Analyzing the Impact of Changes to Variability Models on Products

Dr. Rick Rabiser

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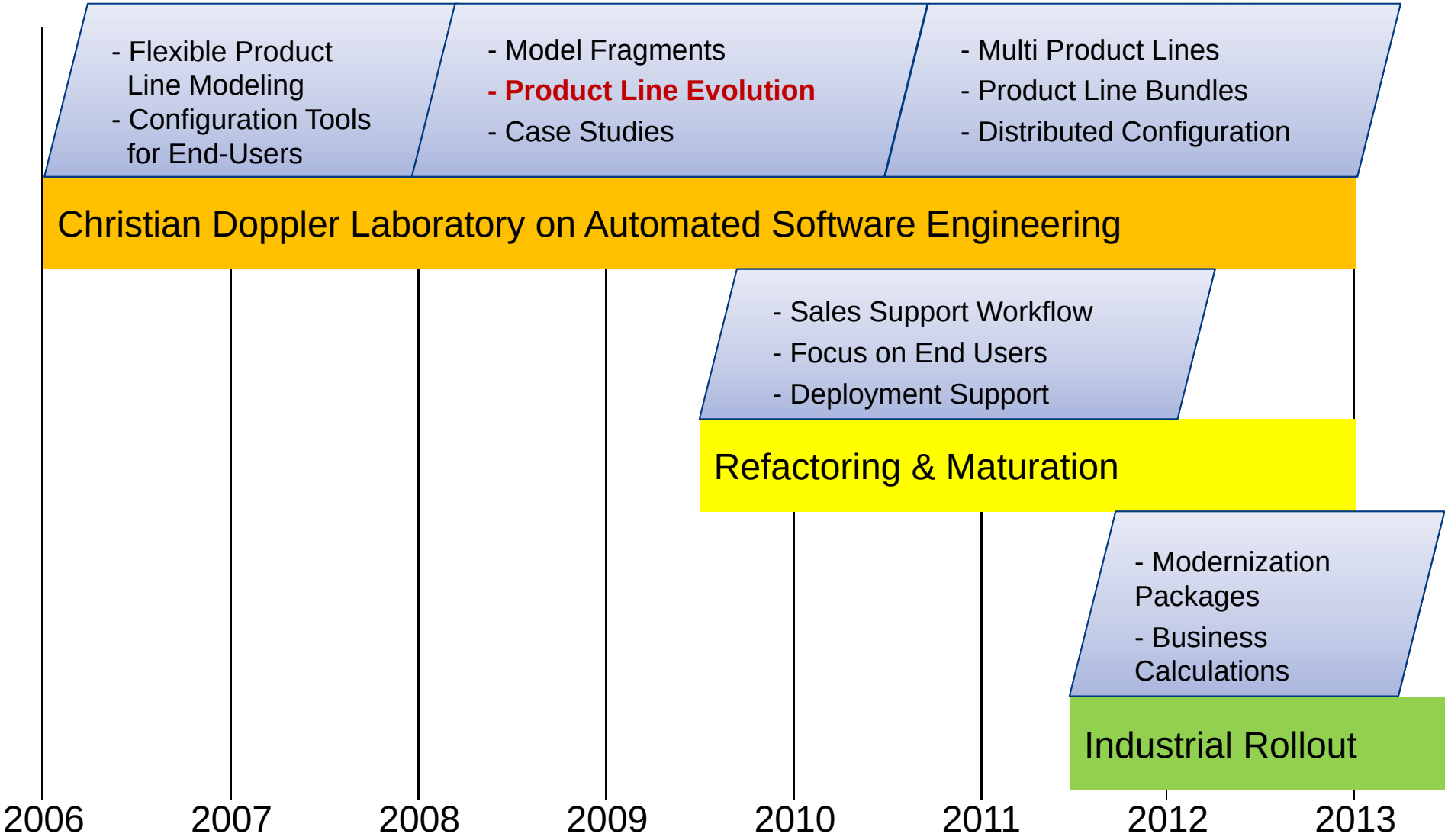
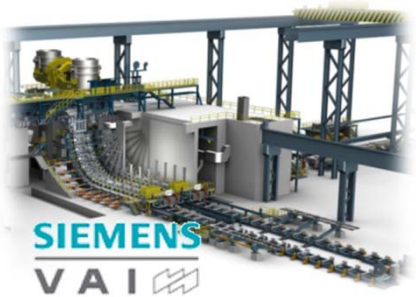
Product Line Research in the CD Lab



Impact Analysis in SPLs: Context, Motivation, Goal

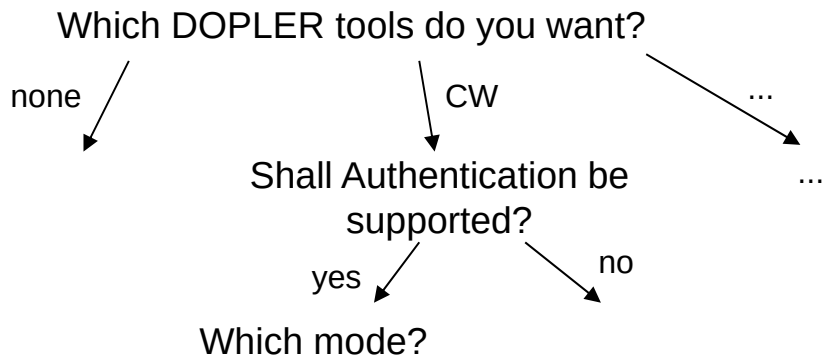


- Maintenance and evolution of product lines is increasingly complex
- We developed a product line engineering tool suite, the DOPLER tool suite DOPLER Decision-Oriented Product Line Engineering for effective Reuse
- We observed the evolution of this industrial product line while it was refactored for industrial use cases by Siemens VAI

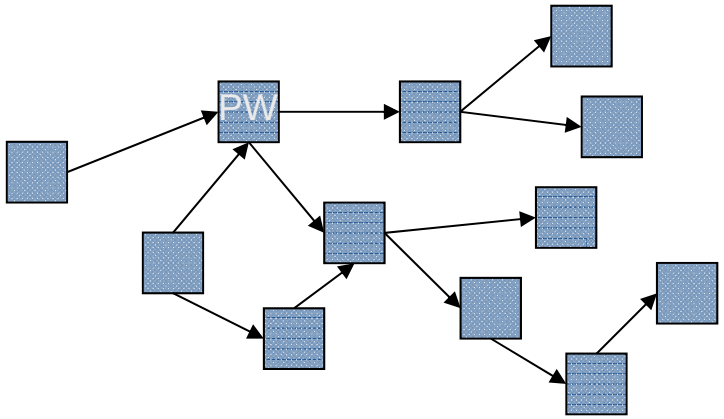
→Developers requested

Support for Analyzing the Impact of Changes on Derived Products

DOPLER Product Line Models



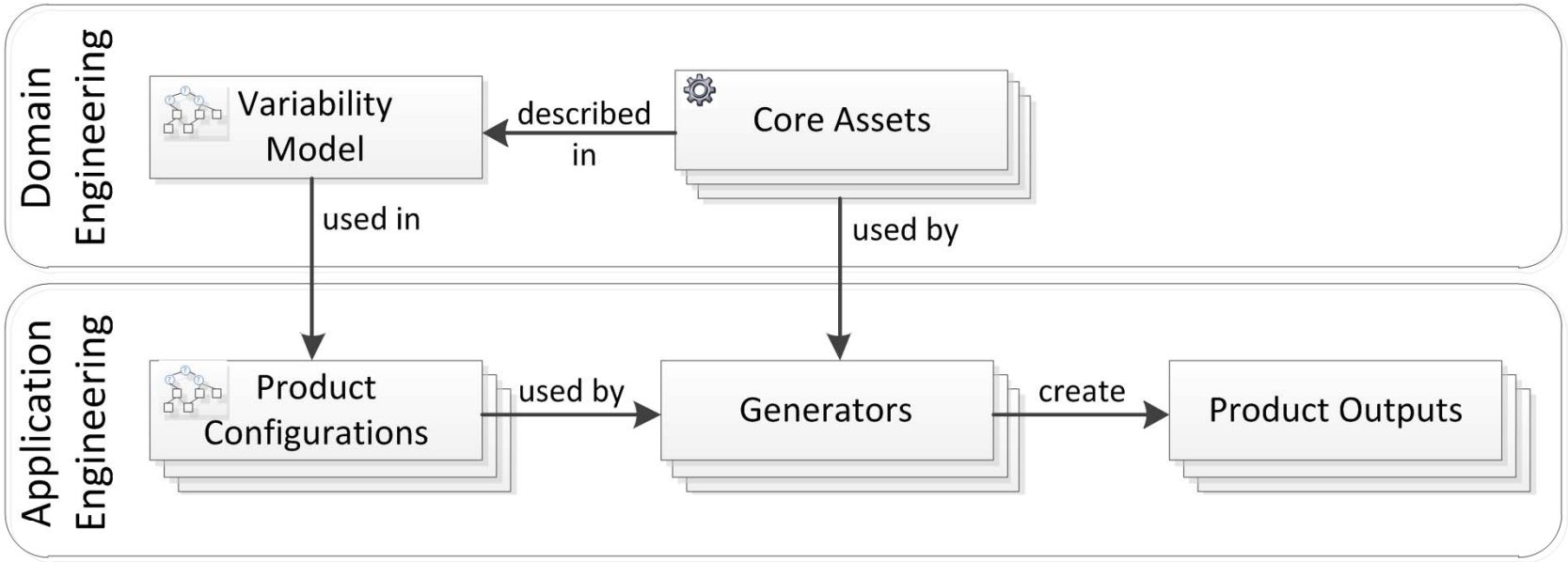
Decision model defines end-user perspective on variability



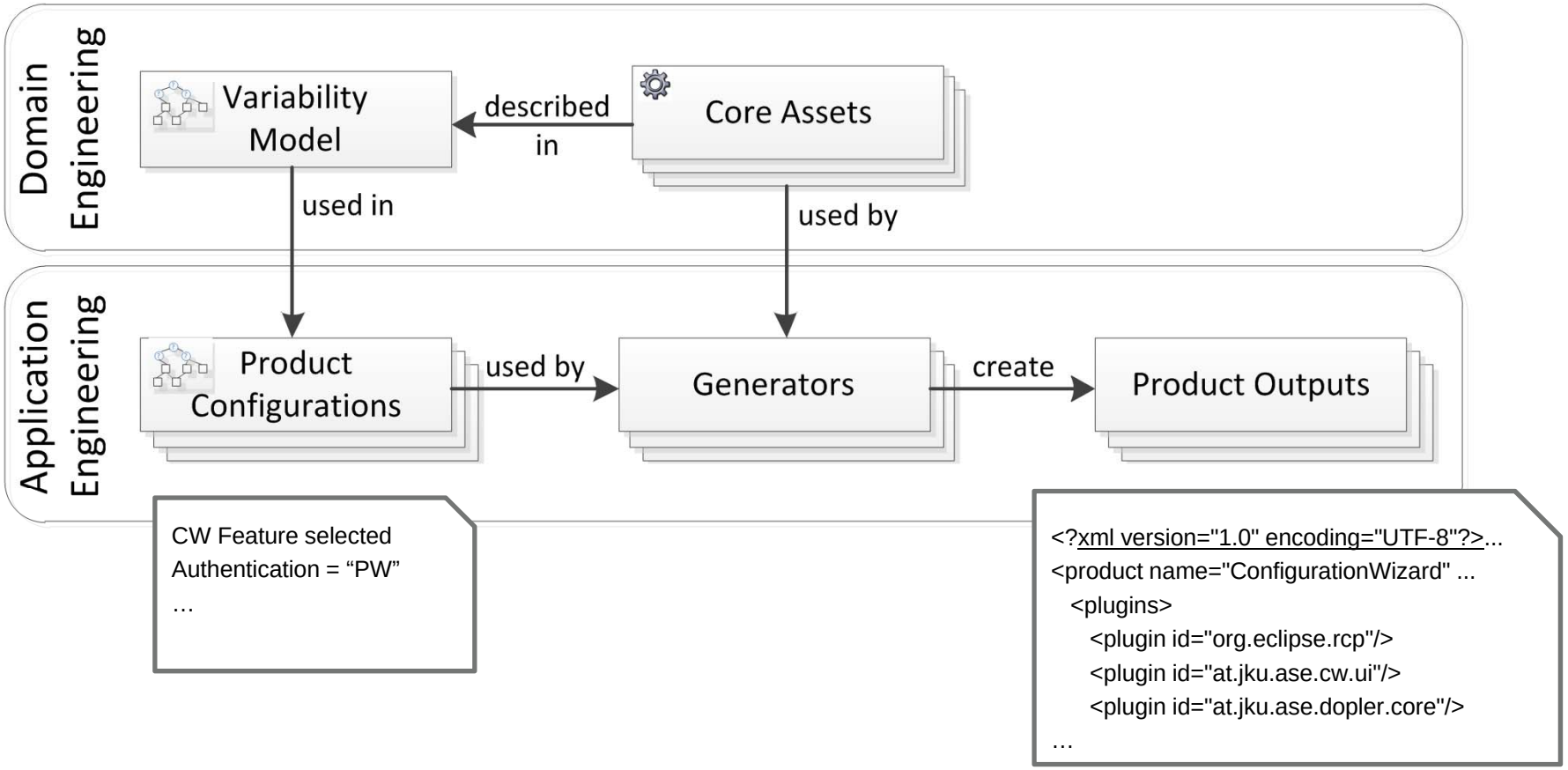
Asset model defines reusable artifacts with links to the implementation

Included assets used by generators to automate product derivation

Product Derivation



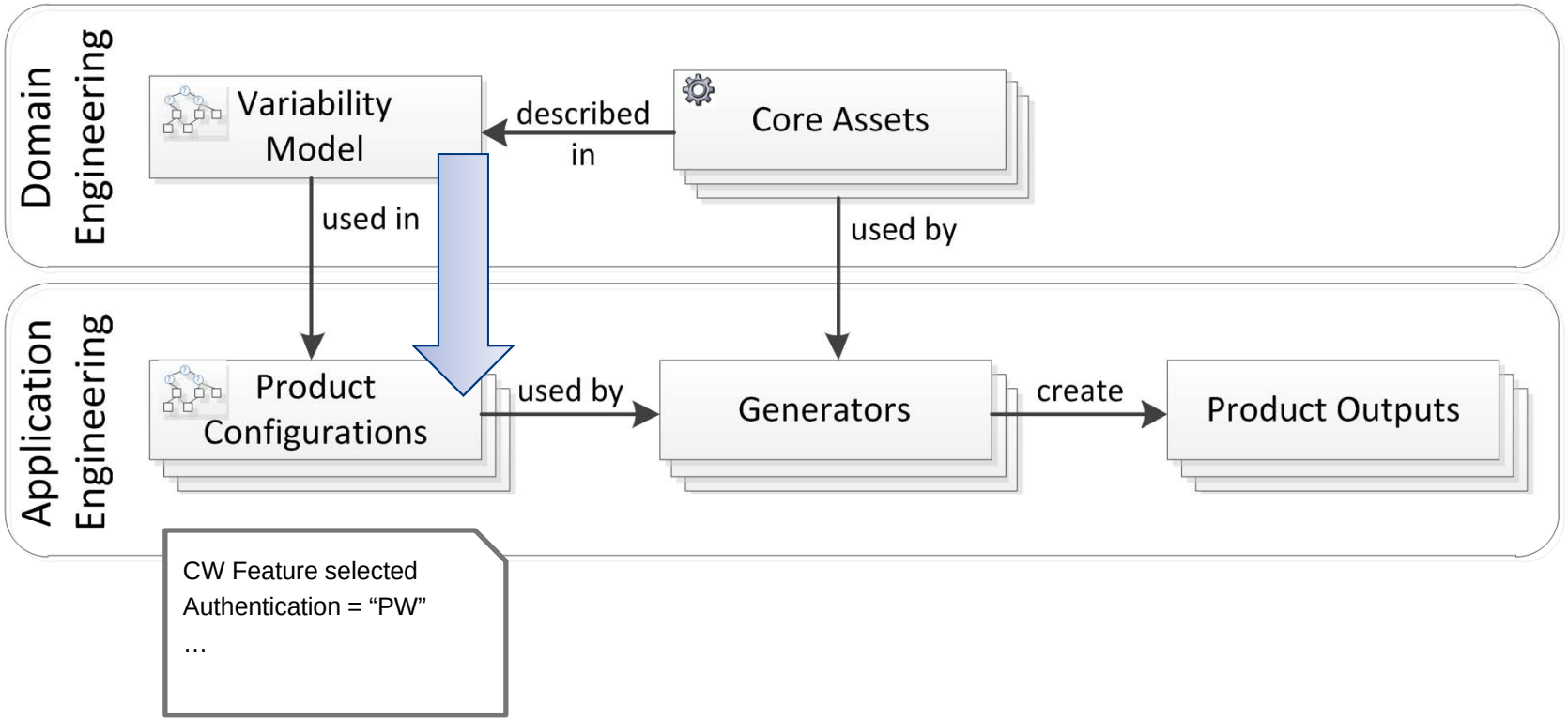
Product Derivation



Problem

Changes may affect product configurations

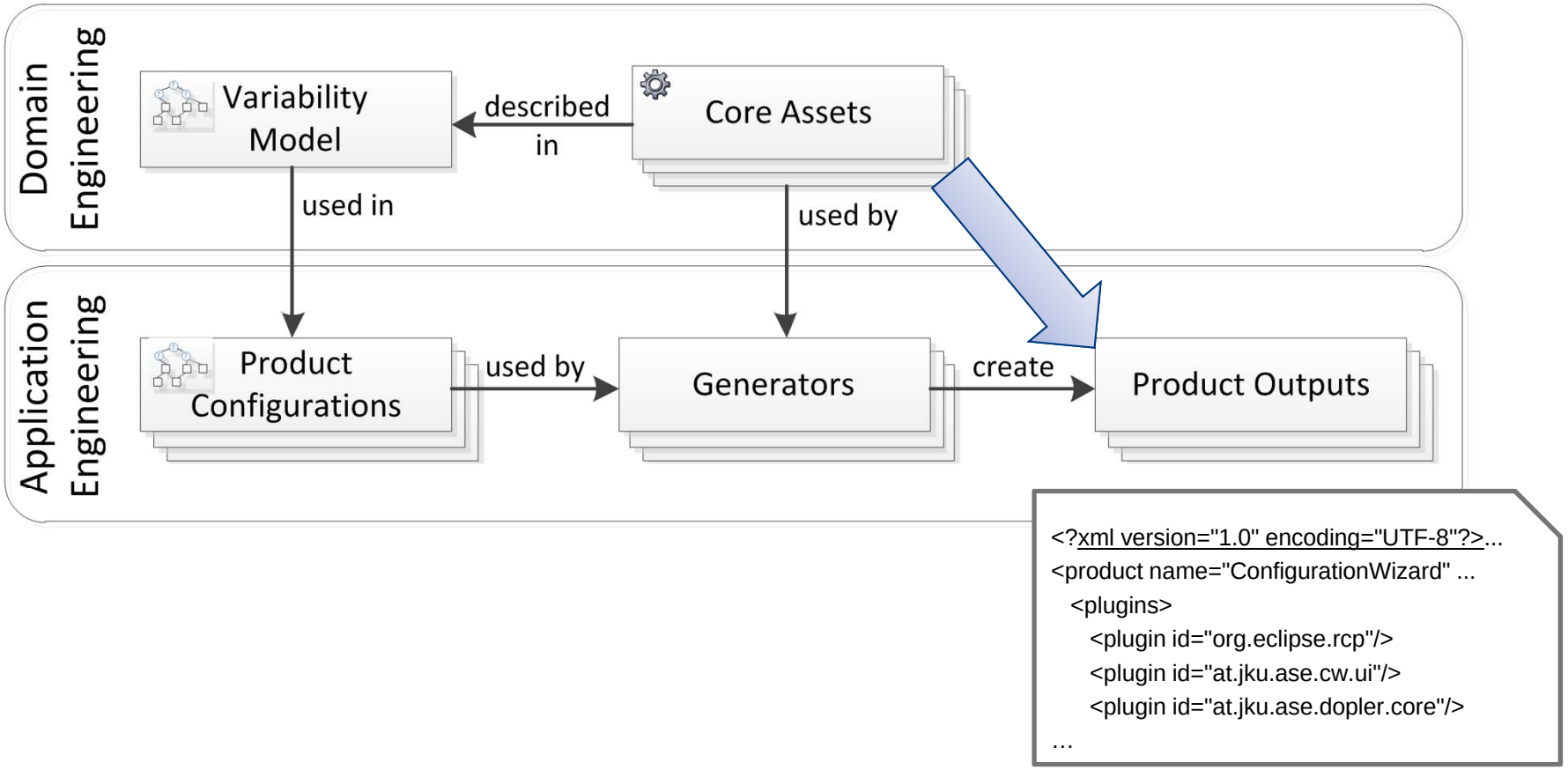
- Features chosen for products are not available any more
- Additional features become available for products



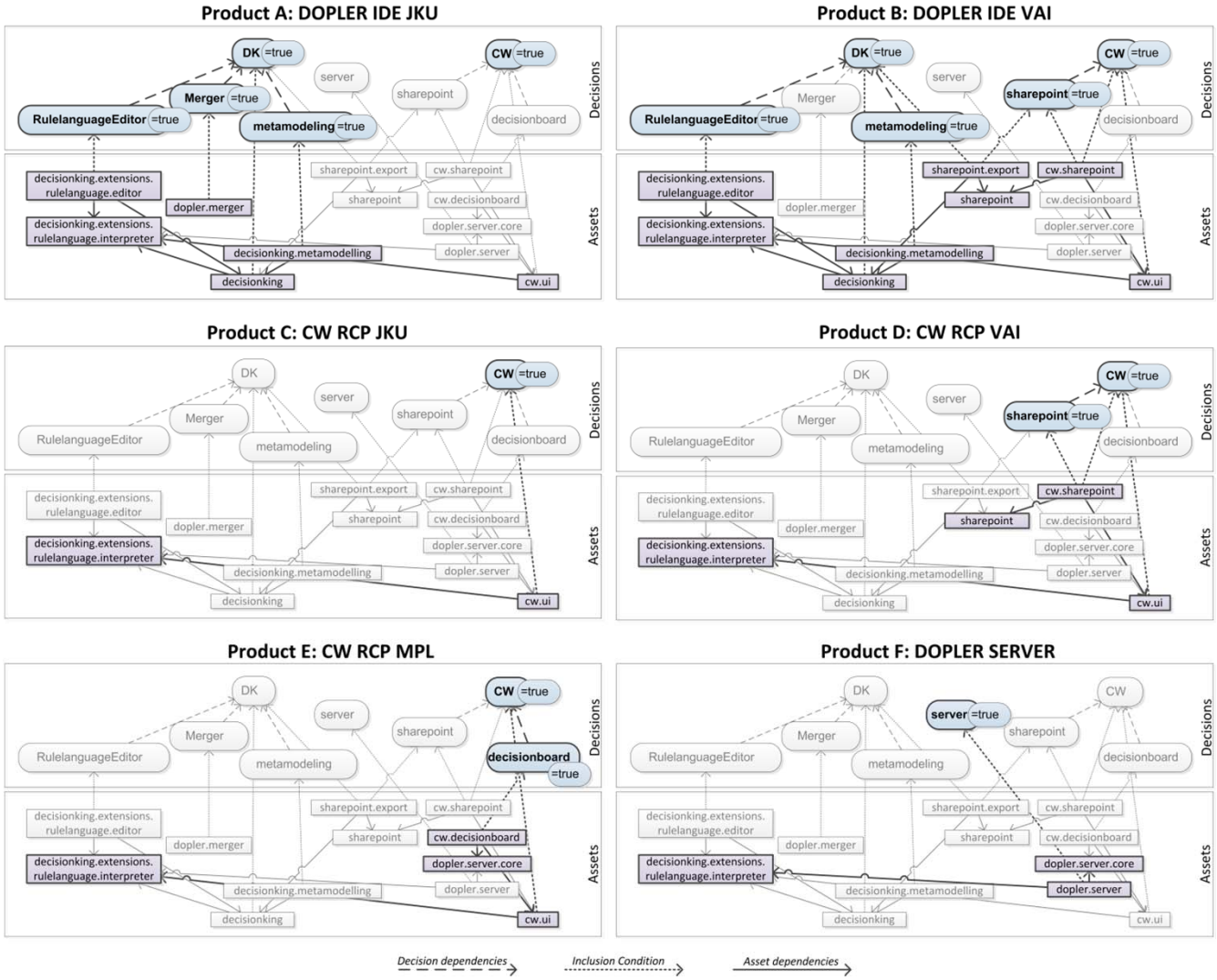
Problem

Changes may affect final product outputs

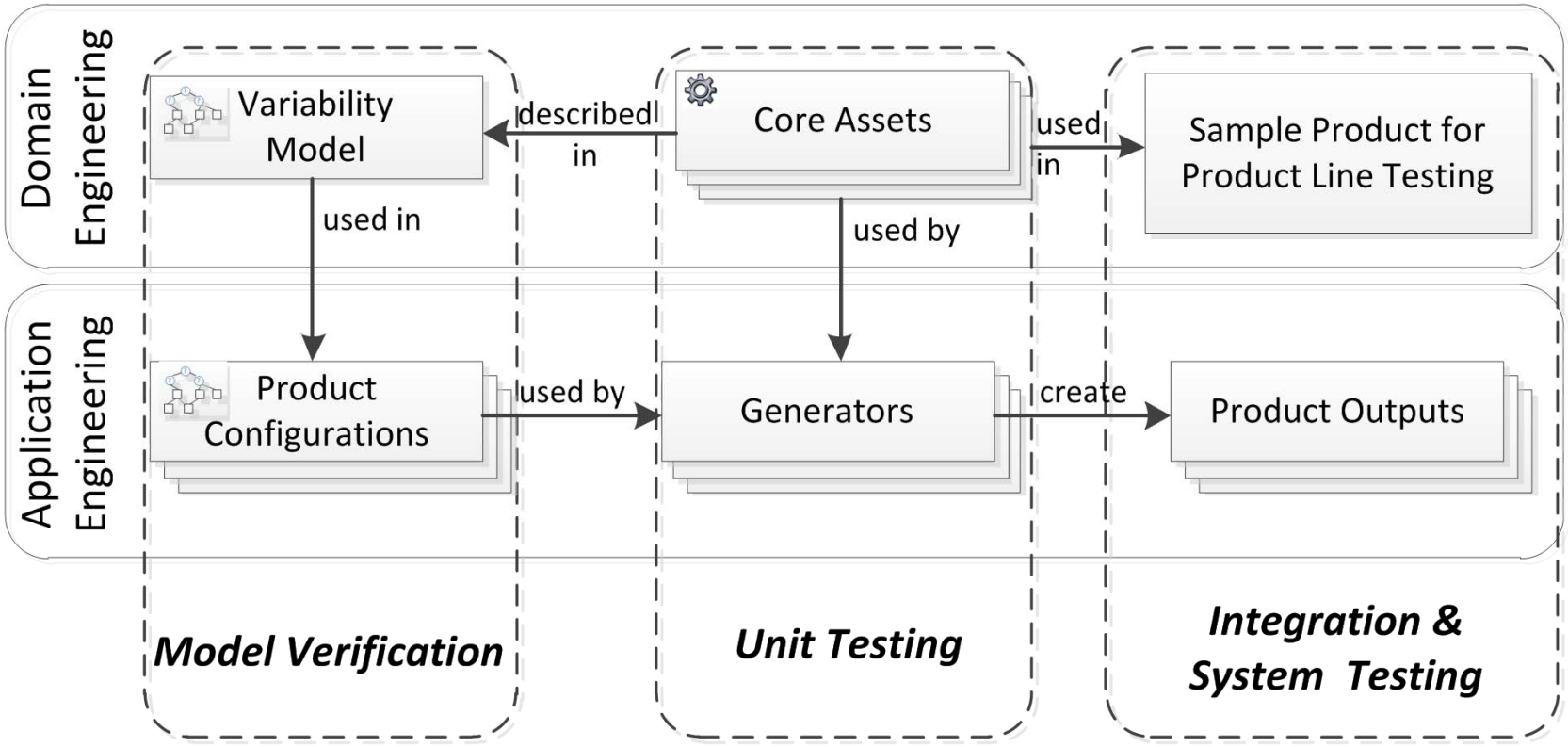
- Components may need to be updated for products
- Components may be added / removed in products



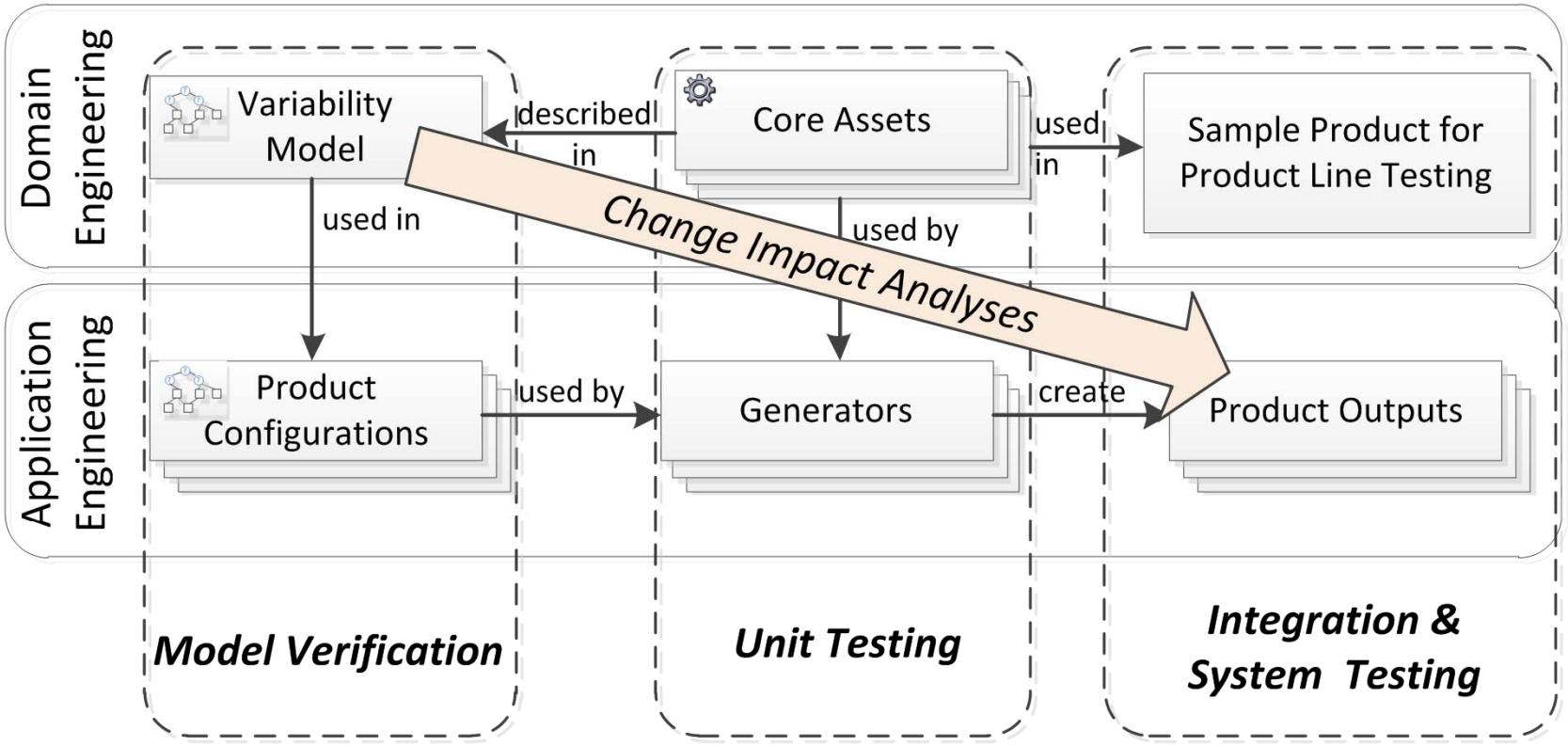
Variability Models are used to derive many products…



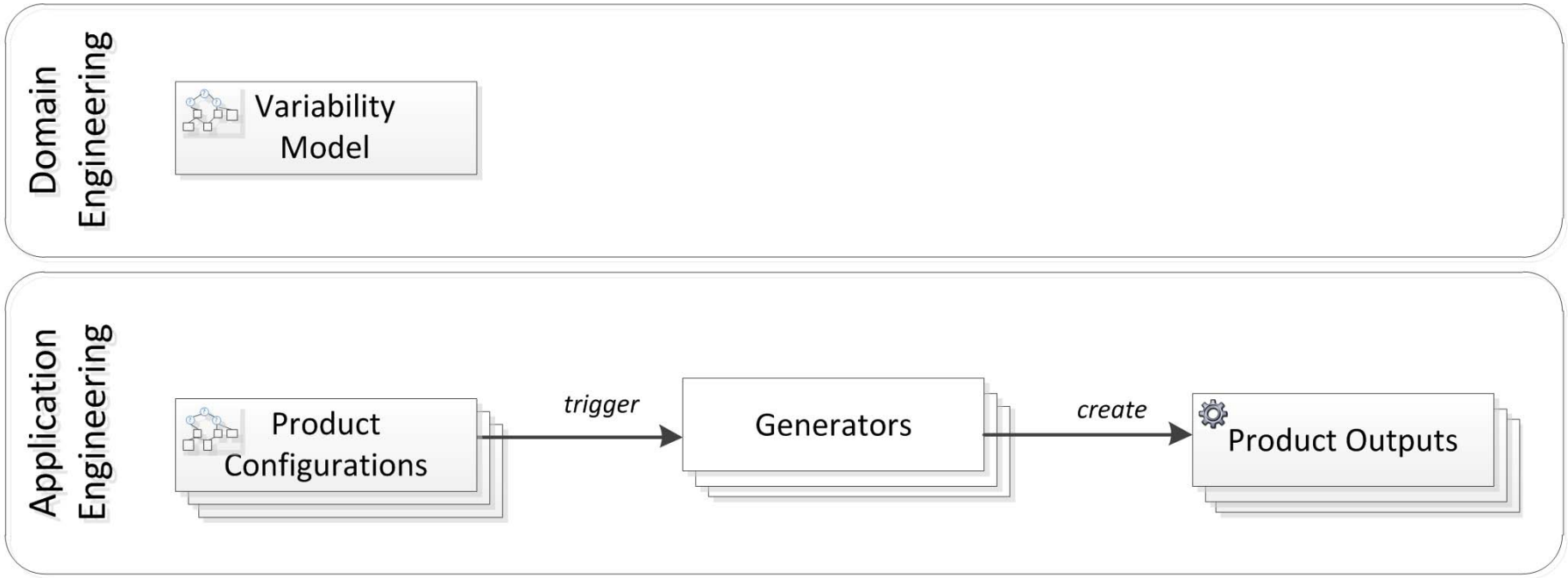
Impact Analysis: Common Approaches



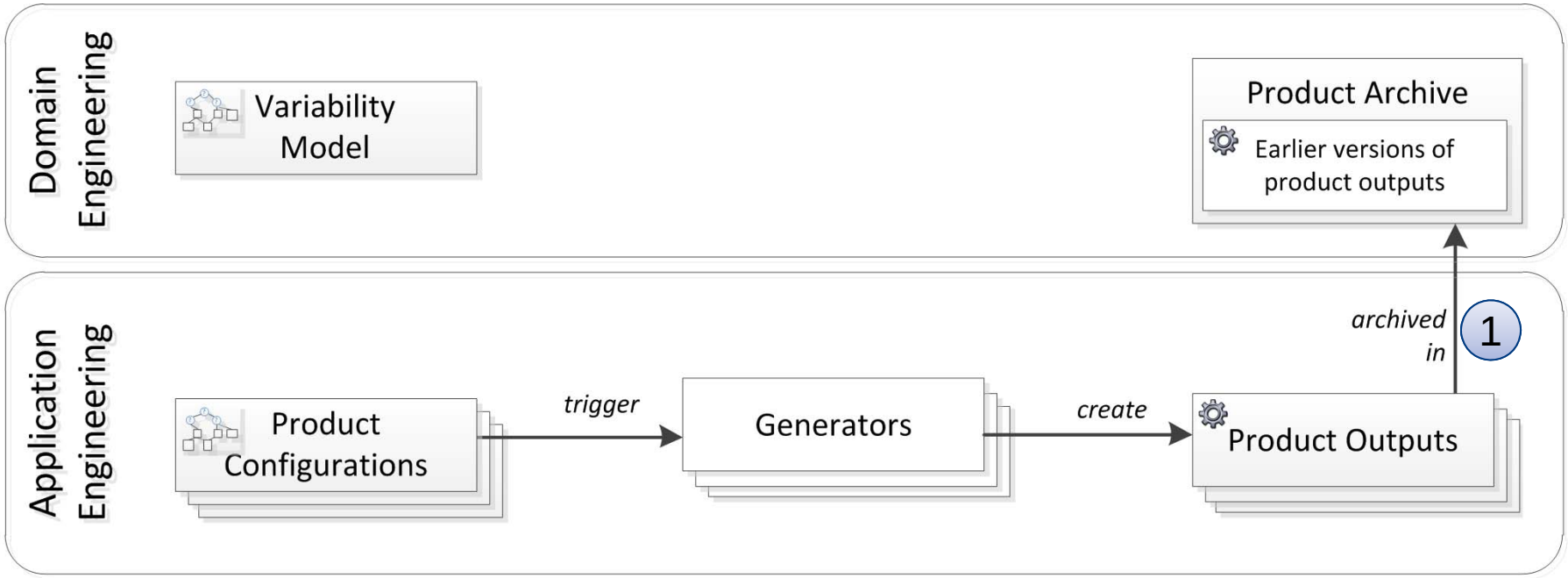
Required Change Impact Analysis



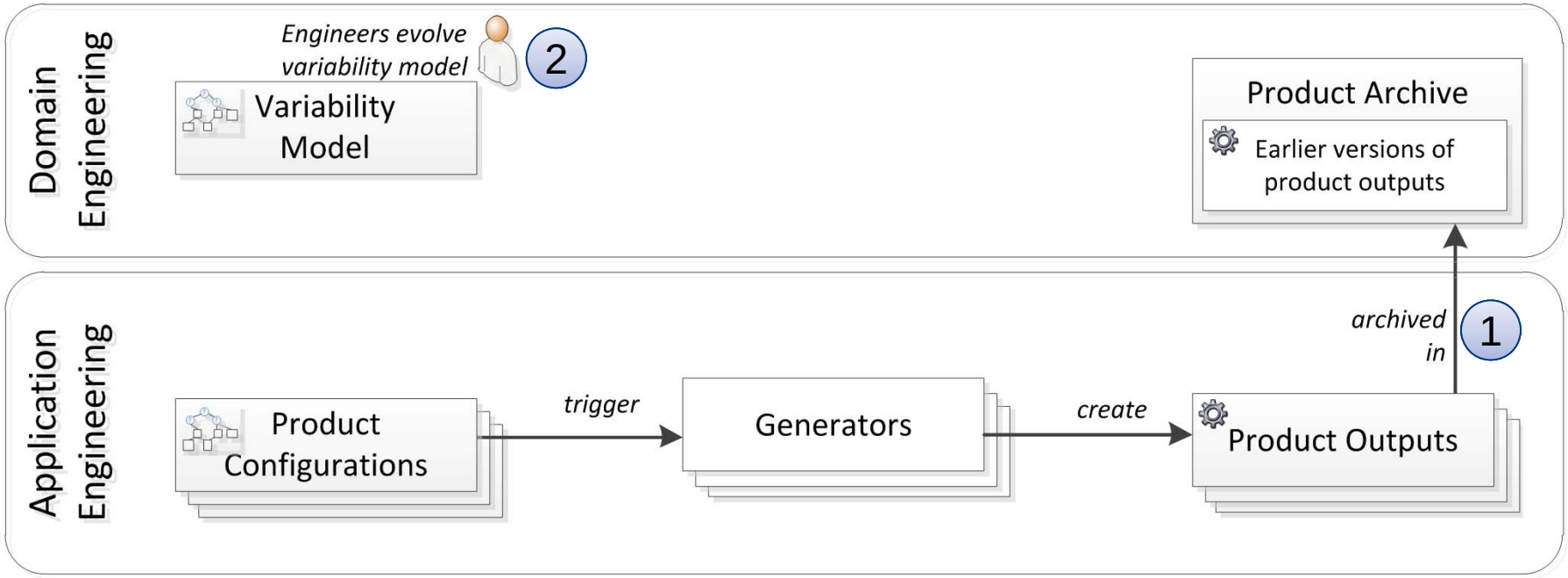
Our Approach



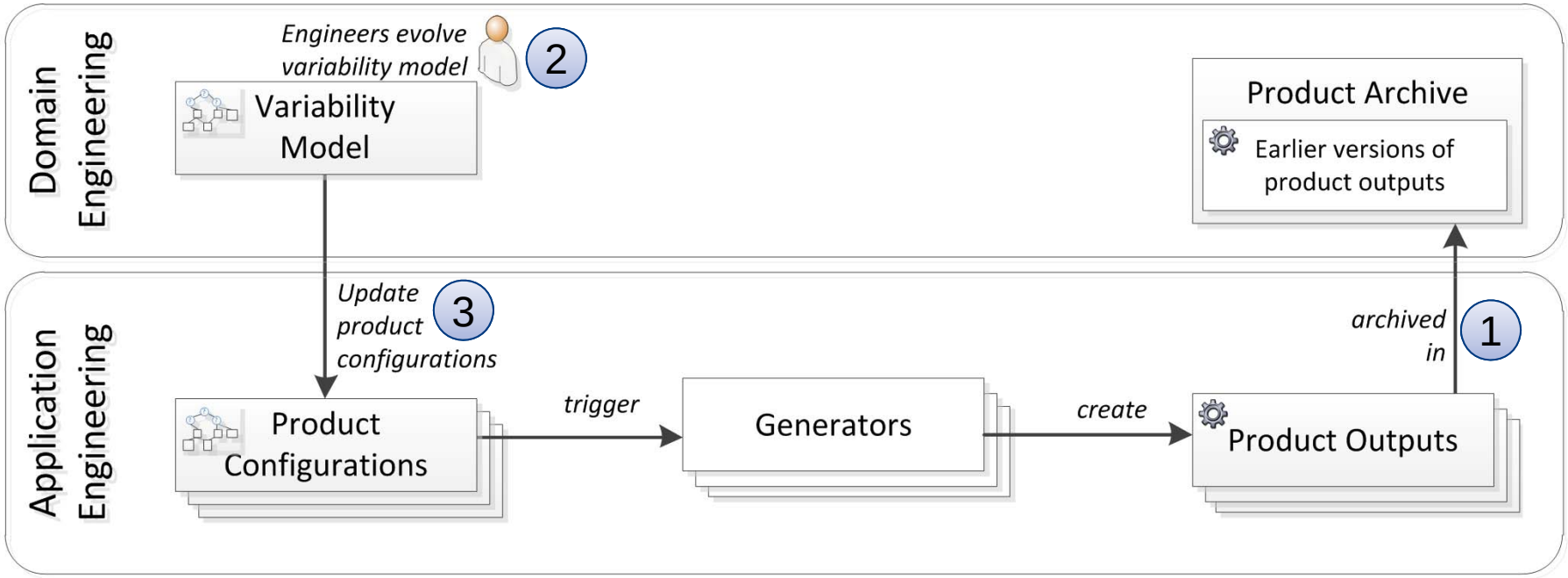
Our Approach



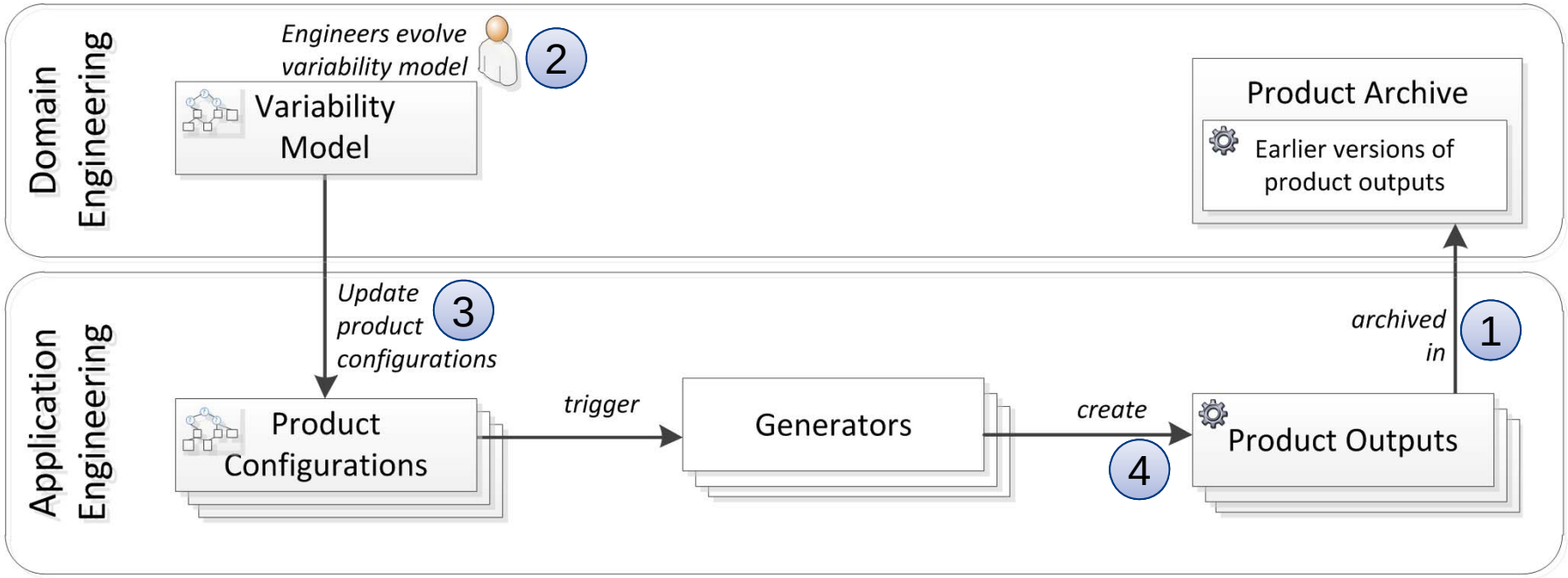
Our Approach



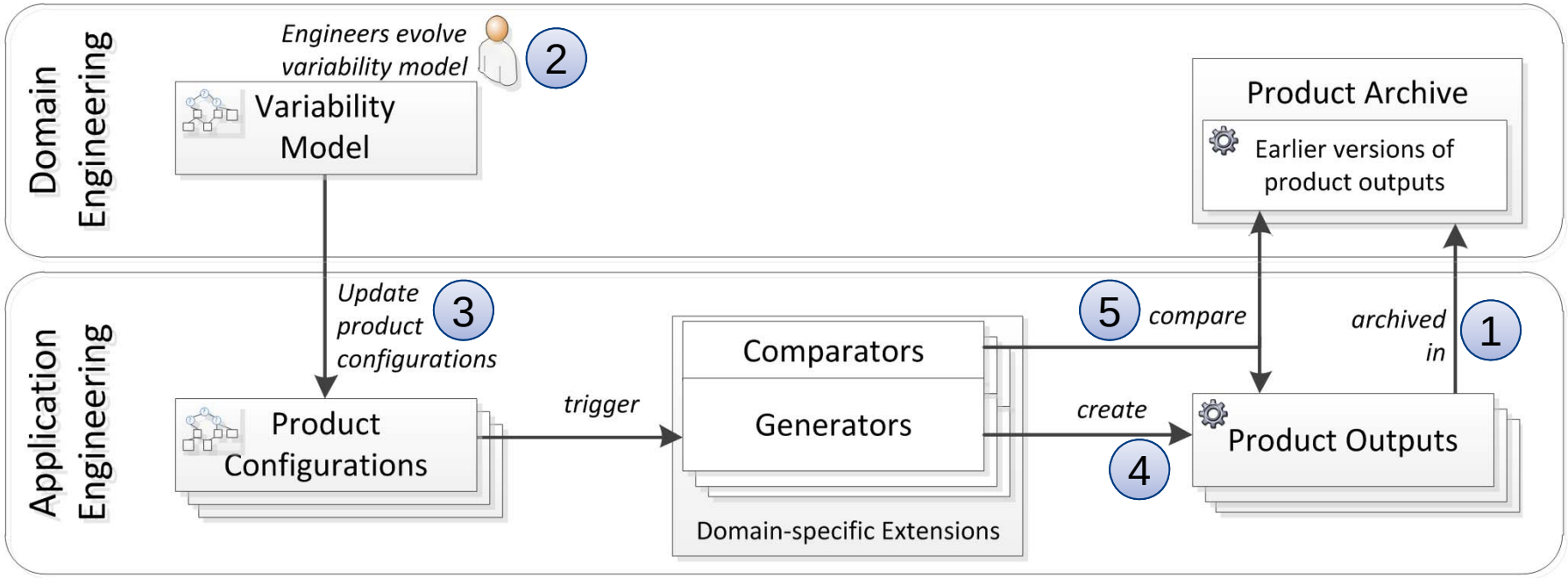
Our Approach



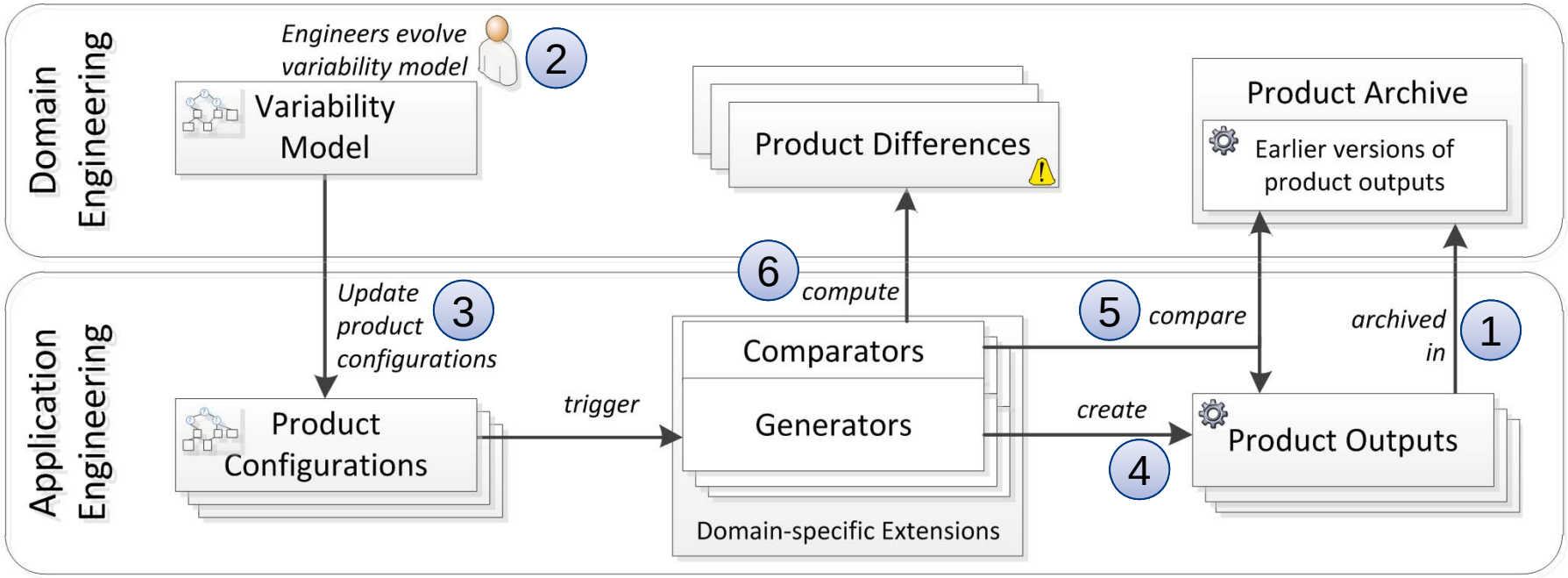
Our Approach



Our Approach

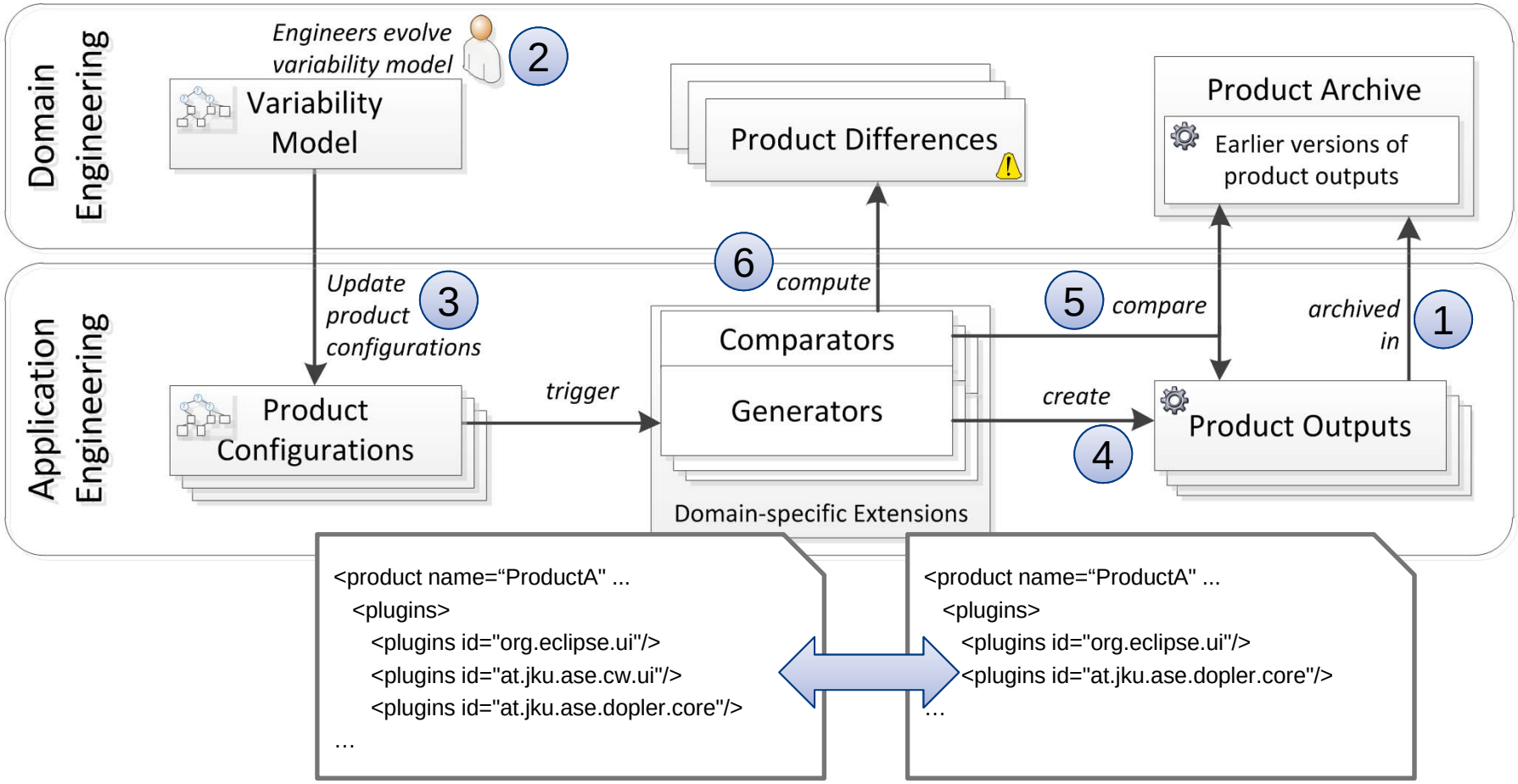


Our Approach

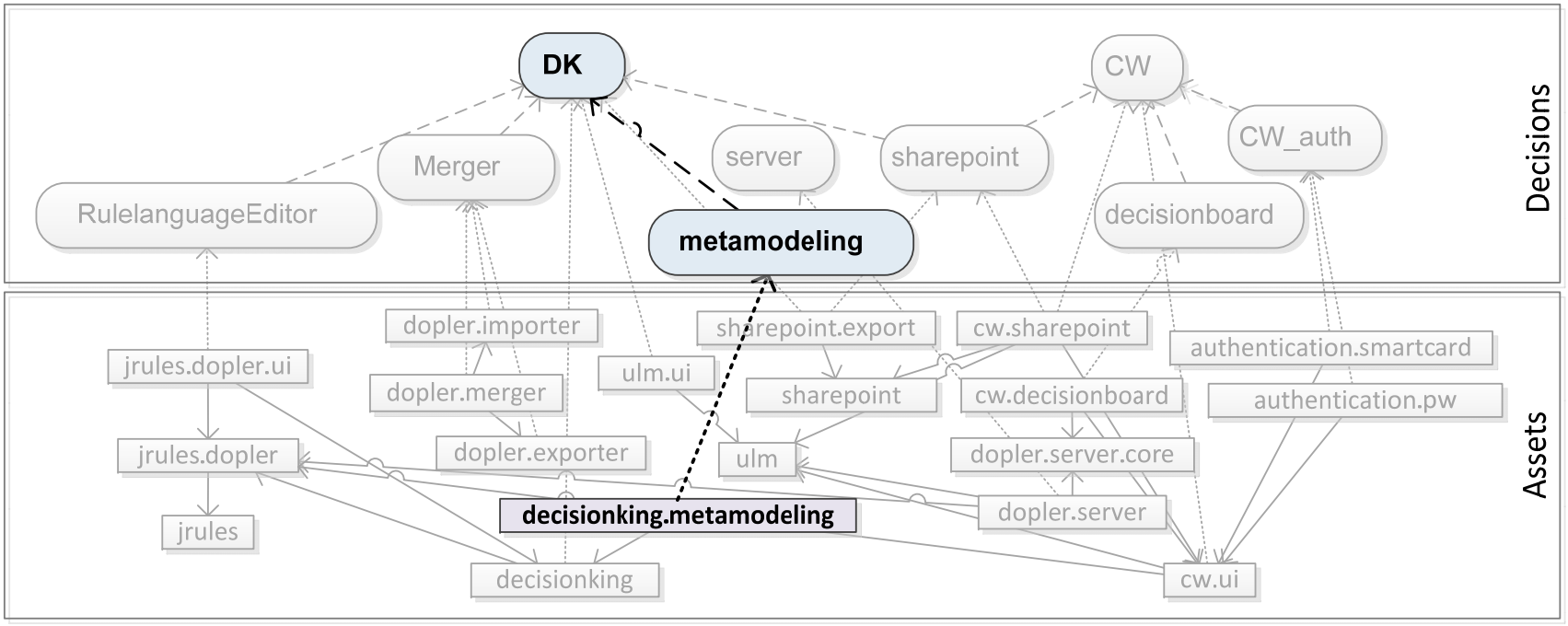


Our Approach

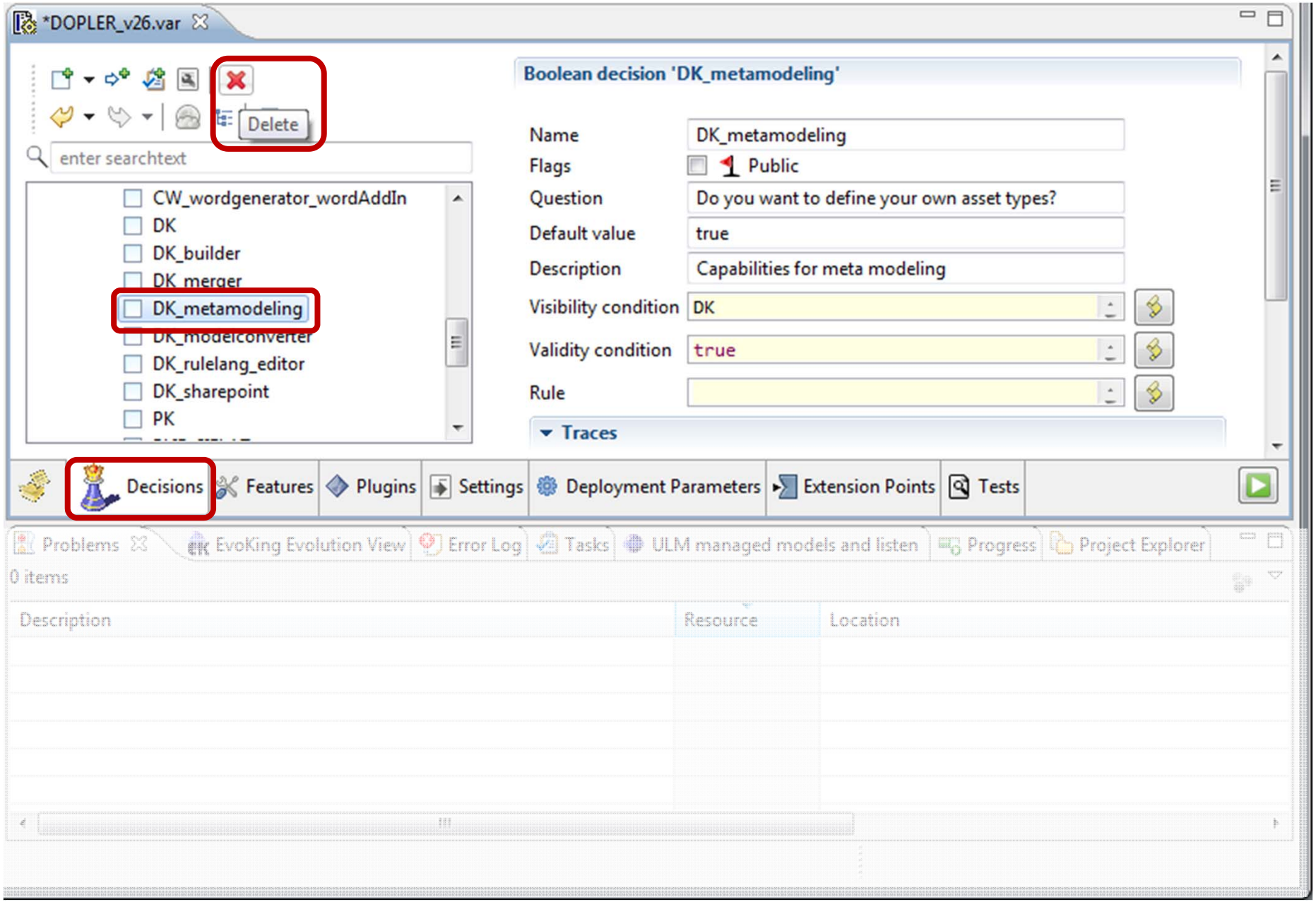
→ Required plugin at.jku.ase.cw.ui would be removed in product



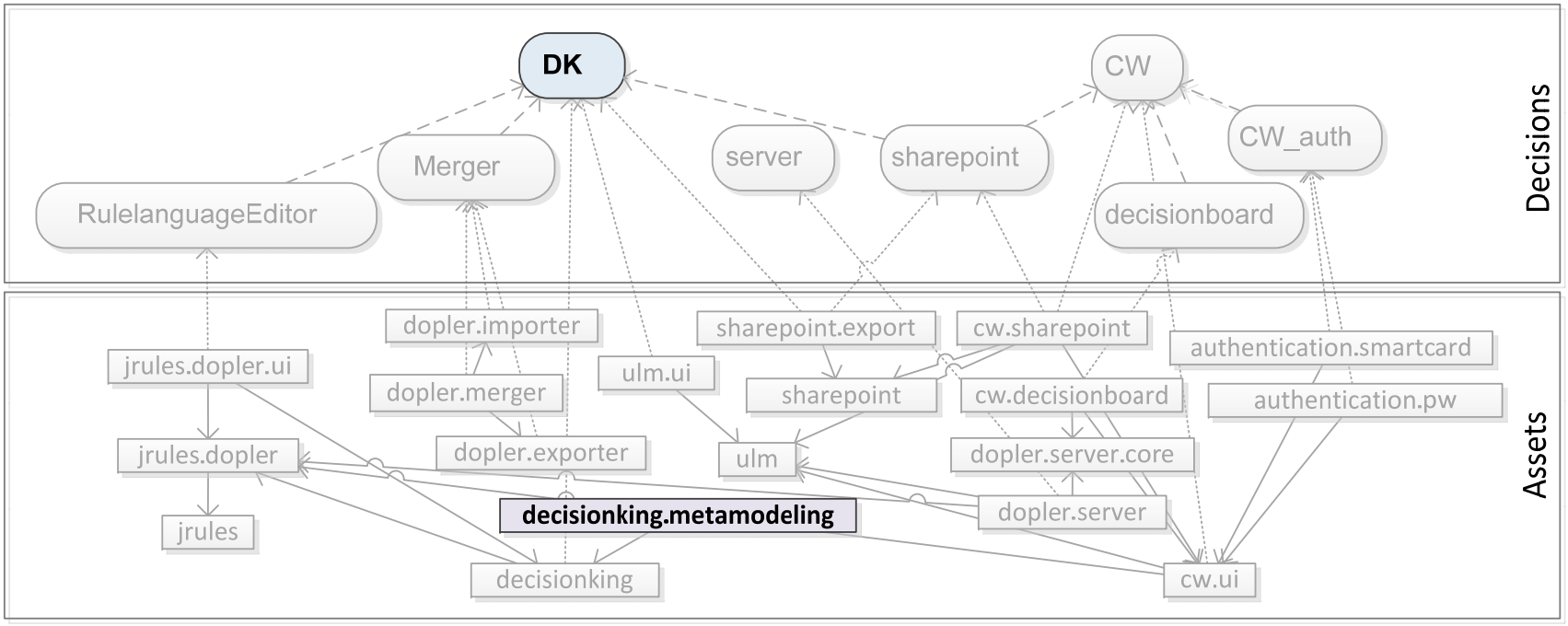
Example



Reduce Variability: Remove the choice on meta modeling.

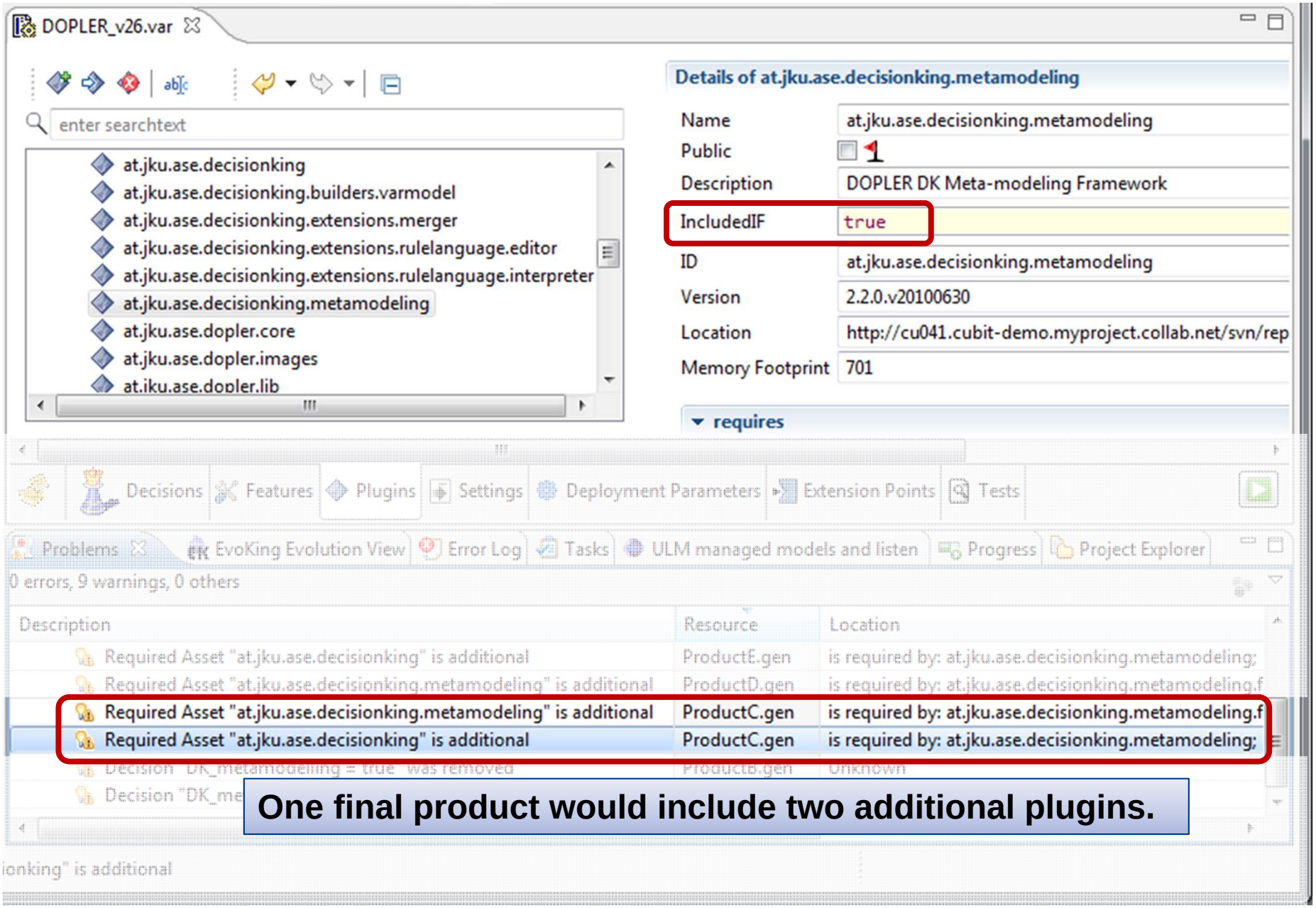

*DOPLER_v26.var
Delete
enter searchtext
CW_wordgenerator_wordAddIn
DK
DK_builder
DK_merger
DK_metamodeling
DK_modelconverter
DK_rulelang_editor
DK_sharepoint
PK
Boolean decision 'DK_metamodeling'
Name
DK_metamodeling
Flags
Public
Question
Do you want to define your own asset types?
Default value
true
Description
Capabilities for meta modeling
Visibility condition
DK
Validity condition
true
Rule
Traces
Decisions
Features
Plugins
Settings
Deployment Parameters
Extension Points
Tests
Problems
EvoKing Evolution View
Error Log
Tasks
ULM managed models and listen
Progress
Project Explorer
0 items
Description
Resource
Location

Example



Always include “decisionking.metamodeling”?

Or make it dependent on another decision?


DOPLER_v26.var
enter searchtext
at.jku.ase.decisionking
at.jku.ase.decisionking.builders.varmodel
at.jku.ase.decisionking.extensions.merger
at.jku.ase.decisionking.extensions.rulelanguage.editor
at.jku.ase.decisionking.extensions.rulelanguage.interpreter
at.jku.ase.decisionking.metamodeling
at.jku.ase.dopler.core
at.jku.ase.dopler.images
at.jku.ase.dopler.lib
Details of at.jku.ase.decisionking.metamodeling
Name
at.jku.ase.decisionking.metamodeling
Public
Description
DOPLER DK Meta-modeling Framework
IncludedIF
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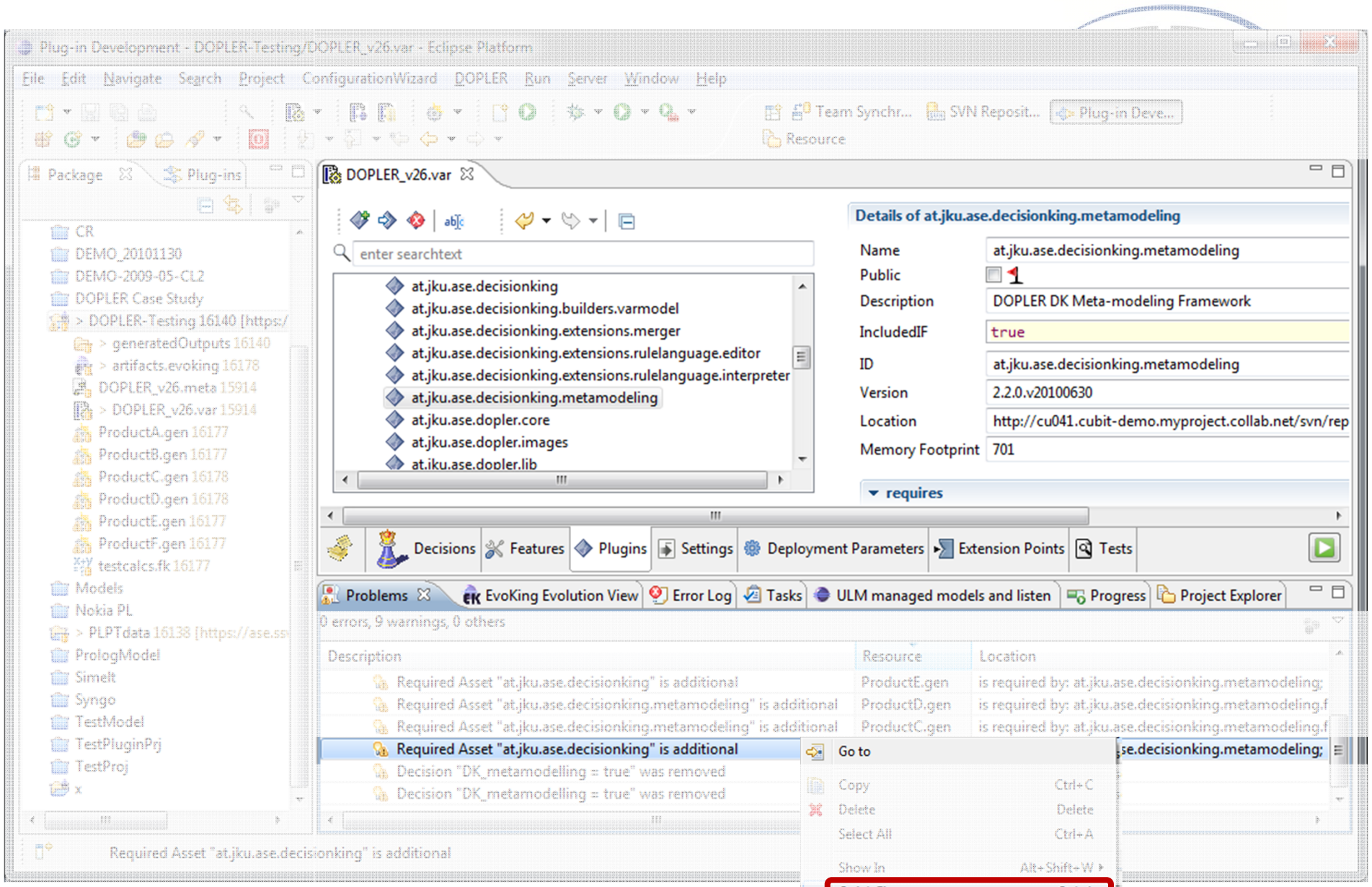
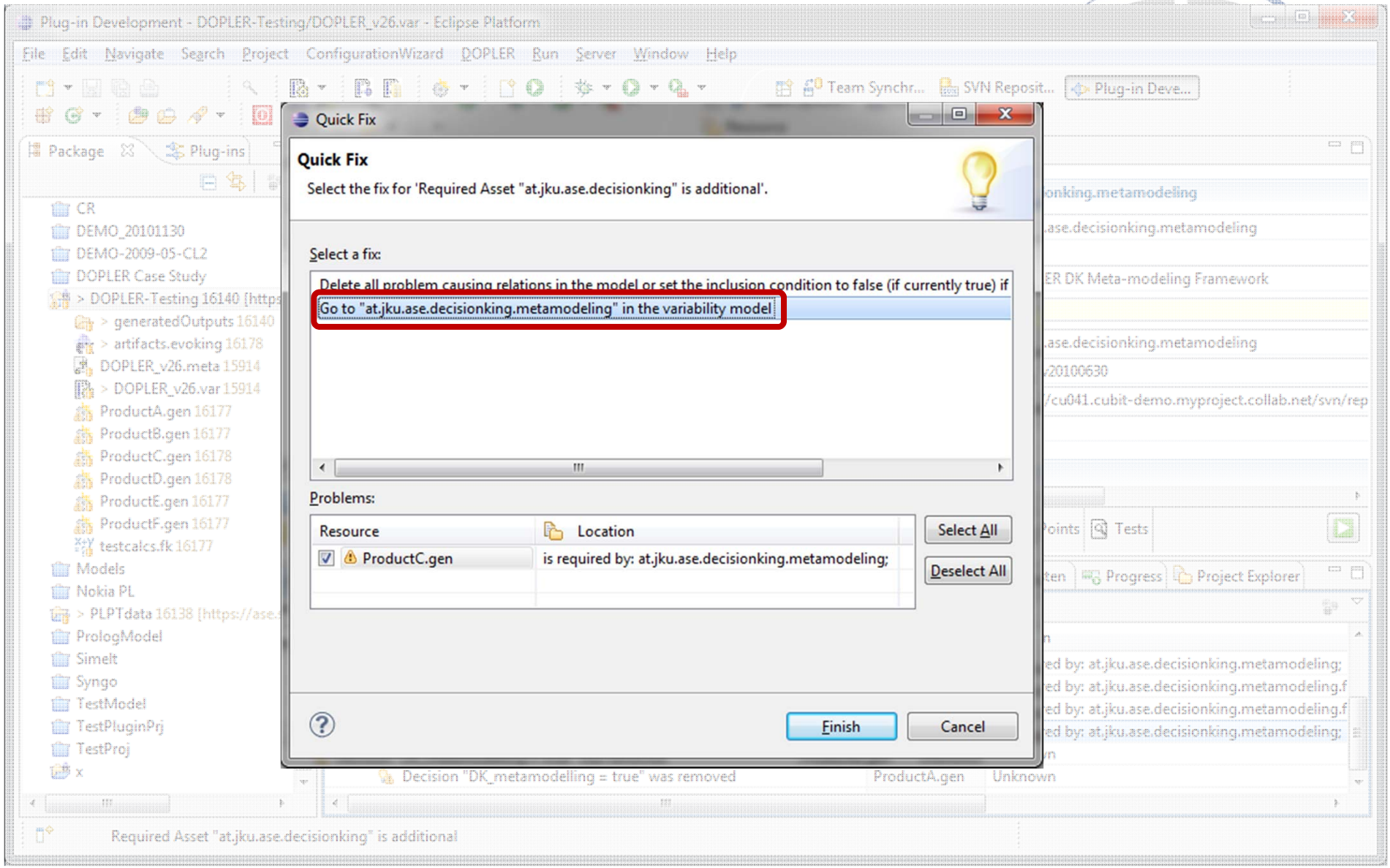
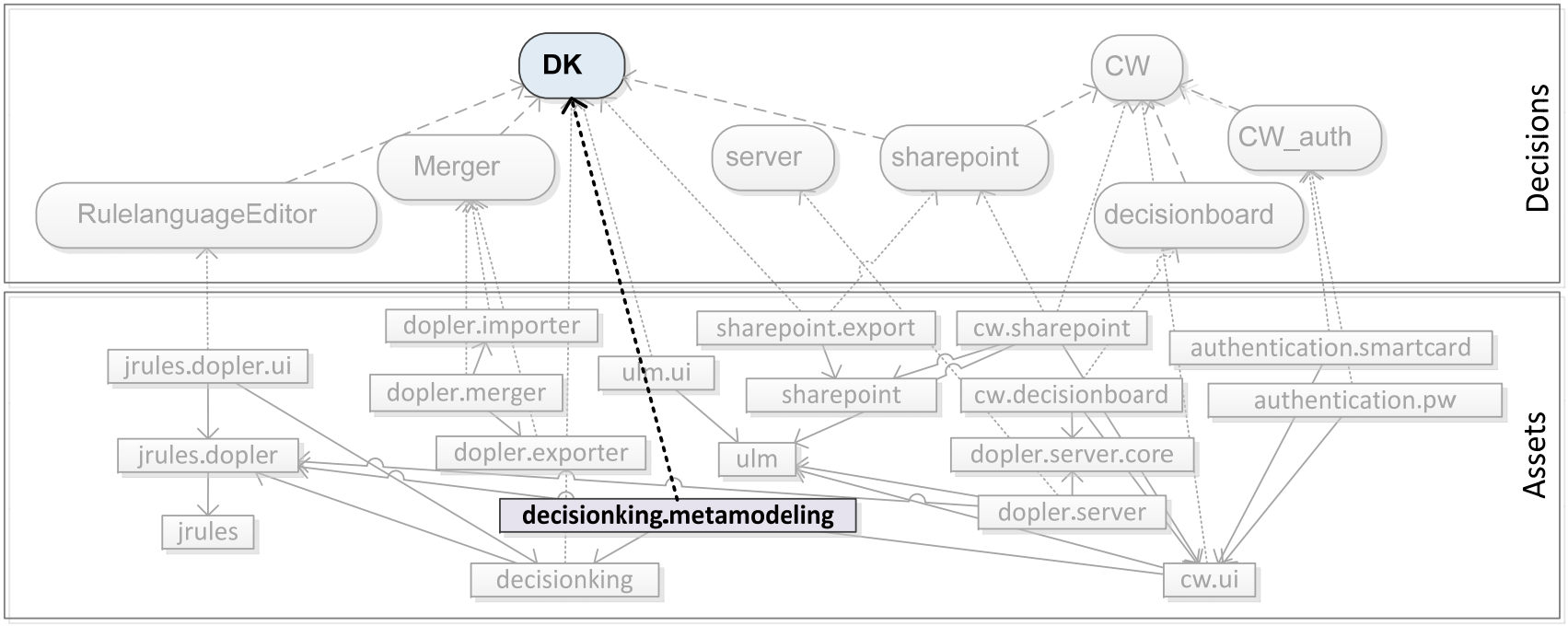
ID
at.jku.ase.decisionking.metamodeling
Version
2.2.0.v20100630
Location
http://cu041.cubit-demo.myproject.collab.net/svn/rep
Memory Footprint
701
requires
Decisions
Features
Plugins
Settings
Deployment Parameters
Extension Points
Tests
Problems
EvoKing Evolution View
Error Log
Tasks
ULM managed models and listen
Progress
Project Explorer
0 errors, 9 warnings, 0 others
Description
Resource
Location
Required Asset "at.jku.ase.decisionking" is additional
ProductE.gen
is required by: at.jku.ase.decisionking.metamodeling;
Required Asset "at.jku.ase.decisionking.metamodeling" is additional
ProductD.gen
is required by: at.jku.ase.decisionking.metamodeling.f
Required Asset "at.jku.ase.decisionking.metamodeling" is additional
ProductC.gen
is required by: at.jku.ase.decisionking.metamodeling.f
Required Asset "at.jku.ase.decisionking" is additional
ProductC.gen
is required by: at.jku.ase.decisionking.metamodeling;
One final product would include two additional plugins.

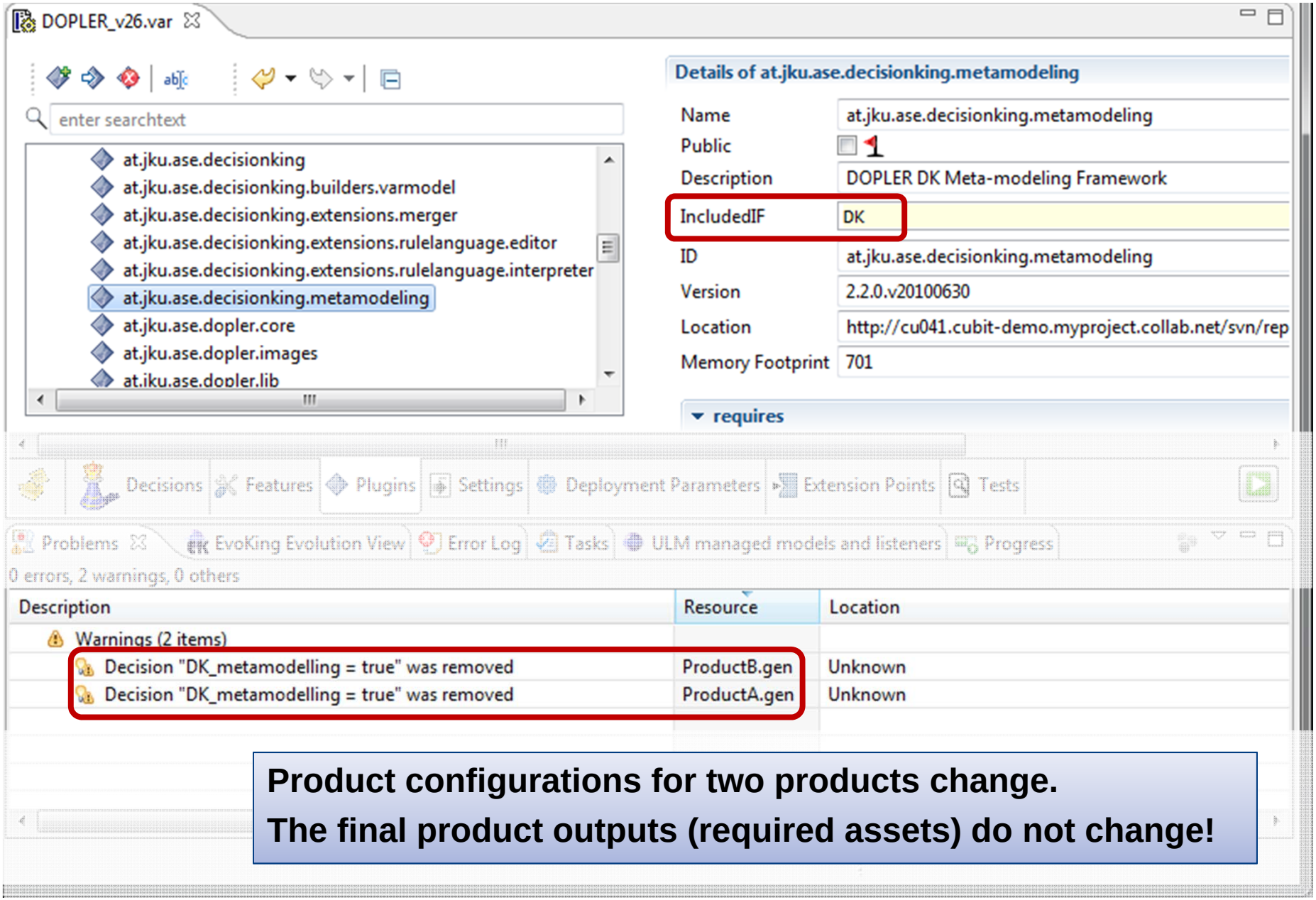

Plug-in Development - DOPLER-Testing/DOPLER_v26.var - Eclipse Platform
File Edit Navigate Search Project ConfigurationWizard DOPLER Run Server Window Help
Package
Plug-ins
DOPLER_v26.var
enter searchtext
at.jku.ase.decisionking
at.jku.ase.decisionking.builders.varmodel
at.jku.ase.decisionking.extensions.merger
at.jku.ase.decisionking.extensions.rulelanguage.editor
at.jku.ase.decisionking.extensions.rulelanguage.interpreter
at.jku.ase.decisionking.metamodeling
at.jku.ase.dopler.core
at.jku.ase.dopler.images
Details of at.jku.ase.decisionking.metamodeling
Name at.jku.ase.decisionking.metamodeling
Public
Description DOPLER DK Meta-modeling Framework
IncludedIF true
ID at.jku.ase.decisionking.metamodeling
Version 2.2.0.v20100630
Location http://cu041.cubit-demo.myproject.collab.net/svn/rep
Memory Footprint 701
requires
Decisions Features Plugins Settings Deployment Parameters Extension Points Tests
Problems EvoKing Evolution View Error Log Tasks ULM managed models and listen Progress Project Explorer
0 errors, 9 warnings, 0 others
Description Resource Location
Required Asset "at.jku.ase.decisionking" is additional ProductE.gen is required by: at.jku.ase.decisionking.metamodeling;
Required Asset "at.jku.ase.decisionking.metamodeling" is additional ProductD.gen is required by: at.jku.ase.decisionking.metamodeling.f
Required Asset "at.jku.ase.decisionking.metamodeling" is additional ProductC.gen is required by: at.jku.ase.decisionking.metamodeling.f
Required Asset "at.jku.ase.decisionking" is additional
Decision "DK_metamodelling = true" was removed
Decision "DK_metamodelling = true" was removed
Go to
Copy Ctrl+C
Delete Delete
Select All Ctrl+A
Show In Alt+Shift+W
Quick Fix Ctrl+1
New Task from Marker...
Properties Alt+Enter
Required Asset "at.jku.ase.decisionking" is additional


Plug-in Development - DOPLER-Testing/DOPLER_v26.var - Eclipse Platform
File Edit Navigate Search Project ConfigurationWizard DOPLER Run Server Window Help
Quick Fix
Quick Fix
Select the fix for 'Required Asset "at.jku.ase.decisionking" is additional'.
Select a fix:
Delete all problem causing relations in the model or set the inclusion condition to false (if currently true) if
Go to "at.jku.ase.decisionking.metamodeling" in the variability model
Problems:
Resource
Location
ProductC.gen
is required by: at.jku.ase.decisionking.metamodeling;
Select All
Deselect All
Finish
Cancel
Decision "DK_metamodelling = true" was removed
ProductA.gen
Unknown
Required Asset "at.jku.ase.decisionking" is additional

Example



Include “decisionking.metamodeling” depending on DK!


DOPLER_v26.var
enter searchtext
at.jku.ase.decisionking
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at.jku.ase.decisionking.extensions.merger
at.jku.ase.decisionking.extensions.rulelanguage.editor
at.jku.ase.decisionking.extensions.rulelanguage.interpreter
at.jku.ase.decisionking.metamodeling
at.jku.ase.dopler.core
at.jku.ase.dopler.images
at.jku.ase.dopler.lib
Details of at.jku.ase.decisionking.metamodeling
Name
at.jku.ase.decisionking.metamodeling
Public
Description
DOPLER DK Meta-modeling Framework
IncludedIF
DK
ID
at.jku.ase.decisionking.metamodeling
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EvoKing Evolution View
Error Log
Tasks
ULM managed models and listeners
Progress
0 errors, 2 warnings, 0 others
Description
Resource
Location
Warnings (2 items)
Decision "DK_metamodelling = true" was removed
ProductB.gen
Unknown
Decision "DK_metamodelling = true" was removed
ProductA.gen
Unknown
Product configurations for two products change.
The final product outputs (required assets) do not change!

Conclusions / Lessons Learned

- Approach currently also used to analyze the impact of product line evolution for a system supporting the management of tombs (RIP)

- Impact analysis in product lines can perform well for real world scenarios
- Existing product generators can be reused
- Simple artifact representations reduce execution time
- Product updates need to be automated

Contributors to this Talk / Related Publications

Wolfgang Heider Daniela Lettner Paul Grünbacher

W. Heider, R. Rabiser, D. Lettner, and P. Grünbacher: Using Regression Testing to Analyze the Impact of Changes to Variability Models on Products. *SPLC 2012*, pp. 196-205.

W. Heider, R. Rabiser, and P. Grünbacher: Facilitating the Evolution of Products in Product Line Engineering by Capturing and Replaying Configuration Decisions. *STTT, vol. 14(5), pp. 613-630, 2012.*

R. Rabiser, P. O'Leary, and I. Richardson: Key Activities for Product Derivation in Software Product Lines. *JSS, vol. 84(2), pp. 285-300, 2011.*

P. Grünbacher, R. Rabiser, D. Dhungana, and M. Lehofer: Model-based Customization and Deployment of Eclipse-Based Tools: Industrial Experiences. *ASE 2009, pp. 247-256.*

Find out more on http://ase.jku.at/

Future Work / New Christian Doppler Lab

- **Monitoring and Evolution of Very-Large-Scale SW Systems**
- Feb 2013-Jan 2020; Head: Paul Grünbacher; http://mevss.jku.at

- **Goal**: Develop and improve methods for monitoring and diagnosing VLSS to support their systematic evolution
  - Requirements-based monitoring and diagnosis

    - Ensuring compliance with requirements after evolving a large-scale component in a VLSS

  - Multi-modeling in software ecosystems

    - Determining the impact of a platform change on globally distributed customer systems in a multi-level ecosystem

  - Application performance management

    - Diagnosing performance bottlenecks in distributed and heterogeneous web applications after software changes