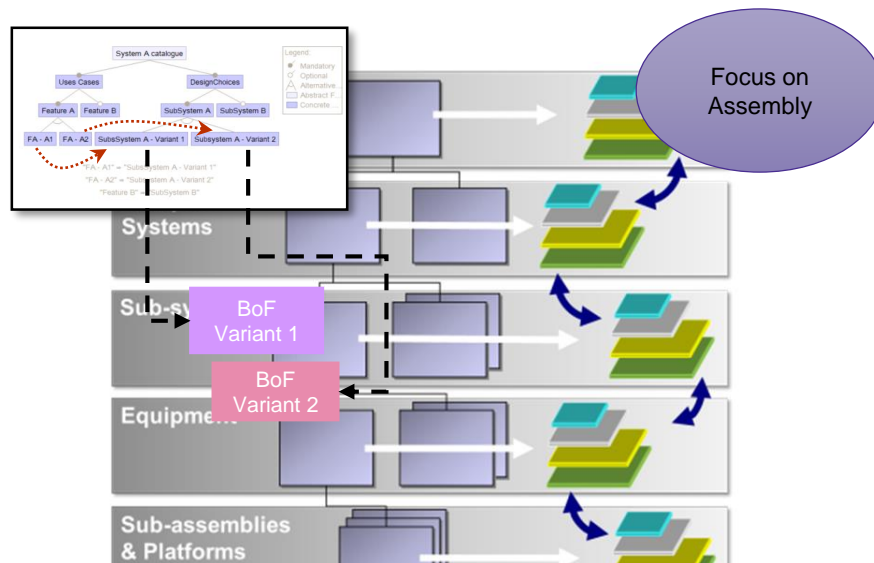


Mapping view between Features & Capella Model Elements (VP)



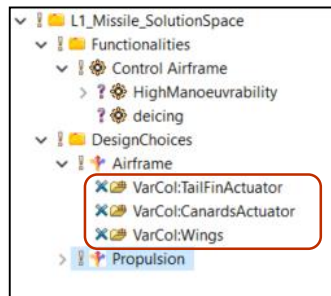
Product breakdown approach (top-down)

High level features are defined at the upper level and refined at the next level following traditional breakdown cycle -> Generally used for new products

Products Assembly approach (bottom-up)

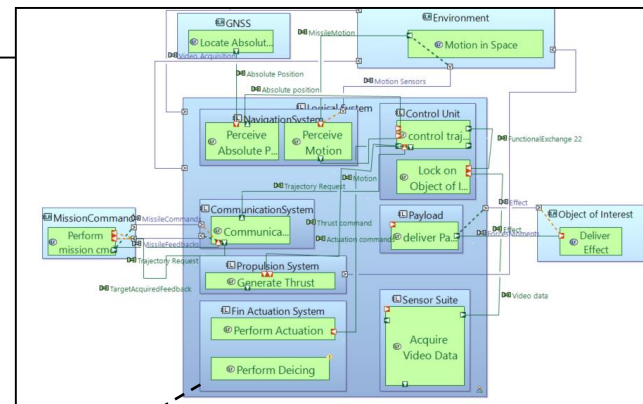
High Level product integrates existing products in the catalogue. In this, case feature catalogue or the system specifies which existing products to assemble -> Generally used for companies which has existing products / perform currently large reuse of existing products.

/ Assembly Strategy - Relations between Capella Models and Feature Catalogue

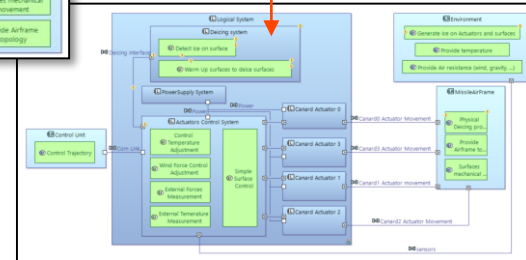
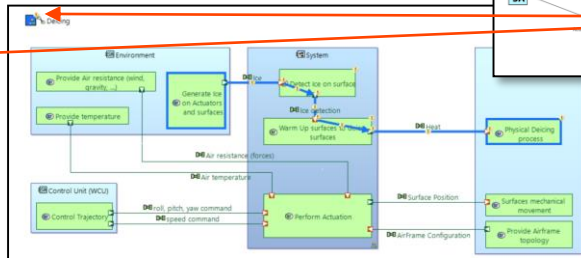
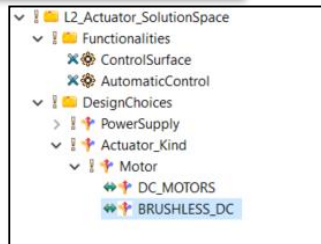
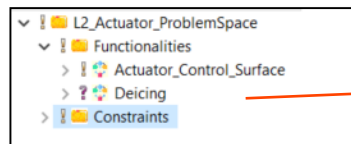


Model Elements		Level	VariantA	VariantB	VariantC
+	Missile_SolutionSpace				
+	Missile_SolutionSpace				
+	Functionalities	1	✓	✓	✓
+	Control Airframe	1.1	✓		
+	HighManoeuvrability	1.1.1	□	□	□
+	deicing	1.1.2	□	✓	✓
+	DesignChoices	2	✓		
+	Airframe	2.1	✓		
+	VarCo1TailFinActuator	2.1.1	✓	✓	✓
+	Tailfin	2.1.1.1	✓		
+	VarCo1CanardsActuator	2.1.2	✓		
+	Canard1_NoDeicing	2.1.2.1	✓		
+	Canard1_NoDeicingL2_Actuator_ProblemSpace	2.1.2.1.1	✓		
+	Functionalities	2.1.2.1.1	✓		
+	Canard1_NoDeicingActuator_Control_Surface	2.1.2.1.1	✓		
+	Canard1_NoDeicingDeicing	2.1.2.1.1	✓		
+	Canard1_NoDeicingConstraints	2.1.2.1.1	✓		
+	Canard1_NoDeicingL2_Actuator_SolutionSpace	2.1.2.1.2	✓		
+	Canard1_WithDeicing	2.1.2.2	✓		
+	Canard1_WithDeicingL2_Actuator_ProblemSpace	2.1.2.2.1	✓		
+	Functionalities	2.1.2.2.1	✓		
+	Canard1_WithDeicingActuator_Control_Surface	2.1.2.2.1	✓		
+	Canard1_WithDeicingDeicing	2.1.2.2.1	✓		
+	Canard1_WithDeicingConstraints	2.1.2.2.1	✓		
+	Canard1_WithDeicingL2_Actuator_SolutionSpace	2.1.2.2.2	✓		
+	VarCo1Wings	2.1.3	□	□	□
+	WingsCfg	2.1.3.1	□	□	□
+	Propulsion	2.2	✓		

system level refers to collection of existing equipment variants (products instances)



Missile Level



 **Capella**

Actuator Level

/ Demo using Capella & Pure Variants – Missile Model

/ Demo using Capella & Pure Variants – Actuator Model

workspace_capella_days - platform/resource/Actuator%20-%20example/SimplifiedActuator.aird/[MCB] Capabilities - Capella

File Edit Diagram Navigate Search Project Run Window Help

Project Explorer

- Actuator
 - Actuator - example
 - SimplifiedActuator.afm
 - SimplifiedActuator.aird
 - Actuator - example
 - REC Catalog
 - Operational Analysis
 - System Analysis
 - System Functions
 - Capabilities
 - ActuateControlSurfaces
 - ManageActuator
 - PerformUnlocks
 - Deicing
 - [MCB] Capabilities
 - Interfaces
 - Data
 - Structure
 - Missions
 - Logical Architecture
 - Physical Architecture
 - EPBS Architecture
 - Representations per category
 - SimplifiedActuator.capella
- Missile - example
 - _FeatureCatalogue
 - _Products
 - _TransformationModules
 - Questionnaire_L1_Missile
- Missile - example
 - MissileExample.afm
 - MissileExample.aird
 - MissileExample.capella

Diagram: A central node 'C' (Control Unit) is connected to 'Control Direction' (M), 'AirFrame' (SA), and 'Environment' (SA). 'Control Direction' (M) is also connected to 'AirFrame' (SA). 'AirFrame' (SA) is connected to 'Deicing' (C). A yellow note points to 'Deicing' (C): "May be hypothetical but illustrates well what is an optional feature associated with a use case".

Mapping Model: capella_actuator

Assigned Variant: /

type filter text

- BRUSHLESS_DC
- ControlledCanards_4
- DC
- WithDeicing

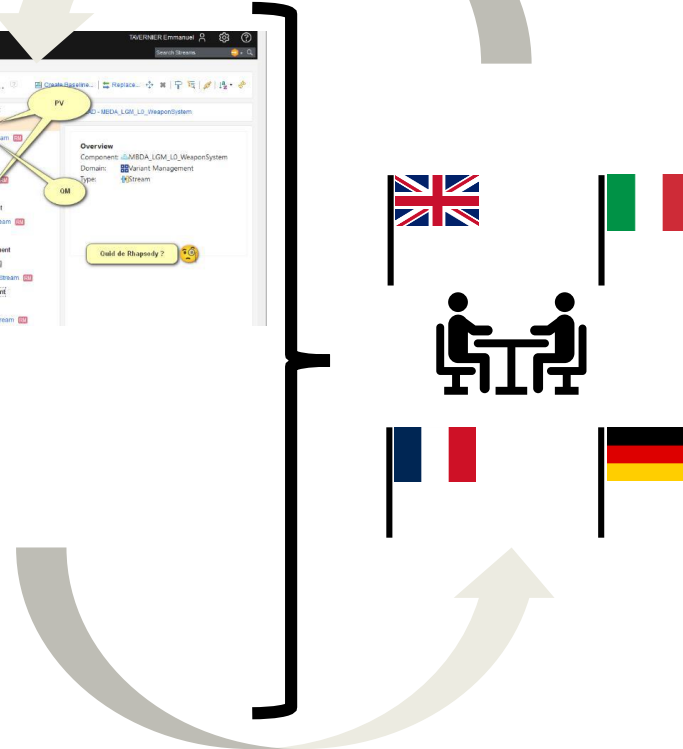
SimplifiedActuator:Actuator - example:System Analysis:Capabilities:[MCB] Capabilities (Synchronized)

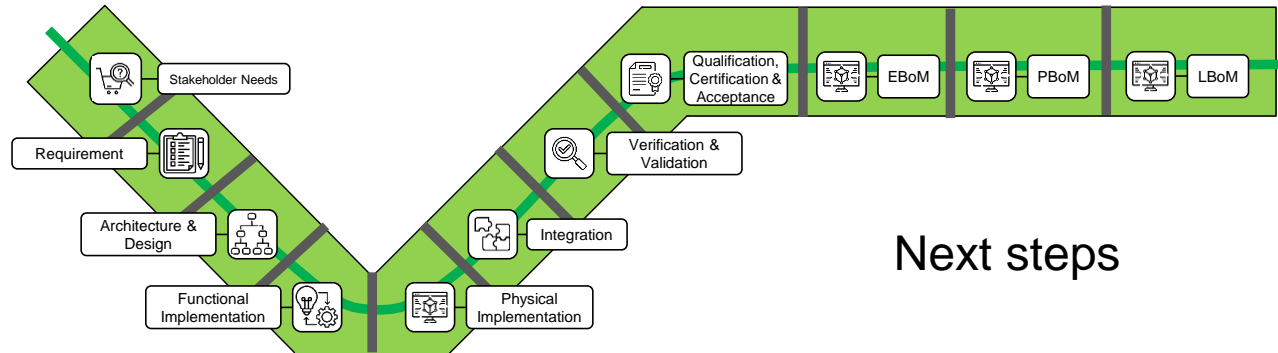
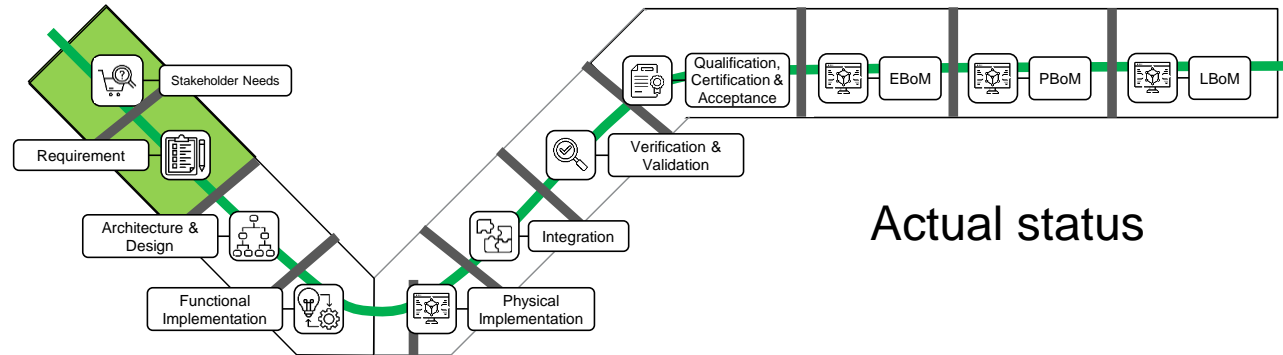
828M of 1000M

- Enhance the process with :
 - Configuration management
 - Additional Engineering practices e.g. common questionnaire



- Guiding Change Management :
 - Guidelines :
 - PLE Concepts
 - PLE MBSE (Rhapsody/Capella/DNG)
 - PLE Factory
 - Illustrated Examples based on MBDA tools
 - E-learning supports :
 - PLE
 - Tools





- MBPLE is a key enabler for efficient reuse by providing a strong governance
- Setup PLE in Organization requires appropriate definition set of Processes, Methods & Tools
- Need a mindset change and organizational changes to increase efficiency
- Configuration Management Process and strategy for Product assets instances and Product Line Assets Change Management is crucial



Dieter Wagner

MBDA

Dieter.wagner@mbda-systems.de



Sebastien DUBE

LGM

sebastien.dube@lgm.group

CONTACT

MBDA

lgm/

