



Pure Variants

プロダクトライン開発の バリエーション管理支援ツール



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はじめに、
バリエーション管理支援ツールや、
それに関わる用語を説明します

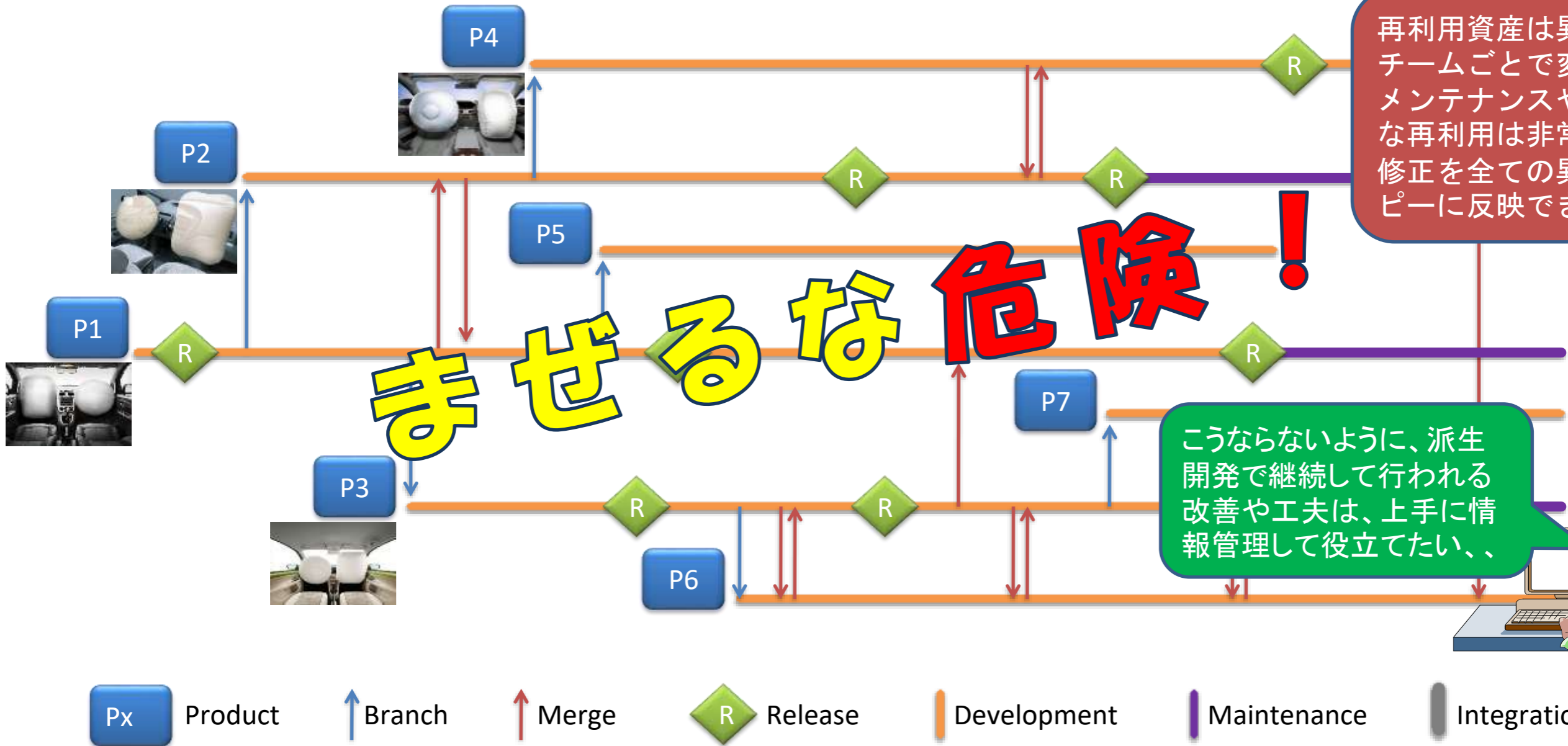
バリエーション、バージョン、バリエーション



複数の派生製品からなる一連の製品群
プロダクトライン = 製品系列

プロダクトライン開発では
各製品のことをバリエーション
バリエーション間の違いはバリエーション
バージョンとバリエーションを混同しないこと

なぜ、混同してはいけないか？



再利用資産は異なるチームごとに変更され、メンテナンスや大規模な再利用は非常に困難。修正を全ての異なるコピーに反映できない


こうならないように、派生開発で継続して行われる改善や工夫は、上手に情報管理して役立てたい、



バージョン地獄

各製品は同じコンポーネントの異なるバージョンで構成される
各製品ごとに機能追加や修正を受けて進化を続け、修正を他機種に反映させることは困難

	P1	P2	P3	P4
Component A	1.0	1.1	1.3	2.0
Component B	1.0	1.2	2.1	2.4
Component C	1.0	1.0	2.3	4.0



そこで登場するのが、
プロダクトライン開発です

プロダクトライン開発



Product Line Engineering (PLE) は、
再利用資産を運用する技術的な取り組みであり

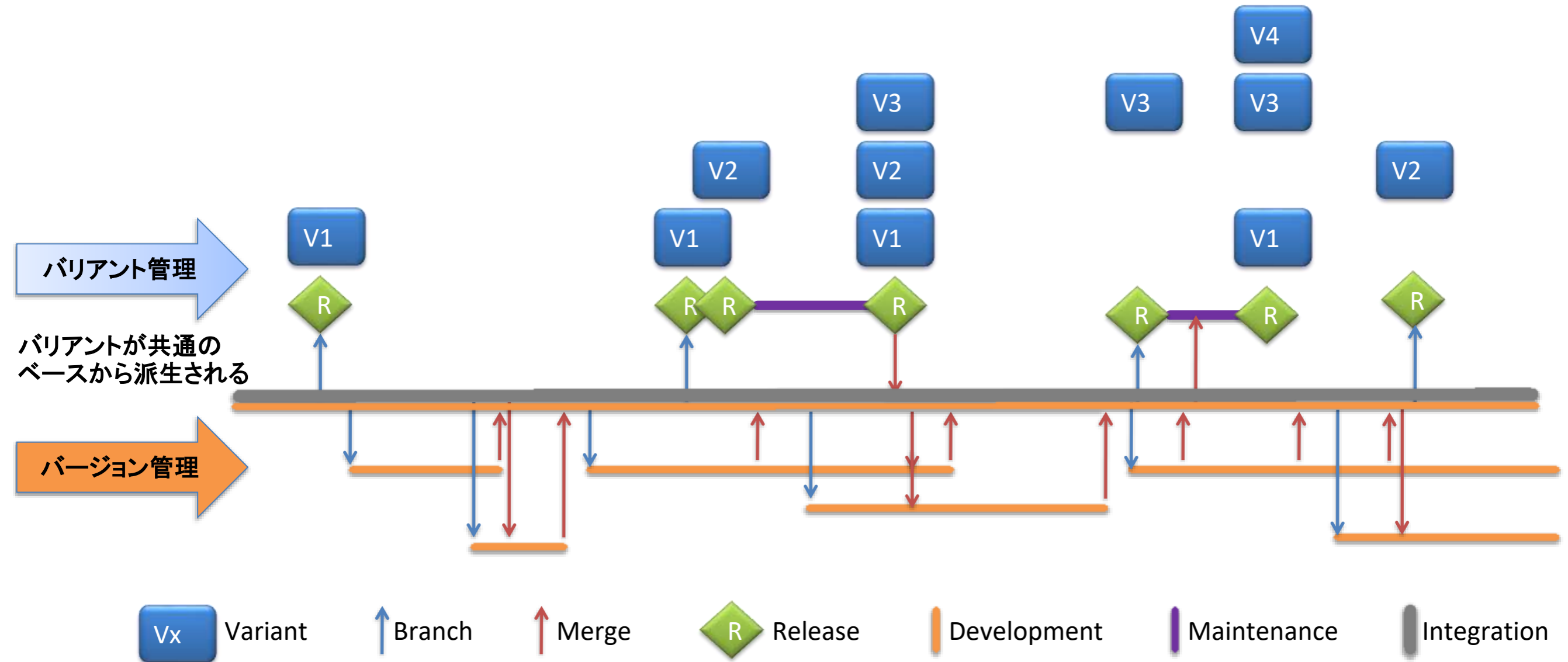
製品(バリエーション)の進化に柔軟に応じることのできる、
開発プロセスや手法を伴う全体的なアプローチが求められる





そのために必要なことは、

適正なバリエーション管理支援ツールを統合





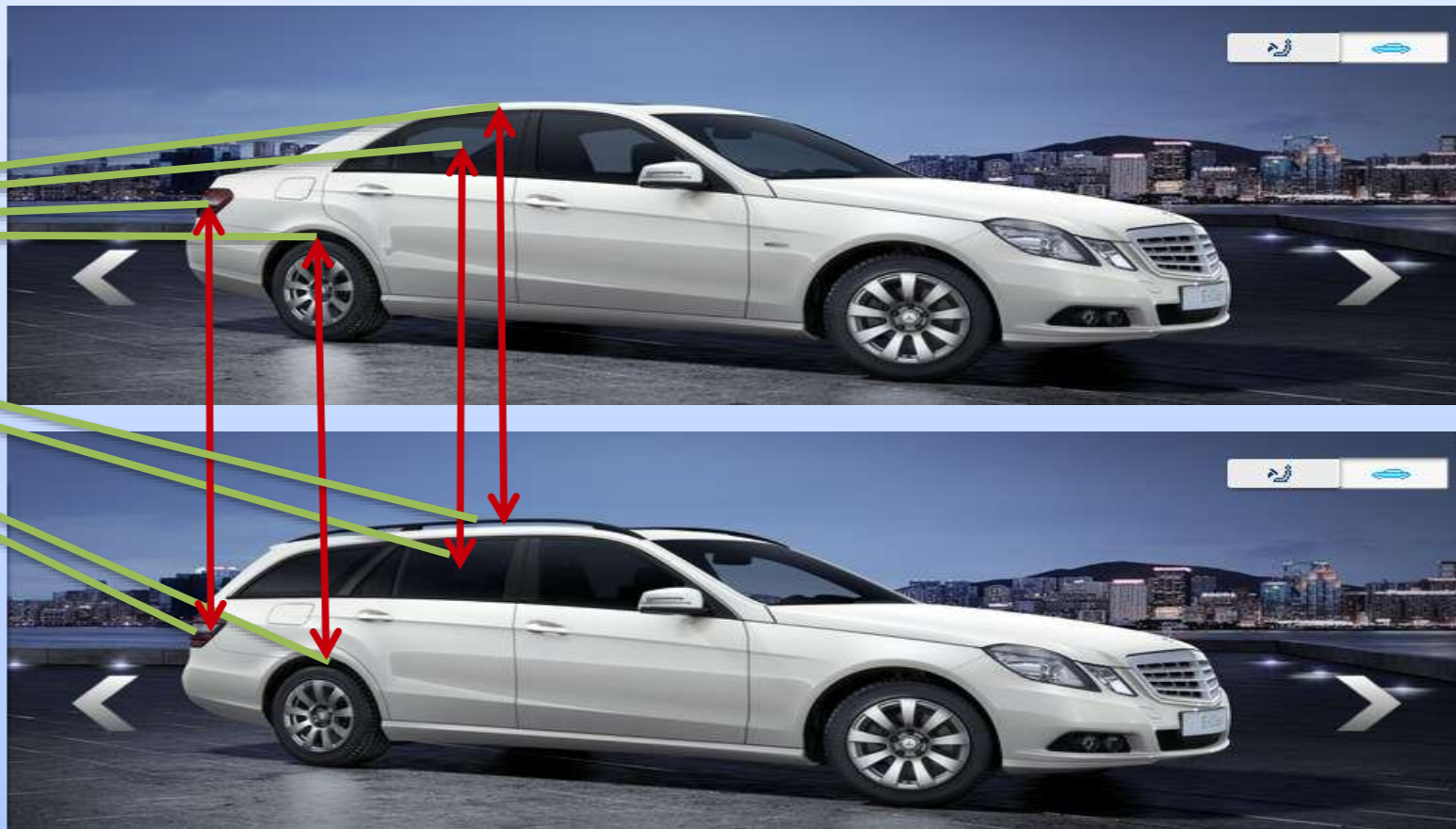
バリエーション管理支援ツール について

バリエーションポイント

問題空間



解決空間



- ・ バリエーションポイントは問題空間と解決空間の両方に存在する
- ・ 双方に結び付くのでバリエーションの決定項目の複雑さを軽減できる

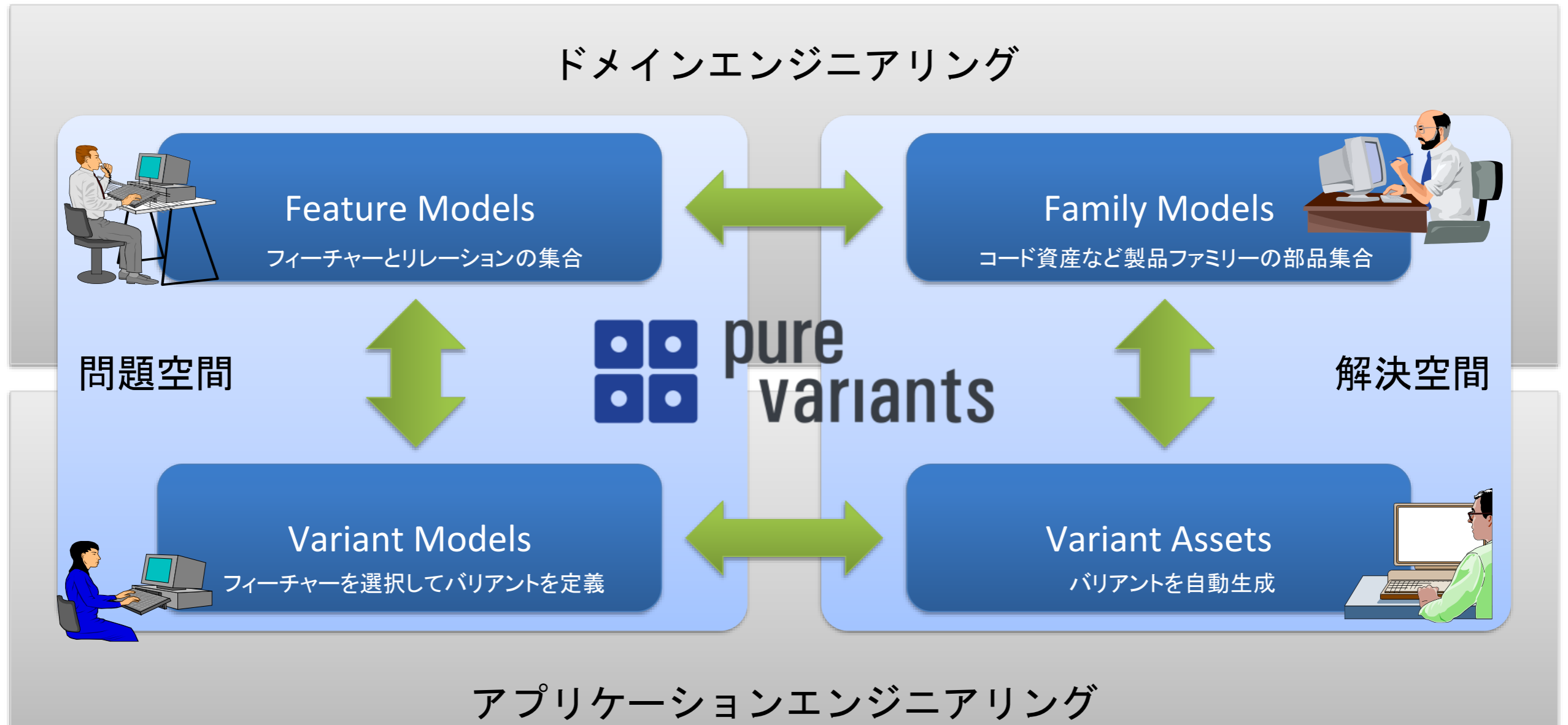
バリエント管理支援ツール



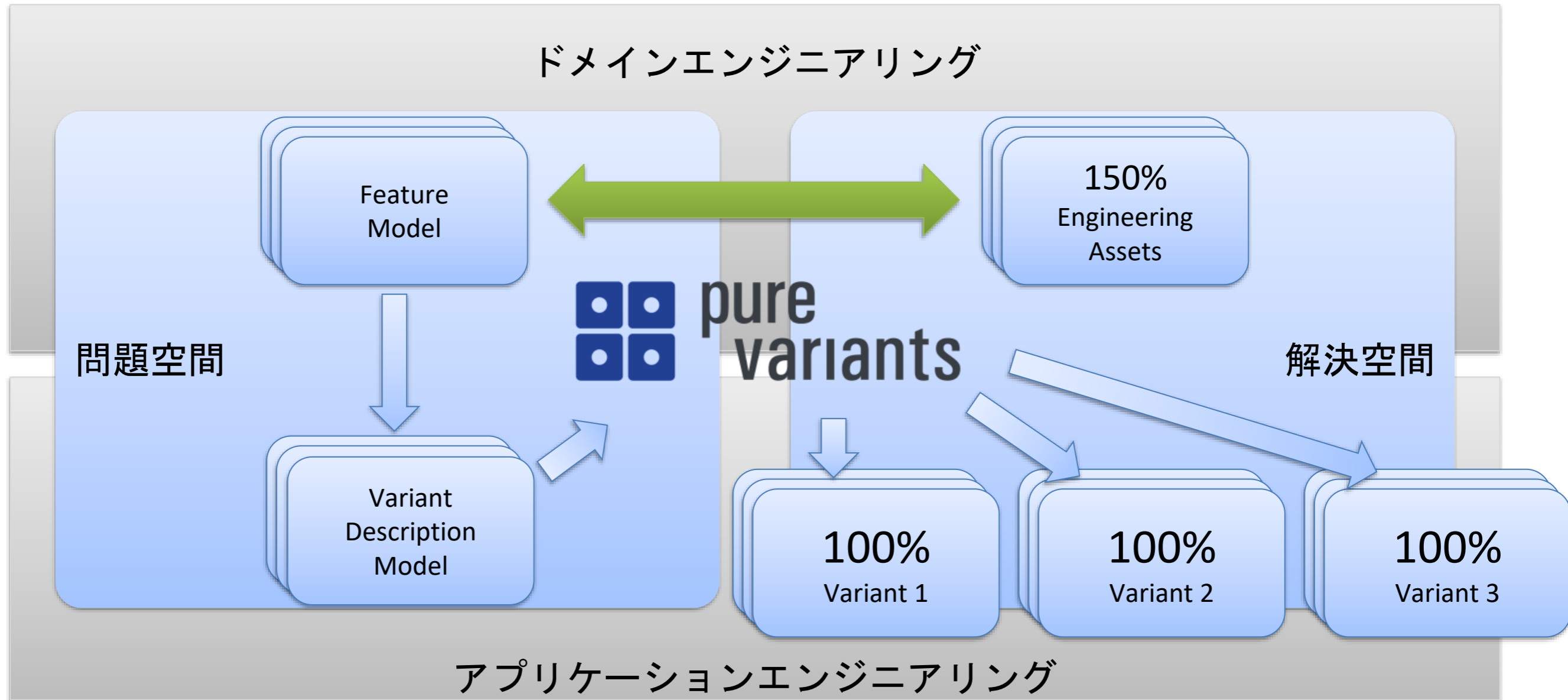
 pure
variants

<https://www.fuji-setsu.co.jp/products/purevariants/>

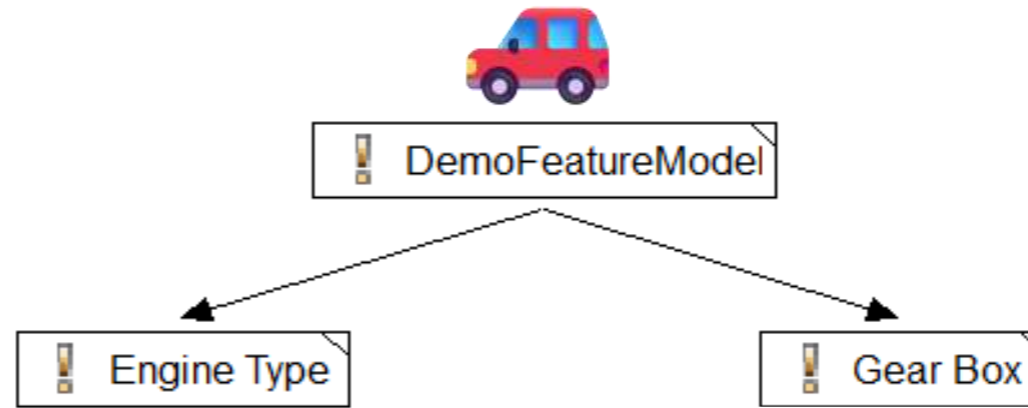
PLEの戦略＝関心事の分離



フィーチャモデルでバリエーションを管理

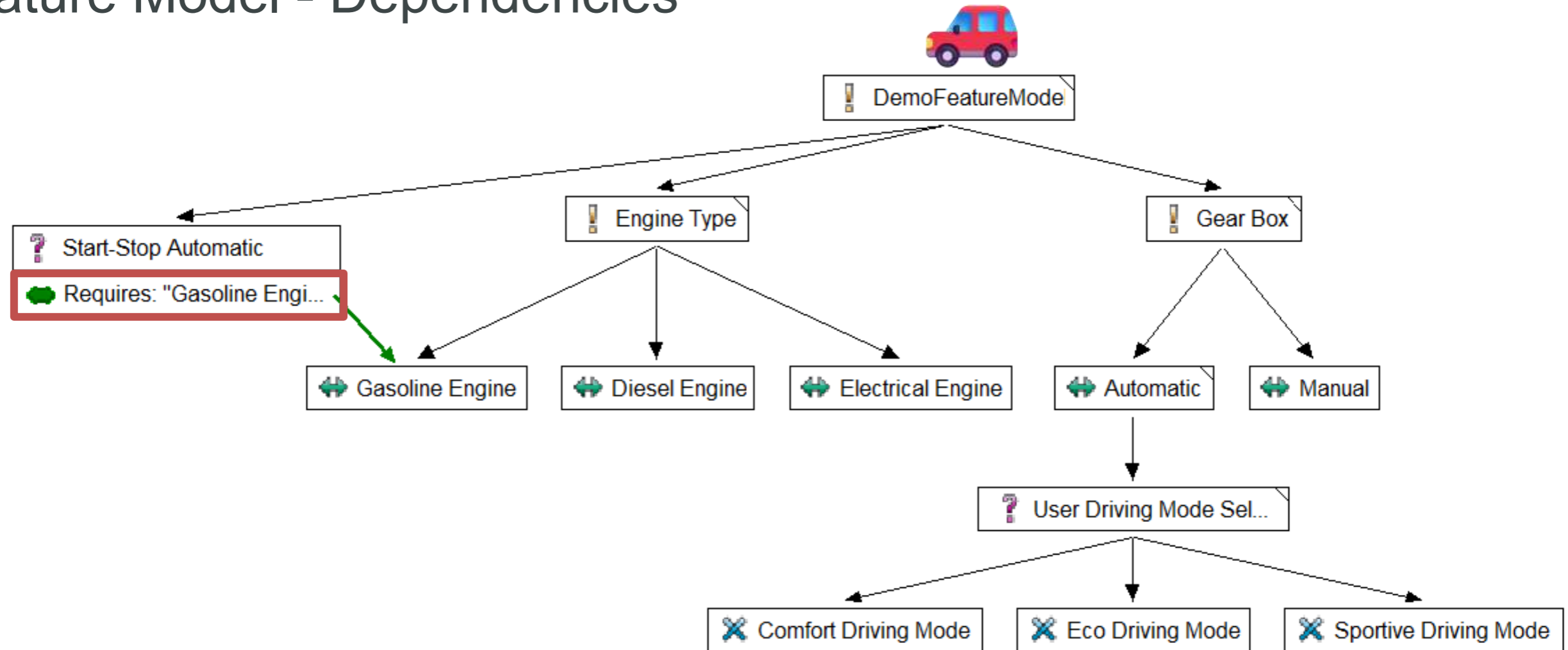


Feature Model



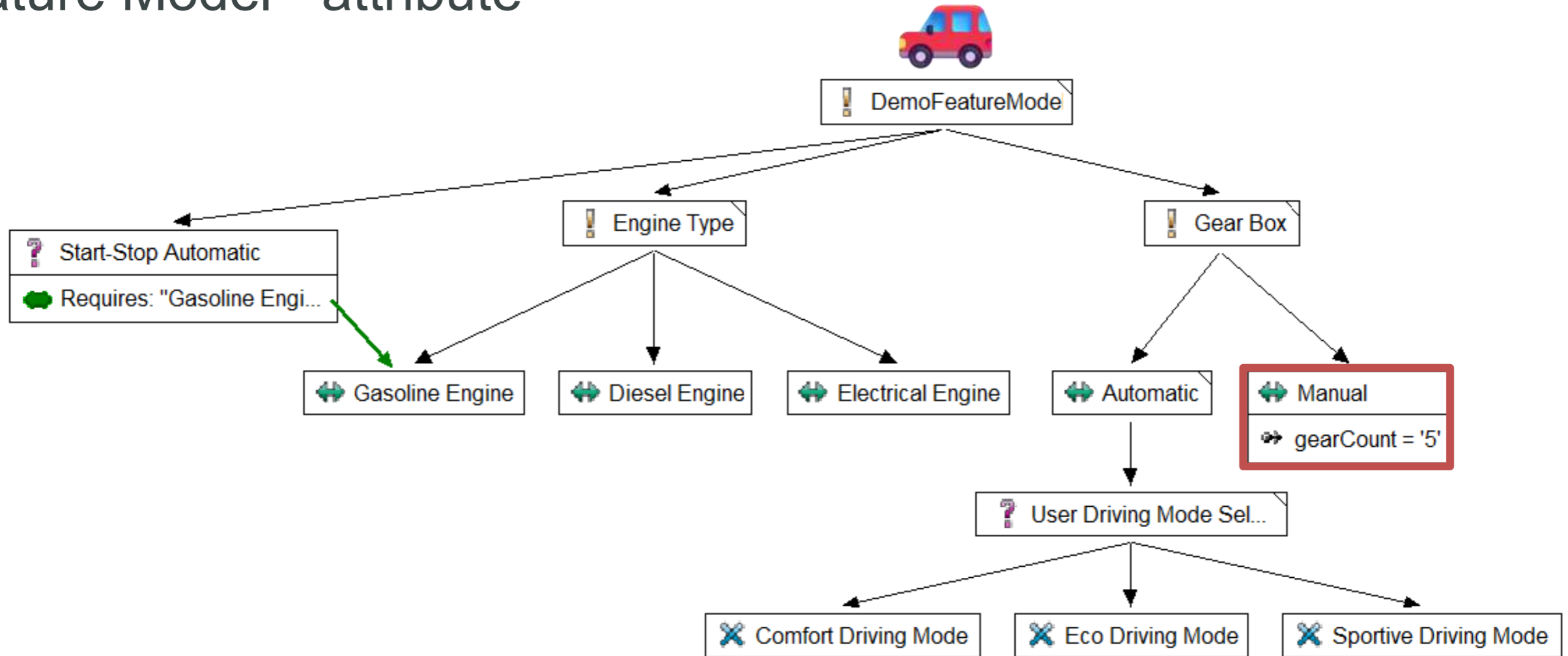
タイプ : ! = Mandatory (必須) ? = Optional (選択自由) ↔ = Alternative (どれか一つ) ✕ = Or (少なくとも一つ)

Feature Model - Dependencies



タイプ : ! = Mandatory (必須) ? = Optional (選択自由) ↔ = Alternative (どれか一つ) ⊗ = Or (少なくとも一つ)

Feature Model - attribute

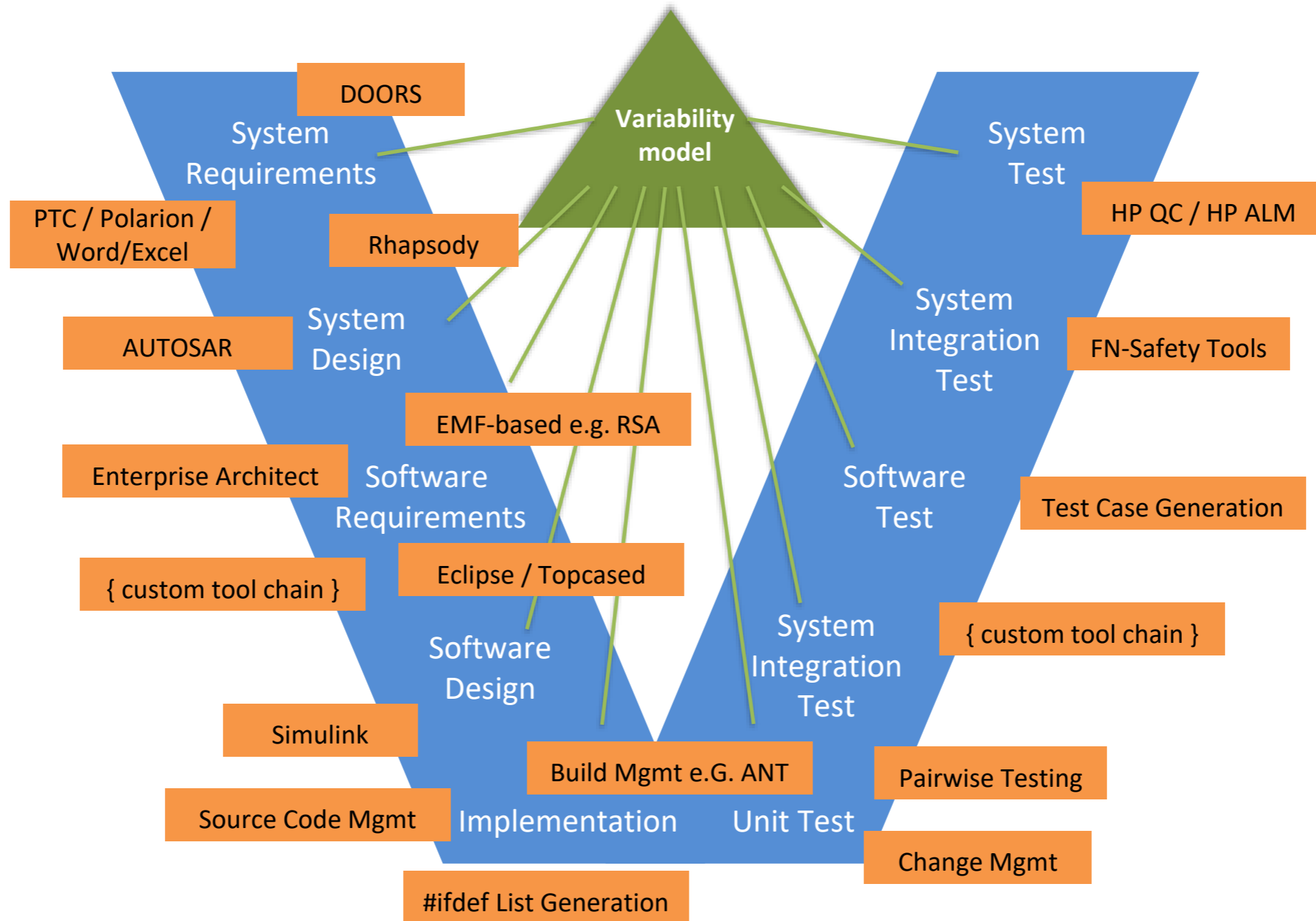


タイプ : ! = Mandatory (必須) ? = Optional (選択自由) ↔ = Alternative (どれか一つ) ⊗ = Or (少なくとも一つ)

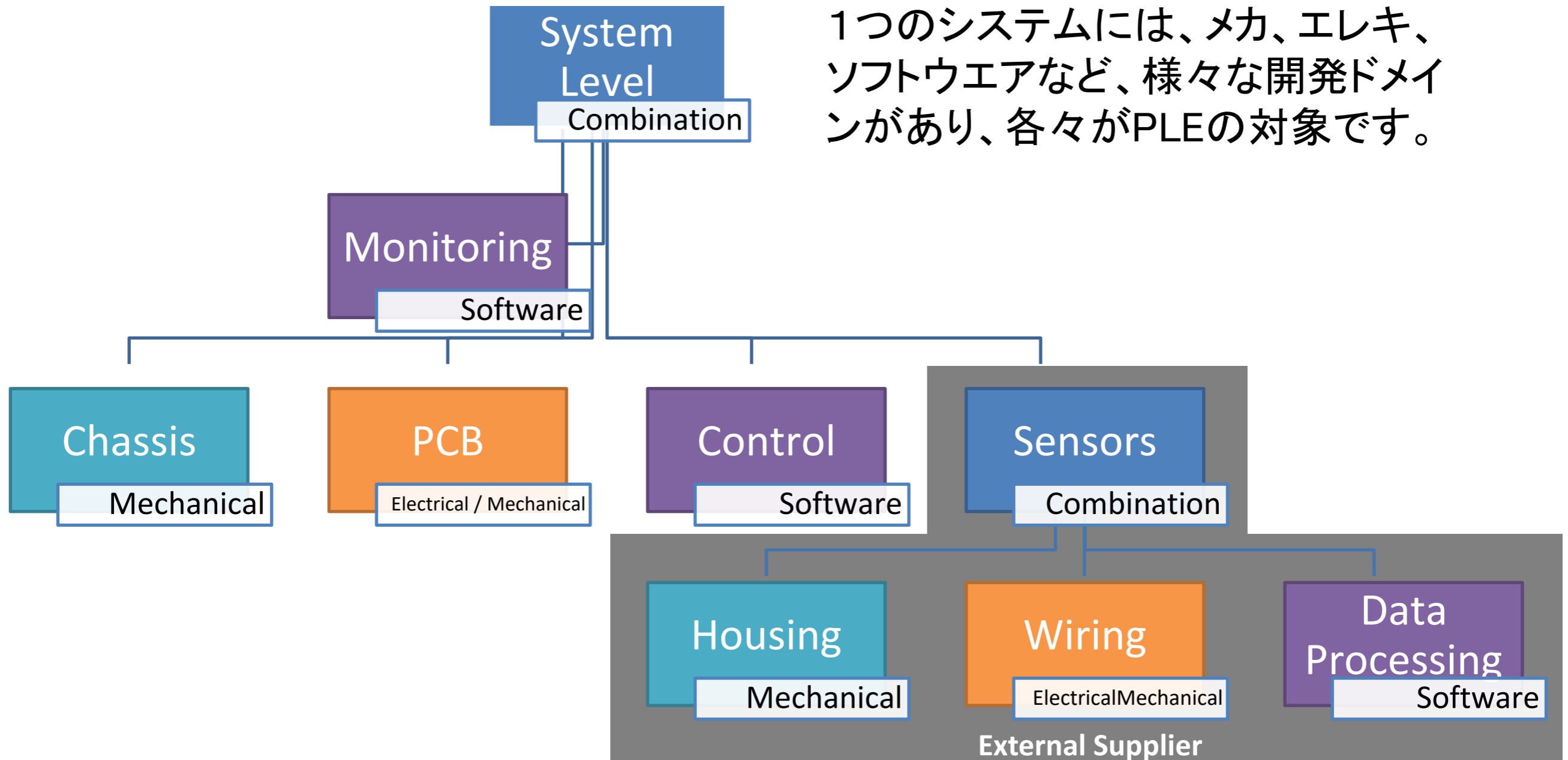


様々な開発支援ツールがある

全ての開発資産は再利用対象



Multi-Domain Building Blocks



1つのシステムには、メカ、エレキ、ソフトウェアなど、様々な開発ドメインがあり、各々がPLEの対象です。


Holistic variant management



プロダクトラインのライフサイクル全体にわたってエンジニアリングツールとバリエーション管理ツールを統合

- Codebeamer
- PTC RV&S
- Azure DevOps
- DOORS Next
- Polarion
- Jama Connect
- CATIA Magic/No Magic
- Zuken
- Enterprise Architect
- Rhapsody
- AUTOSAR and Artop
- Matlab Simulink
- IBM Engineering Test Management
- MS Word, Excel
- medini analyze
- Jira Software
- ...

<https://www.ptc.com/en/products/pure-variants/connectors>



効率良く、間違いなく
バリエーションを構成したい

Excel ?

The image shows a screenshot of a Microsoft Excel spreadsheet titled "Mappe1". The spreadsheet has a grid with columns labeled A through DA and rows numbered 1 through 44. The first row (row 1) is a header row with the word "Feature" in cell A1, and the rest of the row contains the word "Product" in each column. The subsequent rows (rows 2-44) contain a grid of 'X' marks, representing dependencies or relationships between the features listed in the first column and the products in the other columns. A large, semi-transparent black text box is overlaid on the center of the spreadsheet, containing three lines of white Japanese text.

こう複雑になると手が負えません。
数百、数千ものフィーチャーと、それらの依存・排他関係があるなか、
数十、数百ものバリエーションを正しく管理することは容易ではありません。
ルールや制約を上手に用いることが必要です。

フィーチャ間の依存・排他関係

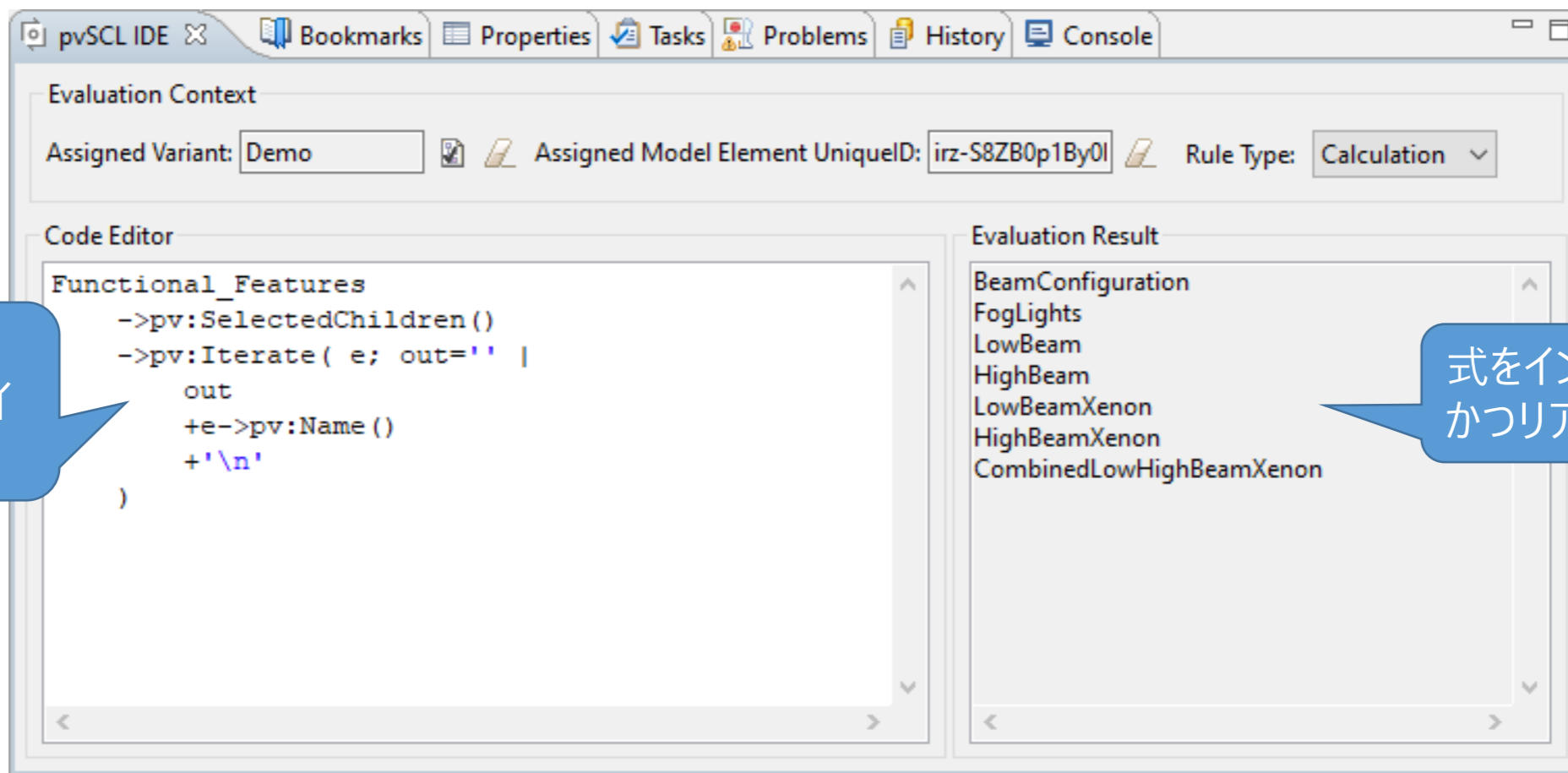
The screenshot displays two feature trees: **Functional_Features.xfm** and **Regions.xfm**.

- Functional_Features.xfm** tree:
 - External Car Lights Features
 - Beam Configuration
 - Fog Lights
 - Daytime Running Light
 - Driver Assistance
 - Automatic Light
 - Automatic High/Low Beam
 - Cornering Lights
 - Adaptive Forward Lighting
 - Static Cornering Lights
 - Requires: "Fog Lights"
 - HazardWarning
- Regions.xfm** tree:
 - Regions
 - EMEA
 - EU
 - Austria
 - Denmark
 - Sweden
 - Requires: "HazardWarning"
 - UK
 - North America
 - Canada
 - Mexiko
 - USA

The **Relations** panel on the right shows the following relationship types:

Type
ps:requires
ps:defaultProvider
ps:discourages
ps:discouragesAny
ps:equalsAll
ps:equalsAny
ps:exclusiveProvider
ps:expansionProvider
ps:influences
ps:provides
ps:recommendedFor
ps:recommendedForAll
ps:recommends
ps:recommendsAll
ps:requestsProvider
ps:requiredFor
ps:requiredForAll
ps:requires

制約言語IDE



オートコンプリート、
構文やエラーのハイ
ライトによる恩恵

式をインタラクティブ、
かつリアルタイムにテスト

- 複雑な制約やルールもインタラクティブに作成できる
- バリエーション管理モデルの編集・テスト・デバッグサイクルを加速

クローン、インヘリタンス

The screenshot shows the Eclipse IDE interface for configuring Variant Description Models (VDMs). The main window displays a tree view of VDMs for 'AutomotiveDemoCarLight'. The 'BaseLight_Inheritance.vdm' is selected, showing its structure with features like 'External Car Lights Features', 'Beam Configuration', and 'Adaptive Forward Lighting'. A 'New Variant Model' dialog is open, showing the 'Inheritance' tab where 'BaseLight' is selected as an inherited model. A 'Selection change failed' dialog is also open, indicating that 'Adaptive Forward Lighting' cannot be selected because it is inherited from the parent model.

work - AutomotiveDemoCarLight/Config/BaseLight_Inheritance.vdm - Eclipse プラットフォーム
ファイル(F) 編集(E) ナビゲート(N) Search プロジェクト(P) 実行(R) ウィンドウ(W) ヘルプ(H)

Variant Projects
AutomotiveDemoCarLight
auxiliary
Config

New Variant Model
Inheritance
Select the Variant Description Models from which to inherit.

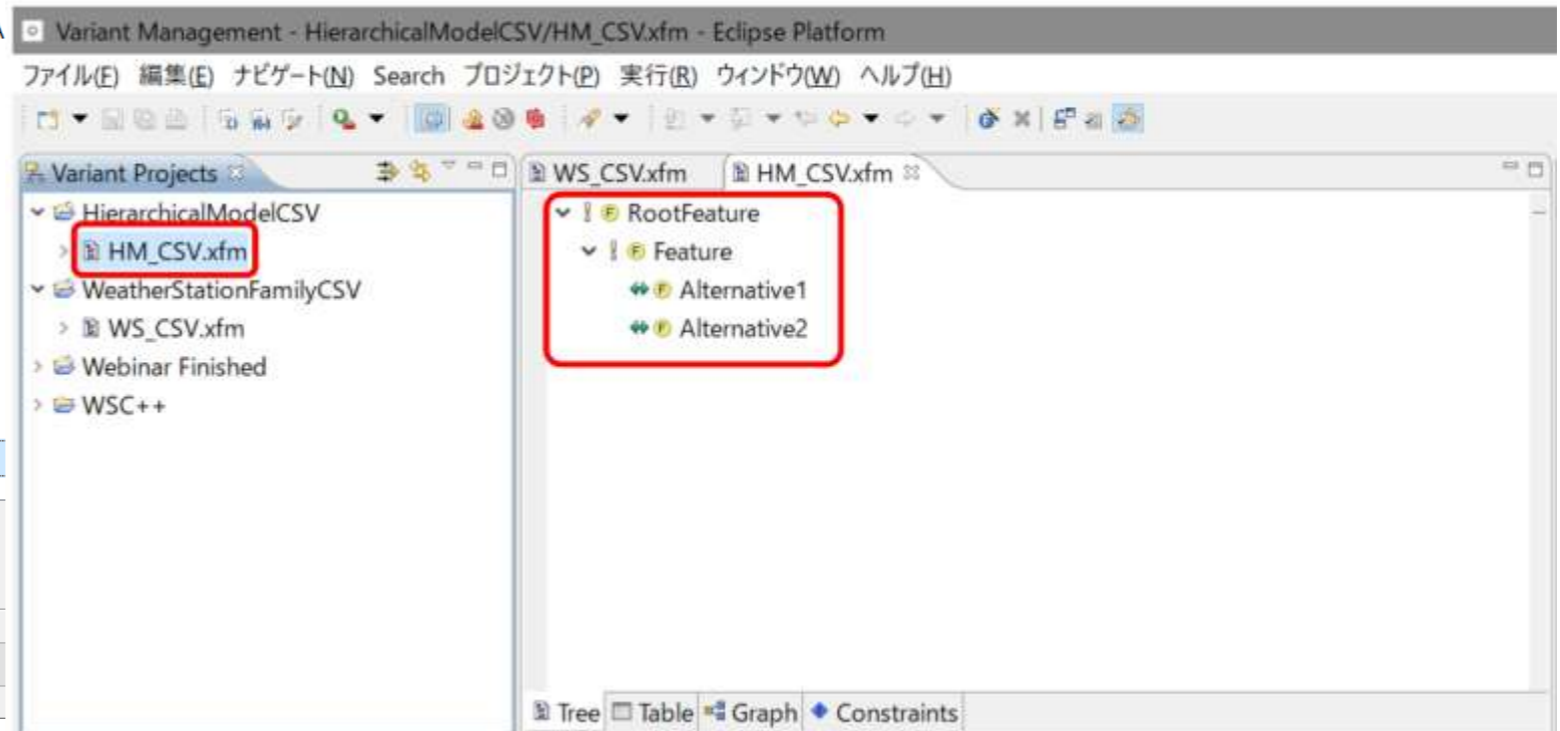
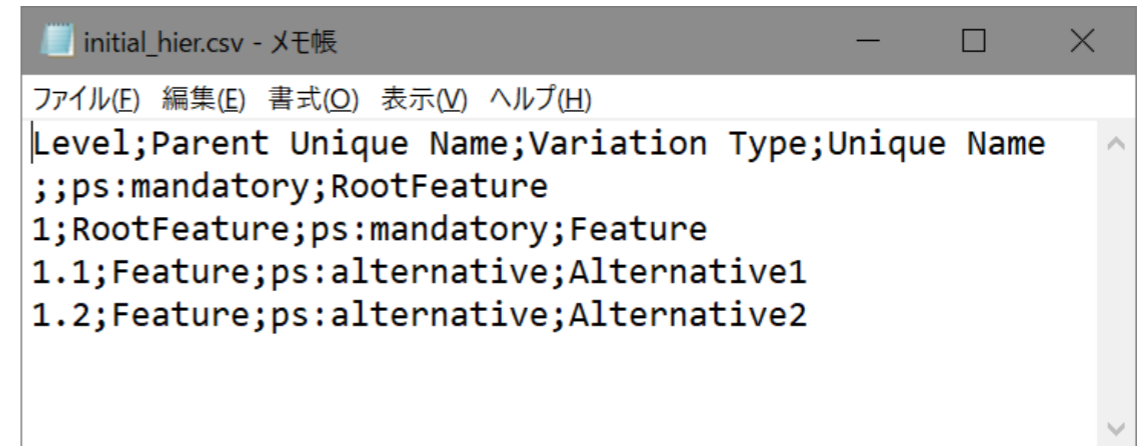
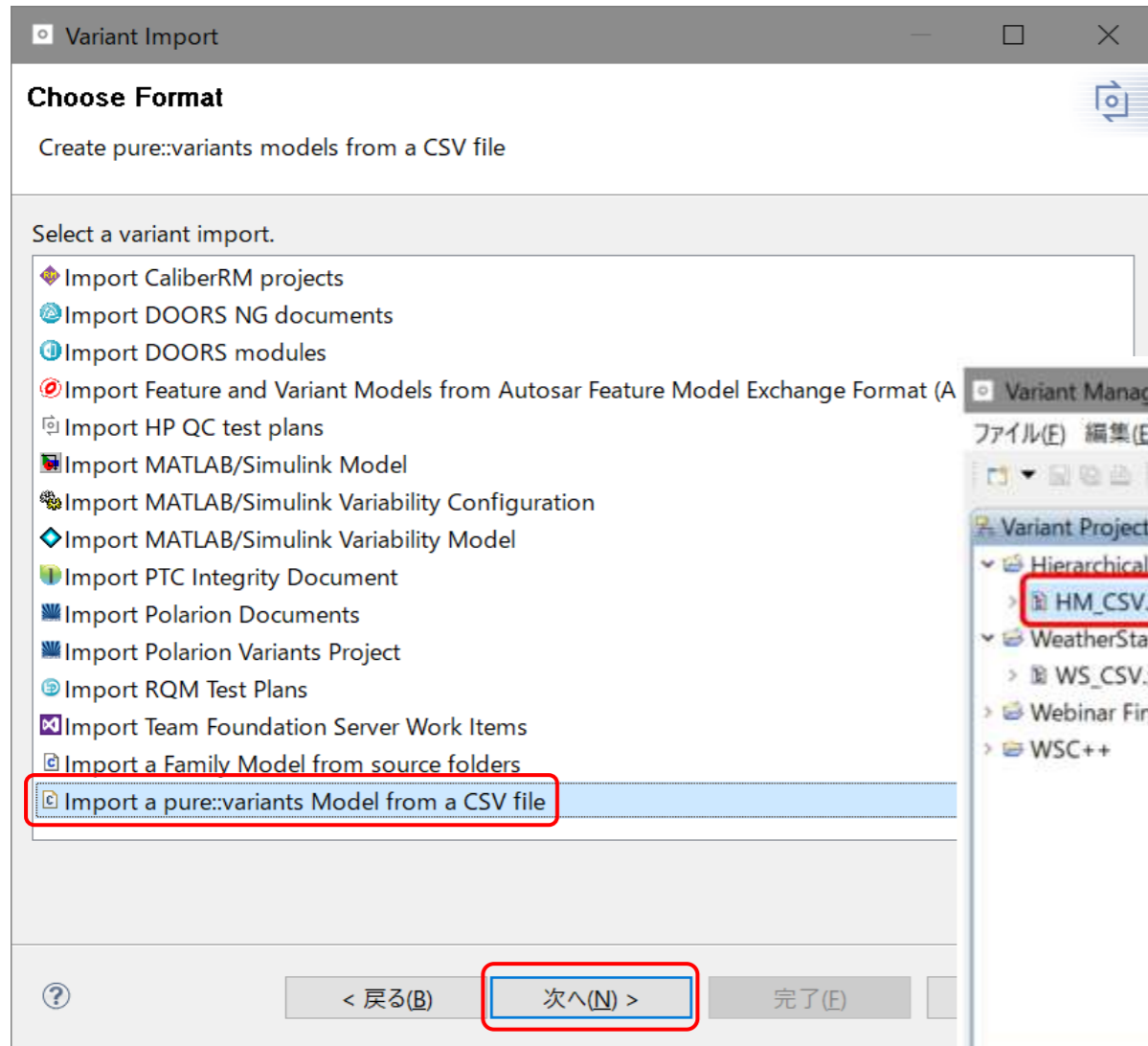
Available Models		Inherited Models	
Name	File Path	Name	File Path
BaseLight_Denmark	/AutomotiveDe...	BaseLight	/AutomotiveDe...
BaseLight_EMEA	/AutomotiveDe...		
BaseLight_Sweden	/AutomotiveDe...		
BaseLight_USA_Canada	/AutomotiveDe...		
HighLight	/AutomotiveDe...		
HighLight_Canada	/AutomotiveDe...		
HighLight_EMEA	/AutomotiveDe...		
HighLight_US	/AutomotiveDe...		

Selection change failed
Selection change not allowed. Reason(s):
Inherited selections can not be changed.
 Do not show this dialog again
OK

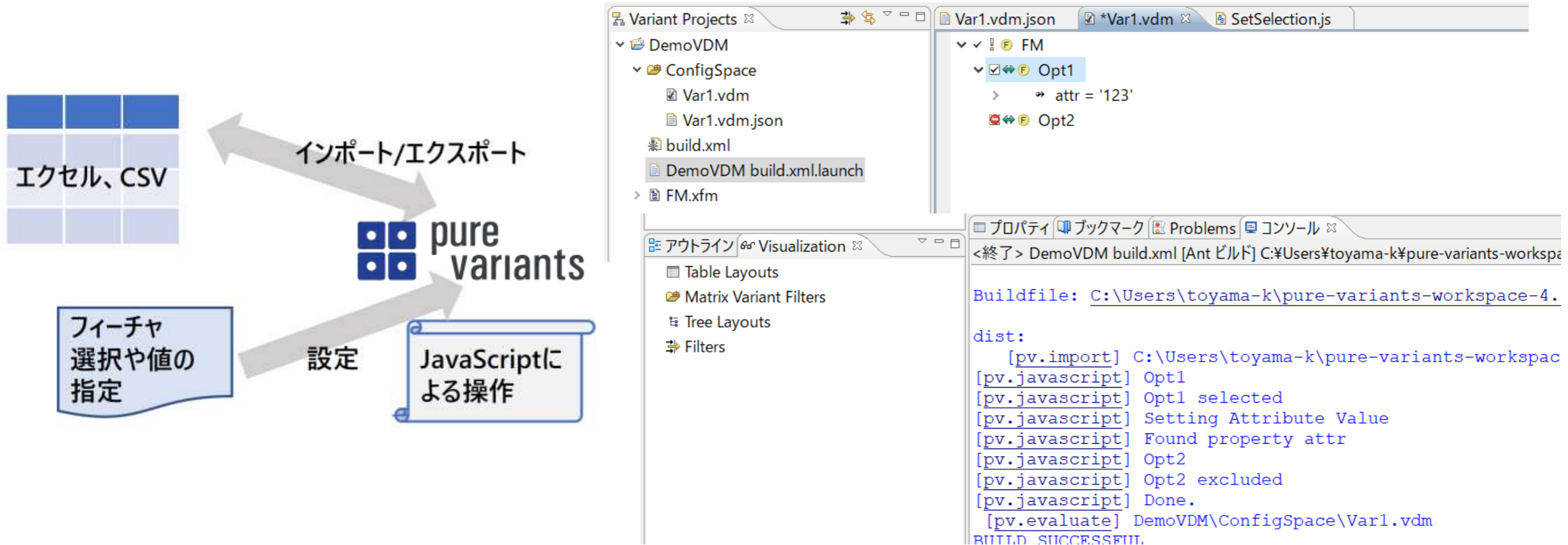
External Car Lights Features
safety = '20'
Beam Configuration
Low Beam
Xenon
Halogen
High Beam
Xenon
Halogen
Dynamic High Beam Adjustments
Fog Lights
Daytime Running Light
Driver Assistance
Automatic Light
Automatic High/Low Beam
Cornering Lights
Adaptive Forward Lighting
Static Cornering Lights
Regions
EMEA
EU
UK
Sw
North America

Relations Result
Parent (1)
Functional_Features (1)
Cornering Lights
Simple Constraint Language (6)
Is Referenced By (5)
CarLightCode (2)
ps:class: adaptiv
ps:flag: FLAG_ADAPTIVEFORV
CarLightRequirements (1)
doors:requirement: Adaptive
Functional_Features (2)
Adaptive Forward Lighting
External Car Lights Features
References (1)
Functional_Features (1)
Adaptive Forward Lighting

CSV インポーター機能

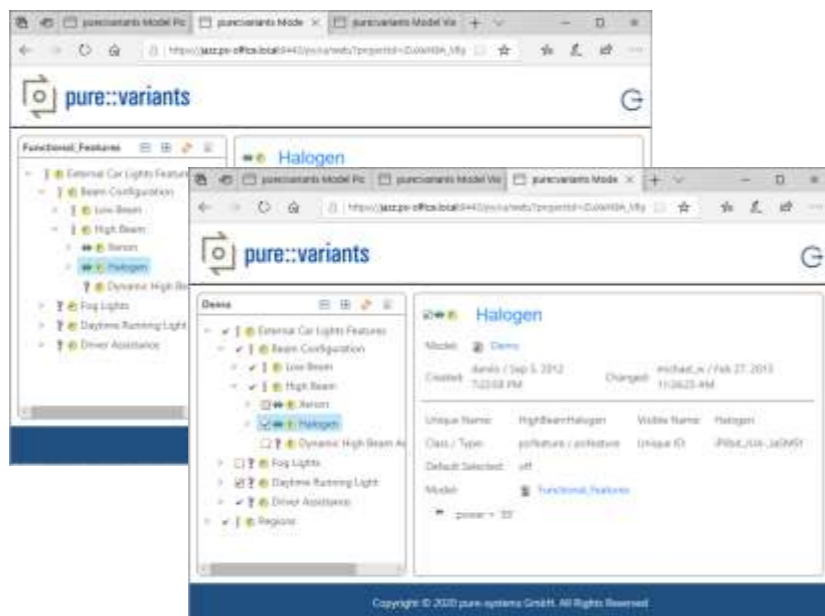


JavaScriptによるモデルの操作（自動化）

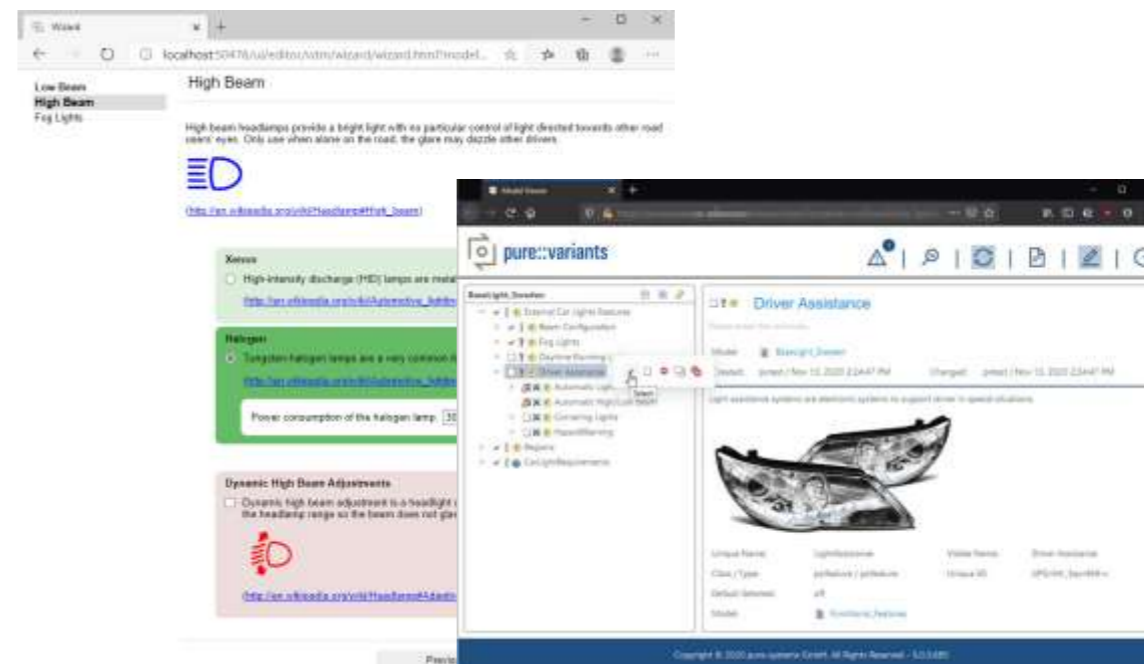


ウェブベースのバリエーションモデルビューアとエディタ

(1) モデルの閲覧

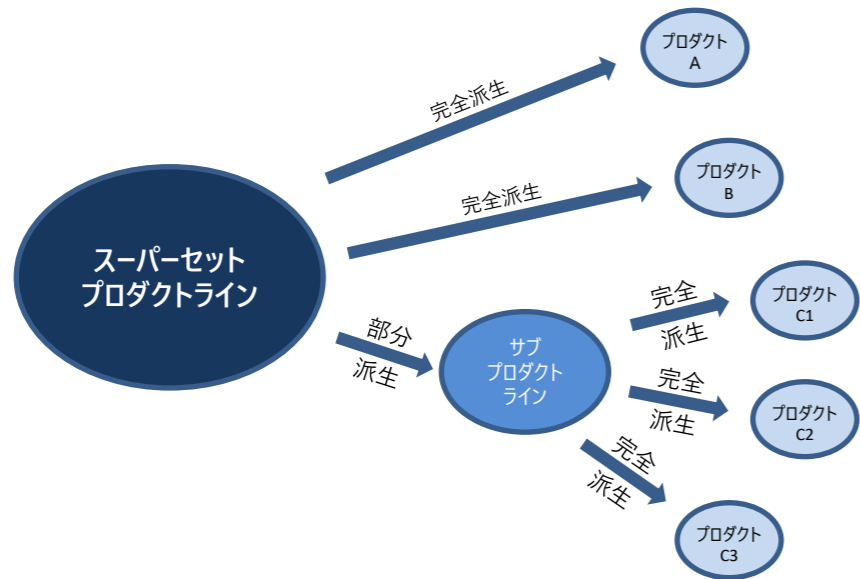


(2) バリエーションの構成

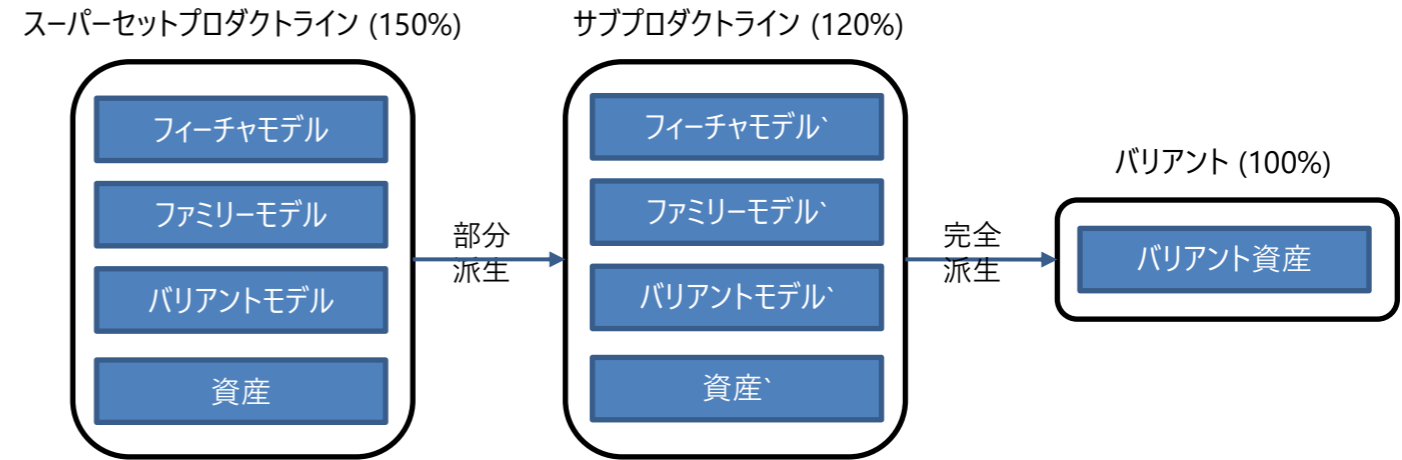


- ツールをインストールする必要なく様々な関係者がアクセスできる
例：OEMとサプライヤー、営業担当が、容易に構成プロセスに参加できる
- カスタマイズできる構成プロセスによってユーザーをガイドできる
- マルチサイト等のライセンス制約も無く協調作業を効率化

サブPLEのサポート



部分派生によるサブプロダクトライン



バリエーション管理情報と資産の両方を部分的に派生できる

- 機密機能やライセンスされない資産へのアクセスを制限できる
- 他のチームや顧客へサブプロダクトラインを配布できる
- 複数の関係者間で、製品構成と派生物を分離できる
- サプライヤーが複数のOEM用に
- OEMが車のタイプ別に



分析機能

バリエーションごとに搭載する機能を比較

*Config

バリエーション		バリエーション												
フィーチャー	Model Elements	Level	BaseLight	BaseLight_Denmark	BaseLight_EMEA	BaseLight_Inheritance	BaseLight_Japan	BaseLight_Sweden	BaseLight_USA_Canada	HighLight	HighLight_Canada	HighLight_EMEA	HighLight_US	
Functional_Features														
External Car Lights Features														
safety														
			'20'	'20'	'20'	'20'	'0'	'40'	'20'	'20'	'30'	'30'	'20'	
i	Fog Lights	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Driver Assistance	4	✓	✓	✓	✓	□	✓	✓	✓	✓	✓	✓	✓
	Cornering Lights	4.3	✓	✓	✓	✓	□	✓	✓	✓	✓	✓	✓	✓
	Automatic Light	4.1	□	□	□	□	□	□	□	✓	✓	✓	✓	✓
	Automatic High/Low Beam	4.2	✓	✓	✓	✓	□	✓	✓	□	✓	✓	✓	□
	Automatic Hazard Warning	4.4	□	□	□	□	□	✓	□	□	□	□	□	□
	Daytime Running Light	3	□	□	✓	□	□	□	□	✓	✓	✓	✓	✓
	Separate DRL Lights	3.2	□	□	✗	□	□	□	□	✓	✓	✓	✓	✓
	Standard Bulb	3.2.2	□	□	✗	□	□	□	□	✗	✗	✗	✗	✗
i	LED	3.2.1	□	□	✗	□	□	□	□	✓	✓	✓	✓	✓
	Reduced Low Beam	3.1	□	□	✓	□	□	□	□	✗	✗	✗	✗	✗
	Beam Configuration	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
i	Low Beam	1.1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
i	High Beam	1.2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regions														
Regions														
	North America	2	□	□	□	□	□	□	✓	□	✓	□	✓	✓
	EMEA	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	EU	1.1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	UK	1.1.3	□	□	✓	□	□	□	□	✓	✓	✓	✓	✓

Matrix

<https://www.fuji-setsu.co.jp/products/purevariants/tutorials.html#CompareMarge>

フィルターでバリエーション間の違いや同一性を分析

The screenshot shows a configuration matrix tool interface. The main table displays model elements and their variants. The table has the following columns: Model Elements, Level, BaseLight, BaseLight_Denmark, BaseLight_EMEA, BaseLight_Inheritance, BaseLight_Japan, BaseLight_Sweden, BaseLight_USA_Canada, HighLight, HighLight_Canada, HighLight_EMEA, and HighLight_US.

Model Elements	Level	BaseLight	BaseLight_Denmark	BaseLight_EMEA	BaseLight_Inheritance	BaseLight_Japan	BaseLight_Sweden	BaseLight_USA_Canada	HighLight	HighLight_Canada	HighLight_EMEA	HighLight_US
Functional_Features												
External Car Lights Features												
Fog Lights	2											
Driver Assistance	4											
Daytime Running Light	3											
Separate DRL Lights	3.2											
Standard Bulb	3.2.2											
wattage		'25'	'25'	'25'	'25'	'25'	'25'	'25'	'25'	'25'	'25'	'25'
LED	3.2.1											
Beam Configuration	1											
Low Beam	1.1											
High Beam	1.2											
Regions												
Regions												
North America	2											
EMEA	1											
CarLightCode												
Architecture												
CarLightRequirements												
CarLightRequirements												
doors:requirement: Indicator Li...	2											
doors:requirement: Head Lights	1											
doors:requirement: Assistance ...	3											

The context menu is open over the table, showing the following options:

- Open variant model 'HighLight'.
- Visualize
- 検証
- Export Matrix...
- Delete 削除
- Filter...
- Create Matrix Variant Filter
- Clear Filter
- Quick Filter > Commonalities, Differences, Uniqueness, Errors
- Show Variants >
- Collapse All
- Expand All
- Table Layout >
- Visualize >

フィルターで分析

The screenshot displays a software interface with a table of model elements and a 'Filter Properties' dialog box. The table has columns for 'Model Elements', 'Level', and various regional light features. The 'Automatic Hazard Warning' element is highlighted, and its filter settings are circled in red. The 'Filter Properties' dialog box is open, showing the 'Define Filter' section with a 'Visible Name' field set to 'contains' and a 'Value' field set to 'Haz'.

Model Elements	Level	BaseLight	BaseLight_Denmark	BaseLight_EMEA	BaseLight_Inheritance	BaseLight_Japan	BaseLight_Sweden	BaseLight_USA_Canada	HighLight	HighLight_Canada	HighLight_EMEA	HighLight_US
Functional_Features												
External Car Lights Features		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Driver Assistance	4											
Automatic Hazard Warning	4.4	□	□	□	□	□	✓	□	□	□	□	□

Filter Properties

Define Filter

Define conditions and add them to the boolean filter expression

Named Filters: Hazard

Define condition

Field	Operator	Value
Visible Name	contains	Haz

Case sensitive:

Buttons: ? Realtime Preview OK キャンセル

バリエーションの分析

The screenshot displays a software interface for variant analysis. On the left, a project tree shows the 'AutomotiveDemoCarLight' project with a 'Config' folder expanded. A context menu is open over 'Config', with 'Model and Variant Analysis' selected. On the right, a 'Similarity Matrix' window shows a table of similarity percentages between variants.

	BaseLight	BaseLight_Denmark	BaseLight_EMEA	BaseLight_Inheritance	BaseLight_Japan	BaseLight_Sweden	BaseLight_USA_Canada	HighLight	HighLight_Canada	HighLight_EMEA	HighLight_US
BaseLight		100%	86%	100%	80%	93%	86%	71%	64%	73%	62%
BaseLight_Denmark	100%		86%	100%	80%	93%	86%	71%	64%	73%	62%
BaseLight_EMEA	86%	86%		86%	66%	79%	72%	71%	64%	82%	62%
BaseLight_Inheritance	100%	100%	86%		80%	93%	86%	71%	64%	73%	62%
BaseLight_Japan	80%	80%	66%	80%		73%	66%	73%	62%	71%	64%
BaseLight_Sweden	93%	93%	79%	93%	73%		79%	64%	57%	66%	55%
BaseLight_USA_Canada	86%	86%	72%	86%	66%	79%		57%	68%	59%	66%
HighLight	71%	71%	71%	71%	73%	64%	57%		88%	88%	90%
HighLight_Canada	64%	64%	64%	64%	62%	57%	68%	88%		81%	88%
HighLight_EMEA	73%	73%	82%	73%	71%	66%	59%	88%	81%		79%
HighLight_US	62%	62%	62%	62%	64%	55%	66%	90%	88%	79%	

バリエーション間の比較や旧バージョンとの比較

The screenshot displays a software interface for comparing variant models. The top window, titled 'Similarity Matrix', shows a list of changes:

- Model Meta Information Changed
 - Automatic High/Low Beam: Selection State Changed (Not Selected <- User Selected)
 - Mexiko: Selection State Changed (User Selected <- Not Selected)

The bottom window, titled 'Variant Model Compare', shows two side-by-side trees for variant models:

- Left Panel: /AutomotiveDemoCarLig...eLight_USA_Canada.vdm**
 - External Car Lights Features
 - Beam Configuration
 - Fog Lights
 - Daytime Running Light
 - Driver Assistance
 - Automatic Light
 - Automatic High/Low Beam**
 - Cornering Lights
 - Automatic Hazard Warning
 - Regions
 - Code/src
- Right Panel: /AutomotiveDemoCarLig.../HighLight_Canada.vdm**
 - External Car Lights Features
 - Beam Configuration
 - Fog Lights
 - Daytime Running Light
 - Driver Assistance
 - Automatic Light
 - Automatic High/Low Beam**
 - Cornering Lights
 - Automatic Hazard Warning
 - Regions
 - Code/src

変更の影響分析

*Functional_Features.xfm

- External Car Lights Features
 - Beam Configuration
 - Fog Lights
 - Daytime
 - Driver As

New

Bookmark

Delete 削除

Refactor Unique Name ...

Unique Name

Change Unique Name ...

Please enter the new name

Unique Name: FogLight_Japan

Scope of models to process

Same Project Referenced Projects Workspace

< 戻る(B) 次へ(N) > 終了(E) キャンセル

Properties

Unique Name

リファクタリングを実行するには、以下の変更が必要です。

実行される変更

- The following artefacts need to be updated:
 - Functional_Features.xfm - /AutomotiveDemoCarLight
 - CarLightCode.ccfm - /AutomotiveDemoCarLight/auxiliary/Code
 - CarLightRequirements.ccfm - /AutomotiveDemoCarLight/auxiliary/Doors/Car Light
 - CarLightRequirements.ccfm - /AutomotiveDemoCarLight/auxiliary/Doors NG
 - SimulinkVariabilityModel.ccfm - /AutomotiveDemoCarLight/auxiliary/Matlab
 - CarLightRequirements.ccfm - /AutomotiveDemoCarLight/auxiliary/TFS
 - pictures.ccfm - /AutomotiveDemoCarLight/auxiliary/pictures

SimulinkVariabilityModel.ccfm

Original Model	Refactored Model
> ! UP sl:variationpoint: VAR_DayLight	> ! UP sl:variationpoint: VAR_DayLight
> ! UP sl:variationpoint: VAR_DriveAssistance	> ! UP sl:variationpoint: VAR_DriveAssistance
∨ ! UP sl:variationpoint: VAR_FogLight <ul style="list-style-type: none">↔ U sl:variation: VAR_FogLight = 0 (Off)∨ ↔ U sl:variation: VAR_FogLight = 1 (On)<ul style="list-style-type: none">◆ (FogLight) REQUIRES SELF	∨ ! UP sl:variationpoint: VAR_FogLight <ul style="list-style-type: none">↔ U sl:variation: VAR_FogLight = 0 (Off)∨ ↔ U sl:variation: VAR_FogLight = 1 (On)<ul style="list-style-type: none">◆ (FogLight_Japan) REQUIRES SELF
> ⚙️ Label = 'On'	> ⚙️ Label = 'On'
> ⚙️ Value = '1'	> ⚙️ Value = '1'
> ! UP sl:variationpoint: VAR_StaticCorneringLight	> ! UP sl:variationpoint: VAR_StaticCorneringLight
> ! sl:baseworkspace: Base Workspace	> ! sl:baseworkspace: Base Workspace



FUJI SETSUBI

pure::variants について:

<https://www.fuji-setsu.co.jp/products/purevariants/>

実践的なプロダクトライン開発について

https://www.fuji-setsu.co.jp/products/purevariants/Danilo_Blog.html#PLE

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THANK YOU

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