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Model Based Engineering (MBE) and Product Line Engineering(PLE): Combining Two Powerful Approaches

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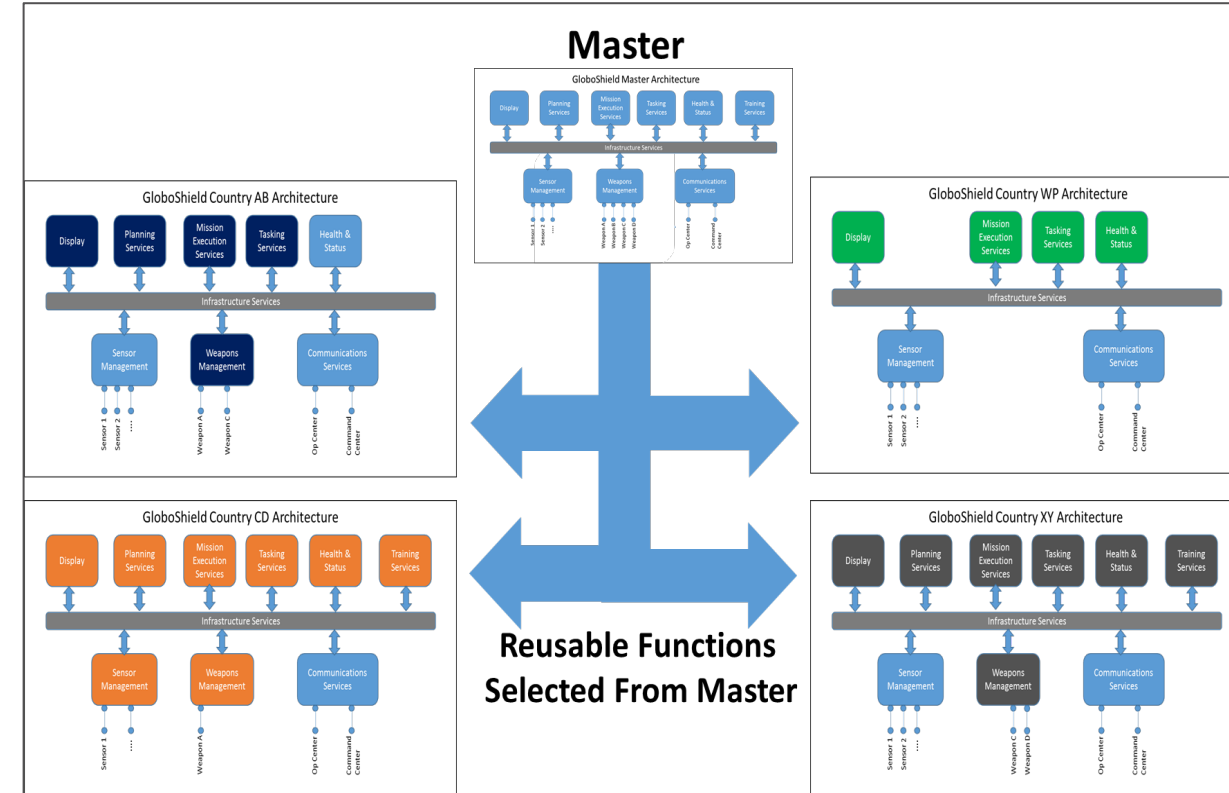
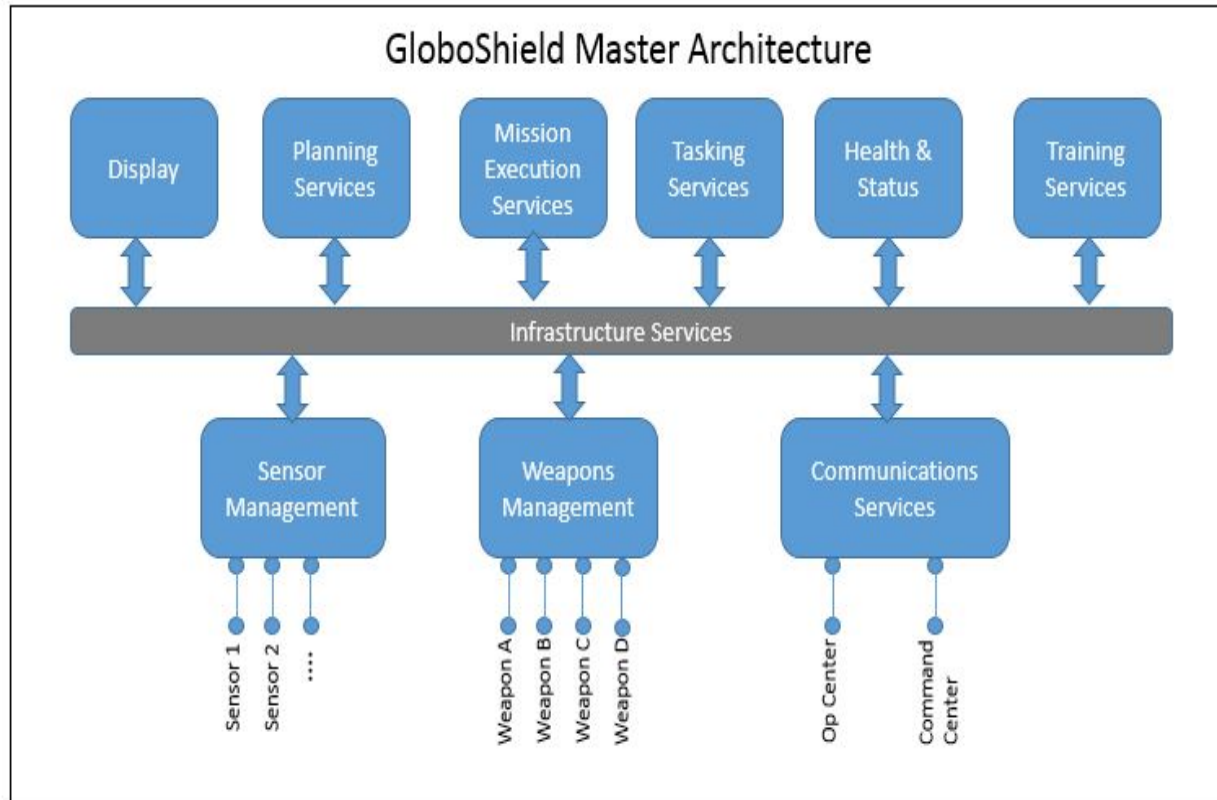


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- IAMD Product Line Goal
- MBE Approach
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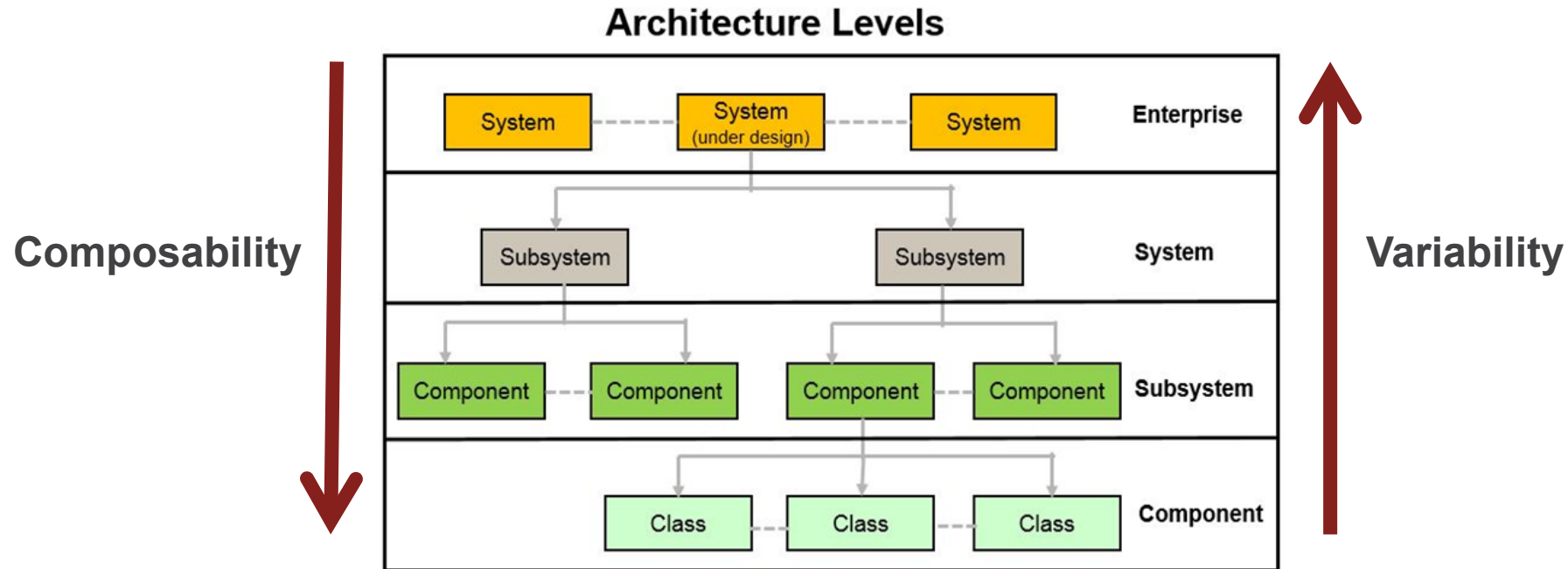
IAMD Product Line : Goal



- Maximize reuse – Identify commonality and manage variation
- Reduce cost – common architecture with composable components
- Manage/Maintain the product line architecture using MBE approach



Architecture Model Considerations

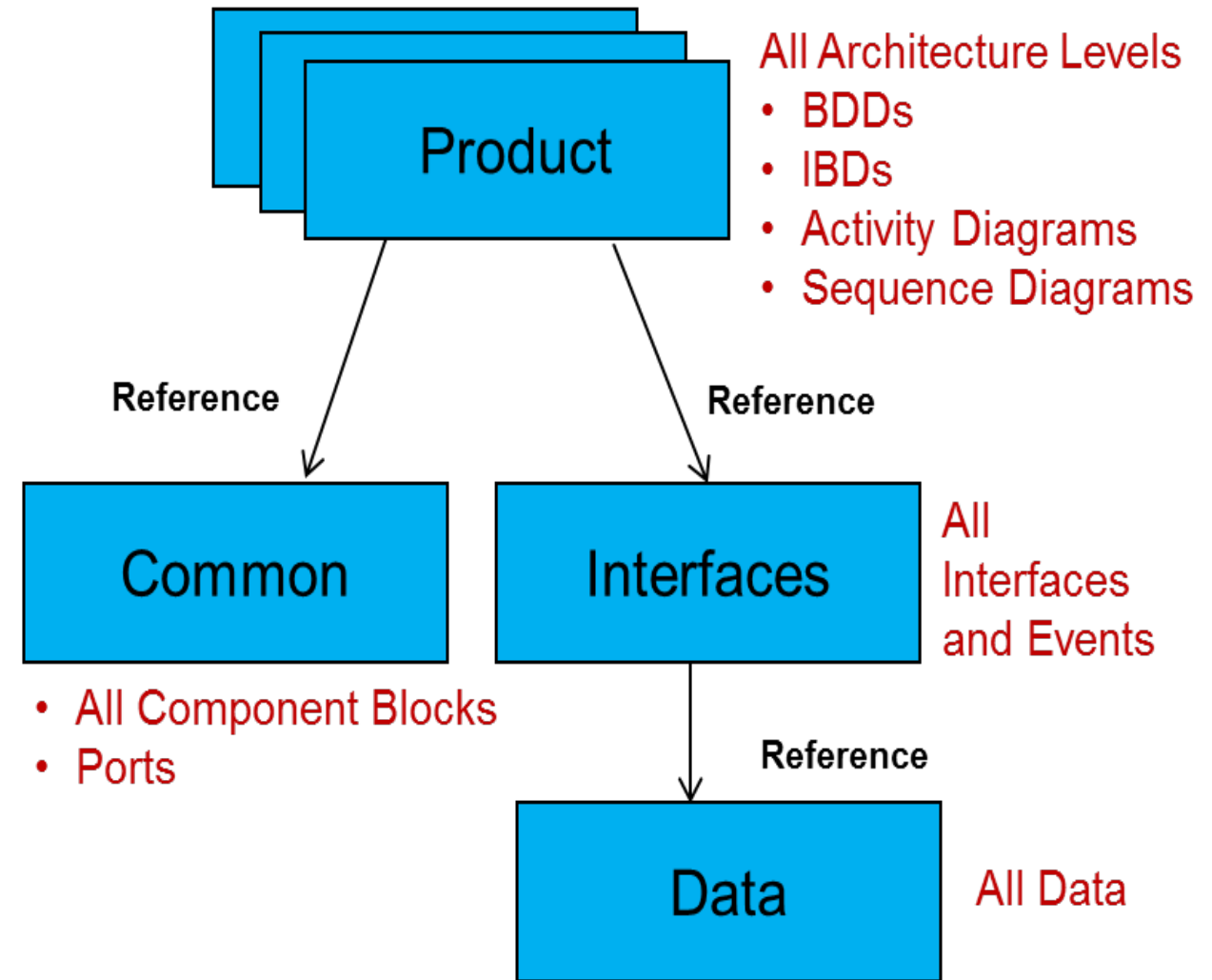


- How to architect and model each IAMD product?
- How to manage variability within the product line architecture?
- How to manage commonality across the product line architecture?

Model Based Product Line Architecture Approach



- Implemented SysML/UML using Rhapsody
- Building blocks:
 - Common components, interfaces, and data
 - Contain all variations
- Products:
 - Composed from the building blocks
 - Variations in building blocks captured and governed as each product developed





MBE Only Approach Limitations

Multiple structural variations mechanisms

stereotypes, inheritance, plug and play components, re-useable interfaces – no consistent approach

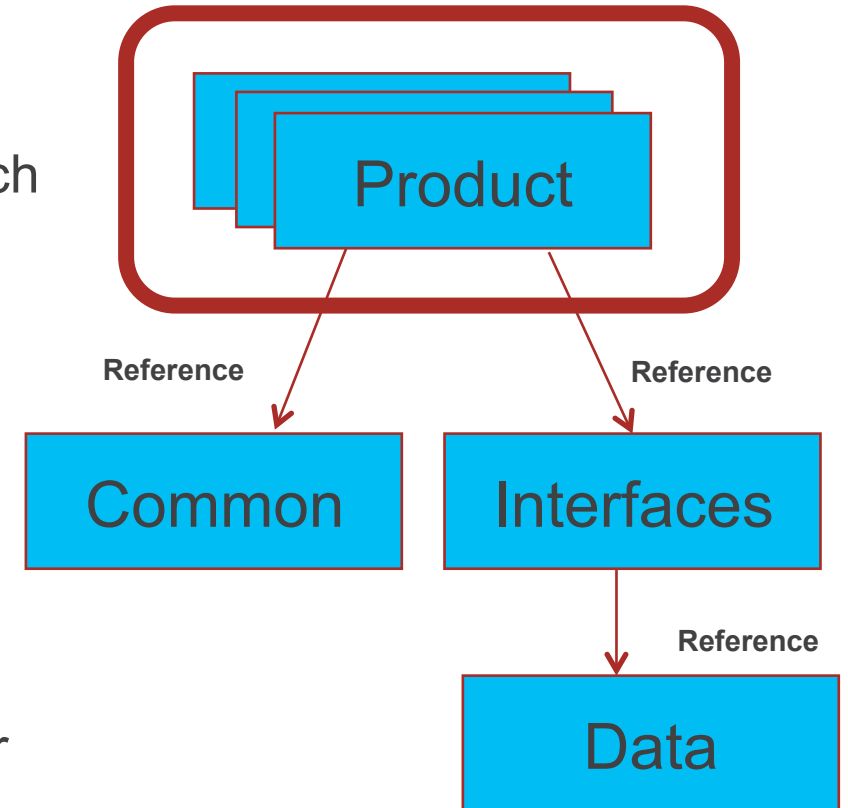
Complex behavioral variation

must create separate behavior views for each variant scenario thread – little to no reuse

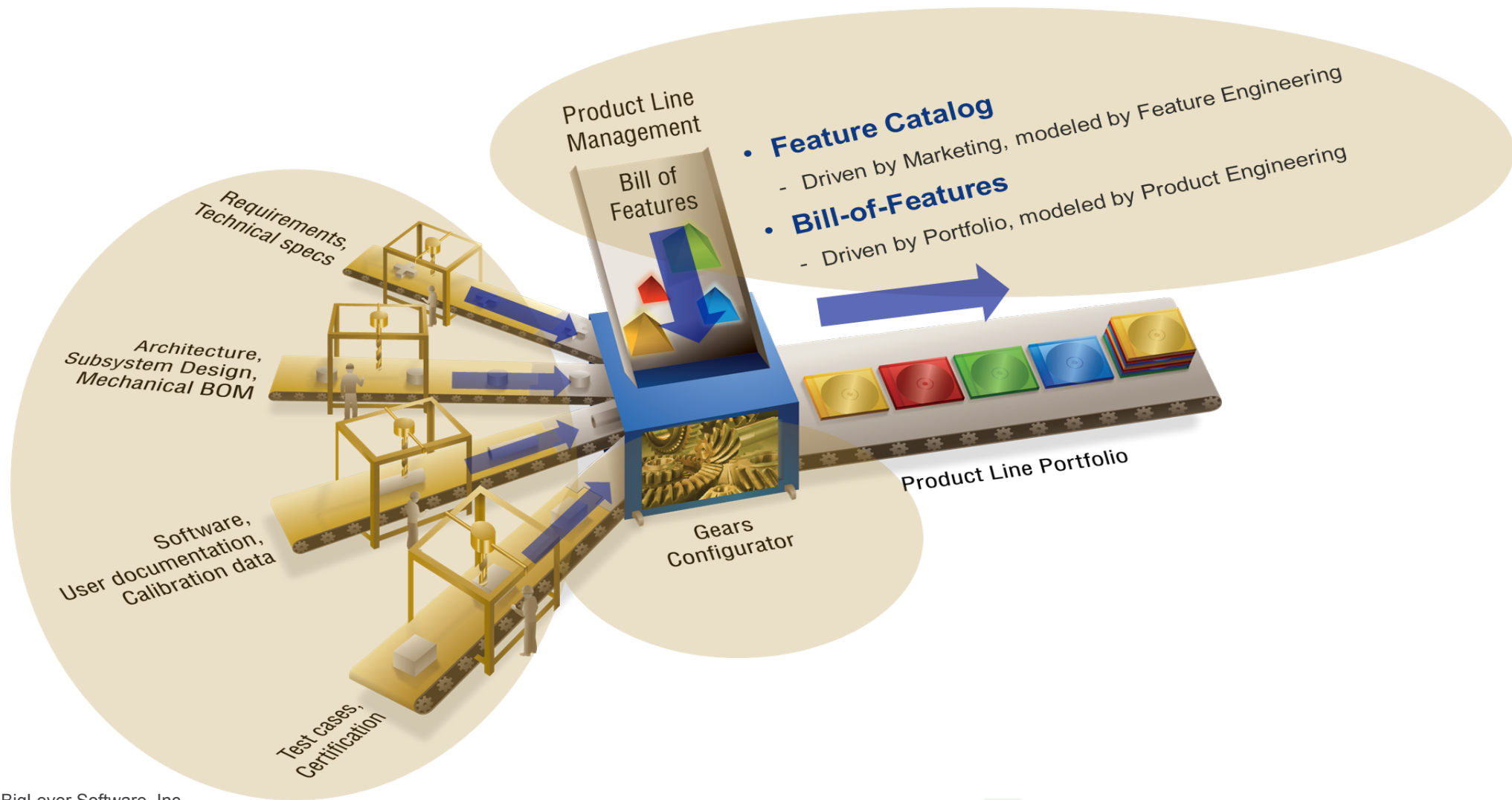
Inconsistent visual variant identification

no mechanism to filter out structural /behavioral variations for each product's architecture

Result: “Clone and Own”



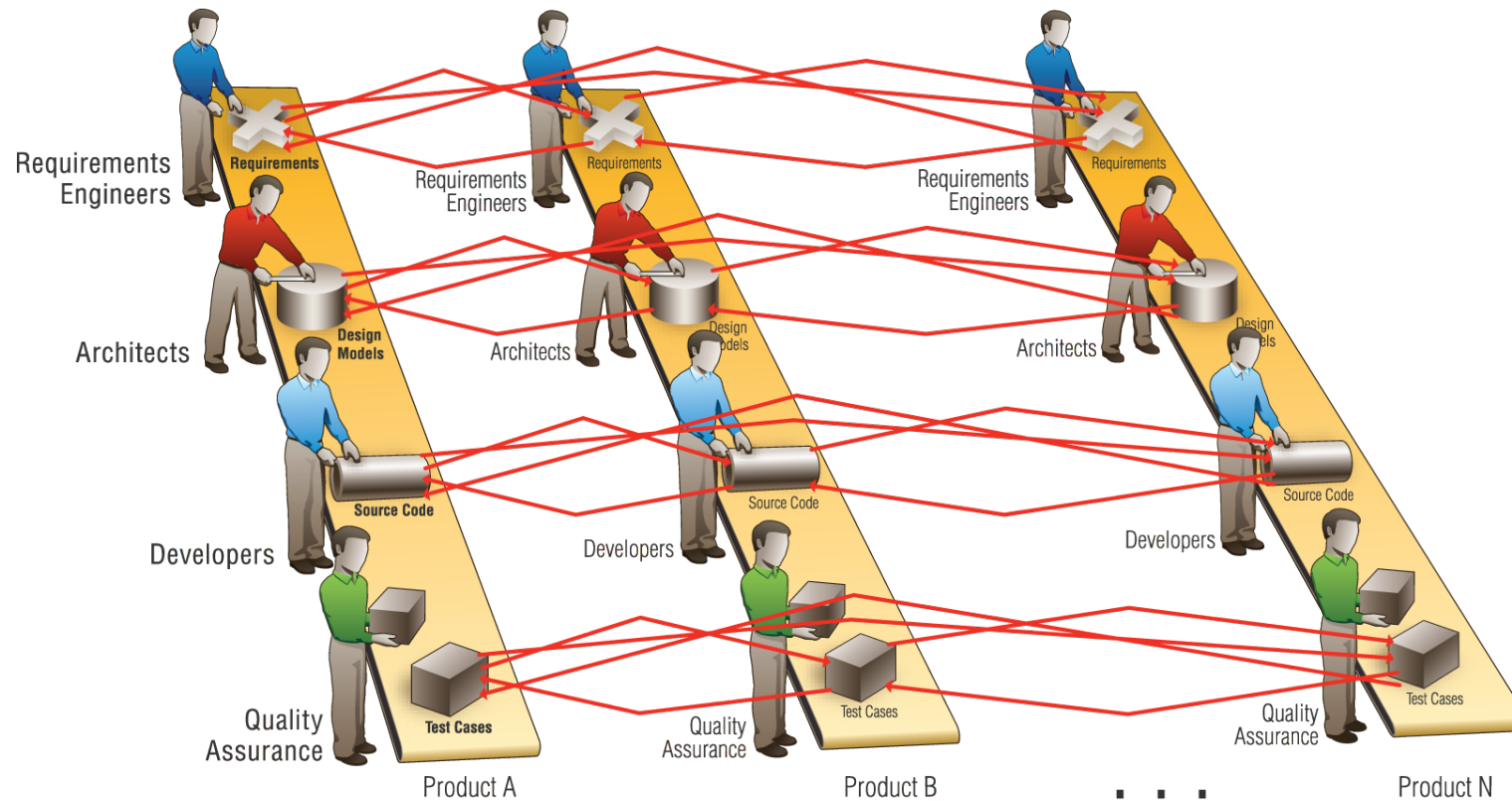
Feature Based PLE Factory – Digital Assets





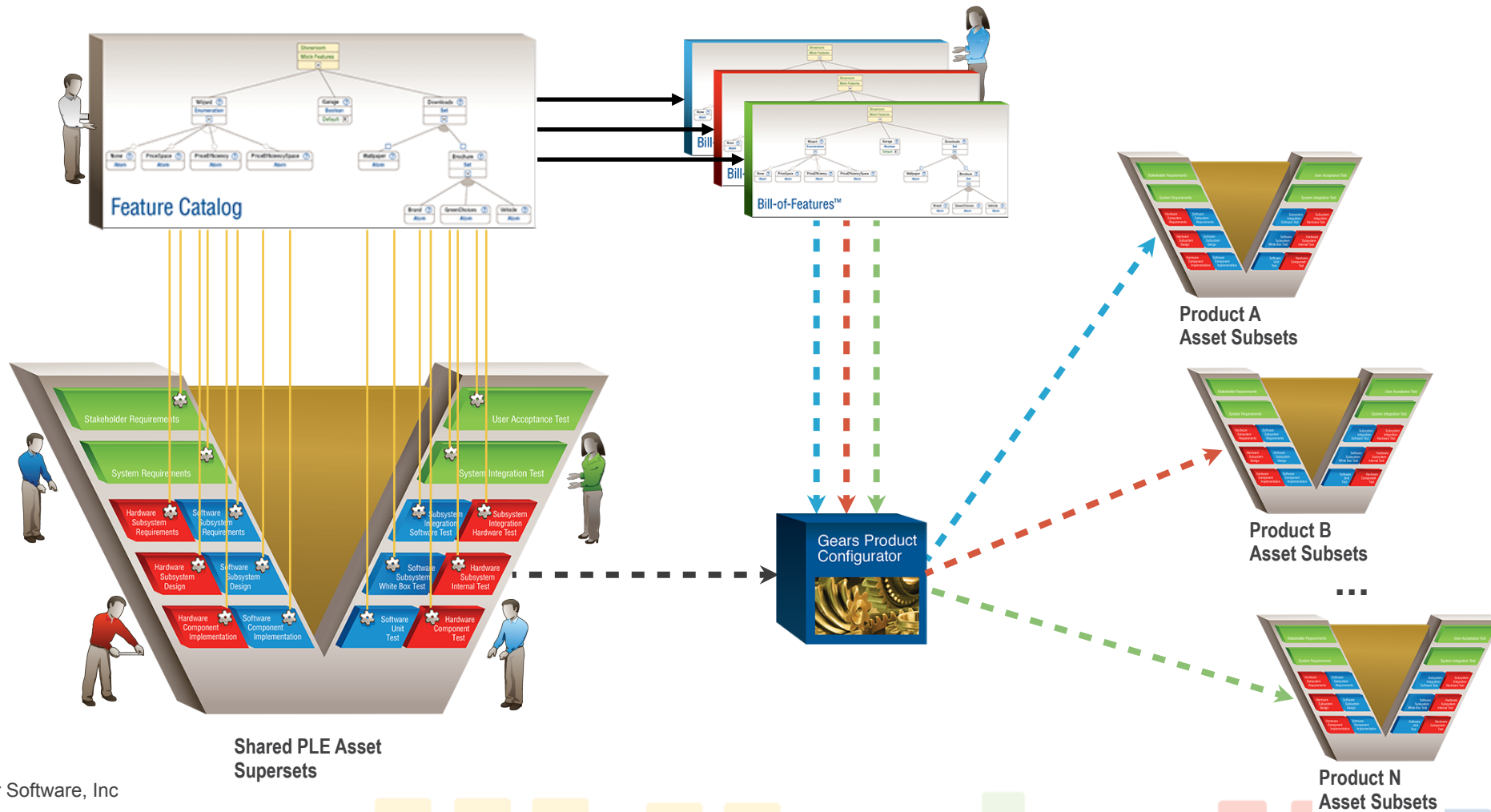
Traditional Product Centric Development

PLE is a move away from product-centric duplication, branch & merge, clone-and-own, N^2 coordination



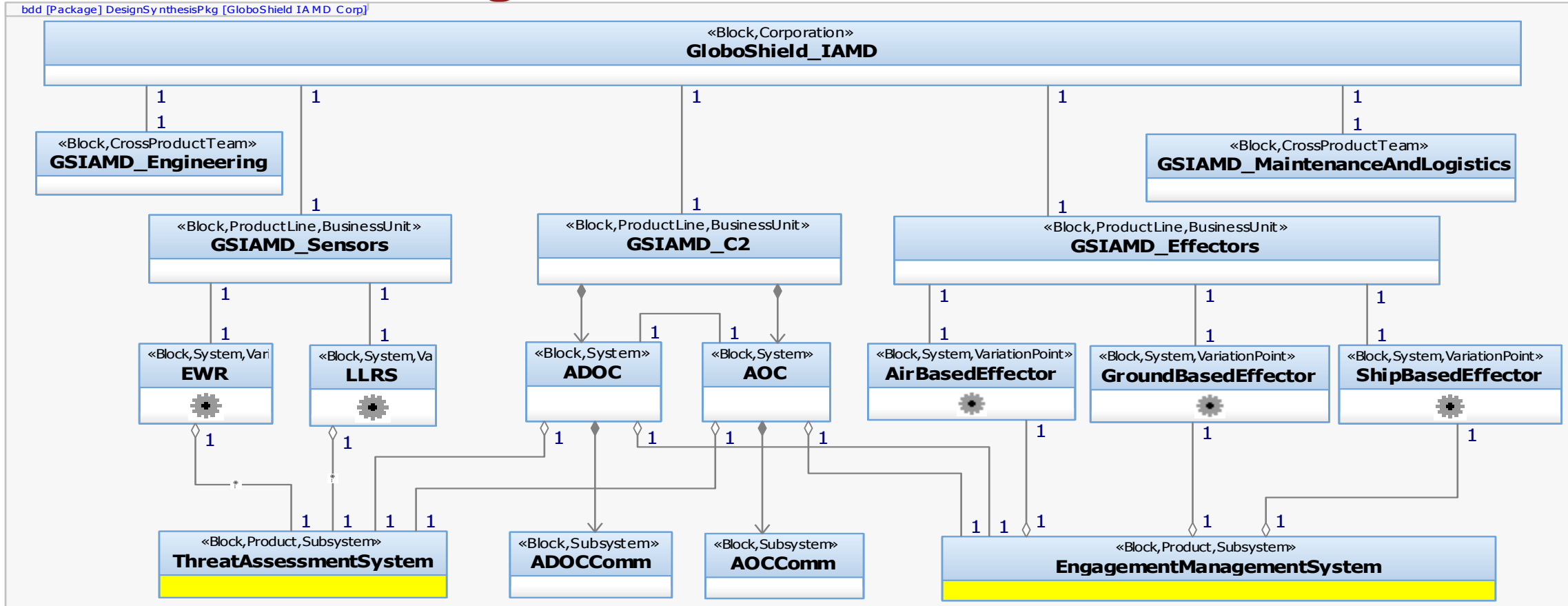


Feature-based PLE Factory Workflow





PLE to Manage Variation

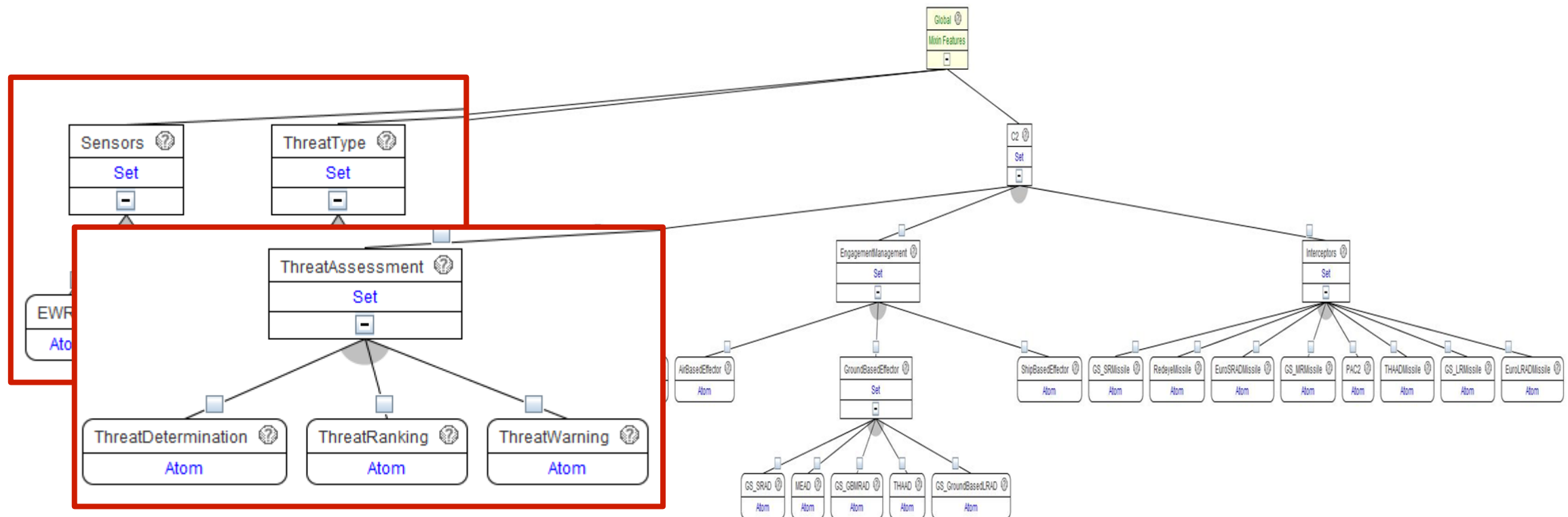


- Implemented the PLE factory approach using BigLever Gears
- Modeled a single enterprise/system view capturing all product variation

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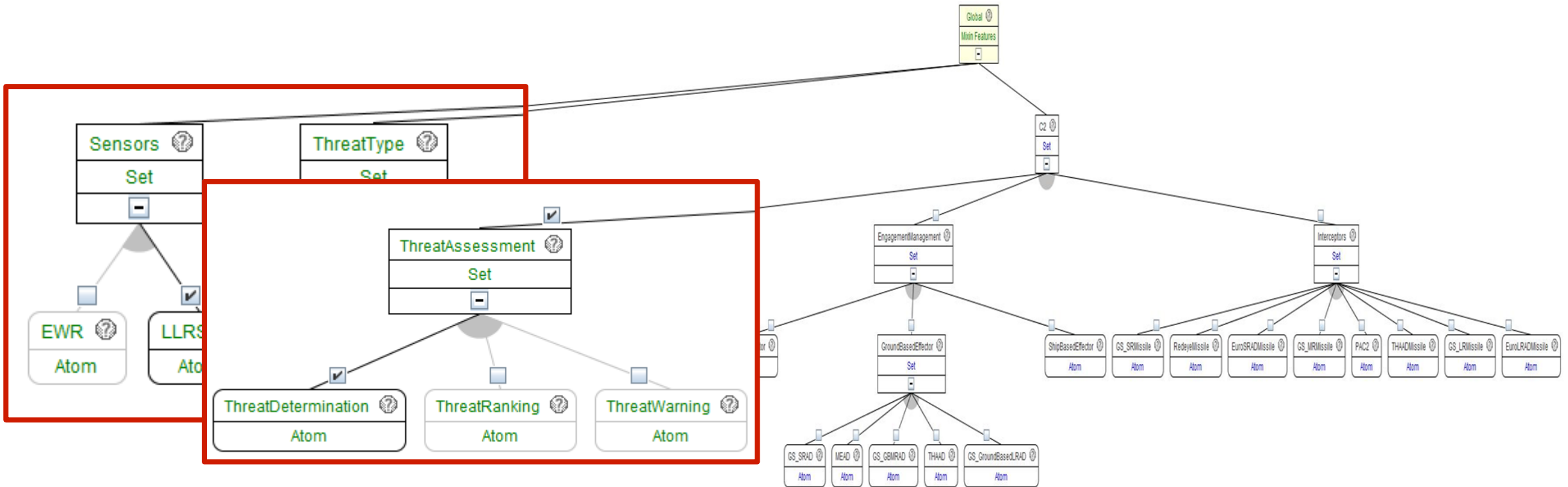
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Feature Model Captures Variant Features



- Feature Model captures the variant features
 - Hierarchical decision tree structure
 - Leaf nodes are the variant feature options

Feature Profile to Specify Product Features



- Specifies the variant choices for a specific product
- Feature Profile for a product to perform Threat Determination on ABT threats

Variation Points Identify Variant Model Elements



del View ▾

- «Product,Variant» PAC2
- «Product,Variant» RedeyeMissile
- «Product,Variant» THAADMissile
- «Product,VariationPoint» ThreatDetermination_COTS
 - Attributes
 - Binding Connectors
 - GearsData
 - GearsLogic
 - Operations
 - Ports
- «Product,VariationPoint» ThreatDetermination_GSSpe
- «Product,VariationPoint» ThreatDetermination_NDI
- «Product,VariationPoint» ThreatDetermination_Service

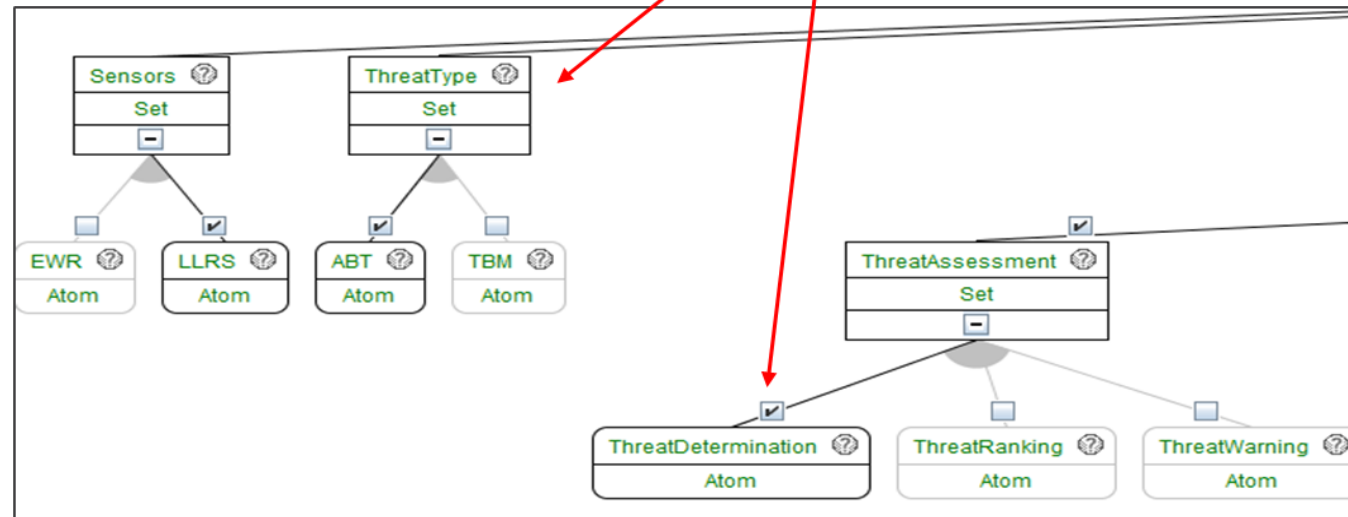
Gears Data : GearsLogic in ThreatDetermination_COTS

General	Description	Relations
Name:	GearsLogic	L
Applicable to:		
Type:	String	
Value:	When ((C2.ThreatAssessment >= {ThreatDetermination}) AND (ThreatType == {ABT})) Select	
Multiplicity	1	

Gears Variation Point

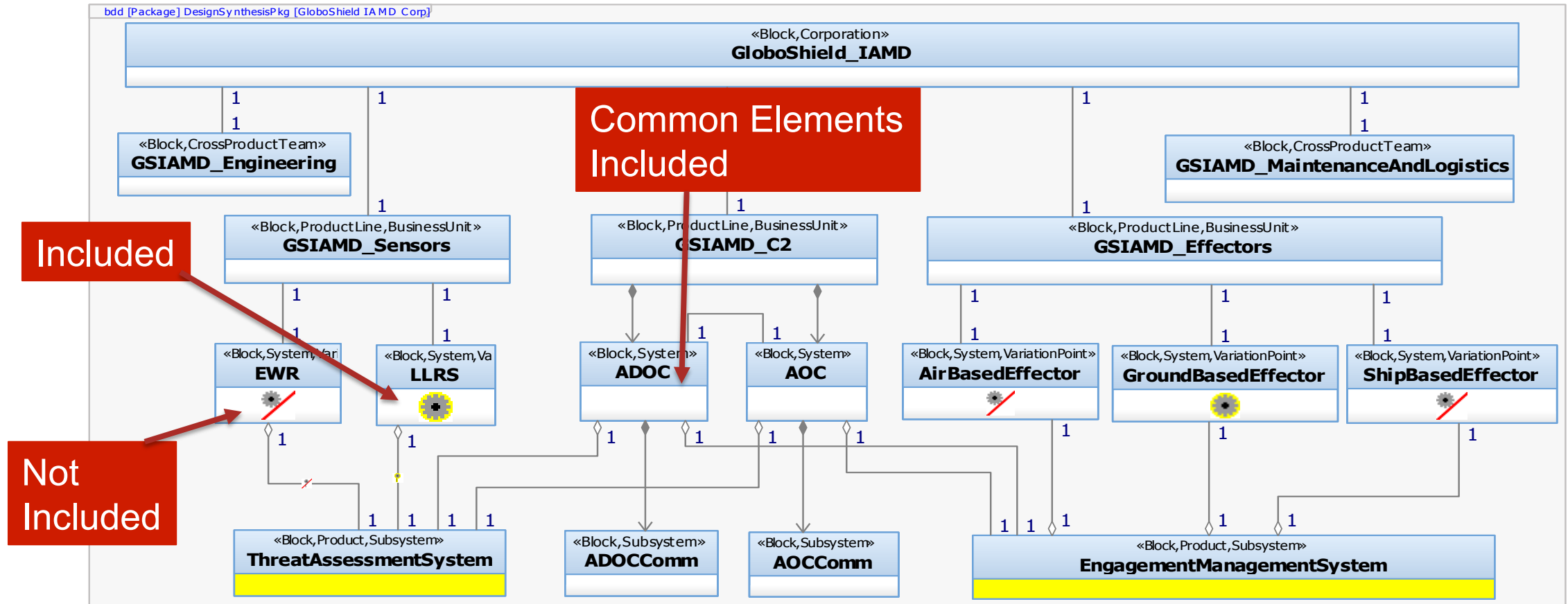
Model element (block) identified as a variation.

Variation Point Logic based on the features described in the Feature Model



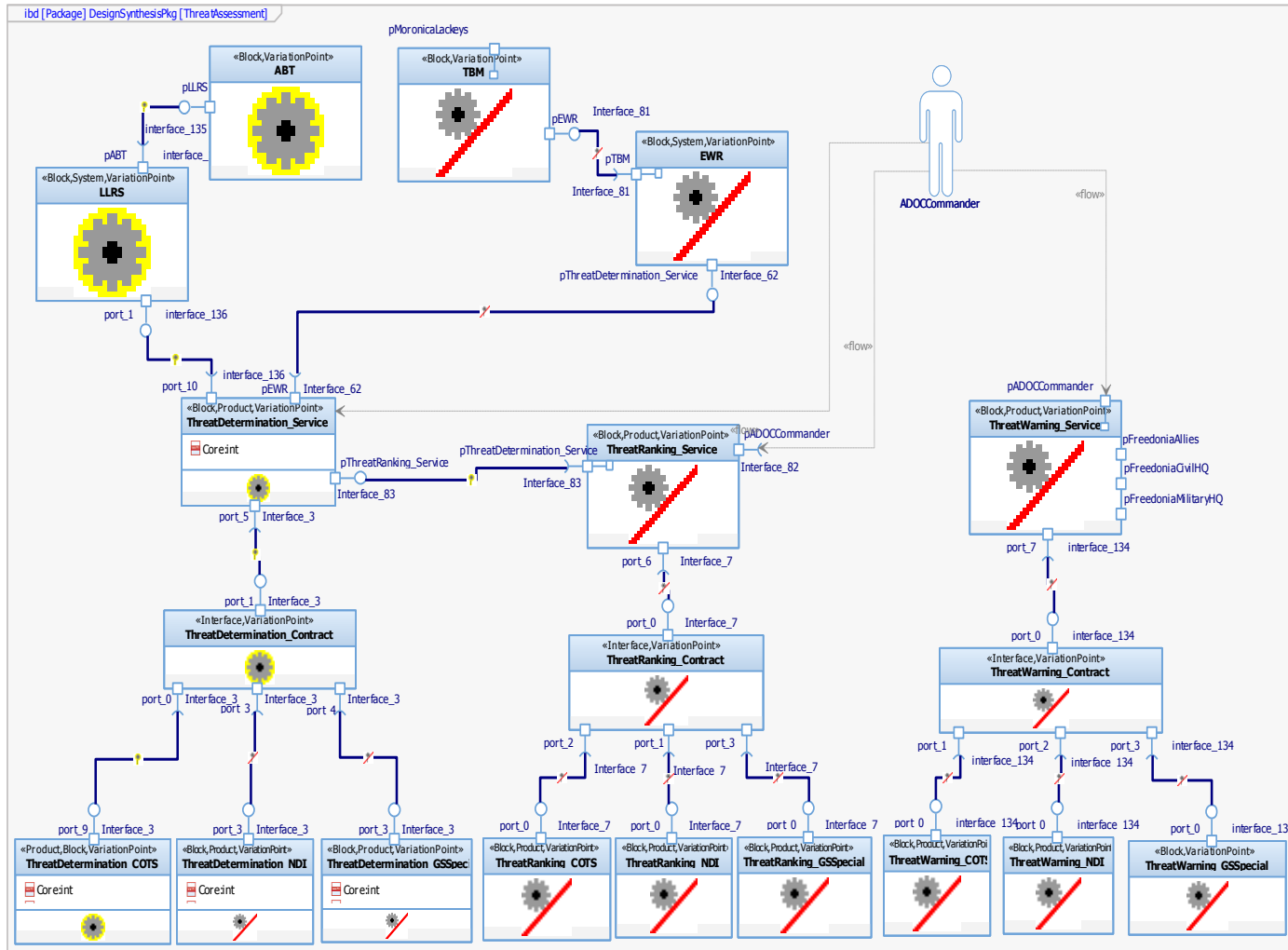
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Product Configurator Configures the Model

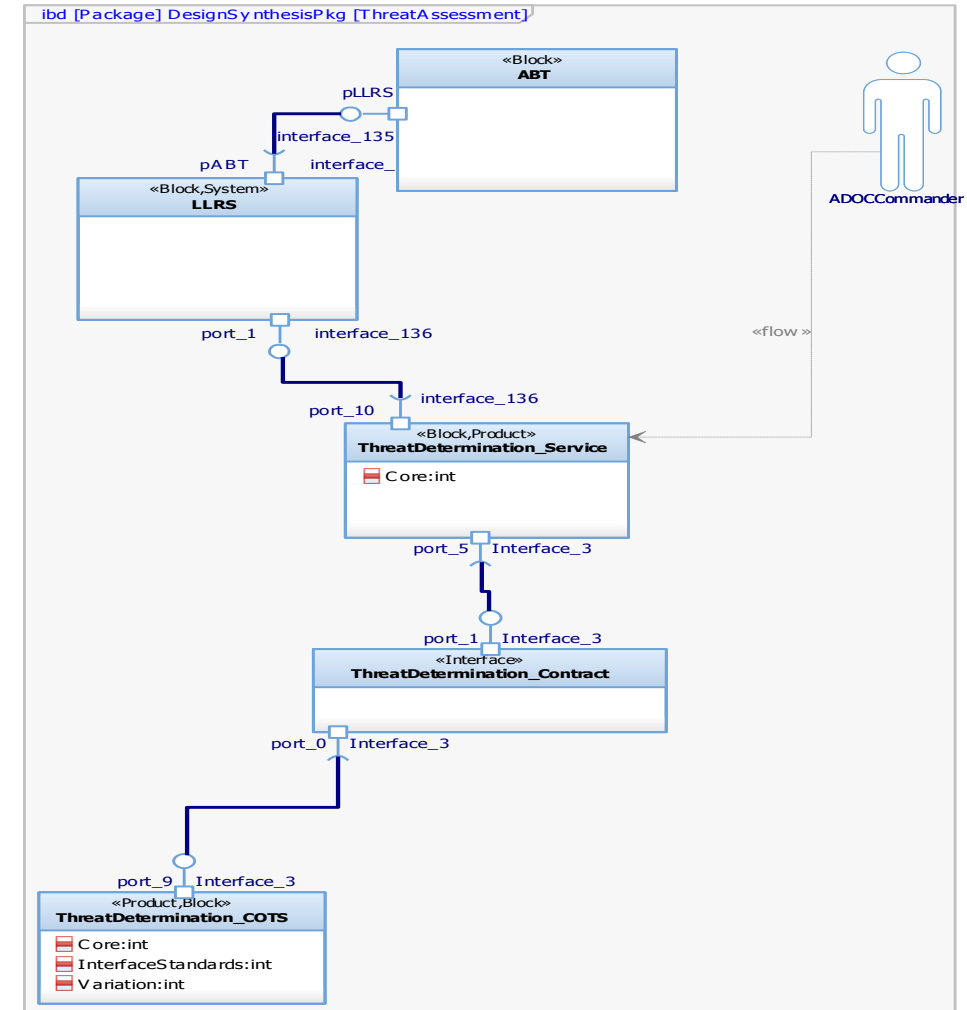


- Configured for ABT Threat Determination product
- Product configurator automatically configures the model based on the feature profile and variation points

Configured IBD: ABT Threat Determination



Rhapsody Master IBD View

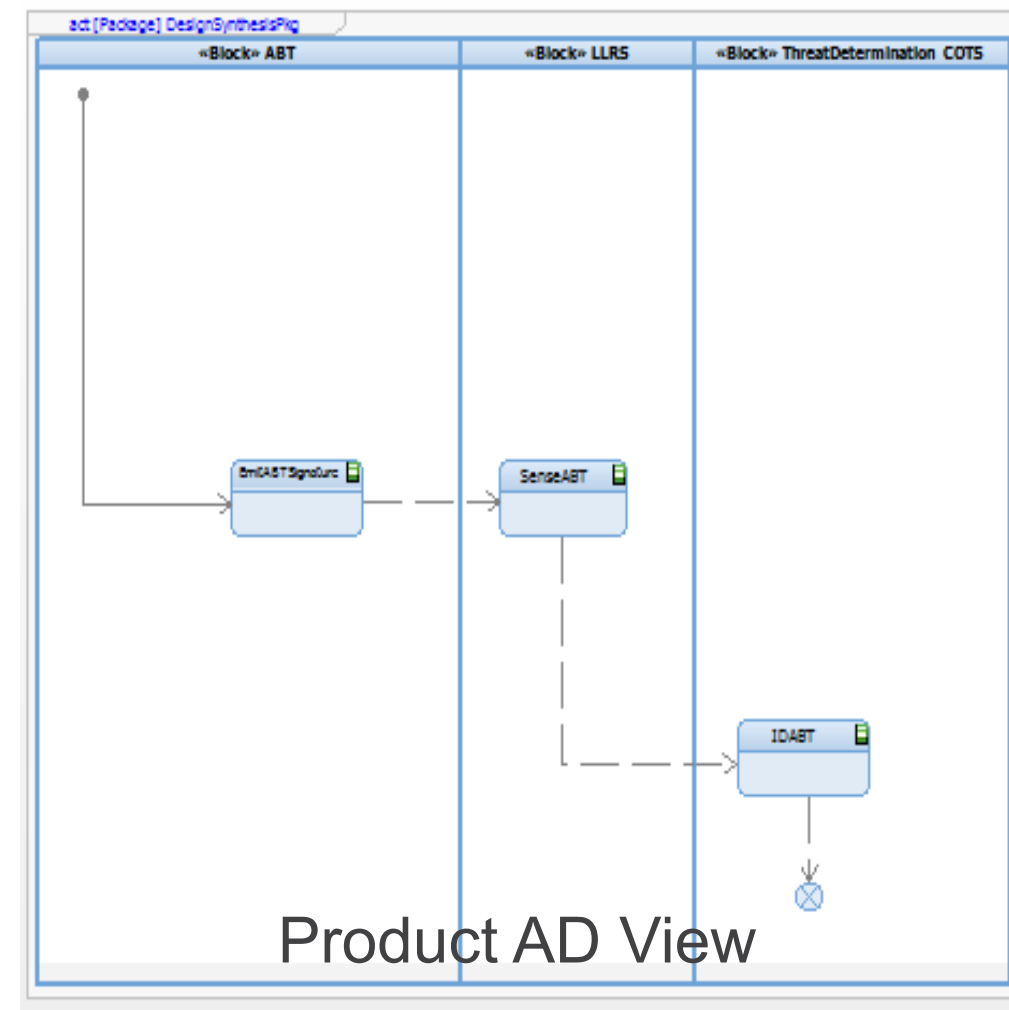
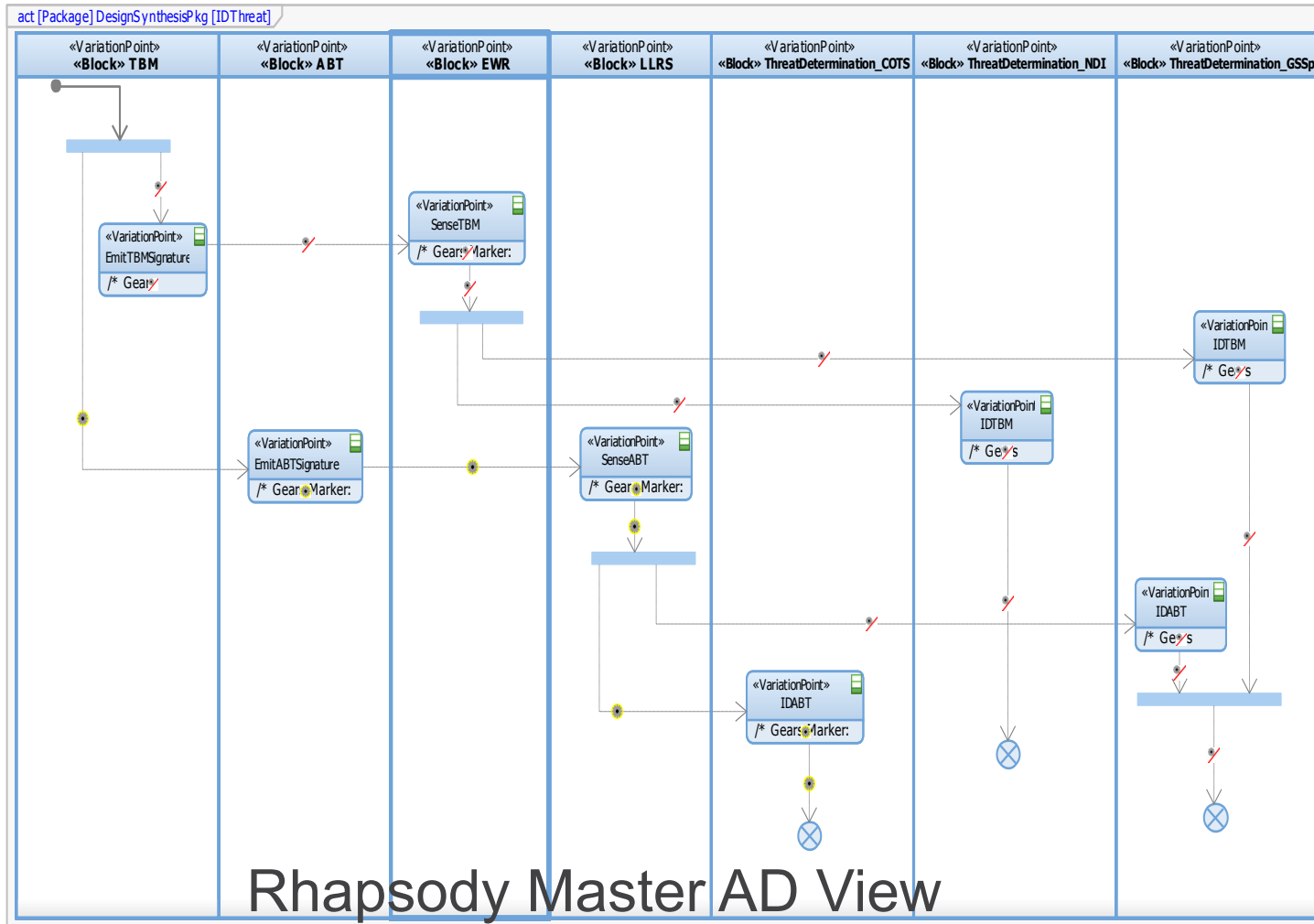


Product IBD View

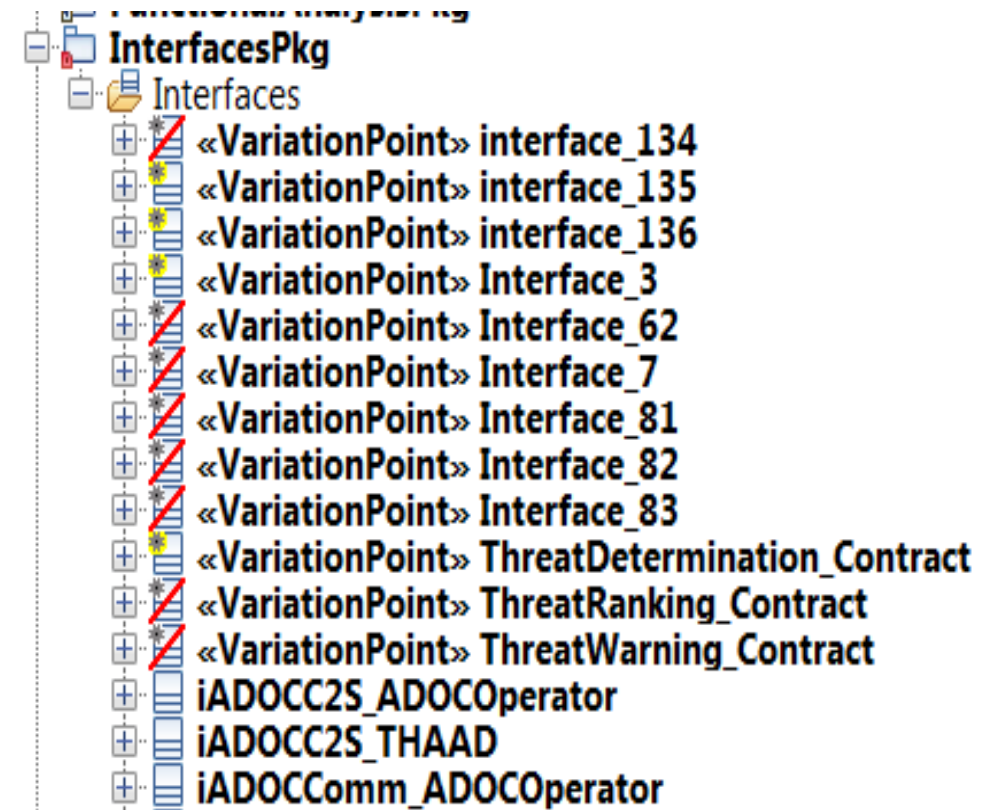
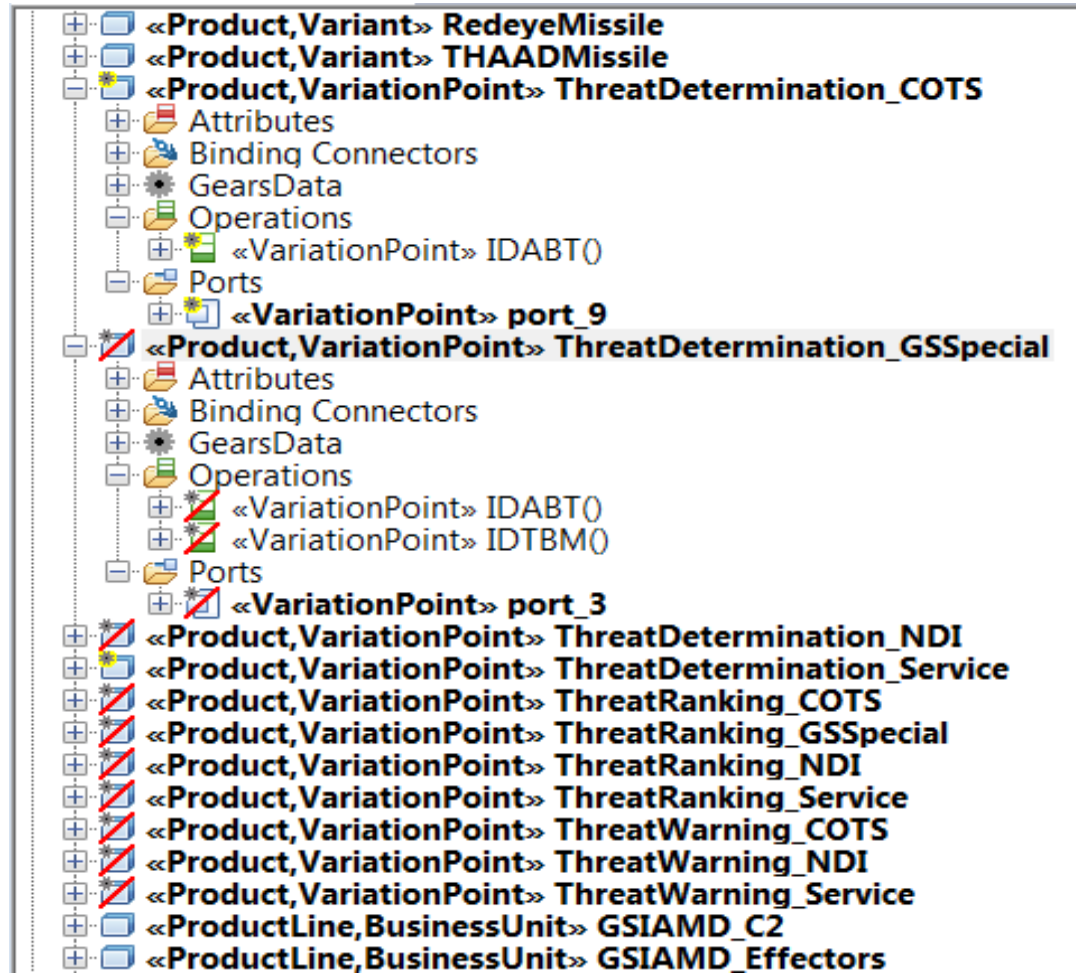
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Configured Activity Diagram: ABT Threat Determination



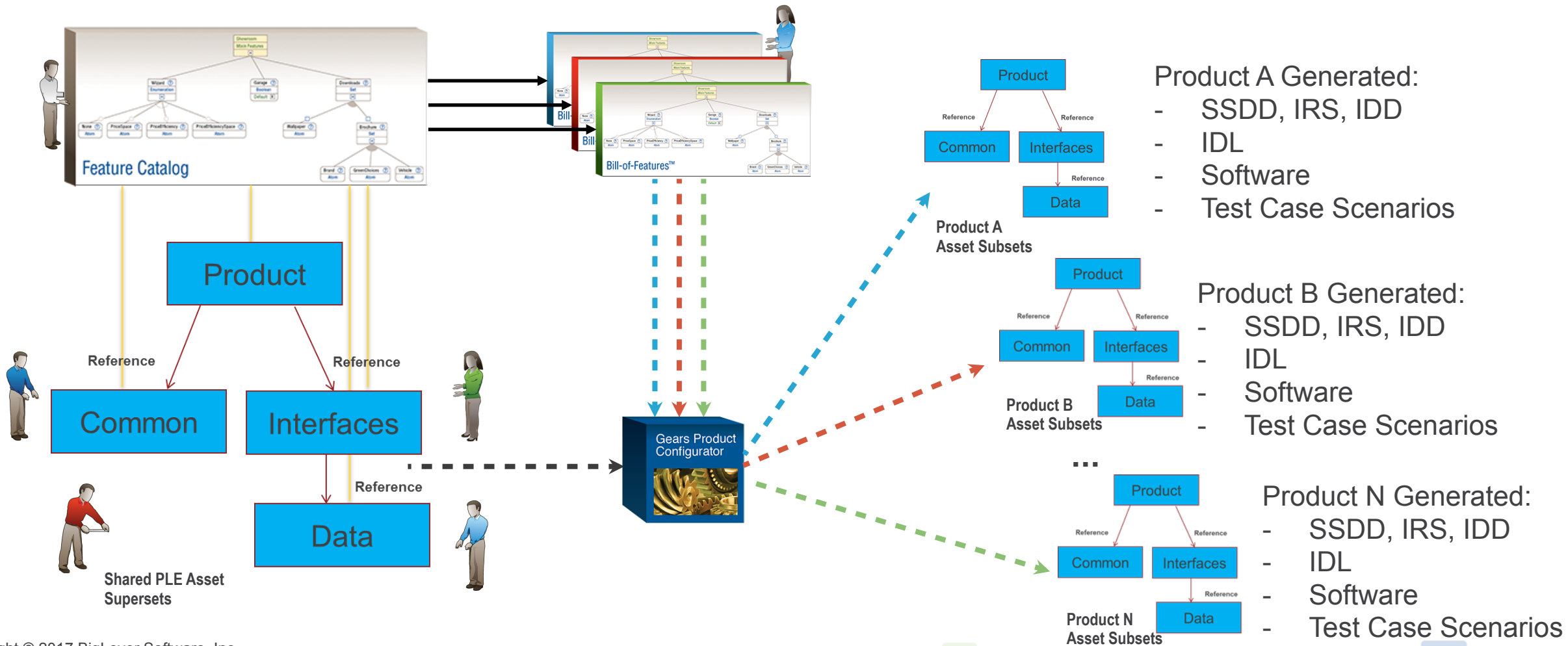
Rhapsody Browser View



Configured view of Rhapsody browser applied to blocks, operations, ports, and interfaces



Model-Based PL Managed Architecture Models





Conclusions

- MBE approach to create/maintain product line architecture through reusable components, interfaces, and data
 - Capturing the architecture information and design decisions in a model repository as a single source of truth.
- PLE factory approach eliminates product "clone and own" through feature-based variation management in the common shared assets.
- Gears Product Configurator automatically produces product-specific architectural models for MBE-based analysis and transformations
 - Staging the configured product models removes the excluded model elements
 - Use Rhapsody and RPE to generate product specific code, test scenarios, reports (SSDD, IRS, IDD), IDL,...

Reduced architecture artifacts to manage by 80%