Product Line Engineering Lecture – Scoping (2)

Dr. Martin Becker
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Recap: Organizational Issues

If you are not yet registered, please register yourself via e-mail to:
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Subject: Register – Lecture
Content
- Name: <your name>
- Course of studies and Semester
- Email
- Experience in Software Engineering
  - University (lectures, classes)
  - Industry
  - Other
## Schedule - Lectures

<table>
<thead>
<tr>
<th>Date</th>
<th>Content</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>29-Oct-10</td>
<td>Introduction</td>
<td>15:30 - 17:00</td>
<td>Z04.06 J. Nehmer (IESE)</td>
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<tr>
<td>5-Nov-10</td>
<td>Scoping</td>
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<tr>
<td>12-Nov-10</td>
<td>PL Infrastructure I (Variability Modelling)</td>
<td>15:30 - 17:00</td>
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<td>26-Nov-10</td>
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<td>3-Dec-10</td>
<td>PL Economics and Approaches</td>
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<td>11-Feb-11</td>
<td>Reengineering / Variant Analysis</td>
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## Schedule - Exercises

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<td>17:15 - 18:45</td>
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--- Recap ---

Introduction
Reuse Approaches

• Typical Engineering Challenges:
  • Increasing # variants, complexity, customization, quality
  • Decreasing time to market, production costs

• Reuse Approaches
  • Ad-hoc, Domain Engineering, Product Line Engineering
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]

Different goals can be followed
Product Line Life Cycle

Application Engineering
- Evaluation
- Adaptation
- Integration
- Coordination
- Evolution

Family Engineering
- Scoping

Product Line Infrastructure
- Product Requirements
- Product

Quality

Productivity
Definition: Product Line Approach

A product line engineering approach consists of

- **engineering processes** addressing product line issues consistently throughout all development activities,
- **management processes** continuously aligning engineered product lines with business goals and needs, and
- **improvement processes** establishing and optimizing the implemented product line approach continuously and incrementally

[Fraunhofer IESE]

Only a comprehensive approach works!
Fraunhofer PuLSE™

Applied research since 1997 (= 4 innovation cycles)

Industry Partners (selection)

- RICOH
- BOSCH
- HITACHI
- MAKER
- testo
- BLAUPUNKT

Deployment Phases

- PuLSE Initialization
- Product Line Infrastructure Construction
- Product Line Infrastructure Usage
- Product Line Infrastructure Evolution

Technical Components

- Customizing
- Scoping
- Modeling
- Architecting
- Designing
- Coding
- Testing and Inspection
- Evolving and Managing
- Instantiating

Support Components

- Project Entry Points
- Organizational Issues
- Maturity Scale
--- 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 => P

From an internal point of view, it is significantly different
- Reuse must be built in AE definition (i.e., no searching but accessing of reusable artifacts)
- We call it "Reuse-Centric Application Engineering"
  AE: R x A => P (or P x A)
  - A: Product Line Artifact Base; set of reusable artifacts

Family Engineering is a function
FE: S => 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

Family/Domain Engineering

Artifact Base

Feedback

Product Line Infrastructure

Application Engineering

Scope

Product Requirements

Product

Identification

Evaluation

Product Line

Adaptation

Integration

Coordination

Evolution

Classification

Documentation

Requirements

Requirements

Requirements

A

B

C

Defining

Specifying

Requirement Engineering

Product Engineering
BAPO Model

B: Business
O: Organisation
A: Architecture
P: Process
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?
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

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

Market vs. Time

Product M → Product XS

Product M → Product XL

Product XL → Product L

Product L ↓ Product S

Product S → Product smart

<<is derived from>>
Identify Features

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

Which features exist for the platform?
- Features \(\neq\) Services!
- Functional + Non-functional Features
- Old + Innovative Features
Scoping – (Sub-)Domains

Legend:
- <domain>
- <Uses>
# Define Product Feature Matrix

<table>
<thead>
<tr>
<th>Area/Subdomain</th>
<th>Description</th>
<th>in</th>
<th>out</th>
<th>Nr. Feature</th>
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## Scoping – Product Feature Matrix

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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 - Overview
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
# Activity: Weighing of Product Line Goals

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<th>TTM-Reduction for all segments</th>
<th>TTM-Reduction over whole PL</th>
<th>Development Effort reduction</th>
<th>Maintenance Effort reduction</th>
<th>Risk Reduction</th>
<th>Quality Improvement</th>
<th>Expert Load reduction</th>
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Domain Evaluation Process

- Which domains will pay most?
- In which domains to invest with development for reuse?
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

Ranges: 0 = negative to 3 = very positive

- Maturity: 3
- Stability: 2
- Variance: 2
- Coupling & Cohesion: 1
- Existing Assets: 3
### Scoping – Quantified Product Feature Matrix

<table>
<thead>
<tr>
<th>Products</th>
<th>High Benefit from reuse</th>
<th>Small Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product 1</td>
<td>Value 1</td>
<td>Value 2</td>
</tr>
<tr>
<td>Product 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>Product 3</td>
<td>Value 5</td>
<td>Value 6</td>
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</tbody>
</table>

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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
Domain Potential 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
Reuse Infrastructure Scoping

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

