lero THE IRISH SOFTWARE ENGINEERING RESEARCH CENTRE

Model-driven Software Product Lines

Goetz Botterweck

ADCSS 2013, Software Factories
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Motivation

Software Product Line Engineering

- Product Configuration
- Product Derivation

How to get started?

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How to get started?

Origin of product lines

I fixed a similar bug yesterday.

Help! We have too many products. Too complex.

This component was changed. Which products need to be updated?


How do we create software systems?


How do we create
software systems?

Product Lines







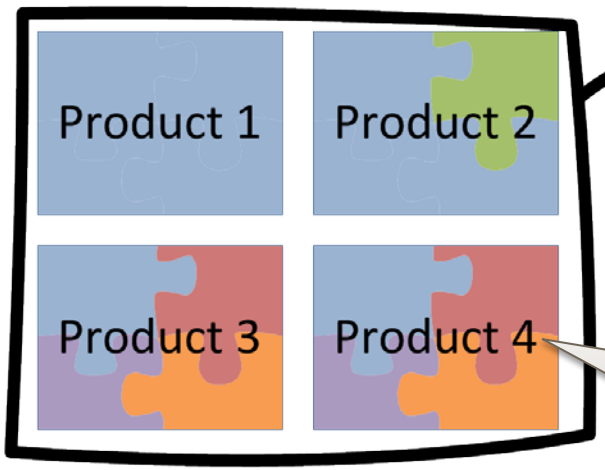



Sharing a common, managed set of features

Developed from a common set of core assets in a prescribed way

Feature A
Feature B
Feature C
Feature D
Feature E

Targeting a market segment (scope)



Product
Pro
Product

Set of software intensive systems

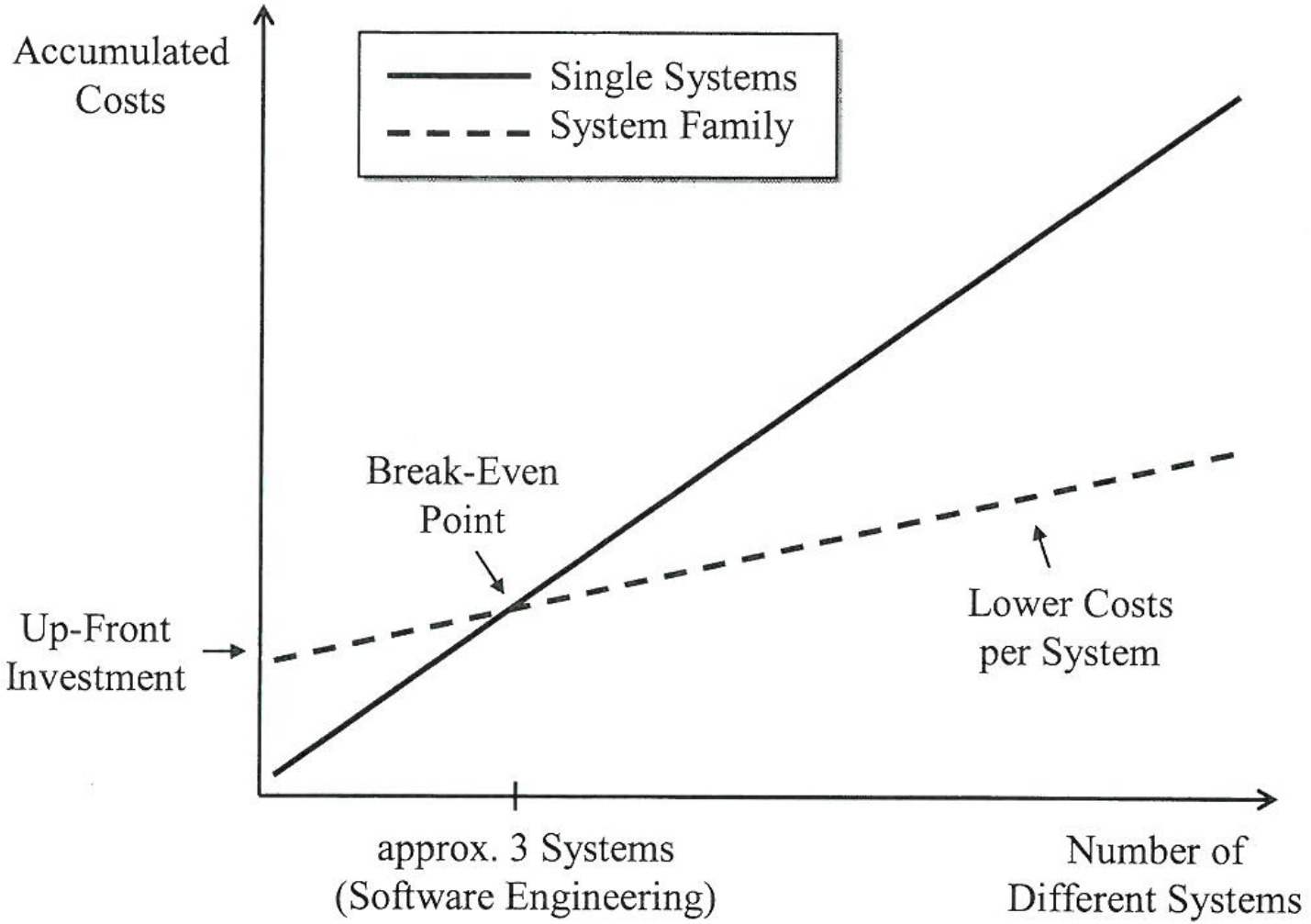
[Clements and Northrop 2002]

Benefits of Product Lines

- High quality
- Reduced time to market
- Market dominance
- Market agility
- Product alignment
- Low cost production
- Low cost maintenance
- Mass customization
- Reduced maintenance effort
- Improved Efficiency and Productivity

[Clements and Northrop 2002]

Develoment Costs



[Pohl et al. 2005, Weiss and Lai 1999]

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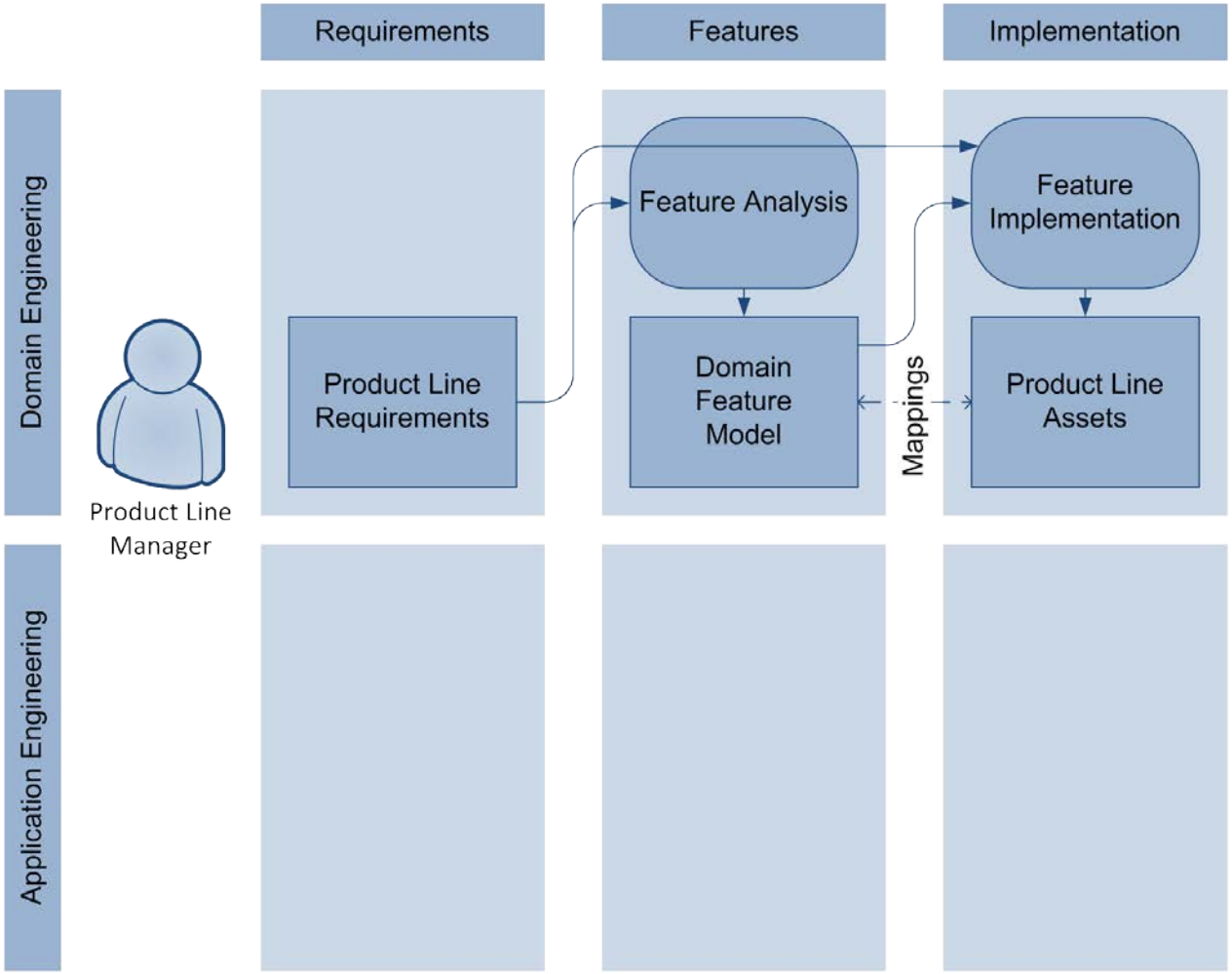
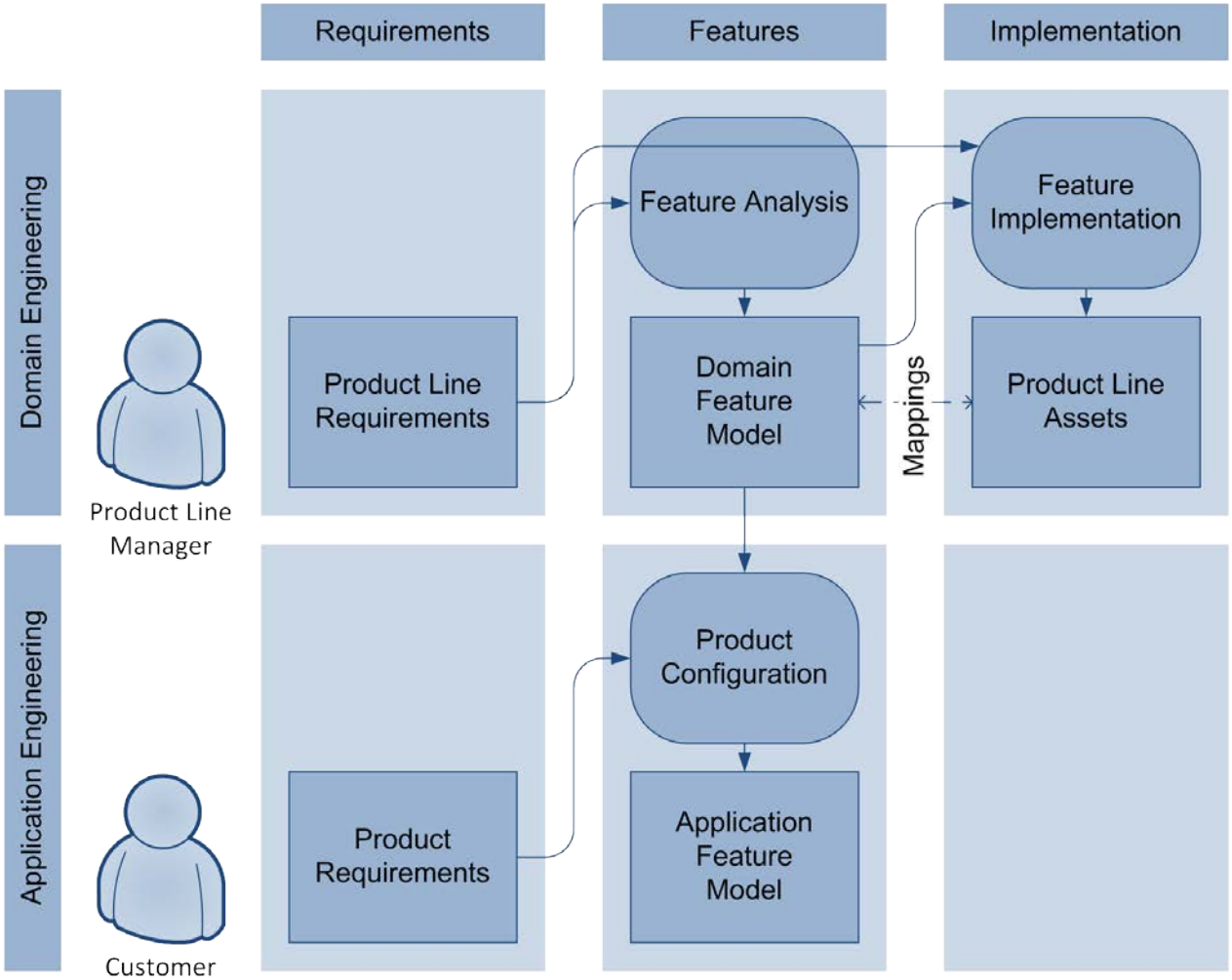
Product Line Engineering:
Domain Engineering



Product Line Engineering:
Application Engineering



Product Line Engineering:
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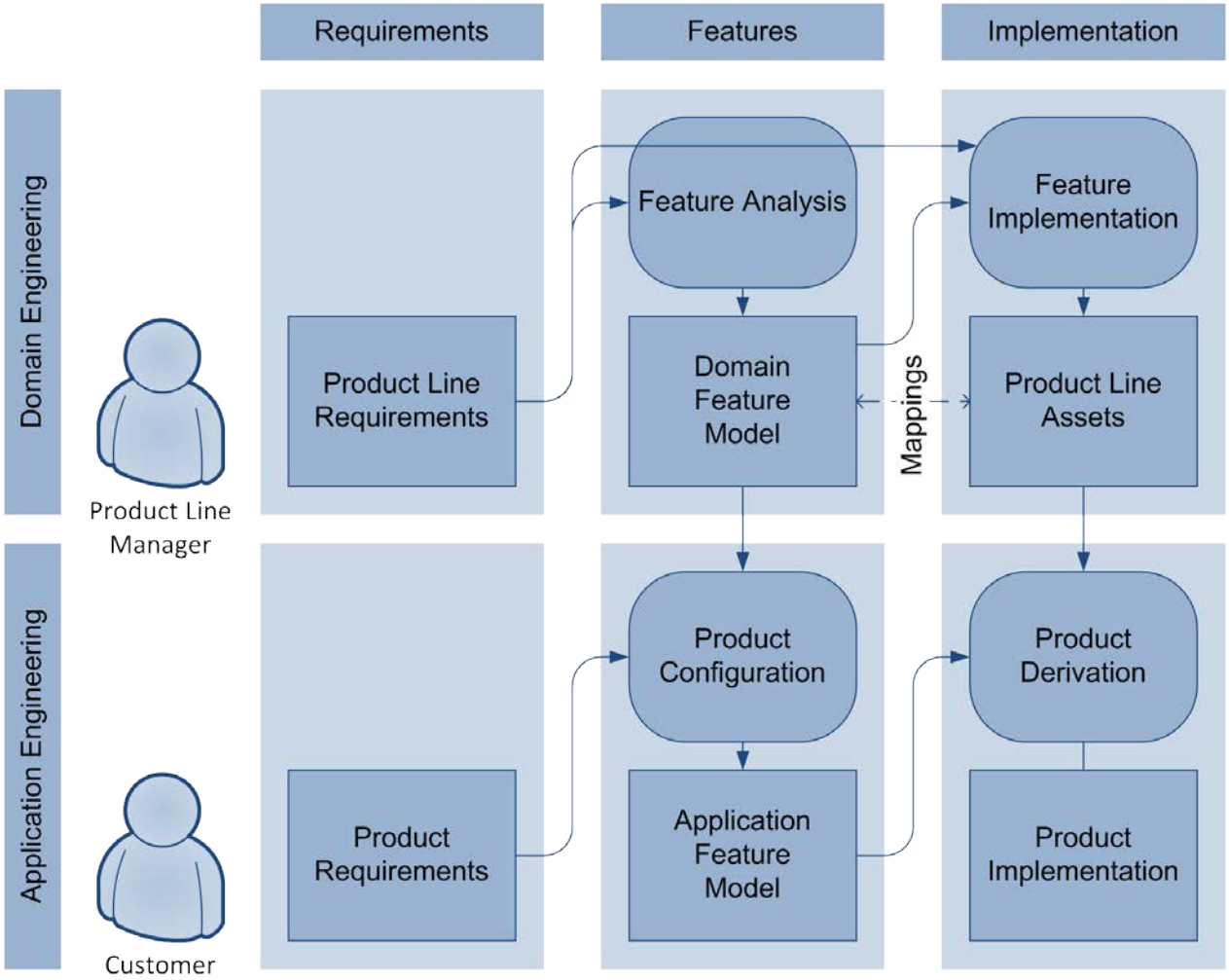
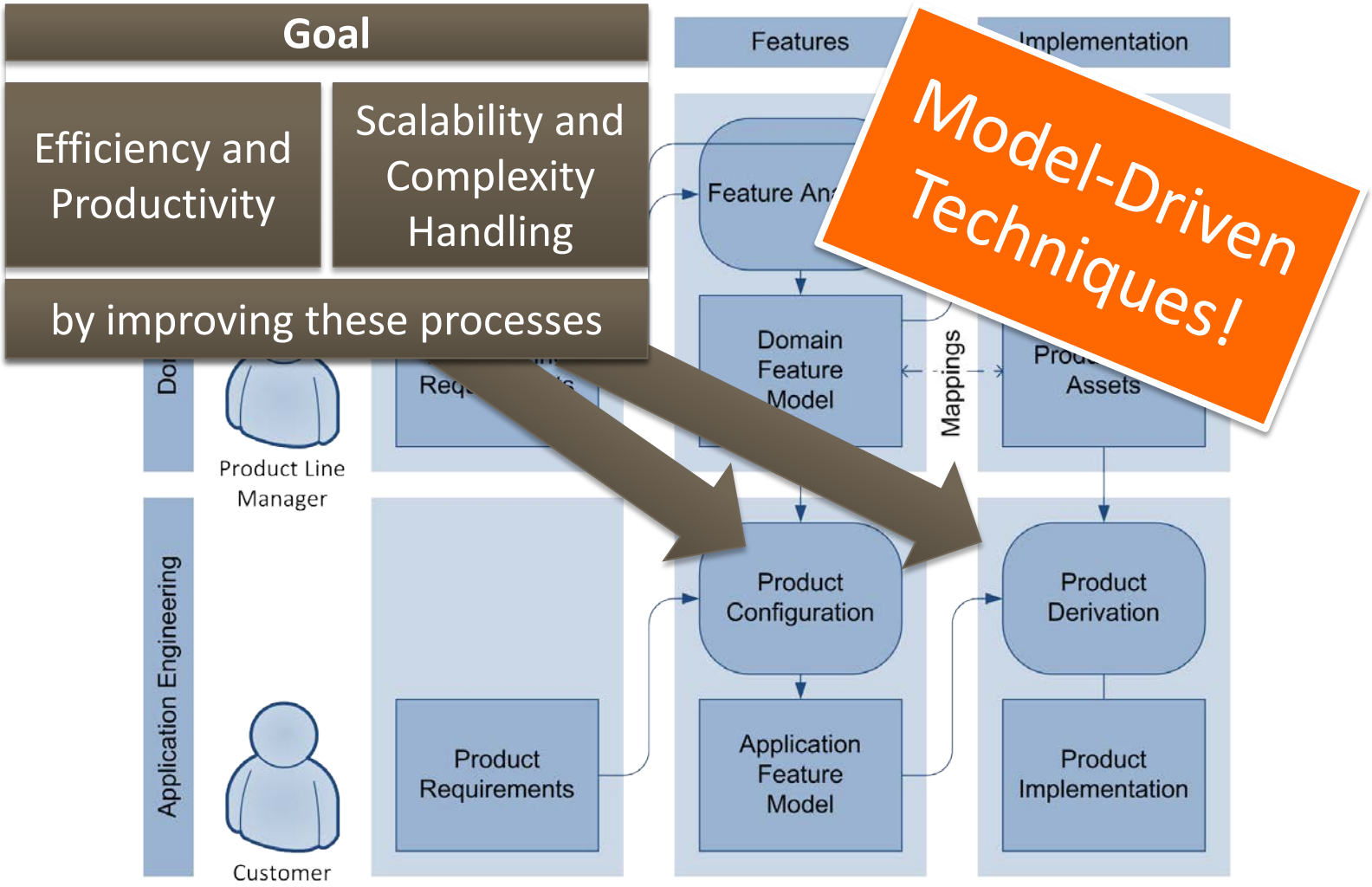


Product Line Engineering:
Application Engineering



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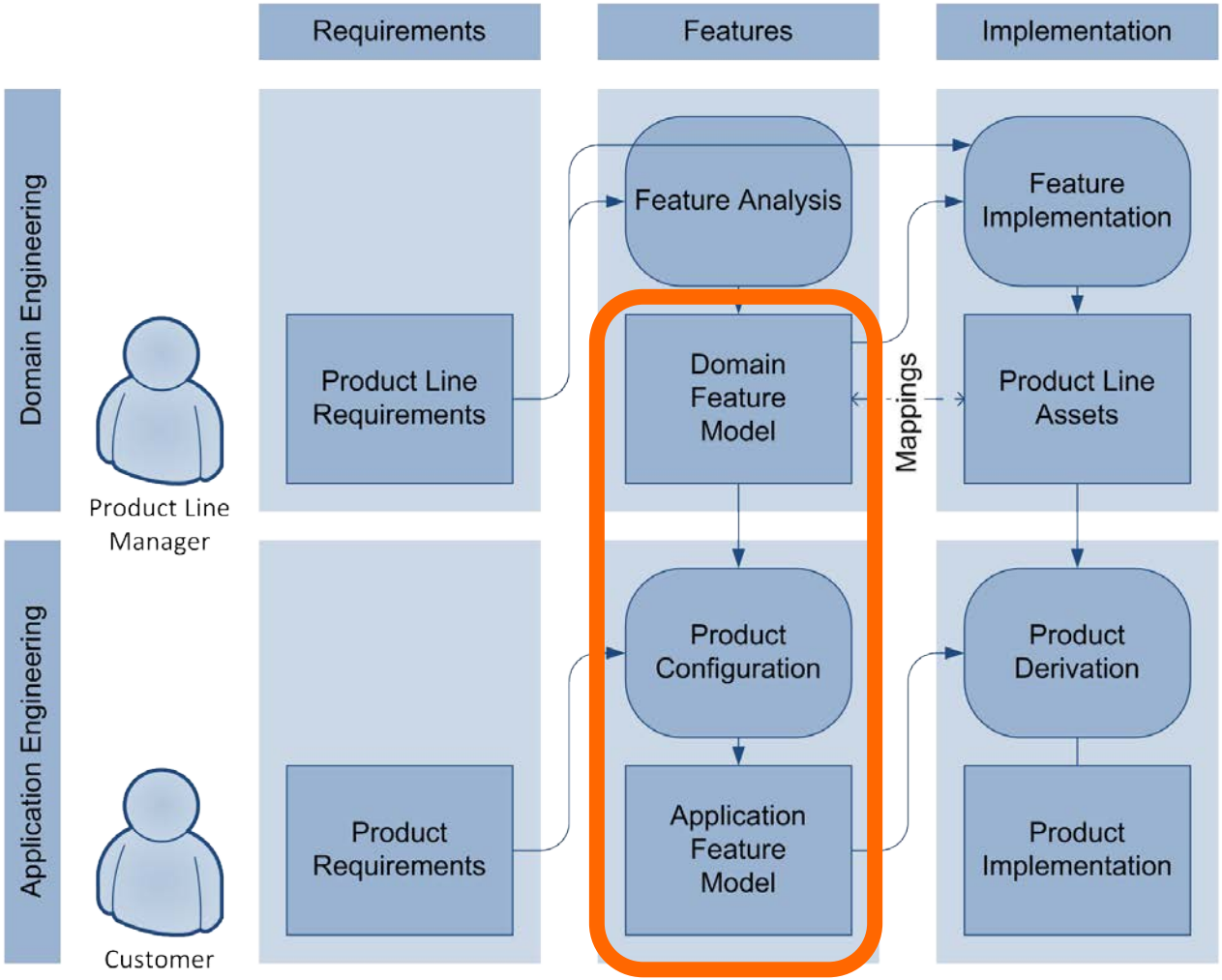
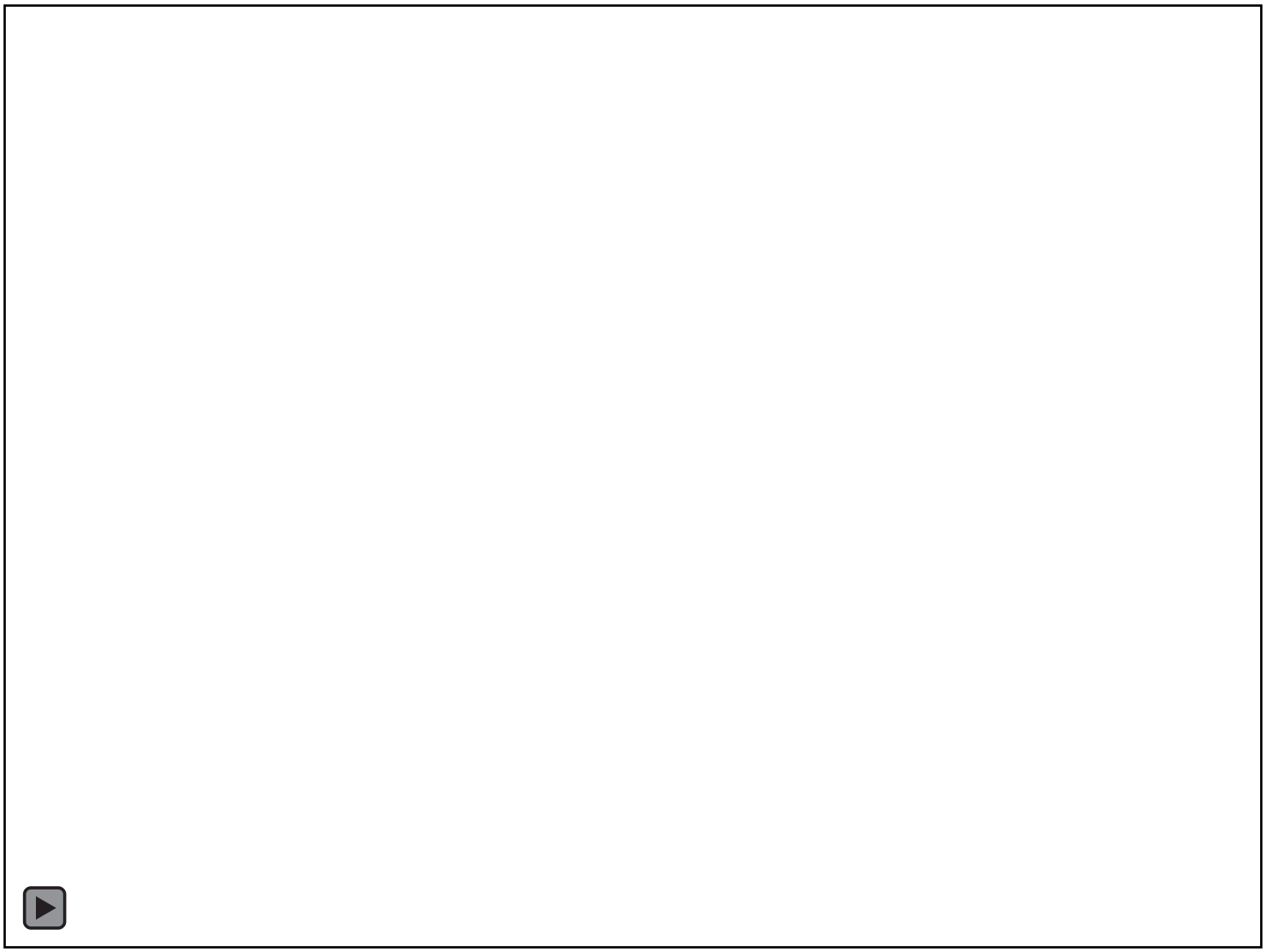
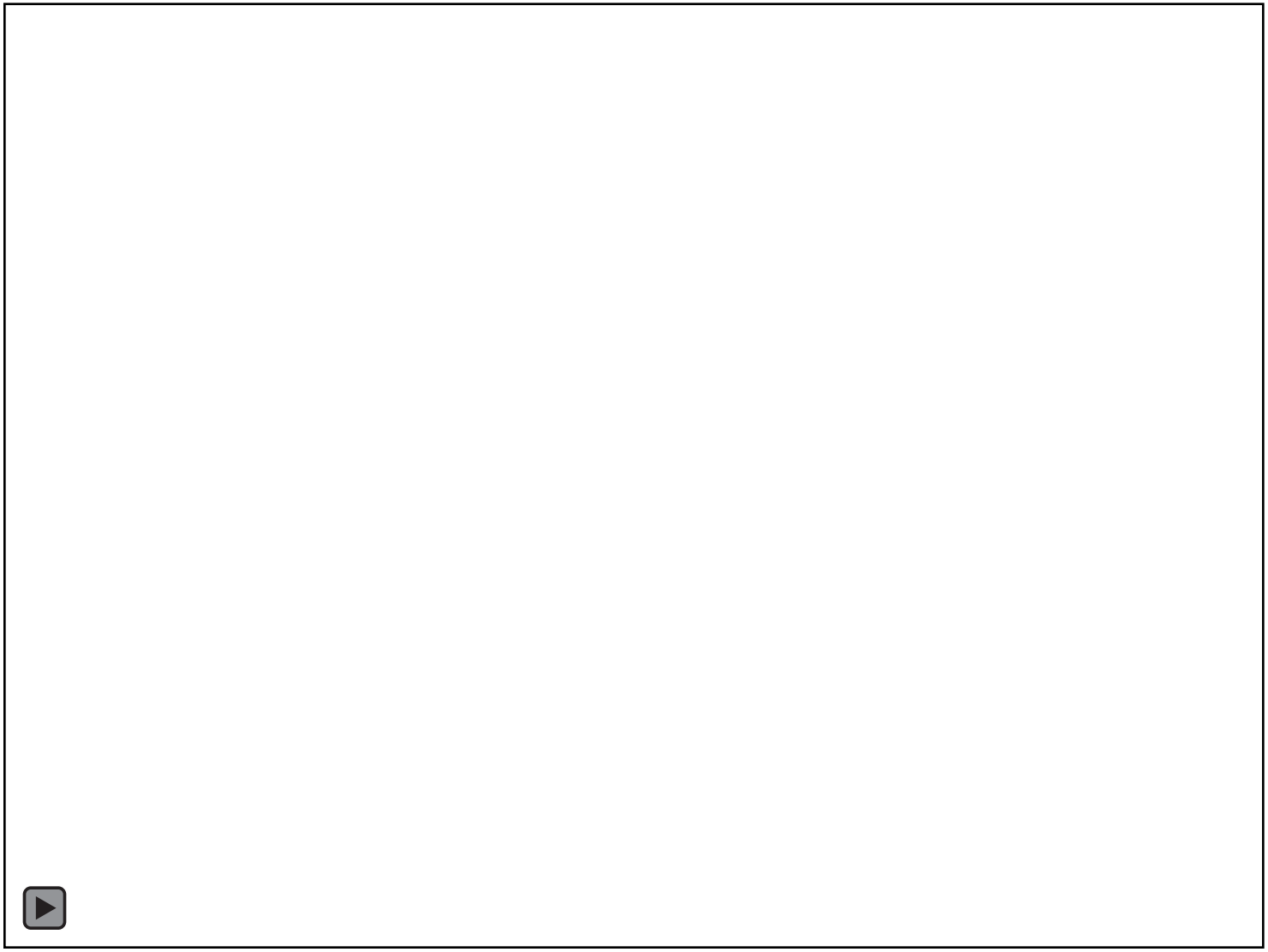
Product Line Engineering:
Application Engineering



Product Configuration

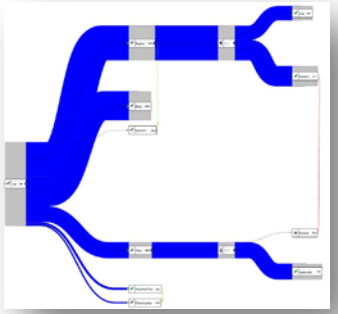


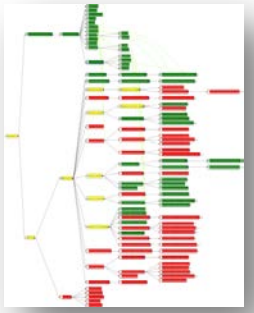
Product Line Flowmaps

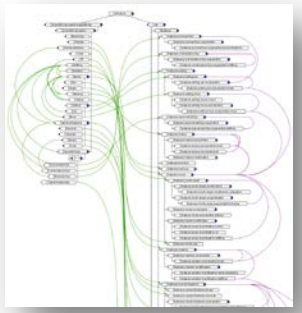


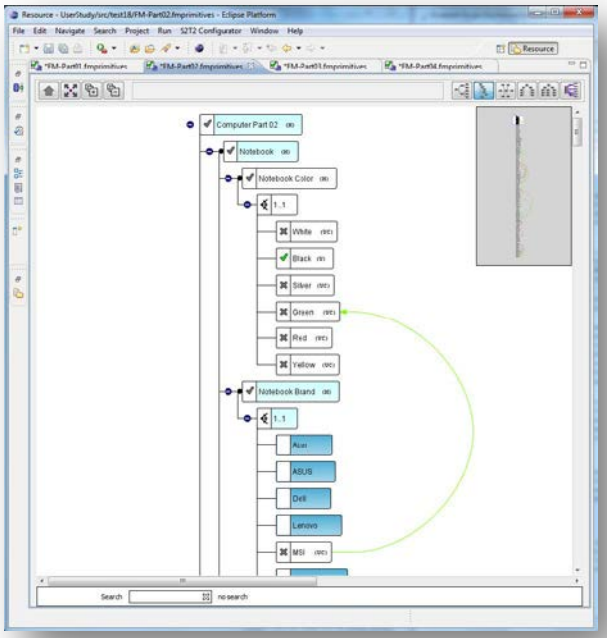
Interactive Configuration

- Configuration of large and complex systems
  - Complexity handling
  - Focussing on *relevant* elements
- Product attributes
  - Price estimation
  - Conflicting goals, trade-off, e.g., price vs. weight
- Collaborative scenarios









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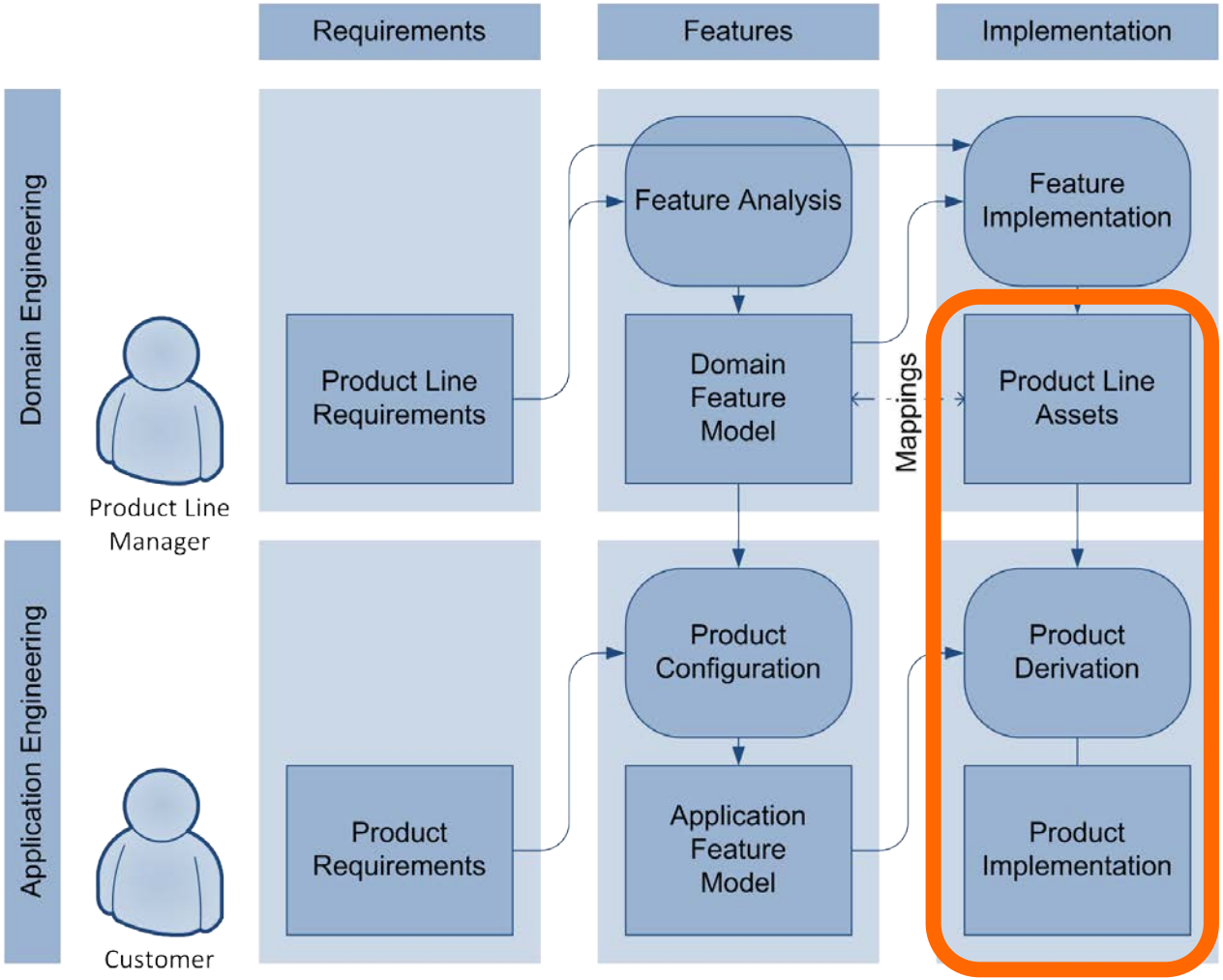
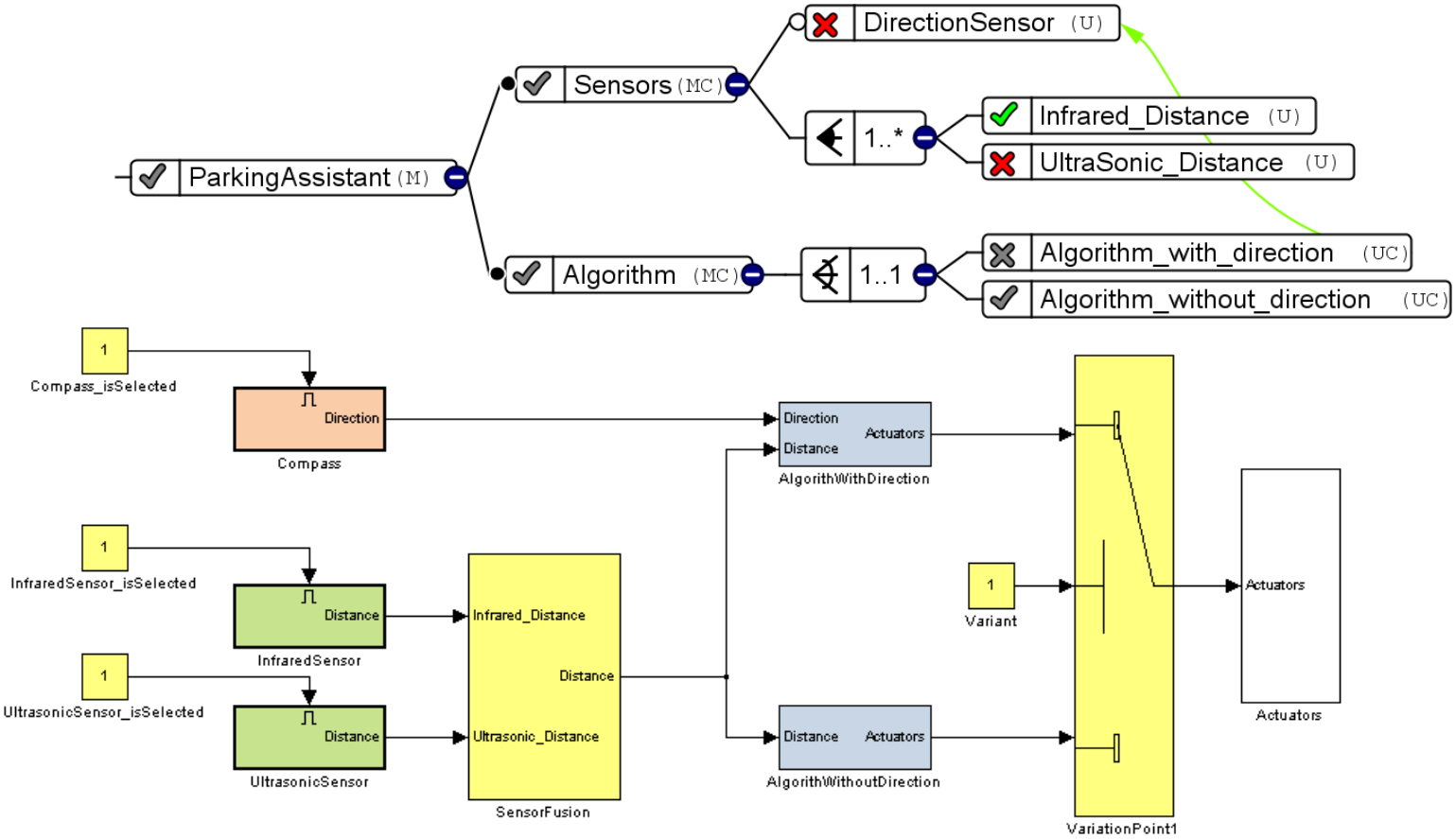
Product Line Engineering:
Application Engineering

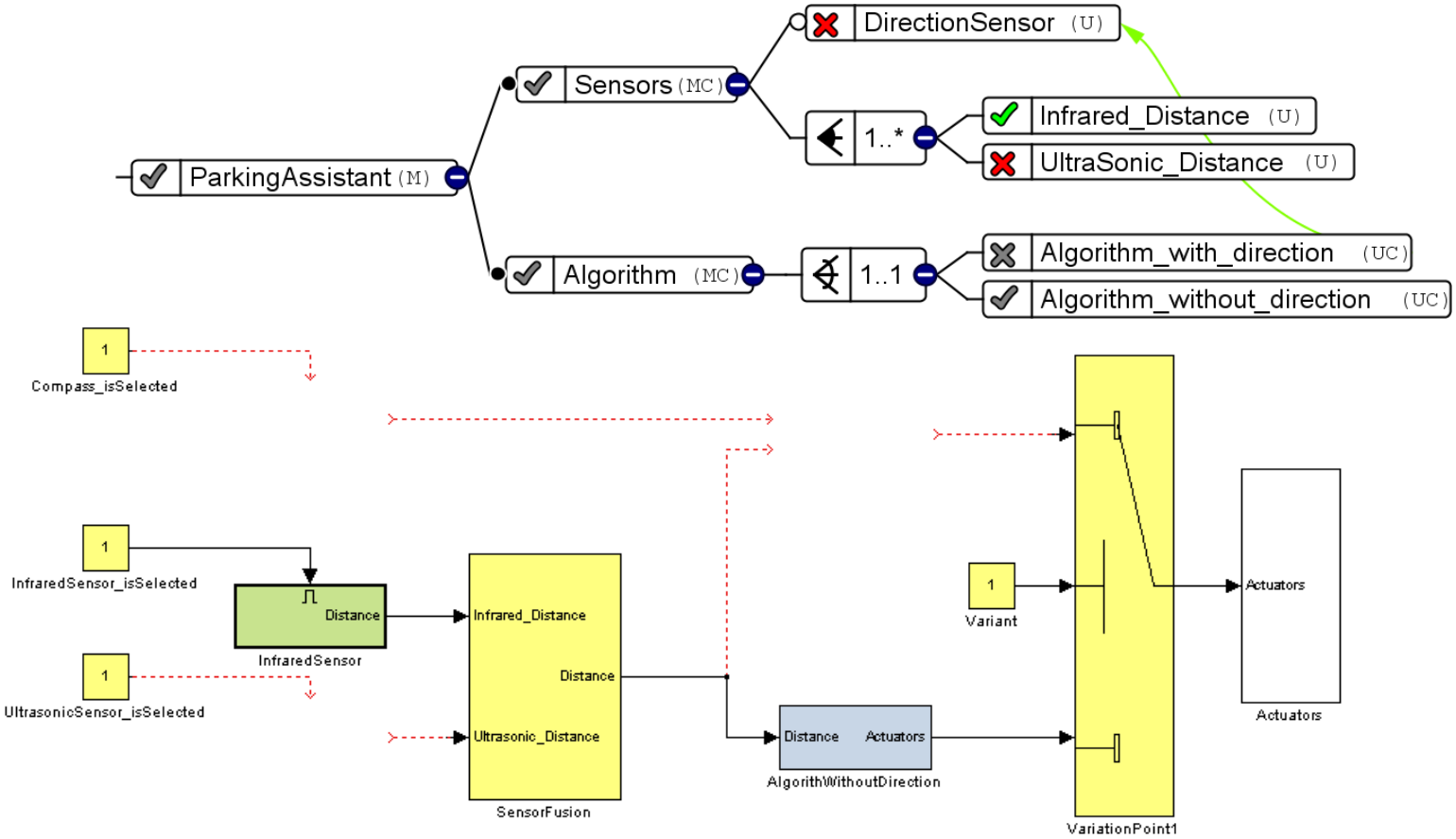


Product Derivation in a Embedded Systems DSL



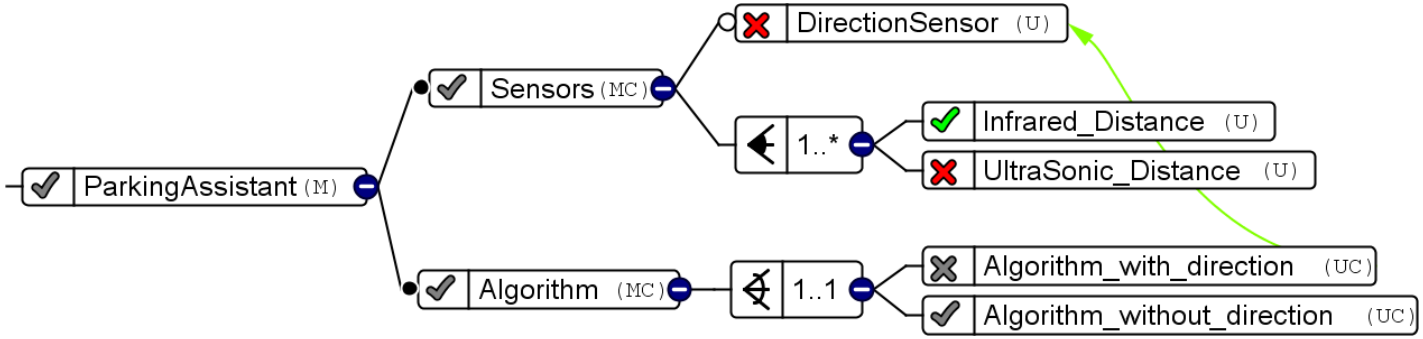
[Botterweck et al. 2009]

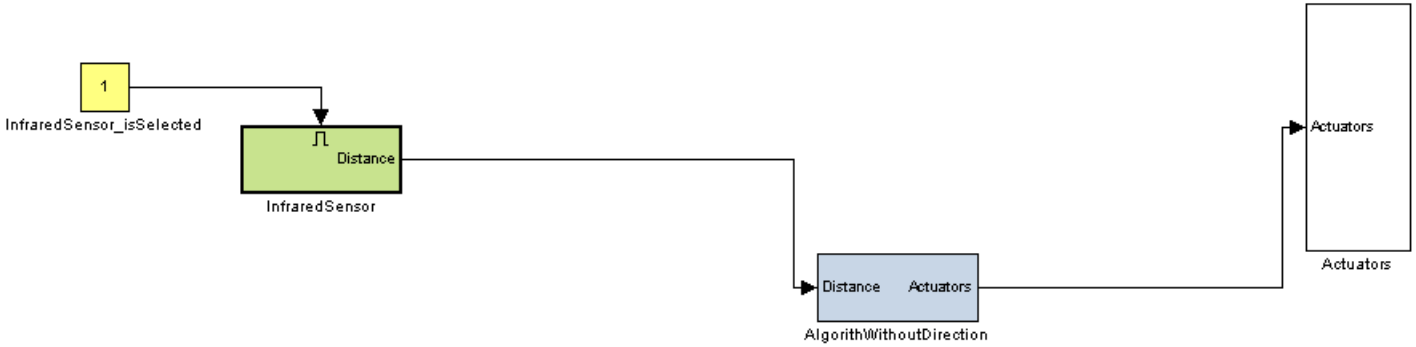
Product Derivation in a Embedded Systems DSL



[Botterweck et al. 2009]

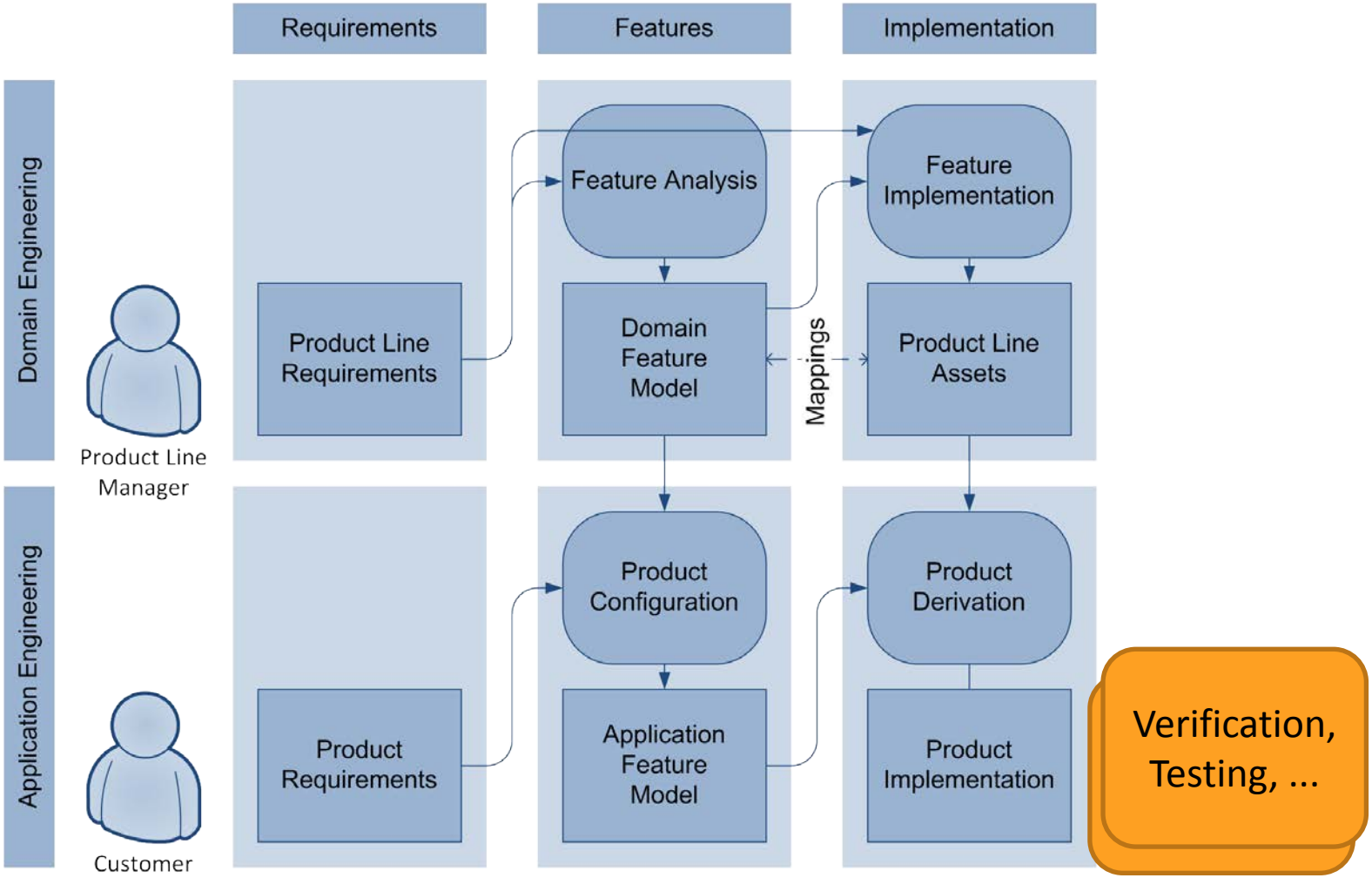
Product Derivation in a Embedded Systems DSL



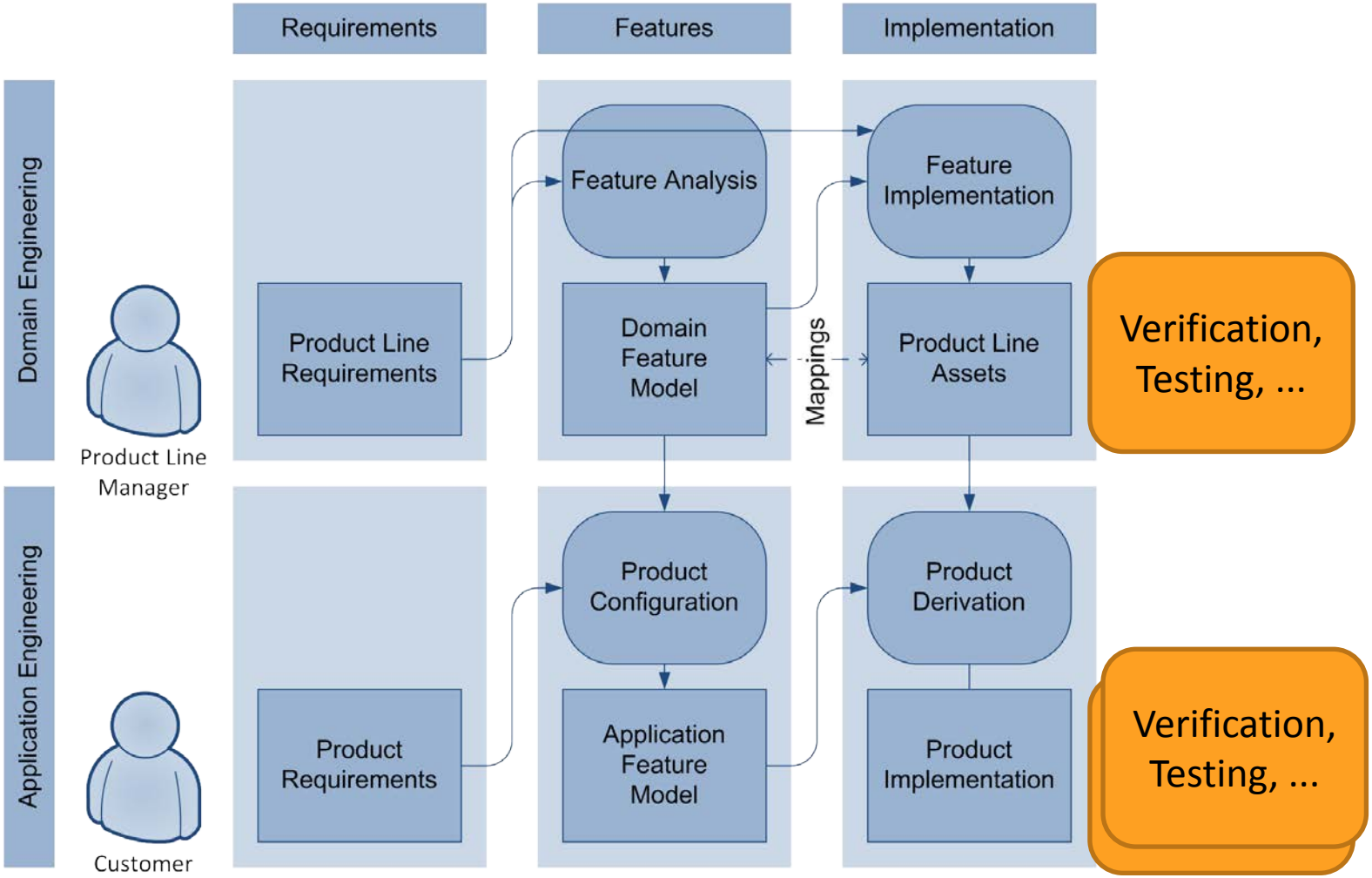


[Botterweck et al. 2009]

Product Line Engineering:
Application Engineering



Product Line Engineering:
Application Engineering



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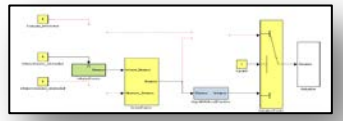
How to get started?

Sucessful applied in practice

Product lines have been used sucessfully used, for instance, for

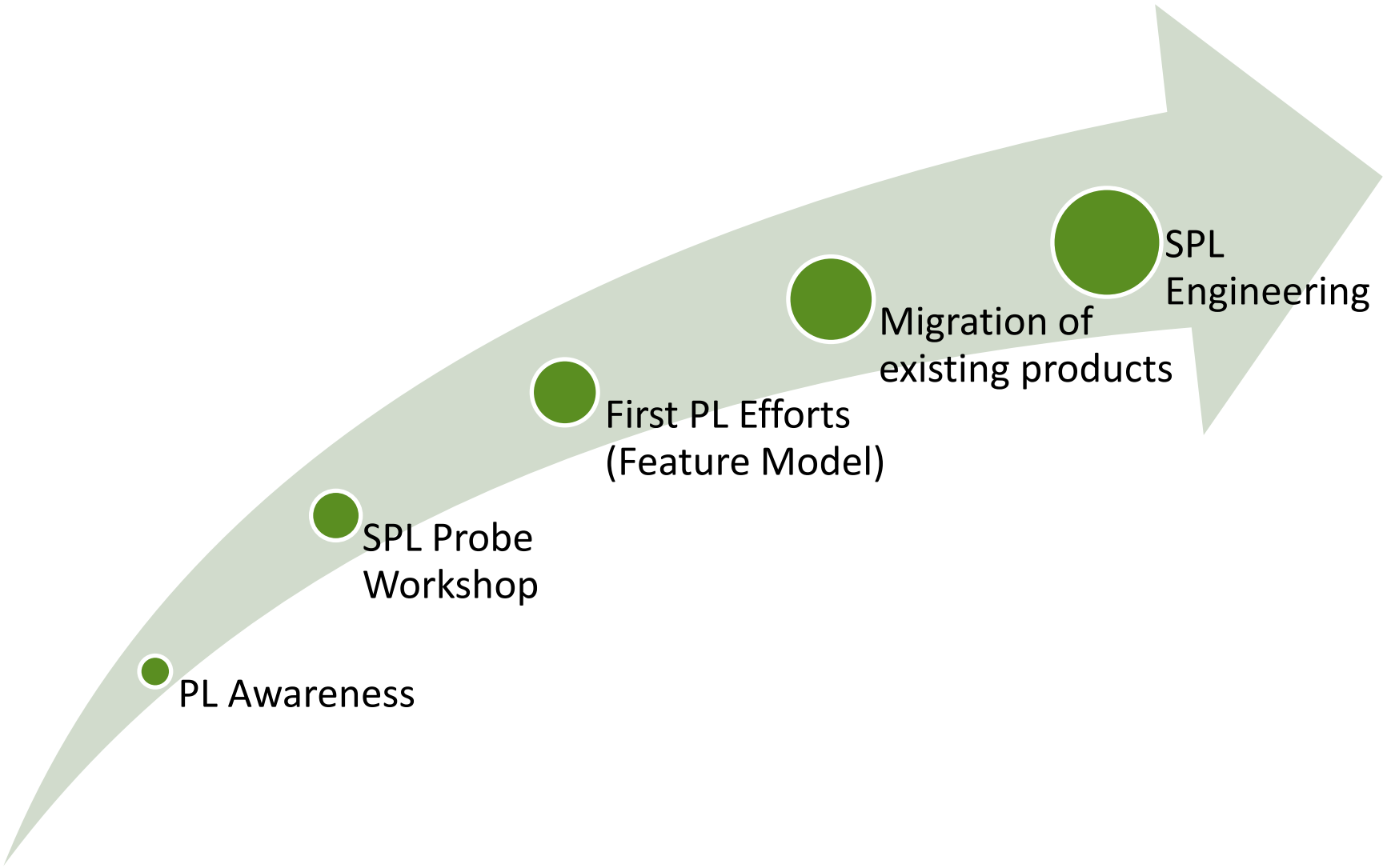
- Avionics Systems, Marine Systems
- Engine Control Software
- Telecommication Systems
- Printer Firmware
- Financial Software
- Mobile Phones
- Medical Systems
- Consumer Electronics
- Acquisition Management Systems
- Power Systems






Where do we
go from here?

Steps Towards Software Product Line Engineering



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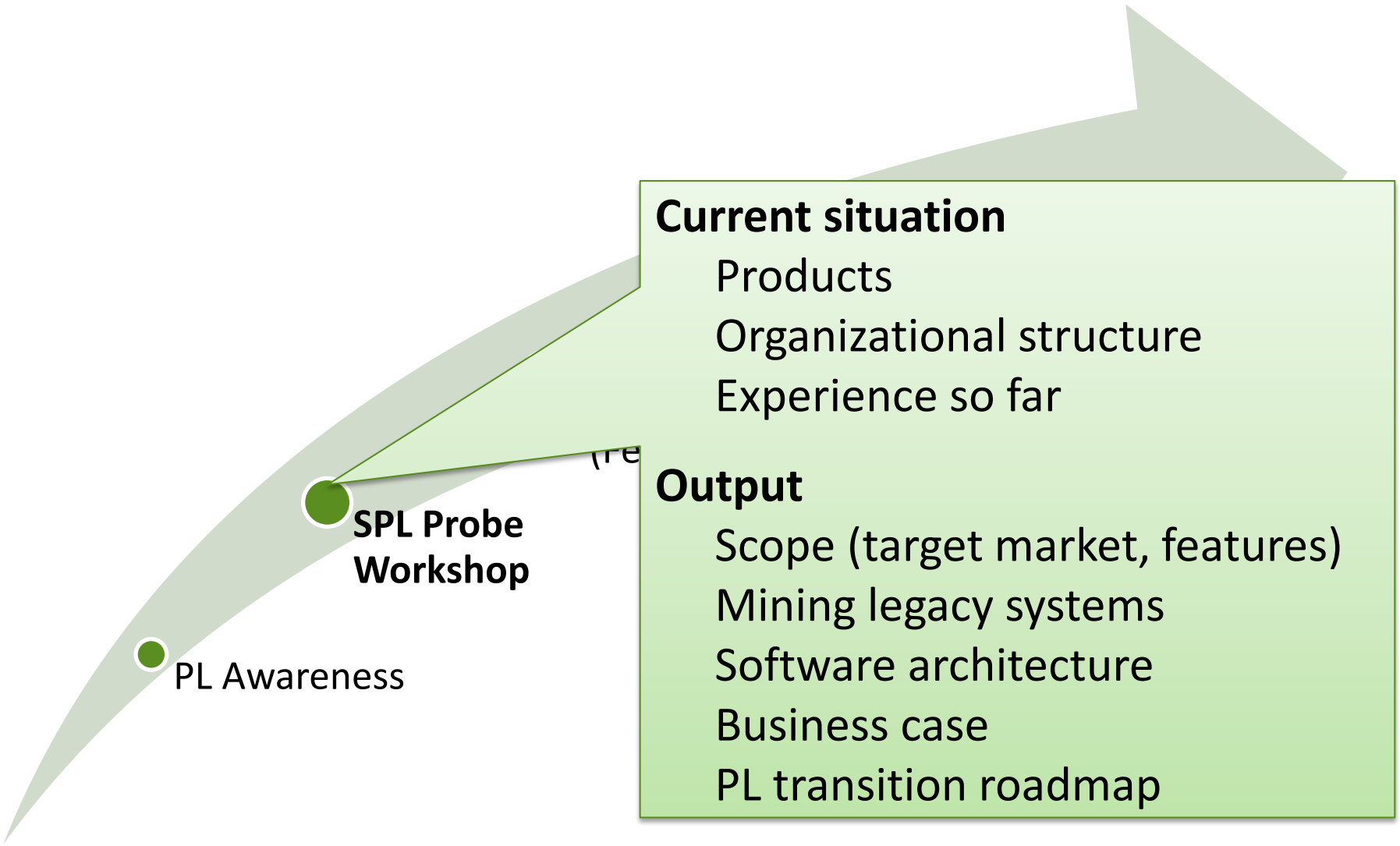
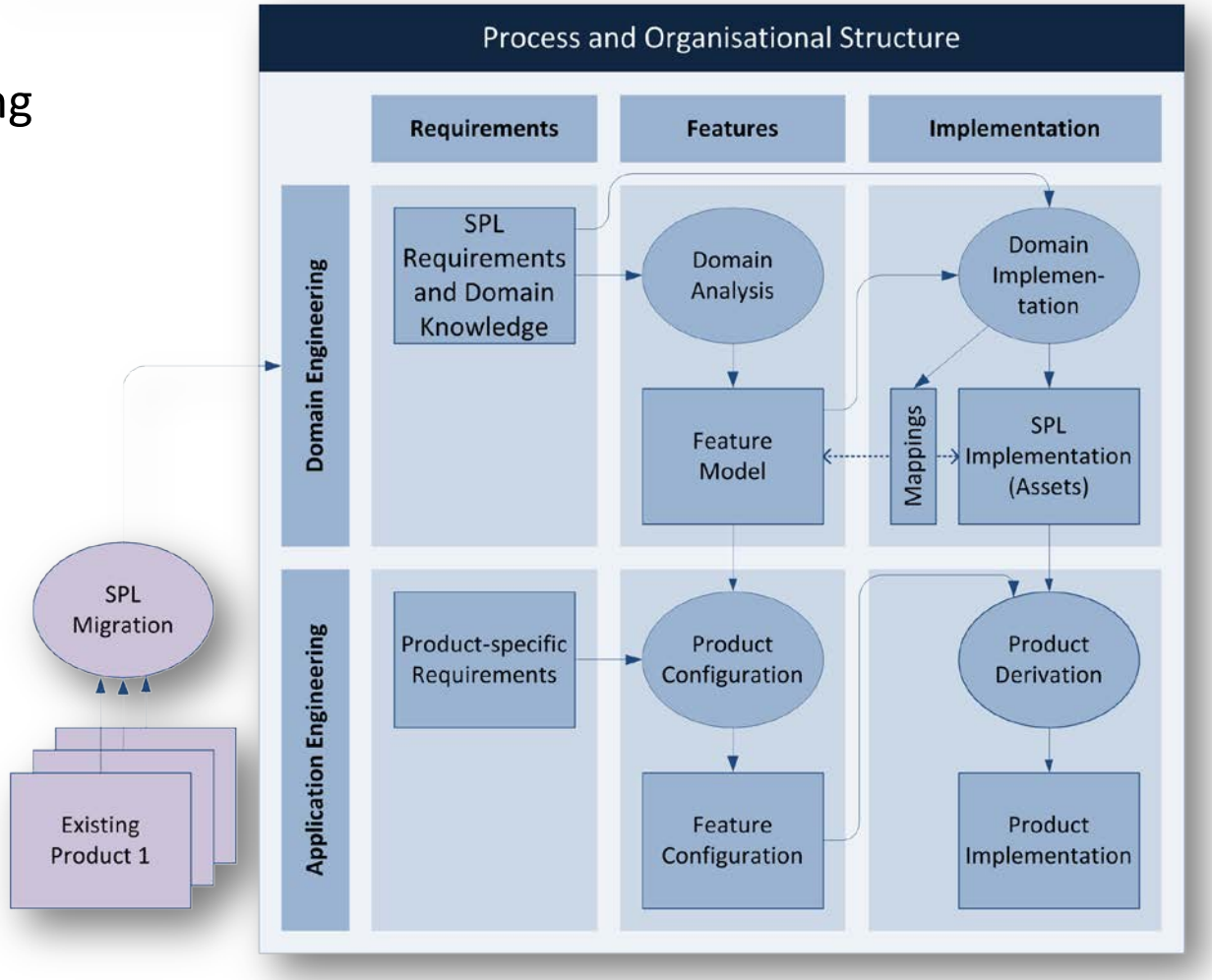


Migration of Existing Products

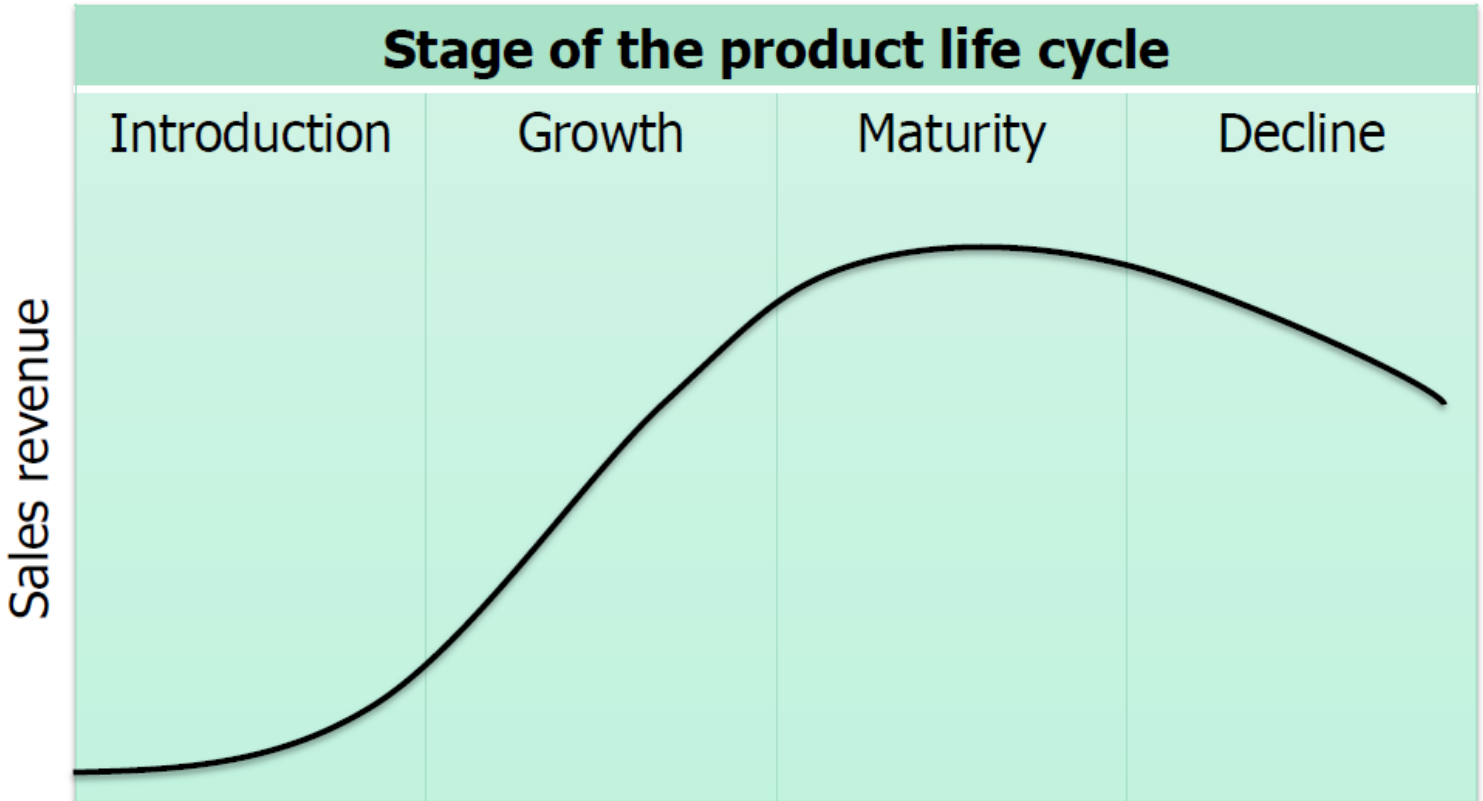
- Analysis
- Reverse Engineering
- Refactoring

Objectives

- Reduce risk
- Lower entry costs

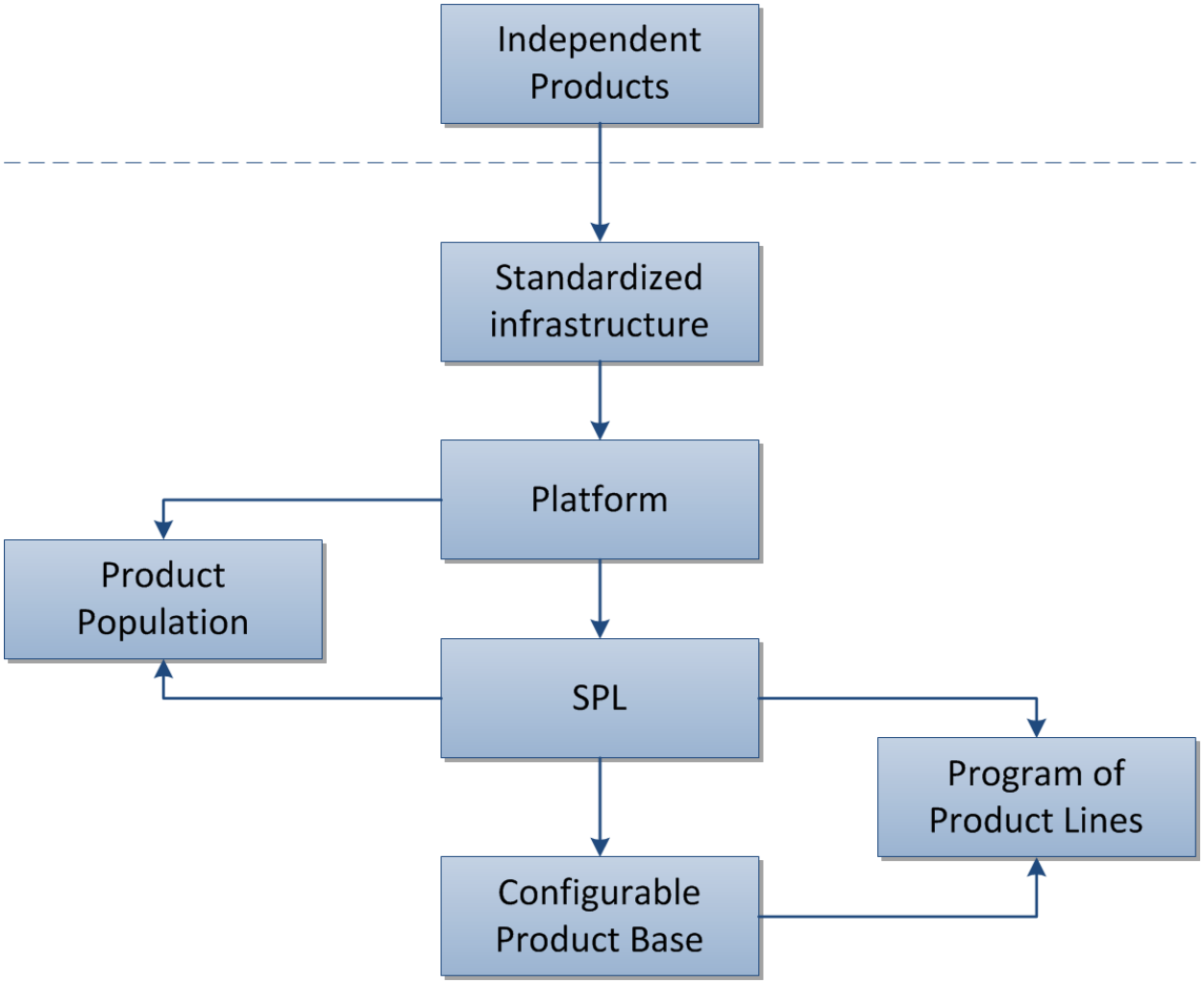


Market Life-Cycles



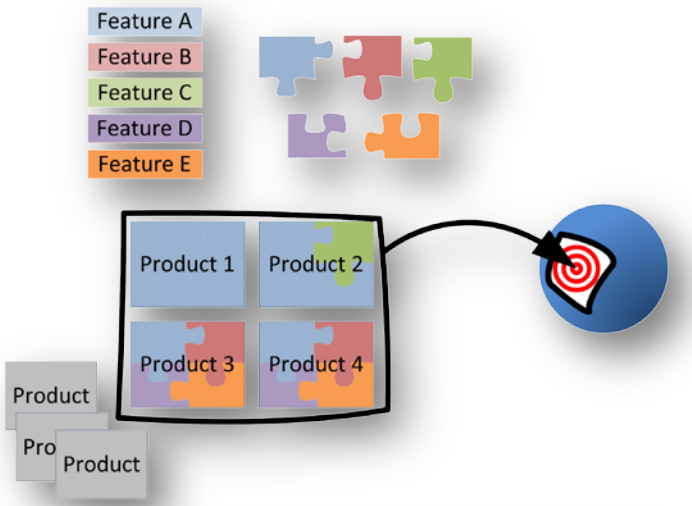
	Introduction	Growth	Maturity	Decline
Customer	Early Adopter	Early Majority	Late Majority	Laggards
Promotion	Inform, Educate	Competitive differences	Cost-effective	Minimal promotion
Variability	One	More versions	**More variants (Product line)**	Best Sellers

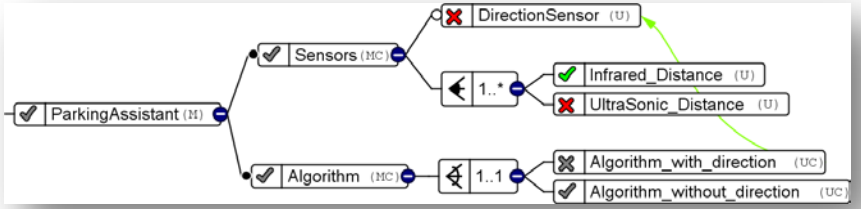
Maturity Levels for SPL Engineering

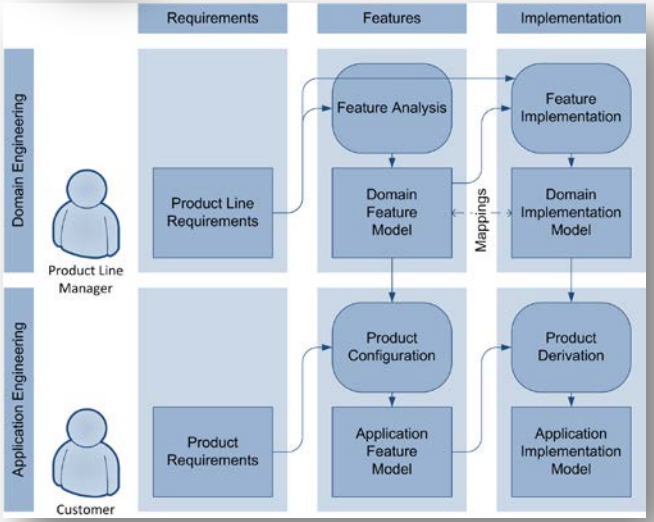


(Jan Bosch, Maturity and Evolution in Software Product Lines: Approaches, SPLC 2002)

Summary


Feature A
Feature B
Feature C
Feature D
Feature E
Product 1
Product 2
Product 3
Product 4
Product
Pro
Product


ParkingAssistant (M)
Sensors (MC)
DirectionSensor (U)
1..*
Infrared_Distance (U)
UltraSonic_Distance (U)
Algorithm (MC)
1..1
Algorithm_with_direction (UC)
Algorithm_without_direction (UC)


Requirements
Features
Implementation
Domain Engineering
Application Engineering
Product Line Manager
Customer
Product Line Requirements
Feature Analysis
Domain Feature Model
Mappings
Feature Implementation
Domain Implementation Model
Product Requirements
Product Configuration
Application Feature Model
Product Derivation
Application Implementation Model