



#### three cases of feature-based variability modeling in industry

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### variability is everywhere













## variability adds complexity

#### code

76	<pre>check_range(unsigned long vstart, unsigned long vend,</pre>				
77	unsigned long kstart, unsigned long kend)				
78	{				
79	unsigned long vaddr, kaddr;				
80					
81	#ifdef DEBUG_CHECK_RANGE				
82	<pre>srm_printk("check_range: V[0x61x:0x61x] K[0x61x:0x61x]\n"</pre>				
83	vstart, vend, kstart, kend);				
84	#endif				
85	/* do some range checking for detecting an overlap */				
86	<pre>for (vaddr = vstart; vaddr &lt;= vend; vaddr += PAGE_SIZE)</pre>				
87	{				
88	kaddr = (find_pa(vaddr)   PAGE_OFFSET);				
89	if (kaddr >= kstart && kaddr <= kend)				
90	{				
91	#ifdef DEBUG_CHECK_RANGE				
92	<pre>srm_printk("OVERLAP: yaddr 0x%lx kaddr 0x%lx"</pre>				
93	" [0x%lx:0x%lx]\n",				
94	vaddr, kaddr, kstart, kend);				
95	#endif				
96	return 1;				
97	}				
98	}				
99	return 0;				
00	}				

#### requirements



tests



#### architecture



#### variability modeling



(toy) feature model

#### survey findings

large diversity of tools

industry lacks guidance



Berger, Rublack, Nair, Atlee, Becker, Czarnecki, Wasowski: A Survey of Variability Modeling in Industrial Practice. VaMoS. 2013

#### quantitative $\rightarrow$ qualitative

among 42 survey participants

conducted 8 semi-structured interviews (1-1.5h)

this paper: 3 described/analyzed in-depth

#### research questions

#### practices?



#### benefits?

challenges?

## subject selection

development scales	small (2 developers)	large (60 developers)	ultra-large (100 teams)
domains	eCommerce	industrial appli- cations/energy	automotive
product line adoption	reactive	extractive	proactive
	consulting company (≤50 employees)	component producer (≤25,000 employees)	car manu- facturer (≤150,000 employees)

# **MODELING CONTEXT**



#### home-grown generator/preprocessor

## B: component producer



#### ~1,100 features



power electronics firmware

## C: car manufacturer



## BENEFITS

## configuration / code generation?



Berger, She, Lotufo, Wasowski, Czarnecki: A Study of Variability Models and Languages in the Systems Software Domain. In: IEEE Transactions on Software Engineering, volume 39.12, 2013

### organization of knowledge!

resembles perceived benefits of MDD\*

B: The first one is that it's visible, you see the features that you had in the code before.

B: Actually, you see the features of the whole product line. Before, they saw features of the specific products.

### scoping, collaboration, and visualization

C: To agree between the R&D organization and with the product planning organization over the content of each product.

B: The same functionality was implemented twice [...] They implemented the same features.

# PRACTICES

#### who edits the models?

centralized model governance

B: We have a colleague who [...] really has the domain knowledge.

B: Whenever we have an issue, we try to organize a workshop or a meeting.

C: On the top level, it's centralized, [maintained by] a central group.

bad news for distributed modeling

### how to build the hierarchy?

result of domain analysis (top-down) and evolution (bottom-up)



## constraints?





## evolution?

primarily addition / rare removal

stable model hierarchies

versioning of the model, not individual features

JUSTAHEAD



# CHALLENGES

### short-term versus long-term benefit

organizational pushback in a matrix organization



## developer motivation and organization

B: Developers are used to working for a long time on the same abstraction level.

C: We have a lot of dependencies between teams, so it's quite difficult for the teams to work autonomously.

# SUMMARY

#### key take-aways

#### benefits

organization of knowledge collaboration configuration

pragmatic practices centralized governance versioning of the model limited constraint modeling

#### challenges

acceptance of abstraction layer organizational pushback dependencies between teams

#### future work

static analysis infrastructure (FarCE) to recover constraints (\*)

incremental adoption of product lines (\*\*)

study feature identification and coordination dynamics

investigate other units of variability

study failed attempts

\*) Nadi, Berger, Kästner, Czarnecki: Mining Configuration Constraints: *Static Analyses and Empirical Results*. ICSE. 2014 \*\*) Antkiewicz, Ji, Berger, Czarnecki, Schmorleiz, Lämmel, Stanciulescu, Wasowski, Schäfer: *Flexible Product Line Engineering with a Virtual Platform*. ICSE/NIER. 2014

## thanks for your attention



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