A Model-driven Product Line Approach For HMI Development
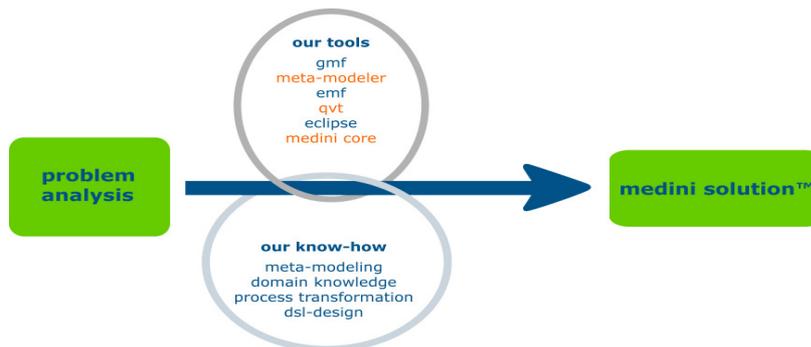
PIK 2009, Berlin

25.05.2009

Marc Born, Omar Ekine

ikv

---

ikv and DENSO – who we are

our tools
gmf
meta-modeler
emf
qvt
eclipse
medini core

problem analysis

medini solution™

our know-how
meta-modeling
domain knowledge
process transformation
dsl-design

DENSO Europe

global supplier
of automotive technology,
systems and components

ikv++ technologies ag

1

roadmap

- motivation

- HMI development process at DENSO

- model-driven HMI development
  - HMI screen flow modeling

  - HMI screen flow simulation

- variant management with software product line approach
  - family models : feature and variation modeling

  - variant models : generated from family models

- tool demonstration

confidential

ikv++ technologies ag

---

motivation

- car infotainment software belongs to those products with relatively large common behavior but different look and feel

- OEMs (car manufacturers) want a high quality, time and cost saving infotainment system satisfying their individual functional and non-functional requirements

- OEM suppliers like DENSO cannot therefore deliver same looking software to all customer

- DENSO therefore has the challenge of combining the following aspects:
  - mass production to reduce cost
  - high degree of software re-use to increase productivity and quality
  - customize software easily to fulfill OEM's individual requirements

confidential

ikv++ technologies ag

navigation system development process at DENSO

model-driven product line development process

- feature-wise stable core navigation software

- separate screen flow from look and feel (skin) design
  - screen flow and skin models have clear semantics

- consistency checks can be applied to models in order to validate them

- HMI model can be simulated in order to detect errors at an early stage

- system features are modeled and connected to HMI models
  - allows fast feature based configuration and generation of customer specific variants

- HMI code can be generated from the models

model-driven HMI development – screen flow modeling

- developed screen flow modeling domain specific language (specialization of UML activities) and graphical editor

- abstract screen model specifies the structure of HMI screens and possible actions that can be triggered from a screen

- a screen flow model specifies the transitions between screens. Transitions are activated by triggering actions

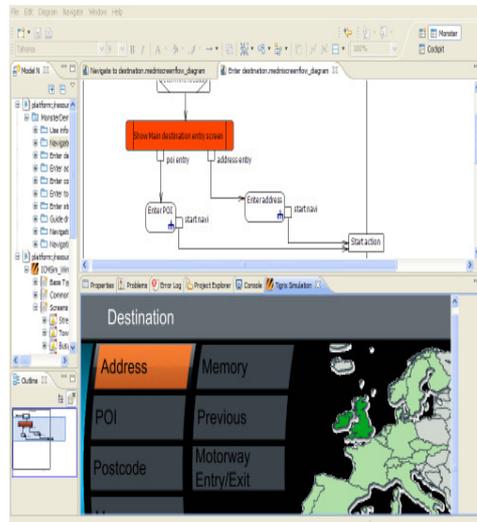- a task model specifies the tasks expected to be executed by the navigation core

3
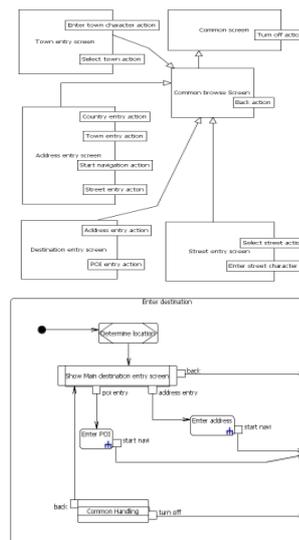
model-driven HMI development – screen flow simulation

- skin is modeled using TiGRiX

- screen flow can be simulated without concrete skin

- connect skin to abstract screens and then simulate flow with skin

- different skins conforming to the same flow can be simulated simultaneously

- skins designed with other technologies like Flash could also be connected and simulated
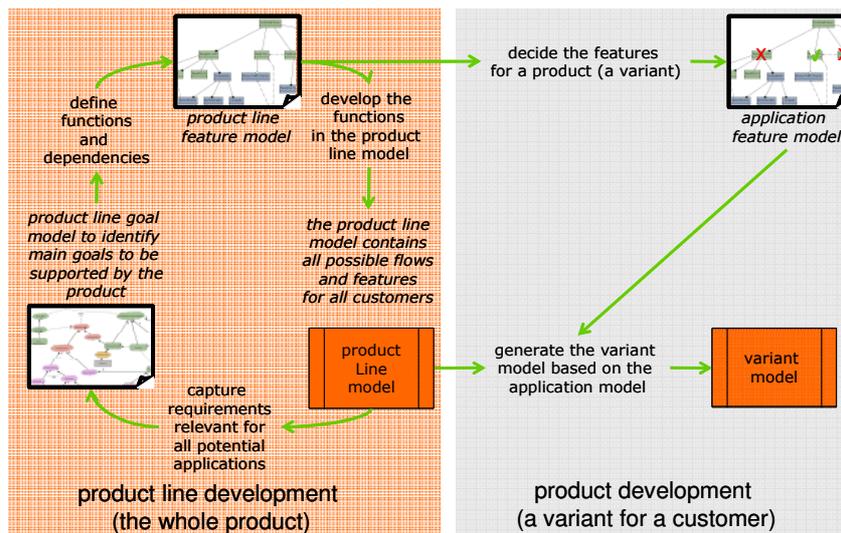
ikv++ technologies ag

SPL based HMI development process - overview

define functions and dependencies

product line feature model

develop the functions in the product line model

decide the features for a product (a variant)

application feature model

product line goal model to identify main goals to be supported by the product

the product line model contains all possible flows and features for all customers

product Line model

generate the variant model based on the application model

variant model

capture requirements relevant for all potential applications

product line development
(the whole product)

product development
(a variant for a customer)

ikv++ technologies ag

4

SPL based development process

main goals of *product line development*
- development of reusable artifacts
- identification of commonalities within a family of products
- identification of variations in a family of products

main goals of *product development*
- development of selected product (variant)
- maximize reuse of existing artifacts
- identification of new common features

➔ **feature models are the central means to organize the relations and dependencies between product line and product artifacts**

confidential

ikv++ technologies ag

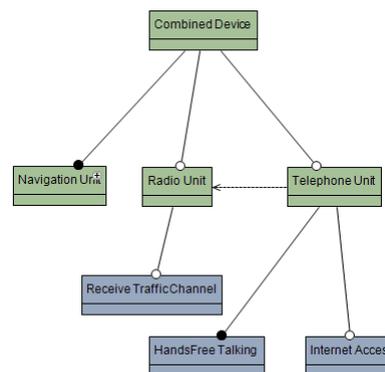## feature models

feature
- a characteristic of a system relevant for some stakeholder
- examples:
  - a requirement
  - a technical function or function group
  - a non-functional (quality) characteristic

features are related to each other
- a feature may have optional or mandatory subfeatures
- features may exclude or require each other

features are related to other artifacts of the product line
- a component may implement a feature
- a feature may fulfill a goal or requirement
- a feature may control the flow of activities in a use case

confidential

ikv++ technologies ag

5

HMI variant management with product line approach

family models

- variation points are explicitly modelled in family screen flow

- family features are applied to screen flow model elements for expressing:
  - **optional flows:** a feature exits or not in a variant
  - **alternative flows:** a feature is realized in different variants differently

variant models

- feature decision is made in family model for a specific variant and used to derive variant feature model

- variant flow model is derived from family flow based on the variant feature model

- QVT engine is used for the transformation
  - flexible adaptation of generation rules without redeployment
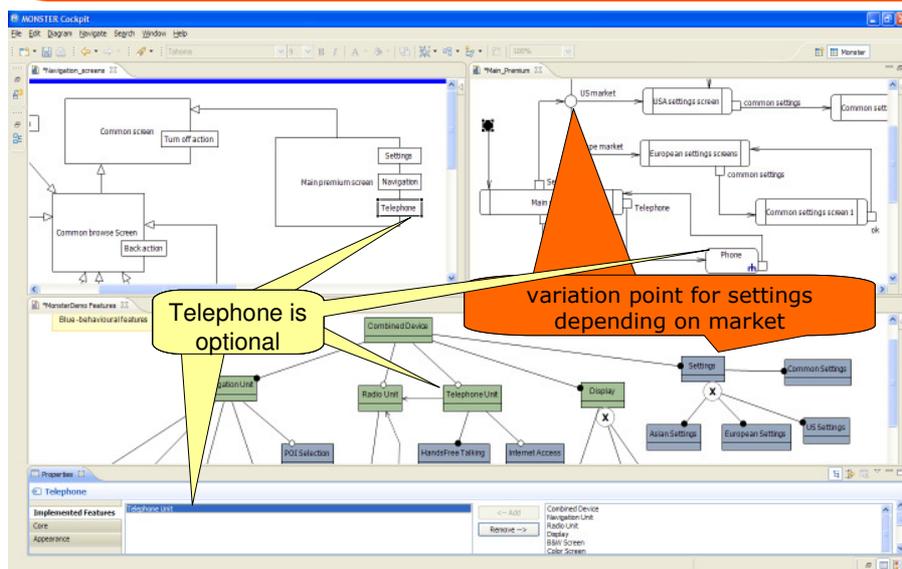 - bidirectional transformation possible

confidential

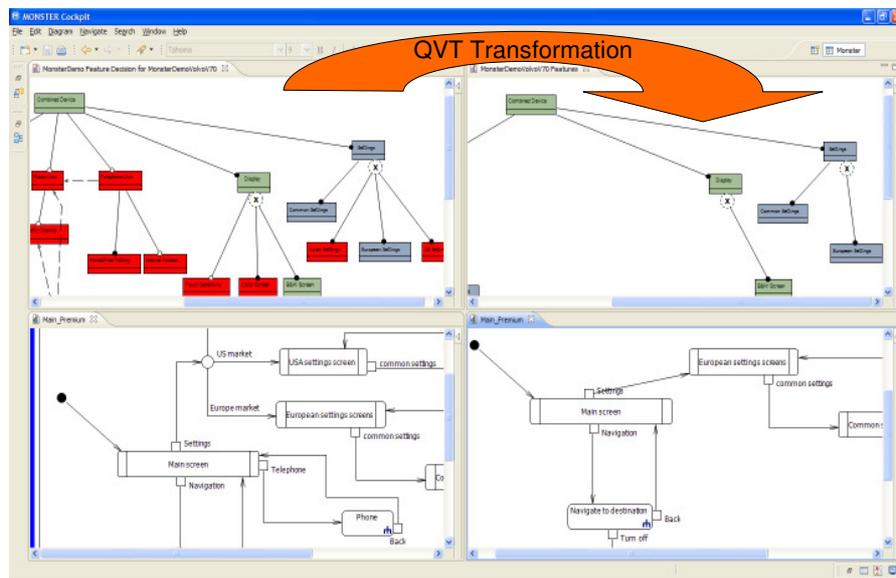ikv++ technologies ag

HMI variant management - family models

Telephone is optional

variation point for settings depending on market

confidential

ikv++ technologies ag

from family to variant models

QVT Transformation

folie 13

confidential

ikv++ technologies ag

---

conclusion

- model driven development provides semantically rich and consistent models which separate flow and skin design but allows connecting them to check conformance and enhance communication

- product line approach increases reuse while allowing easy customization to specific customer requirements

- reduction of the average development time for a new product

- reduced time-to-market and time-to-revenue for a new product

- better product quality and improved company reputation for quality

- increased agility to react on market requirements

➔ **reduction in the average engineering cost per product**

folie 14

confidential

ikv++ technologies ag

Marc Born, CTO

Omar Ekine, Senior Architect

ikv++ technologies ag
Dessauer Strasse 28/29
D-10963 Berlin

www.ikv.de

ikv