Product Line Engineering Lecture – PL Infrastructures I (4)

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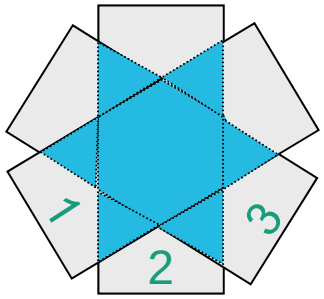

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Lectures - Schedule

Lectures

No	Date	Time	Location
1	21-Oct-11	15:30 - 17:00	48-462
2	28-Oct-11	15:30 - 17:00	IESE
3	4-Nov-11	15:30 - 17:00	IESE
4	11-Nov-11	15:30 - 17:00	IESE
5	18-Nov-11	15:30 - 17:00	48-462
6	25-Nov-11	15:30 - 17:00	48-462
7	2-Dec-11	15:30 - 17:00	IESE
8	9-Dec-11	15:30 - 17:00	IESE
9	16-Dec-11	15:30 - 17:00	IESE
10	6-Jan-12	15:30 - 17:00	IESE
11	13-Jan-12	15:30 - 17:00	IESE
12	20-Jan-12	15:30 - 17:00	IESE
13	27-Jan-12	15:30 - 17:00	IESE
14	3-Feb-12	15:30 - 17:00	IESE

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Exercise Schedule

Exercises in the morning?

Exercises

No	Date	Time	Location	RE Excercises
1	4-Nov-11	17:15 - 18:45	IESE	1. Übung: RE-Spiel (Jörg, **4.11.)**
2	18-Nov-11	17:15 - 18:45	48-462	2. Übung: Functional Specification (by Reeng. Existing system) in Natural Language Specification (**11.11.**)
3	25-Nov-11	17:15 - 18:45	IESE	3. Übung: SBS (Joerg/Dennis, **2.12.** Modelling
4	16-Dec-11	17:15 - 18:45	IESE	4. Übung: SCR (Joerg/Dennis, **9.12.**), Modelling
5	6-Jan-12	17:15 - 18:45	IESE	5. Übung: EPC (Jörg, **6.1.**), Modelling
6	20-Jan-12	17:15 - 18:45	IESE	6. Übung: Use Cases (Jörg, **13.1.)** Modelling
7	27-Jan-12	17:15 - 18:46	IESE	7. Übung: RM Tools (Jörg, **3.2.**), Management
8	3-Feb-12	15:30 - 17:00	IESE	

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Case Study Assignment

No	Case Study	Material	Students
1	Boeing	http://splc.net/fame/boeing.html	Matteo Settenvini; Peter Reuter
2	Bosch Group	http://splc.net/fame/bosch.html	Dominik Magin; Artur Guschakowski
3	CelsiusTech Systems AB	http://splc.net/fame/celsiustech.html	
4	Cummins, Inc.	http://splc.net/fame/cummins.html	Jona Elezi; Archie Sheran
5	Ericsson AXE	http://splc.net/fame/ericsson.html	Elena Rojo; Adriana Selleri Rocha
6	General Motors Powertrain (GMPT)	http://splc.net/fame/gm.html	
7	Hewlett Packard	http://splc.net/fame/hp.html	
8	HomeAway	http://splc.net/fame/homeaway.html	
9	LSI Logic	http://splc.net/fame/lsilogic.html	
10	Lucent	http://splc.net/fame/lucent.html	
11	Market Maker	http://splc.net/fame/marketmaker.html	
12	Nokia	http://splc.net/fame/nokia.html	
13	Philips (Medical Systems)	http://splc.net/fame/philips-medical-systems.html	
14	Philips (Software for Television Sets)	http://splc.net/fame/philips-television.html	
15	Philips (Telecommunication Switching System)	http://splc.net/fame/philips-switching-system.html	
16	Salion, Inc.	http://splc.net/fame/salion.html	
17	Toshiba	http://splc.net/fame/toshiba.html	
18	U.S. Naval Research Laboratory	http://splc.net/fame/us-naval-research-lab.html	
19	Testo	http://www.computer.org/portal/web/csdl/doi/10.1109/SPLC.2006.16	
20	Wikon	http://www.google.de/url?sa=t&rct=j&q=splc%20wikon&source=web&cd=1&ved=0CBwQFjAA&url=http%3A%2F%2Fwww.iese.fraunhofer.de%2Fcontent%2Fdam%2Fiese%2Fen%2Fdokumente%2FStudieVM-Development.pdf&ei=-Ta4TsKrCsKe-Qac4vmEBg&usg=AFQjCNFZDqv9RNzrCTwt7SVAUErP7mkxLg	

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--- Recap ---
Scoping

Scoping

Scoping :== process of **identifying** and **bounding**

areas (subdomains, existing assets)

and **capabilities** (features)

of the product line where investment into reuse is economically useful and beneficial to

product development.

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Common concepts/questions of all scoping approaches

- **Products:**
Which products do I want to have in my product line? What is their market, when will they be released?
- **Domains:**
Which subdomains will my product line have? Which information do they carry? What are „good“, what are „bad“ domains for the product line (in terms of knowledge, stability etc)?
- **Features**
Which features will my product line have? Which product will have what kind of features? Which are easy, which are risky features?
- **Assets**
Which assets do I have in my product line? Which components, documentation etc exists already in a reusable form, which ones do I have to (re-)implement?

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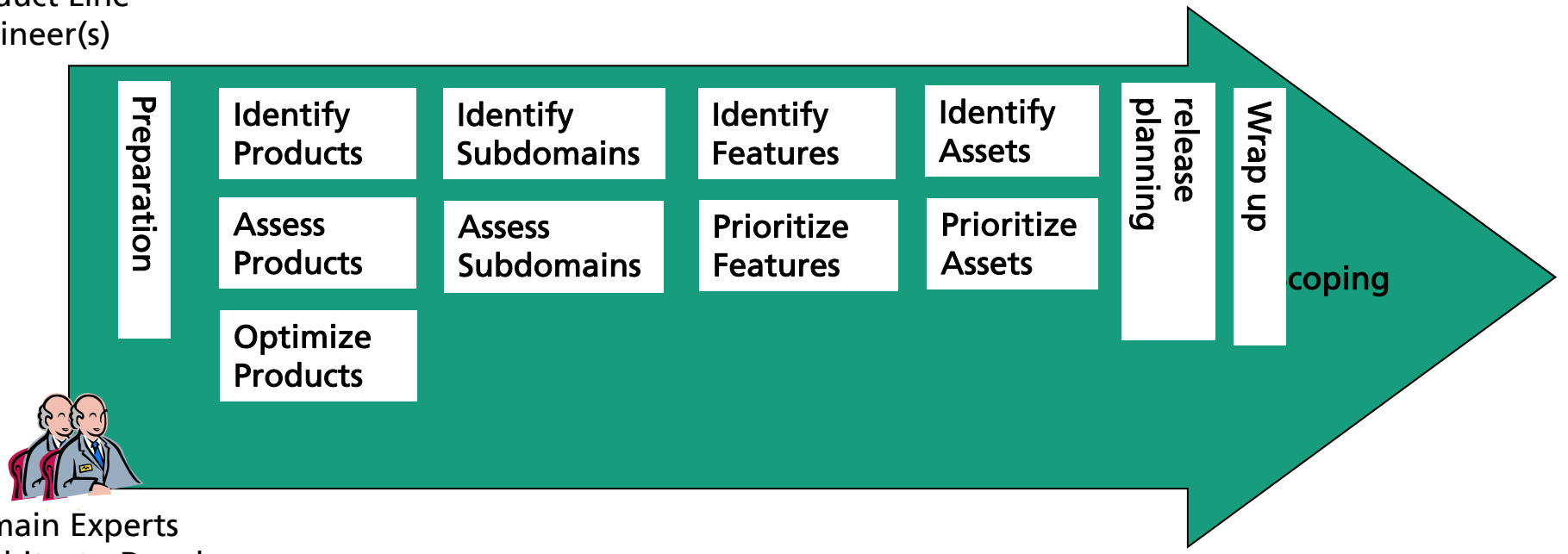
A generic scoping process

Product Line Engineer(s)



Domain Experts (Architects, Developers, Managers, Marketing etc)

A concrete scoping process = a combination of these activities

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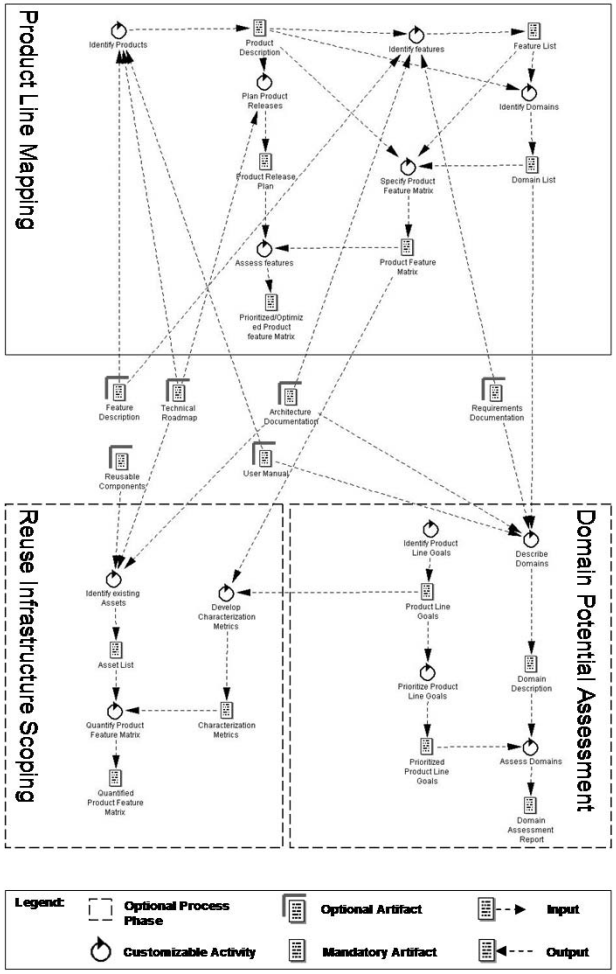
Scoping Process - Overview



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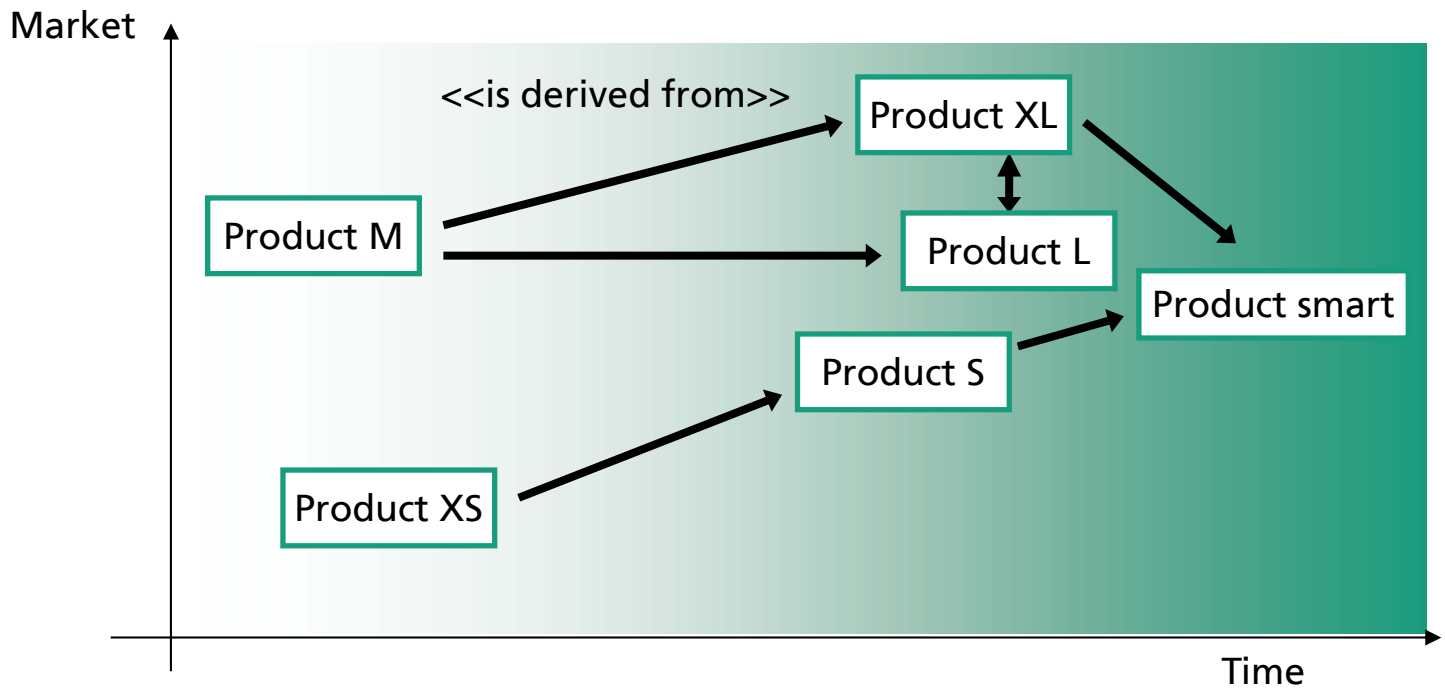
Product Release Plan



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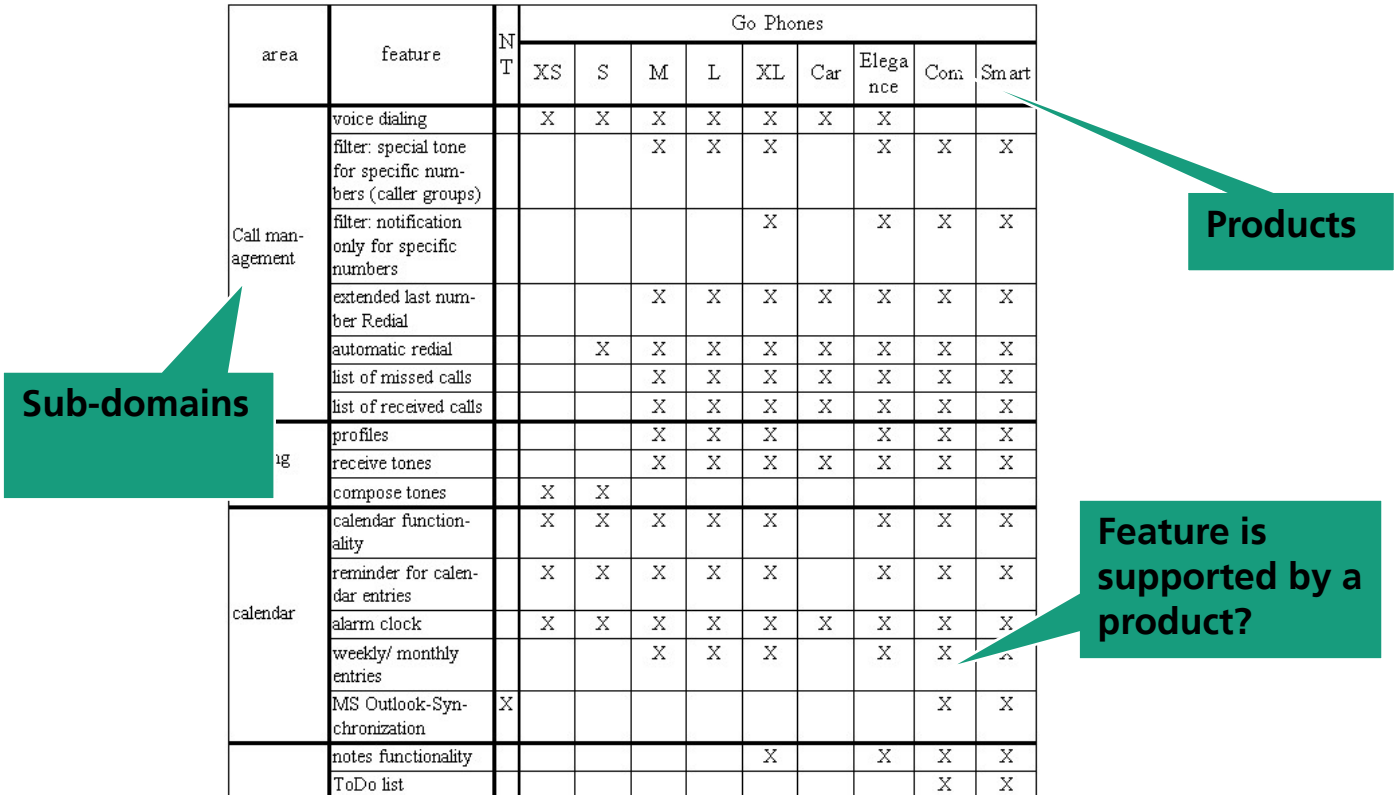
Scoping – Product Feature Matrix



area	feature	NT	Go Phones								
			XS	S	M	L	XL	Car	Elegance	Com	Smart
Call management	voice dialing		X	X	X	X	X	X	X		
	filter: special tone for specific numbers (caller groups)				X	X	X		X	X	X
	filter: notification only for specific numbers						X		X	X	X
	extended last number Redial				X	X	X	X	X	X	X
	automatic redial			X	X	X	X	X	X	X	X
	list of missed calls				X	X	X	X	X	X	X
	list of received calls				X	X	X	X	X	X	X
	profiles				X	X	X		X	X	X
	receive tones				X	X	X	X	X	X	X
	compose tones		X	X							
calendar	calendar functionality		X	X	X	X	X		X	X	X
	reminder for calendar entries		X	X	X	X	X		X	X	X
	alarm clock		X	X	X	X	X	X	X	X	X
	weekly/ monthly entries				X	X	X		X	X	X
	MS Outlook-Synchronization	X								X	X
	notes functionality						X		X	X	X
	ToDo list									X	X

Products

Sub-domains

Feature is supported by a product?

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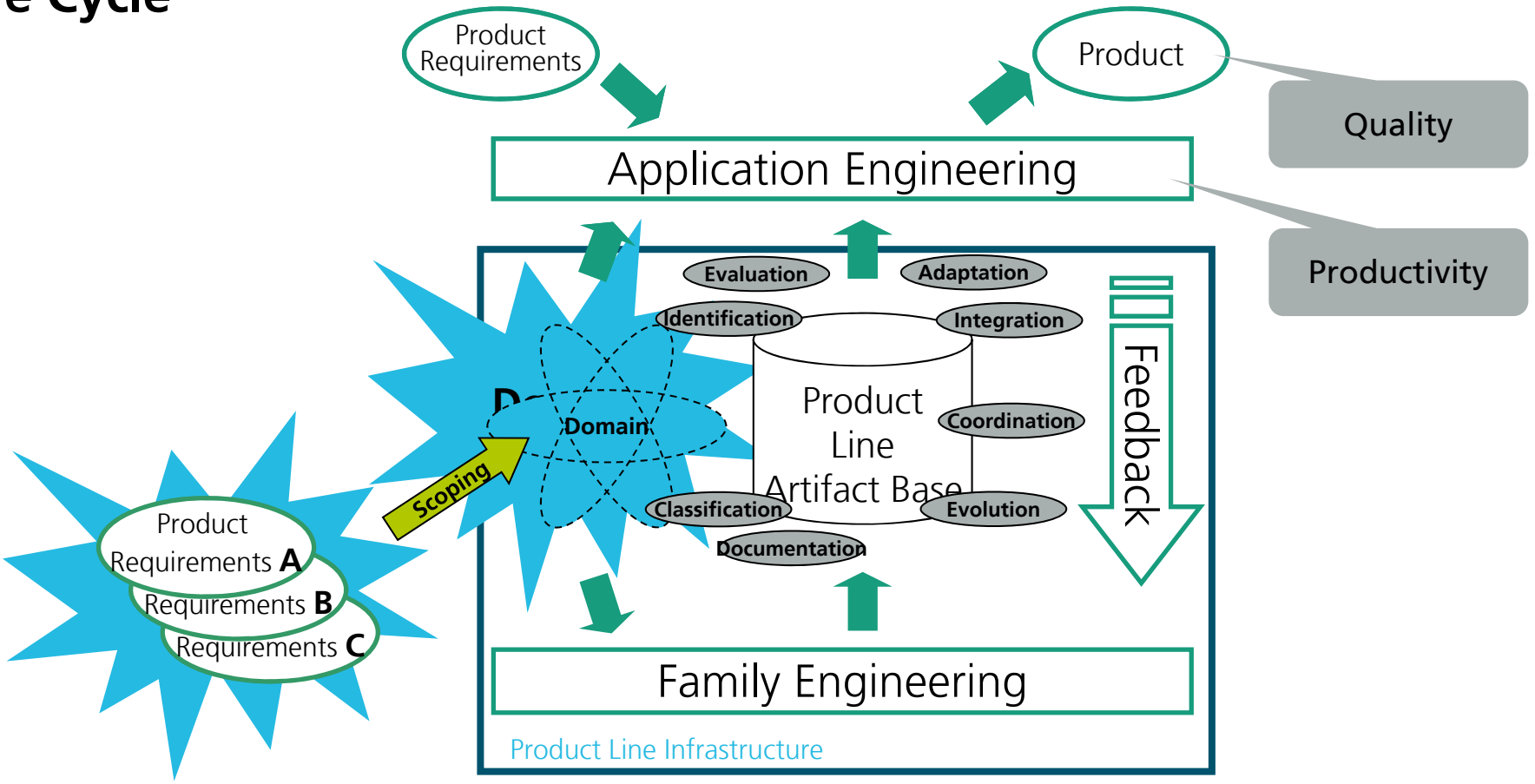
--- Product Line Infrastructure
Part I: Variability Modeling ---

Product Line Life Cycle



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Product Line Infrastructure

Product Line Infrastructure :==

System of **facilities**,

equipment and **services**

needed for the **operation** of a product line

[specialization of ISO9000:2005-12]

Note: The product line infrastructure comprises
the core asset base (aka. Product Line Artifact Base)

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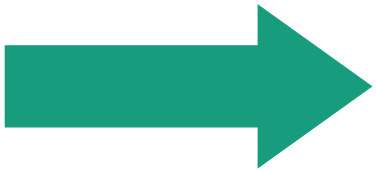
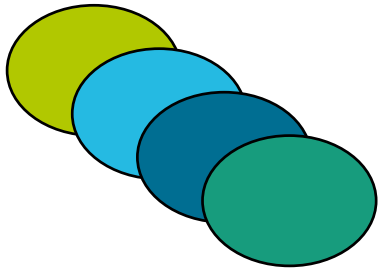
Goal of a Product Line Infrastructure

Product Line Infrastructure





Products

⇨ Goal of a product line infrastructure is to facilitate the derivation of products, i.e the members of the product line

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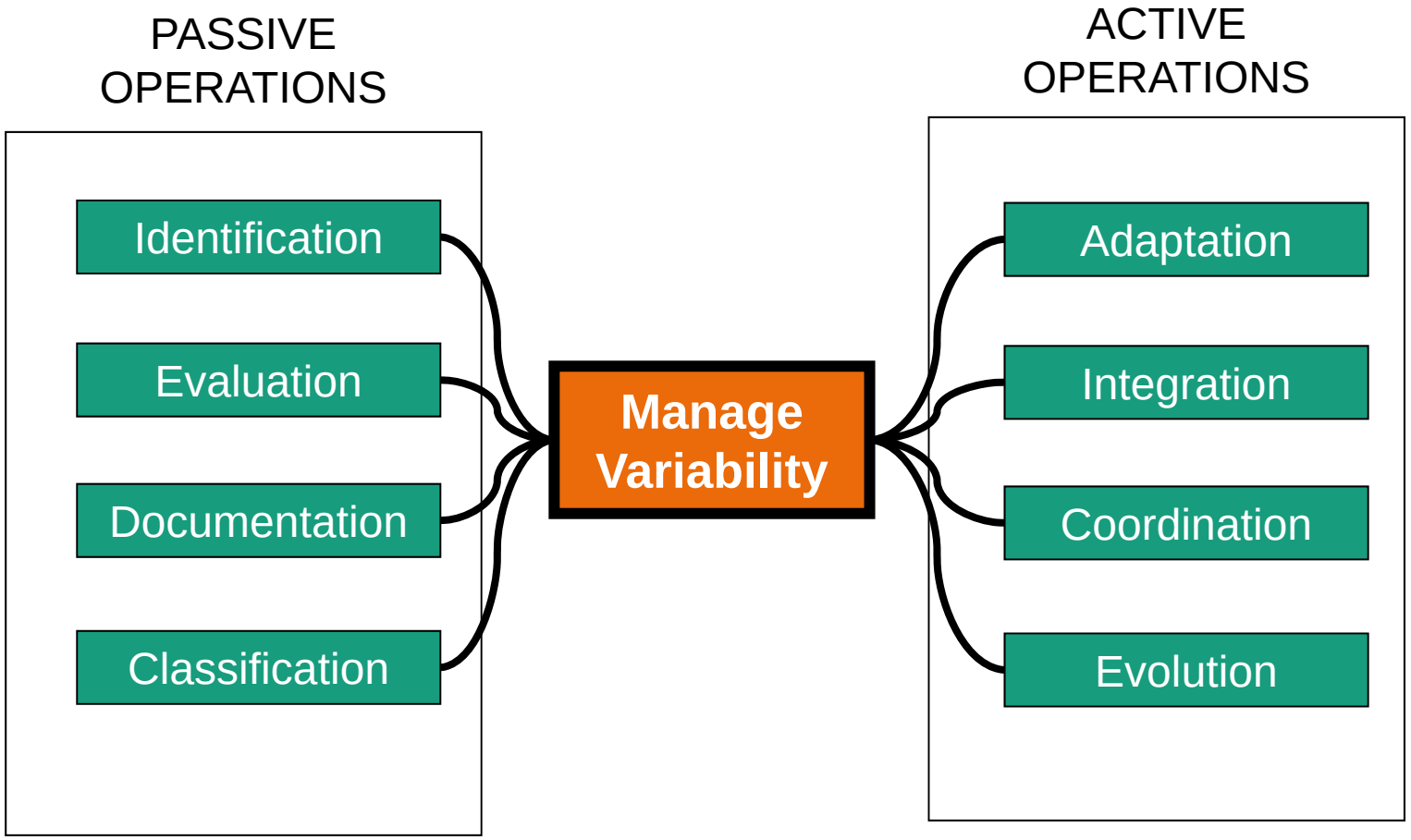
Product Line Infrastructure Operations



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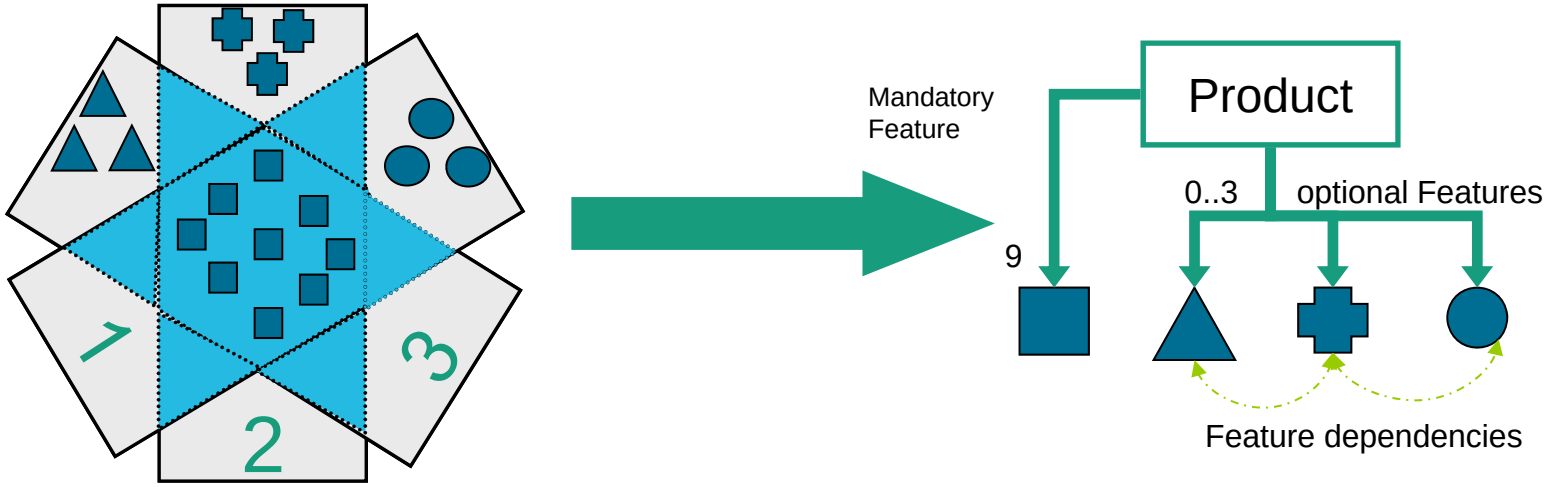
Variability Management



- Variability management is a central component of every Product Line Engineering approach
- It allows managing common and varying parts as well as their interdependencies
  - Specification, Realisation
- It allows configuring, building and managing product line members
  - Production

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On Variability

Variability := a **characteristic**
that is **different**
for some **members** of a *category*
[Bassett97]

Notes:

- Counterpart commonality: … same … all
- A kind of feature
- Delayed (design) decision: FE -> AE
  - Variability → Decision

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Variability

Variability :=

- the **ability** or tendency to **change**
- a **characteristic** that is **different** for some **members** of a *category* *[Bassett97]*
- a **capability** to **change** or adapt a **system** *[Svanberg]*
- a **delayed** design **decision**

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Three Questions to Analyse Variability [Pohl]

- What does vary?
  - ➔ Variability Subject
- Why does it vary?
  - ➔ Variability Driver
- How does it vary?
  - ➔ Variability Object; an instance of a Variability Subject

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Variability in Product Lines

Mobile Phones:

Different Characteristics:

- System: functions, form factor, housing, interaction, CPU, SW-platforms
- Context: User groups, markets, regions, regulations, interconnected systems

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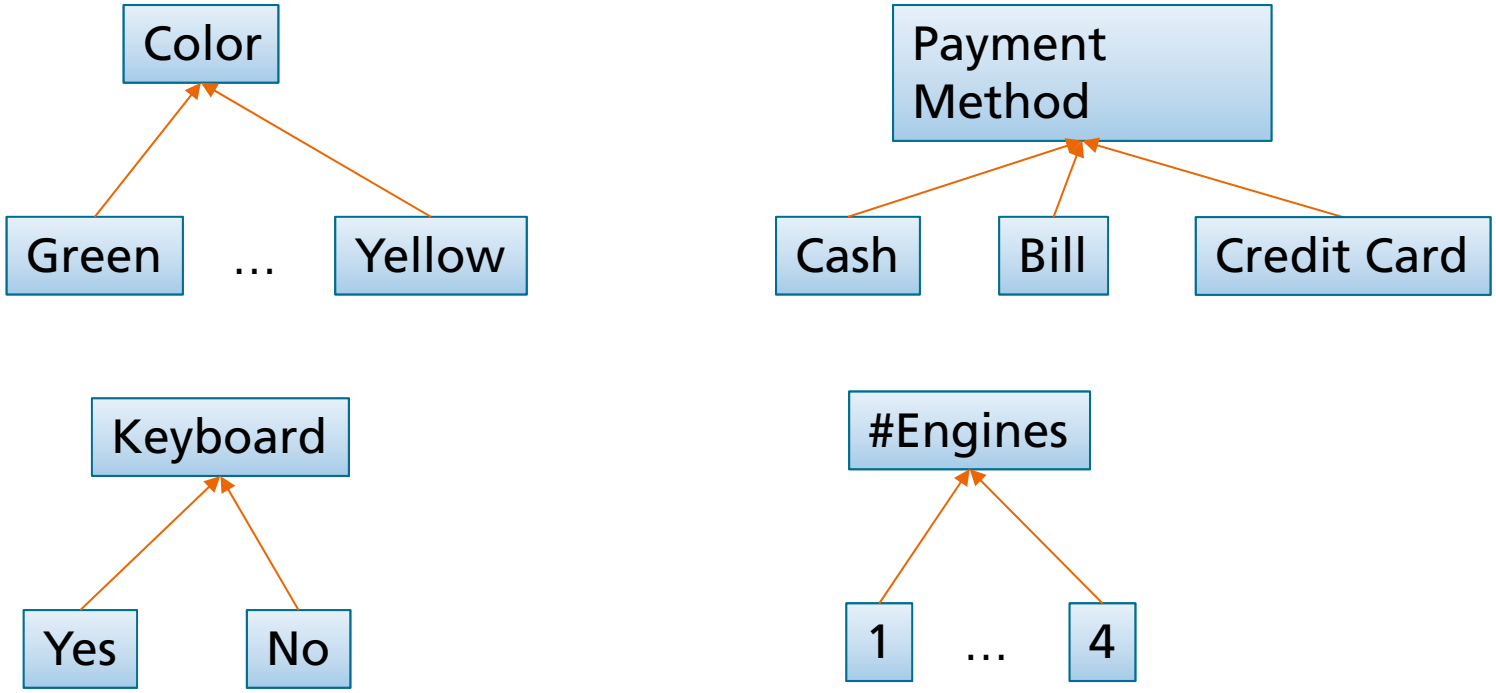
Examples



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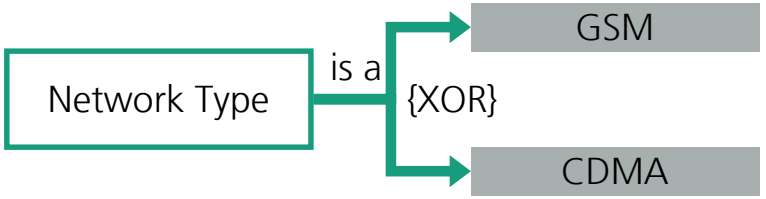
Variability Types (1/2)

Optional Variability

- Boolean
- Select 0..1 out of 1 possibility

Alternative Variability

- XOR
- Enumeration
- Select 1 out of n possibilities



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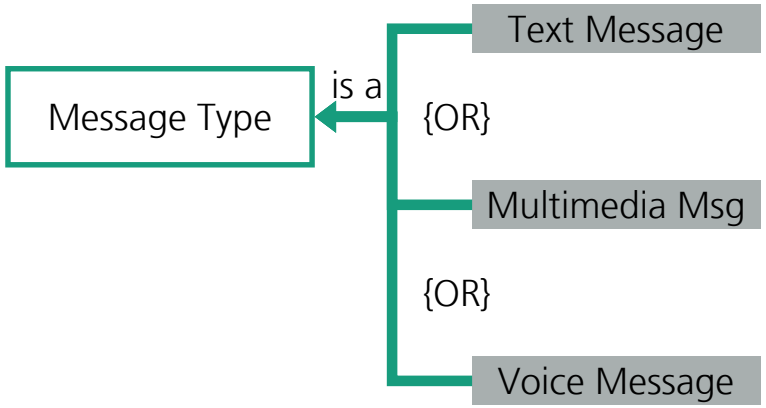
Variability Types (2/2)

Multiple Coexisting Possibilities

- OR
- Set
- Select 1..m out of n possibilities



Numeric

- Enumeration
- Integer
- Float

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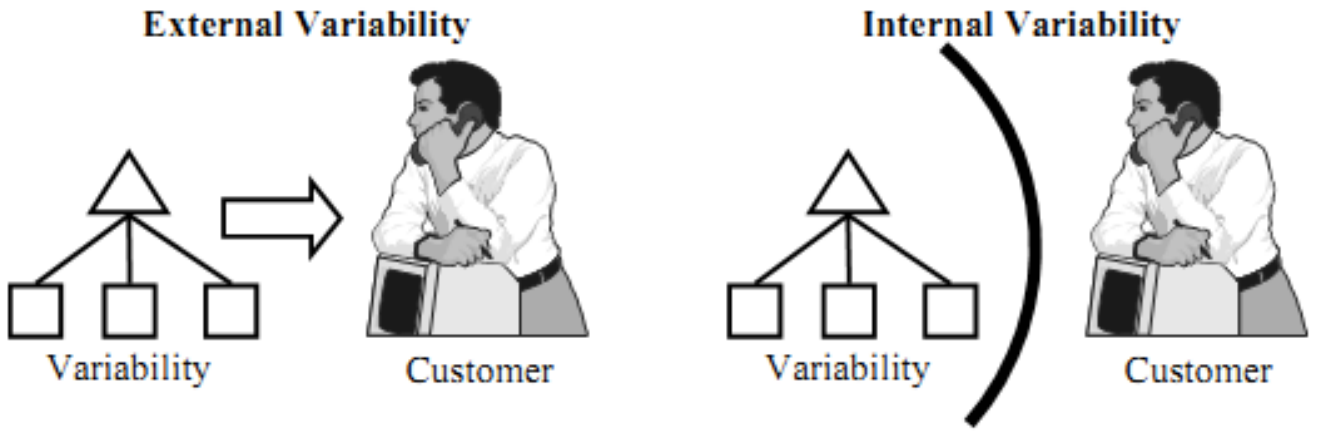
External vs. Internal Variability



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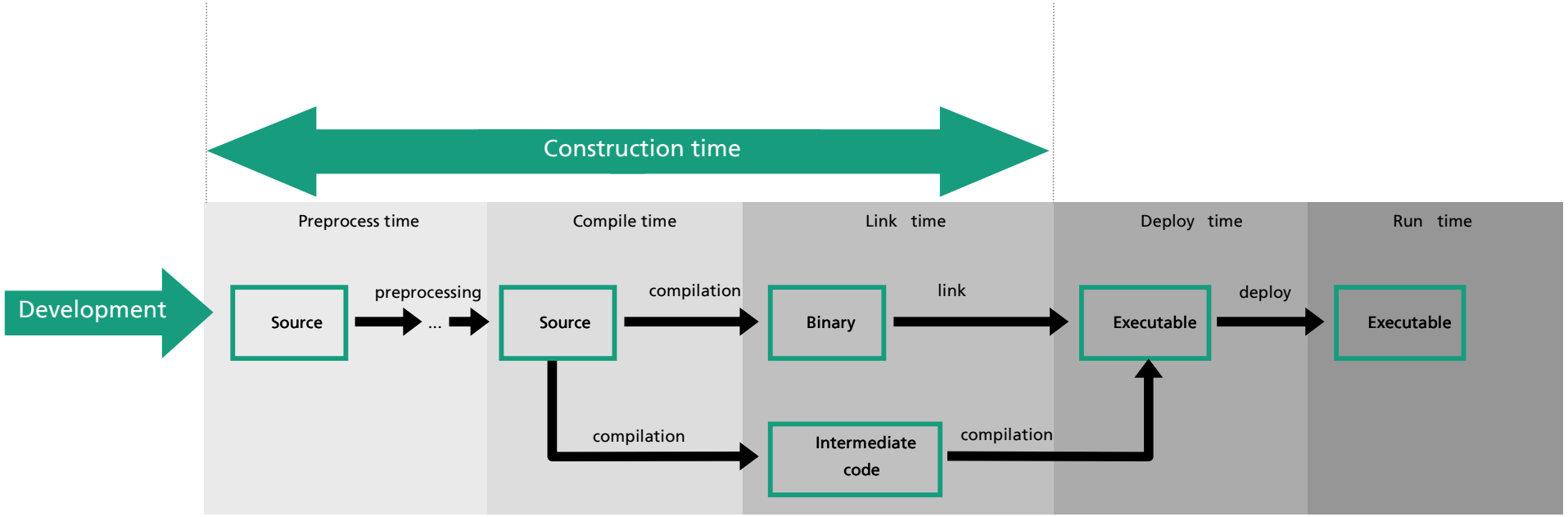
Binding Time of Variability

Binding time refers to the time at which the decision for a variability is made



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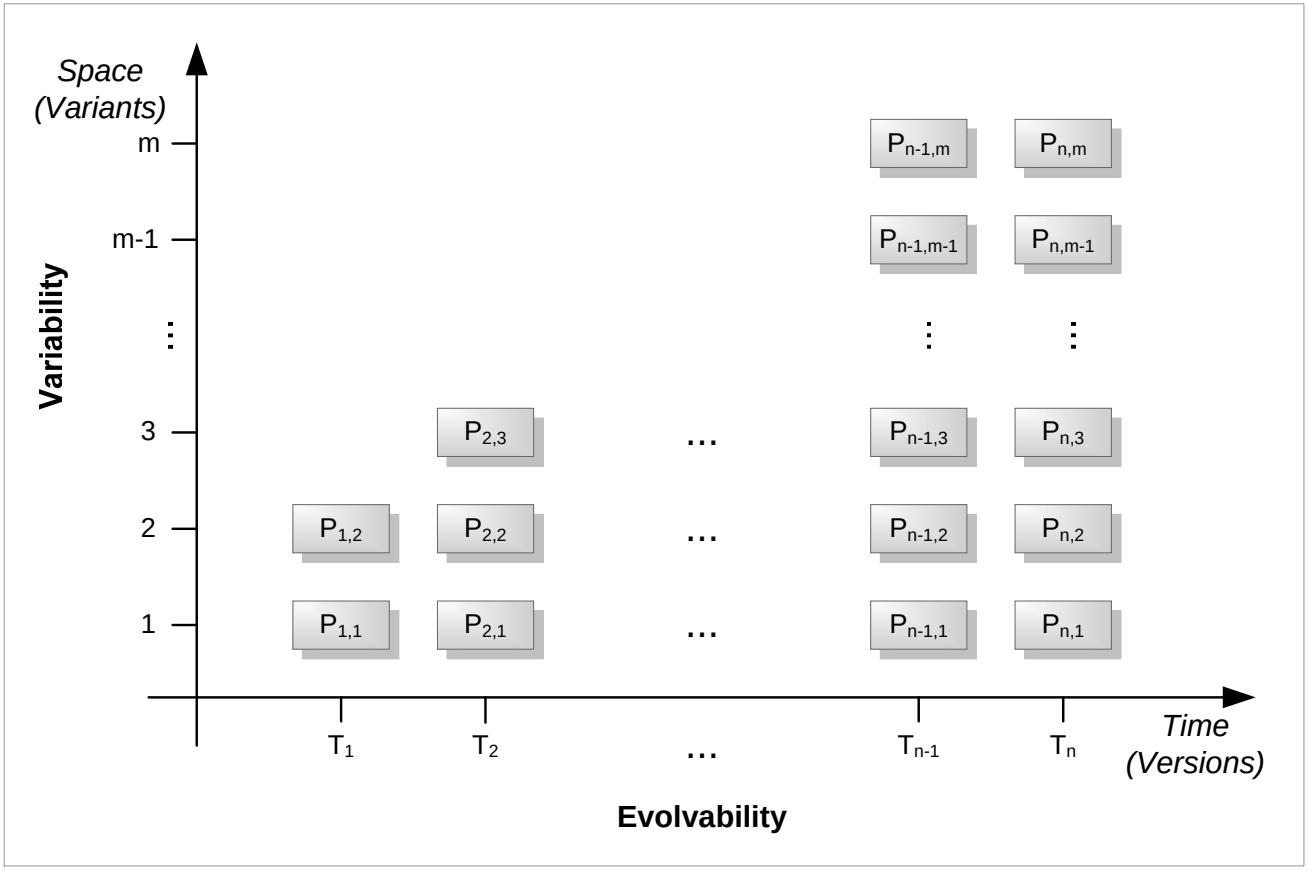
Variability in Space and Time



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Variability Attributes

- Changeability
  - Never, ConfigMode, Runtime
- Range
  - {….}
  - [Min, Max]
  - Changeablilty
- Default
- Binding Time
- Visibility

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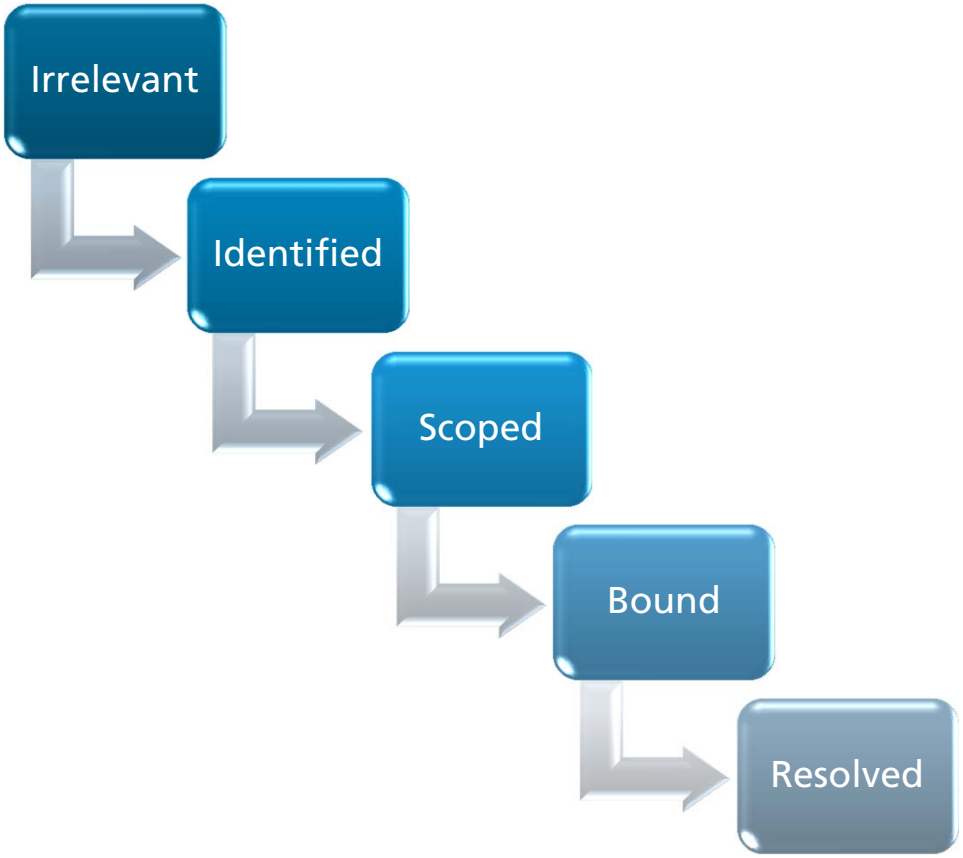
Variability Lifecycle



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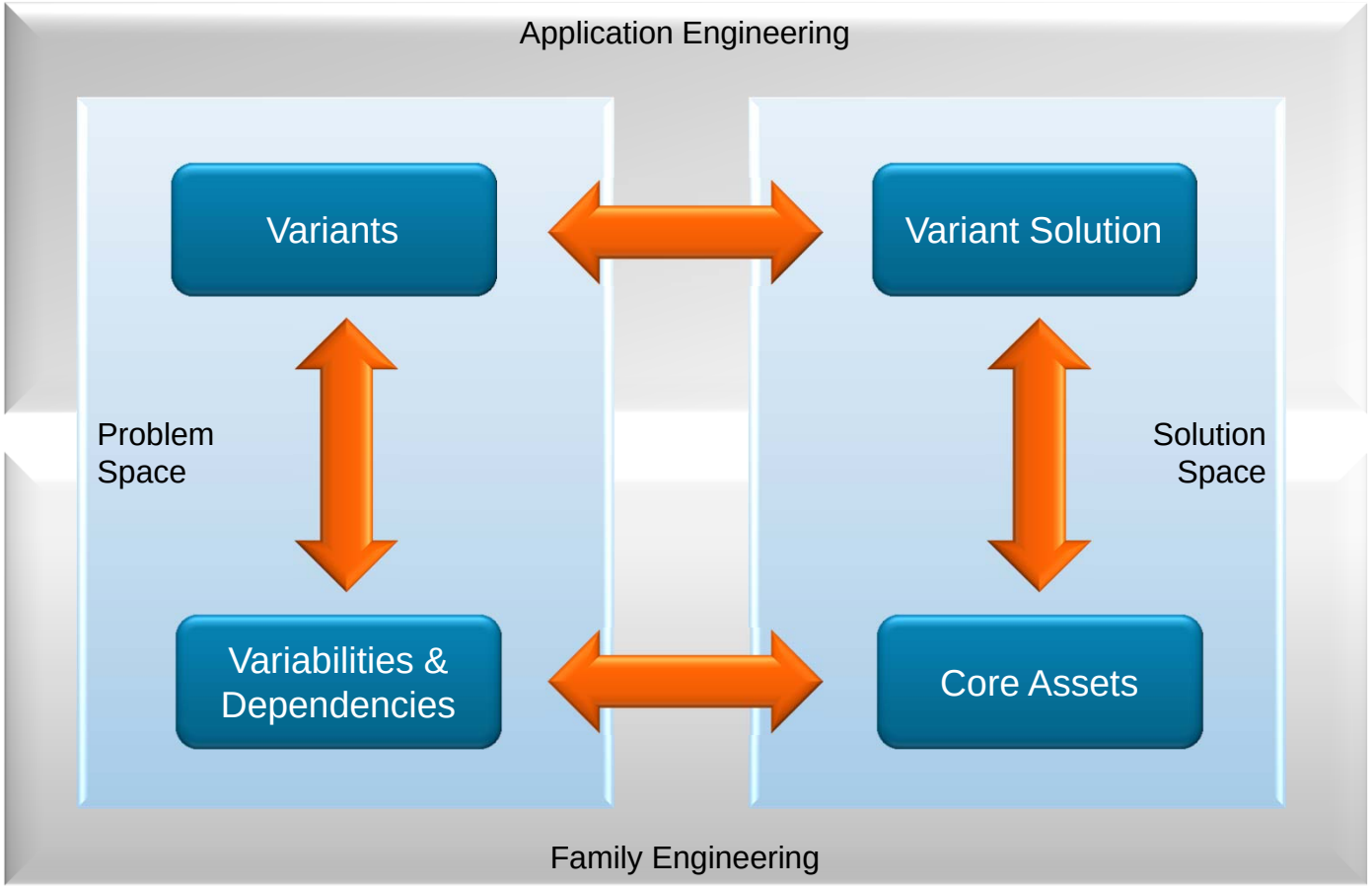
Separation of Concerns



Variability management interrelates the concerns

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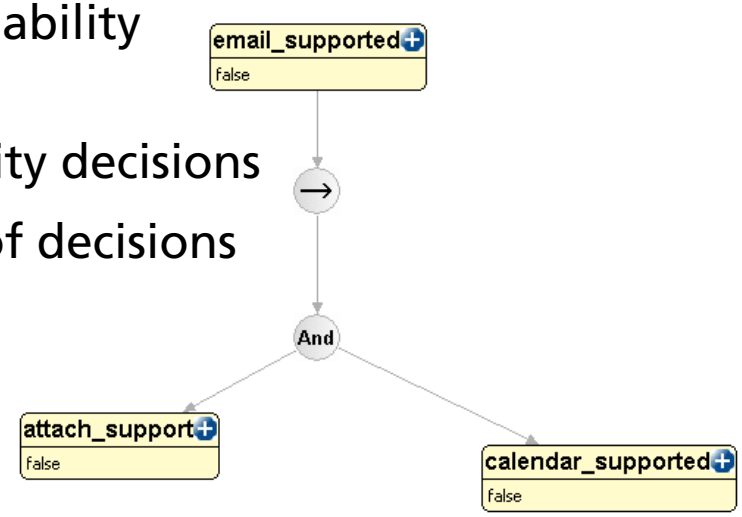
Variability Dependencies

- Dependencies are extremely important in variability management
- They describe dependencies between variability decisions
- Dependencies lead to automated resolution of decisions when a product is derived
- Dependency identification and maintenance is a major challenge
- Typical: Includes, excludes
- Background:
  - Hard facts: Norms, regulations, physics
  - Soft facts: Organisation standards, technology, suggestions



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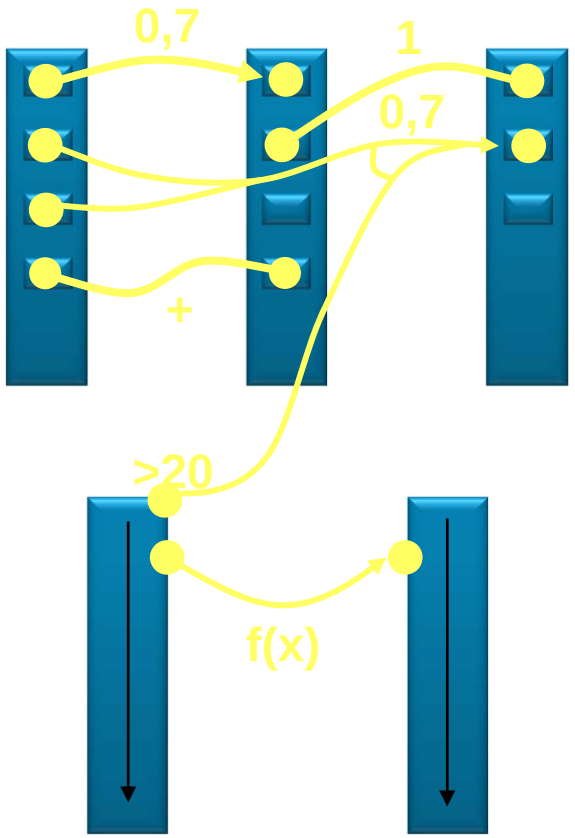
Dependencies

- hard / soft
- Uni directional / bi directional
- Logical expressions
- Functional interrelations
- Source & Target:
  - Value
  - Default
  - Range



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Dependency Attributes

- Changeability
  - Never, ConfigMode, Runtime
- Origin
- Condition
- Trigger: OnInit, OnConfig, OnChange
- Confidence

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Rule-based Approaches

```
IF (Condition) THEN
   (Action) or

IF (Condition) THEN
   (Action is not allowed)
```

- Intuitive
- Widely adopted
- Problematic, if several rules influence the same variability
- Limited evolvability, e.g. addition of new alternative can invalidate rules

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Constraint-based Approaches

```
CONSTRAINT (Feature_1, Feature_2, …,
Feature_N) {
   Combination_1 {
     (Feature_1 = Value_1_1)
     (Feature_2 = Value_1_2)
      ...
     (Feature_N = Value_1_N)
   }//END Combination_1
   Combination_2 {
     (Feature_1 = Value_2_1)
     (Feature_2 = Value_2_2)
      ...
     (Feature_N = Value_2_N)
   }//END Combination_2
   ...
   Combination_N {
     (Feature_1 = Value_N_1)
     (Feature_2 = Value_N_2)
      …
     (Feature_N = Value_N_N)
   }//END Combination_N
}//END CONSTRAINT
```

Other approaches:

- OCL
- Decision Tables

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Discussion on Decision and Feature Models

- Feature Models
  - broader adoption in the practice
  - also enable the description of commonality (mandatory features)
  - more intuitive and thus better suited for documentation

- Decision Models
  - focus on the variability
  - can be hierarchically structured
  - commonality can be modeled as an already taken decision
  - standard traceability to artifacts – each decision has an effect

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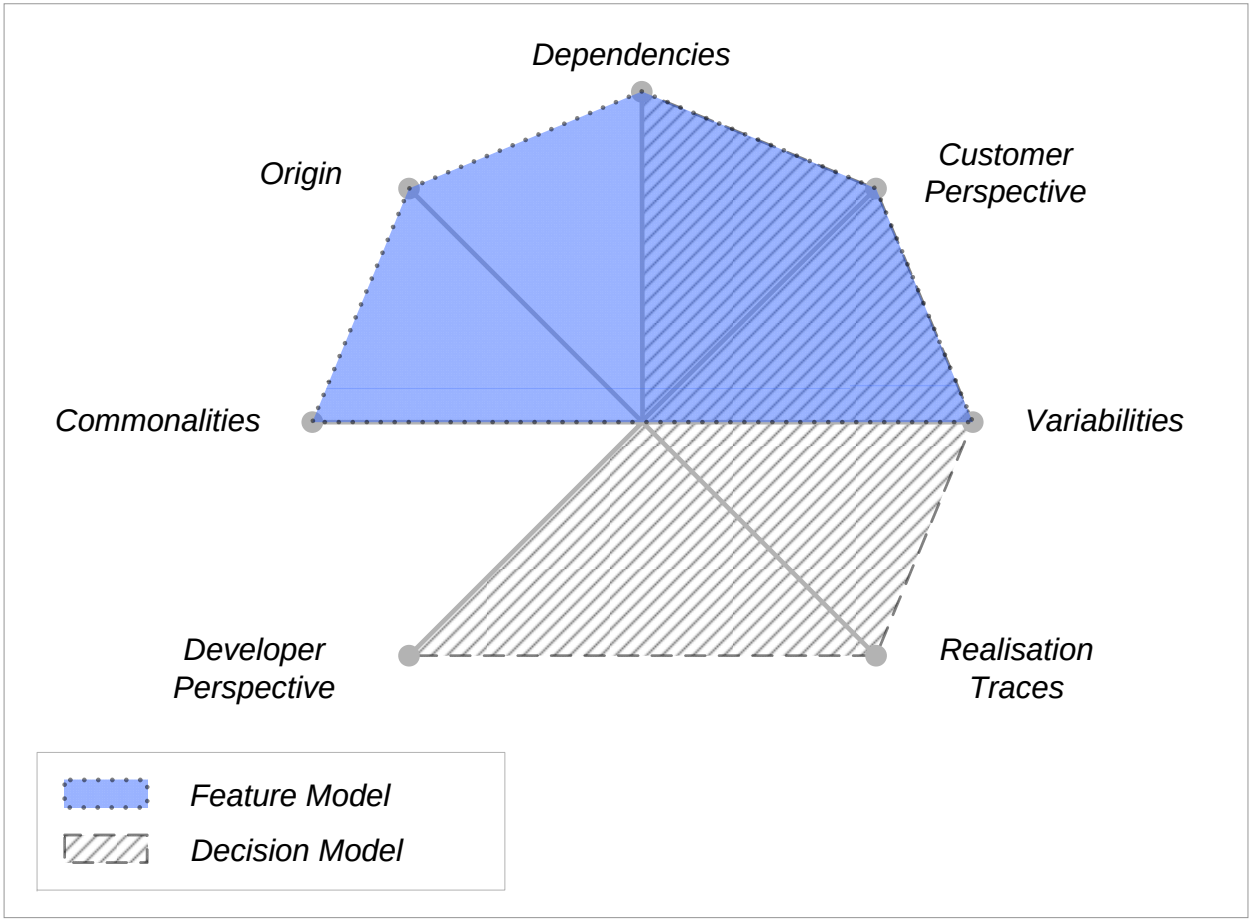
Feature Models vs. Decision Models



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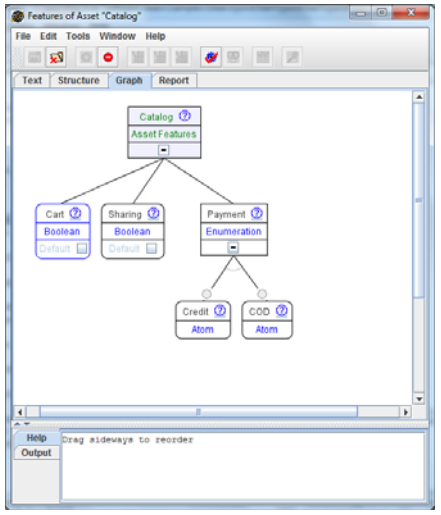
Variability Management Tooling

- Variability Modelling Tools
  - GEARS
  - pure::variants
  - PLUM
  - DecisionKing
  - fmp-plugin and various other feature modeling tools



- Configuration Tools
  - Linux Kernel Configurator (based on the configuration menu language)
    - make-based configuration
  - Special-purpose Configurators
    - camos.Develop
    - K-Config

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Further Reading

- Pohl, Klaus ; Böckle, Günter ; Linden, Frank van der: **Software Product Line Engineering : Foundations, Principles, and Techniques** Berlin : Springer-Verlag, 2005. - ISBN 3-540-24372-0
- David Benavides, Sergio Segura and Antonio Ruiz Cortés: **Automated Analysis of Feature Models 20 Years Later**: A Literature Review http://dx.doi.org/10.1016/j.is.2010.01.001Information Systems . Elsevier. 2010. 35(6). September 2010
- Atkinson et al.: **Component-Based Product Line Engineering with UML, 2001**

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