PLE Tool Support

KV Product Line Engineering (343.354)
Dr. Roberto Lopez-Herrejon
Dr. Rick Rabiser

27.4.2016

Why and when to use a Tool?

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Fixed project size (*10 features*)–Varying process (*regular process* and *advanced process*)

Requirements planning process activities	Simple process: *regular process*						Complex process: *advanced process*					
	without tool			with tool			without tool			with tool		
	unit effort	execu-tions	total effort	unit effort	execu-tions	total effort	unit effort	execu-tions	total effort	unit effort	execu-tions	total effort
Capture raw requirement	46	12	552	9	12	108	66	12	792	15	12	180
Resolve raw requirements	0.3	89	26.7	10.4	89	925.6	6.8	89	605.2	13.2	89	1174.8
Resolve problem statement	7	32	224	2.9	32	92.8	10.9	32	348.8	3.2	32	102.4
Resolve features	8.3	10	83	3.2	10	32	97.4	10	974	37.7	10	377
Develop release plan	0*	2	0	0	2	0	180	2	360	68	2	136
Total effort			855			1158.4			3080			1970.2
Productivity	28.04			20.71			7.79			12.18		
Productivity Impact	- 26.1%						+ 56.4%					

* this activity does not involve subactivities affected by tool insertion.

[Bruckhaus et al. 1996]

→ SPLE comprises many complex processes!

Motivation

- Many activities/processes of SPLE can (and have to) be automated/supported by tools, e.g.,
  - Variability modeling
    - tools hide the concrete syntax behind a graphical user interface and help users to create models in an efficient way
  - Product derivation
    - tools help to make configuration decisions and support constraint propagation, automated conflict resolution, configuration generation
  - Product line planning/scoping
    - tools can facilitate effective collaboration, e.g., for the development of a feature plan
  - ...

Requirements for SPL tools

- Interoperability and Traceability
  - How to integrate SPL tools with (development) processes, teams, and tools already existing in an organization?
  - How to integrate SPL processes with each other (from PL planning to variability modeling to product derivation)?
- Adaptability
  - How to work with the assets and dependencies specific to a particular domain?
  - How to react to changes e.g., evolving technology or changing customer needs?
- Scaleability
  - How to support multiple teams/large organizations?
  - How to work with large systems?

Requirements for SPL tools

- Extensibility
  - How to add additionally required functionality (e.g., 3rd party capabilities)?
- Usability
  - How „easy“ can different user groups work with the tools?
    - Especially important for „non-software-technicians“
    - Learnability, Efficiency, Memorability, Accuracy, Subjective Satisfaction [Nielsen 1994]
- Automation
  - Which tasks can be automated?
  - Which tasks require user intervention?
- Error handling
  - How to react to problems?

Custom-developed „PL“ Tools

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- Typical scenario:
  - Company recognized need to manage variability
    - e.g., too many projects with customers having too many specific requirements, project-specific development no longer accomplishable
  - Company implements their own solution to manage variability
    - Often very close to the code
      - E.g., parameterization, config files, IFDefs
    - Variability is usually not explicitly documented (e.g., in a model)
    - Thus: management of variability becomes a maintenance problem in itself
- However, there are many commercial and academic PL tools existing
  - They are just not well-known and many of them unfortunately are hard to adopt for practical scenarios

SPL Tools – An Overview

- **The DOPLER Tool Suite**
- **Kumbang Tools**
- **pure::variants**
- **Gears**
- **Feature IDE**
- **Other tools**

The DOPLER Tool Suite

CHRISTIAN DOPPLER LABORATORY FOR
AUTOMATED SOFTWARE ENGINEERING

SIEMENS
VAI

JOHANNES KEPLER
UNIVERSITY LINZ | JKU

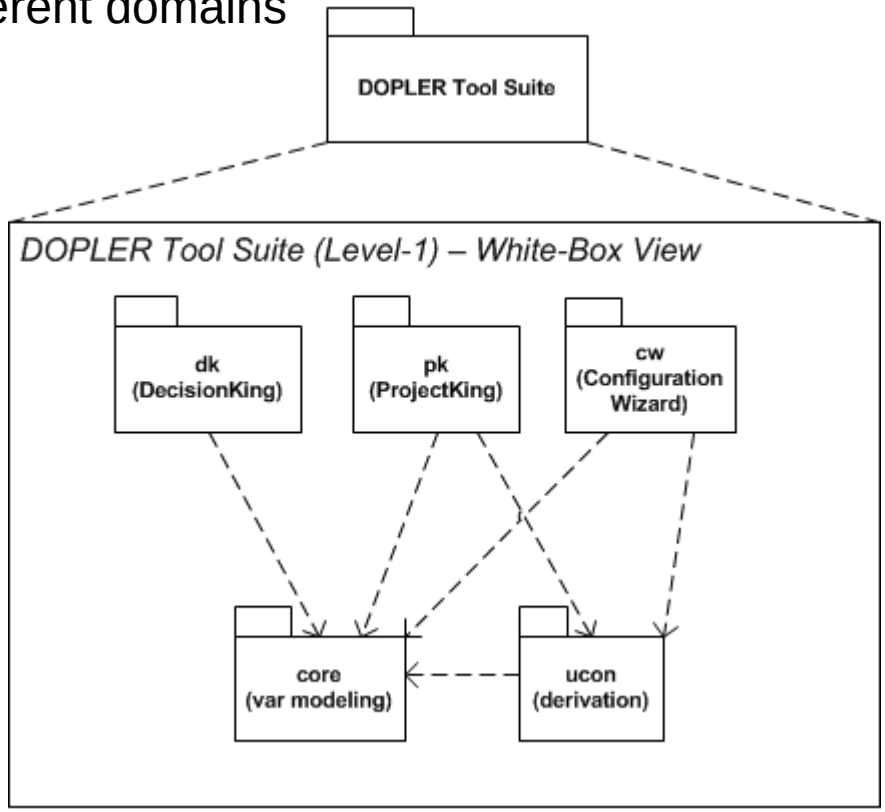
[Dhungana et al. 2006-2009] [Rabiser et al. 2006-2013]

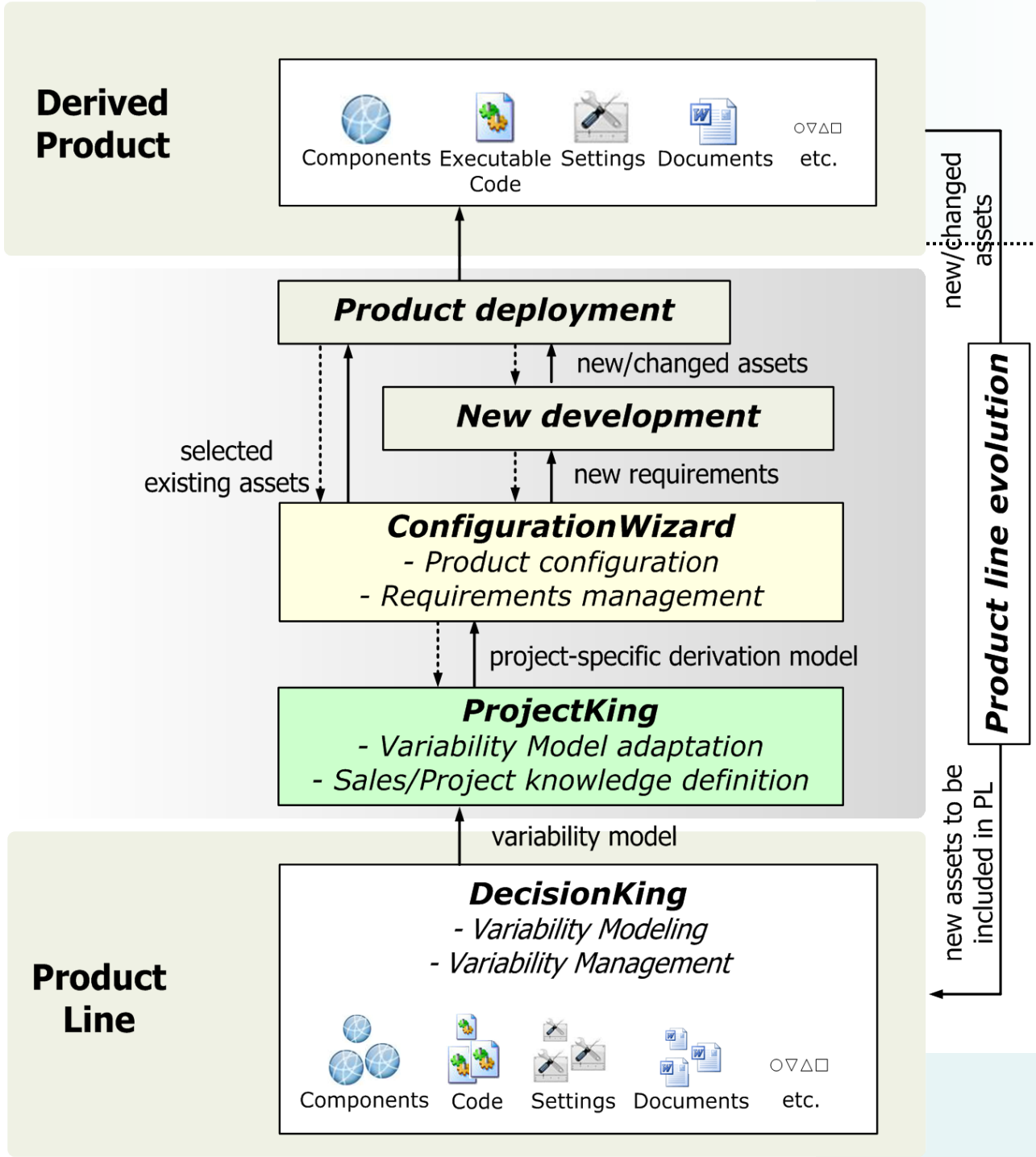
DOPLER Tool Suite

- Supports Decision-oriented modeling and Wizard-oriented usage of variability
- Developed at CD Lab for ASE, JKU in collaboration with Siemens VAI Metals Technologies GmbH and Siemens Corporate Technology
- Flexible and Extensible tool architecture
  - Meta-modeling capabilities for domain-specific adaptations
  - Plug-in Architecture to allow for arbitrary extensions
- Focuses on the needs of end-users for customizing complex products in an intuitive manner

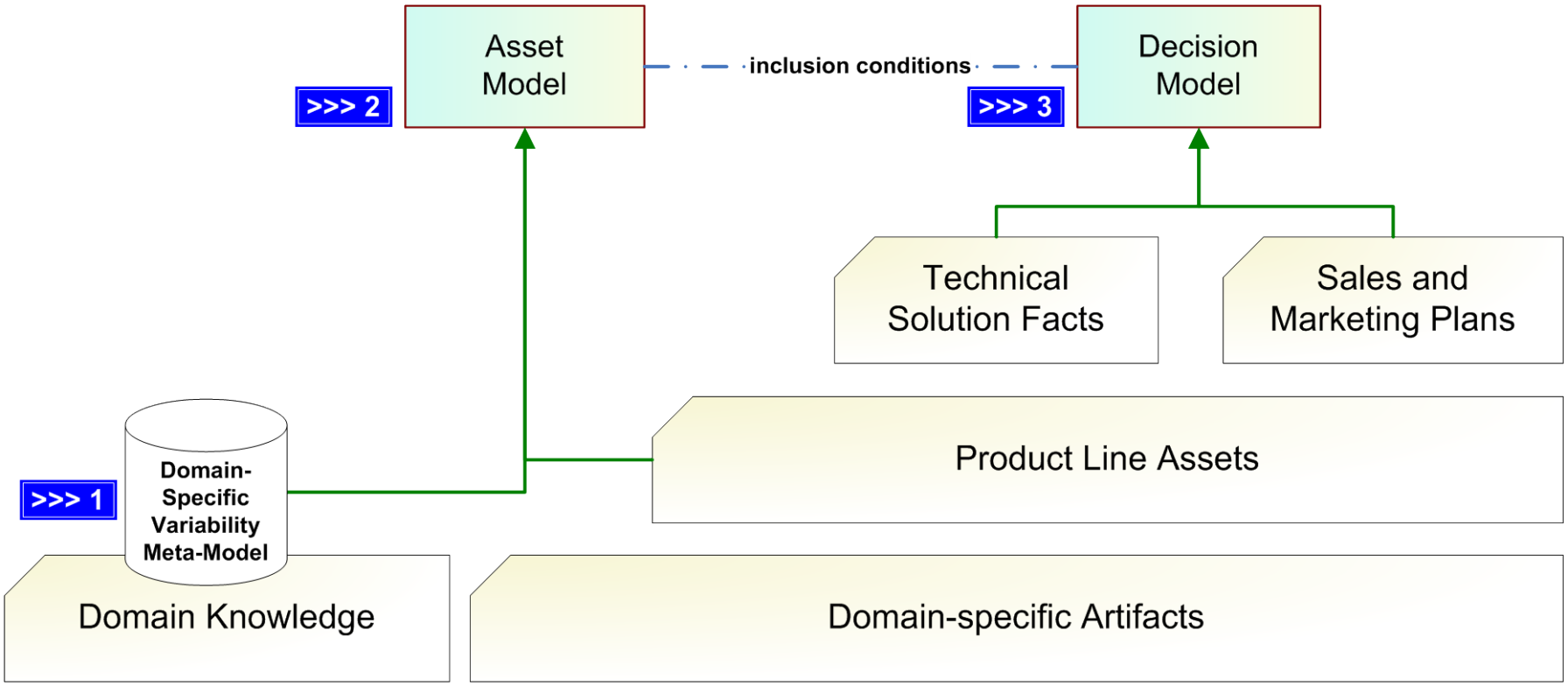
Overview

- 3 tools (composed of multiple plug-ins) and several (optional) extensions
- Customizable- but in general independent of languages, notations and practices in different domains

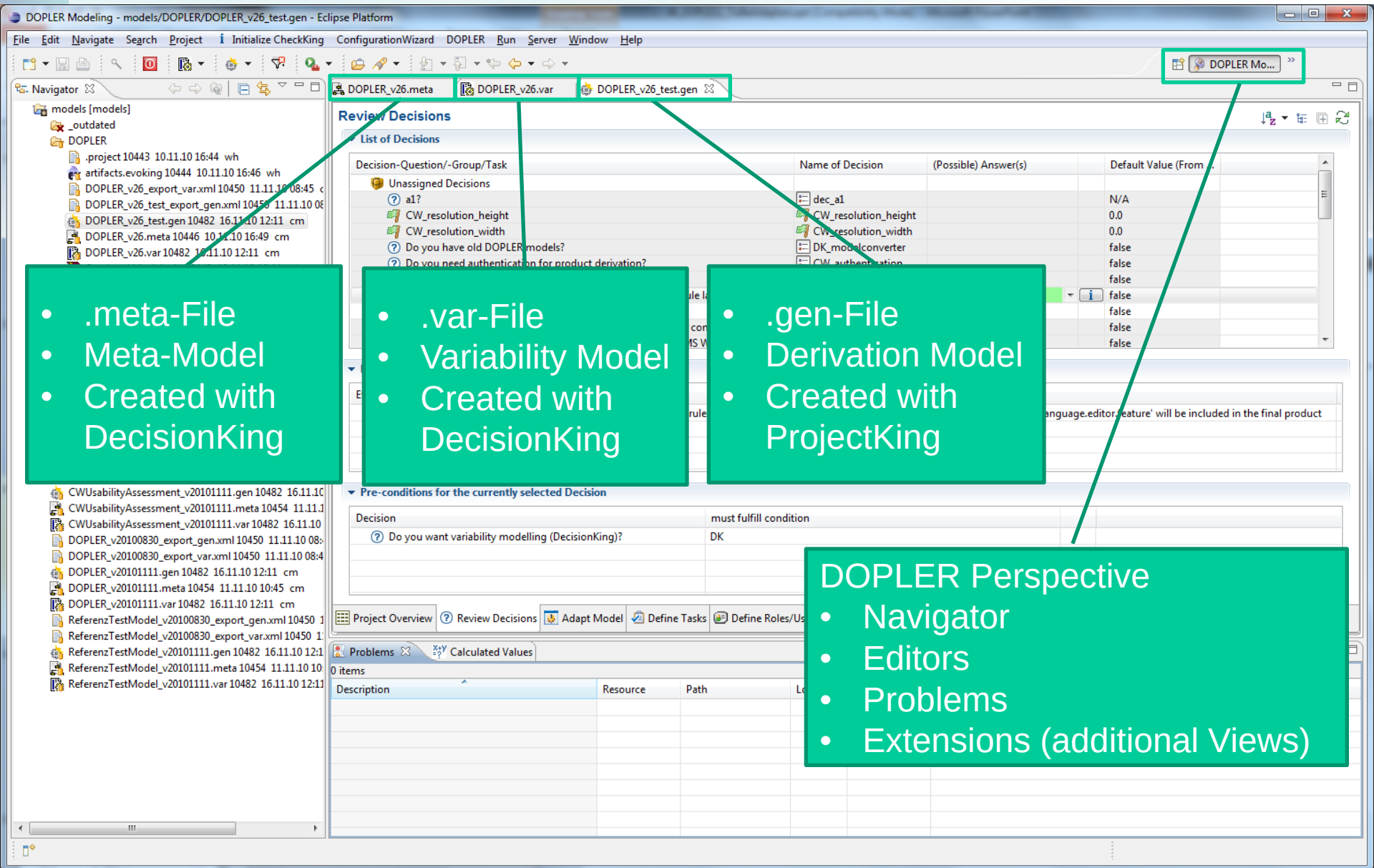



Derived Product
Components
Executable Code
Settings
Documents
etc.
Product deployment
new/changed assets
New development
selected existing assets
new requirements
ConfigurationWizard
- Product configuration
- Requirements management
project-specific derivation model
ProjectKing
- Variability Model adaptation
- Sales/Project knowledge definition
variability model
DecisionKing
- Variability Modeling
- Variability Management
Product Line
Components
Code
Settings
Documents
etc.
new/changed assets
Product line evolution
new assets to be included in PL

Modeling Approach



DOPLER Modeling Perspective



DecisionKing: Meta-model Editor

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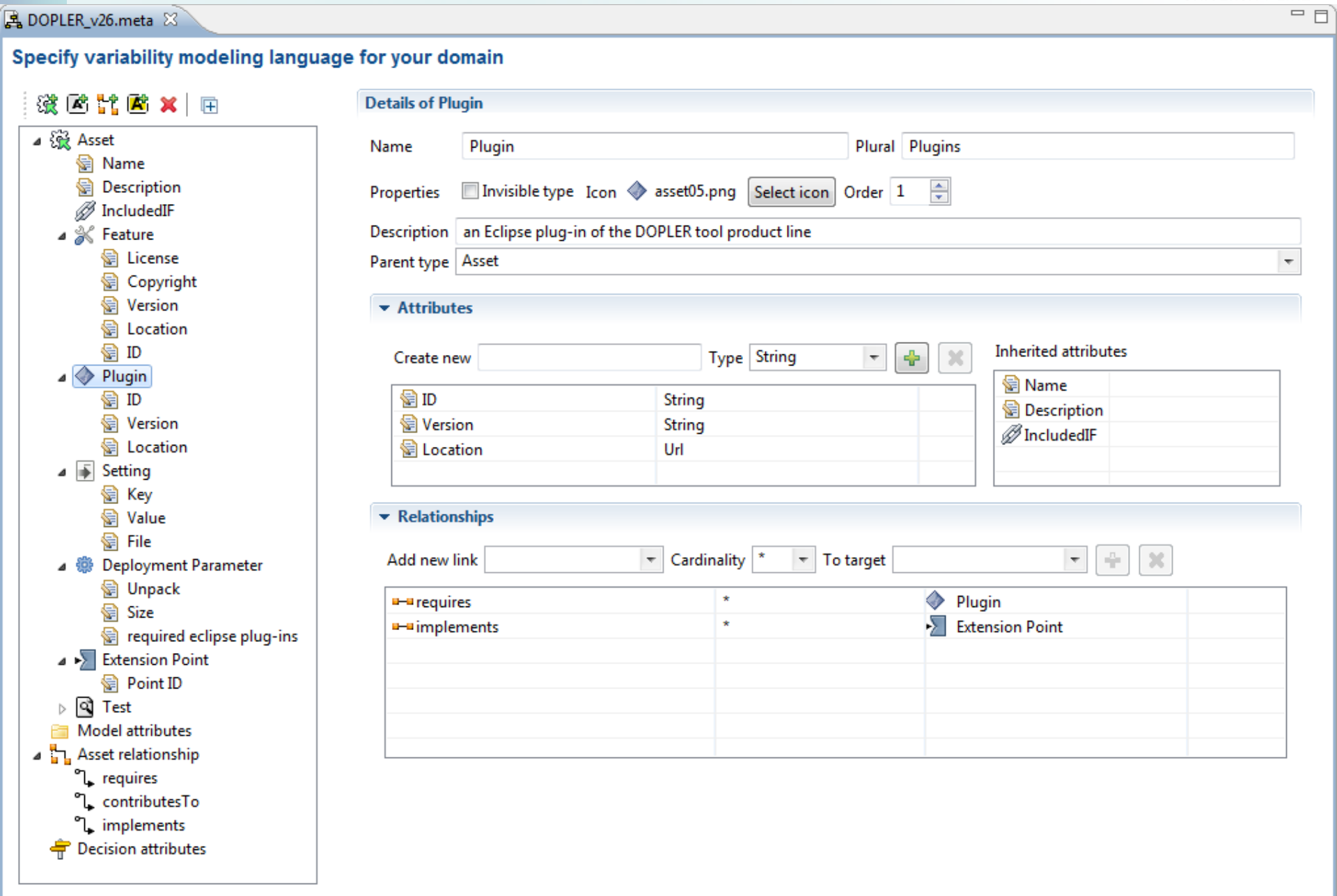

Variability Model Editor - Decisions

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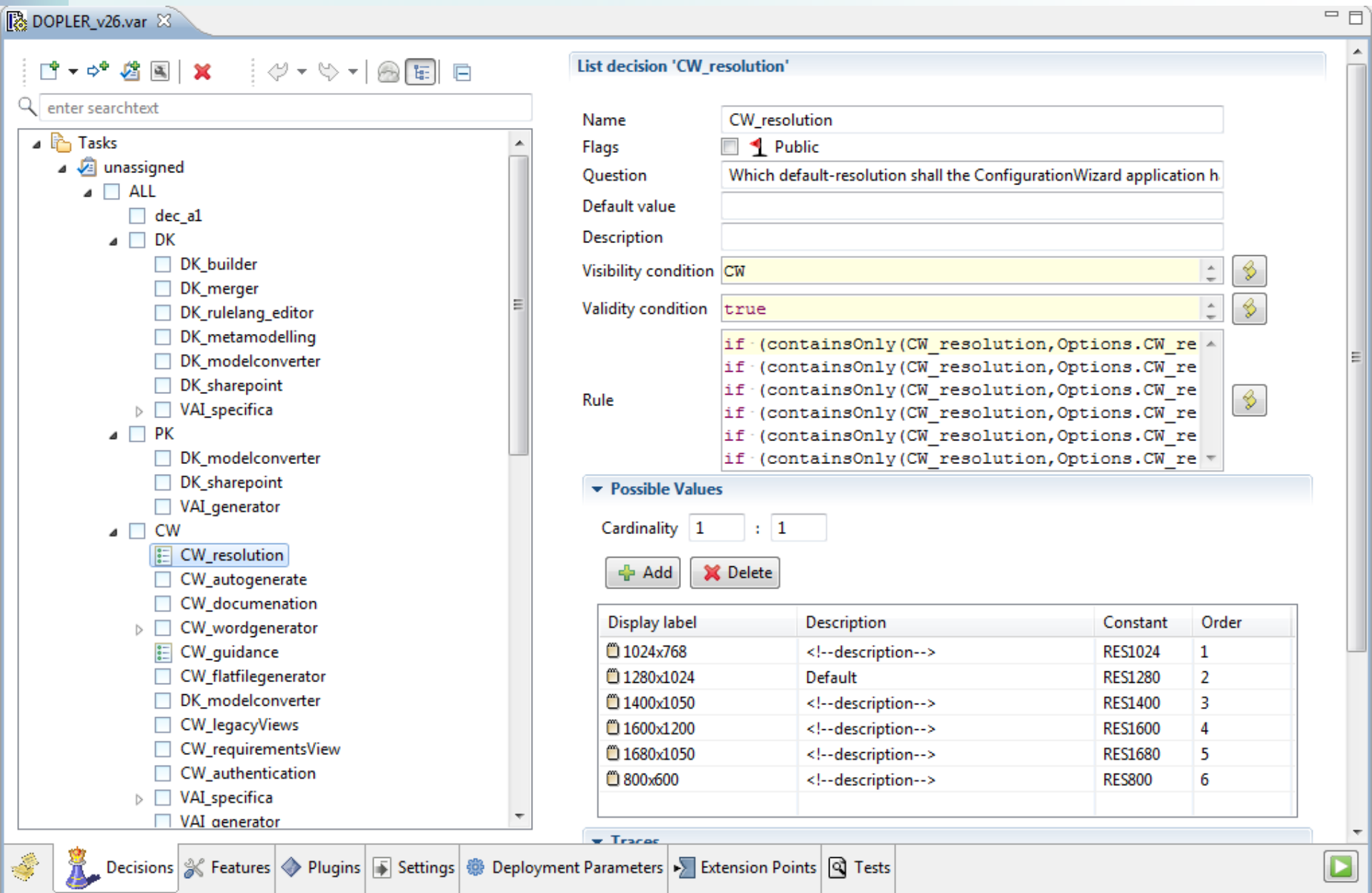

Variability Model Editor - Assets

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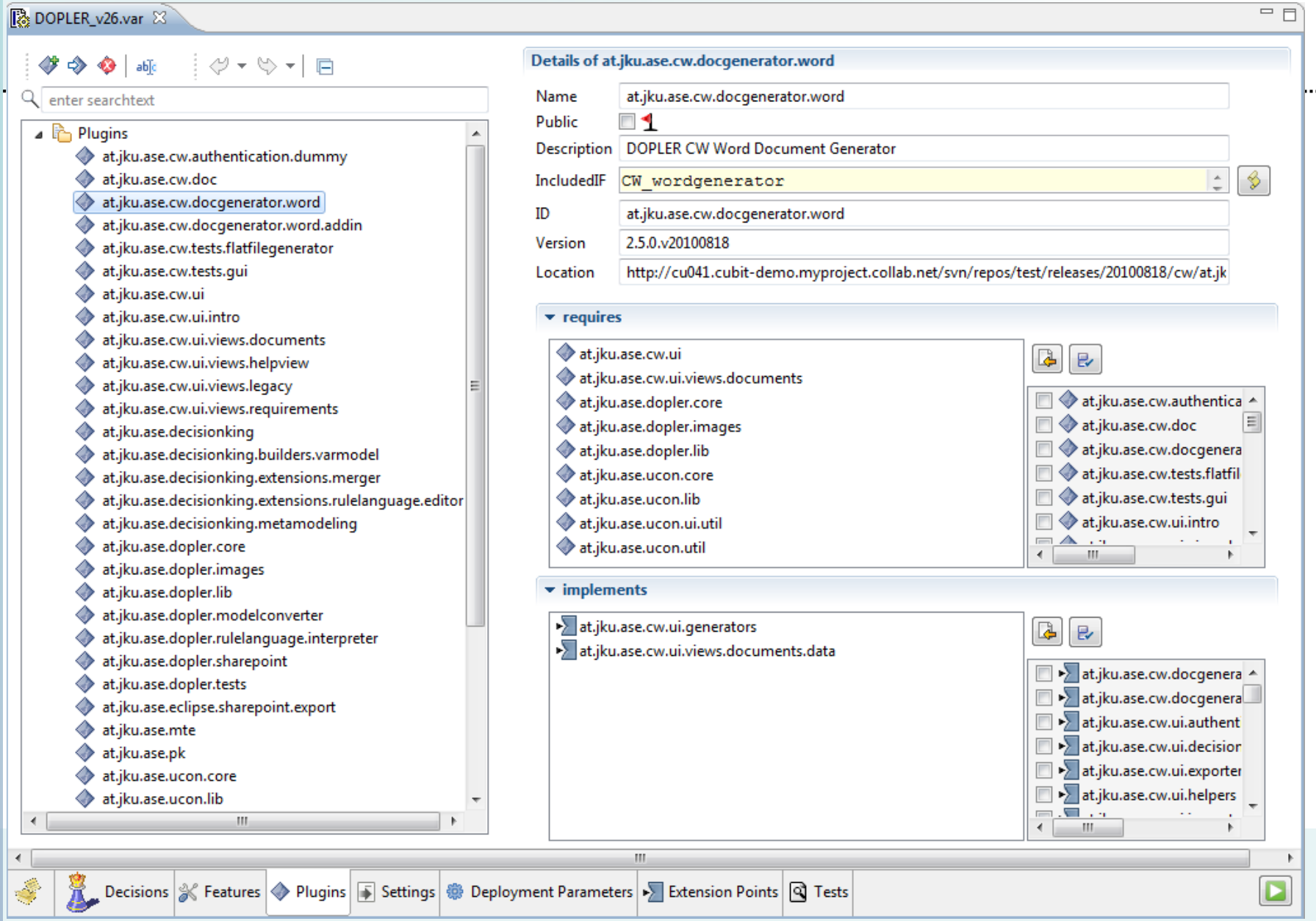
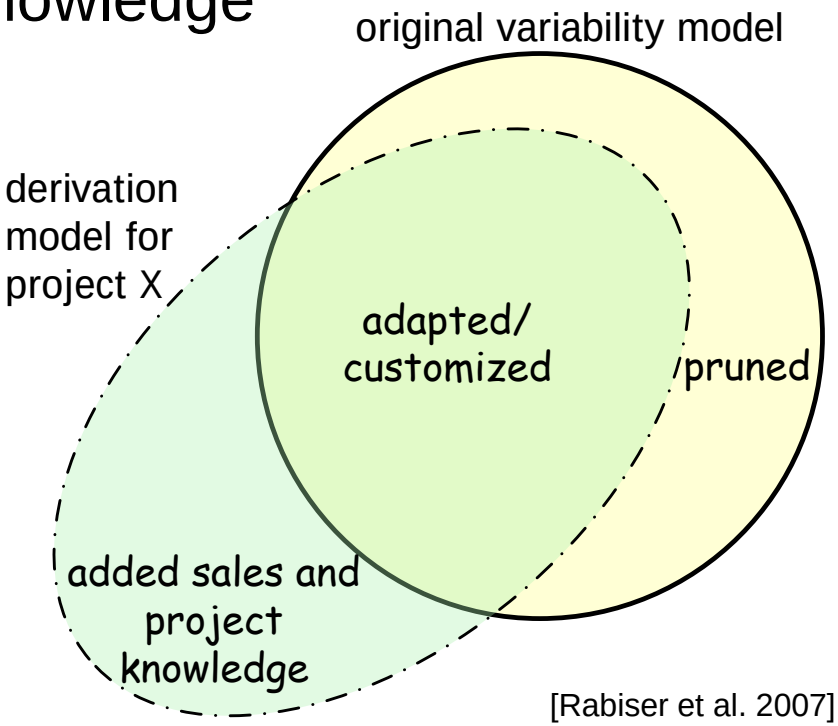


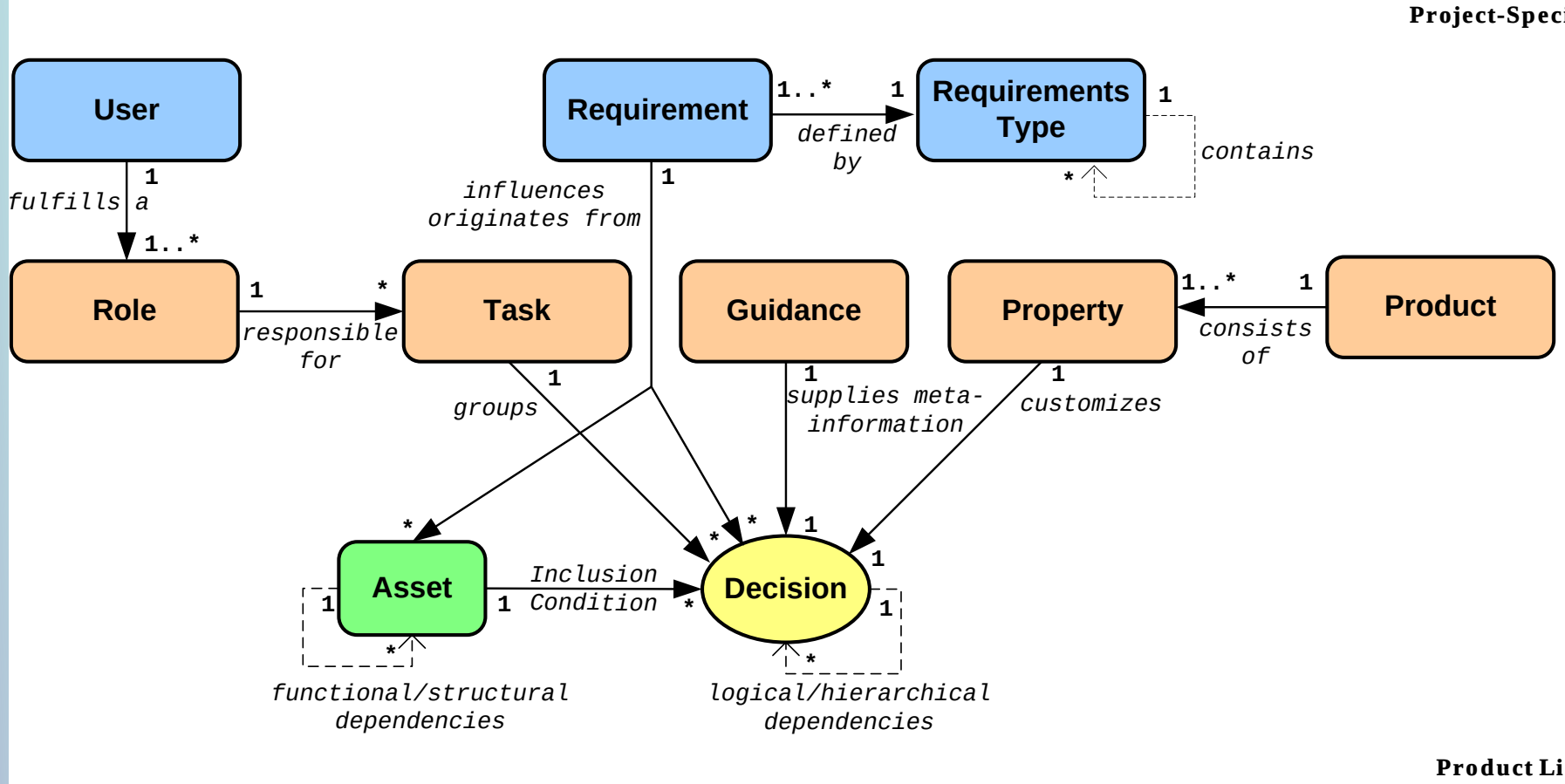
Product Derivation: The Concept of Derivation Models

- Prepare variability models for concrete projects
  - Identify irrelevant variability
  - Add project-specific/sales knowledge
- **Project-specific Derivation Model**
  - Adapted and augmented version of the original variability model
  - Tool-Support: ProjectKing

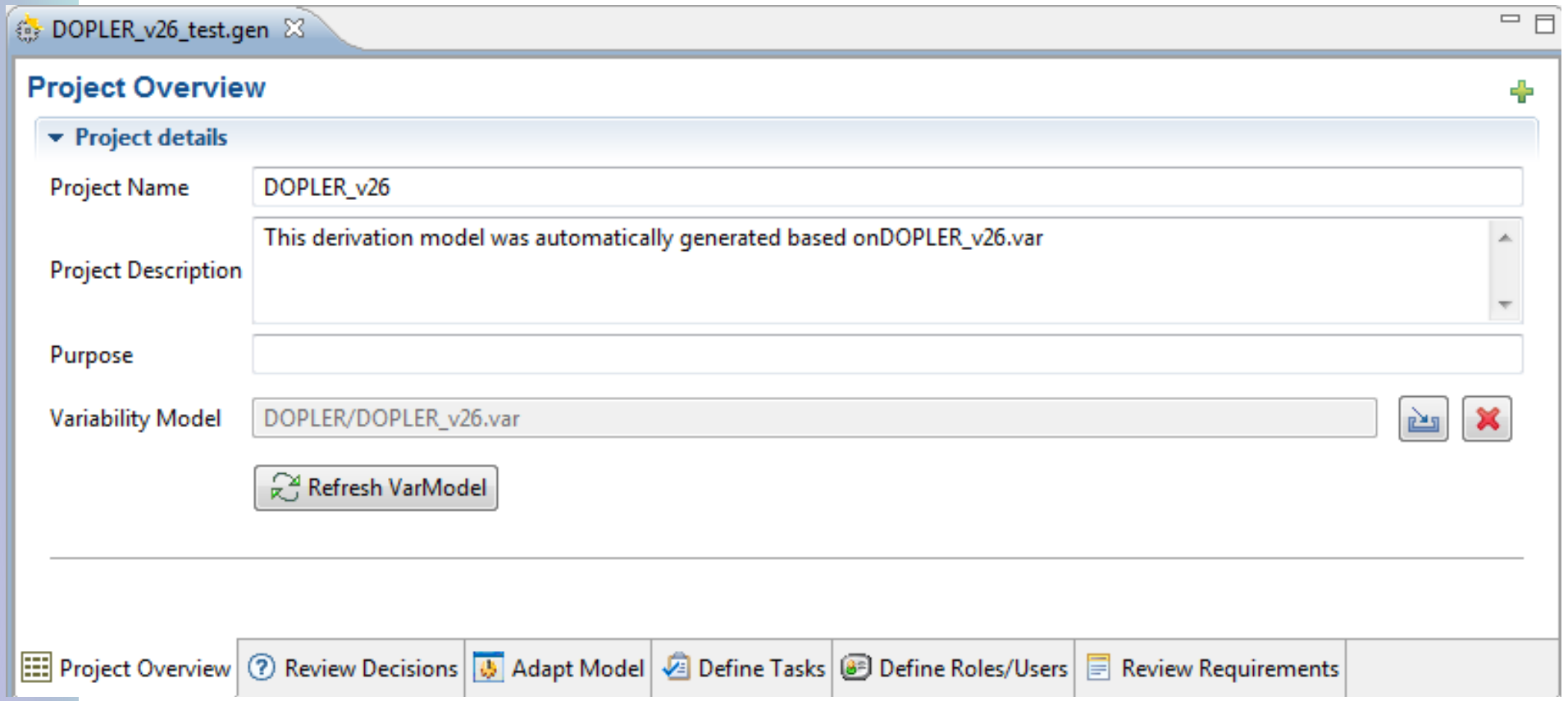


[Rabiser et al. 2007]

Derivation Meta-Model



ProjectKing: Derivation Model Editor



Product Derivation with ConfigurationWizard

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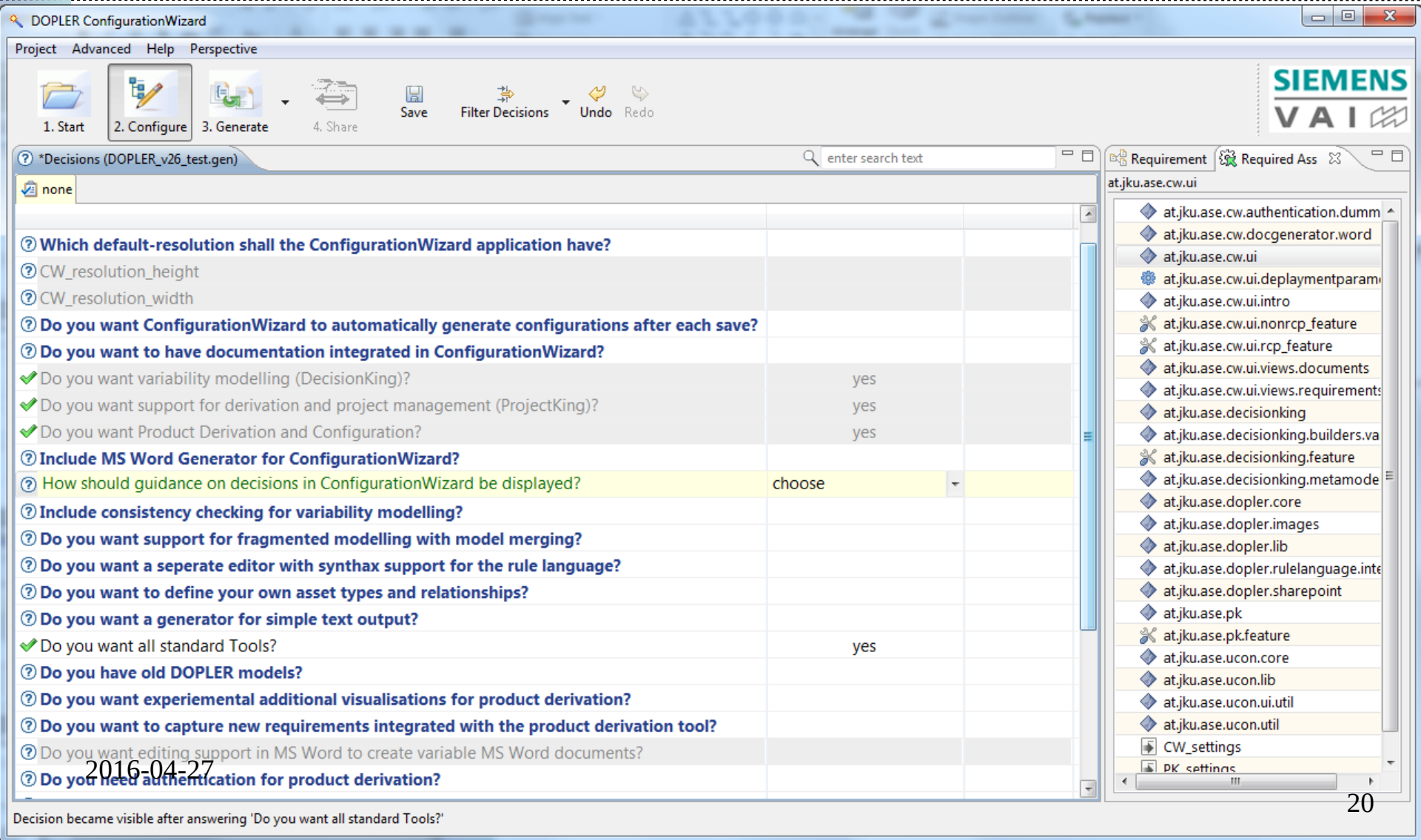

Application Reqs. Mgmt in ConfigurationWizard

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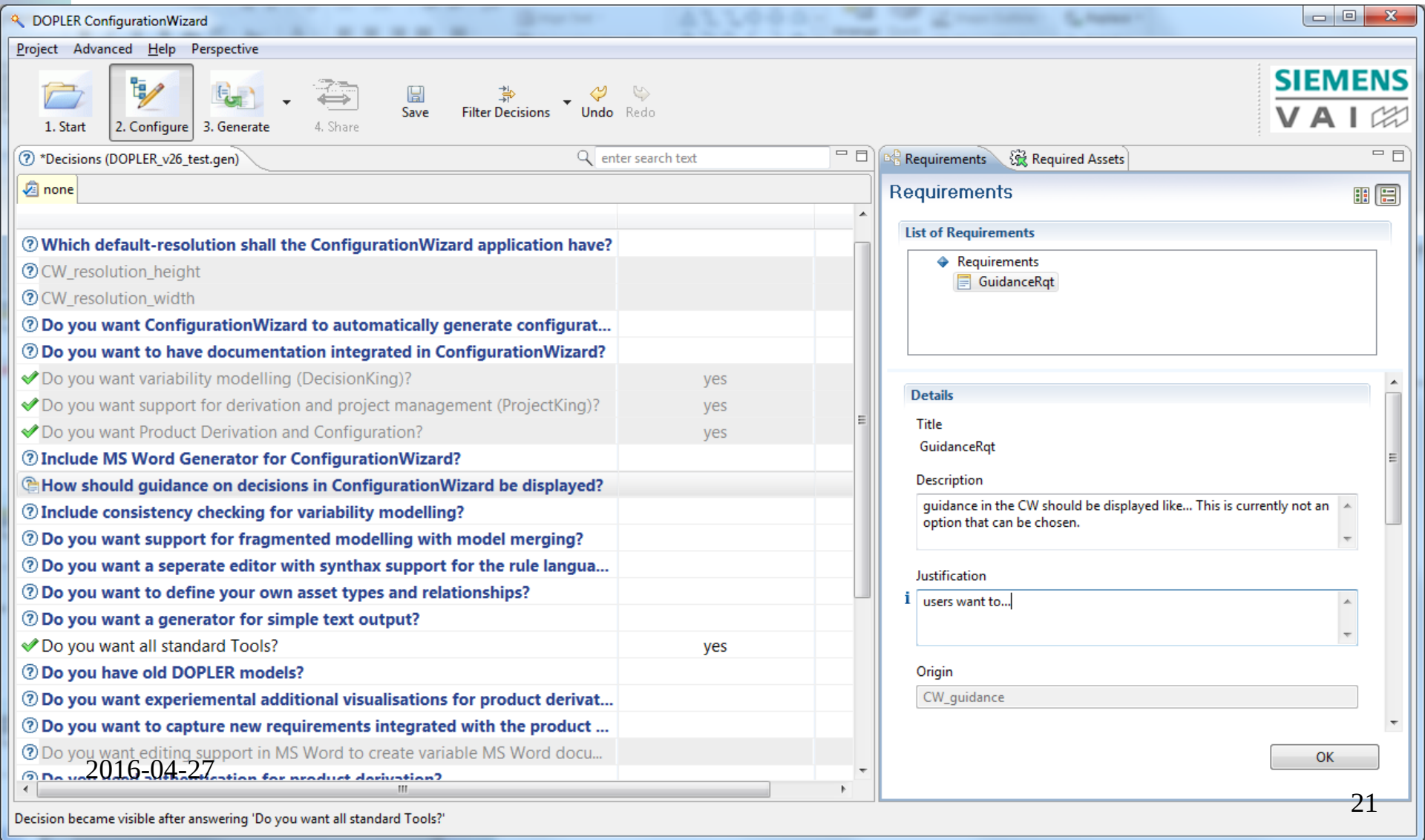
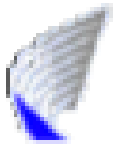


Kumbang Tools

SoberIT
Software Business and Engineering Institute

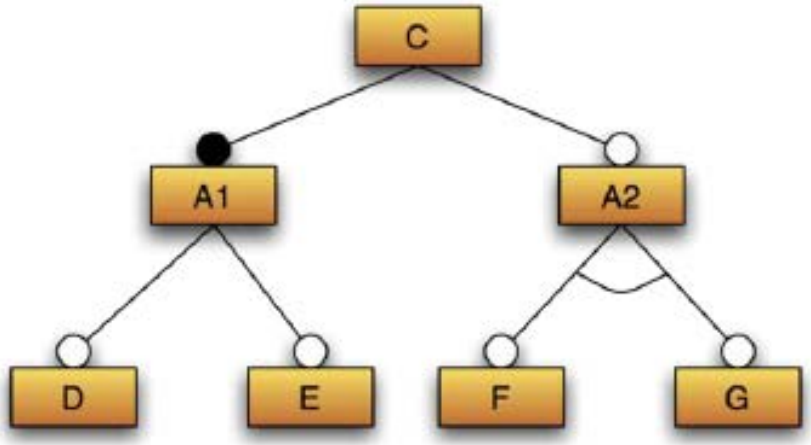


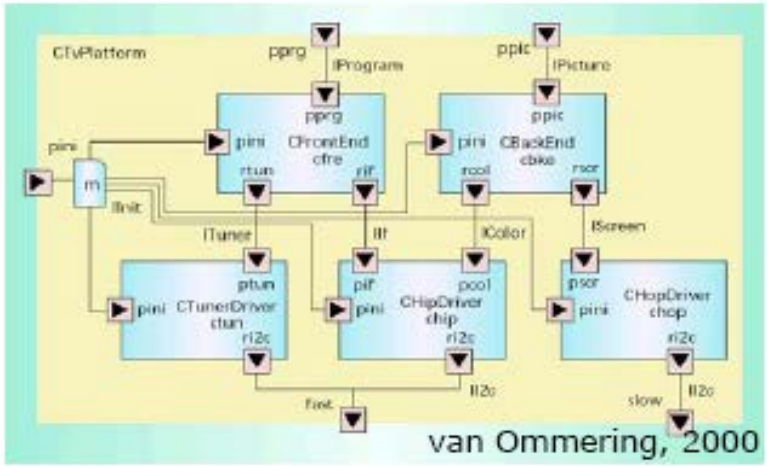
HELSINKI UNIVERSITY OF TECHNOLOGY

[Myllärniemi 2007]

Kumbang Tools

- Developed at Helsinki University of Technology, SoberIT
- Eclipse plug-ins, AI inference engine (smodels), GPL
- Basic Idea:
  - Combining feature modeling and structural modeling
  - Meta-Model called Kumbang





Kumbang Meta-Model

- Meta-model and language for configurable applications
- Modeling variability from two viewpoints adhering to IEEE 1471-2000 standard (Recommended Practice for Architecture Description of Software-Intensive Systems)
  - User-visible aspects: Feature Model
  - Structure of products in terms of components, interfaces, ports, etc.: Koala
  - Interrelations between FM/Koala
- Formal semantics by defining a mapping from the meta-model to Weight Constraint Rule Language

Kumbang Architecture Overview

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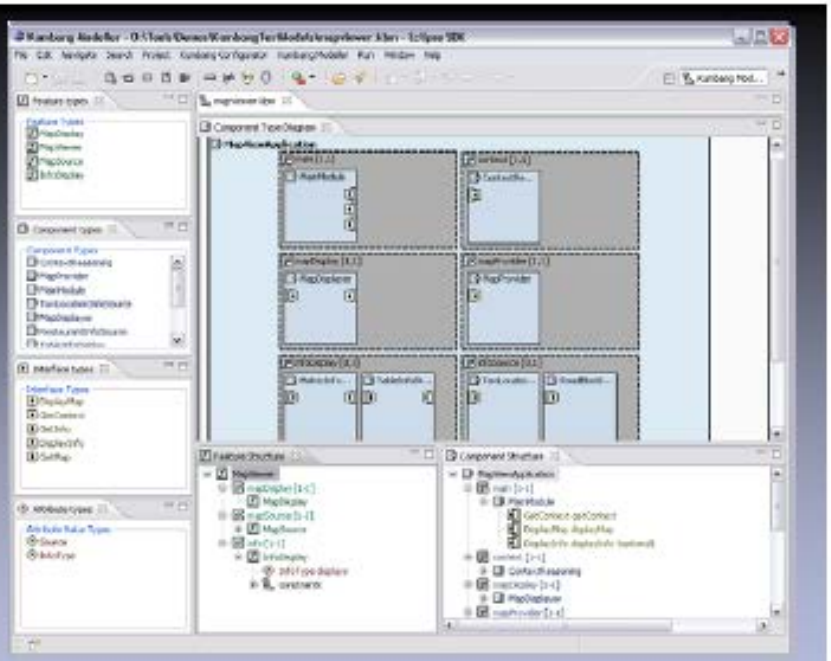
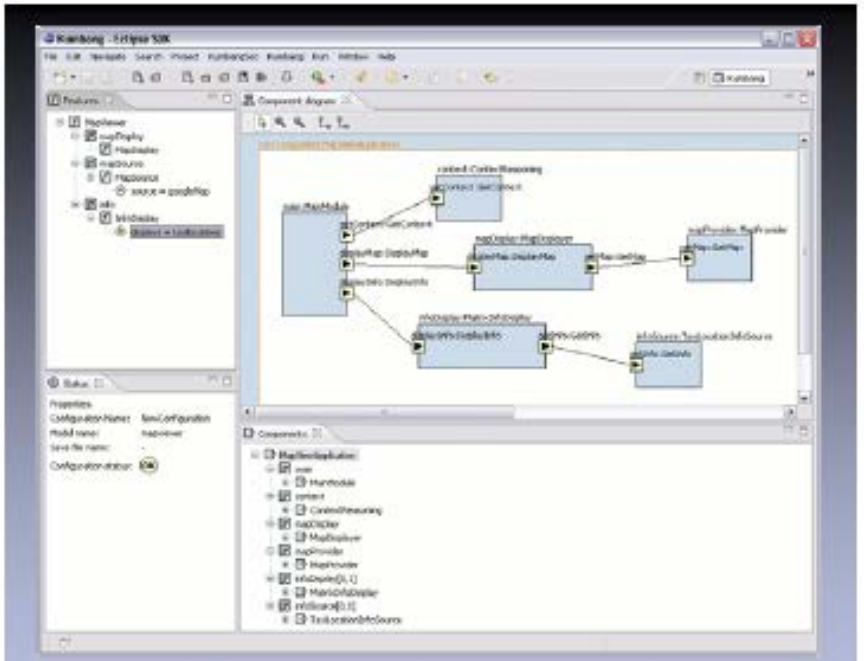
Types



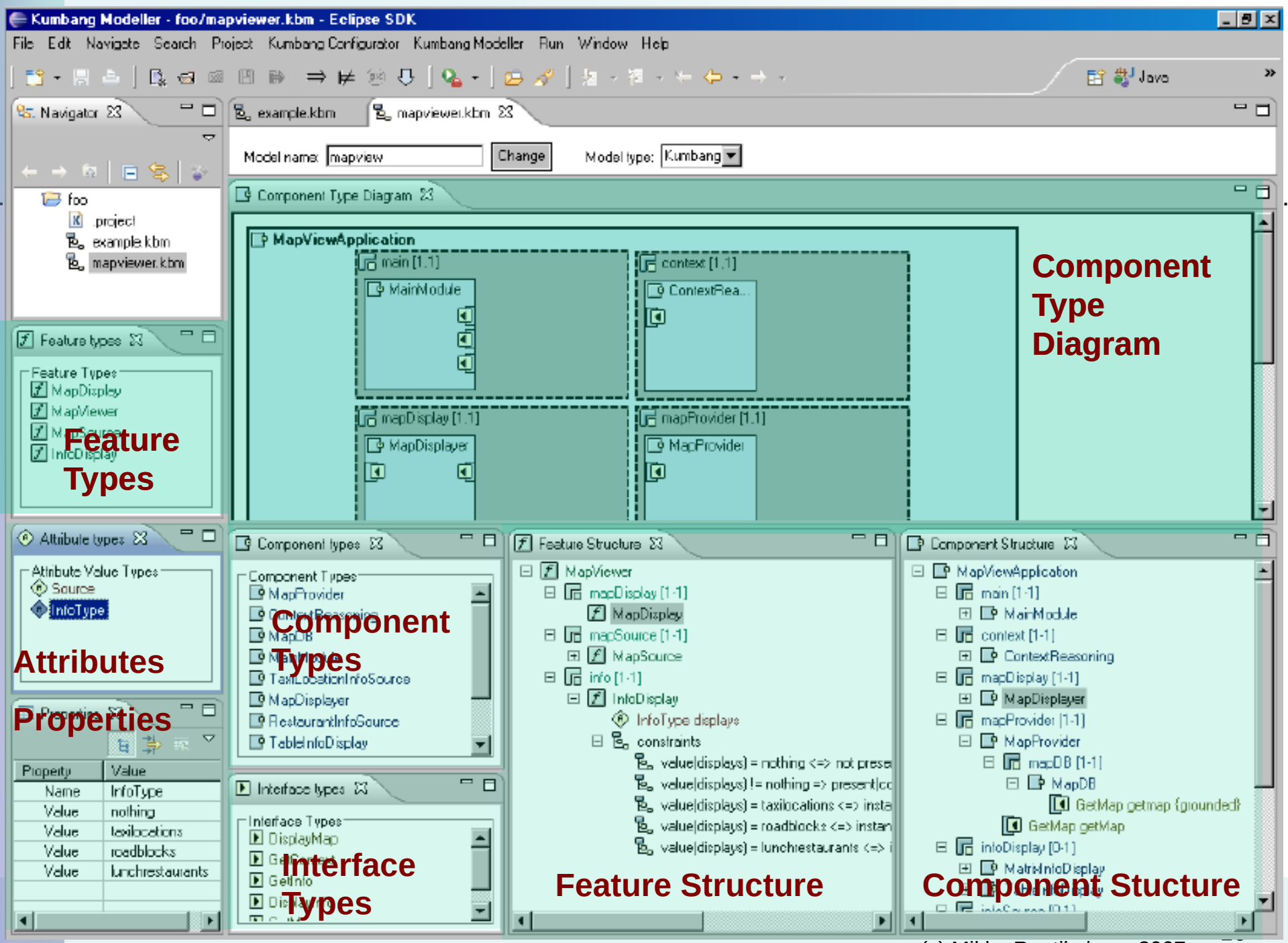
Domain engineering by Kumbang Modeller

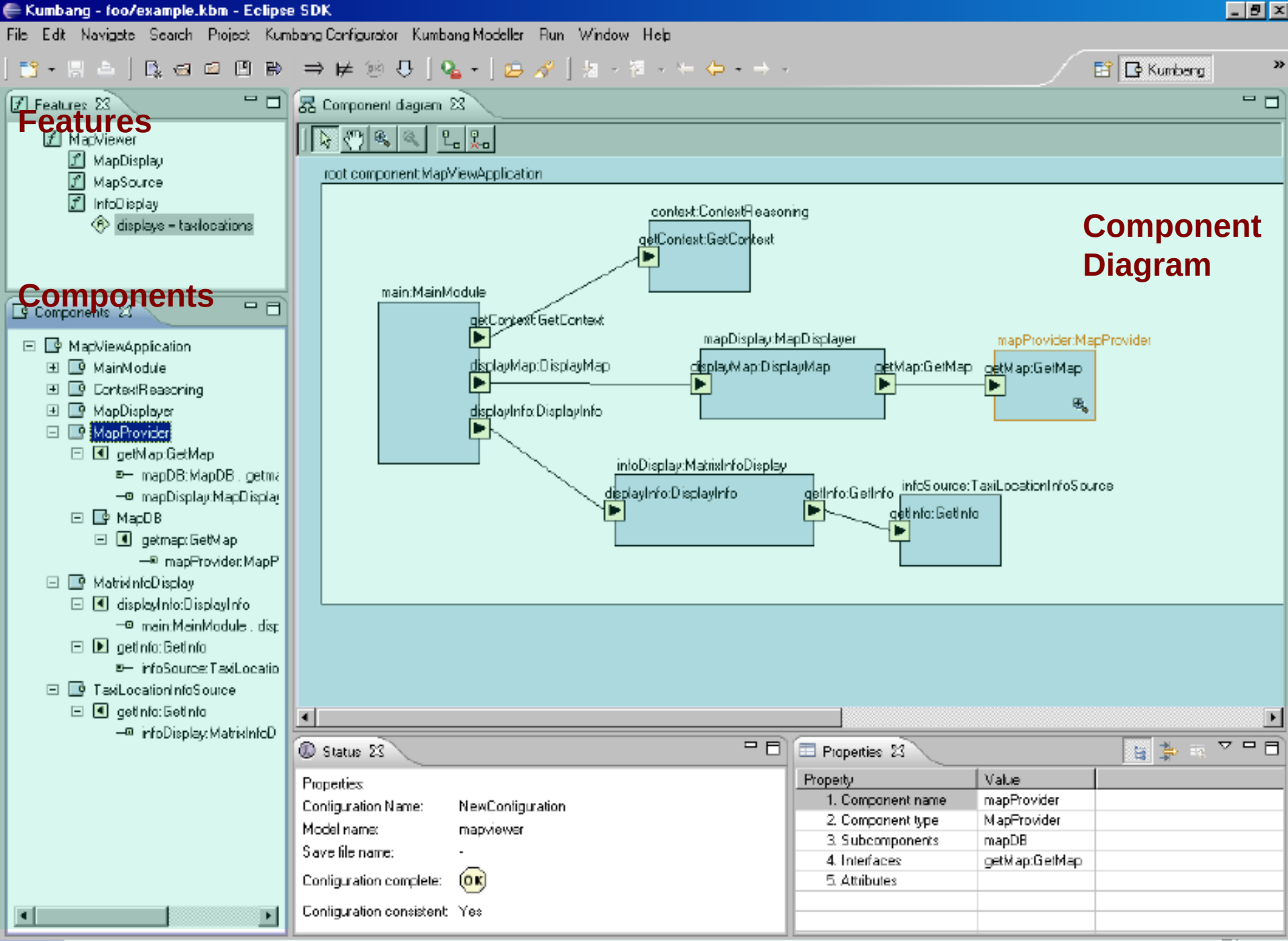
Instances



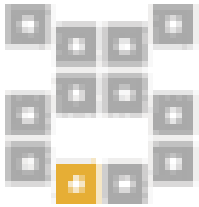
Application engineering by Kumbang Configurator

Kumbang Core
uses AI inference engine smodels





Pure::Variants



pure-systems

[pure systems GmbH]

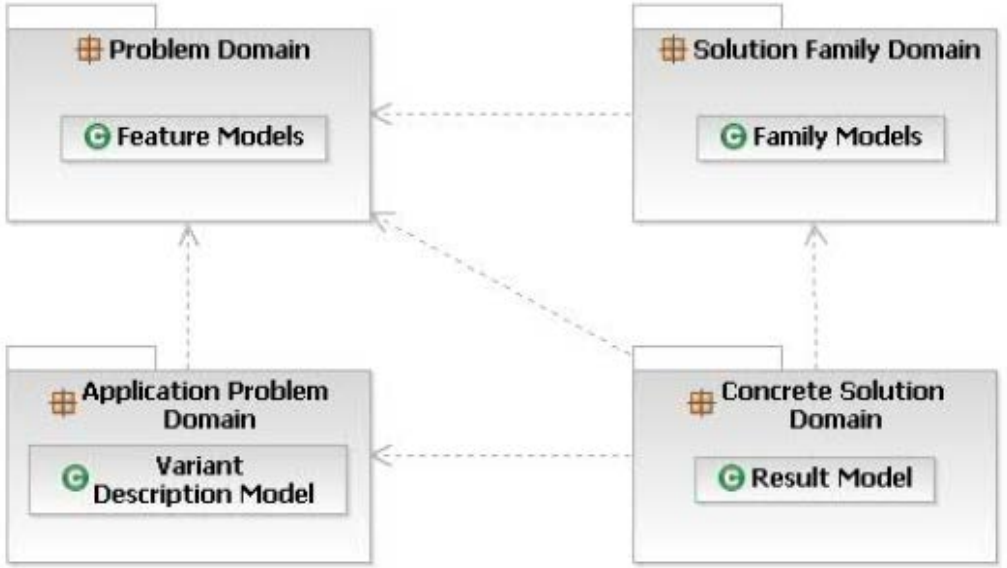
pure::variants

[pure systems GmbH]

- Developed by pure-systems GmbH/Magdeburg
- Commercial tool available in an evaluation, community, developer, integration, and server edition
- Variant management and product configuration based on feature models
- Uses a Prolog-based constraint-solver
- Strong focus on integration and extensibility
  - E.g., pv can be integrated in the Eclipse IDE, used with a webbrowser, in a custom application or as a command line client
  - Several extensions to other tools exist, e.g., to the requirements management tool DOORS or to the enterprise business tool SAP

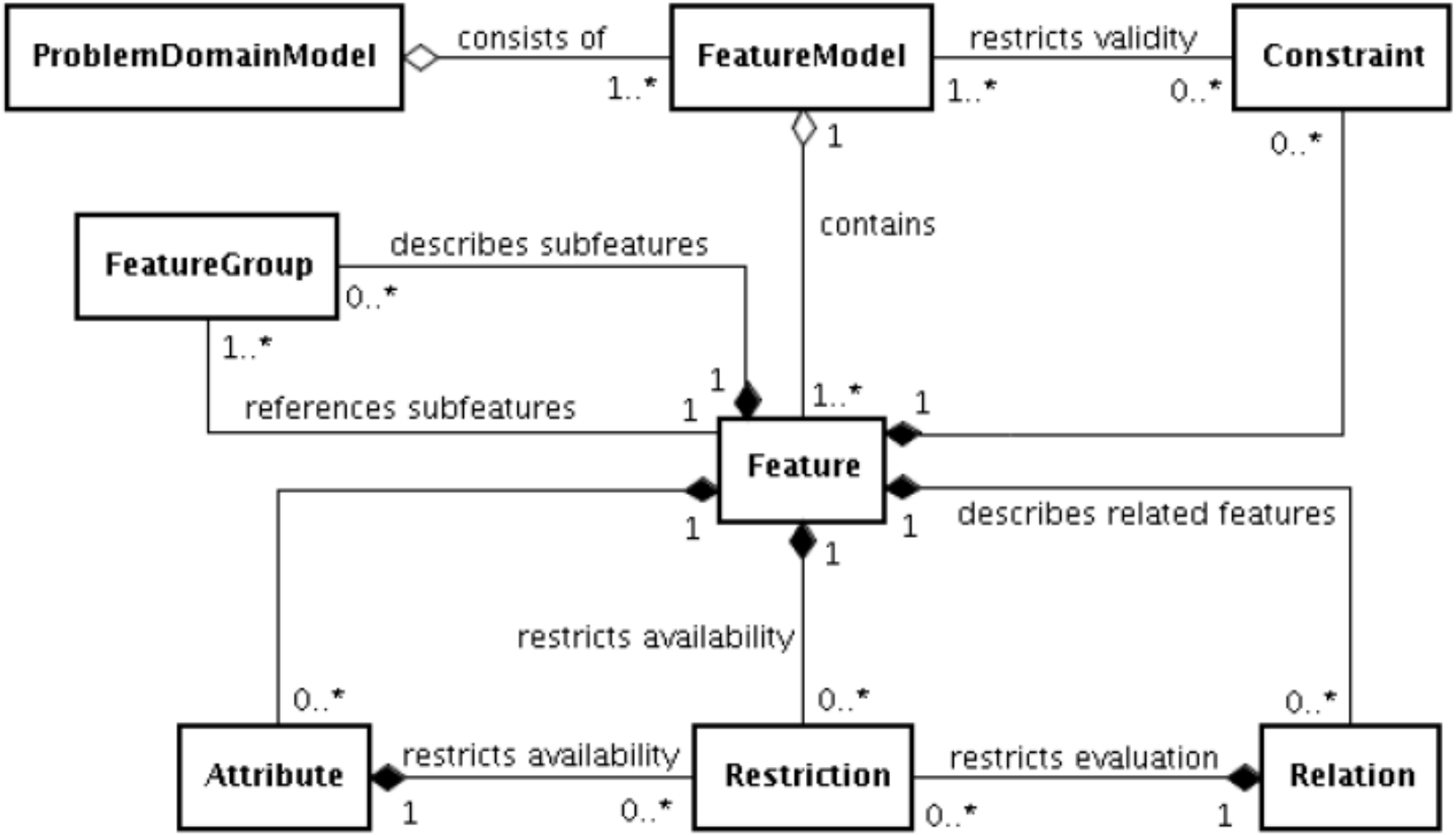
Family-based software development with pure::variants [pure systems GmbH]

- (Hierarchical) feature models to represent the problem domain
- Concrete design and implementation of the PL in family models
- Variant description model to store selected features and values
- Result model describes a concrete instance from the PL



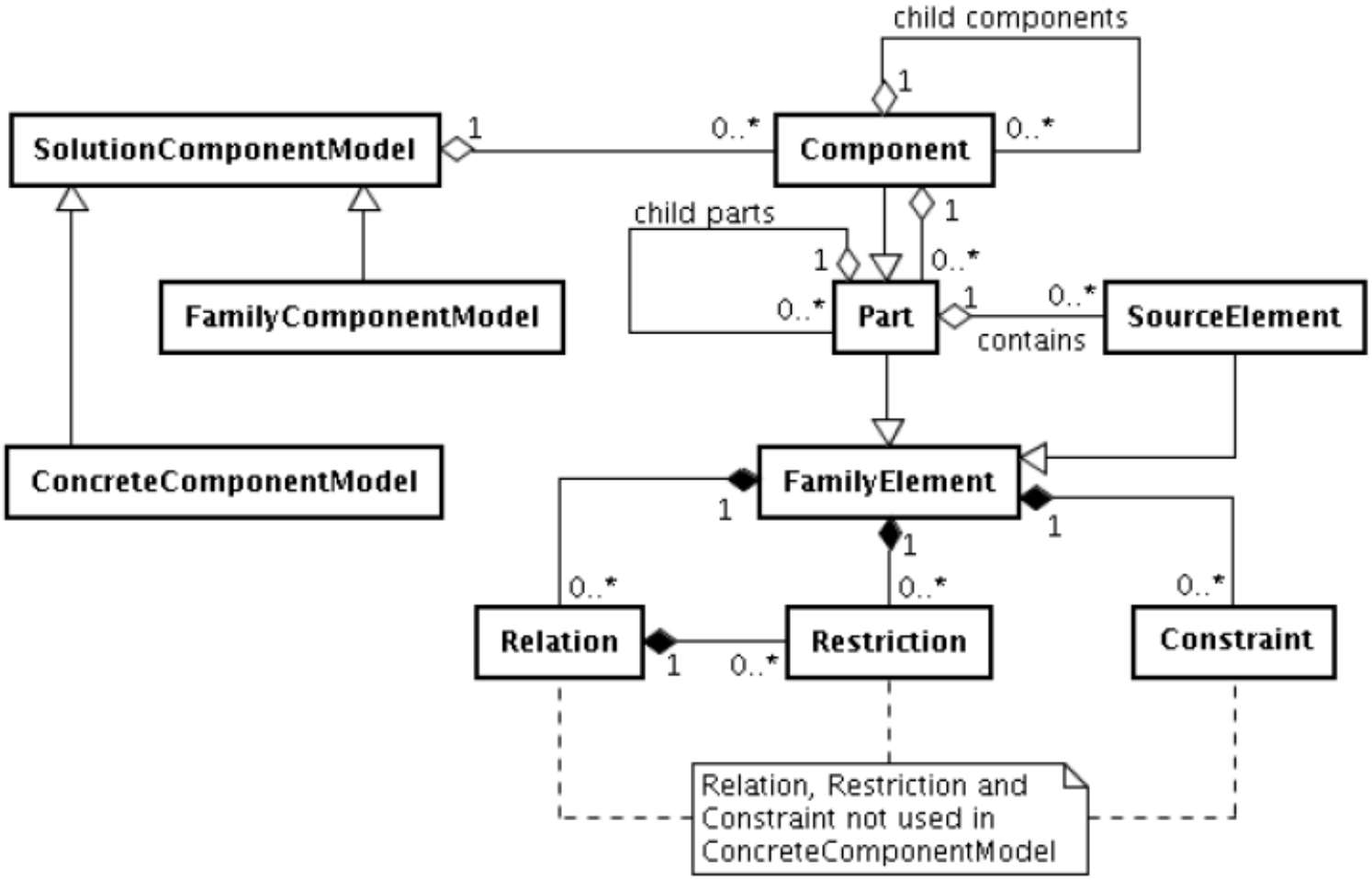
pure::variants feature models

[pure systems GmbH]



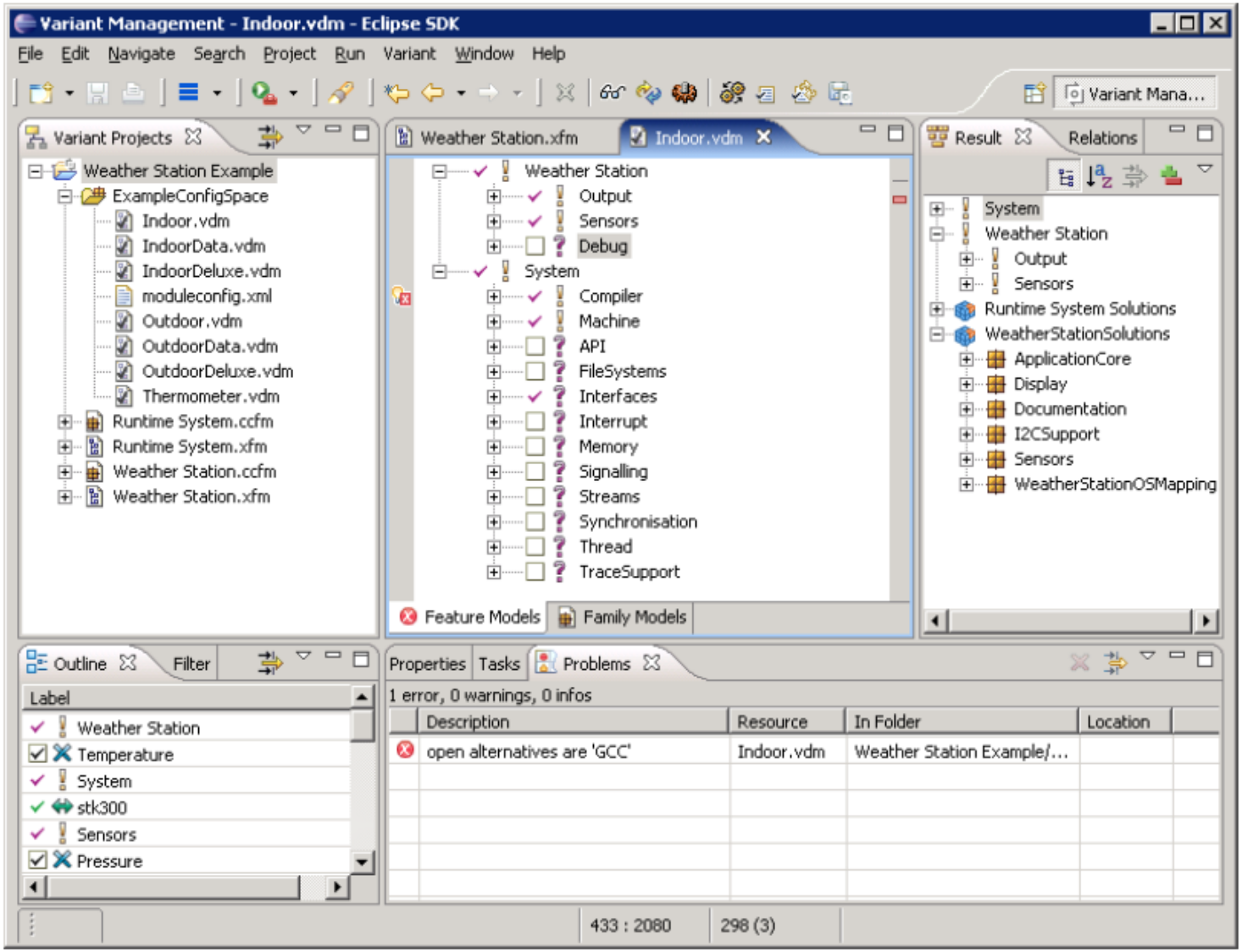
pure::variants family models

[pure systems GmbH]



pure::variants tool screenshot

[pure systems GmbH]



pure::variants and constraints

[pure systems GmbH]

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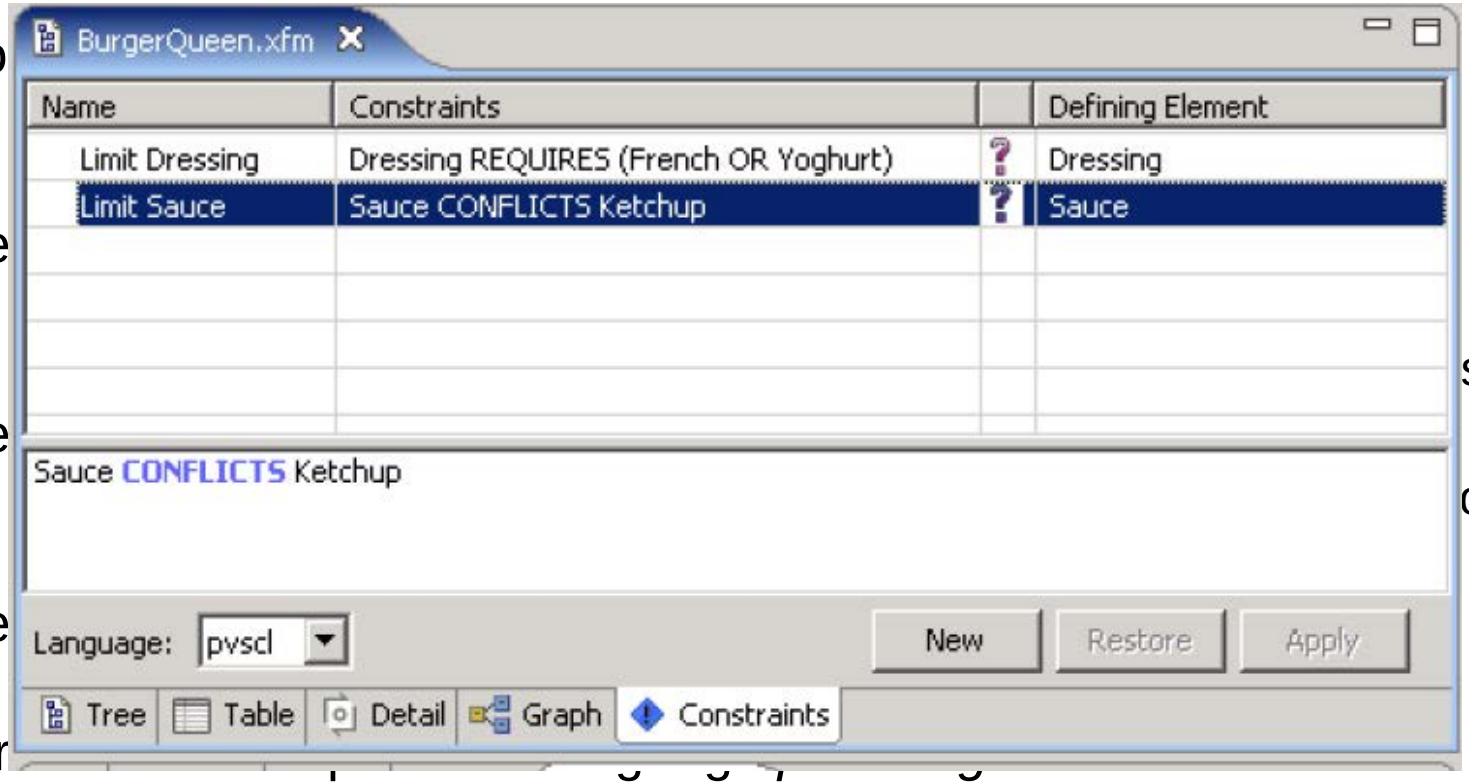
  - Dialect of Prolog
  - Grammar and available rules, see: http://www.pure-systems.com/fileadmin/downloads/pure-variants/doc/pv-user-manual.pdf



Pure::Variants Screencast

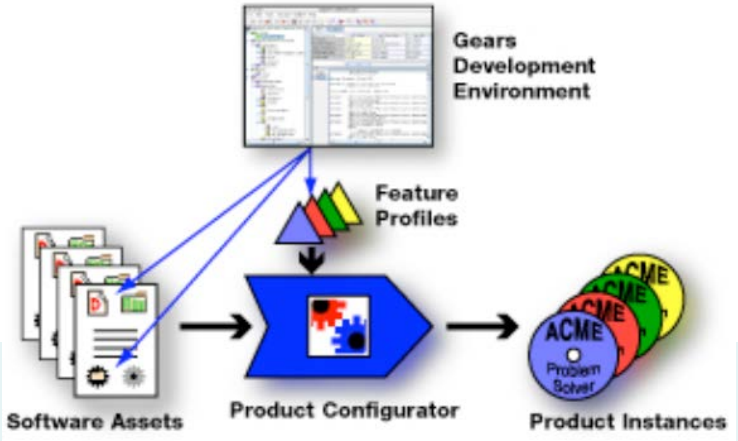
- 10min tutorial
  - http://www.pure-systems.com/flash/pv-spl-10min/flash.html

Gears

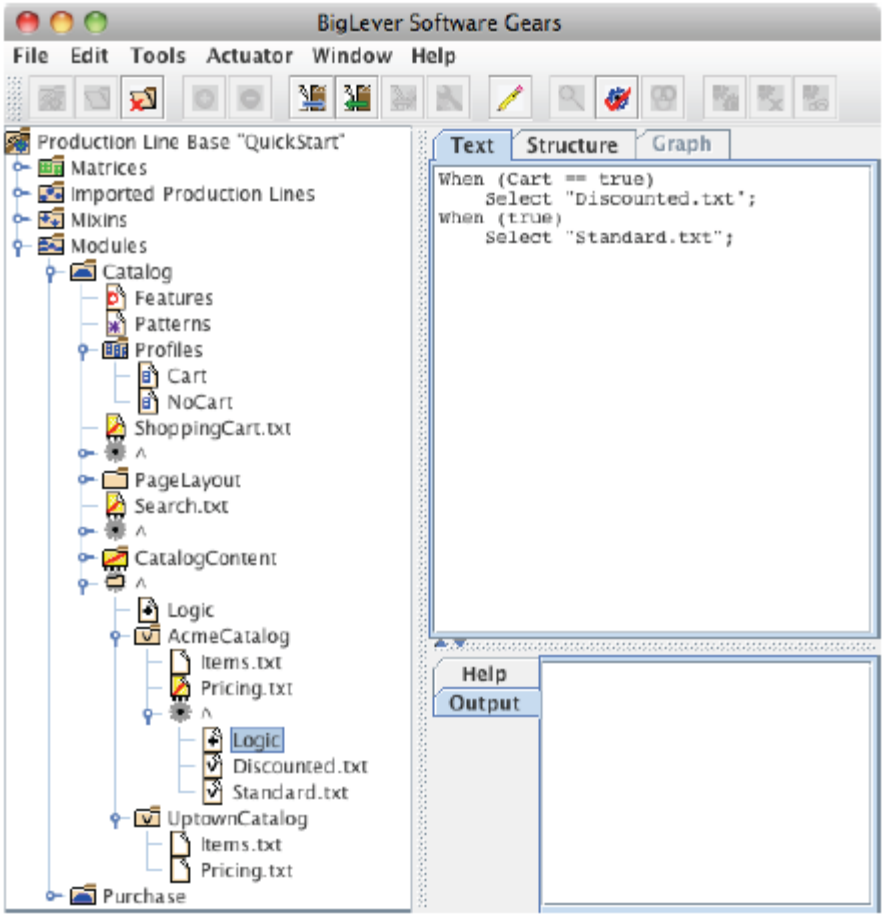
(c) BigLever, Inc.

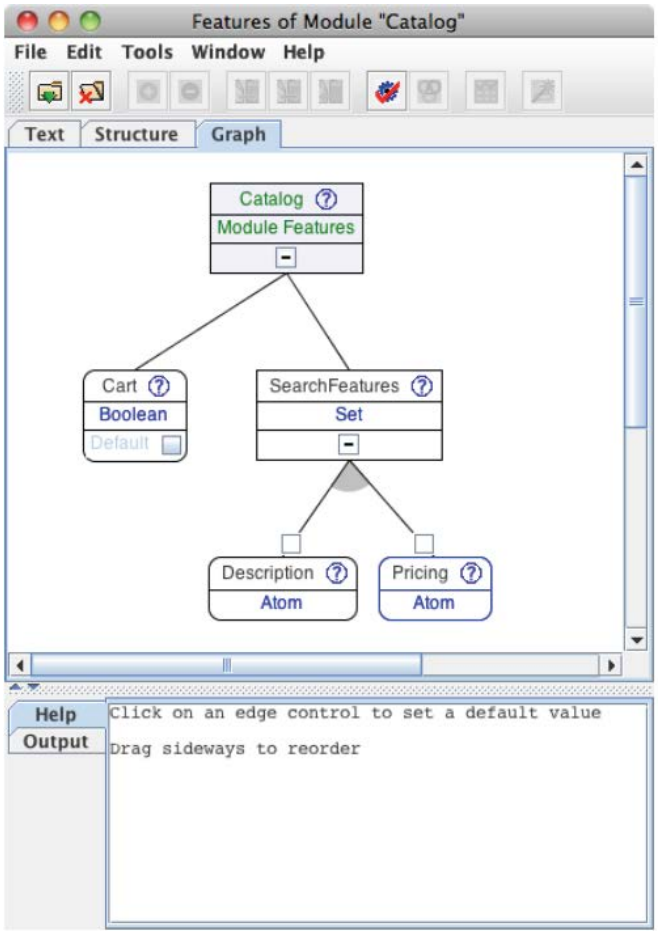
Basic Concepts of Gears

- 3 key elements:
  - Software Assets: the configurable software artifacts
  - Feature Profiles: model each product in terms of optional and varying feature choices for the PL
  - Product Configurator: assembles and configures the software assets, guided by the product feature profiles, to produce each of the product instances



Gears Development Environment





Feature Profile Graph Editor

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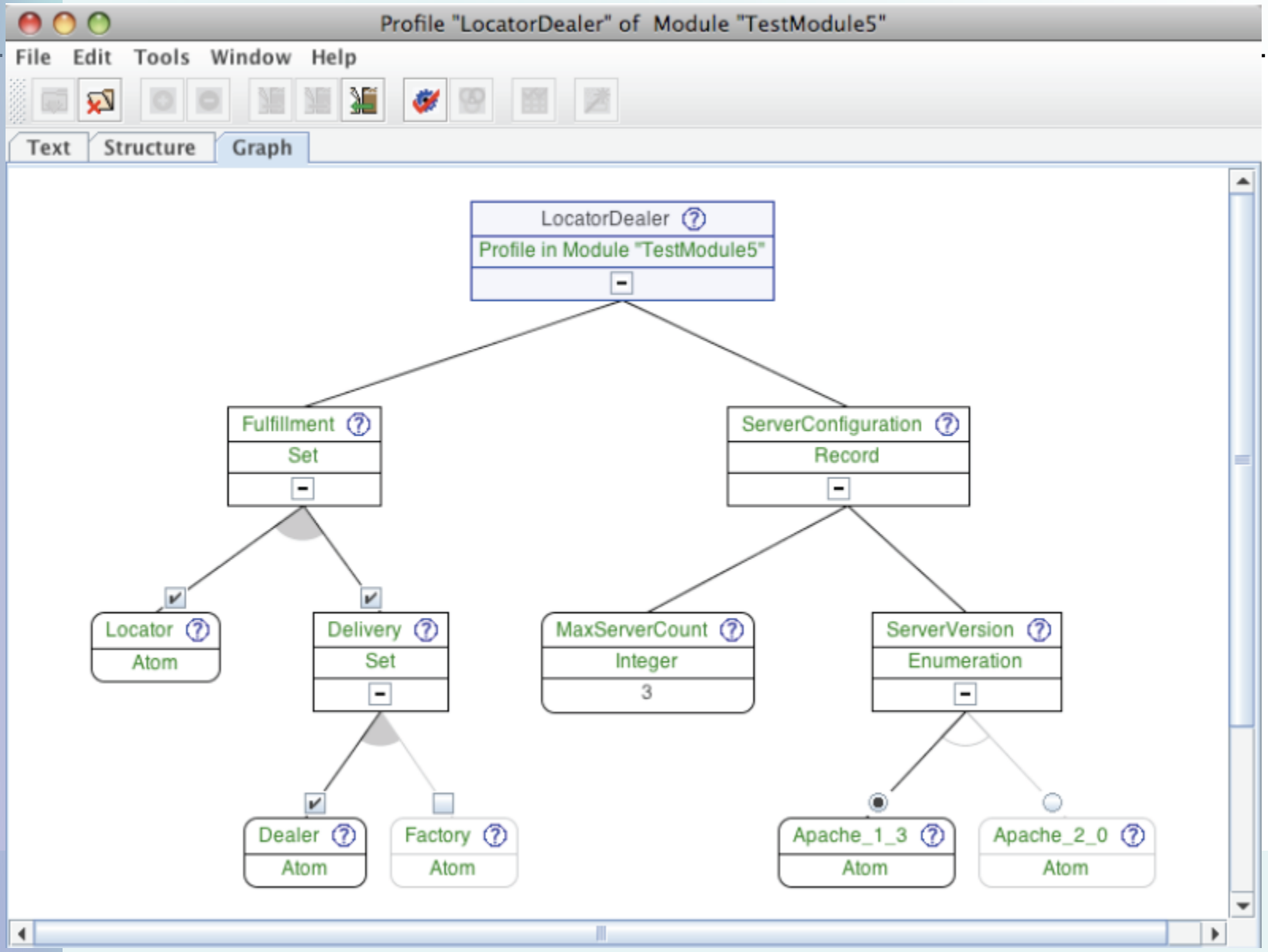


FeatureIDE

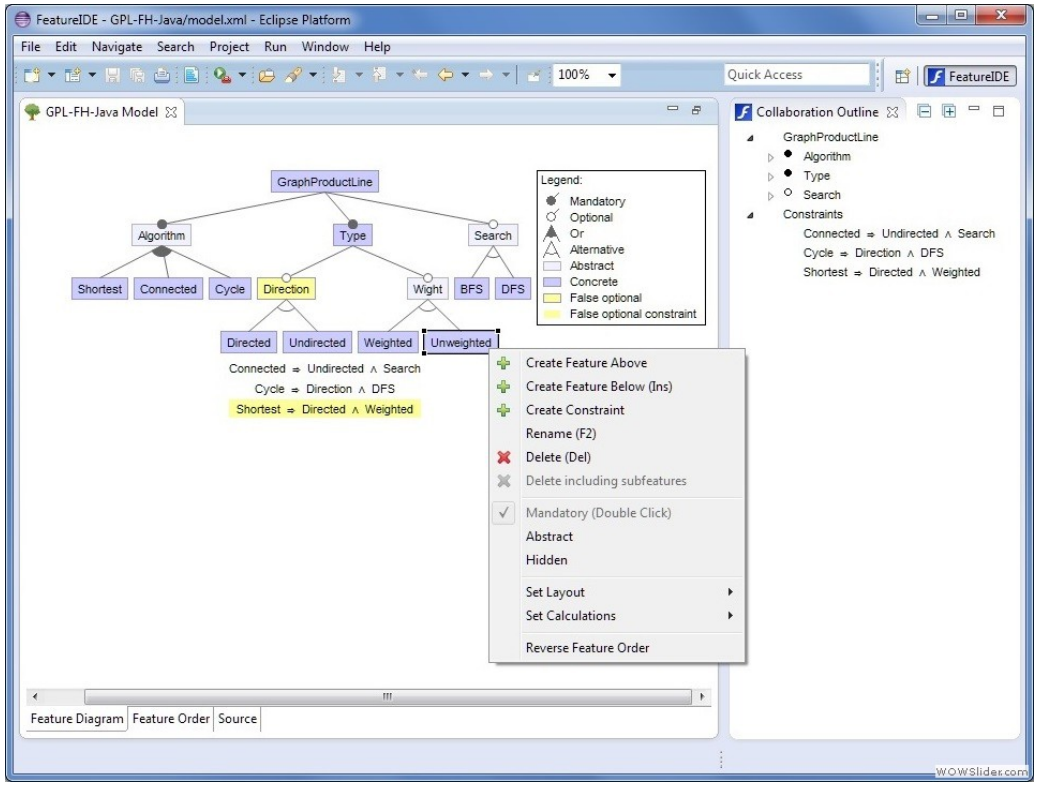
(c) BigLever, Inc.

Feature IDE

- Eclipse plug-in for Feature-Oriented Software Development
- supports all phases of FOSD
  - domain analysis, domain implementation, requirements analysis, and software generation
- implementation techniques integrated
  - feature-oriented programming (FOP), aspect-oriented programming (AOP), delta-oriented programming (DOP), and preprocessors
- provides tool support for AHEAD, FeatureC++, FeatureHouse, AspectJ, DeltaJ, Munge, and Antenna

Tool Demo of the Feature IDE

- You will get a demo during the invited talk by Dipl.-Ing. Daniela Rabiser



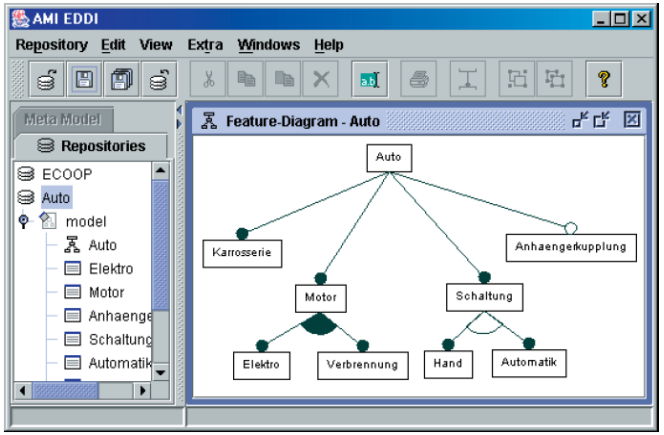
Other SPL Tools

(sorted alphabetically; only a selection, there are more!)

- **AmiEddi/Captain Feature**
- **COVAMOF-VS**
- **Feature Modeling Plug-in (FMP)**
- **FeatureIDE**
- **V-Manage**
- **VARMOD**

AmiEddi/Captain Feature

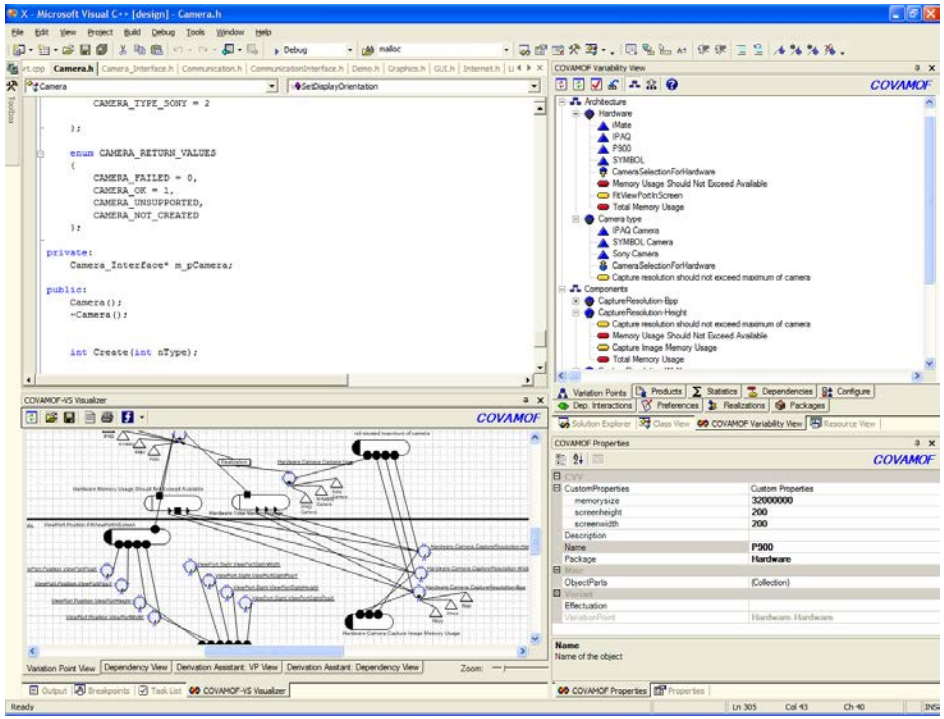
- Developed at Fachhochschule Kaiserslautern
- Implemented in Java/Swing
- Supporting the feature modeling notation by Czarnecki and Eisenecker
- Successor of AmiEddi and implements a cardinality-based notation



- https://sourceforge.net/projects/captainfeature/
- *Last Update: 2013-03-22*

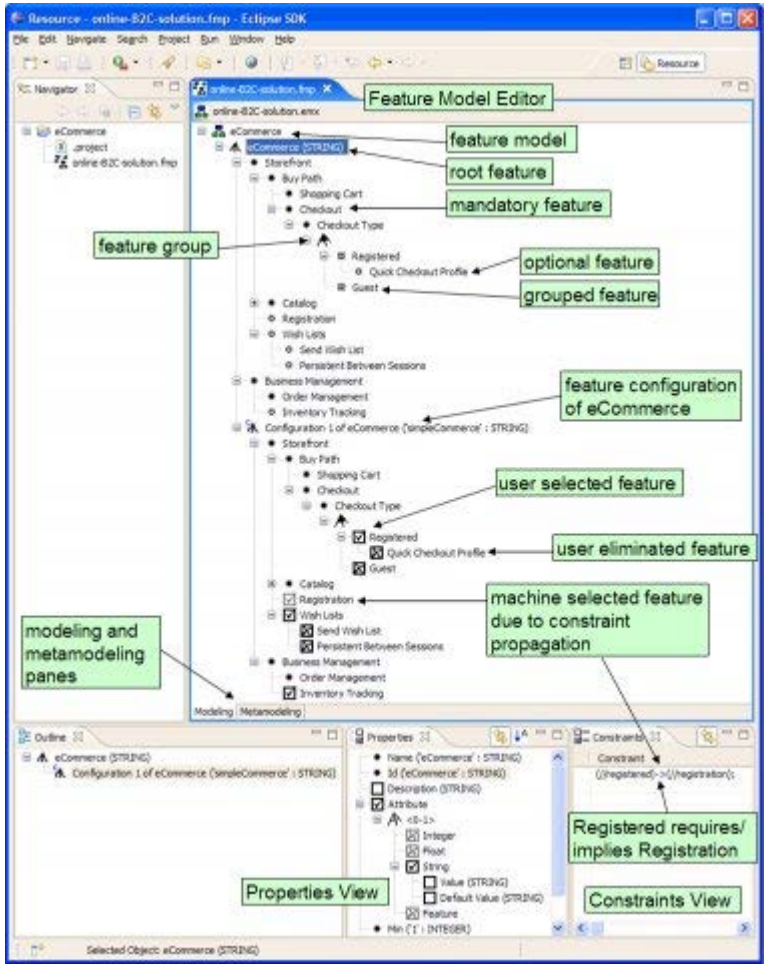
COVAMOF-VS

- Developed at University of Groningen
- Implemented in Microsoft Visual Studio .NET 2003/.NET Framework 1.1/C#
- Supporting the COVAMOF Methodology/Variability Modeling framework
- Variation points and dependencies are modeled over different abstraction levels
- e.g., XML-based feature models, parameter settings, C++/C# source files
- No longer available
- Part of a book: http://dx.doi.org/10.1007/978-3-642-36583-6



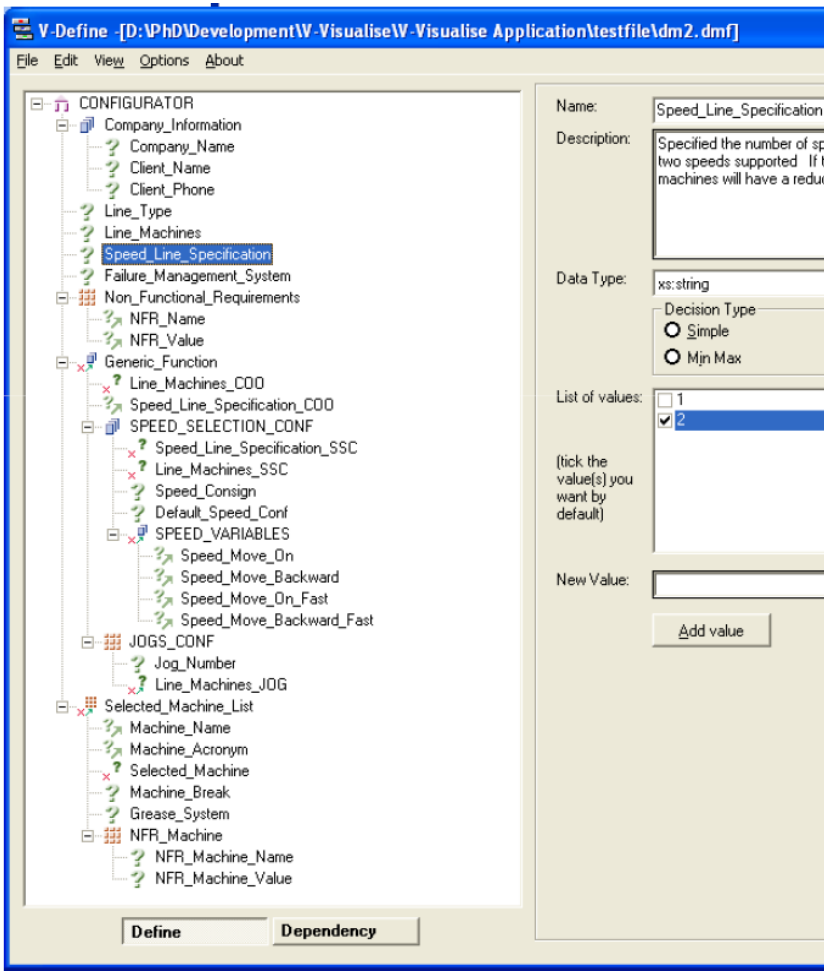
Feature Modeling Plug-in (FMP)

- Developed at University of Waterloo
- Implemented in Java/Eclipse/SWT
- Supports cardinality-based feature modeling as proposed by Czarnecki et al. and configuration based on feature diagrams
- https://sourceforge.net/projects/fmp
- *Last Update: 2013-04-03*



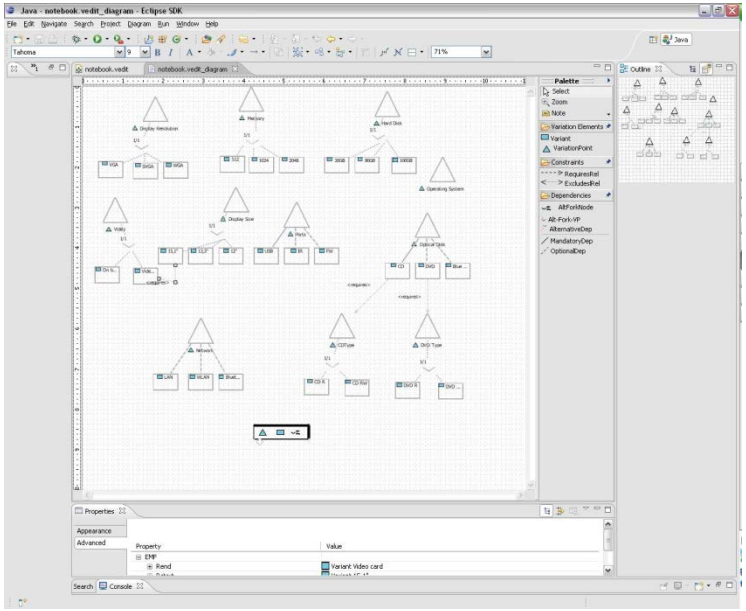
V-Manage Toolset

- Developed at the European Software Insitute (ESI)
- Implemented in Visual Basic(.NET)
- Decision-oriented modeling approach
- V-Define to create decision models
- V-Implement to define variation points in components/component descriptions
- V-Resolve to take decisions
- *No longer active/available*



VARMOD

- Developed at University of Duisburg Essen (Software Systems Engineering Institute)
- Implemented in Java/Eclipse
- Supports Orthogonal Variability Modeling as proposed by Pohl et al.
- Replaced by https://sse.uni-due.de/remidemmi in 2014
- *Last update: 2014-06-18*



Further tools

- Also check:
  - http://www.splot-research.org/ -- live demo now
  - http://fosd.de/

Conclusion

- SPL tool support is an absolute necessity
- Several SPL tools already exist
  - Few commercial and many research tools
  - All have their benefits and drawbacks
- Most tools are not stable/adaptable/interoparable/ scalable enough to be usable in industry/practice
- Most tools focus on product line modeling and do not provide (or provide only little) support for the product derivation/application engineering process
- Empirical data on the usefulness of existing tools is rare
  - You have to try out every tool to find out if it is really useful for your purpose/domain

Next Week (4.5.)

- No Lecture (Landespatron)
- Next lecture: 11.5. PL Testing (RL)

Used/Useful References

- [Bruckhaus et al. 1996]

  T. Bruckhaus, N. H. Madhavji , I. Janssen, and J. Henshaw, "The Impact of Tools on Software Productivity," *IEEE Software*, vol. 13, pp. 29-38, 1996.

- [Nielsen 1994]

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