SWC Software Construction | RWTH AACHEN UNIVERSITY

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Software Construction

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  Dipl.-Inform. Alexander Nyßen
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  Dipl.-Inform. Thomas von der Maßen

  Dipl.-Inform. Moritz Schnizler (until June)

  Dipl.-Inform. Axel Uhl
  (external at Interactive Objects, Freiburg, until November)

  Dipl.-Inform. Thomas Weiler
  (third-party funds position)

- Student Researchers:

  Holger Schackmann, Andreas Dornbusch

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  Information about our research and teaching activities can be found at:
  http://www-lufgi3.informatik.rwth-aachen.de

Overview

Research

In 2003 we have intensified and expanded our research on software product line development. A first running prototype of a dedicated product line requirements engineering tool, called *RequiLine*, was developed. It supports both modelling features and requirements. It offers a semantical information model that can be used throughout the product line development process, e.g. during application development when new products are configured based on the product line's platform. RequiLine was successfully presented in several contexts (conferences and industry companies). Currently we are enhancing its functionality and usability. In February Alexander Nyßen joined our group. He is funded by ABB Corporate Research and is doing research in the area of product line development of small embedded devices. A couple of workshops have been organized and an initial architecture modelling approach has been proposed and tried.

In the course of the year two research projects were completed. In the project *Object Based Internet Search* Axel Uhl has developed a new approach for organizing information in the web by means of searchable objects. The main results of this project are a conceptual model of internet search, an implementation of a Java framework supporting the construction of searchable internet application and a formal model regarding the bandwidth consumption of distributed search. Axel successfully passed his doctoral examination in December. Moritz Schnizler has finished his research on *Role Based Testing* of object collaborations. This testing technique uses role models describing the behaviour object collaborations to systematically derive test cases, that can be reused whenever the role models are implemented. This approach has shown to be very effective in detecting collaboration errors. Beside the conceptual work a set of tools based on the JUnit framework was developed to support the implementation and reuse of role based tests.

Teaching

In addition to undergraduate courses on Programming and Software Development the group offers on the graduate level the following set of courses focusing on Software Construction and Software Quality Assurance:

- Lecture *Software Quality Assurance*
- Lecture *Component Technology*
- Lecture *Product Line Development*
- Lecture *Object-Oriented Software Construction*
- Seminars on various topics.

Research Projects

Requirements Engineering for Software Product Lines

T. von der Maßen, H. Lichter

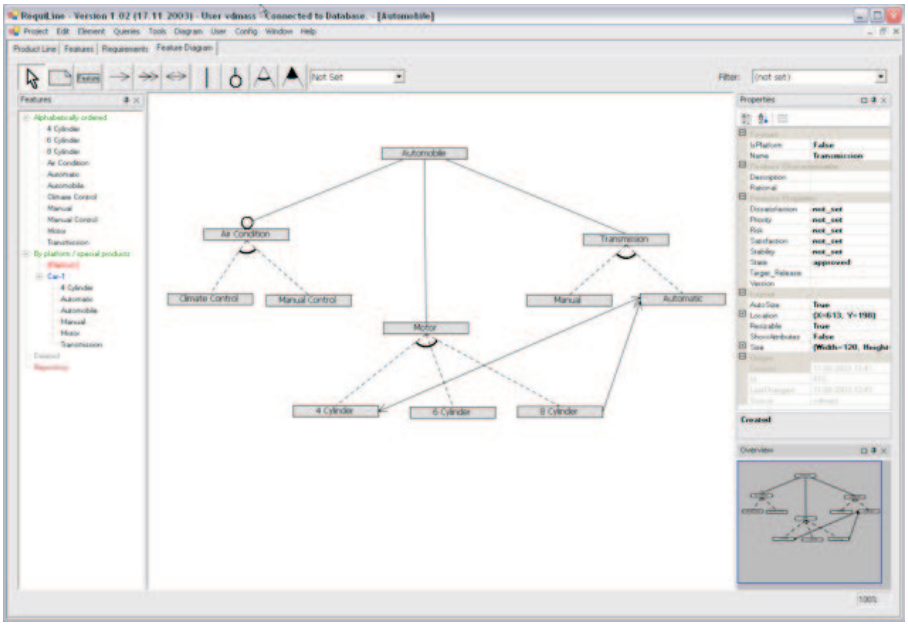
The development of a Software Product Line (SPL) is a demanding task for all stages of the software development process especially for the requirements engineering. The identification and modelling of common and variable characteristics are an essential task during the requirements engineering process. Communicating variability to stakeholders affect the success of projects significantly.

Modelling variability can be done from different views and on different levels of abstraction. Whereas the level of abstraction determines the granularity of descriptions of characteristics, different views reveal information about perspectives on a system. Therefore the domain can be modelled from a static point of view to reveal information about structural hierarchies. Feature modelling is one methodology to express these hierarchies through compositional-relationships combined with variability information.

Modelling variability from a behavioral point of view has been neglected so far. To overcome this deficiency one aim of this project is to analyze methods and notations to express functional variability in variant operation sequences. Use Cases and Use Case diagrams have been chosen to be an adequate notation to express functional behavior, but have to be extended by concepts and modelling elements to express variability.

Our research group has developed a prototype of a requirements engineering tool, named *RequiLine* that supports the management of requirements and feature models, equally. The development of *RequiLine* has been mainly driven by the identified requirements for an adequate tool support for product lines and therefore to overcome the deficiencies existing requirements engineering tools have in managing variability and dependencies. Our experience shows, that requirements engineering tools are used together with graphical editors to draw feature models. Unfortunately the created drawings do lack of any semantic and could not be used for queries or consistency checks. *RequiLine* is a first study to close this gap.

As *RequiLine* currently supports only textual representations of features and requirements, a graphical editor for feature models is currently under development. The integration of Use Cases is possible but in a limited way. The extension of full variability support in Use Cases and the connection with features and requirements is a future task to work on.



RequiLine's main GUI

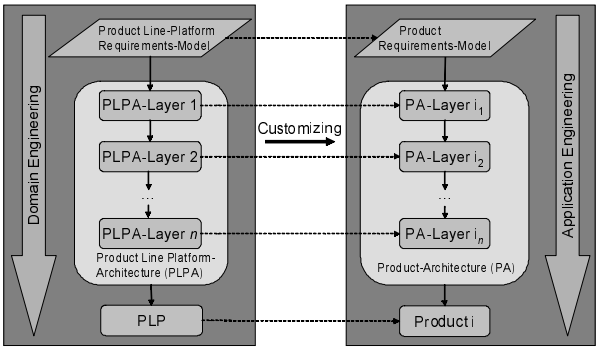
Architectures for Software Product Lines

T. Weiler, H. Lichter

External cooperation: ABB Corporate Research, Ladenburg

Product line-based software development can only lead to full success if it is recognized as an integrated concept, which involves all phases of the software engineering process. This project concentrates on architecture modelling for SPLs.

We have developed a top-level process for SPL architecture modelling. Within the *domain engineering* initially the requirements for the entire PLP are collected together with the identified variability and afterwards compiled into a *requirements model* for the PLP, which among other things contains for example a *feature model*. This requirements model forms the basis for the top-level layer of the PLP architecture. Starting from this still abstract architecture layer, the PLP architecture gets more and more refined in further architecture layers. This procedure is according to the *Model Driven Architecture* (MDA) approach introduced by the OMG.



SPL architecture modelling process

In the last step within the domain engineering the PLP architecture gets realized as far as possible. Thereby - according to the differentiation in *common* and *variable components* - both finished and incomplete components are placed in the PLP. At the beginning of the *application engineering* firstly the requirements for a *concrete product* are determined on base of the requirements for the PLP. Afterwards - similar to the domain engineering - a first coarse architecture layer for the product is developed, which is based on the layer of the same abstraction level as in the PLP architecture. In the following this top-level architecture becomes more and more refined and improved. Thereby the variability included in the PLP architecture is resolved conform to the previously identified product requirements. In the last step the executable system is implemented based on this product architecture.

At the moment we are analyzing, which inputs from the requirements process must be given to build an architecture model for a SPL. Therefore different approaches for using *feature modelling* are analyzed how far they can serve as a basis for SPL architecture modelling and which inputs are missing.

Product Line Development for Embedded Systems

A. Nyßen, H. Lichter

External cooperation: ABB Corporate Research, Ladenburg

While hardware development is largely understood and can be efficiently performed, state-of-the-art software engineering for embedded systems is far behind that of other application areas. Thus, embedded software systems are often monolithic platform-dependent systems that are built from scratch and are hard to maintain, upgrade, customize or even port to other platforms. To establish systematic development to this field is challenging, because the stringent non-functional requirements that are imposed on an embedded software system by its surrounding environment (like memory consumption or timing constraints) and the

special application domains (e.g. hazardous application areas) do not allow to apply common software engineering practices ”as is” but require that they have to be ”tailored” to meet these new demanding requirements.

Inspired by the large success product line engineering has brought to hardware development, it seems to be a promising approach to gain more reuse, higher product quality and lower product development costs in software development also, especially in the development of embedded software systems. However, product-line practices cannot be reasonably applied if no systematic development is established in the developing organization, which can be taken as a firm basis to build upon. That is why past work of this project focussed on methodical aspects and - furthermore inspired by the practical needs of our business coorporation partners - resulted in the definition of an iterative development process and a detailed design method that are capable of forming the basis for the application of more far-reaching product line engineering practices.

Current work in this project is now focussed on concepts, languages, and tools for the development of product-line architectural models. As they are the major core assets of a product line, which form the basis for all succeeding development activities inside the product-line life cycle, they are investigated with high priority. The aim is to specify the architecture of an embedded systems product line in a component-based manner in the form of an architectural frame - a macro architecture - into which components (either newly developed or extracted from existing products) can be integrated. As the design of a product-line architectural model has to be embedded into a product-line development process, the integration of the design acitivities with the pre- and succeeding activities of the product-line life cycle are also of interest. Regarding the preceding activities, further research is needed on how a product-line architectural model can be inferred from existing product specific architectural models in a way consistent to the requirements and features gathered in earlier development steps. Taking the viewpoint of the succeeding steps in the product-line life cycle, it is of interest, how product instantiation (i.e. the deduction of a product specific model from the product-line architectural model) and product implementation can be supported (e.g. by code generation).

Other Activities

Board Member of the *GI-Fachgruppe 2.1.6. Requirements Engineering, H. Lichter*

Member of the *GI-Fachausschuss 2.1 Software Engineering and Programming Languages*, *H. Lichter*

Member of the program comittee, GI-Conference *SEUH 2003*, Berlin, 27.-28.2.2003, *H. Lichter*

Member of the program comittee, ACM Symposium on Applied Computing 2003, Special Track on Software Engineering: Applications, Practices, and Tools, March 9 to 12, 2003, Melbourne, Florida, USA, *H. Lichter*

Reviewer for dpunkt-Verlag Heidelberg and computing reviews, *H. Lichter*

Deputy of the Computer Science Department in the RWTH's quality of teaching program, *H. Lichter*

Organization of the Computer Science Department's mentors program, *H. Lichter*

Member of the Computer Science Department's commitee for Service-Lehre, *H. Lichter*

Organization of the Beginner's Course in Computer Science 2003, *H. Lichter, T. Weiler*

Member of the GI-Arbeitskreis *Requirements Engineering für Produktfamilien* of the GI-Fachgruppe Requirements Engineering, *T. von der Maßen*

Member of the GI-Arbeitskreis *Featurelisten* of the GI-Fachgruppe Requirements Engineering, *T. von der Maßen*

Speaker of the GI-Arbeitskreis *Werkzeuge für die Produktlinienentwicklung* of the GI-Fachgruppe Requirements Engineering, *T. von der Maßen*

RequiLine demonstrations at IESE Kaiserslautern, BOSCH Stuttgart, ABB Ladenburg, *T. von der Maßen*

Research stay at ABB Corporate Resarch Germany, Ladenburg, April 2003 *A. Nyßen*

Talks and Publications

Talks

H. Lichter: *Einsatz der Feature-Modellierung bei der Entwicklung von Produktlinien -Konzepte und Werkzeuge,* ABB Corporate Research, Ladenburg

H. Lichter: *Softwareprozessverbesserung mit dem CMMI - Eine Einführung,* Kister AG, Aachen

H. Lichter: *Wirtschaftlichkeit von Software-Prüfungen,* REGINA, Working Group Software Test

H. Lichter: *Modellierung von Produktlinien-Architekturen,* University Trier

T. von der Maßen: *RequiLine,* Interner Arbeitskreis ”Requirements Engineering” der Robert Bosch GmbH, Stuttgart

T. von der Maßen: *RequiLine - Ein Requirements Engineering Werkzeug für Software-Produktlinien,* Fraunhofer IESE, Kaiserslautern

T. von der Maßen: *RequiLine - Ein Requirements Engineering Werkzeug für Software-Produktlinien,* Annual Meeting GI-Fachgruppe Requirements Engineering, Erlangen

T. von der Maßen: *RequiLine: A requirements engineering tool for software product lines,* Fifth International Workshop on Product Family Engineering PFE-5, Siena, Italy

T. von der Maßen: *Werkzeuge zur Feature-Modellierung bei der Entwicklung von Produktlinien,* ABB, Ladenburg

M. Schnizler: *Rollenbasierter Test objektorientierter Programme,* Universitt Hamburg, AB Softwaretechnik, Fachbereich Informatik

H. Lichter, R. Melchisedech, O. Scholz, T. Weiler: *Erfahrungen mit einem Workshop-Seminar im Software Engineering Unterricht,* SEUH 03, Berlin, dpunkt-Verlag

T. Weiler: *Modelling Architectural Variability for Software Product Lines,* Software Variability Management Workshop 2003, Groningen, February 2003

Publications

T. von der Maßen, H. Lichter: *RequiLine: A requirements engineering tool for software product lines,* Proceedings of International Workshop on Product Family Engineering PFE-5, Springer LNCS 3014, Siena, Italy, November 2003

T. von der Maßen, H. Lichter: *Modellierung von Variabilität mit UML Use Cases,* Softwaretechnik-Trends, Vol 23 Nr 1 ISSN 0720-8928, 2003

T. von der Maßen, A. Birk, G. Heller, I. John, S. Joos, K. Müller, K. Schmid: *Report of the GI Work Group ”Requirements Engineering for Product Lines”,* IESE-Report No. 121.03/E, November 2003

T. von der Maßen, A. Birk, G. Heller, I. John, K. Schmid, K. Müller: *Product Line Engineering: The State of the Practice,* IEEE Software, November / December 2003, Volume 20, No. 6, pp. 52-60

H. Lichter, T. von der Maßen, A. Nyßen, T. Weiler: *Vergleich von Ansätzen zur Feature Modellierung bei der Softwareproduktlinienentwicklung,* Technical Report AIB-2003-07, RWTH Aachen

H. Lichter, R. Melchisedech, O. Scholz, T. Weiler: *Erfahrungen mit einem Workshop-Seminar im Software Engineering Unterricht,* Proceedings SEUH 03, Berlin, dpunkt-Verlag

T. Weiler: *Modelling Architectural Variability for Software Product Lines,* Proceedings of Software Variability Management Workshop 2003, Groningen, February 2003

A. Uhl: *Architectures enabling scalable internet, Aachen,* RWTH Dissertation, 2003

A. Uhl, S.W. Ambler: *Point/Counterpoint: Model Driven Architecture Is Ready for Prime Time / Agile Model Driven Development Is Good Enough,* IEEE Software vol20(5), pp 70-73, 2003