

Product Line Engineering Lecture – Scoping (3)

Dr. Martin Becker

martin.becker@iese.fraunhofer.de



Recap: Organizational Issues

If you are not yet registered, please register yourself via e-mail to:

adeline.silva@iese.fraunhofer.de

Subject: Register – Lecture

Content

- Name: <your name>
- Course of studies and Semester
- Email
- Experience in Software Engineering
 - University (lectures, classes)
 - Industry
 - Other

--- Recap ---
Introduction

Product Line Engineering

General domains are large and have fuzzy boundaries

Scoping defines sharp domain boundaries based on concrete product requirements

- Existing products
- Competitor products
- Future or envisioned products

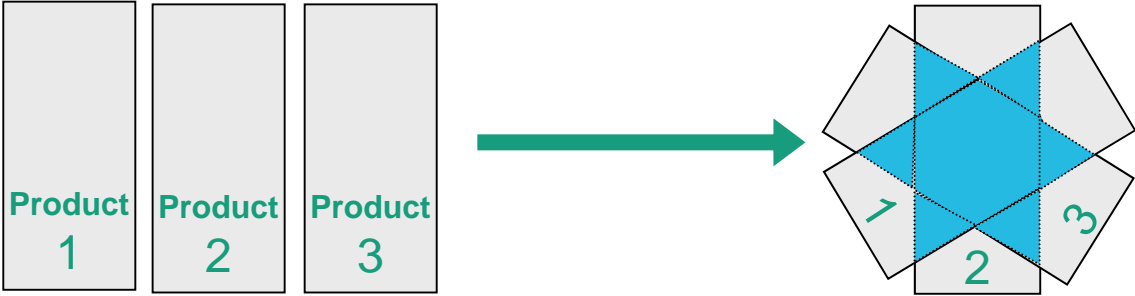
Family engineering is thus

- More focused and closer to production (than DE), as well as
- More efficient

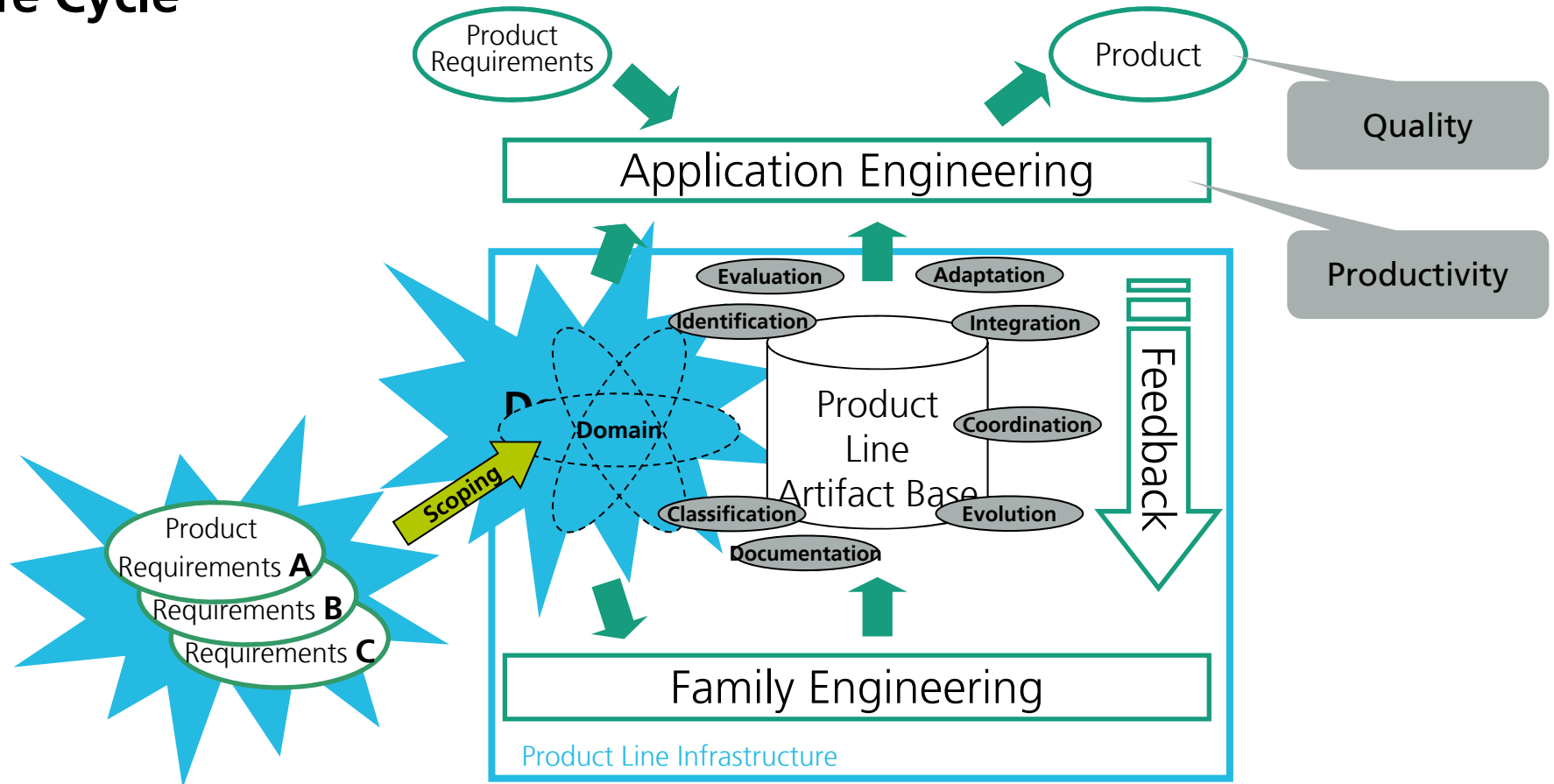
Emphasis is on Application Engineering!

Product Line

Product Line := a family of products designed to take advantage of their **common aspects** and **predicted variabilities** [Weiss, Lai]



Product Line Life Cycle



--- Product Line Scoping ---
How to define and plan
a product line?

Product Line Process Models

From an external point of view, application engineering is identical to single system development

- AE: $R \Rightarrow P$

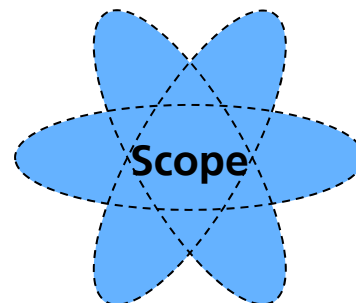
From an internal point of view, it is significantly different

- Reuse must be built in AE definition (ie, no searching but accessing of reusable artifacts)
- We call it "Reuse-Centric Application Engineering"
AE: $R \times A \Rightarrow P$ (or $P \times A$)
 - A: Product Line Artifact Base; set of reusable artifacts

Family Engineering is a function

FE: $S \Rightarrow A$

- **S: Product Line Scope**



Family Engineering as Project

Family engineering is an engineering project

- In principle, as any other project

Results, however, are of high strategic importance

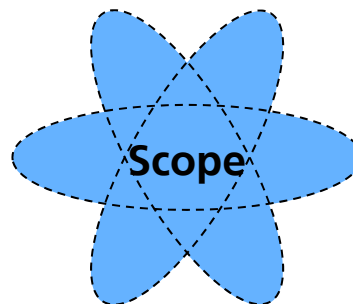
- Reusable artifacts
- Reuse infrastructure

Results determine capability of an organization

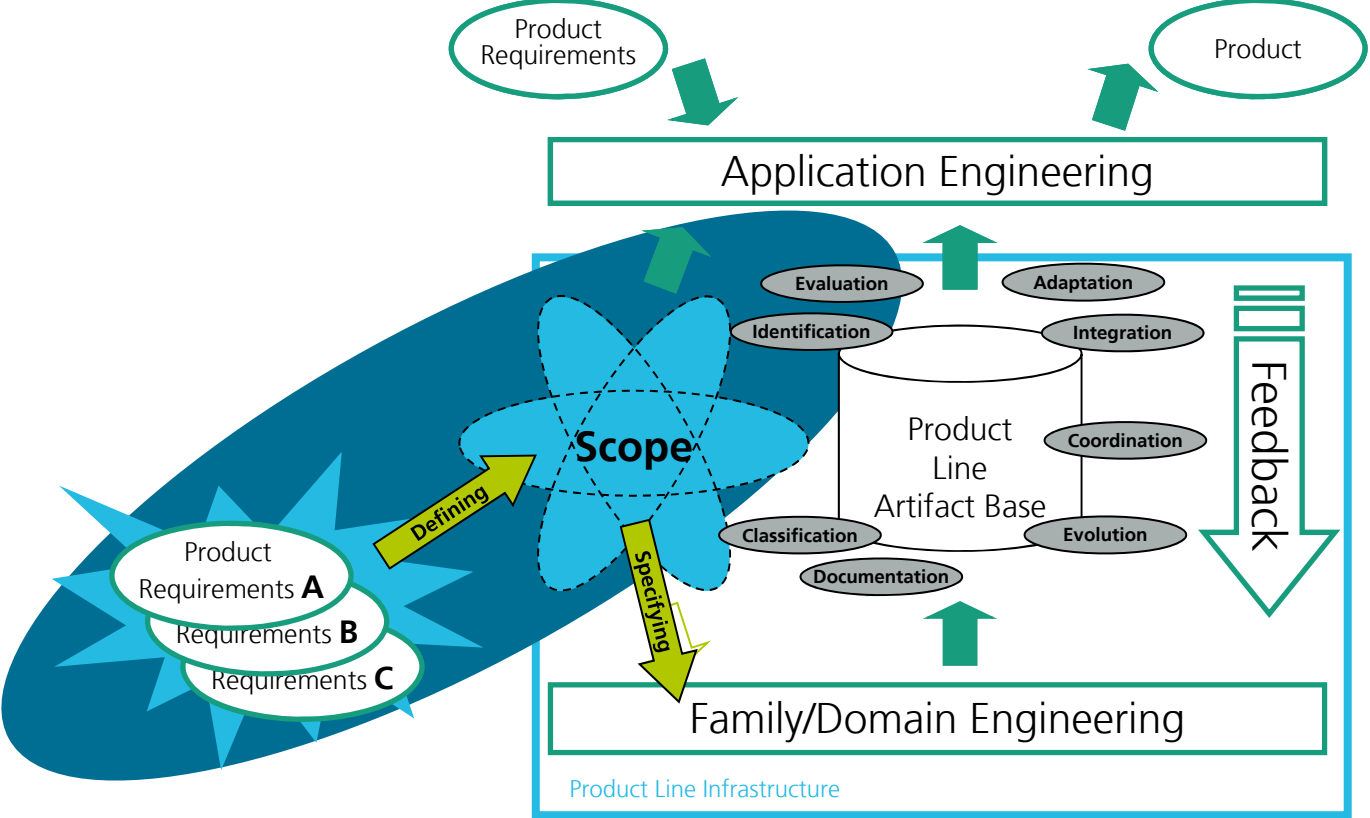
- Products that can be engineered efficiently

Input must thus outline an organization's strategy

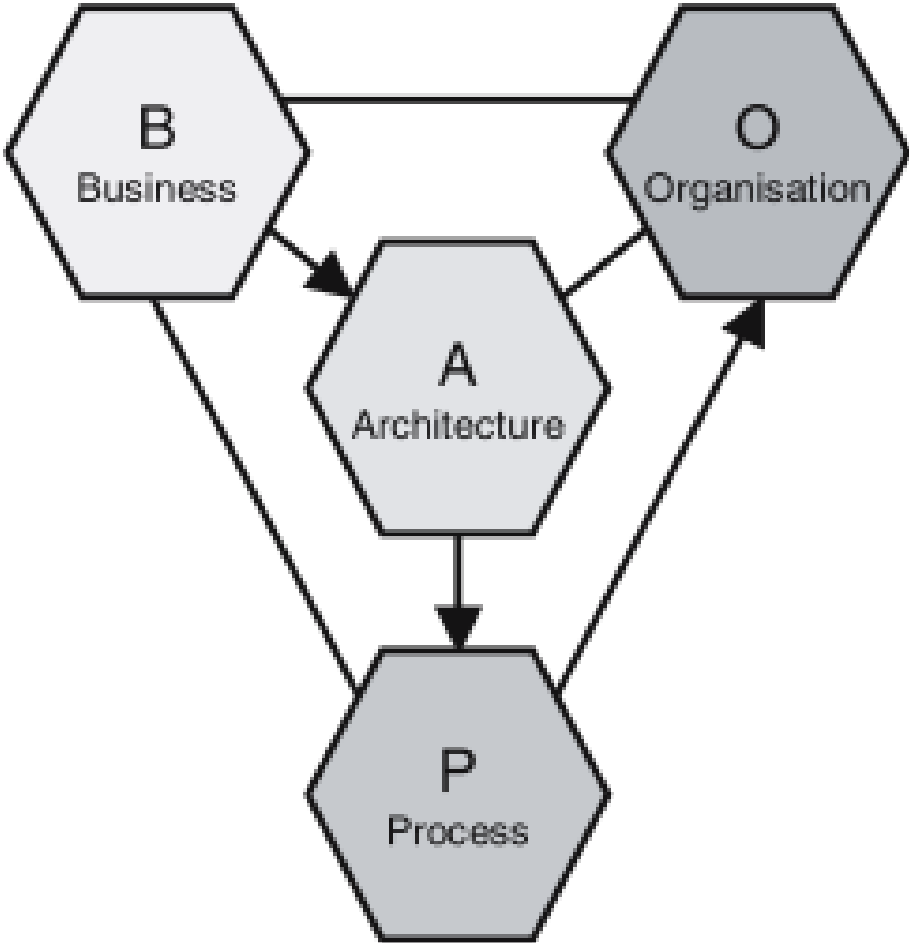
- What products to built?
- Roadmap
- Schedule
- Quality preferences



Scoping – Context



BAPO Model



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.

Scoping – Scope Definition (1/2)

Integrated planning of complete product lines

Recording of existing and anticipated products and their features

Gain explicit understanding of an organization's product portfolio (i.e., which systems it will build)

Assessment of areas where product line engineering brings most benefits

Scoping – Scope Definition (2/2)

Driven by set of concrete products

Identification of commonalities

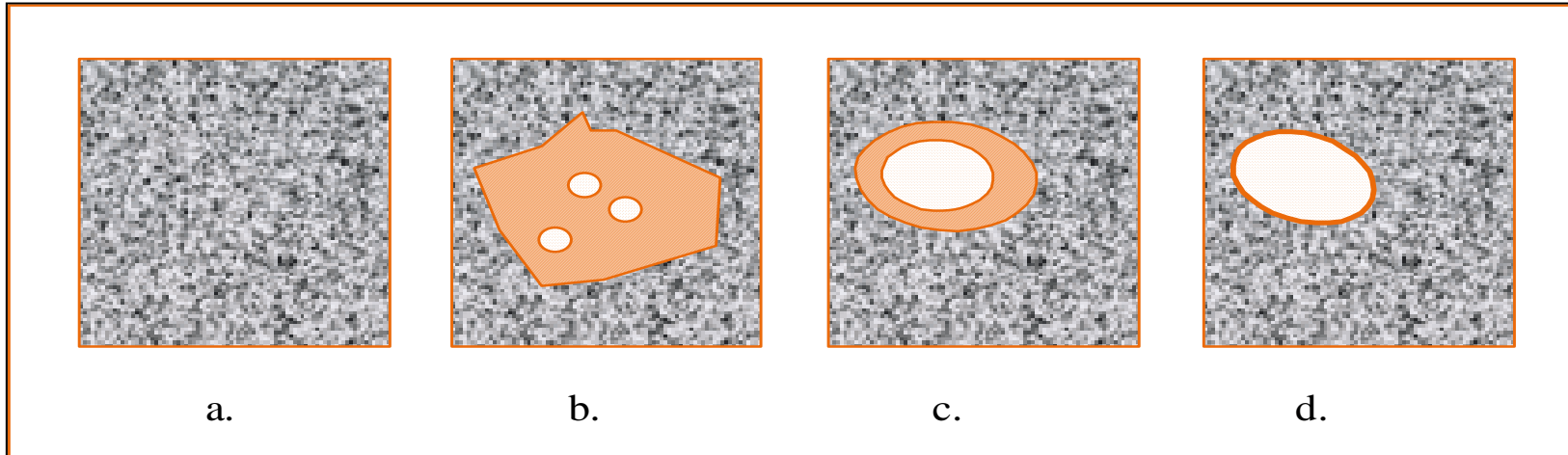
Decision on variation to be supported

- Concrete instances or
- Classes of variations

Clustering of commonalities among products

- Cohesive functional areas (domains)
- Not defining subsystems (components)

Scoping Definition Process



- a: Space of all possible products
- b: Early, coarse-grained "in/out" decisions
- c: Product line scope with a healthy area of indecision
- d: Full product line scope = complete and correct product line requirements

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?

15

Other important aspects

Commonality and Variability

Decision on “right” scope

Delineation of product line

- Too big: unnecessary effort
- Too small: essential product not buildable with justifiable effort

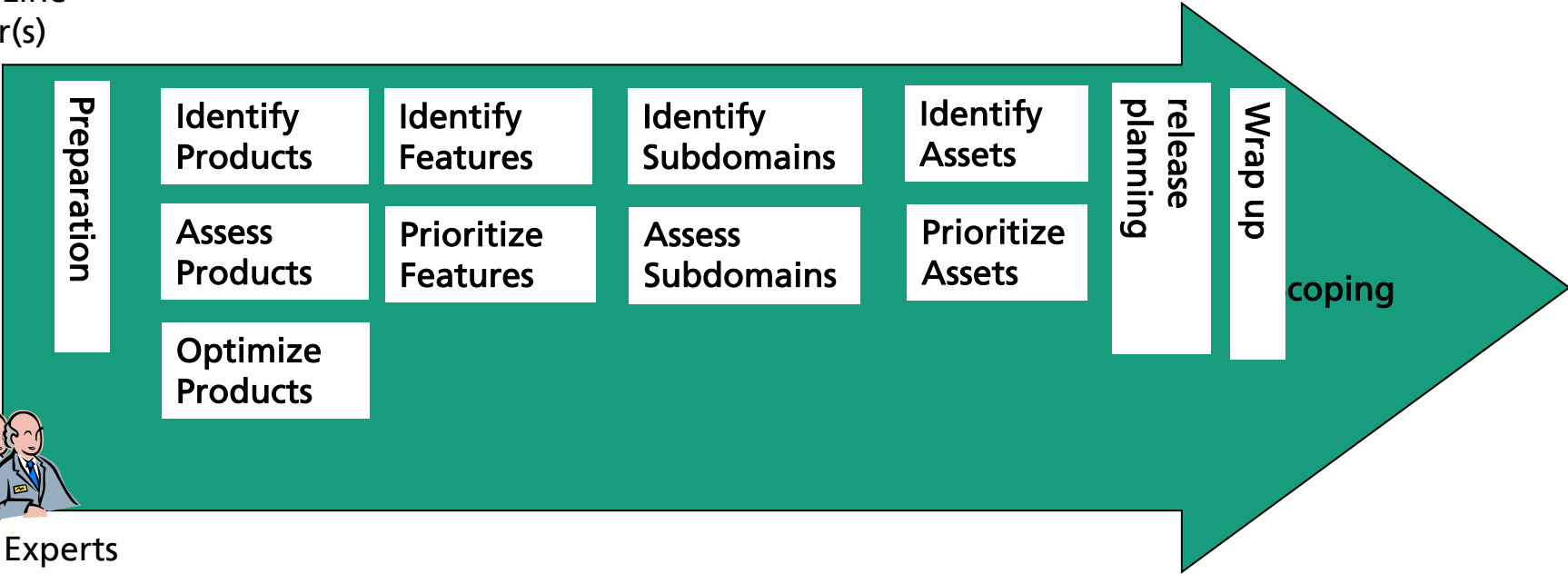
Product line/Scope communication

- Marketing has to sell supported features
- Management has to know scope and evolve it over time
- Engineers have to realize the scope
- Quality assurance and tester have to know the scope

A generic scoping process



Product Line Engineer(s)



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

A concrete scoping process = a combination of these activities

Scoping – Family Specification (1/2)

Process of systematically defining which features and characteristics are covered by the product line infrastructure and which are not

Analyze features and feature groups supported by different products

Recommend or define optimally reusable artifacts in the context of an organization's product line

- Products or Components

Scoping – Family Specification (2/2)

Initial mapping of clusters (domains) to components

- Conceptual architecture (1st draft)
- Note: generally not a 1:1 mapping
 - Architectural concerns (e.g. distribution)
 - Crosscutting concerns

Planning systematic reuse

- Of clusters
- Within each cluster

Organization of variability among products relative to clusters

Our Approach: PuLSE-Eco (Economic Scoping)

Developed since 2000 at Fraunhofer IESE in the context of our Product Line Engineering approach PuLSE

Used by Fraunhofer IESE in many product line projects in different industrial contexts

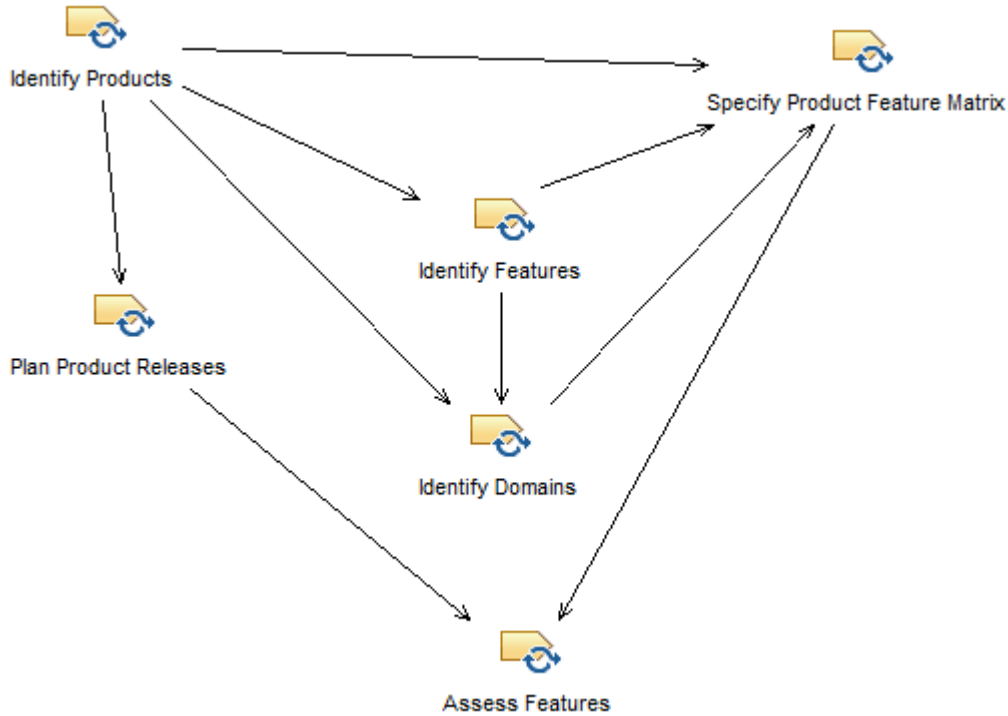
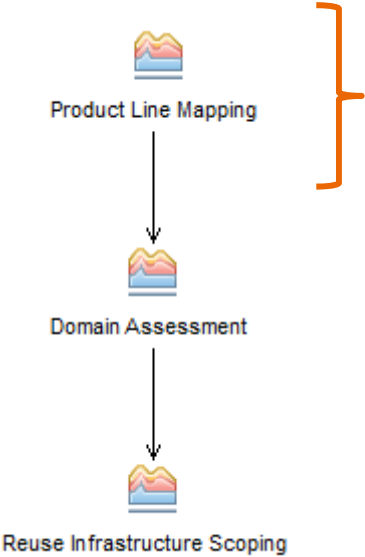
Used to determine the scope of the product line

- What should be reused (what is already there)?
- What should be made reusable (what is not there)?
- Which products should be built?

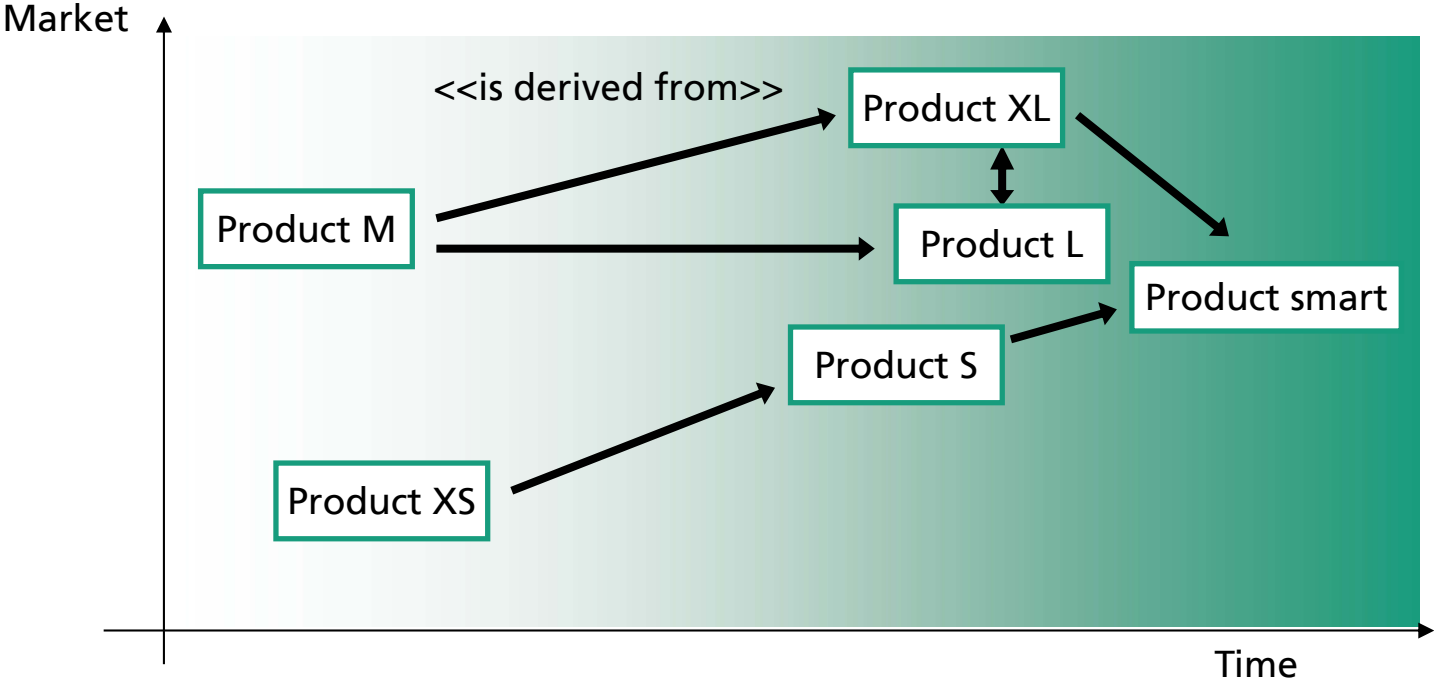
Centered around the concept **“domain”**: An area of functionality within the product line (e.g. “printing”, “messaging”, “security”)

Basis for **product centric development**: never forget the products that you want to build!

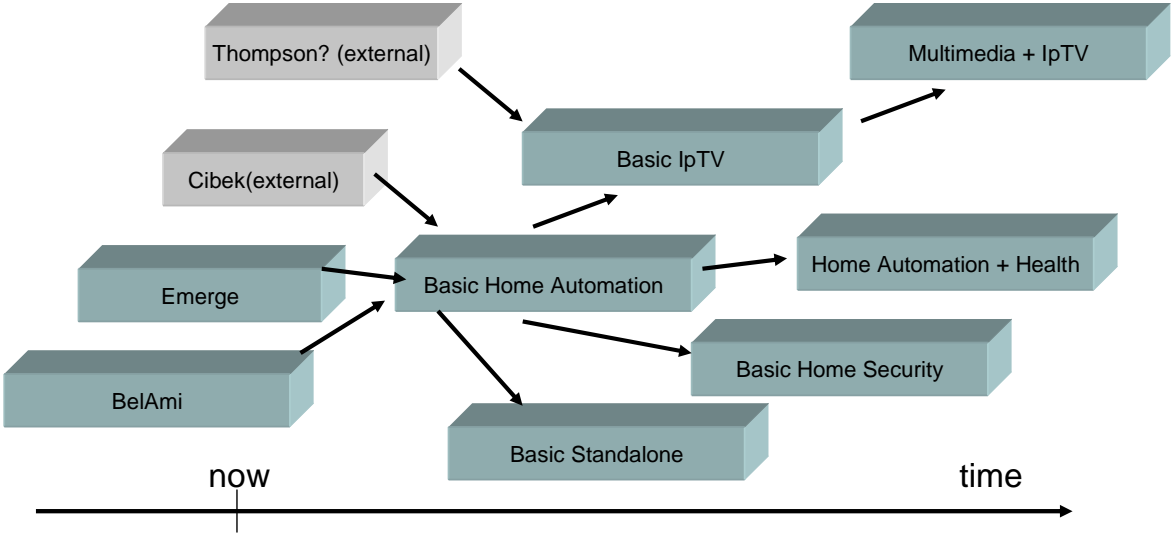
Scoping process - overview



Product Release Plan

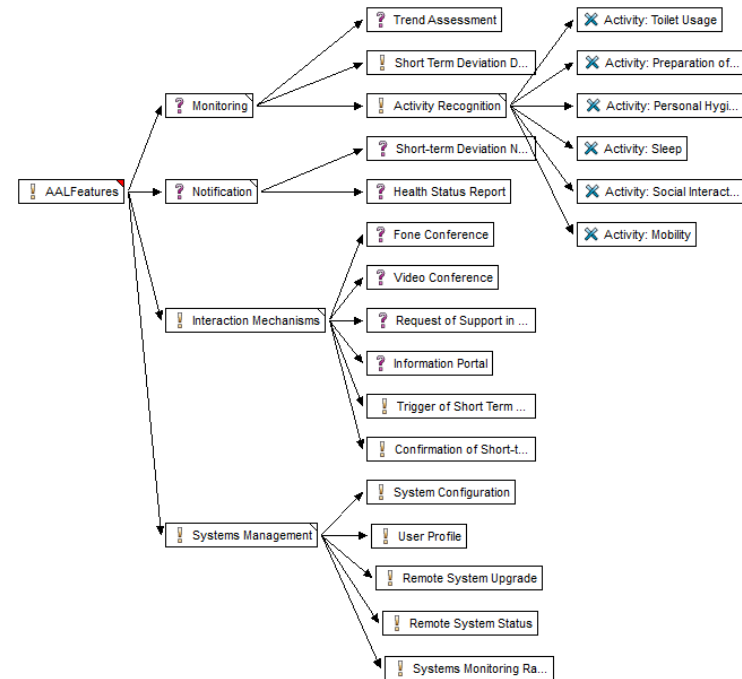


Product Release Plan



Features

Feature := a distinguishing characteristic of a system item (includes both functional and nonfunctional attributes such as performance and reusability). [IEEE829-2008]

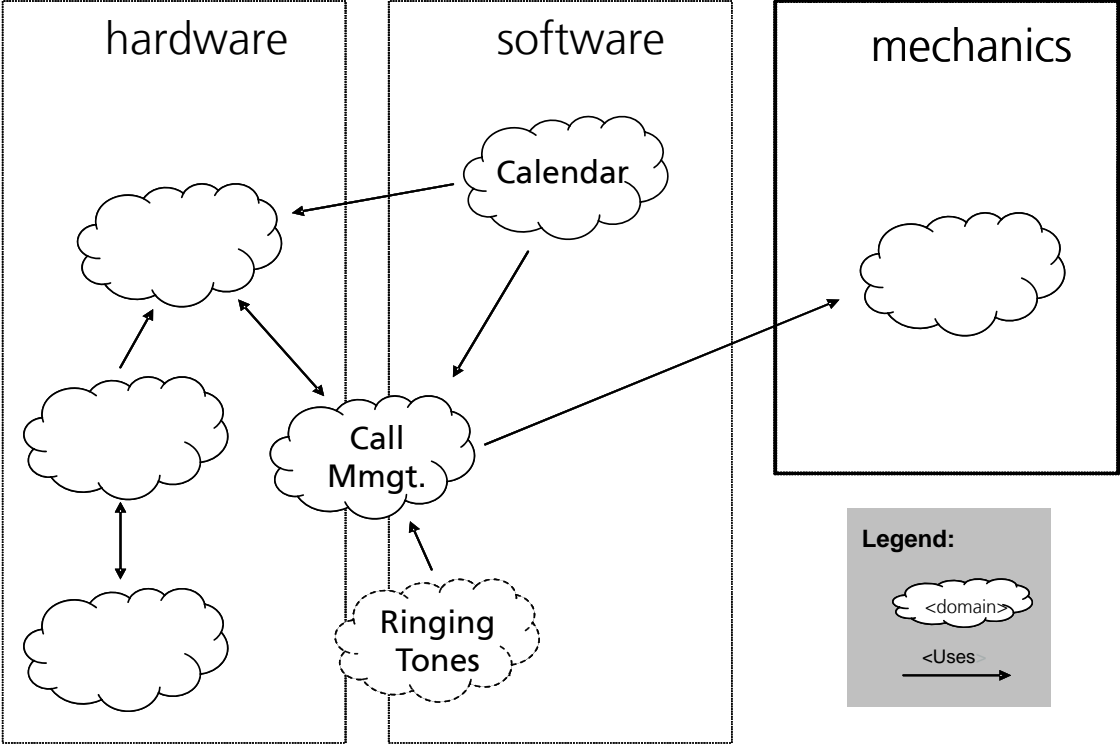


Identifying Features

Which features exist for the platform?

- Features \neq Services !
- Functional (external, end user)
- Non-functional Features (internal, implementation)
- Old + Innovative Features

Scoping – (Sub-)Domains



Define Product Feature Matrix

Area/ Subdomain	Description	in	out	Nr. Feature		Product 1	Product 2	...	Product N
Subdomain 1	Only overview? Concentrate or one domain?			1					
				2					
				3					
				4					
				5					
Subdomain 2				7					
				8					
				9					
				10					
				11					

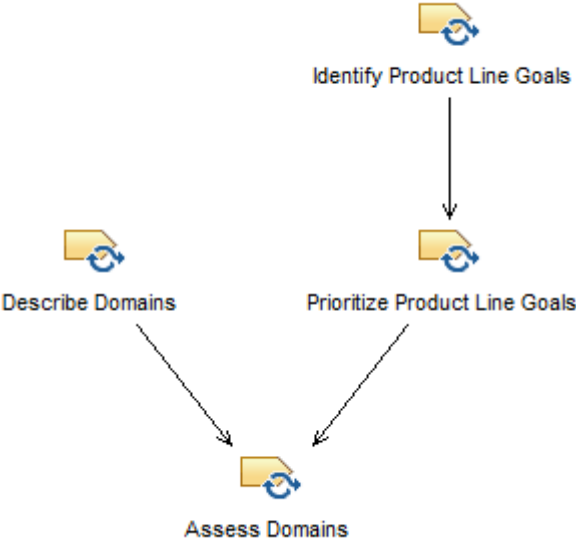
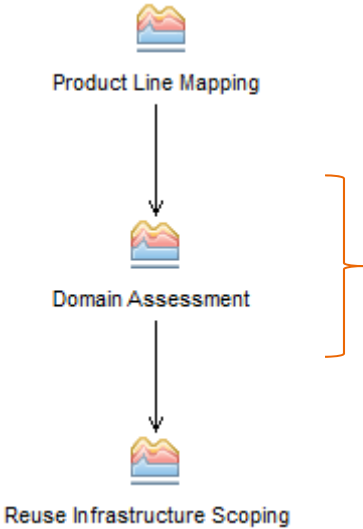
Scoping – Product Feature Matrix

Subdomain	Nr	Feature	values	Basic	Basic+	Comfort	Comfort+	DeLuxe
Monitoring	1	Activity Recognition		x	x	x	x	x
	2	Short-term Deviation Detection		x	x	x	x	x
	3	Trend Assessment				x	x	x
	4	Activity: Toilet Usage				x	x	x
	5	Activity: Preparation of Meals				x	x	x
	6	Activity: Personal Hygiene				x	x	x
	7	Activity: Sleep				x	x	x
	8	Activity: Social Interaction					x	x
	9	Activity: Mobility		x	x	x	x	x
Notification	10	Short-term Deviation Notification		x	x	x	x	x
	11	Health Status Report				x	x	x
Interaction Mechanisms	12	Trigger of Short-term Deviation		x	x	x	x	x
	13	Confirmation of Short-term Deviation		x	x	x	x	x
	14	Videoconference			x		x	x
	15	Foneconference			x		x	x
	16	Information Portal						x
	17	Request of Support in Activity					x	x
System Management	18	System Configuration		x	x	x	x	x
	19	Remote System Status (specific system)		x	x	x	x	x
	20	Remote System Update		x	x	x	x	x
	21	Systems Monitoring Radar (all systems: green, red)		x	x	x	x	x
	22	User Profile (contact person)		x	x	x	x	x

Product Line Mapping

- Identify products relevant to product line
- Identify features of current and innovative products
- Group and prioritize features
 - Grouping corresponds to set of relevant domains
- Relate products and features (product map)

Scoping process – Domain Assessment



Domain Assessment

- Identify assessment team per domain
- Interview workshop with assessment team
- Assess domain based on interview data
- Review of results by assessment team
- Finalization of domain assessment
- Draw conclusions from an across-domain perspective

Task: Assess Domains



Disciplines: Scoping Process Tasks

[Expand All Sections](#) [Collapse All Sections](#)

Relationships		
Roles	Primary Performer: <ul style="list-style-type: none">Scoping Expert	Additional Performers:
Inputs	Mandatory: <ul style="list-style-type: none">Domain DescriptionProduct Line Goals	Optional: <ul style="list-style-type: none">None
Outputs	<ul style="list-style-type: none">Domain Assessment Report	
Process Usage	<ul style="list-style-type: none">Scoping Process > Domain Assessment > Assess Domains	

[Back to top](#)

Steps	
<div style="border: 2px solid orange; padding: 10px;"><ul style="list-style-type: none">Identify assessment team per domainInterview workshop with assessment teamAssess domain based on interview dataReview of results by assessment teamFinalization of domain assessmentDraw conclusions from an across-domain perspective</div>	Expand All Steps Collapse All Steps

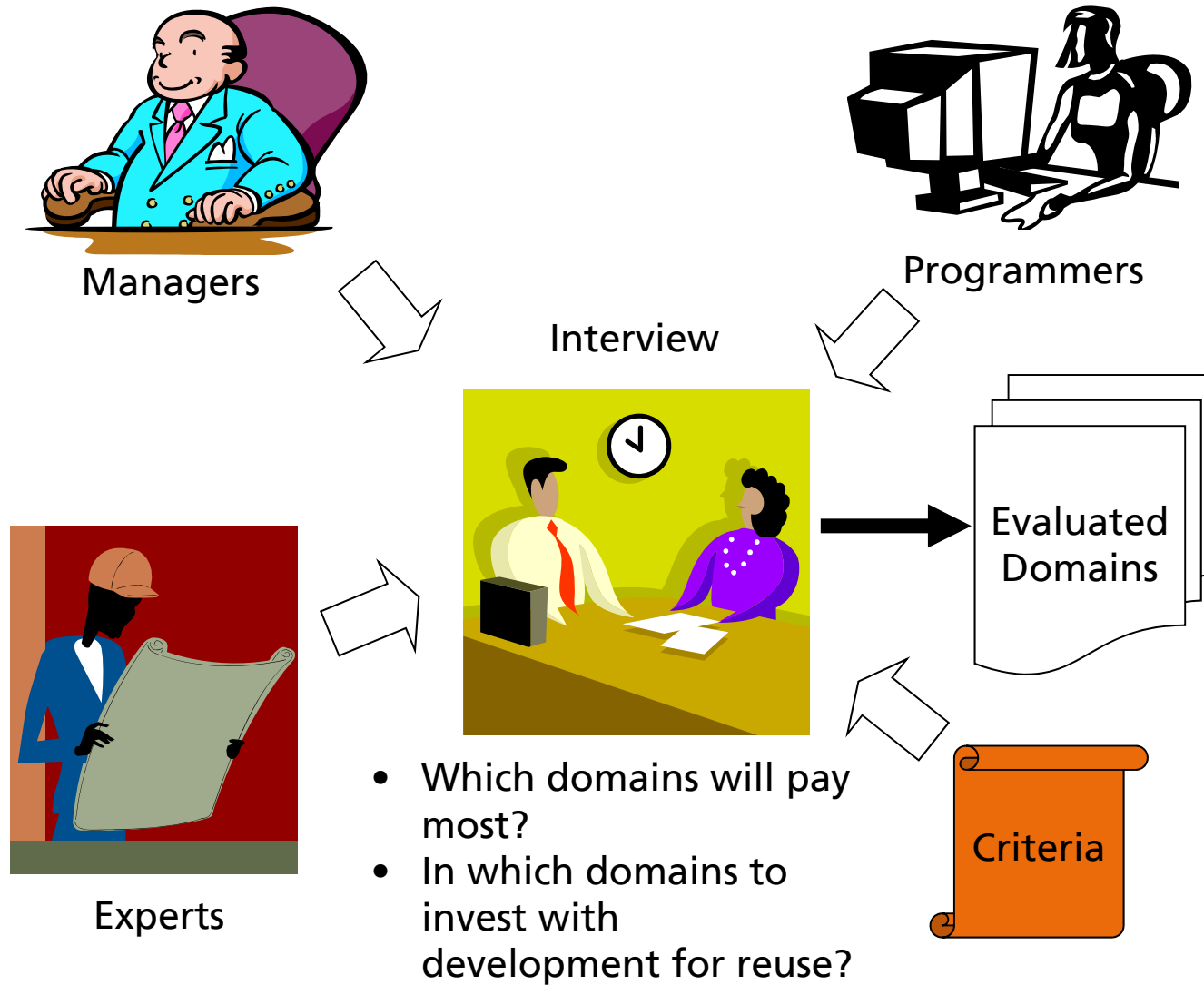
[Back to top](#)

Illustrations	
Reusable Assets	<ul style="list-style-type: none">Domain Assessment Questionnaire

Identify Goals

- Reduction in the time to market required for individual products
- Reduction in the overall development cost
- Reduction in required development effort per product
- Reduction in the overall maintenance cost
- Higher quality standards consistently across all products
- Common look and feel, as well as high interoperability, among products

Domain Assessment Process



Domain Assessment: Criteria (1/2)

■ **Maturity**

How mature is the domain, i.e., how well understood is the domain and how well organized are the concepts in the domain?

■ **Stability**

How stable and standardized are concepts and behavior in the domain (e.g., protocols)?

■ **Commonality and Variability**

How pervasive are commonalities in the domain and to what extent do systems in the domain vary systematically?

■ **Coupling and Cohesion**

Is the domain strongly coupled with other domains; is the functionality truly cohesive (i.e., is it truly a domain)?

■ **Existing Assets**

Do assets (implementations) in the domain already exist?

Domain Assessment: Criteria (2/2)

■ **Resource constraints**

What resources are available to the organization for setting up product line development?

■ **Organizational constraints**

How does the domain relate to organizational entities and does this support reuse or not? (e.g., avoid domains that are split over several organizational units)

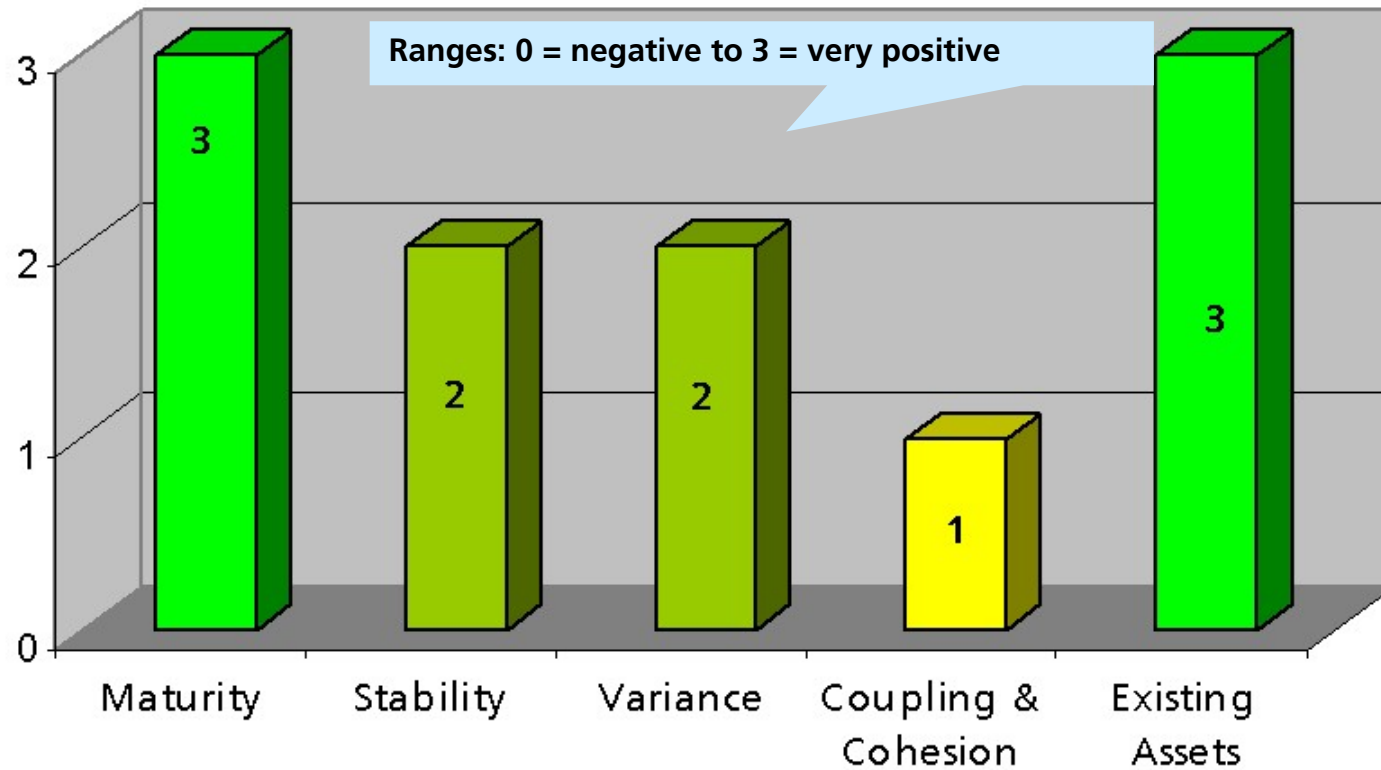
■ **Market potential – External**

What is the expected market potential for implementations in the domain in the external market?

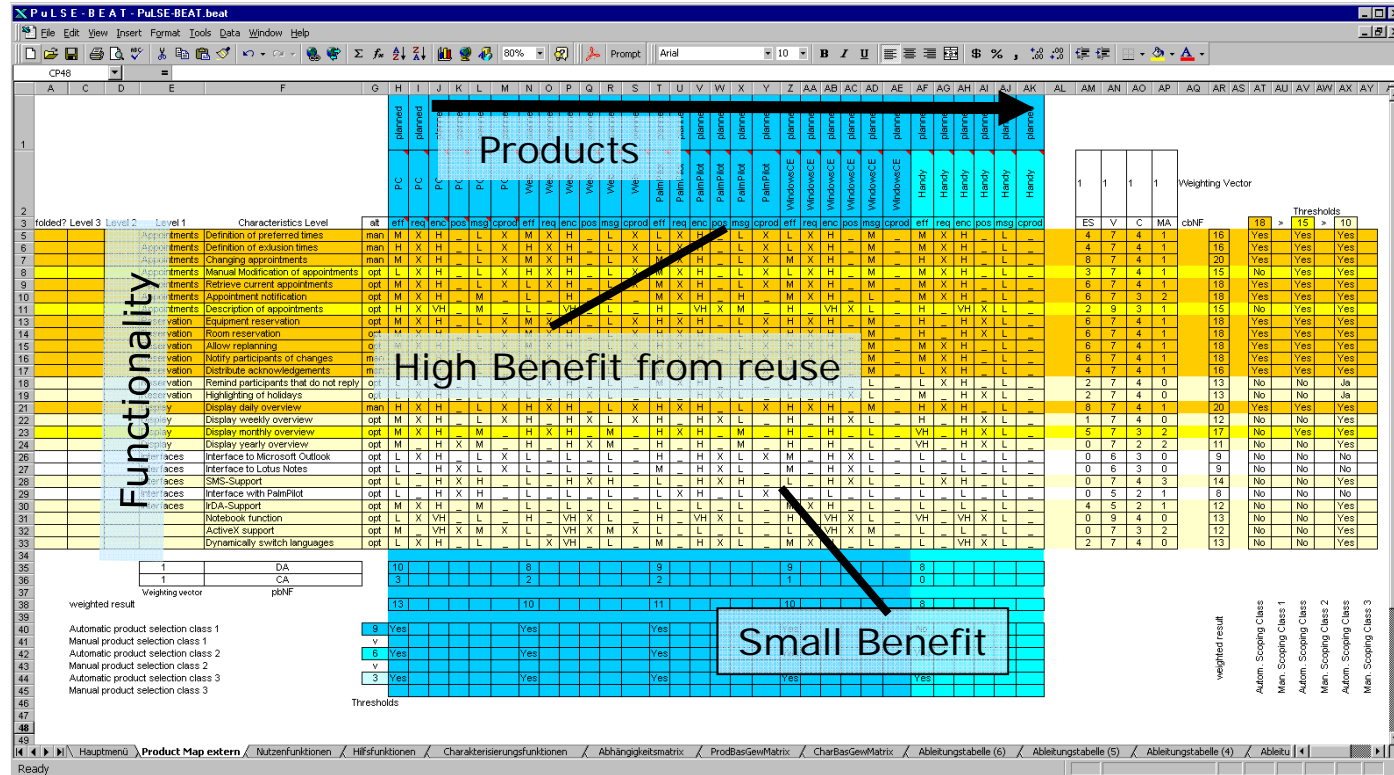
■ **Market potential – Internal**

What is the expected market potential for implementations in the domain in the organization? What is the internal strategy of the product line organization in this domain?

Evaluation of Sub-Domains/-Systems



Scoping – Quantified Product Feature Matrix



Product Line Strategy

Decision made per domain assessed

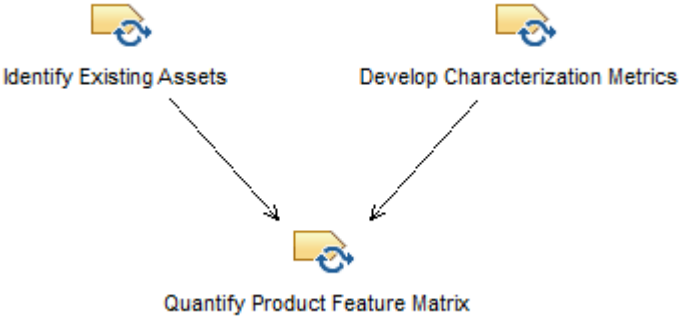
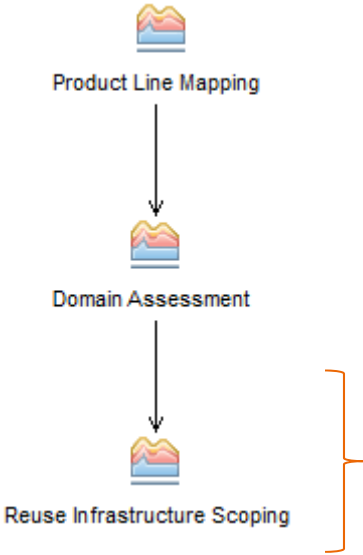
- Relative ranking
- Start with most promising areas
 - Note: early successes are crucial while migrating to product line engineering

Strategies

- Revolution: Invest into PL upfront (Proactive)
- Evolution: Build up PL incrementally over time (Reactive)

PL Strategy is determined by domain strategies and must match business objectives

Scoping Process – Reuse Infrastructure Scoping



Reuse Infrastructure Scoping – Identifying assets

For each existing component, gather the following information:

- name
- short description
- owner/developer
- interfaces

Summary

Family engineering is a development project

- High importance
- FE is a continuous activity (virtual project)
- Increments define FE projects

Scope is the input to FE projects

- Specification of PL reuse infrastructure

Scoping

- Scope definition
- Conceptual planning of reusable artifacts over time

Further Reading

- [1] J.-M. Debaud and K. Schmid. A Systematic Approach to Derive the Scope of Software Product Lines, in the Proceedings of the 21st International Conference on Software Engineering (ICSE), IEEE Computer Society, 1998
- [2] I. John et al. A Practical Guide to Product Line Scoping, in the Proceedings of the 10th international on Software Product Line Conference, IEEE Computer Society, 2006
- [3] J. Van Zyl, A. J. Walker. Strategic product development. In Proceedings of the 1st Software Product Line Conference (SPLC1). Kluwer, 2000