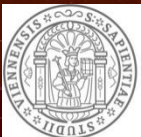


On the Interdependence and Integration of Variability and Architectural Decisions

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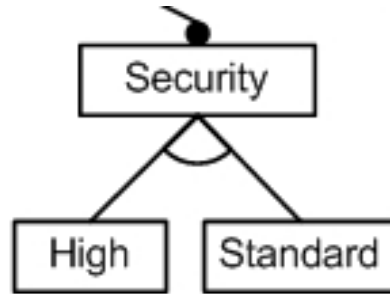


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Variability Decision

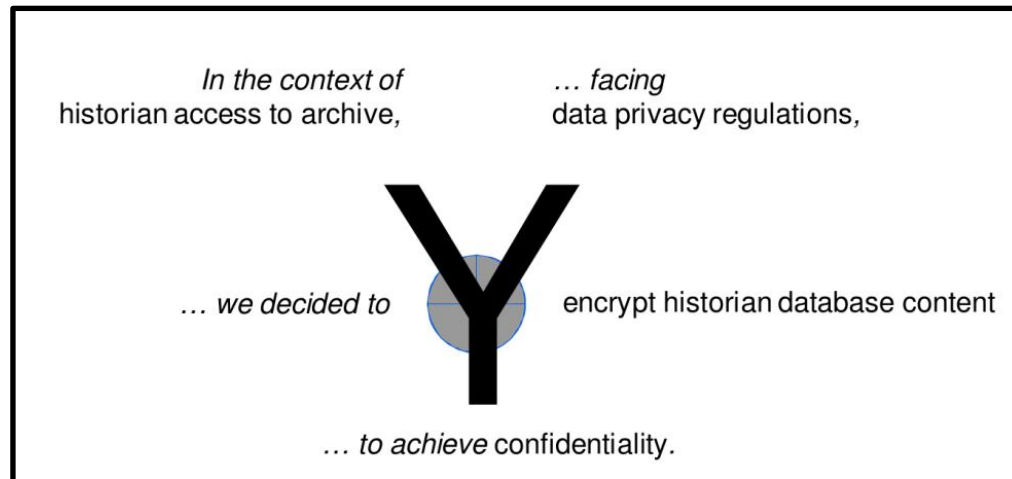
- ...is a decision related to the differences among the products that derive from a product line.



- From an architectural perspective, variabilities may reflect different architectural options considered during the design of the product line that are independent of the products' features.

Architectural Decisions

- ... is the result of the evaluation of alternative design options in terms of architectural elements such as patterns, components, or connectors and the selection of the best-fitting solution.



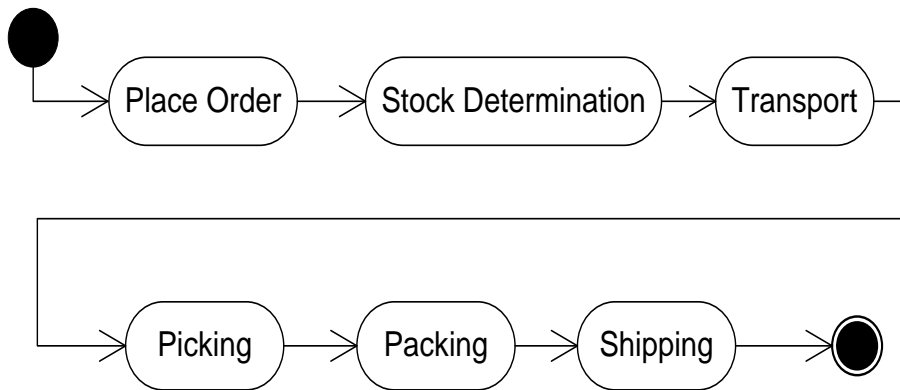
- Architectural decisions refer to the software design both at product line and product level.

Research Problem

- Variability decisions often overlap with or influence architectural decisions (e.g., resolving a variability may enable or prevent some architectural options).
- *The interdependence and integration of variability and architectural decisions have neither been studied nor addressed in a systematic way, yet.*
- ✓ This work intends to fill this gap and proposes the **systematic integration** of the two types of decisions along with **tool support**.

Motivating Case

Warehouse Management System



Goods out process of a warehouse



Architectural Decisions and Variability Decisions

Variability Decision	Possible values	Binding Time
Picking rate	High/Medium/Low	Design Time
Partial pallet strategy	Highspeed/Optimal reduction	Runtime
Stapler crane strategy	Single fork/Multiple forks	Design Time

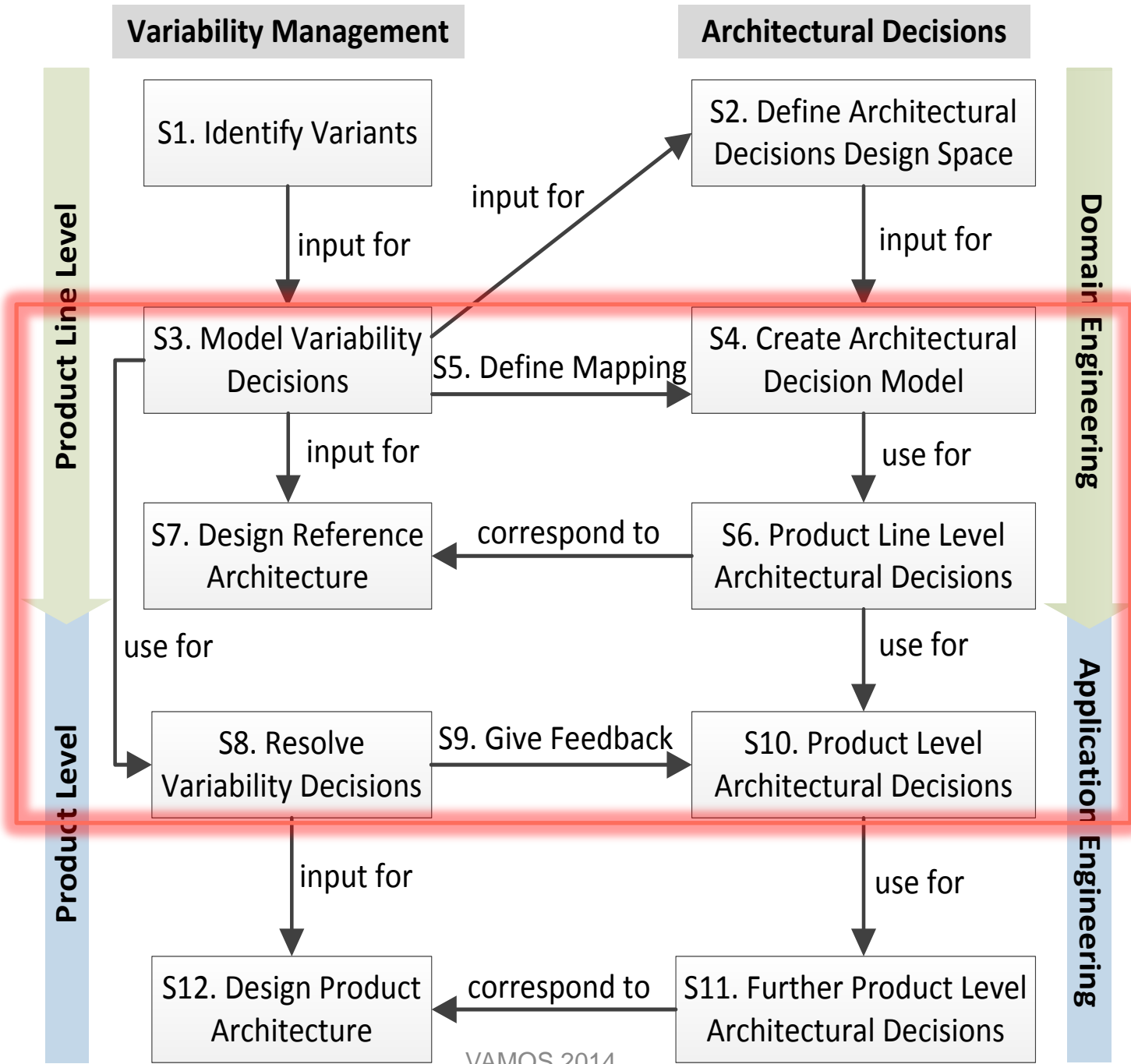
Architectural Decision	Options	Influenced by Variability Decision
IPC type	Open source Medium Price Very Expensive	Picking rate - Low - Picking rate - Medium/High
Deployment devices	Single server Multiple servers/round-robin Multiple servers/load monitoring	Picking rate - Low Picking rate - Medium Picking rate - High
Service identification	Business delegate proxy Business delegate adapter	- -

...and their Interdependency

- Low picking rate implies *IPC open source* and *Single server*
- Medium picking rate implies *IPC very expensive* and *Multiple server with round-robin*
- High picking rate implies *IPC very expensive* and *Multiple server with load monitoring*

➤ *How to express and resolve these interdependencies systematically?*


Proposed Approach





Tool Support: EasyProducer







Product Configuration Editor: PL_WMS

 Validate Product

 Instantiate Product

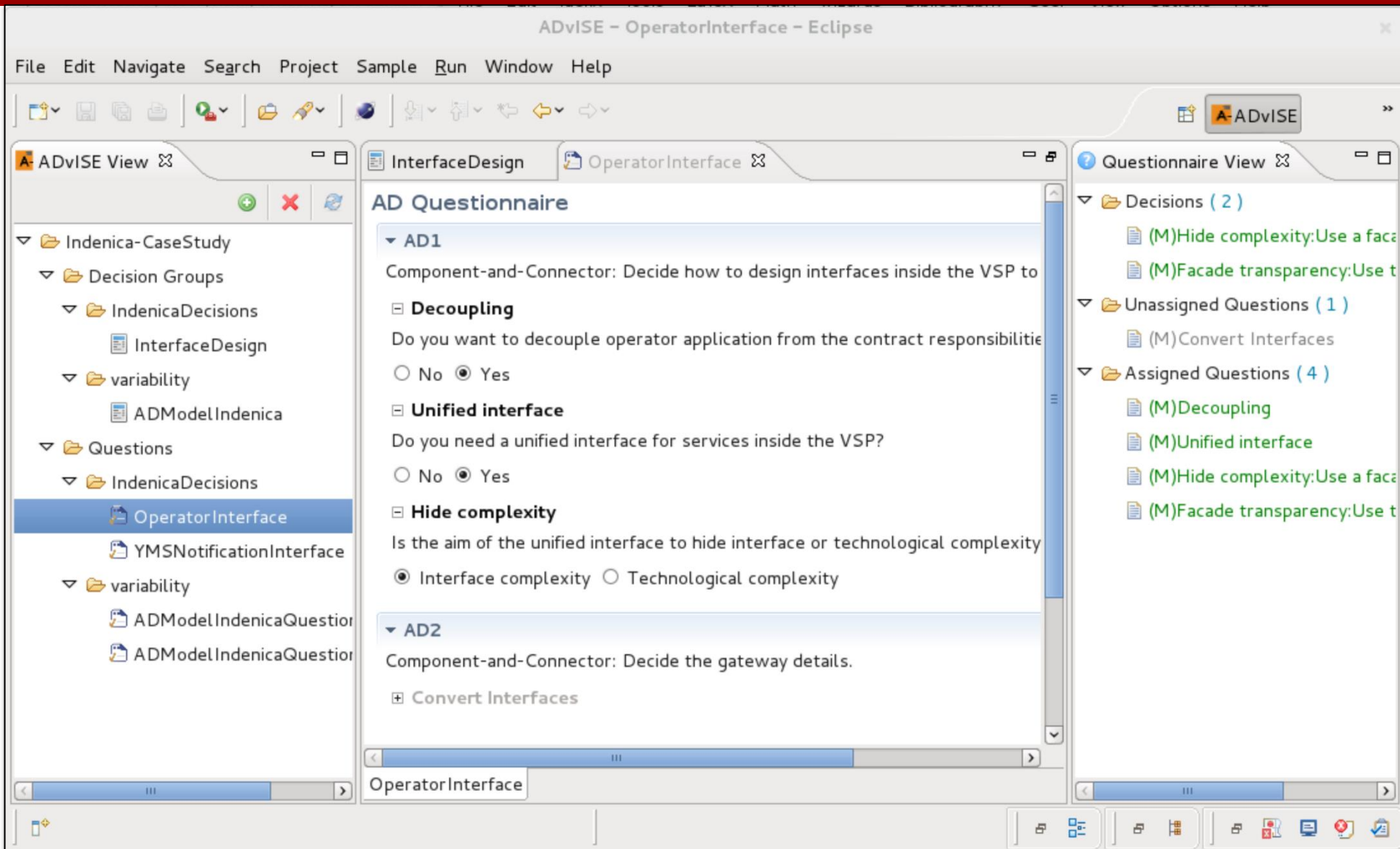
 Propagate Values

 Freeze All

	Decision Name	Current value	Freeze
	VP1	medium	freeze
	VP2		
	VP3	single	freeze
	VP4	computer	freeze

```
1 project PL_WMS {
2
3     version v0;
4
5     enum PickingRateType {high, medium, low};
6     enum PartialPalletStrategyType {highSpeed, optimalReduction};
7     enum StaplerCraneStrategyType {single, multiple};
8     enum UIDeviceType {computer, mobile};
9
10    PickingRateType      VP1;
11    PartialPalletStrategyType VP2;
12    StaplerCraneStrategyType VP3;
13    UIDeviceType         VP4;
14
15    enum BindingTime {designTime, compileTime, initTime, runTime};
16    attribute BindingTime bindingTime = BindingTime.designTime to PL_WMS;
17    assign (bindingTime = BindingTime.runTime) to {
18        PartialPalletStrategyType VP2;
19    }
20 }
```

Tool Support: ADvISE



Tool Integration

```
<mappings>
...
<vp name="VP1">
  <relation type="excludes">
    <vd id="PickingRateType.medium"/>
    <add id="AD4.IPC type of
software.IPC open source"/>
  </relation>
</vp>
...
</mappings>
```

Mapping between Variability and
Architectural Decisions

```
VP1 = PickingRateType.medium
VP3 = StaplerCraneStrategyType.single
```

Product Configuration with EasyProducer

AD Questionnaire

AD4

Component-and-Connector: Product design

IPC type of software

What kind of software shall be used for managing IPC?

☒ IPC open source ☐ IPC medium price ☐ IPC very expensive

IPC software

Which software will be used?

☐ Software 1 ☐ Software 2

Updated Architectural Decision Model with
ADVICE

Conclusions and Future Work

- Interdependencies between variability and architectural decisions exist but are mainly kept implicit.
- Formalizing the interdependencies requires additional efforts but leads to better automated support in integrating variability management and architectural decision making in the long run.
- Variability and architectural decisions remain consistent at product derivation.

Some open challenges

- Reconsidering a variability decision may cause inconsistencies to existing architectural decisions. How to deal with this?
- What other interdependencies exist? How to classify, formalize them?
- What is the impact of changing both decisions during the evolution and maintenance of product lines and products?