Software product lines, feature modelling, analysis and configuration

David Benavides
benavides@us.es
Evolución y Gestión de la Configuración

The main goal of this lesson is to give an overview of “software product lines” from a practical and research point of view

SPL

FM

AAFM

FOP

An important topic at the University of Sevilla

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Un trabajo de la US elegido como el artículo más influyente en el área de Ingeniería de Líneas de Producto Software

admin 6 octubre, 2017 Actualidad, Ingeniería-Arquitectura

Un trabajo de investigación del grupo ISA de la Universidad de Sevilla ha sido distinguido como el artículo más influyente en el área de Ingeniería de Líneas de Producto Software (*MIP, Most Influential Paper Award*). Dicho galardón fue concedido durante la 21ª edición de la conferencia internacional de dicha

Premio Nacional SISTEDES a la Mejor Tesis Doctoral

Sistedes

Premio Nacional a la mejor *Tesis Doctoral*

"Evolution, testing and configuration of variability intensive systems"

D. José Ángel Galindo Duarte

Tenerife, Julio 2017

D. Antonio Vallecillo
Presidente de SISTEDES

pure-systems VAMOS 2020 METOP

The 14th Working Conference on Variability Management for Software-Intensive Systems
Magdeburg, February 5-7, 2020

MOST INFLUENTIAL PAPER AWARD

This Certificate is awarded to

David Benavides, Sergio Segura, Pablo Trinidad, Antonio Ruiz Cortés
FAMA: Tooling a Framework for the Automated Analysis of Feature Model
in VaMoS 2007, p. 129 – 134

Mathieu Acher, Program Chair

Maxime Cordy, Program Chair

2017 Software Product Lines Most Influential Paper Award

David Benavides, Pablo Trinidad Martín-Arroyo, Antonio Ruiz Cortés

Automated Reasoning on Feature Models

In CAISE 2005 (pp. 491-503). LNCS 3520, Springer, 2005.

This is the first paper that brought together attribute grammars, constraint solvers, feature models, and optimizations of SPL configurations into a coherent and elegant framework. It opened the door to what has become a trending topic in recent years, namely the automated analysis of feature models.

This paper has influenced different areas of SPL engineering, specifically in variability modeling and analyzing feature models with attributes and logics. Among the specific examples this paper has contributed to the progress of SPL research in the last decade are: (i) it helped to explain feature model analysis for feature model quality assurance, error checking and repairing; (ii) in feature model analysis it contributed to selecting a set of products for testing coverage among all the potential combinations; (iii) it facilitated the reverse engineering of feature models to obtain a feature model from product descriptions; (iv) it promoted software product line evolution approaches to ensure consistency; (v) it impacted on work on product configuration, selection and optimization of products.

The paper also encouraged researchers to develop new SPL tools for improved checking of the validity of feature models, using the results of this paper. Several third party tools build on the results of this paper and are widely used by the SPL community both in academia and industry.

Nominators

Lidia Fuentes, Universidad de Málaga, Spain
Klaus Pohl, Universität Duisburg-Essen, Germany
Douglas C. Schmidt, Vanderbilt University, USA
Roberto E. López-Herrejón , Université du Québec à Montréal, Canada

SPL MIP Award Committee 2017

Don Batory (Chair), University of Texas at Austin, USA
Julia Rubin, University of British Columbia, Canada
Goetz Botterweck, University of Limerick, Ireland
Rick Rabiser, Johannes Kepler University Linz, Austria
Stefania Gnesi, ISTI-CNR, Italy

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n trabajo de la US galardonado como el rtículo más influyente en el área de onfigurabilidad del software

min 7 febrero, 2020 Actualidad, Ingeniería-Arquitectura

El trabajo acerca de un programa informático desarrollado en la Universidad de Sevilla (US) ha recibido hoy 7 de febrero el **Premio al Artículo más Influyente en el área de configurabilidad del software** (MIP, Most Influential Paper Award). La mención y entrega de diplomas se ha celebrado durante la décimo cuarta edición de la Conferencia Internacional sobre Variabilidad de Software (VaMoS

Diario de Sevilla REGÍSTRATE INICIAR SESIÓN

INVESTIGACION

Expertos de la US mejoran la calidad de las apps de Android en varios dispositivos móviles

- El investigador José Ángel Galindo ha sido galardonado con el Premio a la Mejor Tesis Doctoral de la Sociedad de Ingeniería de Software y Tecnologías de Desarrollo de Software (SISTEDES)

El doctor José Ángel Galindo Duarte y el alumno Alejandro Rojas. / US

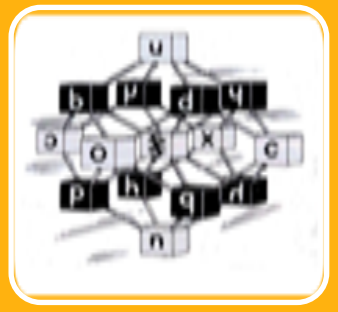
17 Julio, 2017 - 02:00h

US LA REVISTA DE LA UNIVERSIDAD DE SEVILLA

binUS Boletín Interno de Noticias UNIVERSIDAD D SEVILLA

Part I

Software Product Lines



Variability Modelling

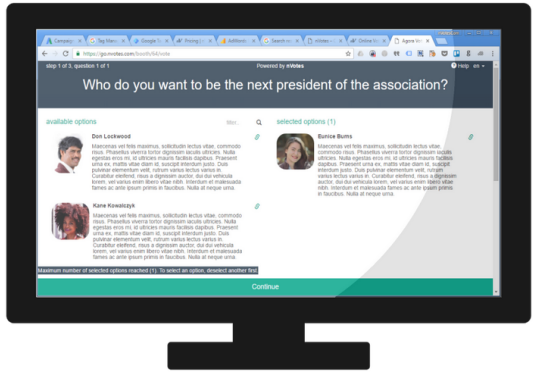
Some real cases

Real cases

nVotes

Features & Plans Contact us

Secure & easy online voting



Secure, robust and affordable internet election management solution that makes it easy for voters to cast their vote online

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Real cases


DIPUTACION DE SEVILLA
INPRO
DIPUTACION
buscar...
Zona Empleados
RSS | Directorio | Mapa Web | Contacta
Sociedad de Informática Provincial
INPRO
Inicio
La Empresa
Noticias
Novedades
Nuestros Usuarios
Productos y Servicios
I+D

Real cases


Equipo
Carpeta personal
Instalar Guadalinex v9
Todas las aplicaciones
Accesorios
Educación
Juegos
Gráficos
Internet
Oficina
Sonido y vídeo
Acceso universal
Wine
Preferencias
Administración
Lugares
Archivos recientes
Actualización de software
Analizador de uso de disco
Aplicaciones preferidas
Applets
Archivos
Ayuda
Bloc de Notas
Bloqueador de pantalla
Bluetooth
Calculadora
Capturar pantalla
Cliente de correo Thunderbird
Color
Conexiones de red
Menú
22 de nov, 00:45

Real cases

What configurations should I test to defend my users from bugs?

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Software product lines

Industrial Trends

Organizations are evolving	• *Project* Centric Software Engineering • *Product* Centric Software Engineering
Software ***variability*** constantly increasing:	• Variability goes from hardware to software • Variations points grows by thousands
Assets' ***Reuse*** is shifting	• from ad-hoc to ***systematic***

What is a software product line?

Real example

Real example

Mass production

producing efficiently a large amount of standardized products

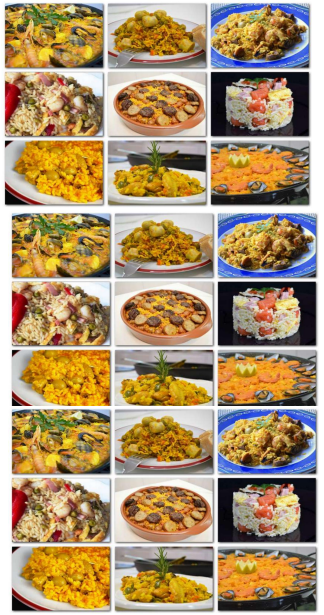
Software product lines

No customization
-
one product

oduction

acing efficiently a large amount of
standardized products

Software product lines



Mass customization

“a paradigm shift for the enterprise to offer products and services best catering to individual customer's needs whereas keeping near-mass production efficiency “

[Tseng, M.M., Jiao, J. (2001)]

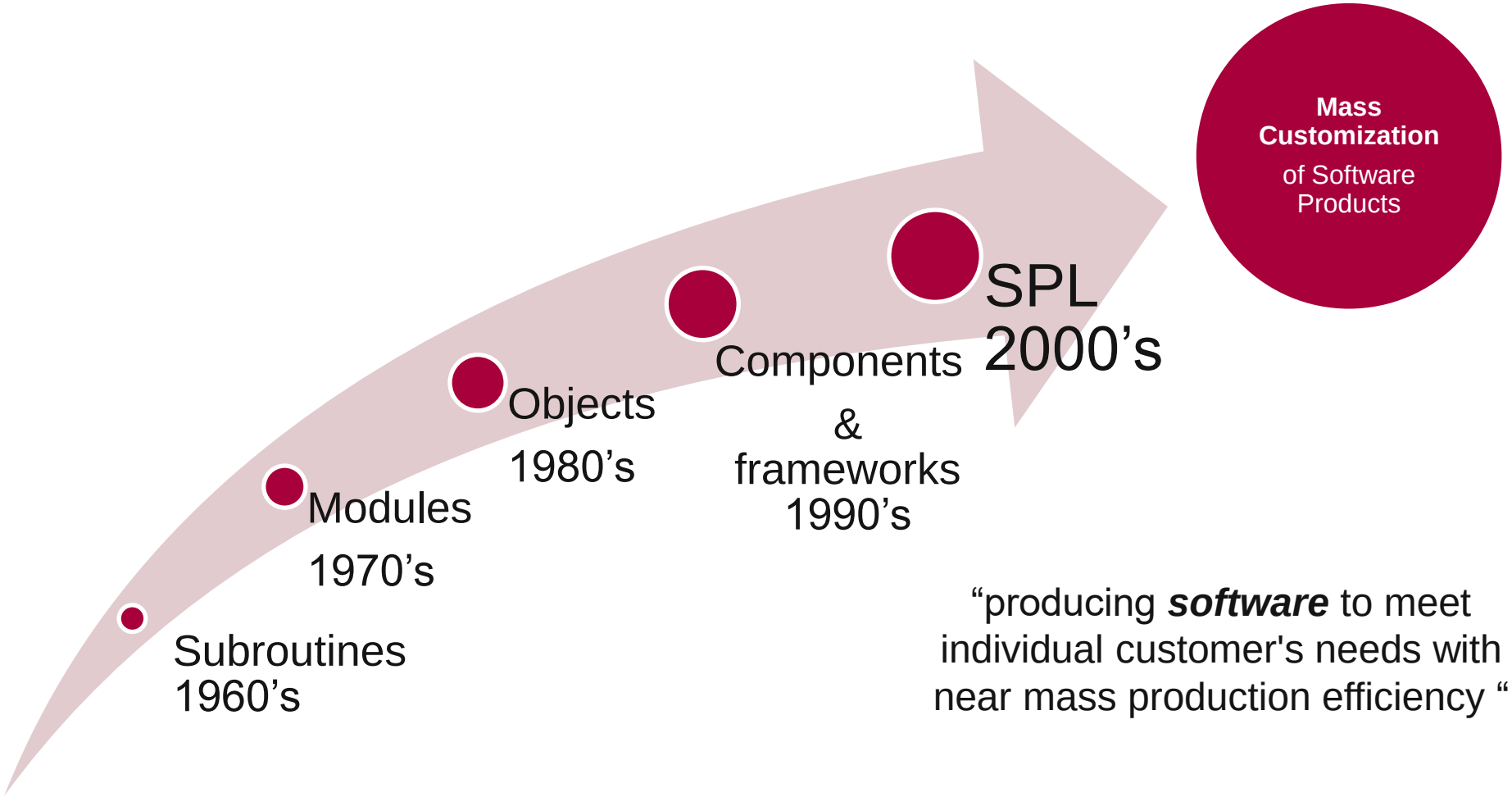
Customization
-
A set of products

Mass customization

“a paradigm shift for the enterprise to offer products and services best catering to individual customer's needs whereas keeping near-mass production efficiency “

[Tseng, M.M., Jiao, J. (2001)]

Software product lines



"producing ***software*** to meet individual customer's needs with near mass production efficiency "

Software product lines

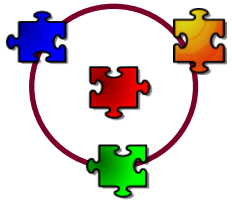
Common features

- Alarm clock
- Calls
- Messaging

Variable features

- Media
- Games
- Connectivity

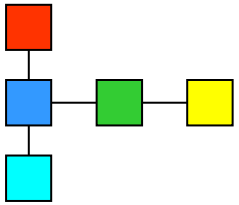
Variability Model



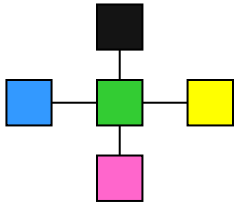
- Documents the variability of SPL
- Enable managing the variability

Software product lines

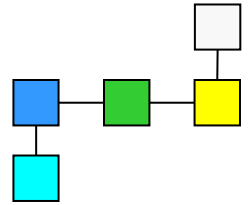
Traditional Approach (*mass production*)



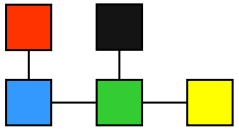
Product 1



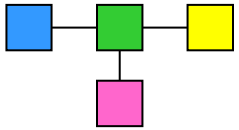
Product 2



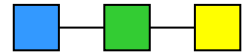
Product 3



Product 4

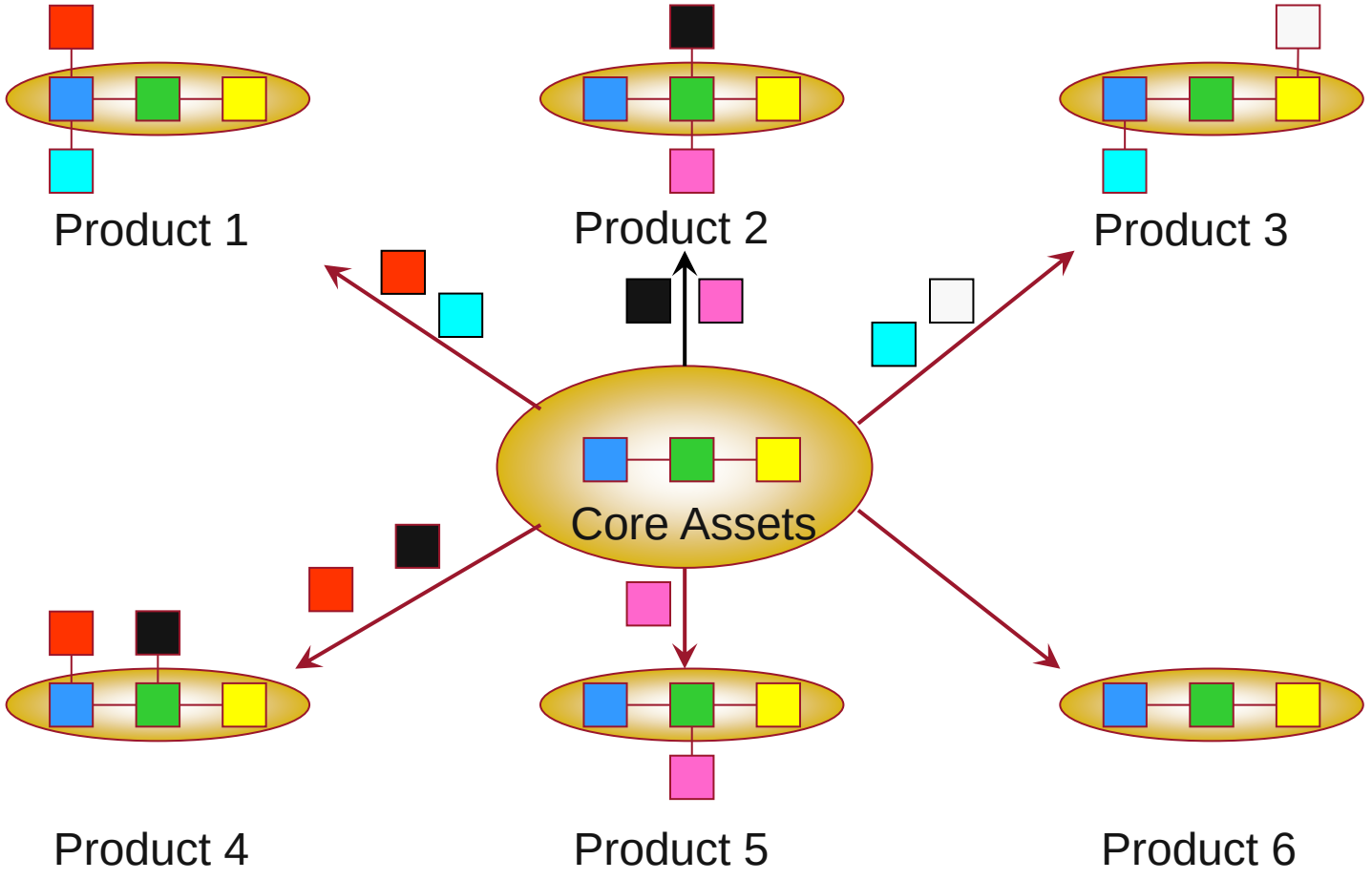


Product 5

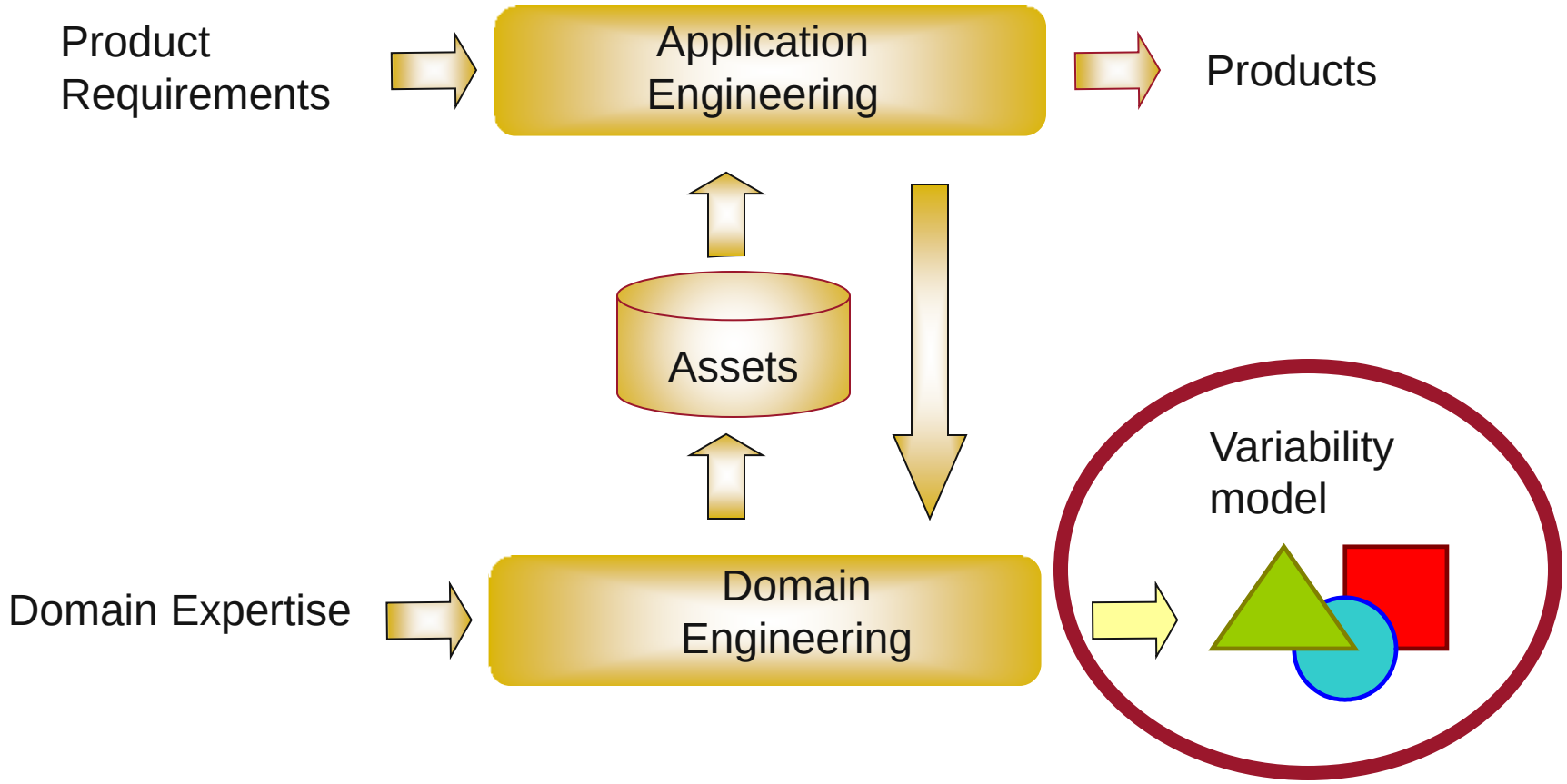


Product 6

Product Lines Approach (*mass customization*)



SPL: Activities



SPL framework

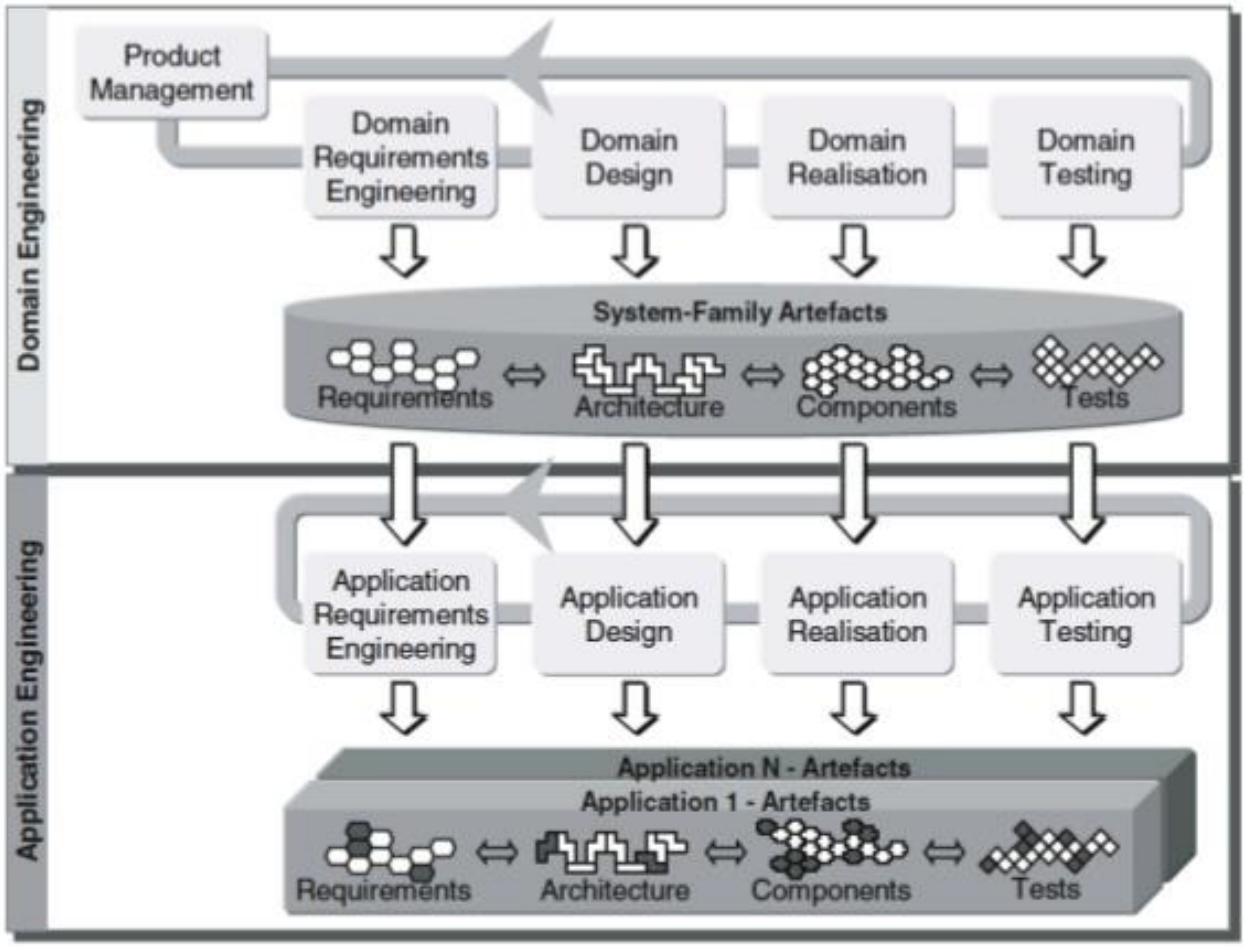


Fig. 1.2. The two-life-cycle model of software product line engineering

From "Software Product Line Engineering" by Phol et al.

A more practical view of the SPL framework

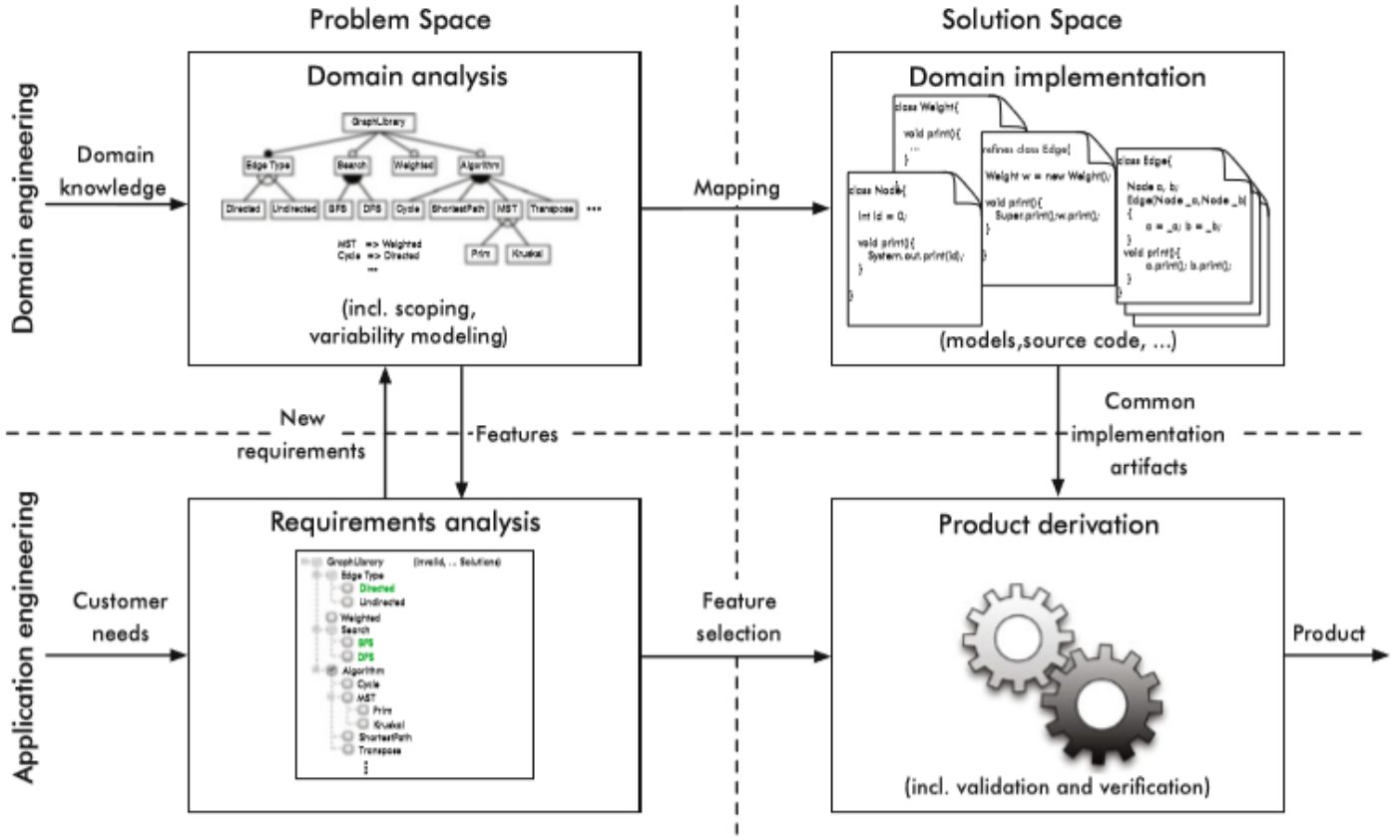


Fig. 1.1 An overview on software product-line engineering

From “Mastering Software Variability with FeatureIDE”

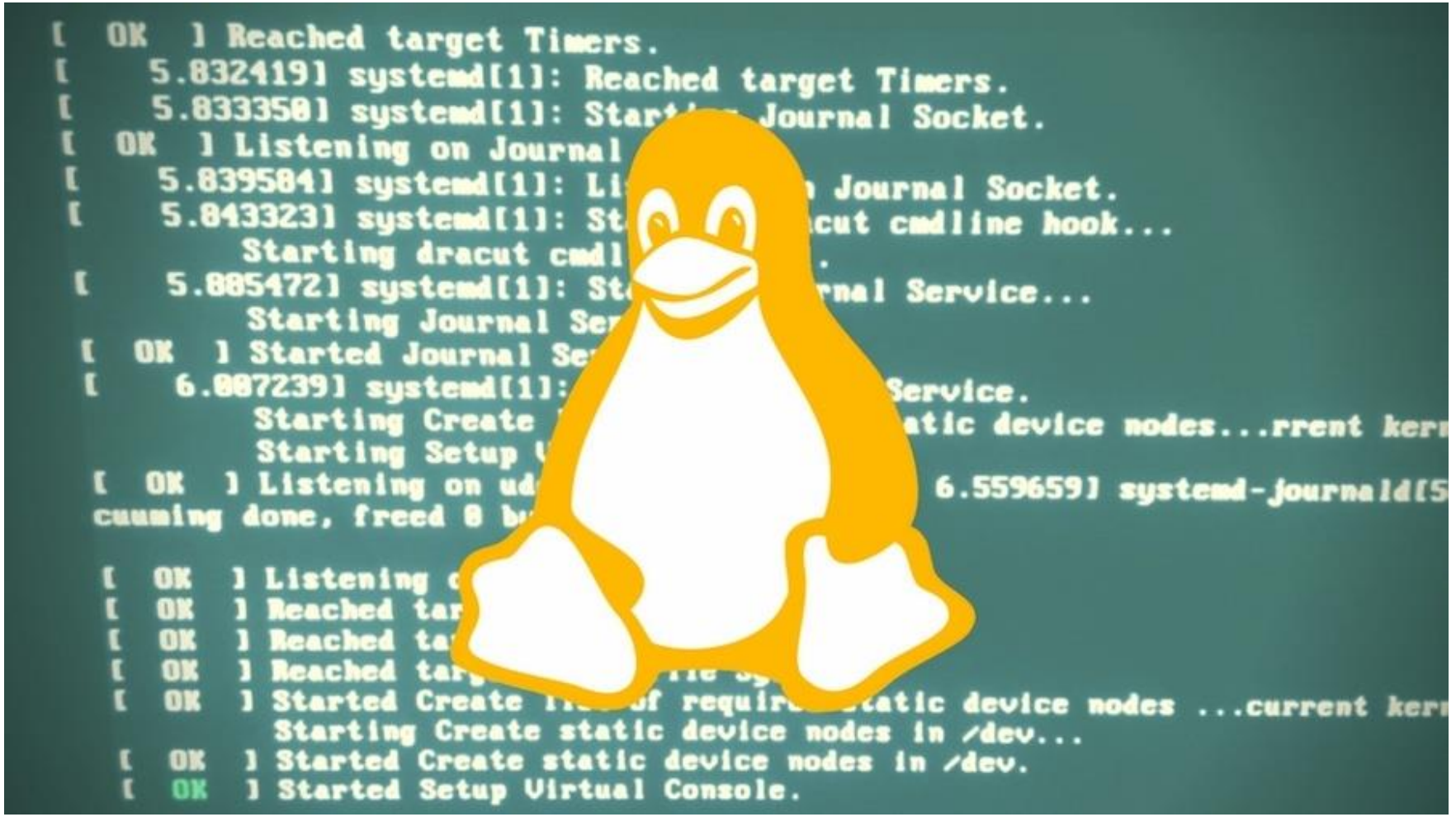
What are the reasons for SPLE “tentations”?

Product explosion

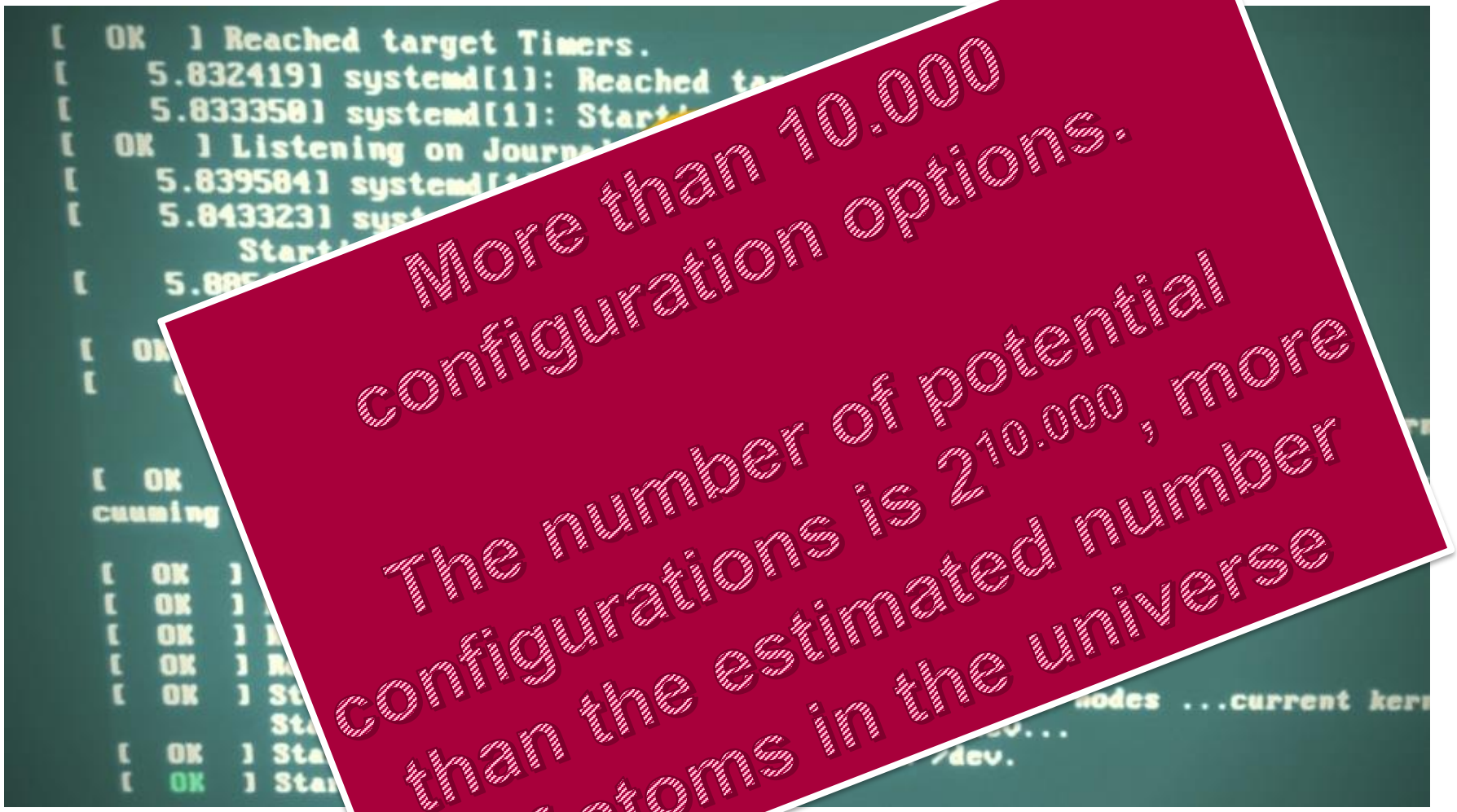
Customers explosion

Technology explosion

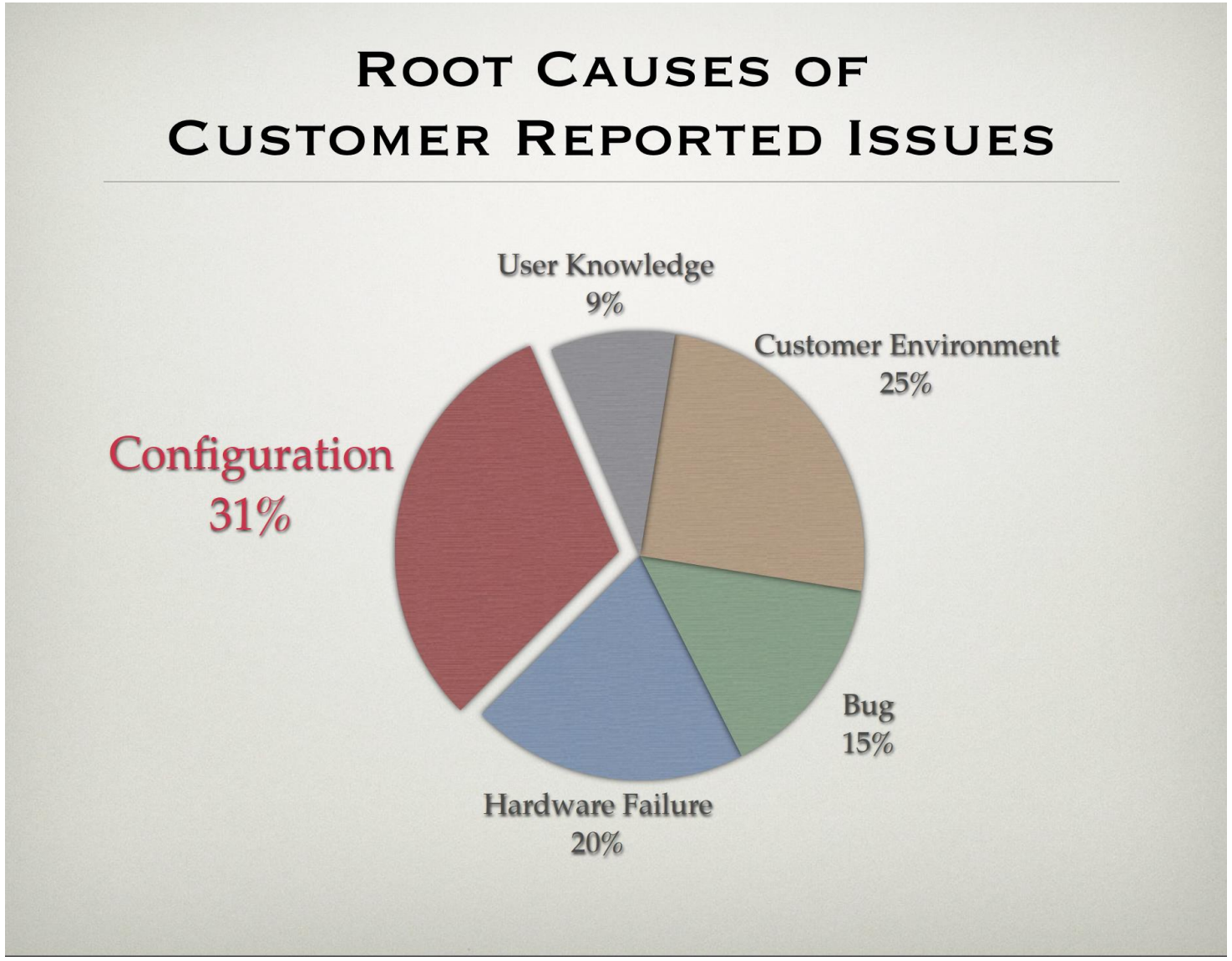
Configuration explosion



Configuration explosion



Configuration explosion



Taken from http://sigops.org/sosp/sosp11/current/2011-Cascais/12-yin-slides.pdf

Explosions consequences

- Product oriented development
- Fire-fighting mode
- Opportunistic reuse

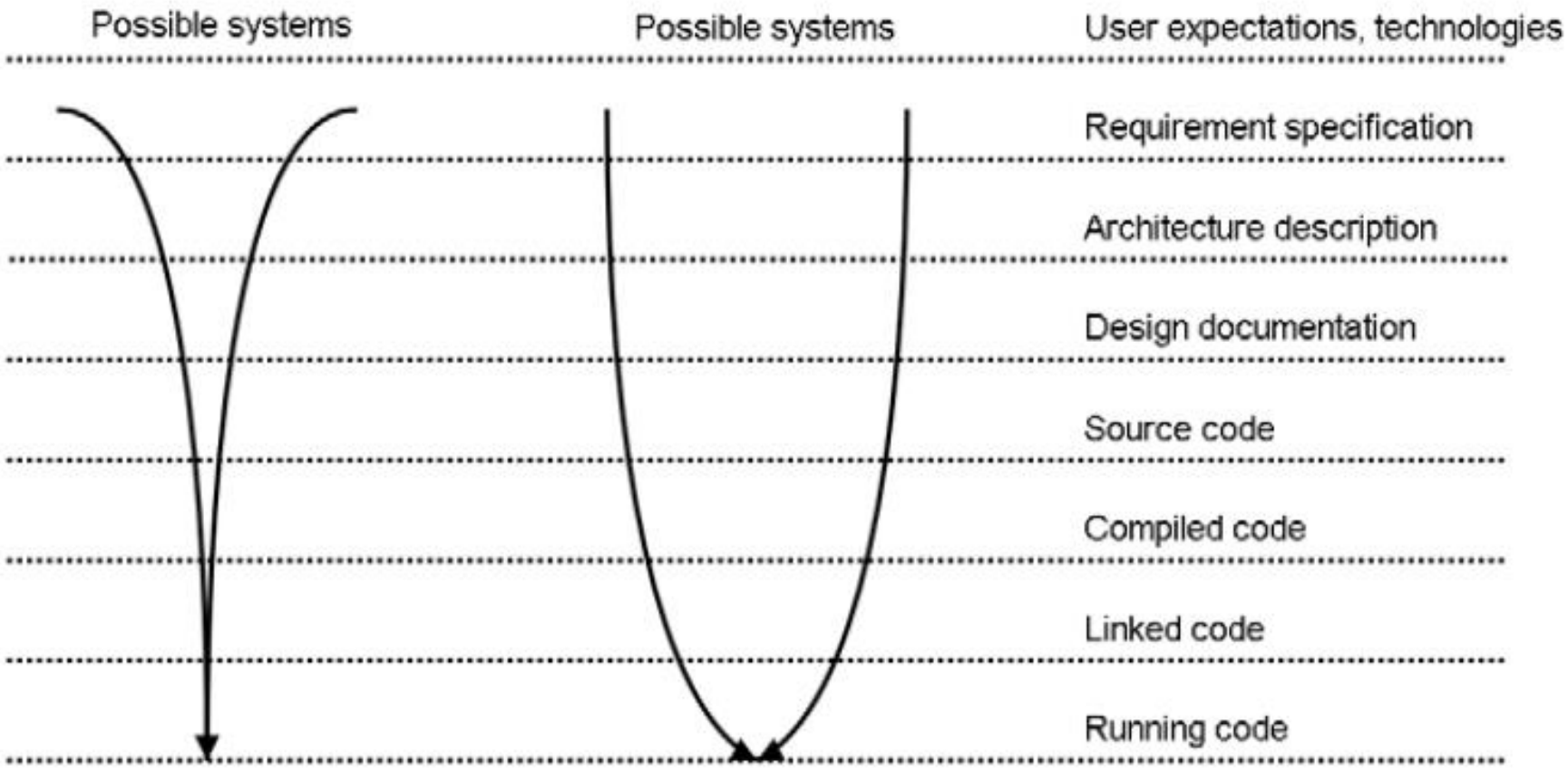
- Lack of innovation
- Quality degradation
- Knowledge lost

Some “tentations”

- Product portfolio diversity
- Common user experience for product in the portfolio
- Customization of products

What are the goals?

SPL metaphors



Svahnberg M., van Gurp J., Bosch J., *On the Notion of Variability in Software Product Lines*. Proceedings of IEEE/IFIP Conference on Software Architectures, 2001.

SPL metaphors

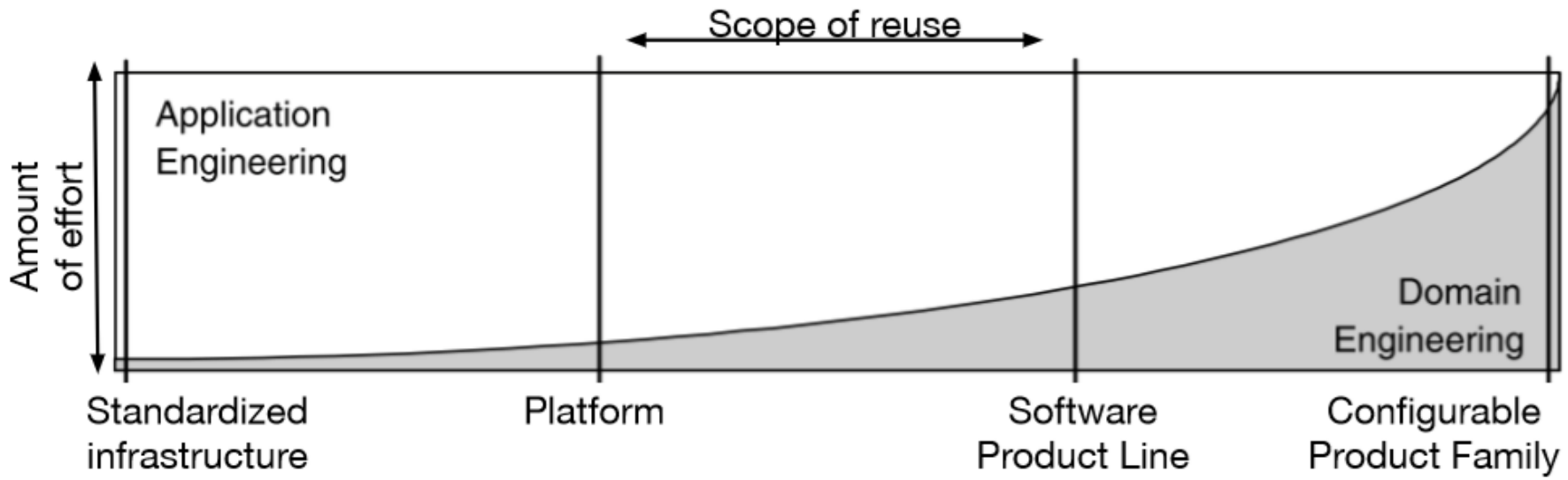
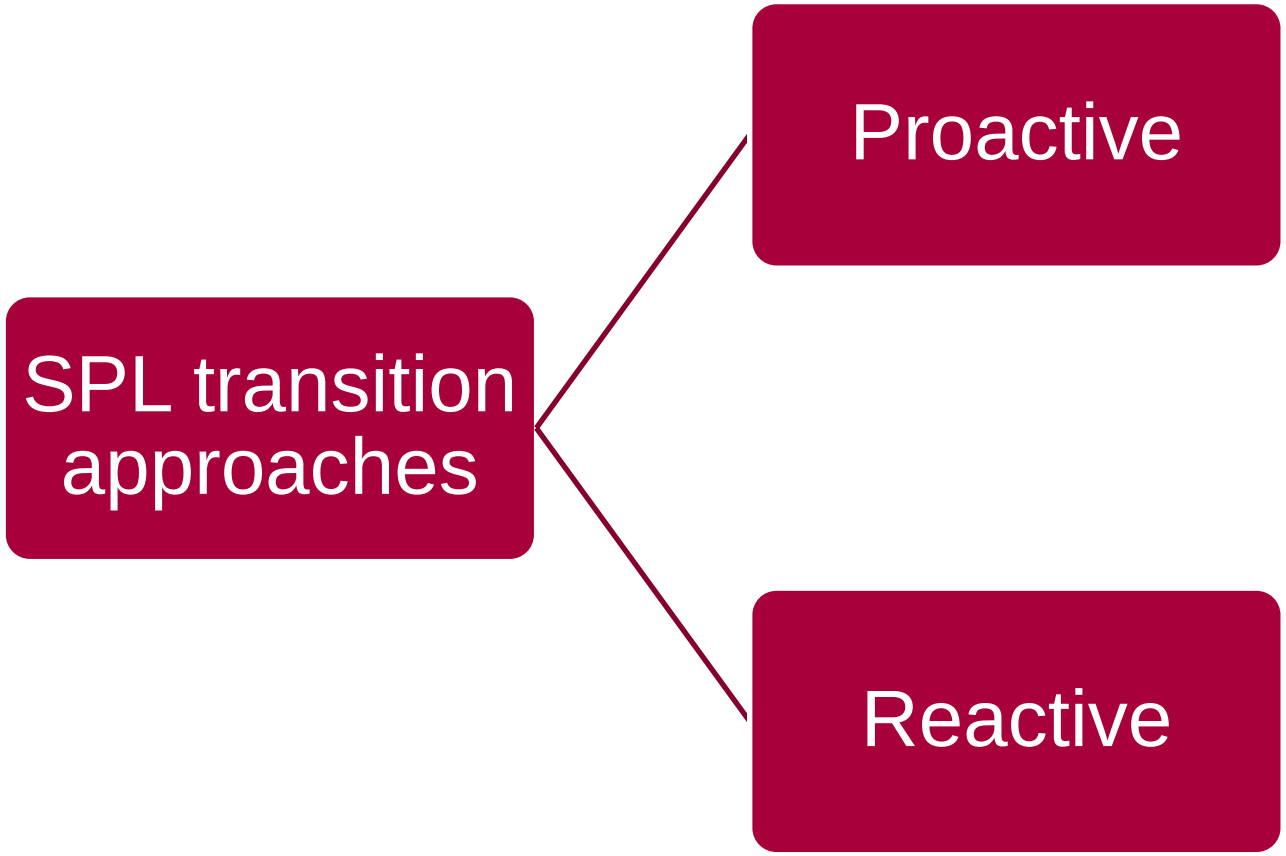


Figure 1.1: SPL maturity stages: from less mature (left) to more mature (right)[DSB05]).

OK, I trust you but...
how shall I transition?

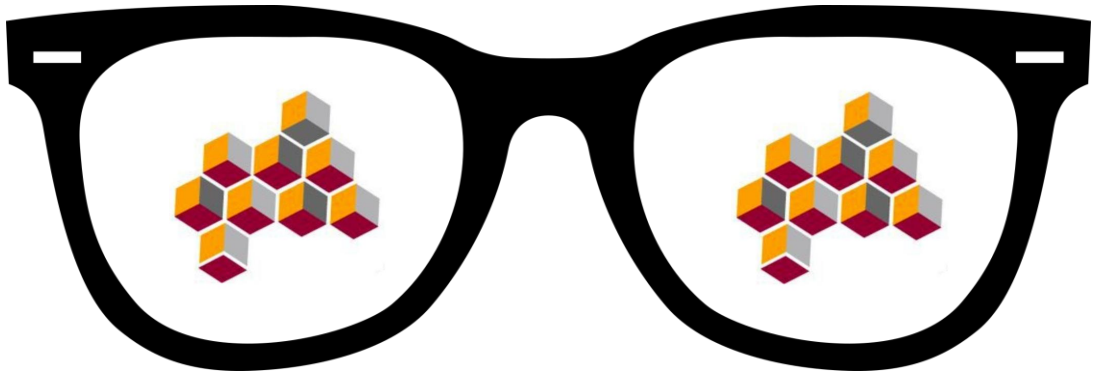

SPL transition approaches
Proactive
Reactive

Some barriers

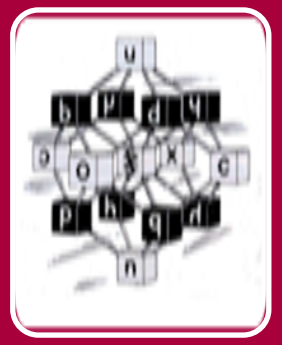
Business strategy

Variability, a new degree of complexity


DISCUSSION
QUESTIONS



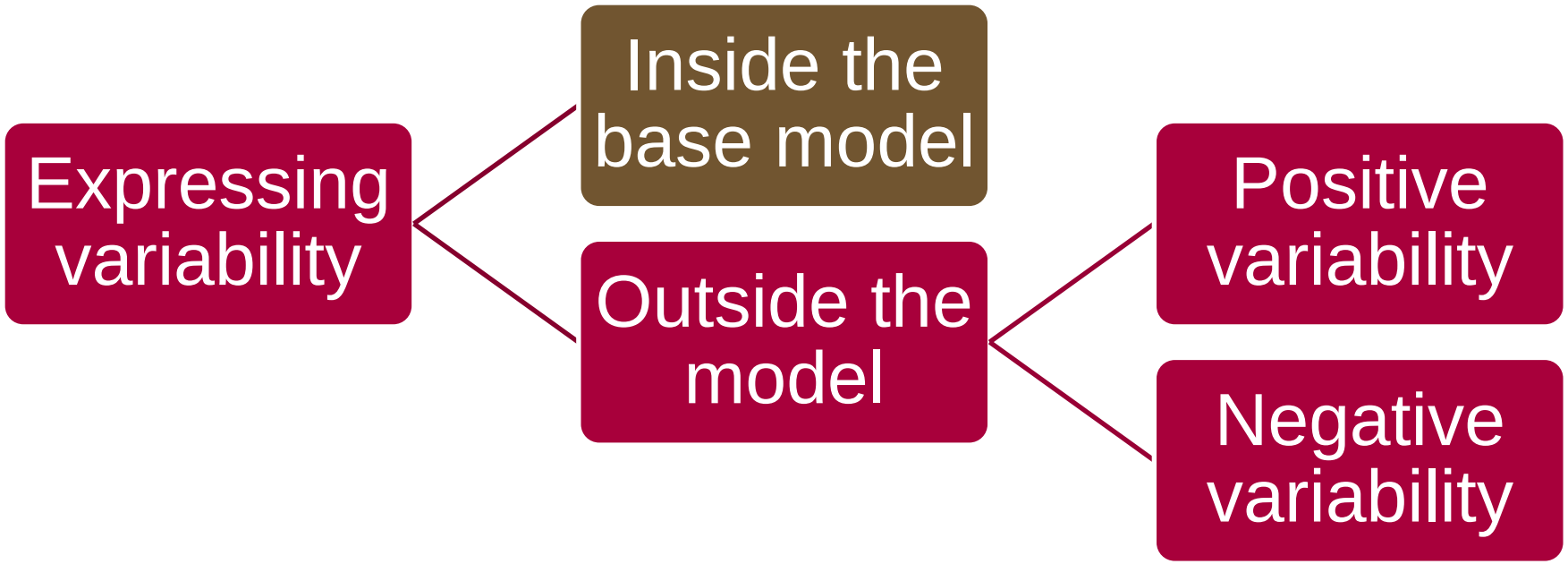
Software Product Lines



Variability modelling

How to model variability?

How to model variability



Inside the model

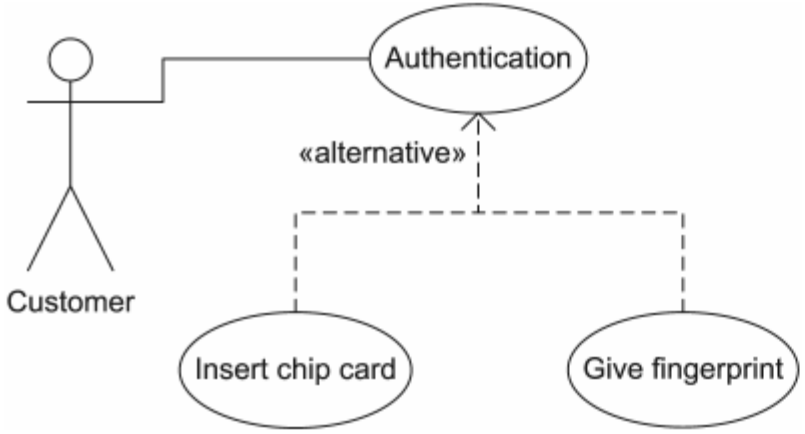


Figure 5: Example of an alternative relationship

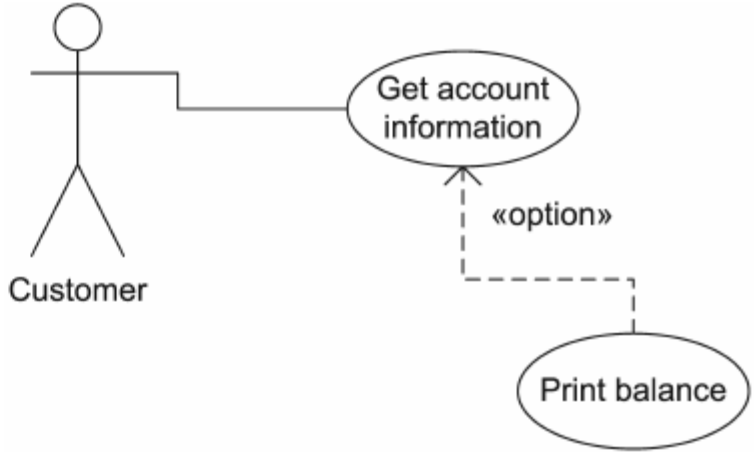
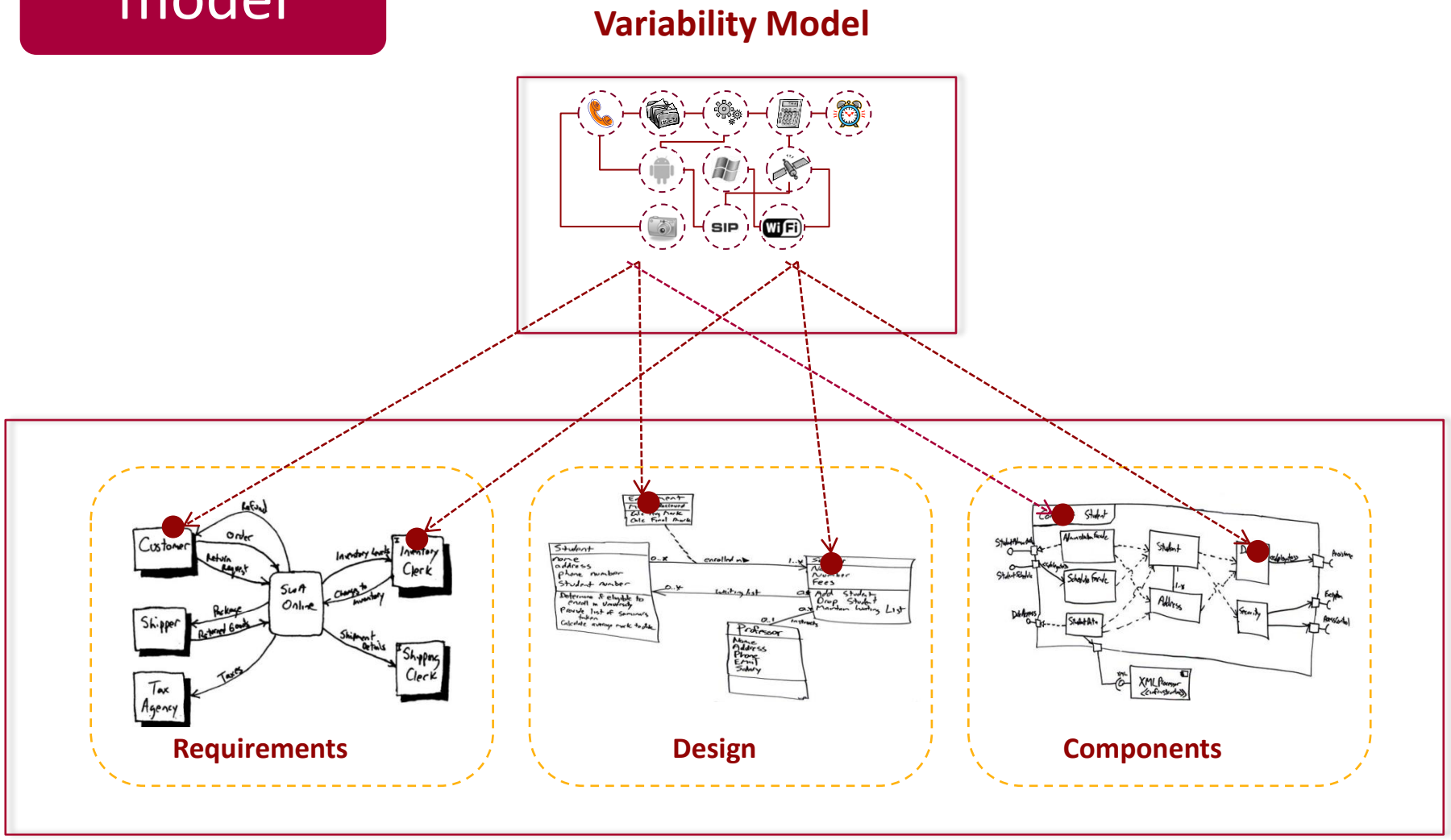


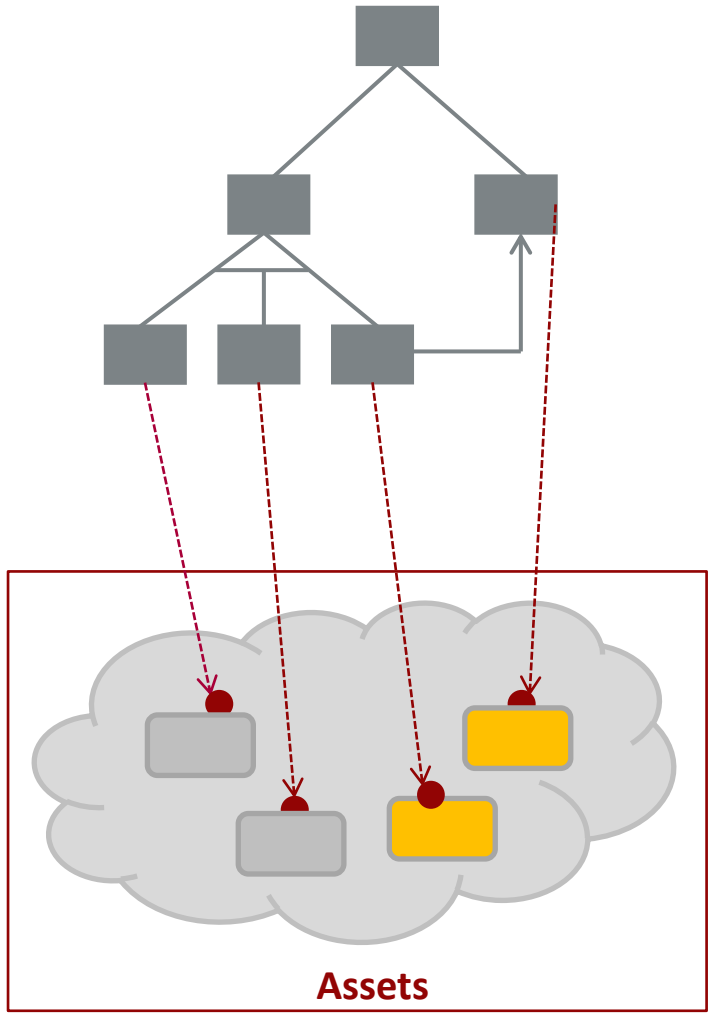
Figure 6: Example of an optional relationship

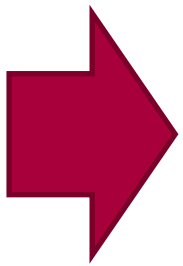
Taken from Modeling variability by UML use case diagrams by Von der Massen et al.

Outside the model

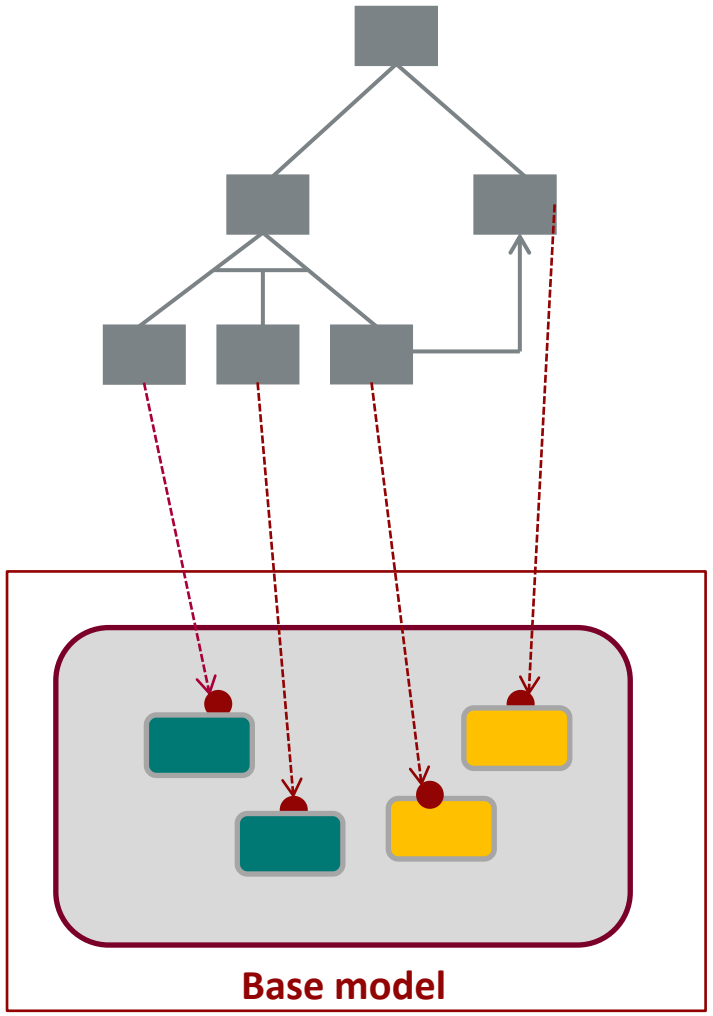


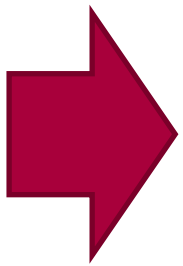
Positive variability

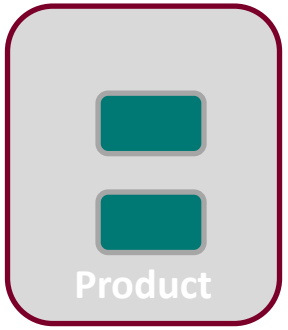




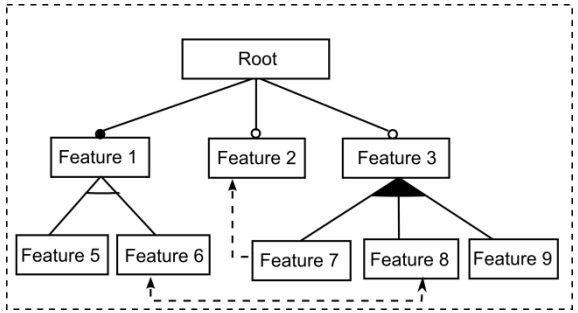
Negative variability



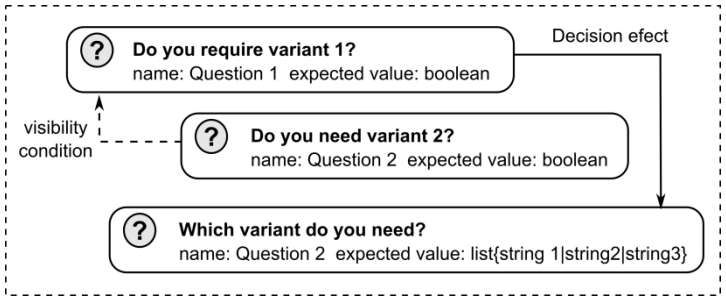




How to model variability



Feature modelling

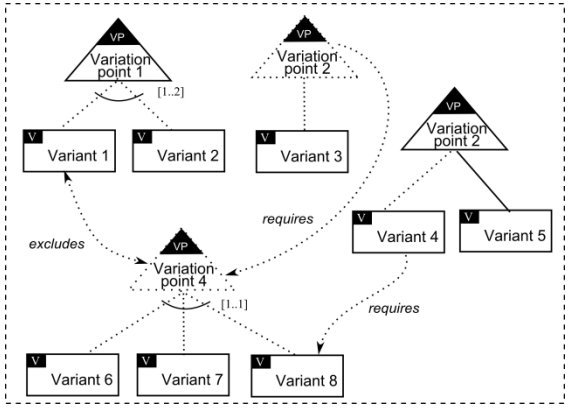


Decision modelling

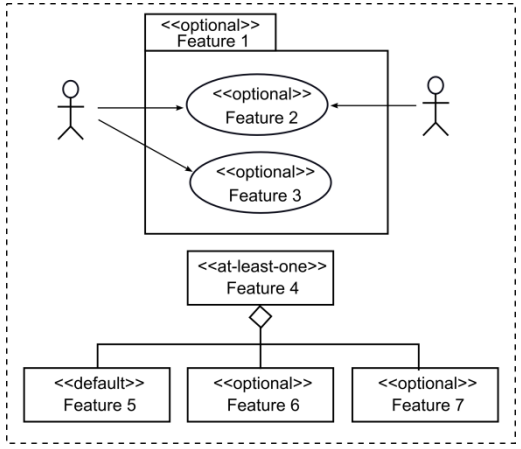
Techniques

Ad-hoc solutions: tables, textual docs, ...

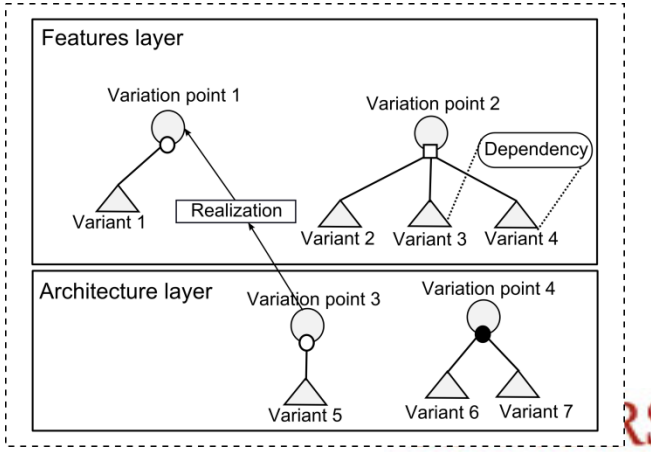
Orthogonal variability modelling



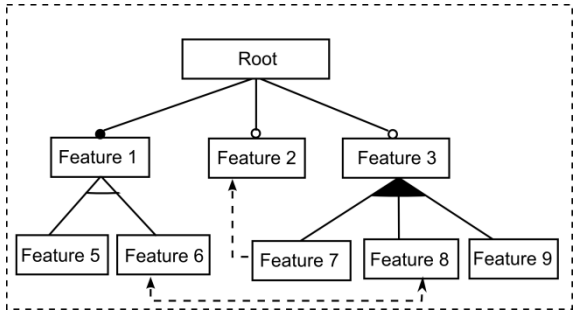
UML-based



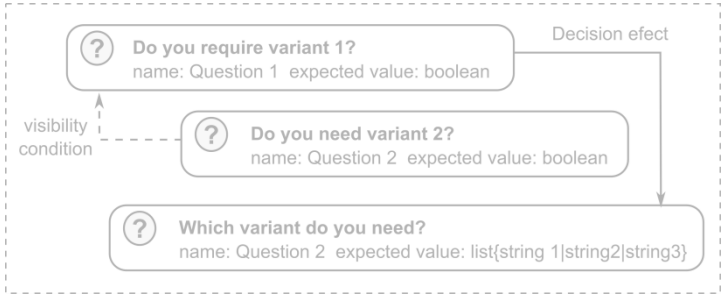
COVAMOF



How to model variability



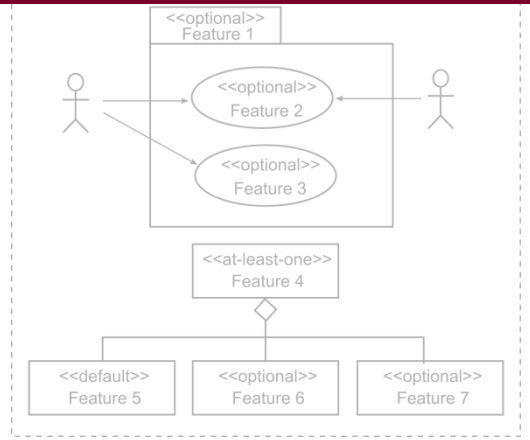
Feature modelling

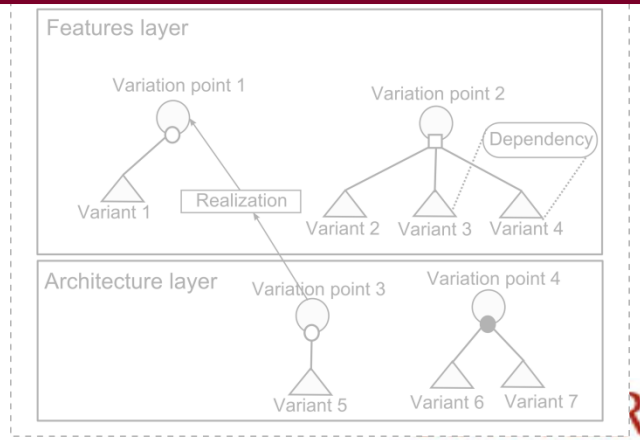


Decision modelling

Ad-hoc
tables,
...

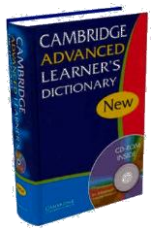
Feature models were first introduced by Kang et al. in 1990





How to specify a particular product?

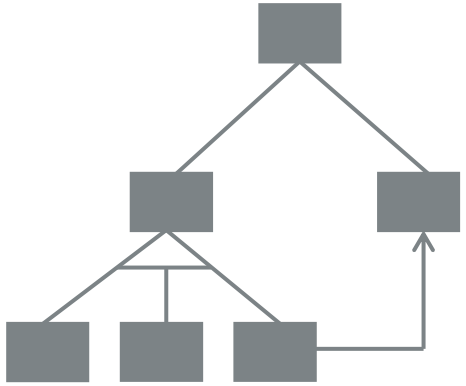
FEATURE



"An important part of something"

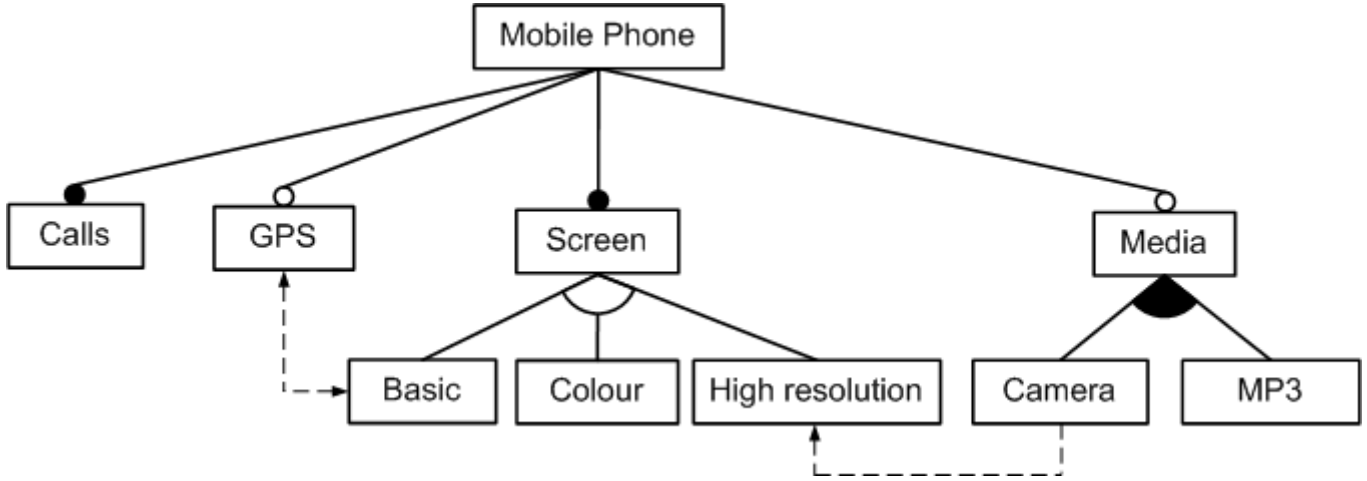
"A prominent or distinctive characteristic of a software system"

How to specify an SPL?

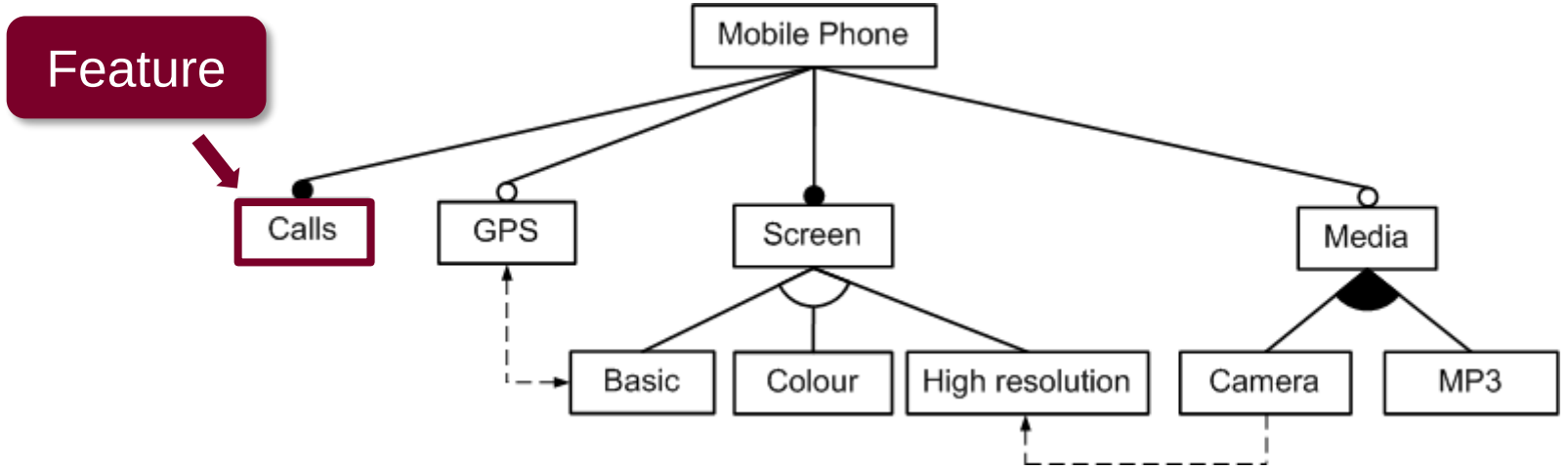


“Feature Model: A hierarchically arranged set of features to represent all possible products of an SPL”

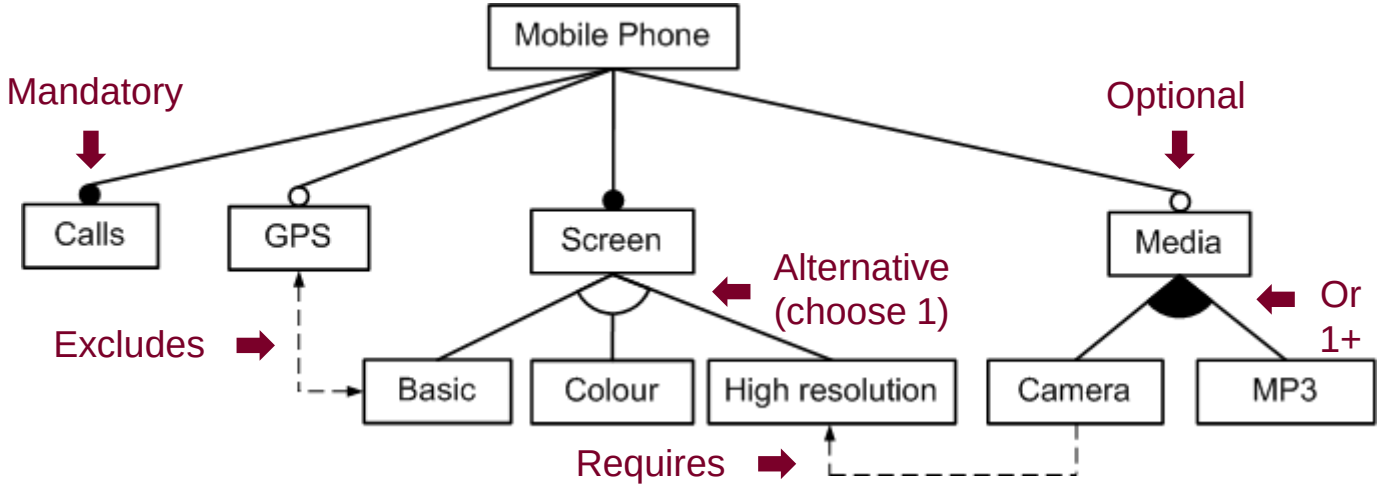
Feature models



Feature models



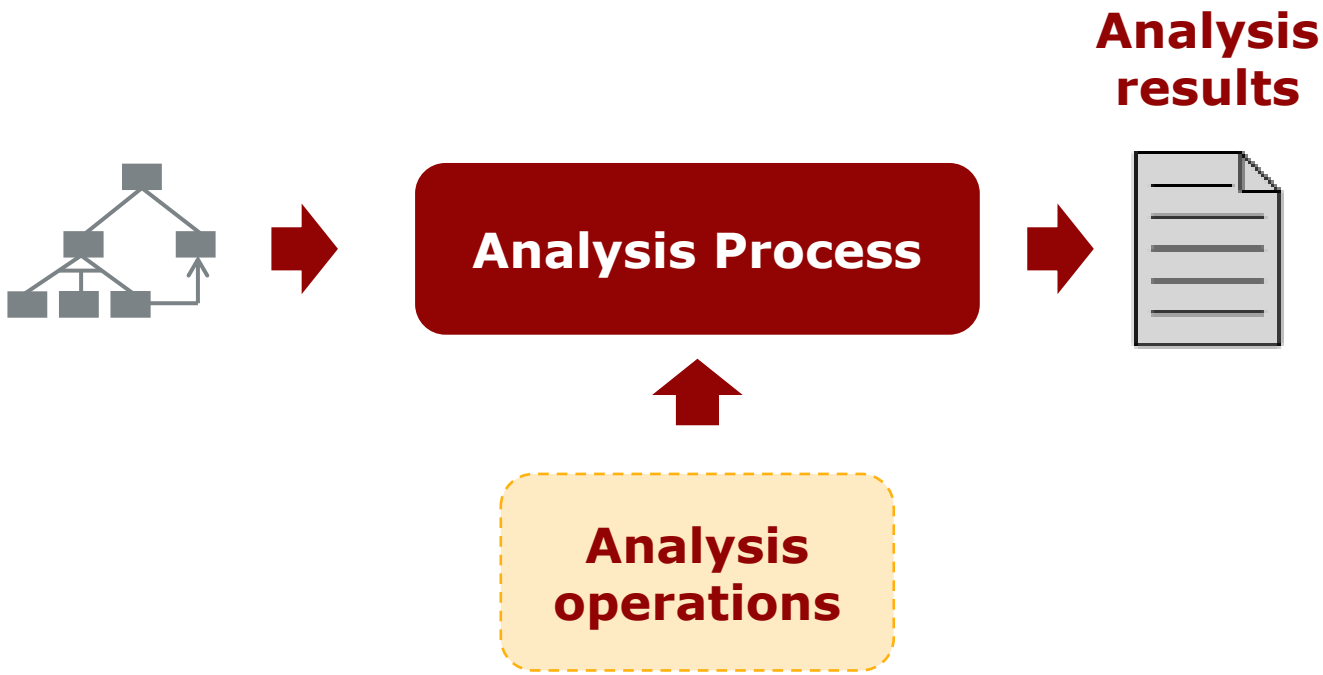
Feature models



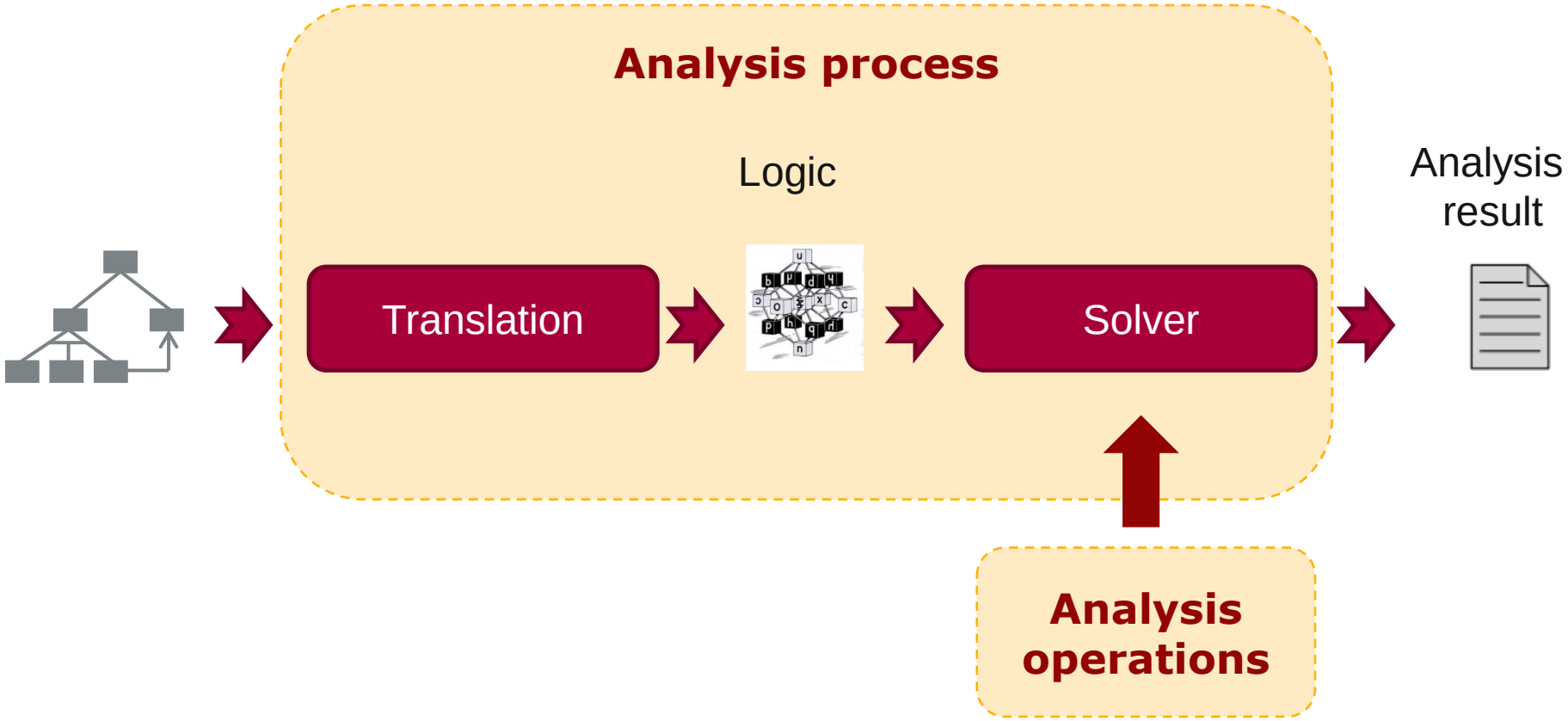
Design a feature model for your own SPL!

Challenge 1: Automated analysis of Feature Models

Computer-aided, extraction of useful information from feature models

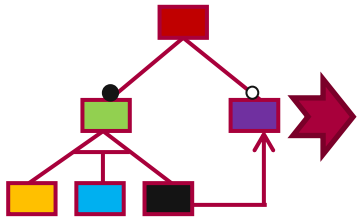


Analysis process



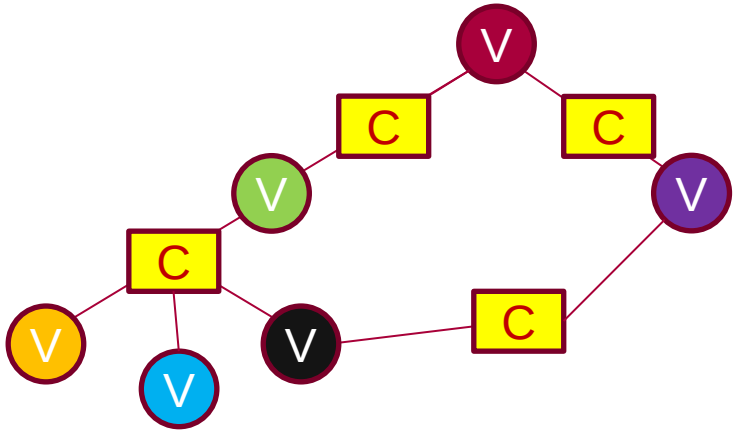
Feature models as CSPs

Feature Model



Translation

Constraint Satisfaction Problem



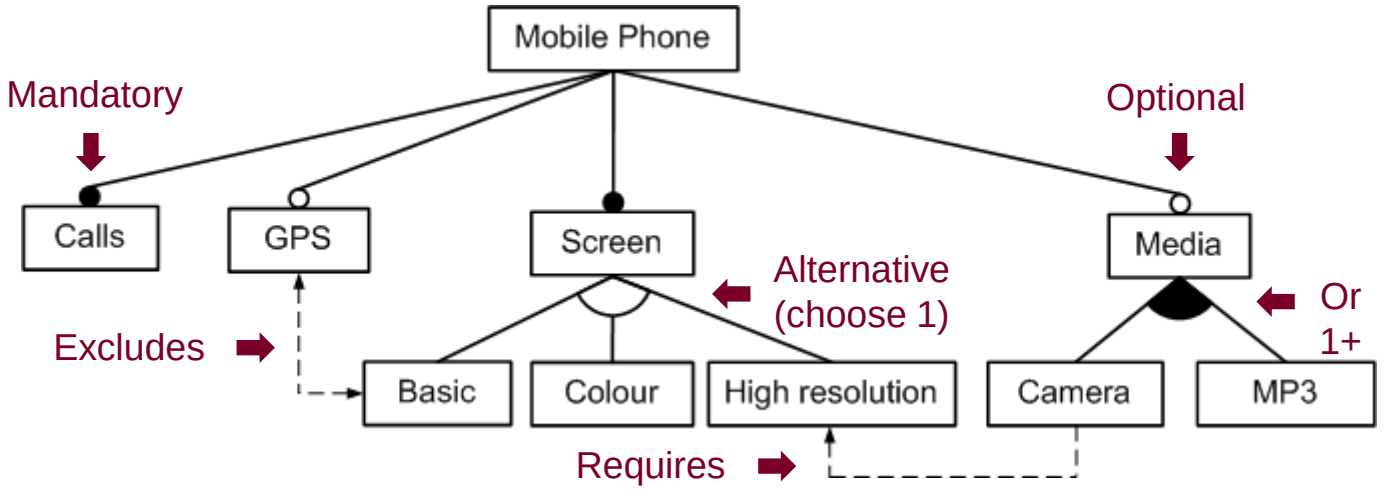
Feature models as CSPs

- A CSP is defined as:
  - A set of variables
  - A set of domains for those variables
  - A set of constraints restricting the values of the variables
- A CSP solvers is defined as:
  - A software tool that takes a CSP and find possible assignments of variables, if any, taking into account the constraints.

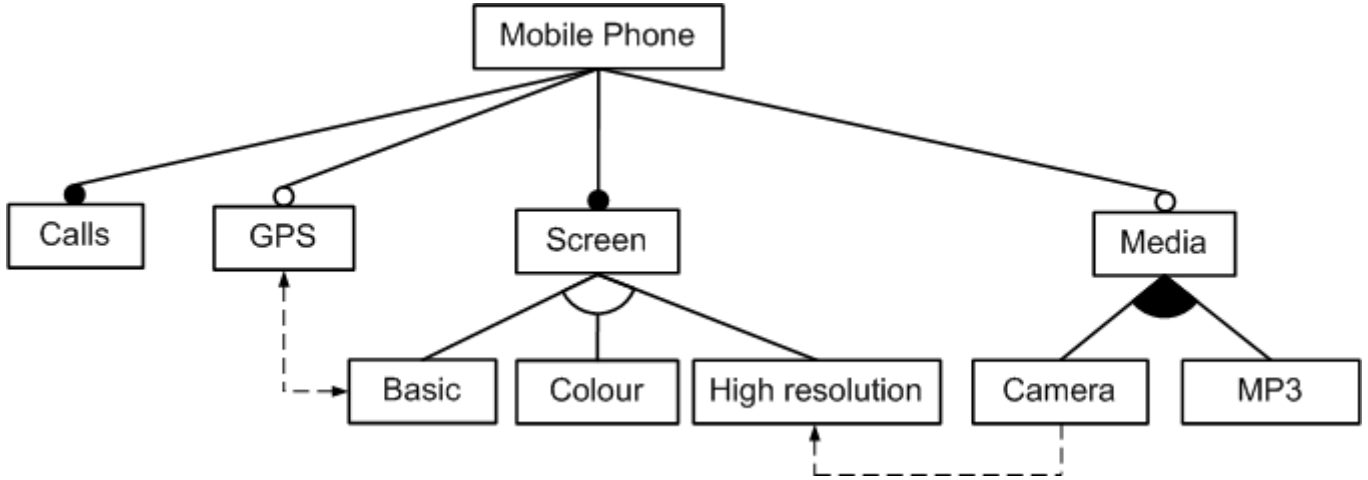
CSP example

- CSP:
  - A set of variables: X, Y, Z
  - A set of domains for those variables:
    - X in {2,3}, Y in {4,6}, Z in {1,10}
  - A set of constraints restricting the values of the variables:
    - X + Y < Z
- Solutions for the CSP:
  - X = 2; Y = 4; Z = 6 
  - X = 3; Y = 5; Z = 8 
  - X = 3; Y = 6; Z = 9 

Feature models

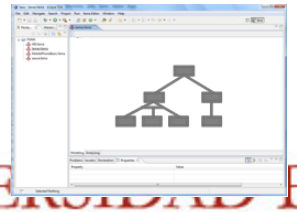


Automated analysis of feature models:
Computer-aided extraction of information from FMs

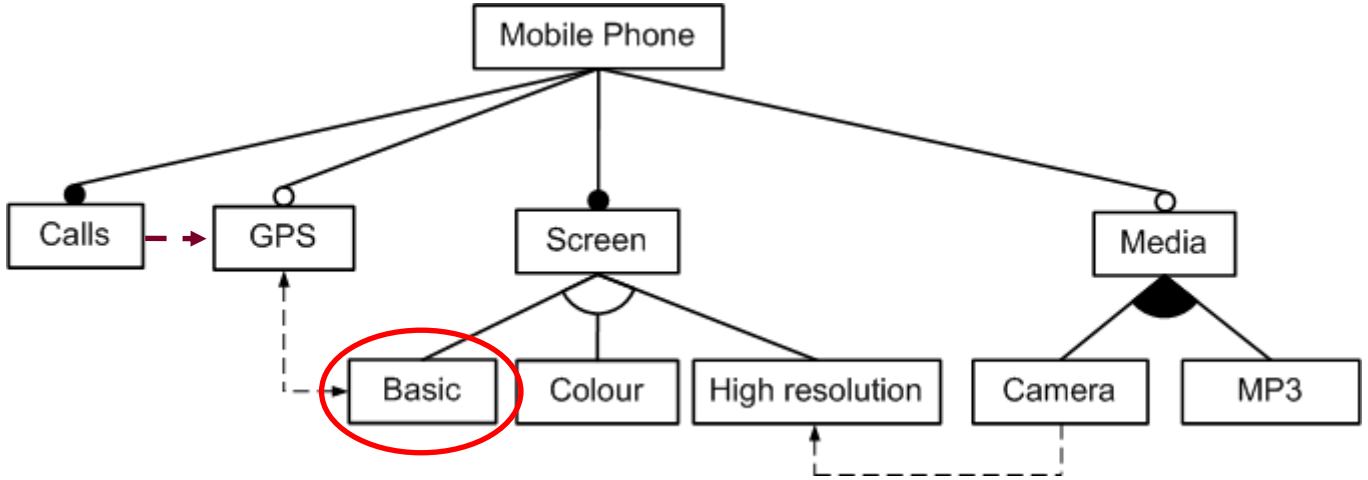


How many products?

14

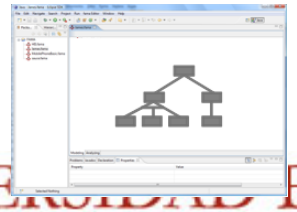


Automated analysis of feature models:
Computer-aided extraction of information from FMs

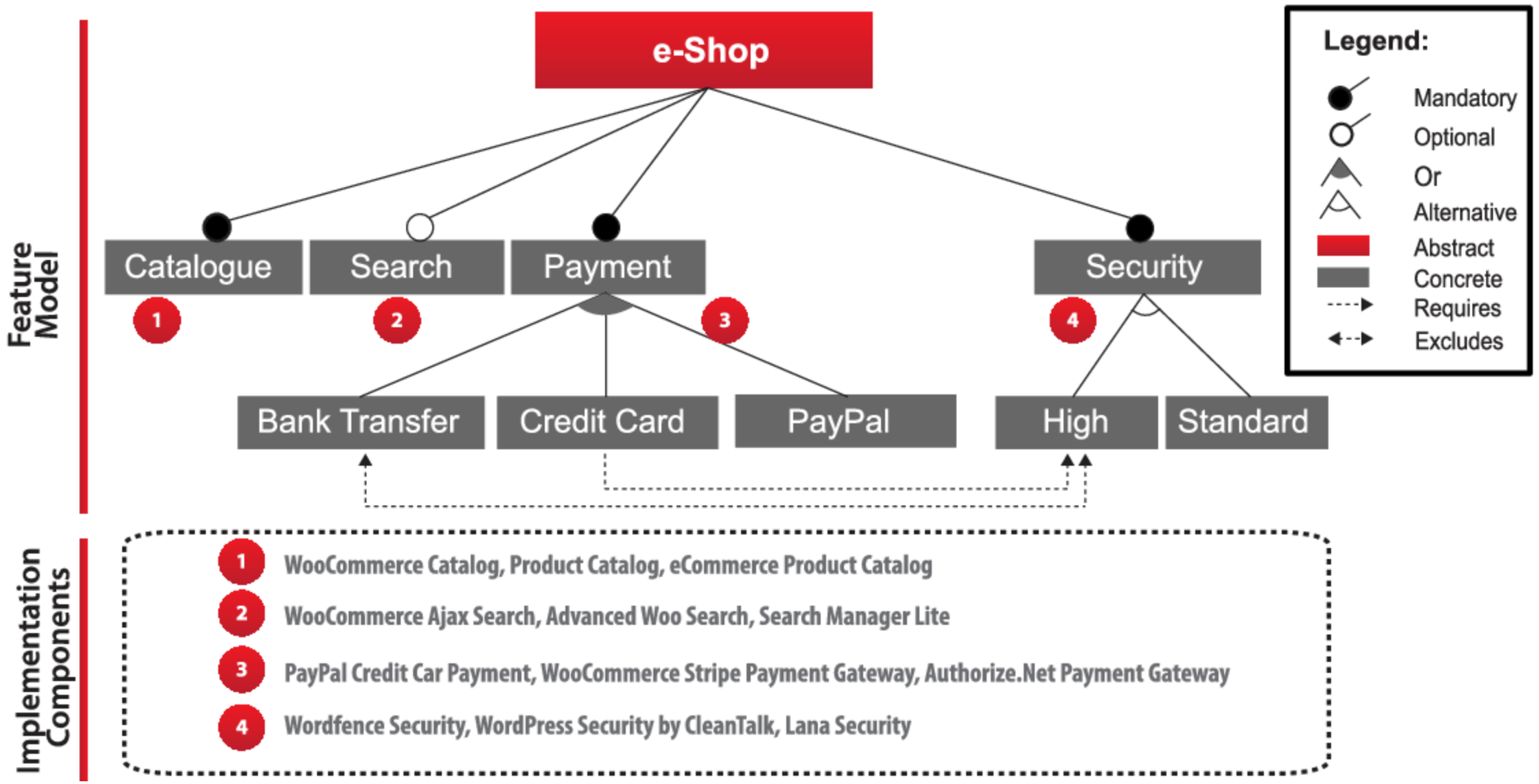


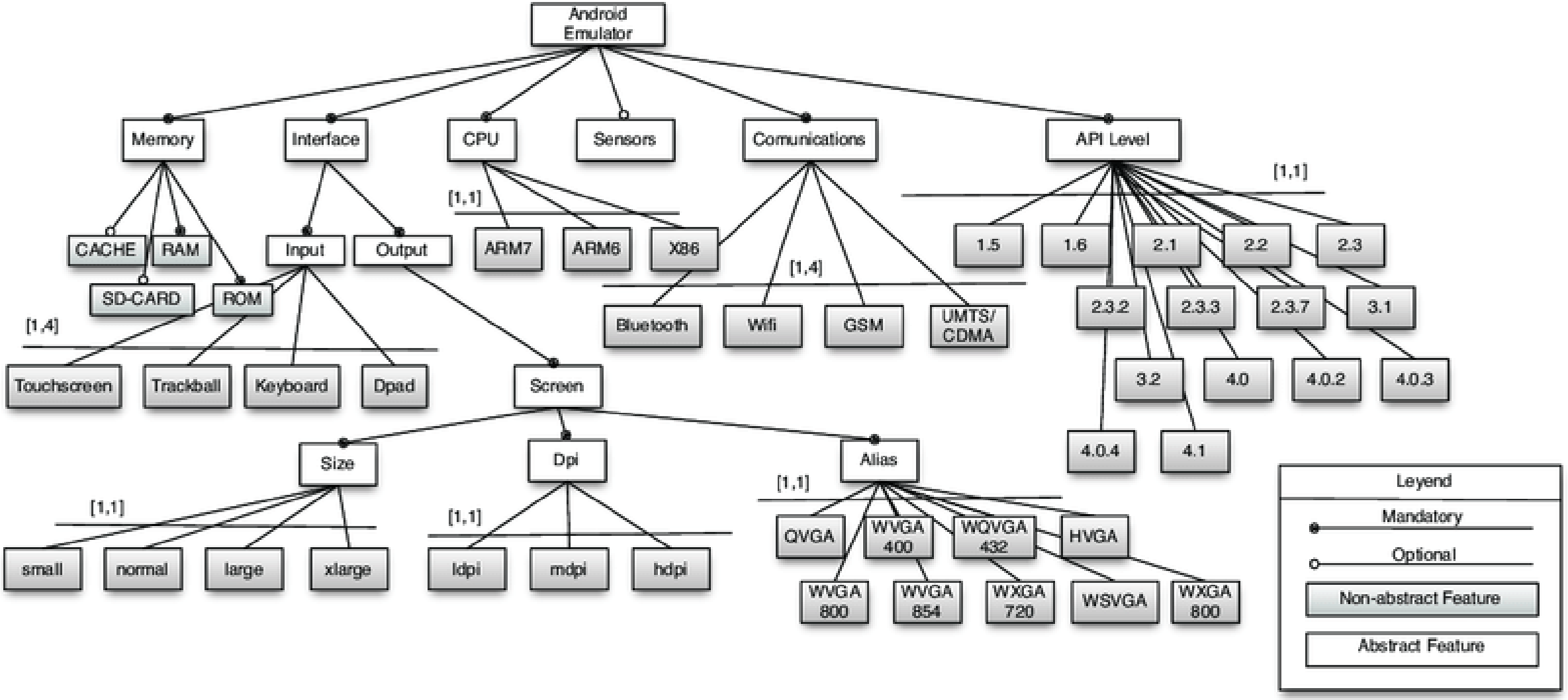
Any error?

Yes, feature "Basic" is dead



Other problems!




Android Emulator
Memory
Interface
CPU
Sensors
Comunications
API Level
CACHE
RAM
SD-CARD
ROM
Input
Output
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ARM7
ARM6
X86
[1,4]
Bluetooth
Wifi
GSM
UMTS/ CDMA
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1.5
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2.3.7
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Trackball
Keyboard
Dpad
Screen
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Dpi
Alias
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WQVGA 432
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WVGA 854
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Optional
Non-abstract Feature
Abstract Feature

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IDE Feature

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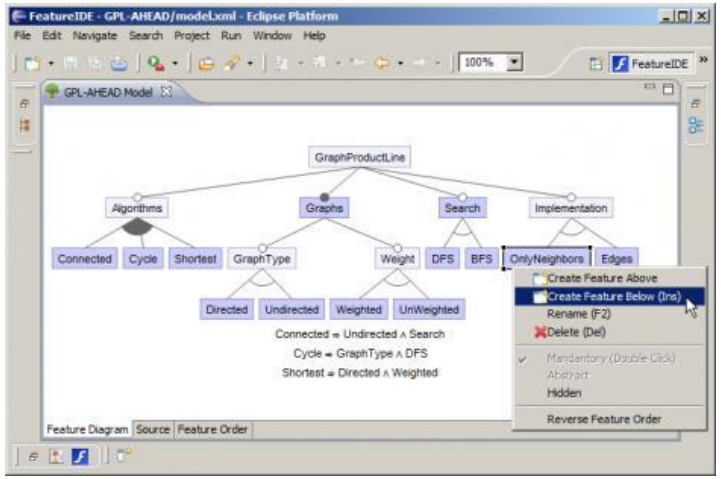

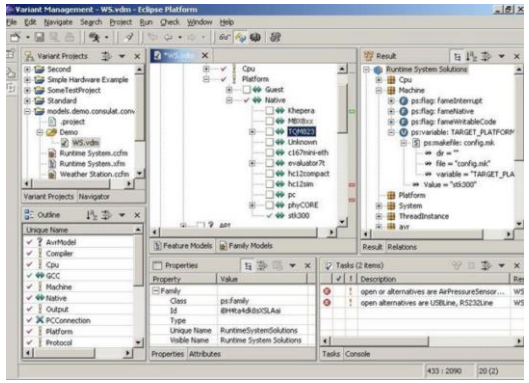

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Conclusions

- SPL is a *new* software production paradigm
- Variability management is essential

Bibliografía

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Volume 35, Issue 6, September 2010, Pages 615-636

Automated analysis of feature models 20 years later: A literature review ☆

David Benavides, Sergio Segura, Antonio Ruiz-Cortés

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Variability in Data Visualization: a Software Product Line Approach

Jose-Miguel Horcas
University of Seville
Seville, Spain
jhorcas@us.es

Jose A. Galindo
University of Seville
Seville, Spain
jagalindo@us.es

David Benavides
University of Seville
Seville, Spain
benavides@us.es

ABSTRACT

Data visualization aims to effectively communicate quantitative

(SPLC '22), September 12–16, 2022, Graz, Austria. ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3546932.3546993

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Christian Kästner, School of Computer Science, University of Magdeburg, Germany

Sven Apel, Department of Informatics and Mathematics, University of Passau, Germany

Software Qual J (2016) 24:365–405
DOI 10.1007/s11219-014-9258-y

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