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Abstract

Product lines deliver three key benefits: cost avoidance, reduced risk, and shortened development schedules. The two main drivers of this are commonality through reuse and efficient variation management. The standard approach to commonality is to develop common core components across member products of a product line. When a common component is adopted by multiple product lines, its return on investment rises even further. In some cases, such a component becomes the foundation of a lower-level product line, often referred to as a *building block line*. Product Line Engineering (PLE) tools mainly focus on solving the variation management side of the equation; however, commonality is not automatically achieved. This brief outlines how our PLE tool suites can evolve to better enable reuse, achieving a more balanced approach that empowers enterprises to scale product lines effectively.

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Discovering & Enabling Opportunities for Commonality

Broadening Product Line Thinking Beyond Variation Management

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Variation management alone does not result in commonality and reuse.

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Message Objective:

Product line thinking needs to start by focusing on enabling commonality and reuse.

Variation management is integrated to improve efficiency.

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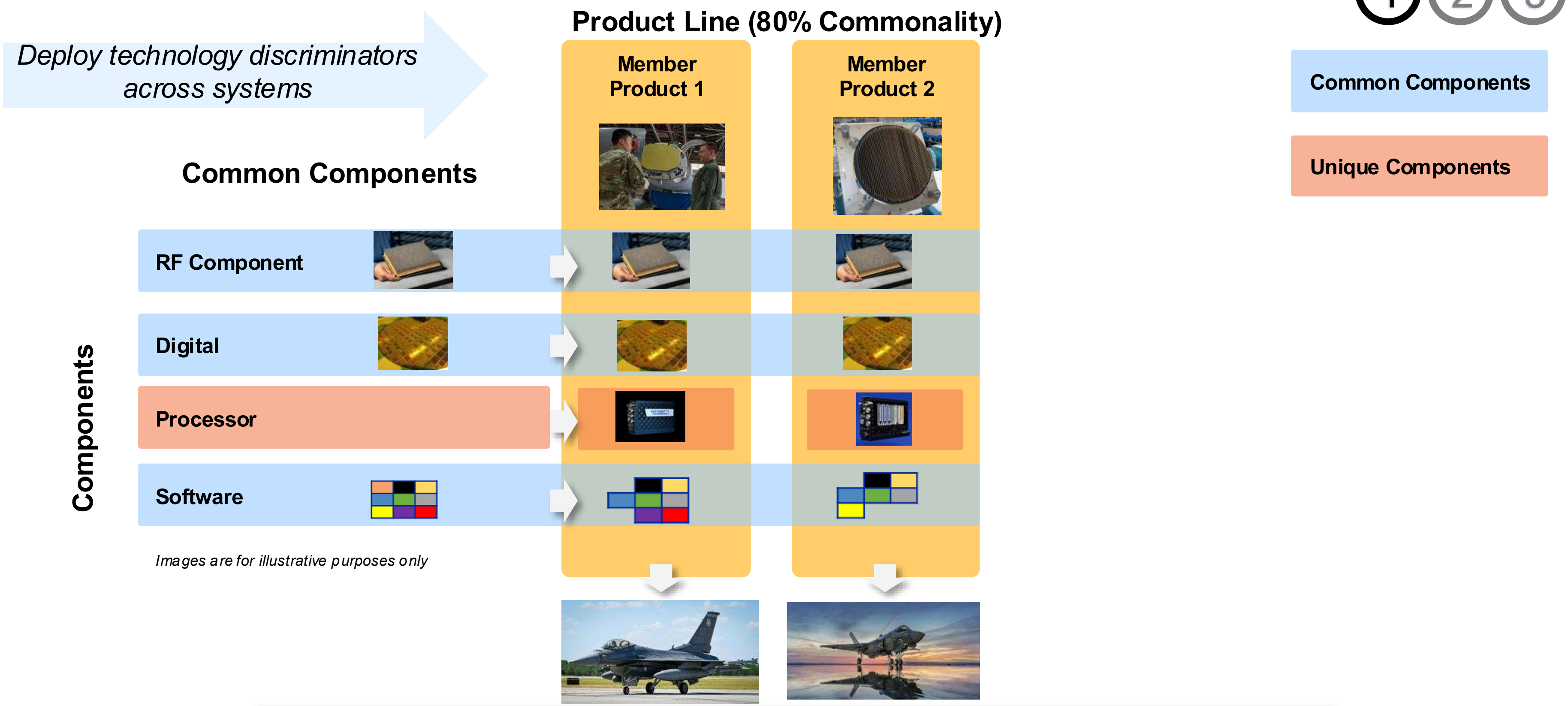
Developing Commonality

1. ***Utilizing common core components across product variants and product lines***

2. ***Leverage modular designs and standard interfaces***

3. ***Provide environment for discovering, enabling, and driving reuse and commonality investment***

Single Product Line Component Strategy



Common Components Rapid Delivery of Affordable Capability

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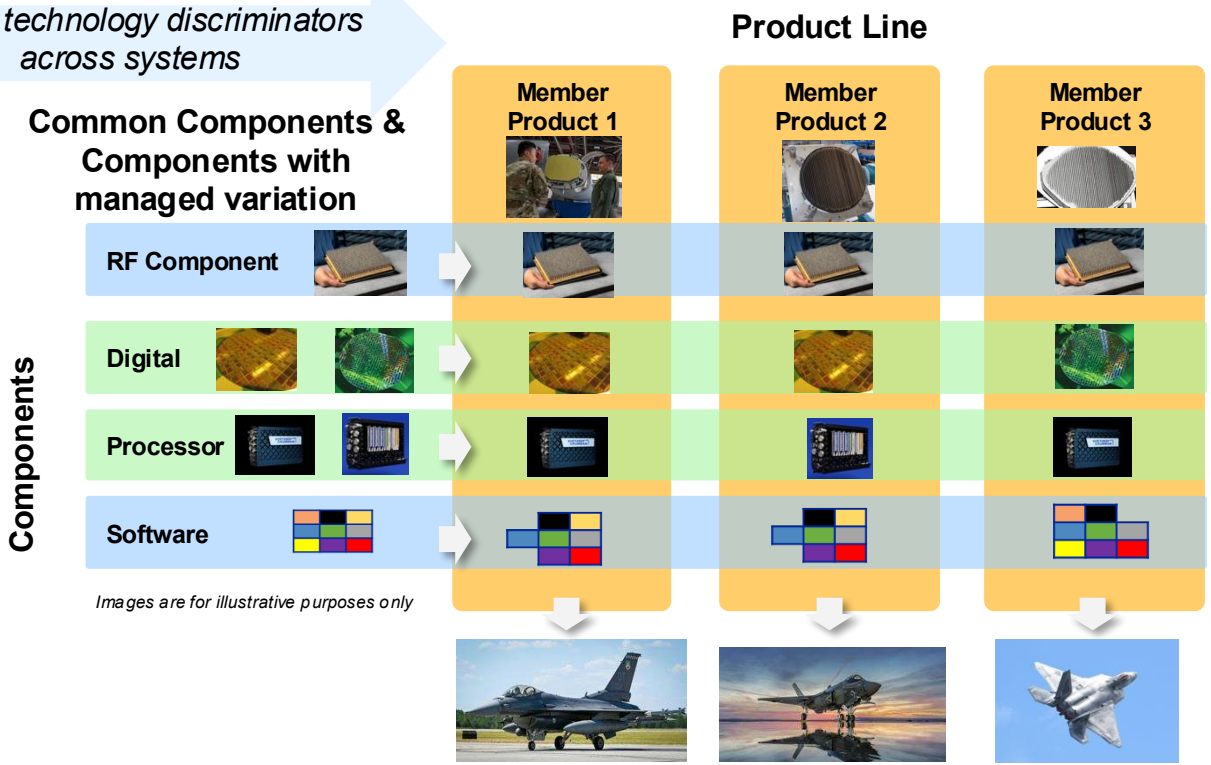
Single Product Line Component Strategy

1 2 3

Deploy technology discriminators across systems



Common Components

Components with Managed Variation

Components with managed variation can extend the reusability of an investment

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Multi-Product Line Component Strategy

1 2 3

Common Components

Managed Variation

Common Components & Components with managed variation

Product Line 1

Product Line 2

Components	Member Product 1	Member Product 2	Member Product 3	Member Product 1	Member Product 2
RF Component					EO/IR
Digital					 Digital
Processor					
Software	 				  Software

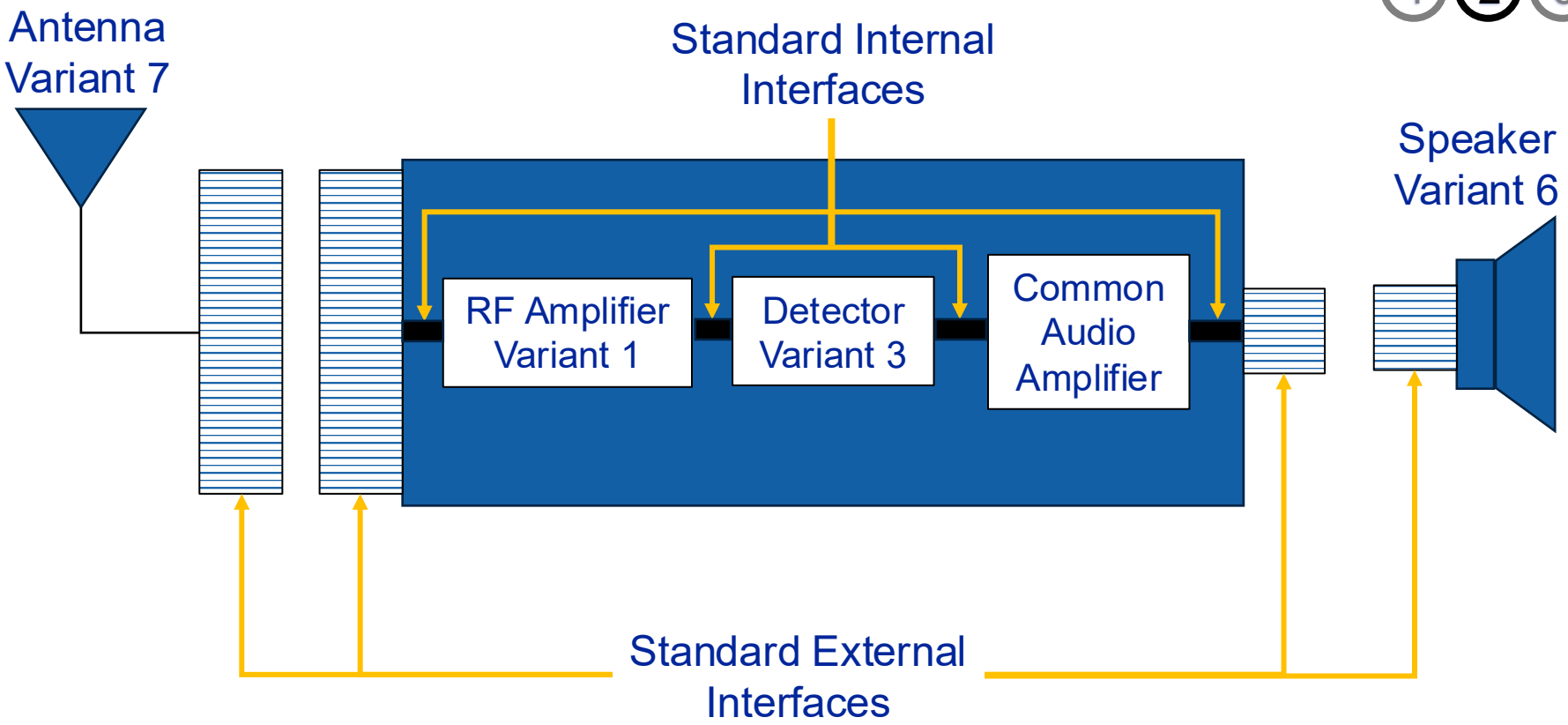
Images are for illustrative purposes only





Product Lines Enable Rapid Delivery of Affordable Capability

Modular Design & Standard Interfaces

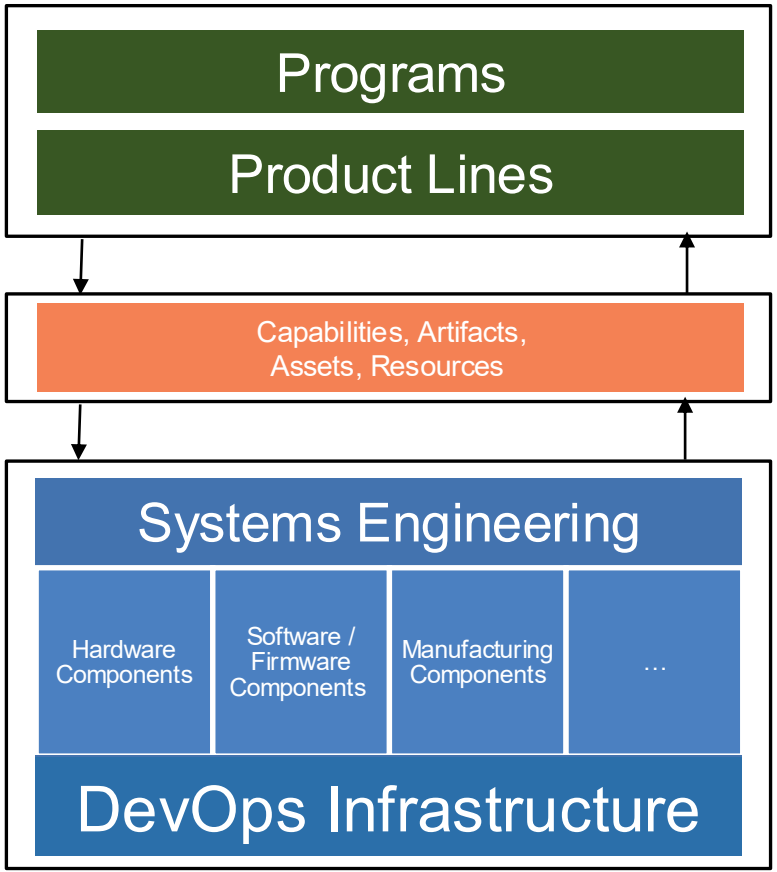


Environment for Discovery of Reuse Opportunity

Consumer / Producer Tier:

Data Search & Exchange Interface:

Repository / Ecosystem Tier:



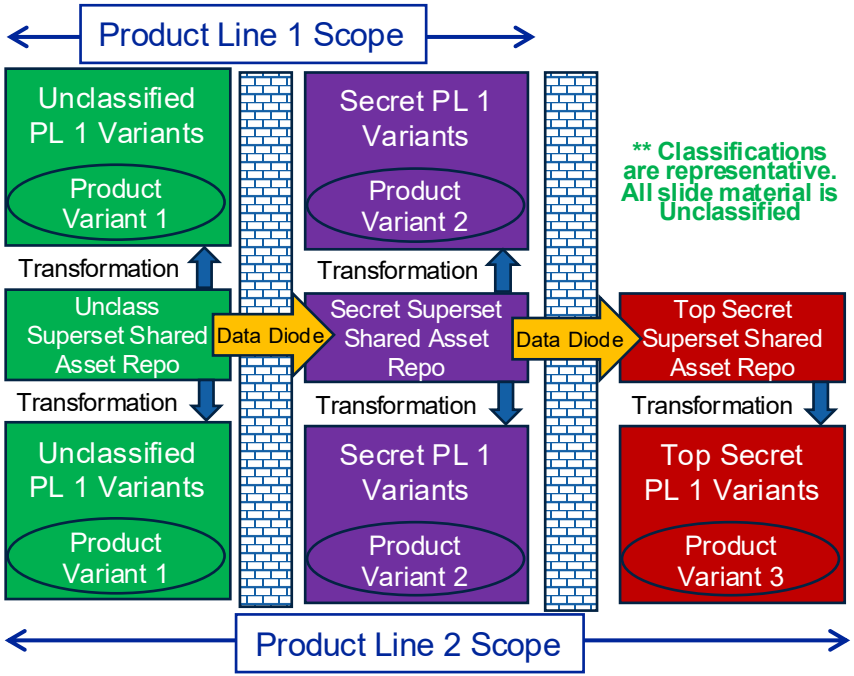
Keys to Discovery

- Interoperability
- Meaningful data structure
- Association of artifacts and data to components

Enabling Reuse by Breaking Down Barriers

1 2 3

Classification Barrier to Reuse



Tooling & Process Alignment Barrier to Reuse

DevOps Processes Example

CM, Governance, Ticketing, etc.	*Dev teams working in same tools, under same governance*
Code Dev.	*Dev teams leveraging same VMs & Tools*
Code Repository	*All Developed Code in Common Repository*
Integration, Test, Deployment	*Common Tools & Pipeline*
Staged for Delivery	*Common Tools*

There must be infrastructure in place to enable reuse

Drive Reuse within the Organization

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1 2 3

Business Development

Incentivized To:

- Consult PL Catalog
- Facilitate direct sales of existing products

Architects / Engineers

Incentivized To:

- Reuse modular reference architectures
- Leverage common and variation managed components

Program Management

Incentivized To:

- Track projected schedule and cost savings from reuse
- Promote funding of common and variation managed components

Even with barriers removed there must be a system in place to motivate reuse

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How Can Pure Variants & Sister Tools Evolve to Support?

Organizing

Multidisciplinary Product Taxonomy

Tooling to assist in developing a product taxonomy for components, assemblies, and systems that humans or AI can leverage for reuse discovery

Multidisciplinary Product Data Structure

Tooling to develop and implement data structure for providing performance data and other assets needed in trade studies

Auto Interface

Ability to generate interfaces for components that meet a set standard to allow for rapid reuse in modular reference architectures

PLE Interoperability

Interoperability between MBSE, ALM, PLM, Business, and Manufacturing systems is paramount to optimizing investments in commonality

Model of Models

Leveraging common components with managed variation will require expanded control of tools like MBSE and PLM

Auto Components

Ability to generate components from legacy or low TRL capabilities to rapidly reuse in modular reference architectures

Solutioning

Suggestions

AI support in design process for architecture and feature selection based on leveraging and improving reuse.

Composable Modeling & Optimization

Ability to compose configurations against a reference architecture and validate and optimize against objectives

Conclusion

Evolving our PLE Toolsets would be a monumental task for a single company, therefore a concerted effort across the industry, tool vendors, and the customer base must be pursued.