Towards System & Software Product Line Management Implementation in Extented Enterprise

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AIRBUS GROUP INNOVATIONS

Agenda

1. **Motivation**
2. Objectives
3. Principles & Methods of SPL
4. Current Activities & First Results
5. Conclusion & Outlook
6. Questions

Motivation (1)

Experienced Issues in Product Development today:

- The **reuse of information artifacts** is currently manual, prone to errors, not traced and strongly limited in scope.

- The deployed **development data** differs from one program to the next and even between different domains.

- The **link between engineering objects** in the different information databases is not fully possible with the today tools.

➔ **Consequence: The reuse of engineering artifacts remains low and, even if possible, it doesn't allow enough profitability.**


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Motivation (2)

Needs:

- Rising need for **individualized products** & **system functions**.

- Individualized products incorporate a higher **complexity** and contain **system & software variants** throughout all **engineering artifacts**.

- The increasing complexity of product development requires an integrated management of **development efficiency**, **traceability** and **cost optimization**.

- ➔ **Future Prospect: ability to propose a panel of variant solutions while reducing their development cost and improving the profitability**

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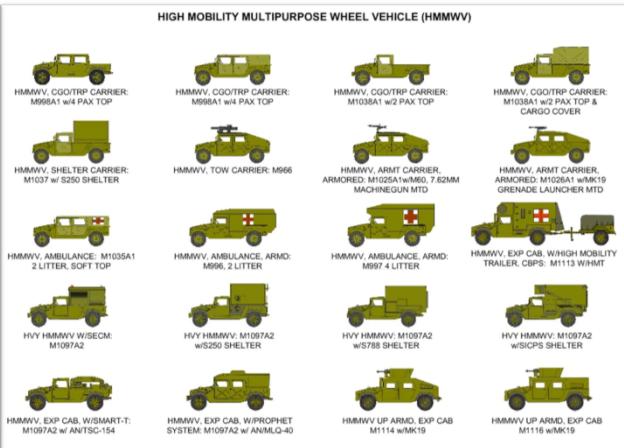
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Objectives

Goals:

- to envisage the **development of a systematic and low risk approach for System Product Line Management (SPL)** by covering the following identified challenges:

Variant Management	Systematic Reuse	Product Line Driven Architectures
Identify the right degree of granularity for **variability**	Identify useful **artifacts for reuse**	Derive product lines through **modularization** of architectures
Pre-define the product variability in terms of **variants** and **variant families**	Assess potential reuse and analyse the **impact** on information that should be reused	Identify, benchmark and rank available **vendors' tools** supporting the product line approach
Develop **concepts**, **methods** and **processes** for variant management	Develop **concepts**, **methods** and **processes** for systematic reuse	
Develop a business strategy for variant management process **integration**	Develop a business strategy for **systematic reuse**	

Current Research Focus

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Principles & Methods of SPL (1)

Benefits of the SPL Approach:

Improve Quality
The artifacts developed for a database in a product line environment are reviewed and verified in many products and contexts

Reduce Time to Market
The time to market is considerably shortened as many artifacts can be reused for each new product

Reduce Development Cost
The reuse of building blocks and common artifacts for different product developments leads to long-term cost reduction.

Manage Evolution & Obsolescence
Well-defined interfaces in the reference system architecture enable replacing of single elements (new or changed artefact) without affecting the complete system

Improve Cost Estimations
Marketing and sales can focus on those products that can be easily produced within the product family. In a value engineering effort, the prices for these functions and features are well identified and known

Improve Customer Orientation
Customers get products adapted to their needs and wishes as well as higher quality products since reusable building blocks and their configurations have been tested in many other products

Benefit	Percent Reporting *
Improved Quality	52 %
Reduced Cost	45 %
Improved Productivity	39 %
Improved Customer Orientation	39 %
Reduced Time to Market	30 %

Principles & Methods of SPL (2)

Success Criteria of the SPL Approach:

Deep Domain Expertise
The organization must have significant experience in developing products before adopting a product line approach. This experience provides **knowledge of commonalities within the product line domains** that are likely to yield significant reuse possibilities.

Process Discipline
Developers in product line organizations must cooperate in the development of assets and products. The **processes they use must be applied consistently** both within asset creation and product development.

Change of Mindset
The organization **must shift its thinking from product-by-product development to the product line perspective**. Developers, marketers, and management must realize that they no longer create, market, and sell individual, stand-alone products.

Architectural Excellence
Product lines are generally built around a product line architecture that may either be built into a generator or be a separate asset. Success in the product line requires an **architecture that can support variation** discovered in understanding product line domains.

Management Commitment
A product line will not survive lacking strong management commitment. The product line commitment may run against the demands of individual product deliveries, but **management must align those demands without sacrificing the product line concept**
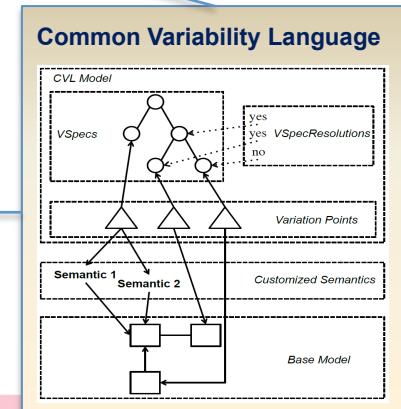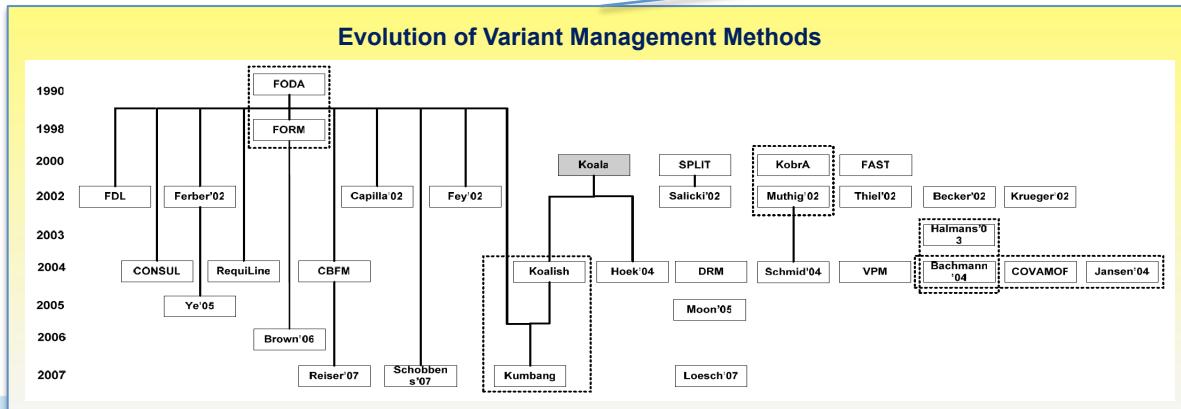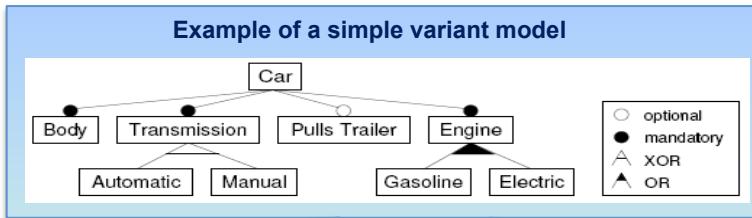
Product Line Champion
Successful organizations must have **one or more individuals who maintain the product line vision** through the development of assets and initial product line products. They must understand the product line concepts and have the authority to make change happen.

Principles & Methods of SPL (3)

Variant Management Methods

- Feature-Oriented Domain Analysis (FODA)
- Variability Identification (DRM)
- Process Support (FAST)
- (Software) Configuration-Based Variability (COVAMOF)
- Architecture-Centric Variability

Example of a simple variant model

Evolution of Variant Management Methods


Common Variability Language

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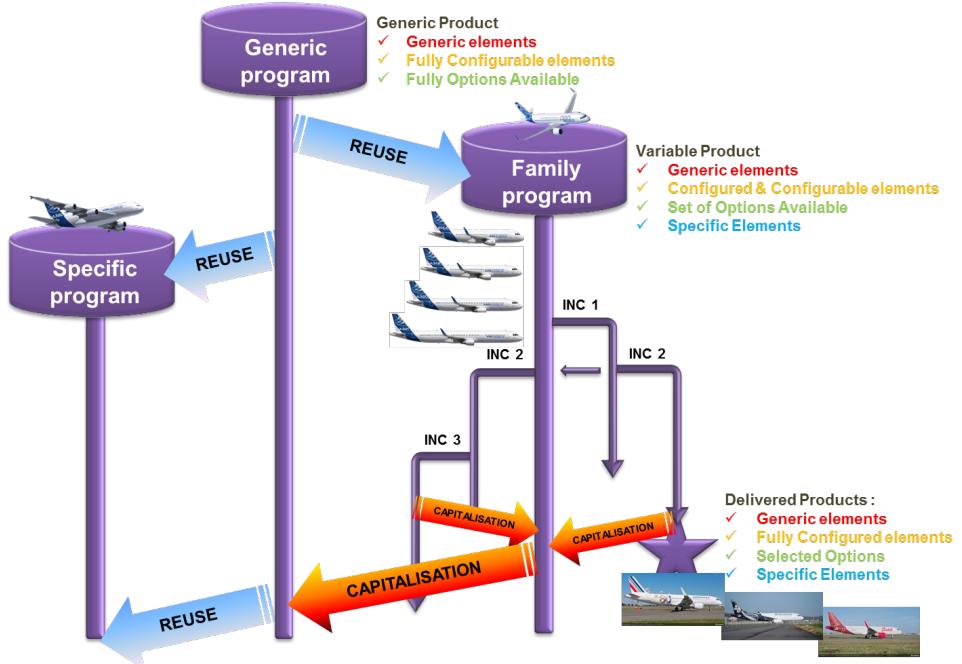6. Questions

Current Activities & First Results (1)

Requirements-Based Product Family Management

- Provide the capability to **manage high levels of commonality** between product variants in order **to maximize reusability**. The distinction can be made between Product Families (program axis) and Product Lines (domain axis).

- **Variability Management (VM)** is considered as **a prerequisite towards full PFM** because requirements, all related design references and V&V information for a number of variants of a given product (e.g. aircraft) must be managed.

- The aim of this approach was to bring a **requirements-based VM capability** in the short run for new aircrafts, which is effective and based on the existing features of the DOORS tool.
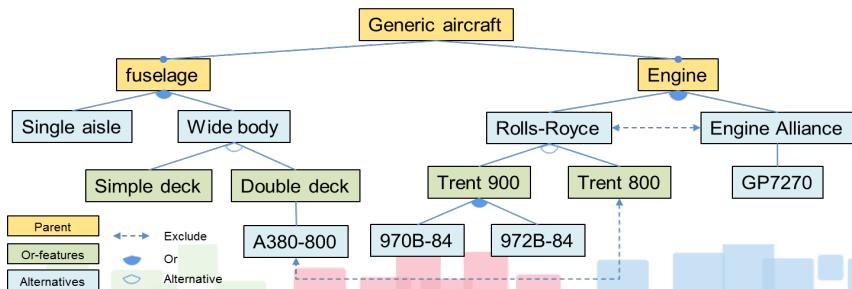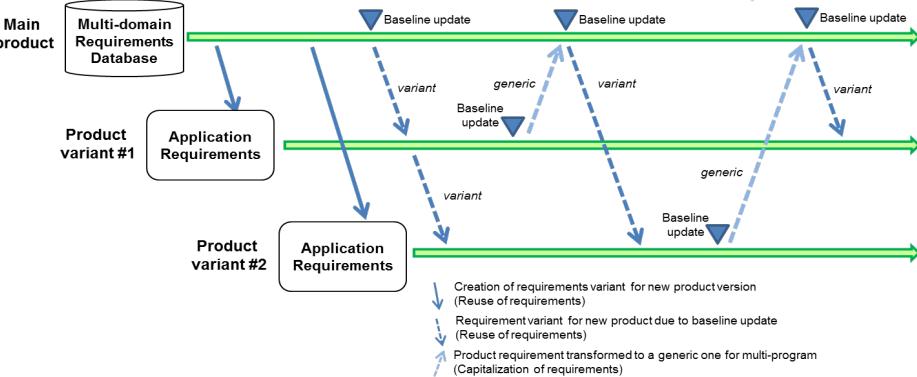
Current Activities & First Results (2)

Principles of Reuse and Capitalization of Information

Generic Product
- ✓ Generic elements
- ✓ Fully Configurable elements
- ✓ Fully Options Available

Variable Product
- ✓ Generic elements
- ✓ Configured & Configurable elements
- ✓ Set of Options Available
- ✓ Specific Elements

Delivered Products :
- ✓ Generic elements
- ✓ Fully Configured elements
- ✓ Selected Options
- ✓ Specific Elements

DD family

Specific A/C

DD: Double Deck aircraft
P:V – Pure::variant tool

Generic requirement

If the root cause of the leak at an interface between an <<A/C>> or <<Engine>> part, and a Seller part, is not identified, then <<XX>>% of this leakage shall be included in the Nacelle leakage.

Variable requirement

If the root cause of the leak at an interface between an Airbus Double Deck or Rolls-Royce engine part, and a Seller part, is not identified, then [30-50] % of this leakage shall be included in the Nacelle leakage
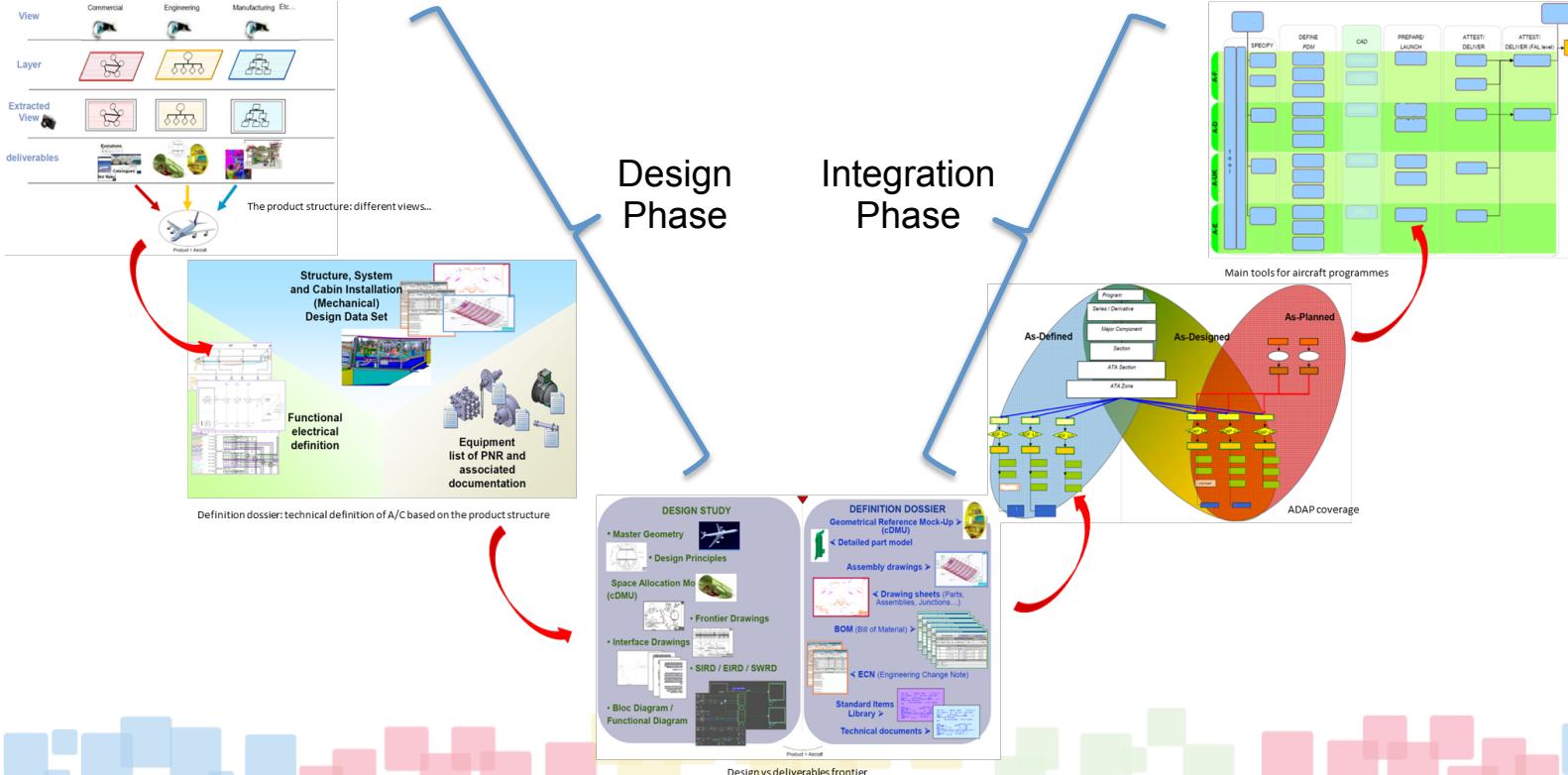
Delivered requirement

If the root cause of the leak at an interface between an A380Neo or Rolls-Royce T1000 part, and a Seller part, is not identified, then 40 % of this leakage shall be included in the Nacelle leakage.

Current Activities & First Results (3)

Process for Tool Chain

The product structure: different views...

Definition dossier: technical definition of A/C based on the product structure

Design Phase

Integration Phase

Design vs deliverables frontier

Main tools for aircraft programmes

ADAP coverage

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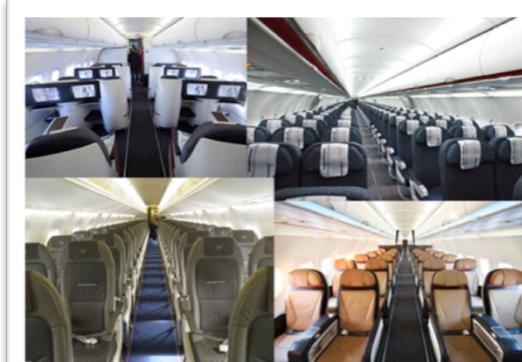5. **Conclusion & Outlook**
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Conclusion & Outlook (1)

Key Findings:

- SPL is **not a novel domain of investigations**, it is already well known by automotive, electronic & supplying industries. Therefore, **several methods and tools** are in place but it remains difficult to **get back real success stories** including **figures on the return on investments and benefits**

- The adoption of SPL involves **changes of magnitude** not only in the way the **enterprise organization** develops its products. It implies a **significant investment** plus a **change in the processes & mindset** to be well implemented and efficiently used.

- Within the Airbus Group, SPL is of interest for divisions having **different production lines** and if they realize a **critical amount of products** that can be grouped into **product families.**

Conclusion & Outlook (2)

Future Perspectives & Next Steps:

- Identifying potential **new lines of inquiry** in term of knowledge & use of SPL as well as finding new research areas focusing on **emerging SPL concepts** and **possible applications** of existing tools for the Airbus Group divisions

- Investigating real but size limited **use cases** provided by one or several Airbus business units in order to **show the interest and possible use** of SPL methods and solutions.

- Establishing **link with interoperability community** to incorporate methods for deep **management of interoperability constraints** because this seems critical for the enterprise in charge regarding the integration of all SPL parts.

UC Power Plant Integration:

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UC Cabin & Cargo Layout Precalculations:
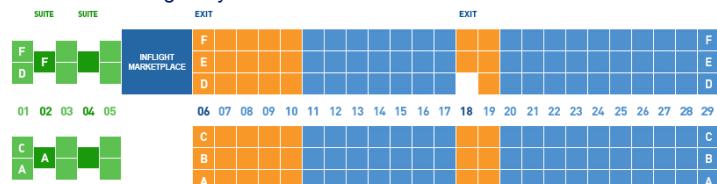
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Thank you for your attention!

References & Contact Information:

Mauersberger, R.; Reytérou, C. (2016). *Towards Systems and Software Product Line Management Implementation in Extended Enterprise.* Proceedings of the 26th Annual INCOSE International Symposium 2016, INCOSE, 2016

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