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Incorporating Variability and Reuse into System Architecture Models – Principles and Challenges

This presentation is more a problem statement than a solution proposal



1. Introduction to Challenges in Modeling Product Lines and Variants
2. Modeling Concepts
 - a. Composition and Reuse
 - b. Composition, Reuse and Modularity of Interfaces
3. Modeling Issues
 - a. Model Configuration Management
 - b. Tool Limitations
4. Proposed Core Data Model
5. Conclusion

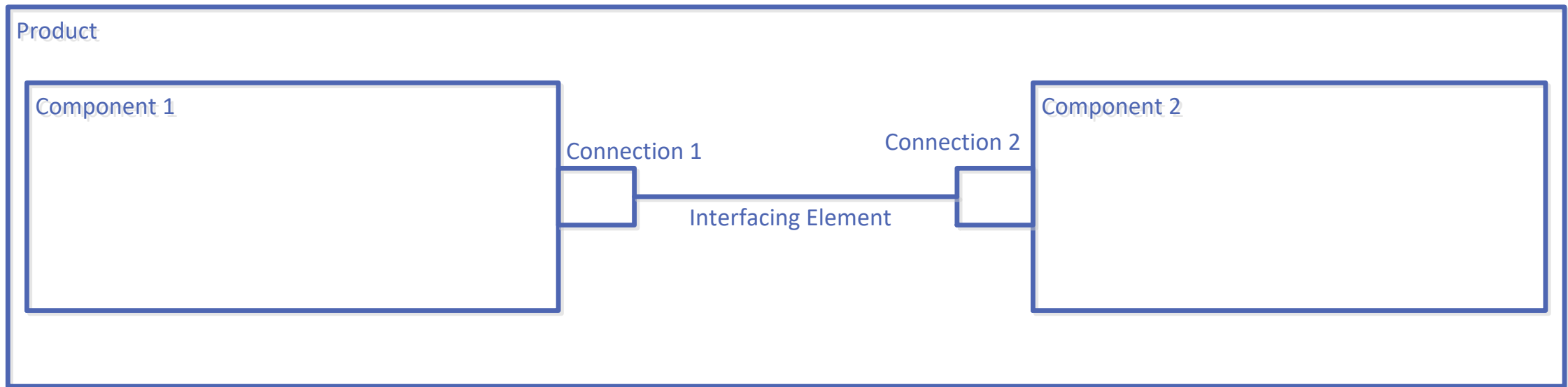
Agenda





Introduction to Challenges in Modeling Product Lines and Variants

A Simple Product



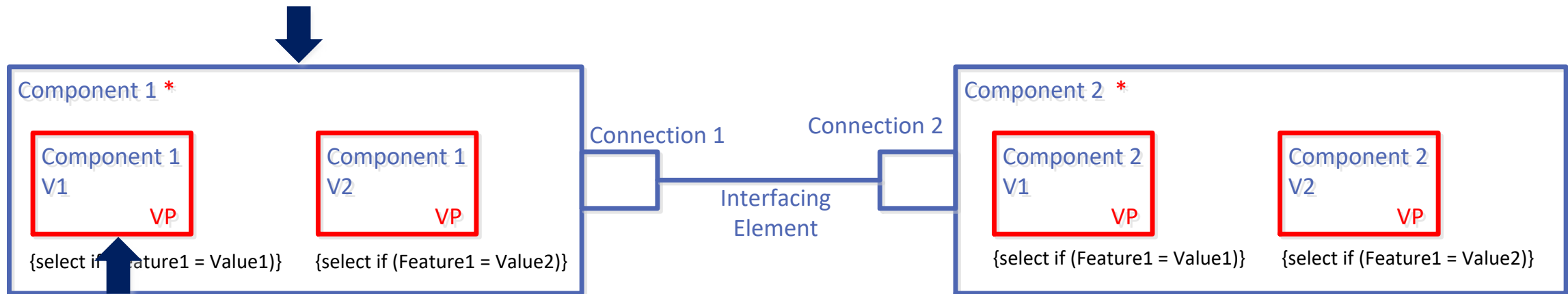
LEGEND

* = Component has variants

VP = Variation Point

{ } = Variation Point selection criteria

A Simple Product Line with Variants



LEGEND

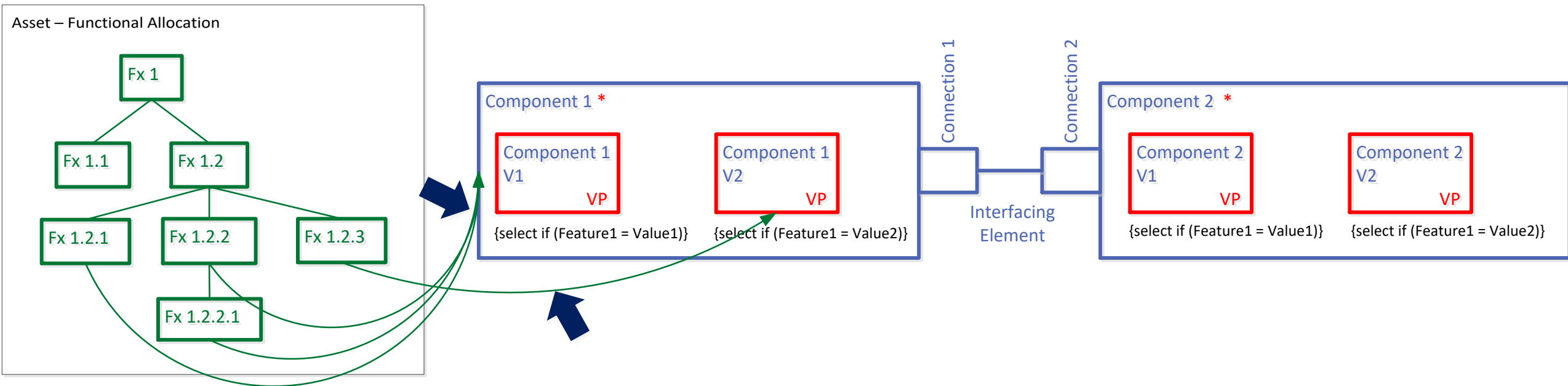
* = Component has variants

VP = Variation Point

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A Simple Product Line with Variants

- Allocation Inheritance



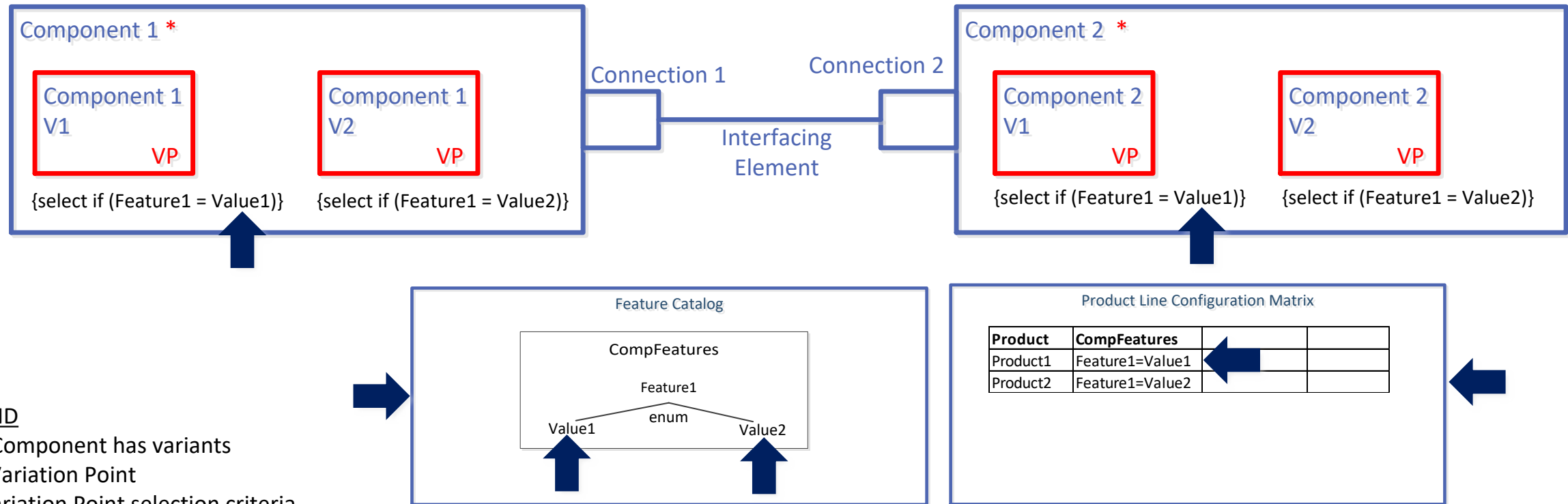
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A Simple Product Line with Variants



LEGEND

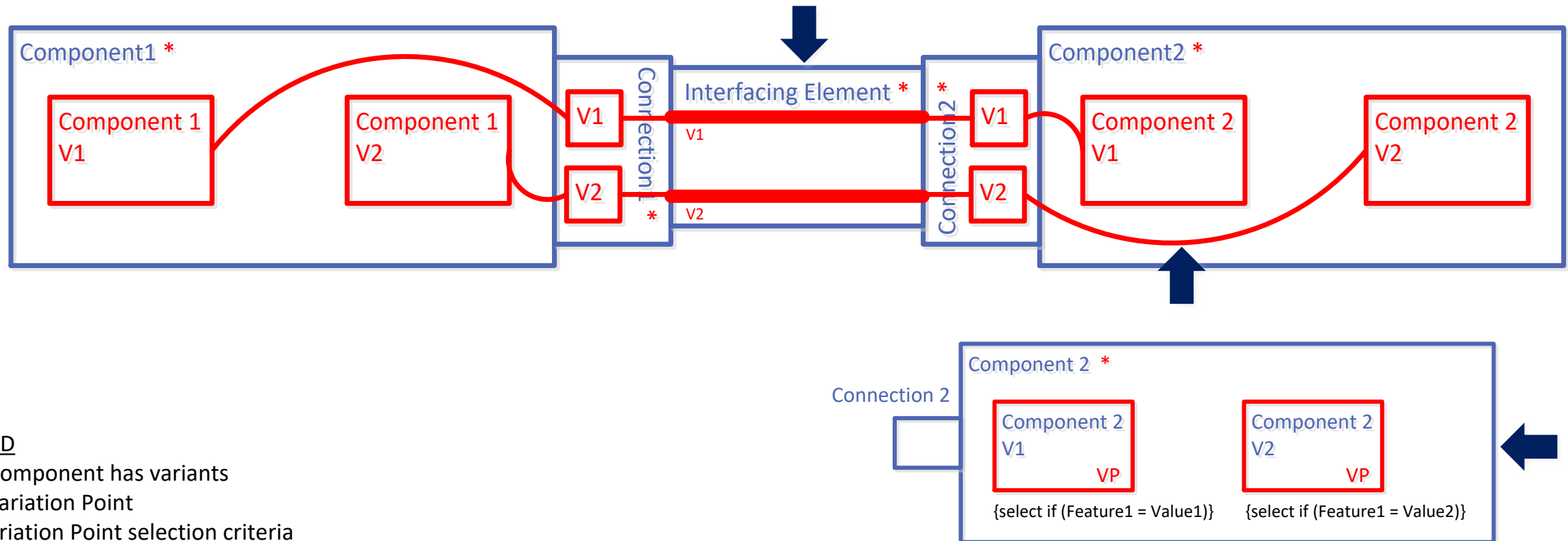
* = Component has variants

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Interface Variants

- Product Line Model with Component and Interface Level Variants

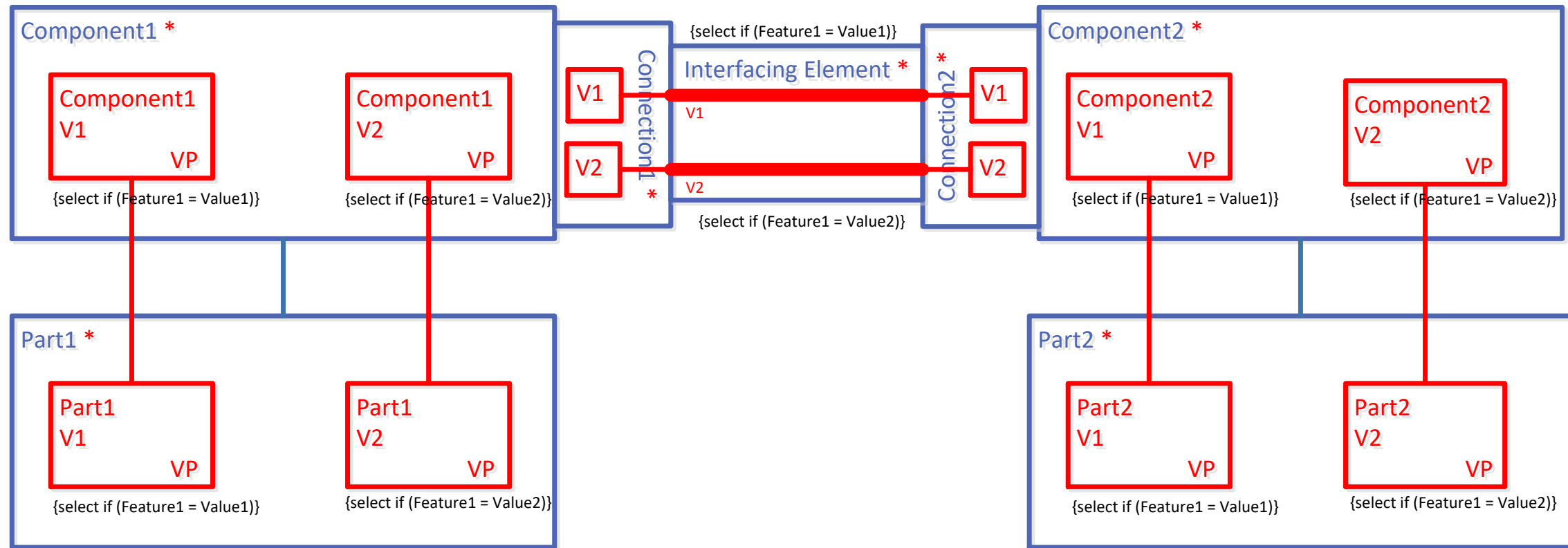




Composition and Reuse

Decomposition and Composition

- Product Line Decomposed to the Part Level



LEGEND

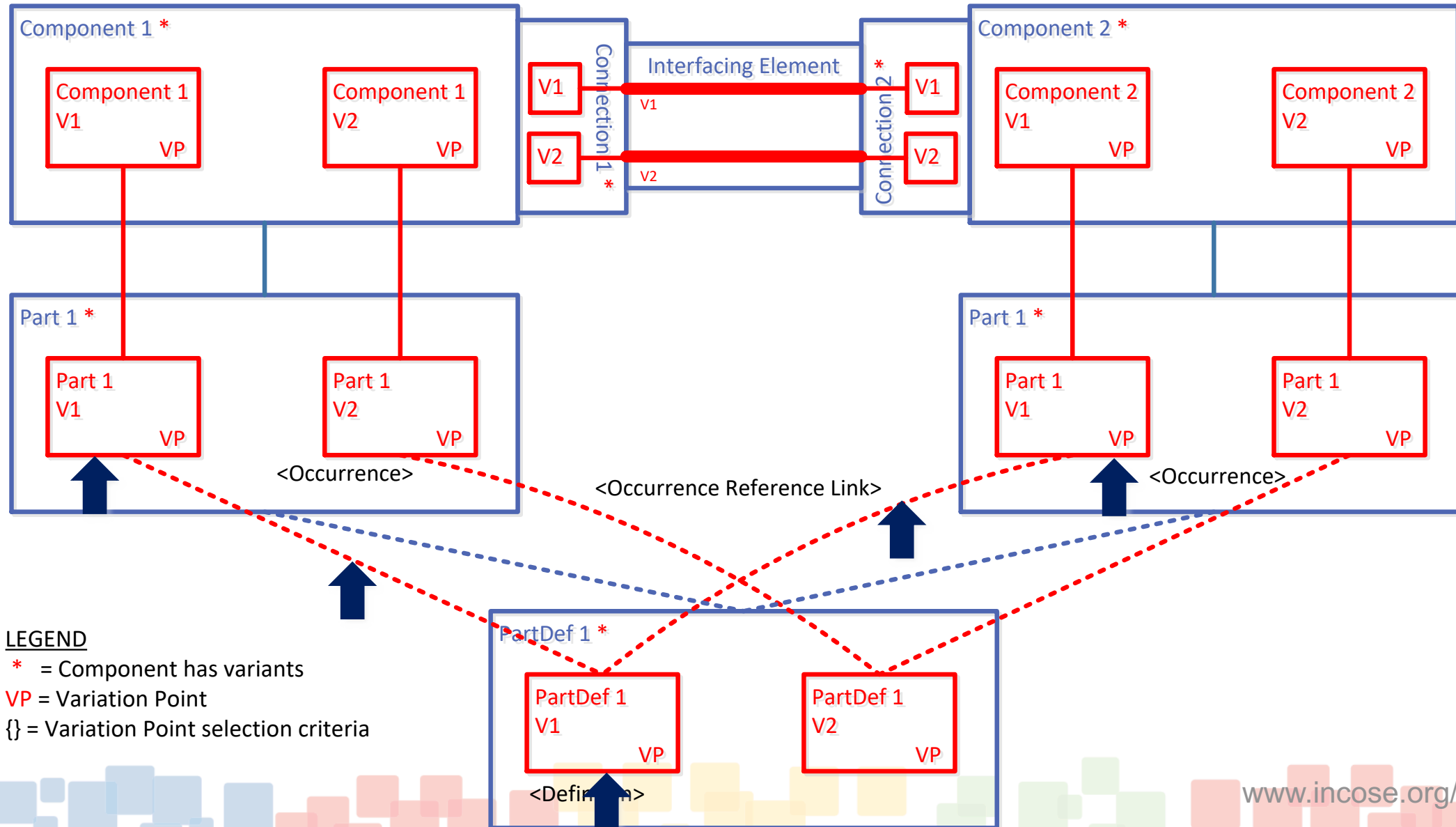
* = Component has variants

VP = Variation Point

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Reuse of Product Line Components

- Reuse Facilitated by Occurrence Modeling of System Elements within a Product Line

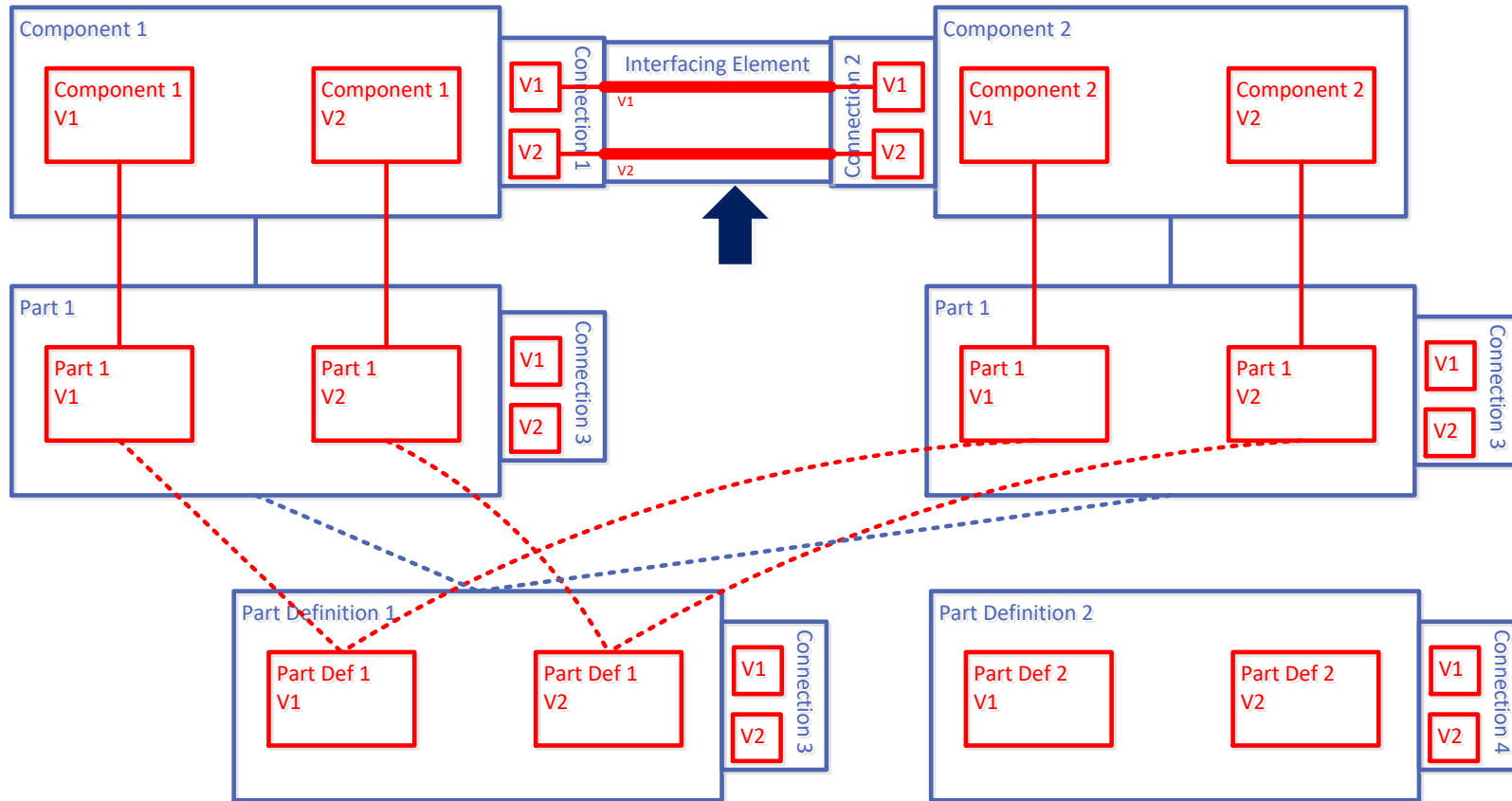




Composition, Reuse and Modularity of Interfaces

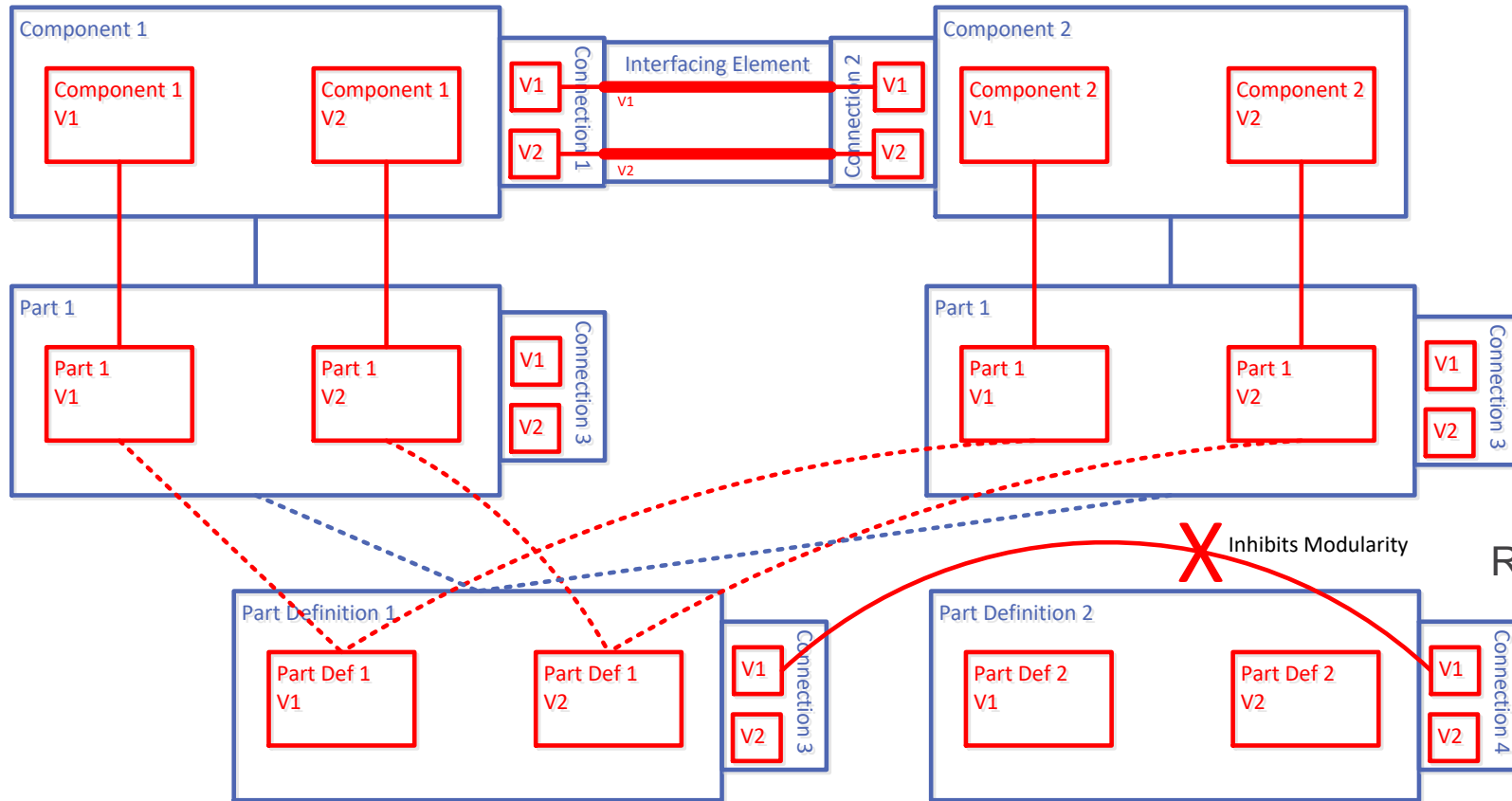
Modularity of Interfaces

- Product Line Interface Restrictions to Protect Modularity of Interfaces
 - Interface only at the product installation (Line Replaceable Unit (LRU)) level



Modularity of Interfaces

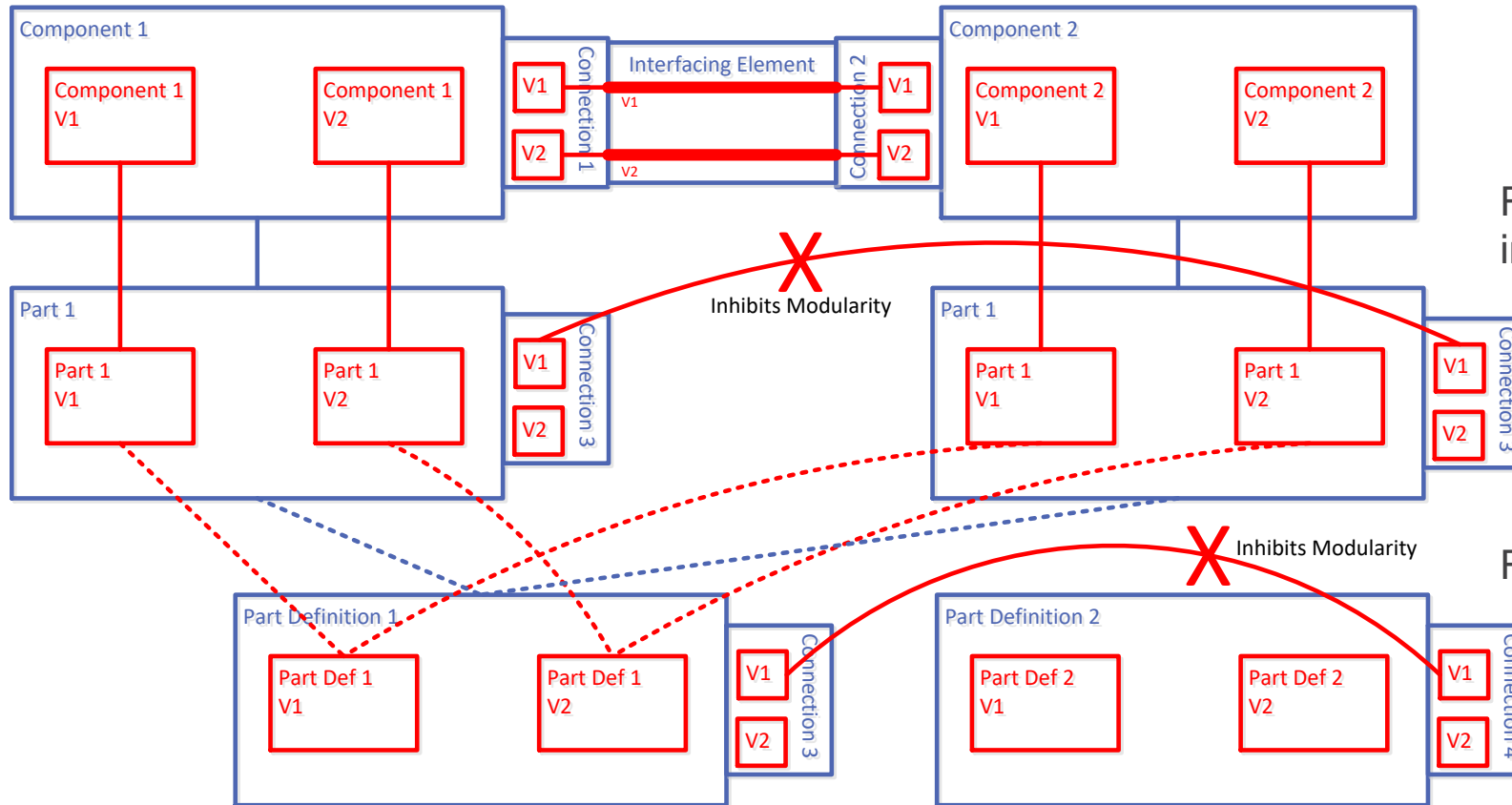
- Product Line Interface Restrictions to Protect Modularity of Interfaces



Restrict interfaces between parts in library

Modularity of Interfaces

- Product Line Interface Restrictions to Protect Modularity of Interfaces

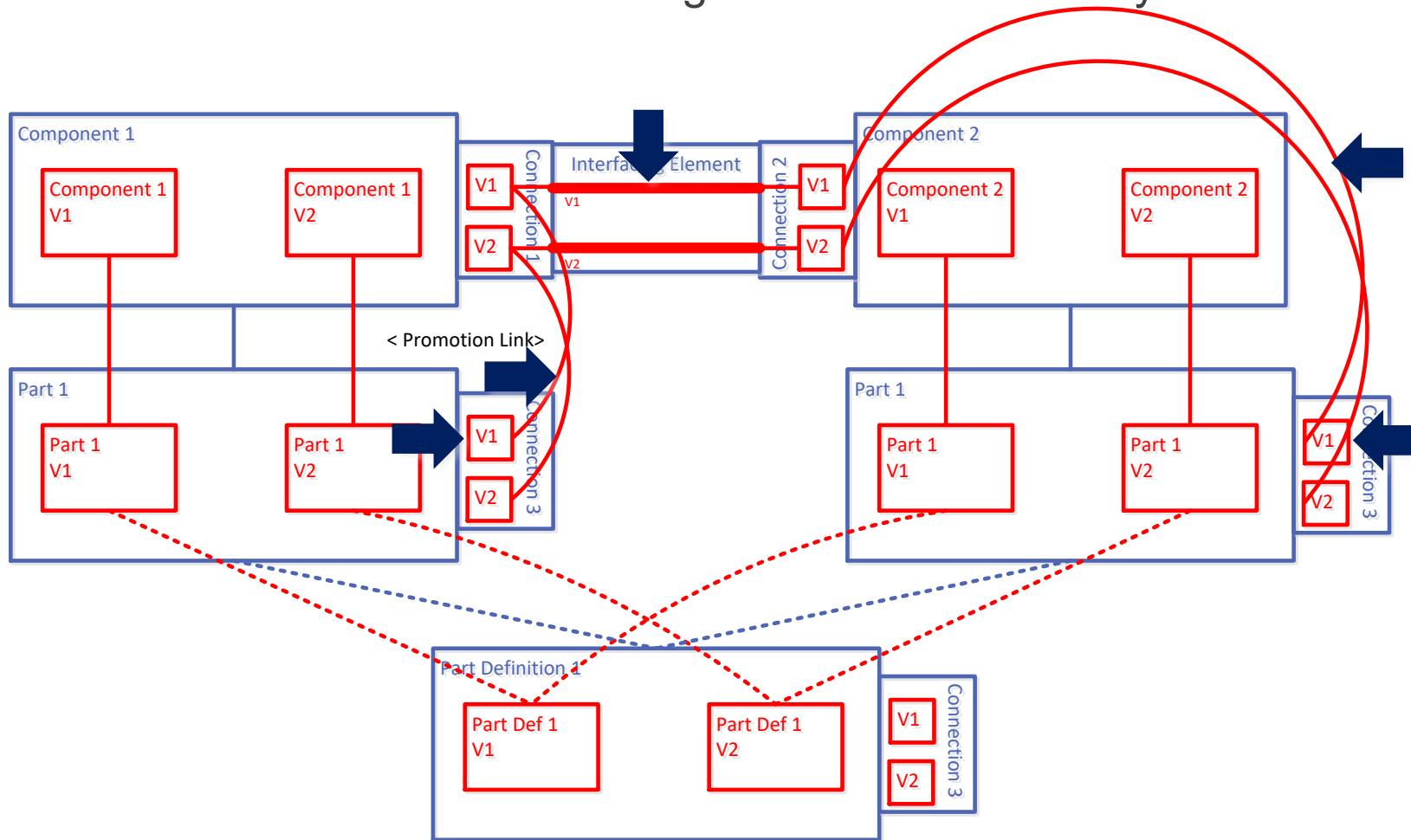


Restrict interfaces between component internal parts

Restrict interfaces between parts in library

Modularity of Interfaces

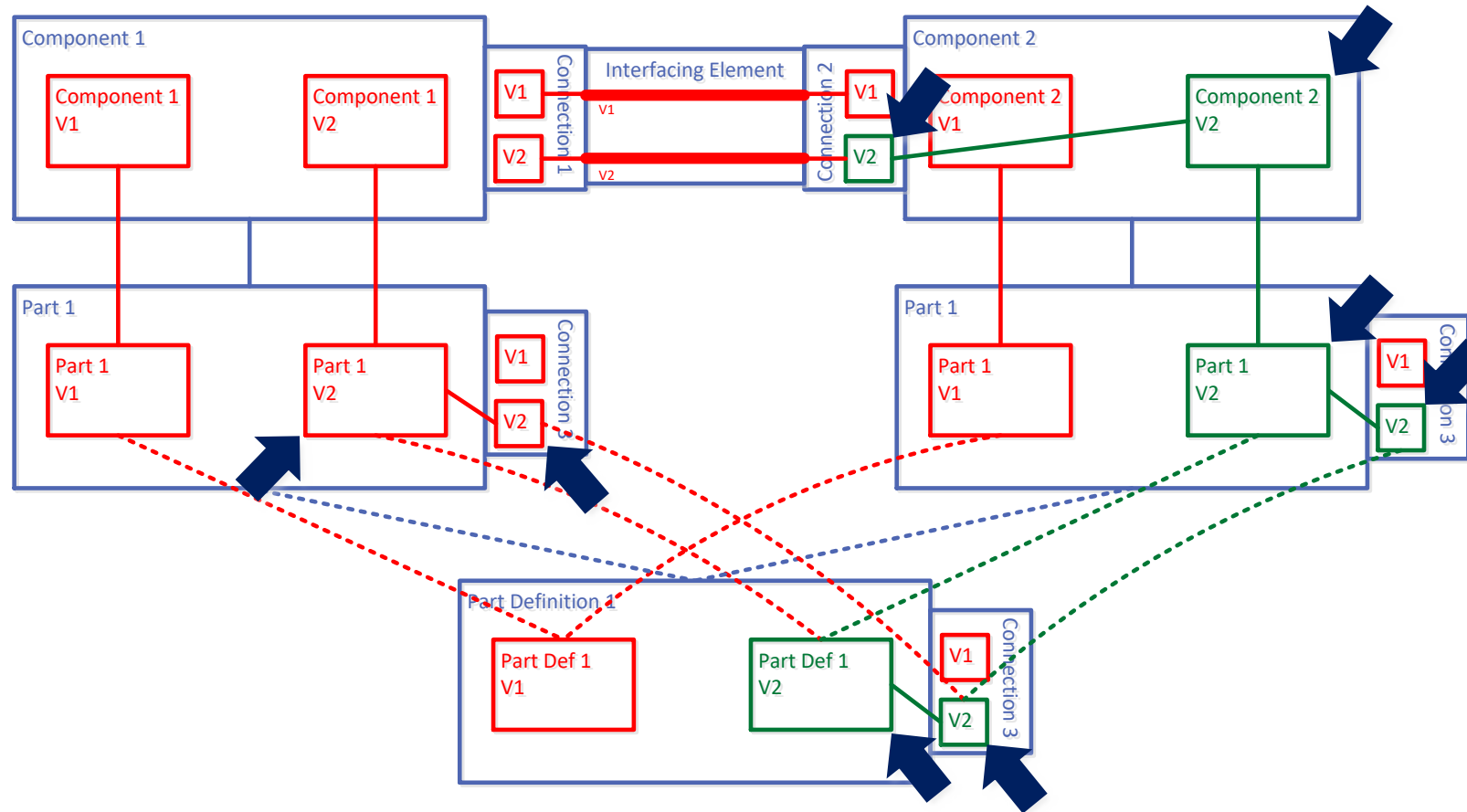
- Product Line Interfacing to Enforce Modularity of Interfaces





Model Configuration Management

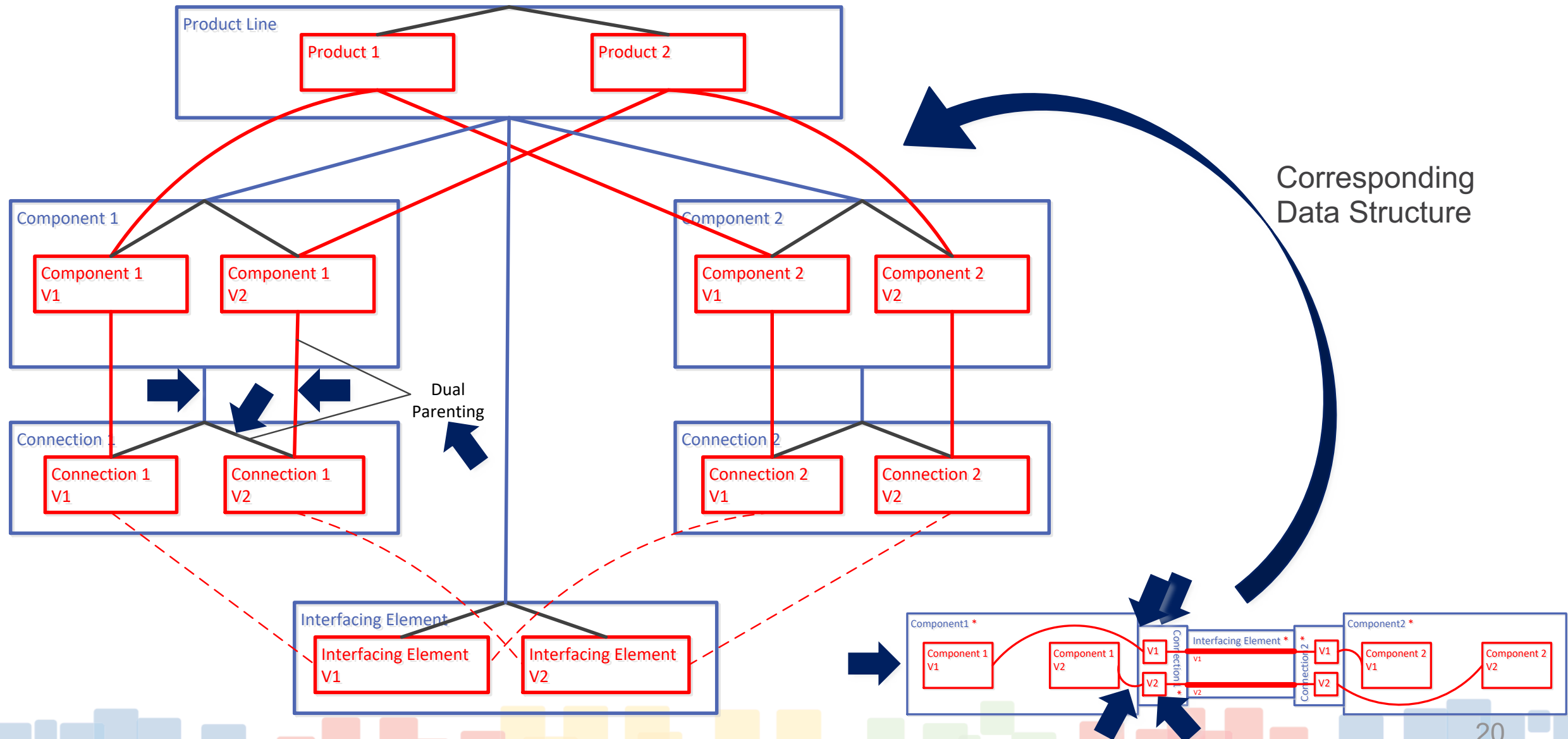
Challenges of Configuration Management in Product Line Models



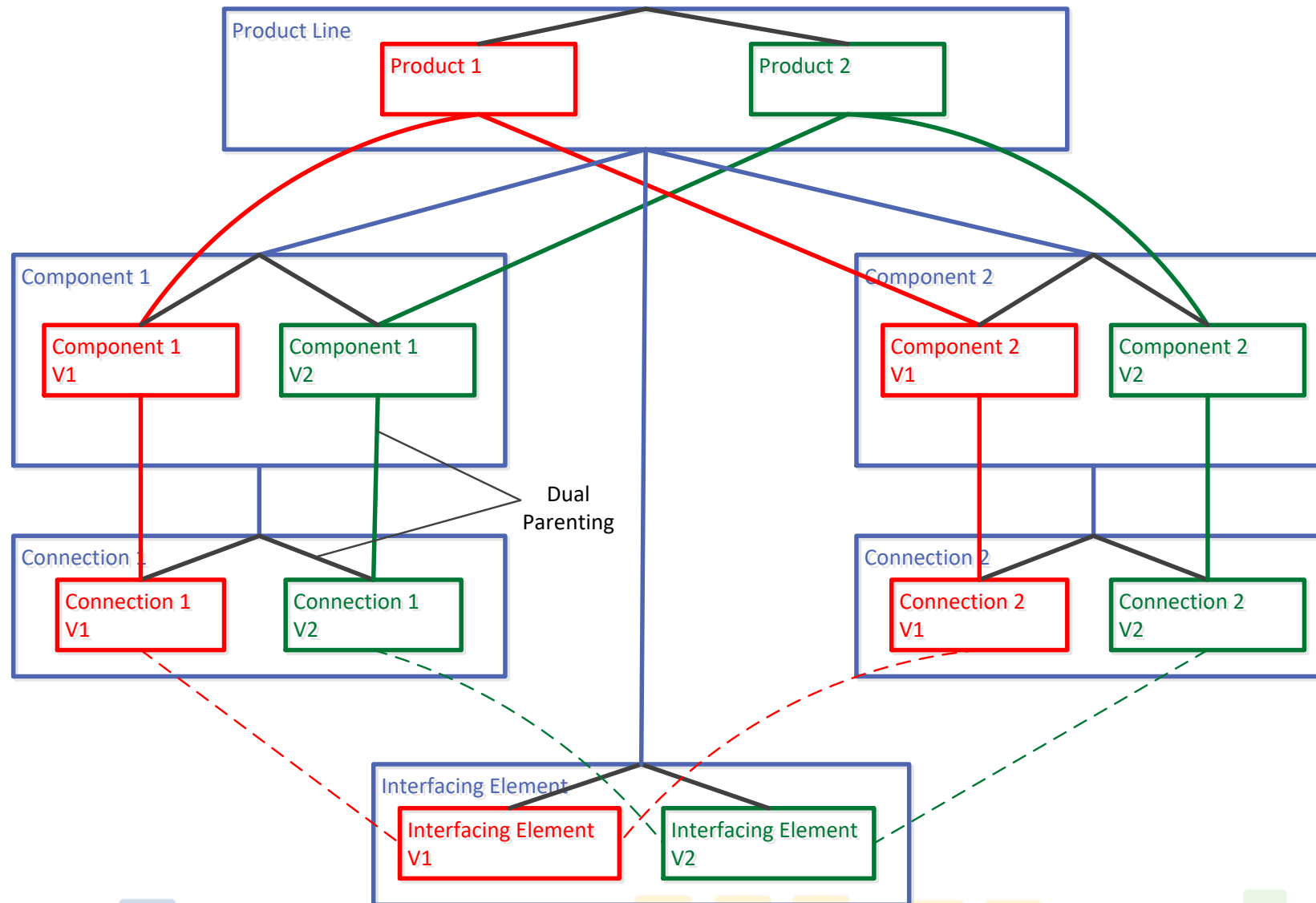


Tool Limitations

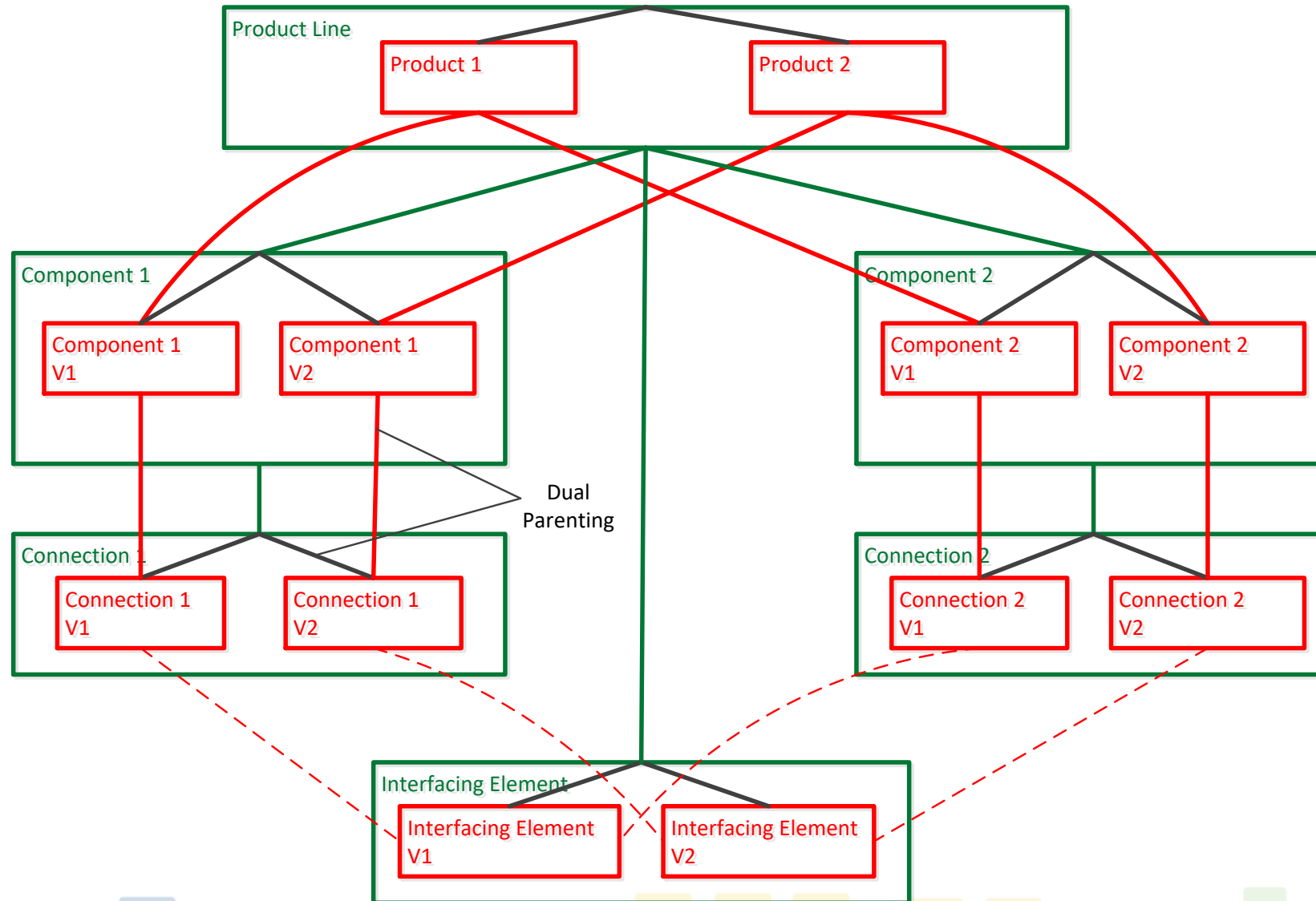
Product Line Model Incorporating Connection and Interface Element Variants



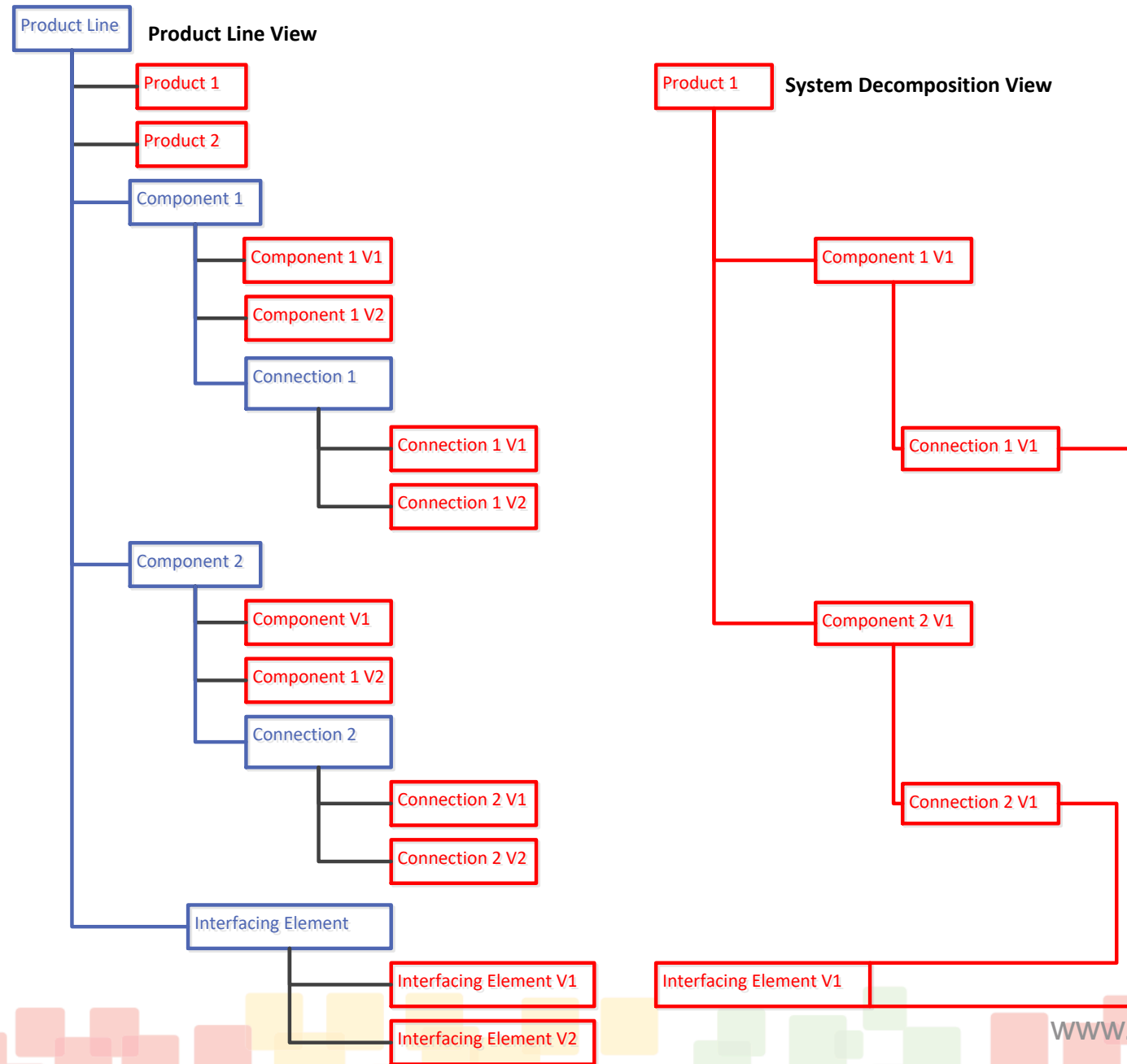
Product Line Model Incorporating Connection and Interface Element Variants



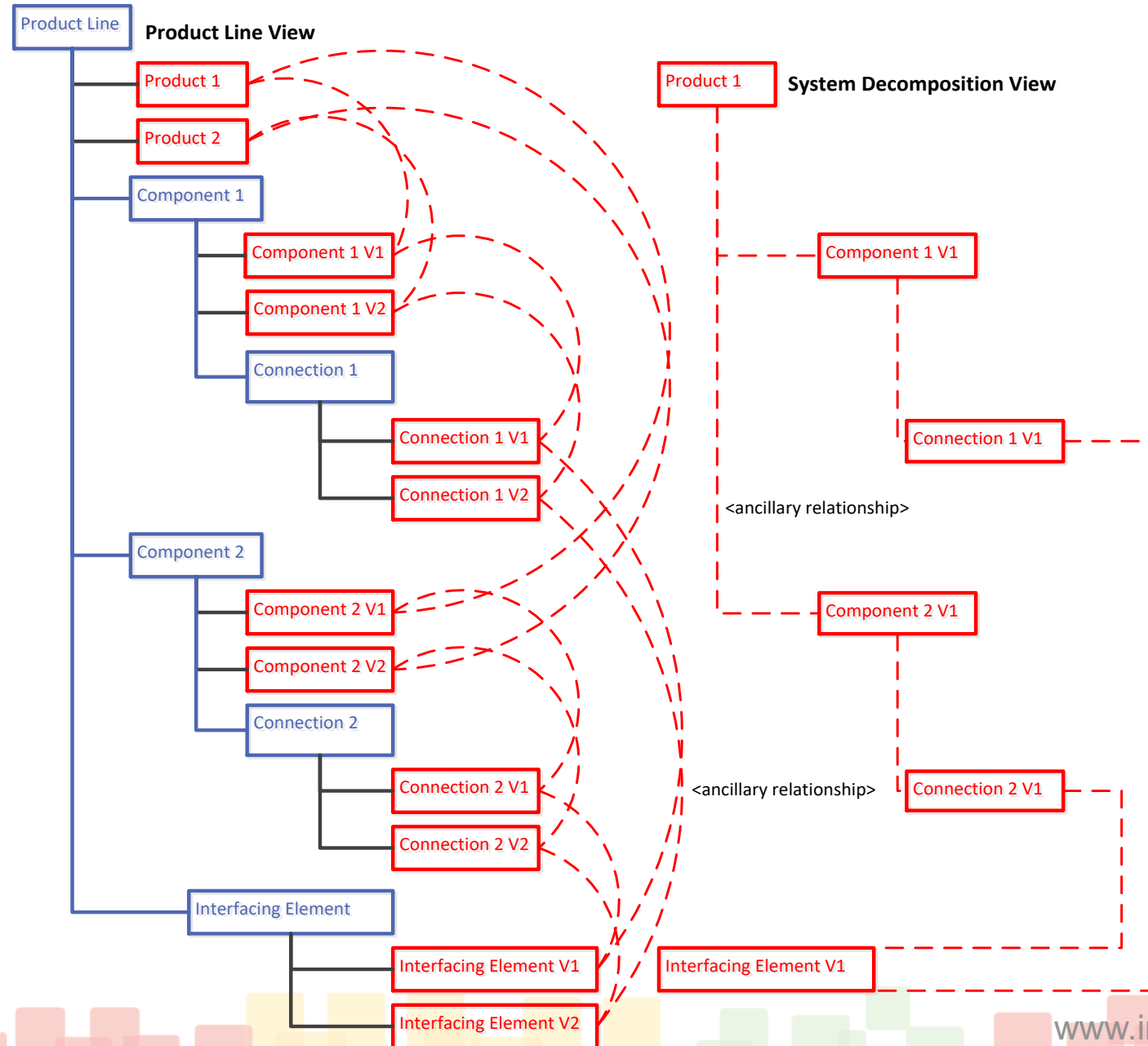
Product Line Model Incorporating Connection and Interface Element Variants



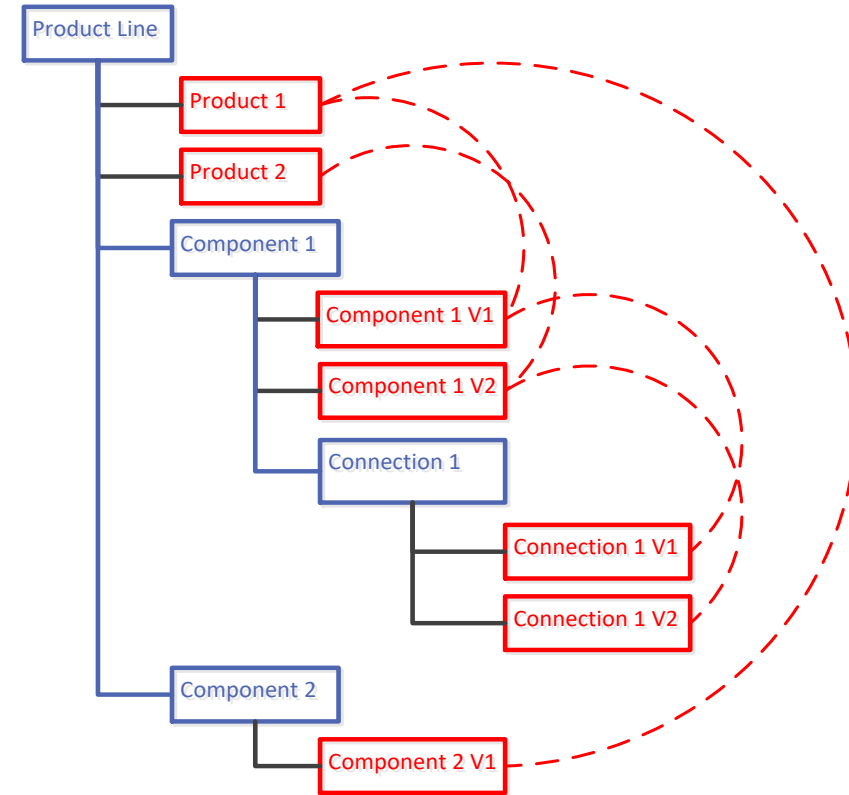
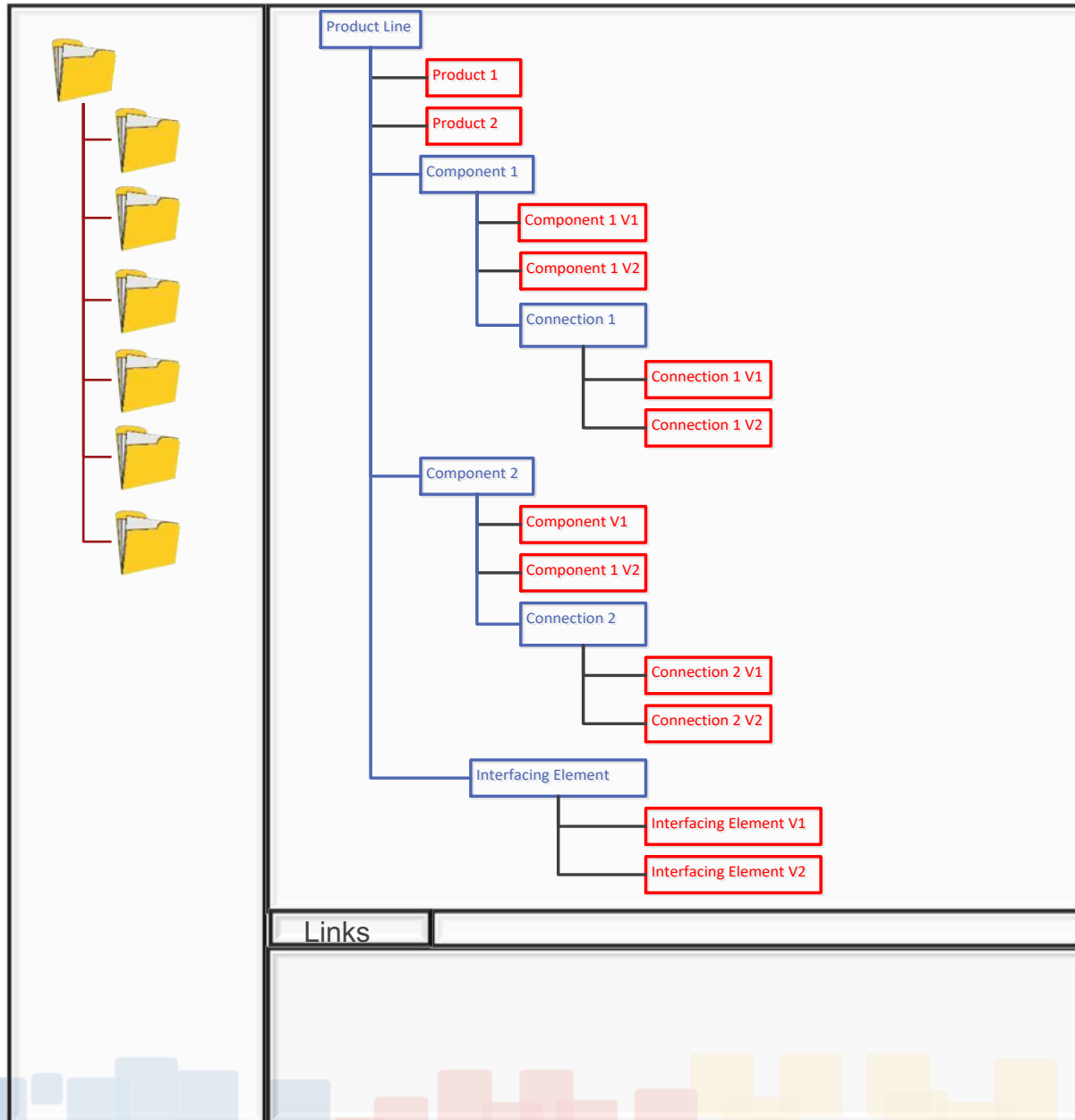
Product Line Data Structuring Limitations in Current Tools



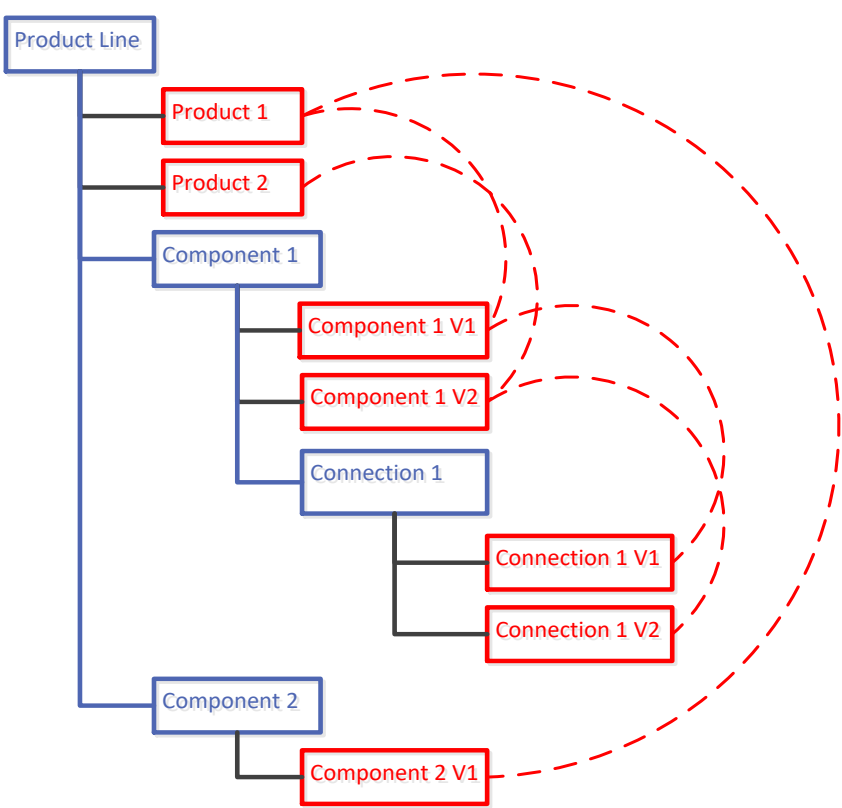
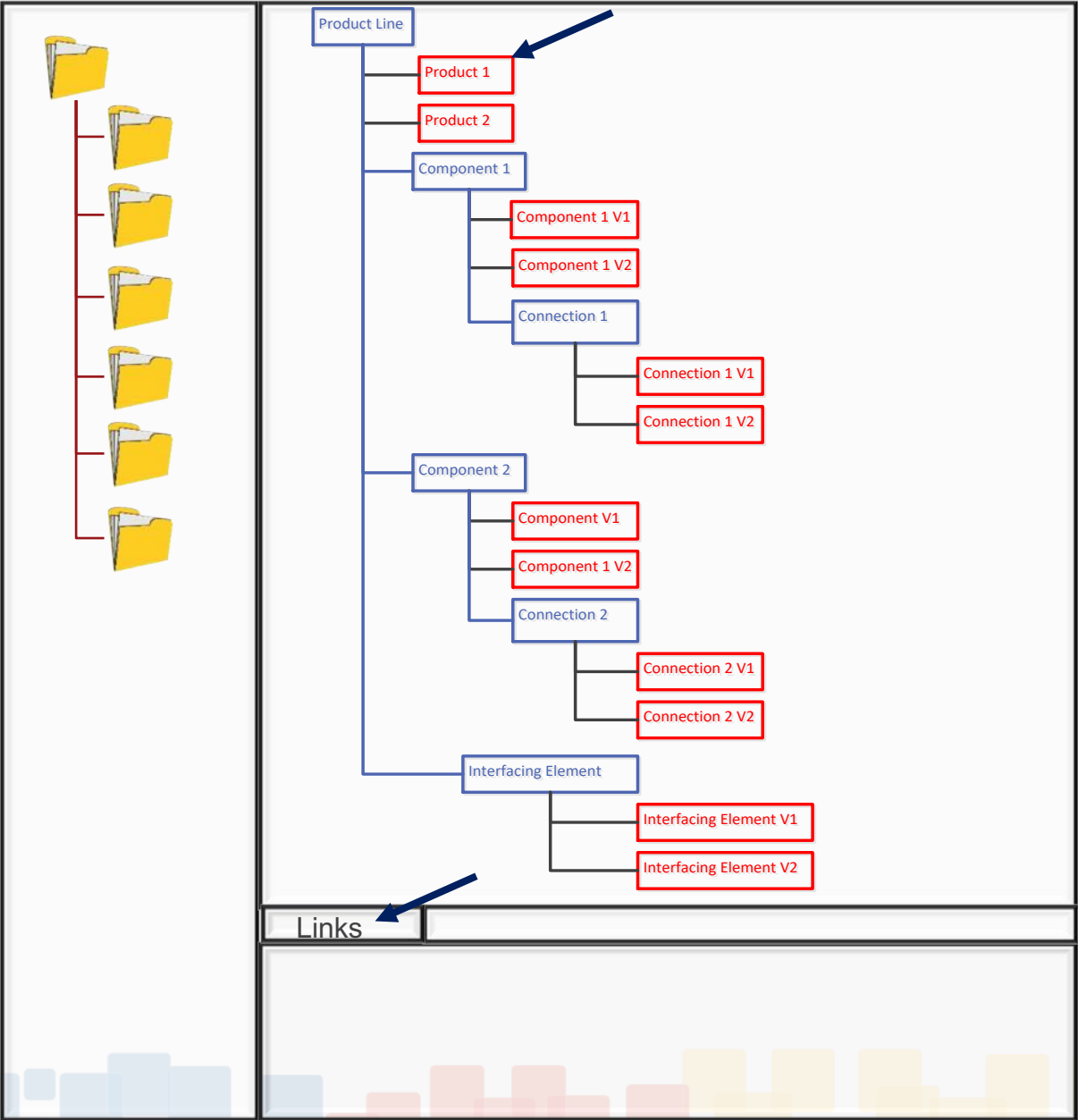
Using Ancillary Relationships to Derive Product Line Views in Current Tools



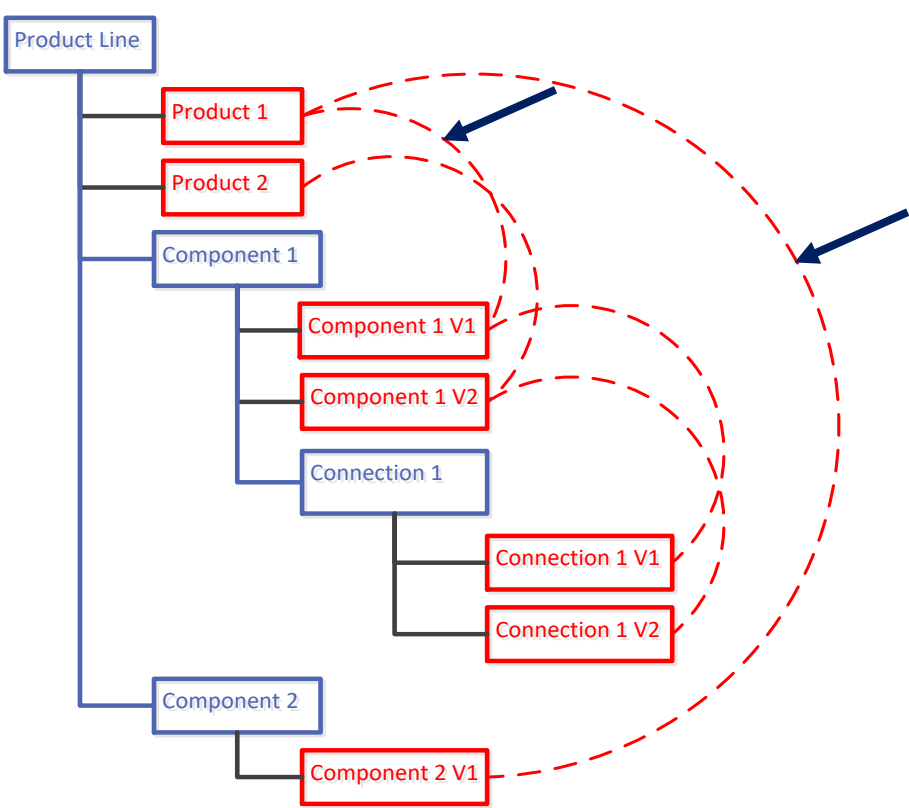
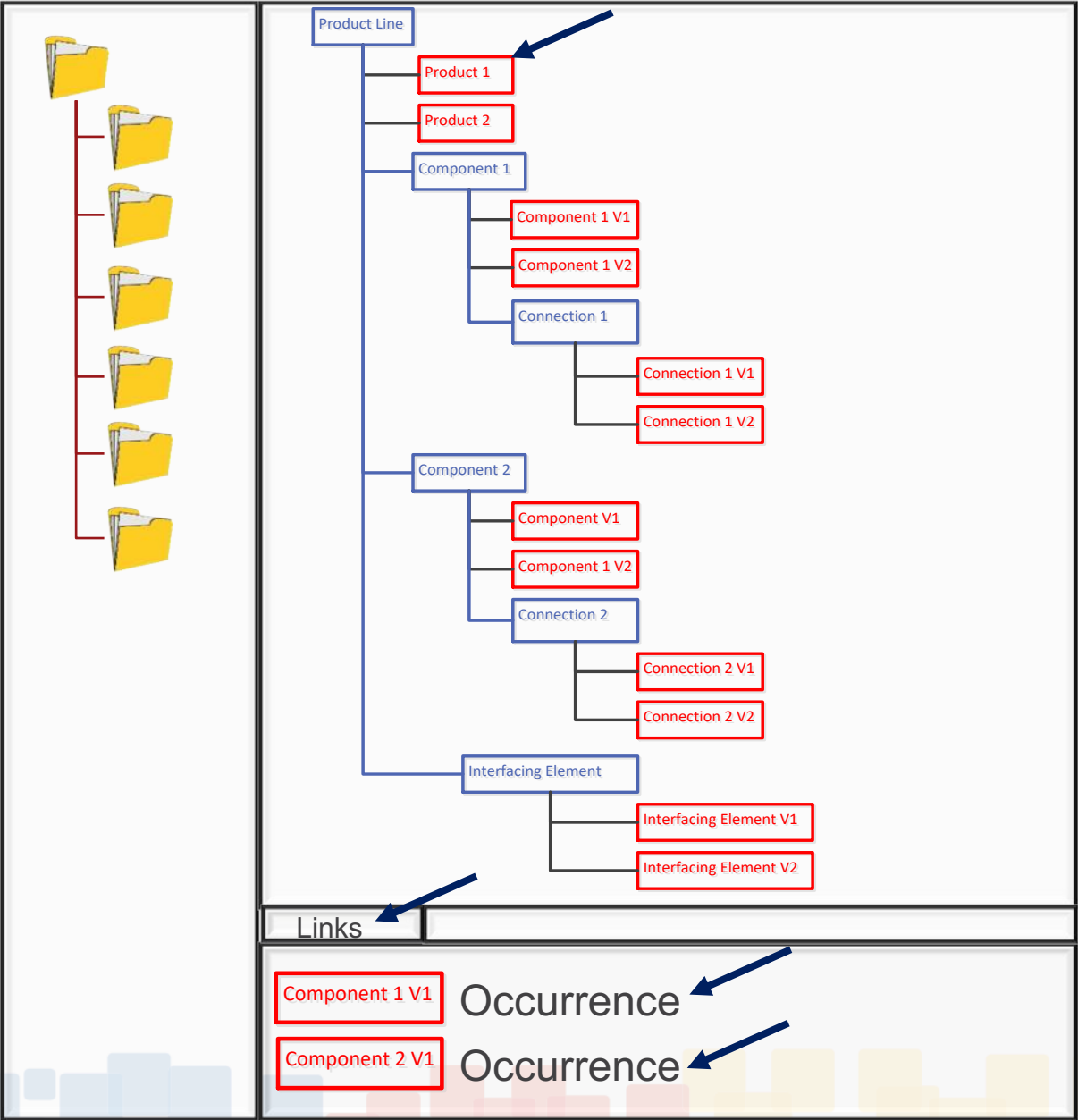
Example of Tool Limitations



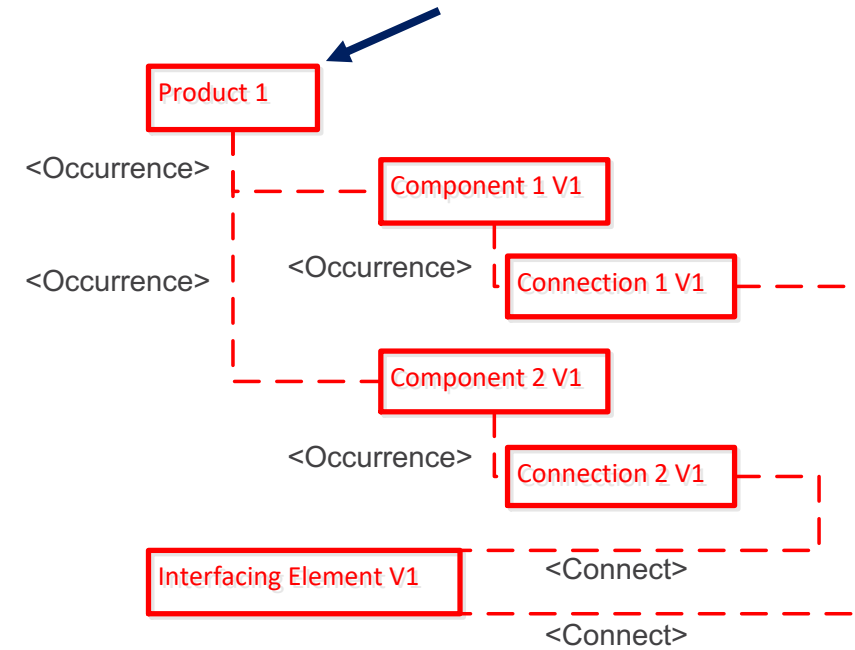
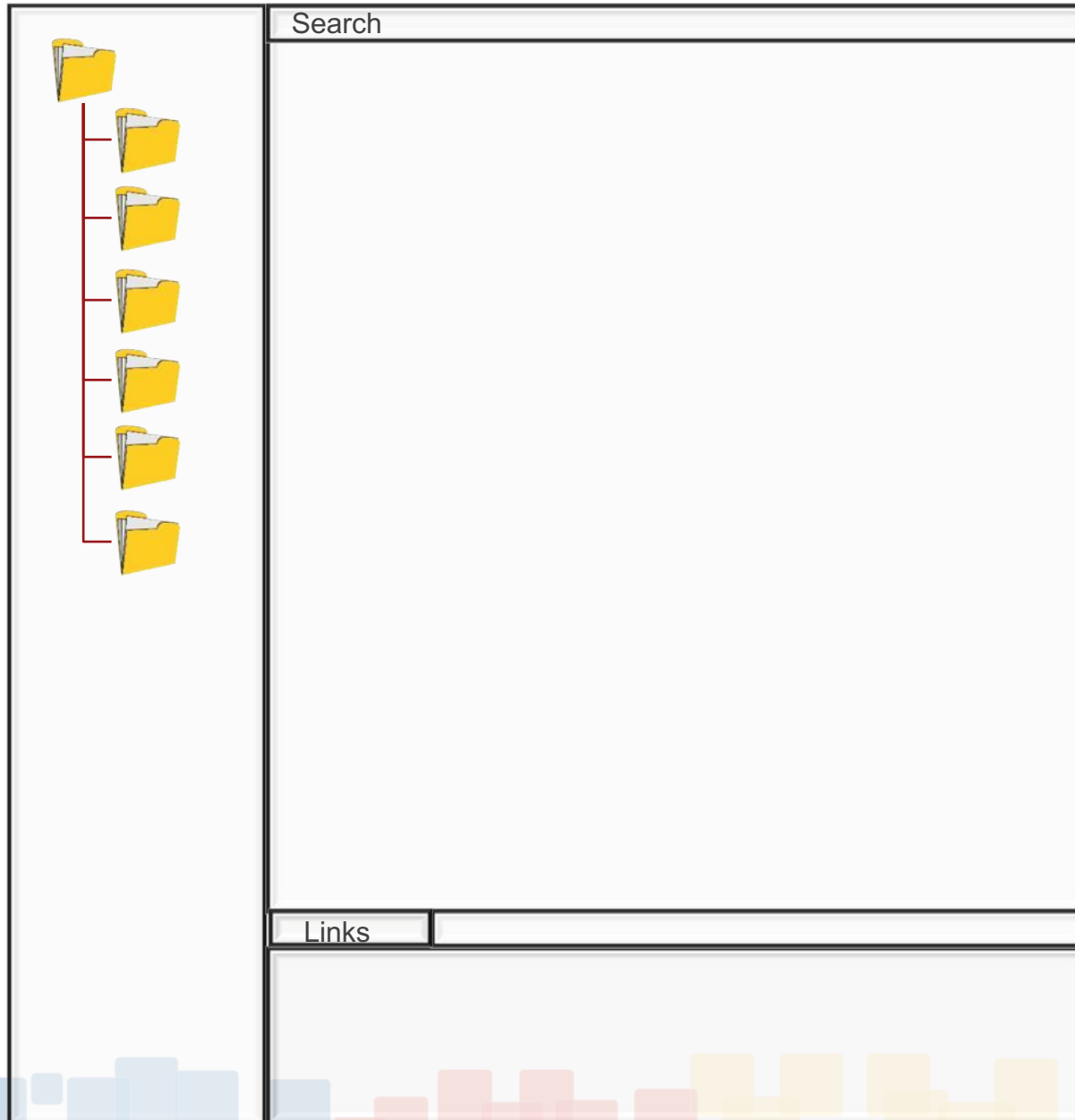
Example of Tool Limitations



Example of Tool Limitations

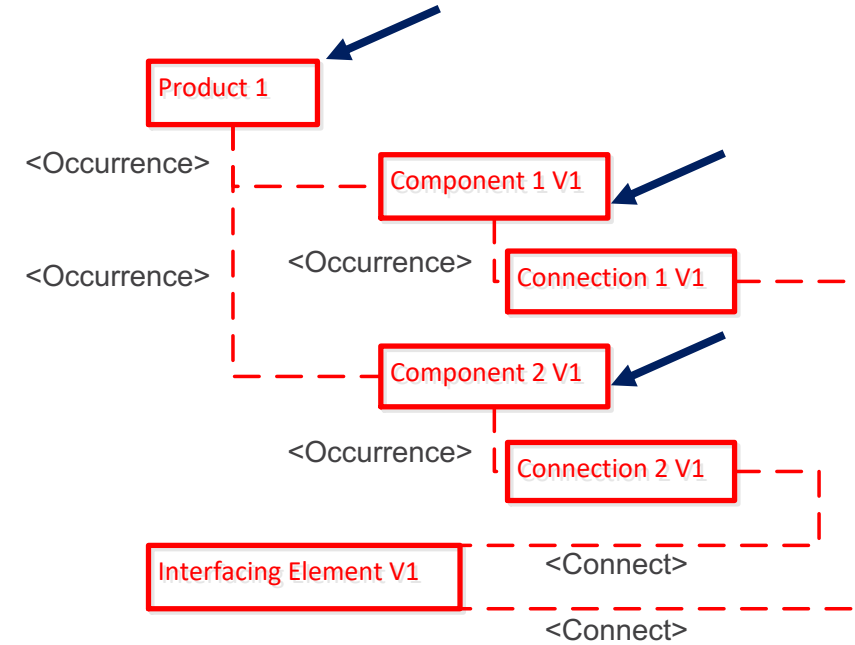
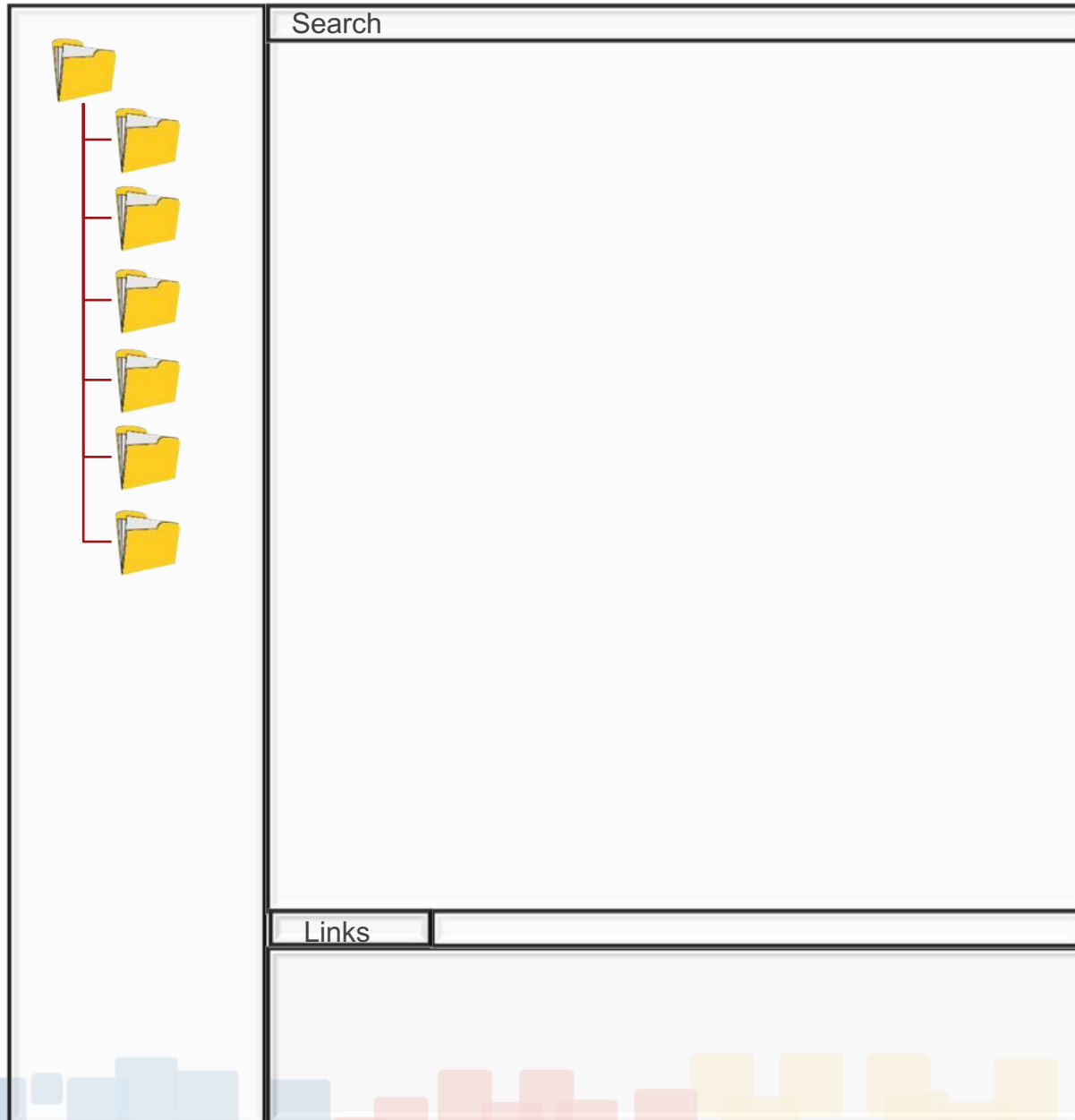


Example of Tool Limitations



Example Query
Select Product 1

Example of Tool Limitations

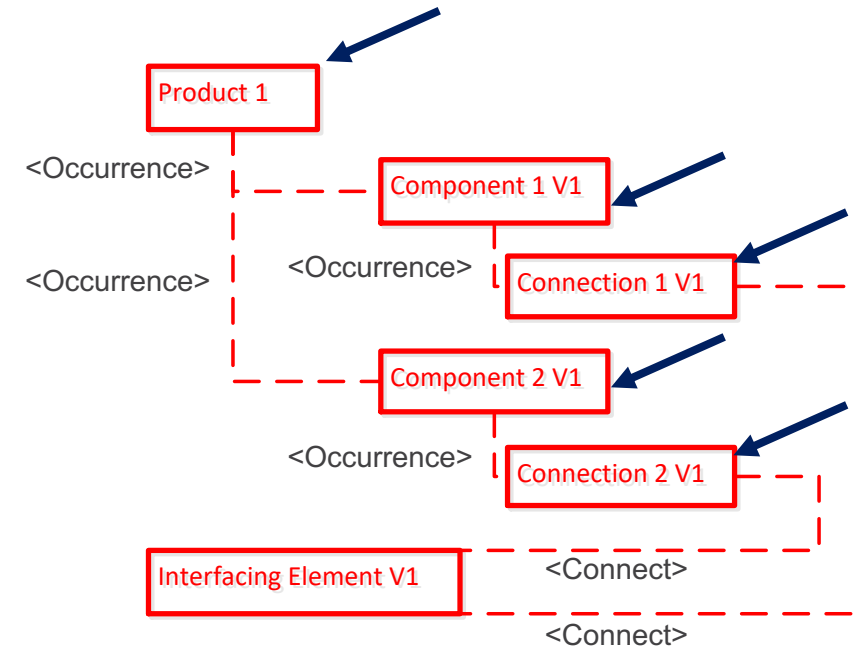
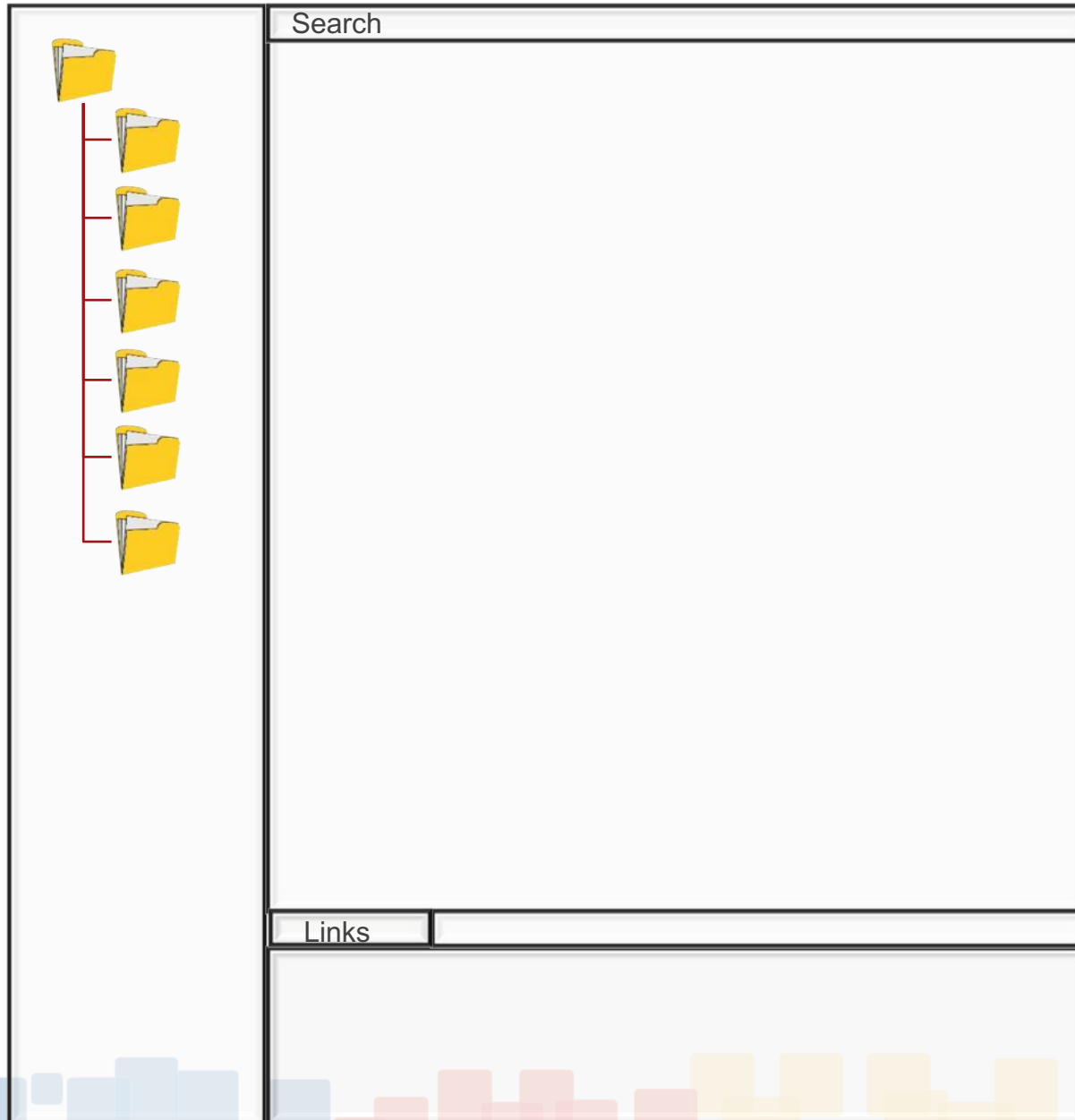


Example Query

Select Product 1

For each add linked objects <Occurrence>

Example of Tool Limitations



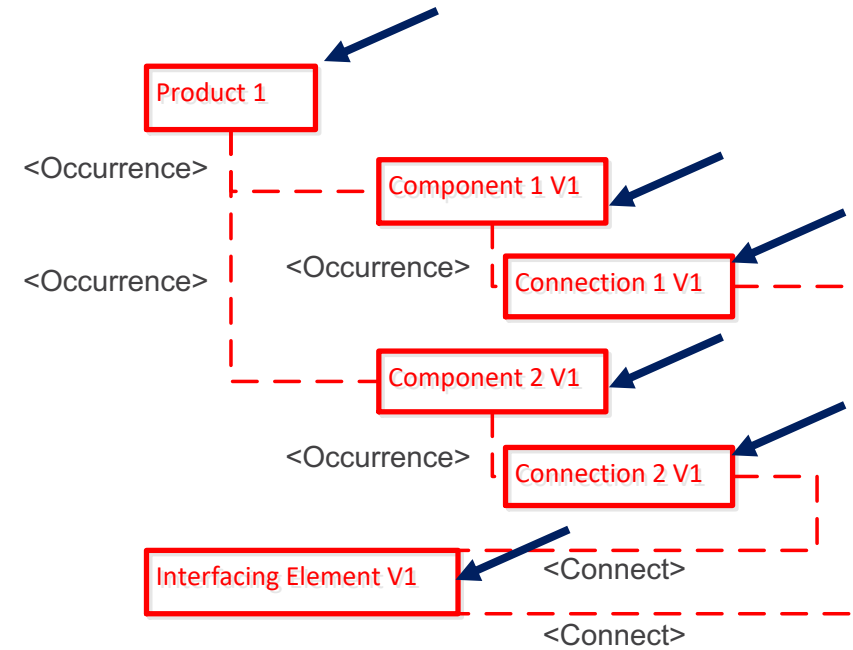
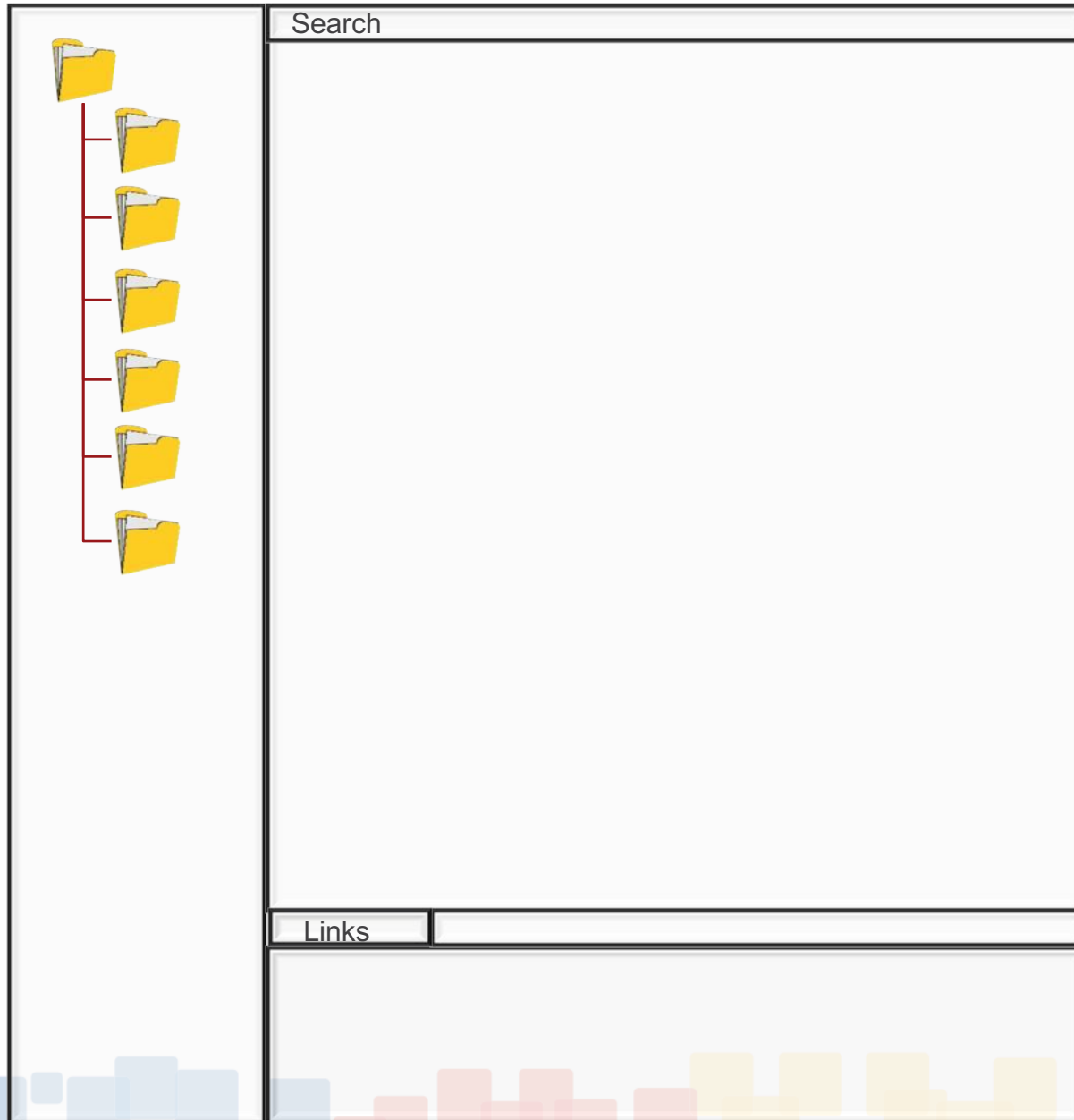
Example Query

Select Product 1

For each add linked objects <Occurrence>

For each add linked objects <Occurrence>

Example of Tool Limitations



Example Query

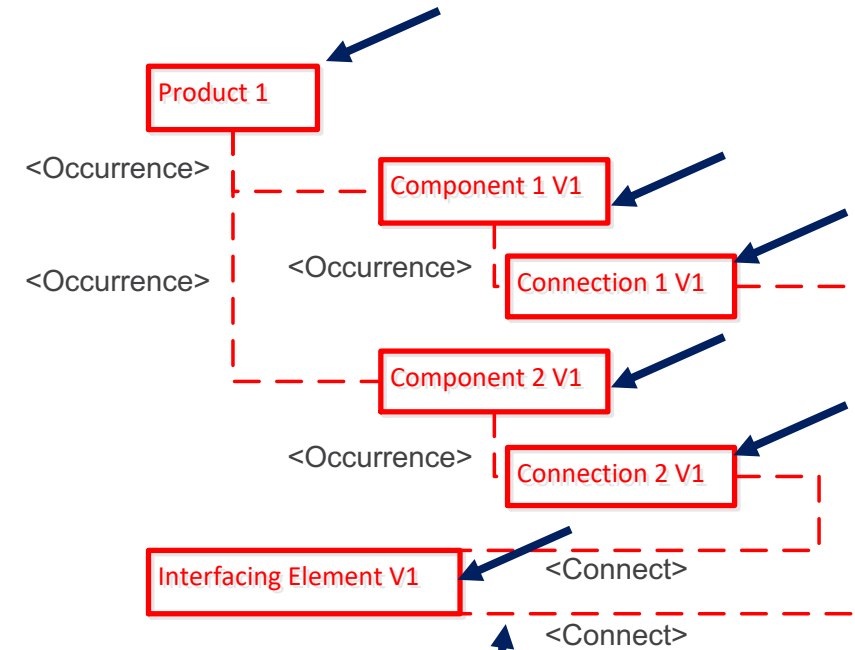
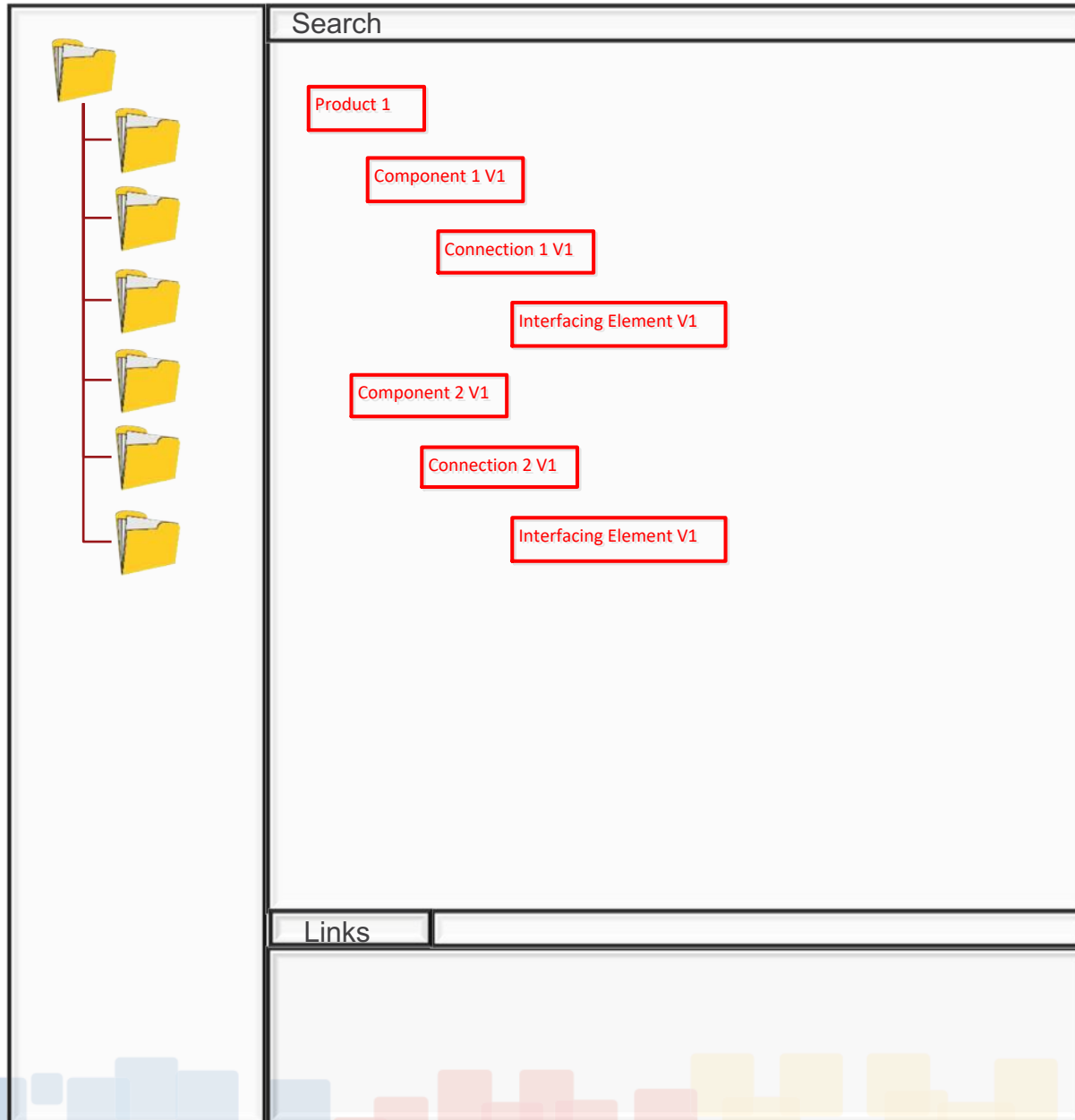
Select Product 1

For each add linked objects <Occurrence>

For each add linked objects <Occurrence>

For each add linked objects <Connect>

Example of Tool Limitations



Example Query

Select Product 1

For each add linked objects <Occurrence>

For each add linked objects <Occurrence>

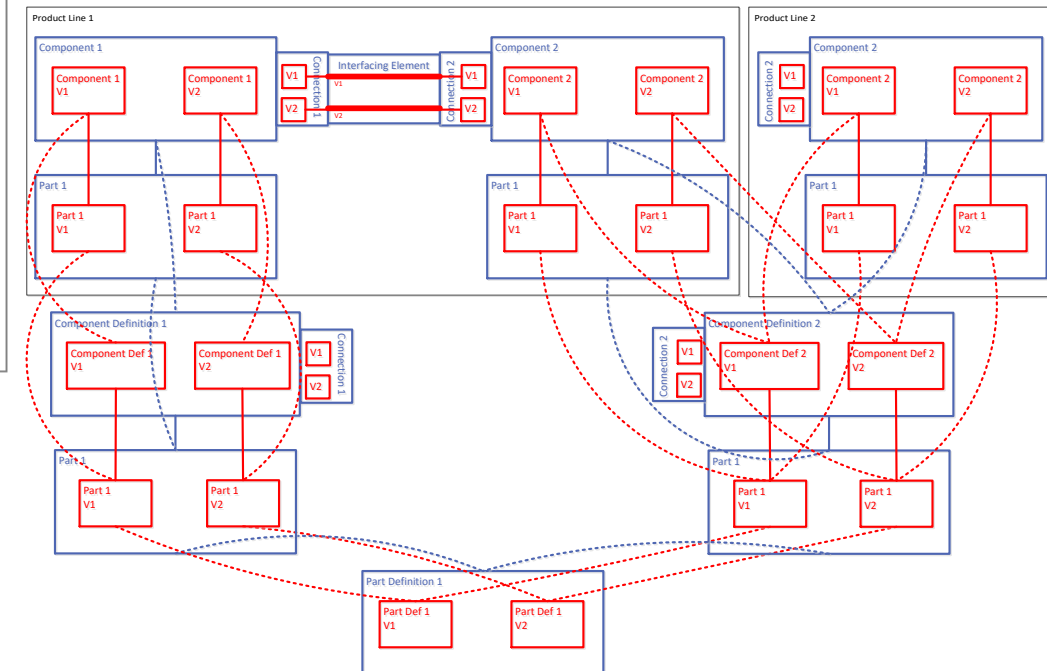
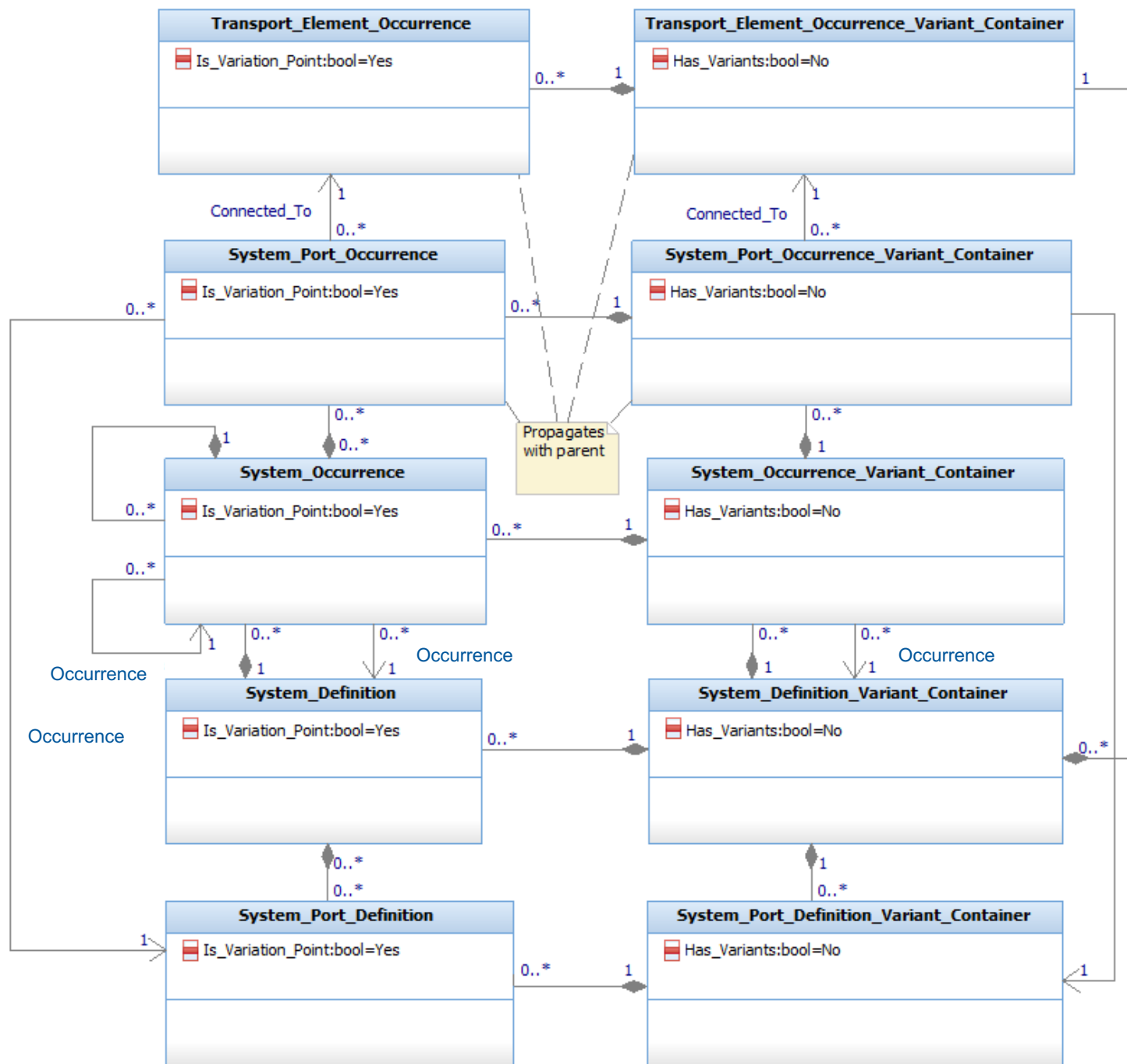
Potential for inadvertent deletion

For each add linked objects <Connect>

Performance issues for large models

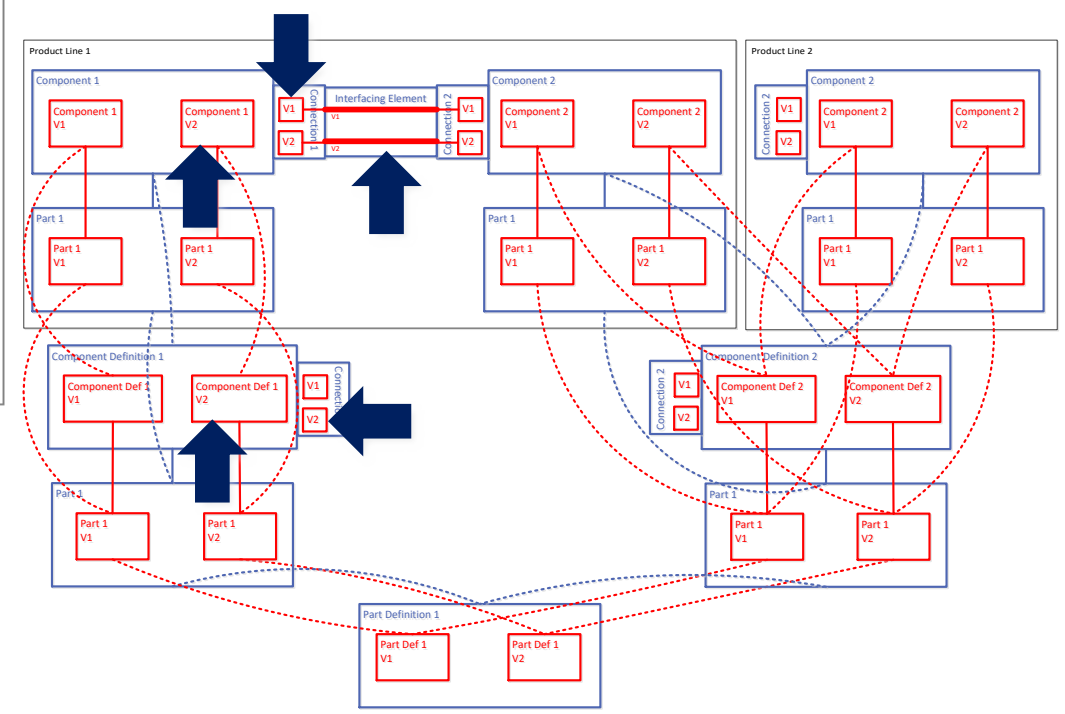
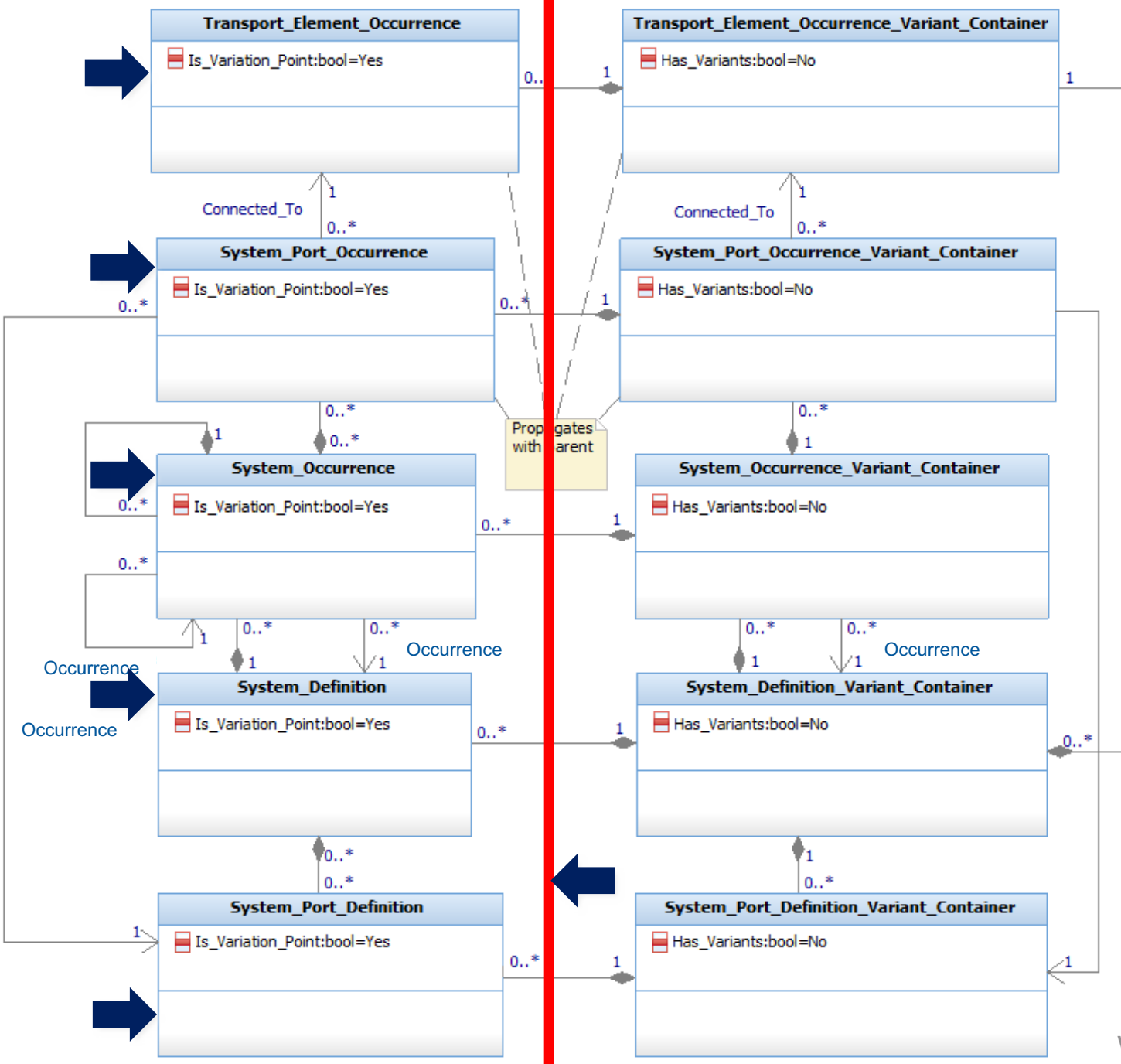


Proposed Core Data Model



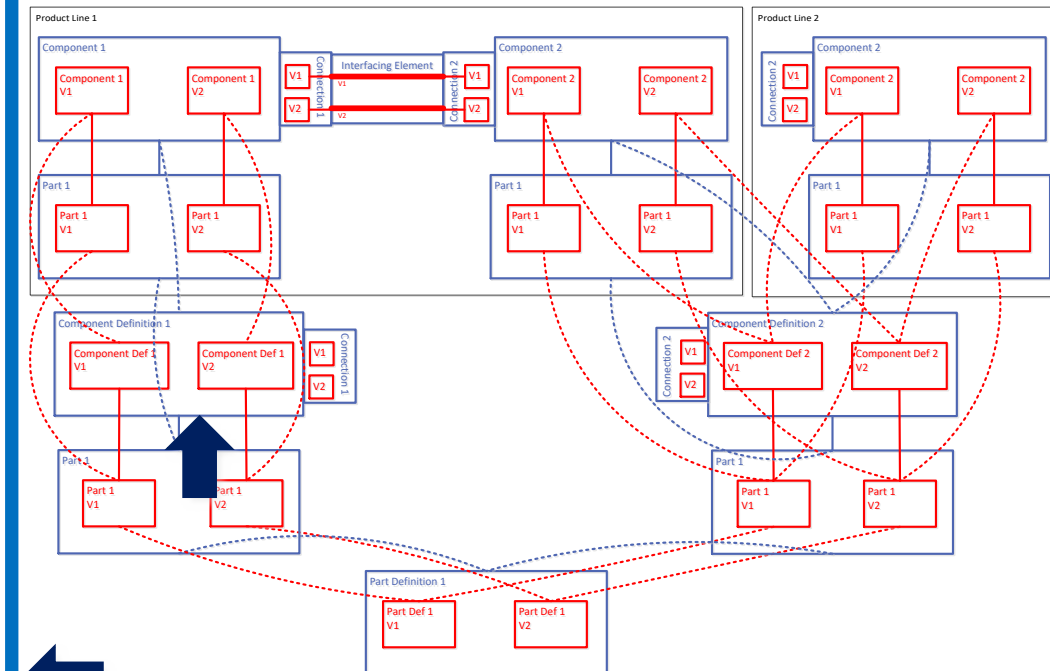
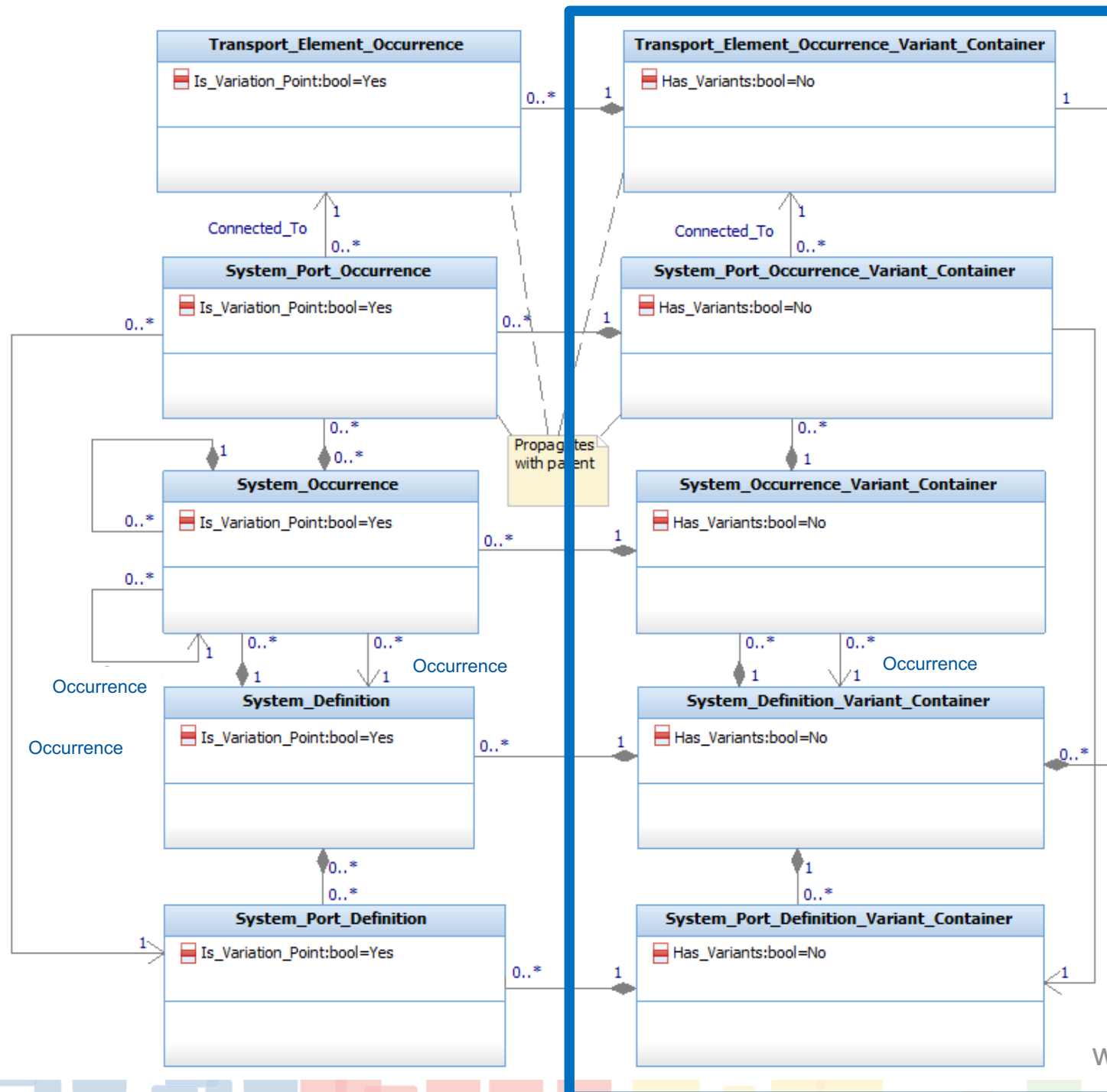


System Composition/Decomposition (Occurrence) Model

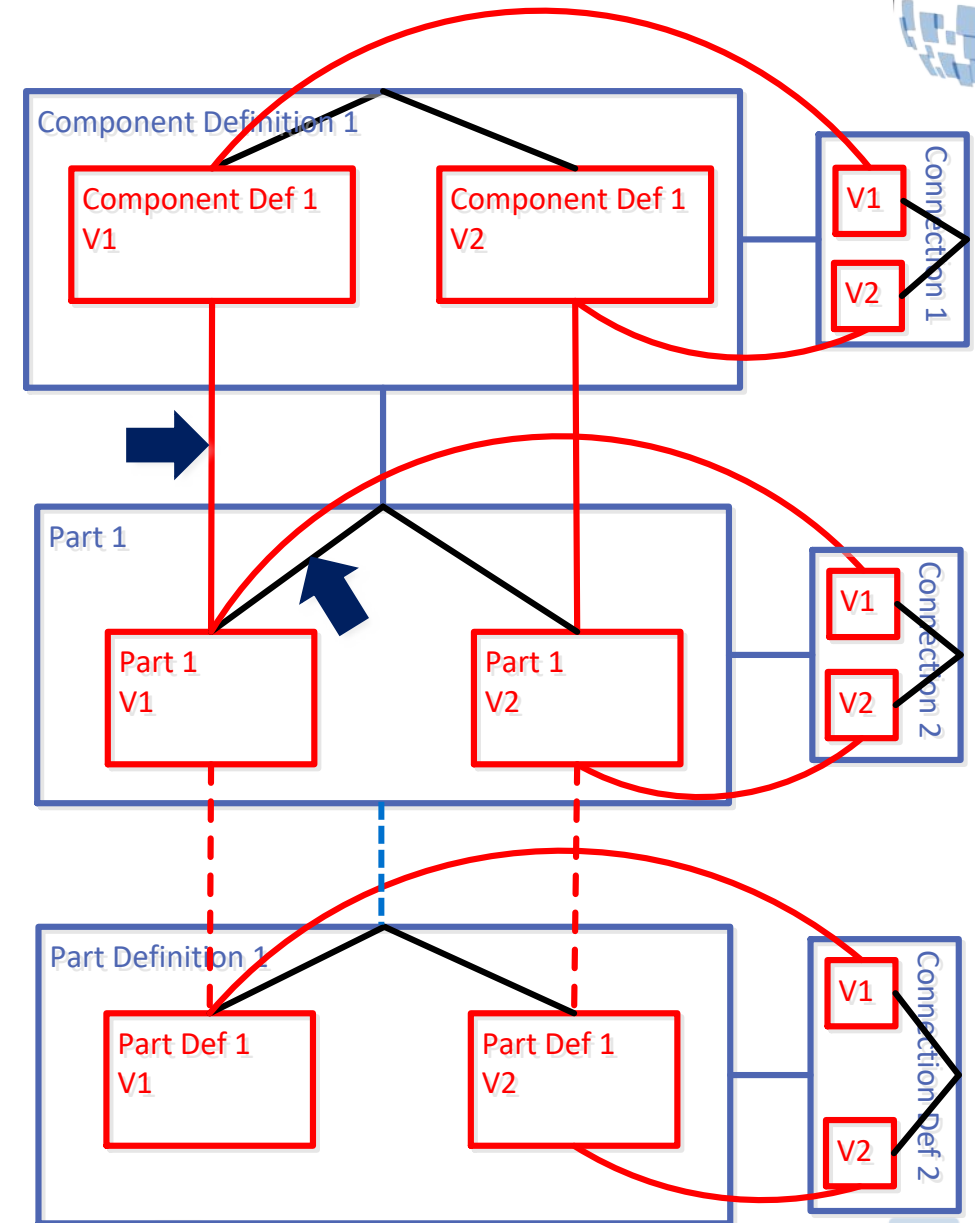
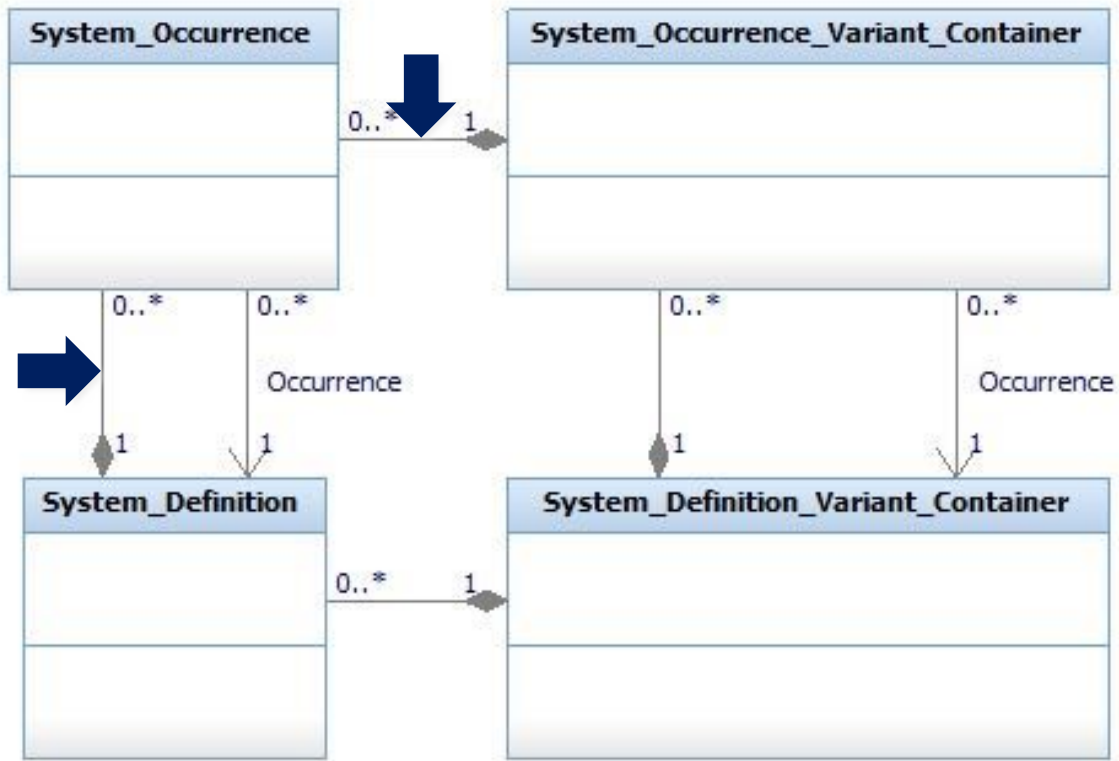




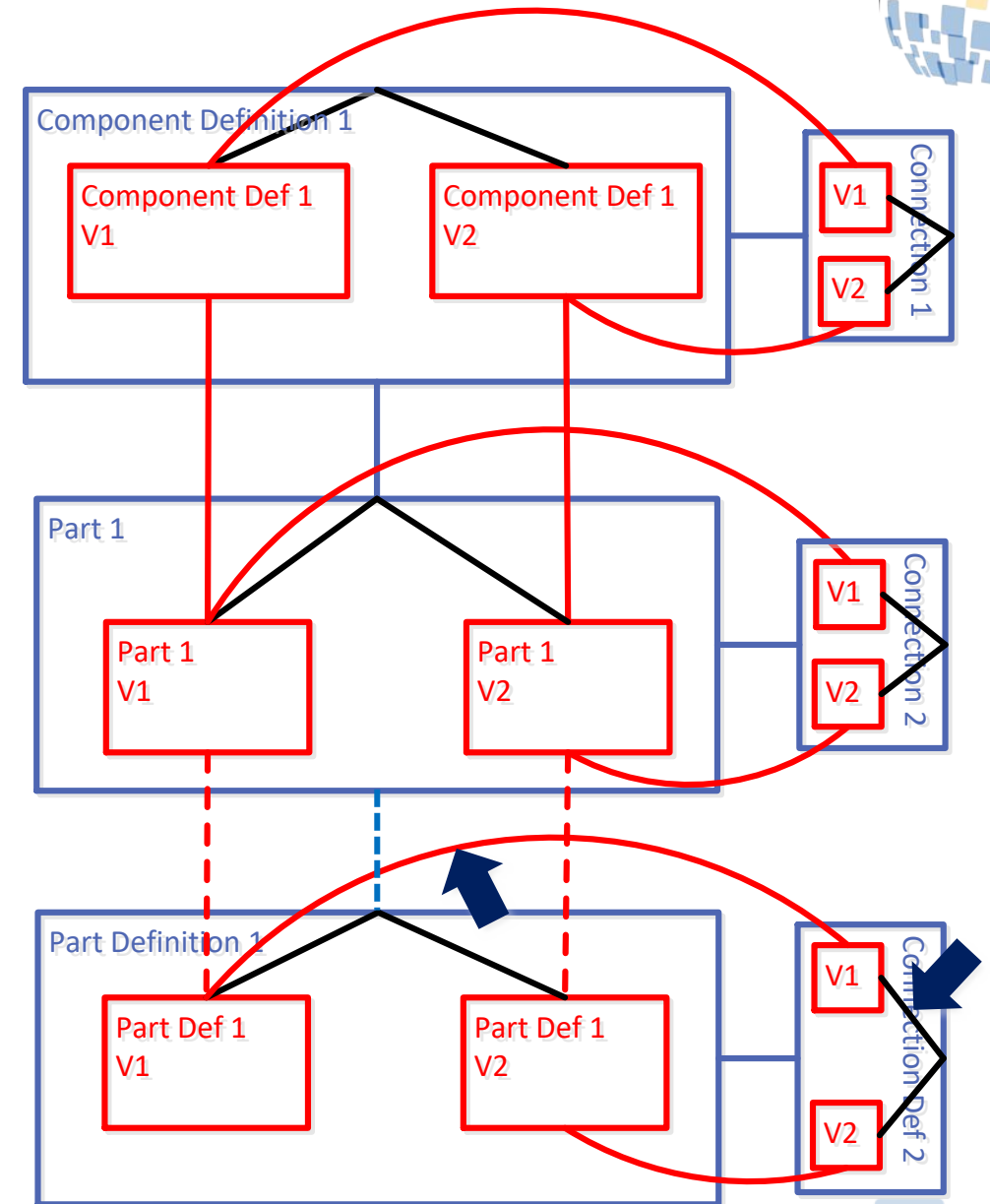
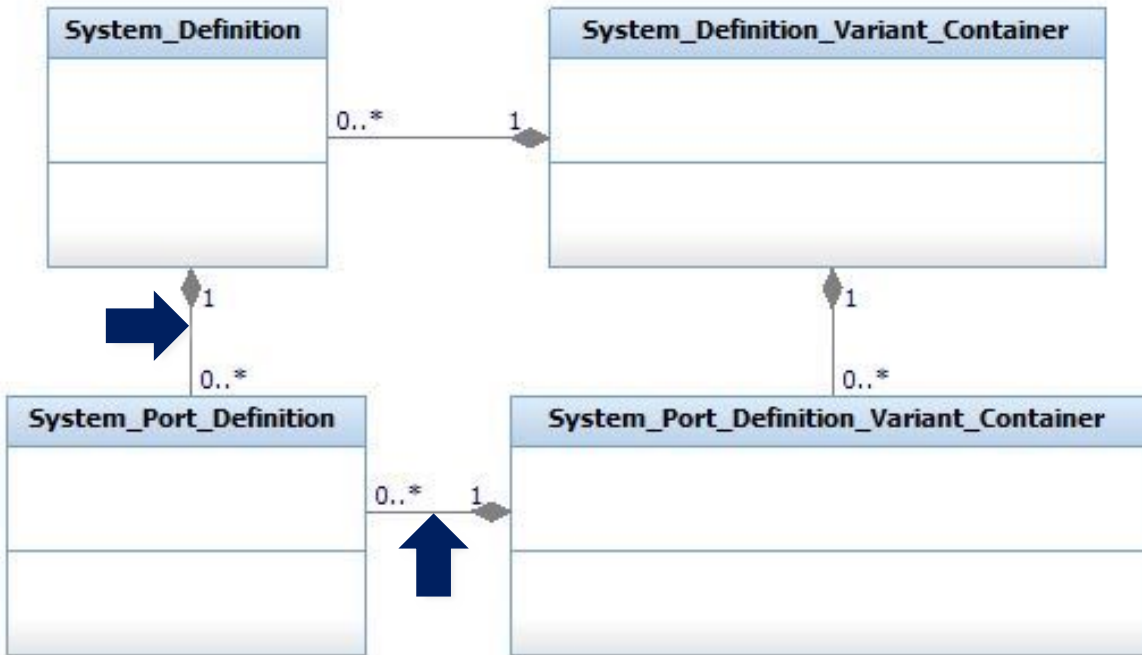
Product Line Composition/Decomposition (Occurrence) Model



Dual Parentage



Dual Parentage





Conclusion

Key Issues



- Managing Interface Variants
- Modularity of Interfaces
- Model Configuration Management
- Tool Limitations with respect to Dual Composition Structures

Conclusion



- Feature-based PLE models need to be deliberately architected for simple and effective reuse of product options.
- PLE modeling standards should be published, and incorporated into PLE modeling tools that support
 - simultaneous competing data structures of system hierarchy and Product Line hierarchy
 - simple and effective interface variance management
 - interface modularity enforcement
 - effective data management schema for asynchronous release of product configurations



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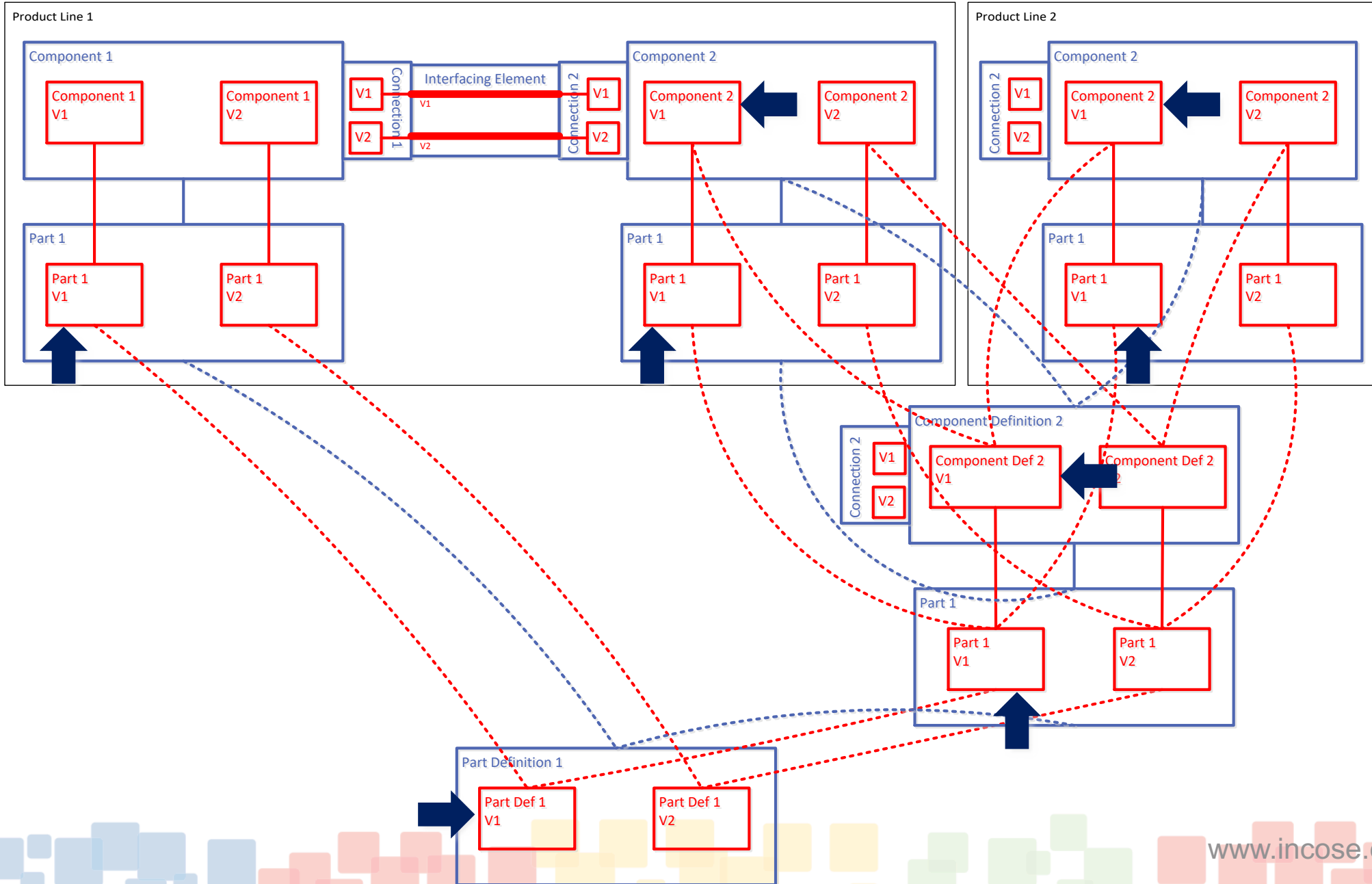
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www.incose.org/symp2018

Questions?

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Reuse Across Product Lines



Challenges of Configuration Management in Product Line Models

