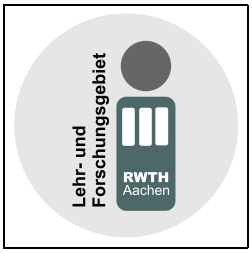
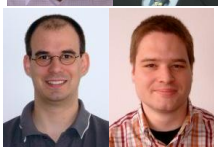
Software Construction



Staff



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  Dipl.-Inform. Alexander Nyßen
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  Dipl.-Inform. Holger Schackmann
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  (third-party funds position)

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Overview

Research

In 2004 we have carried on our research projects on software product line development. The product line requirements engineering tool (RequiLine), developed in our group, was substantially enhanced by an interactive means to enter and visualize feature models. A series of presentations and talks were given, which show that our tooling approach is promising and fits most requirements. During 2004 a couple of companies as well as research institutions used RequiLine for evaluation purposes. In autumn a diploma theses was started in cooperation with an industrial partner, which aims to asses and evaluate RequiLine in a large industrial product line project.

Within the context of architecture modeling for software product lines we have developed a first prototype of a plugin for the eclipse platform called PLA-Editor which allows to annotate UML class diagrams with variability information. Currently the plugin supports modeling variability which can be resolved at design time of the products derived from the product line platform. Thereby it assists the designer with a consistency checker which checks the designed architecture for inconsistencies regarding the modelled variability.

Based on the conceptual results on modeling architectures for small embedded devices the development of an architecture modeling tool was started, based on the UML2 standard, called ViPER. Although the tool is far from being complete it validates our chosen architectural and tooling approach.

Beside these project activities we have organized a workshop in the context of the GI conference Modellierung 2004 which was dedicated to the use of feature modeling in product development. Furthermore we have hosted some GI requirements engineering working group meetings and organized the D.A.CH workshop in September. Concerning our teaching activities we enhanced the course on Software Quality Assurance and Project Management by integrating a project management simulation tutorial (SESAM). This tutorial was carried out in cooperation with the software engineering chair of the University of Stuttgart.

In July Holger Schackmann joined our group. He is funded by an industrial partner and is doing research in the area of managing the development and evolution of multi-products in a multi-project context. Until now a concept on interleaved processes focusing on requirements management, project planning, and change management was developed.

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 and Project Management*
- Lecture *Component Technology*
- Lecture *Product Line Development*
- Lecture *Object-Oriented Software Construction*
- Seminars on various topics.
- Practical Labs

Research Projects

Requirements Engineering for Software Product Lines

T. von der Maßen, H. Lichter

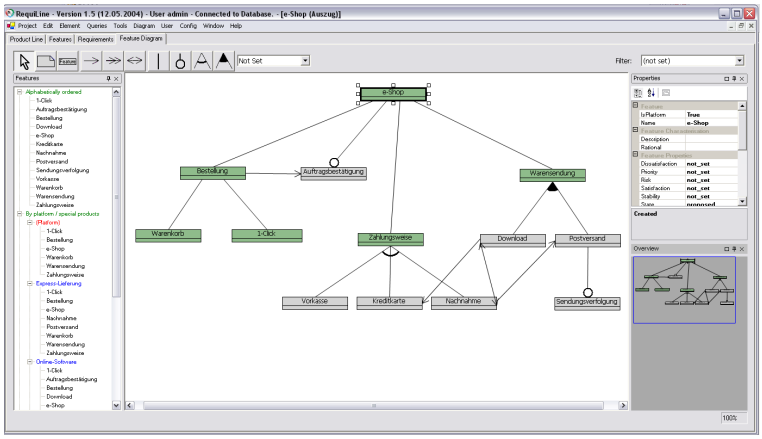
The development of a Software Product Line (SPL) is a demanding task for all stages of the software development process especially for the requirements engineering. The identification and modeling of common and variable characteristics are an essential task during the requirements engineering process.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

modeling 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 modeling is one methodology to express these hierarchies through compositional-relationships combined with variability information.

Ensuring the integrity and consistency within and across feature models are of high importance, too. The derivation of products from the product line models can only be done, if the product line models do not show any inconsistencies. Therefore the research group has defined categories of inconsistencies and identified the problems that can appear within the models.

Our research group has developed furthermore 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 it allows to define queries and consistency checks on the model.



RequiLine's feature editor

As *RequiLine* currently supports only a very limited way to derive products, a product derivation wizard is currently under development. This wizard should guide the user through the instantiation process to avoid building inconsistent product derivations. In the current release features and natural language requirements are in the focus. The integration of Use Cases is possible indeed 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.

Feature-based Architecture-Modeling for Software Product Lines

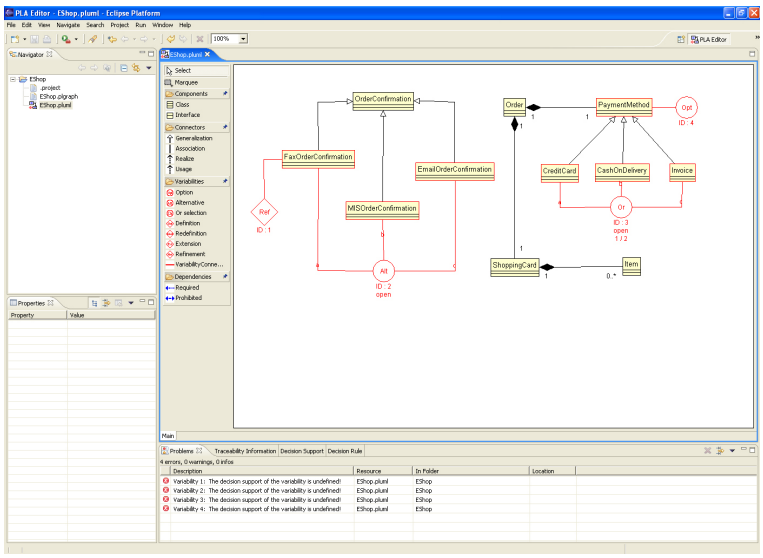
T. Weiler, H. Lichter

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. In this project we analyze how variability influences software architecture. For that purpose we have developed a metamodel which allows modeling of variability in arbitrary architecture description languages (ADLs) which are based on entities and relations. This metamodel can be extended by the metamodel of concrete ER-based ADLs like for example uml class diagrams.

Based on this approached a first prototype of a plugin for the eclipse platform called PLA-Editor was developed which allows to annotate UML class diagrams with vari-

ability information. Currently the plugin supports Modeling variability which can be resolved at design time of the products derived from the product line platform. Furthermore the plugin assists the designer with a consistency checker which checks the designed architecture for inconsistencies regarding the modelled variability.



PLA-Editor Plugin for Eclipse

Currently a methodology which allows smooth transition from requirements engineering to architecture Modeling by using feature models as a basis is developed. While the single phases of the software development process are mostly self-contained with continuous methodology, notation and also adequate tool support, the transitions often exhibit a gap. To bridge this gap, transformations between the different methodologies and notations used in the adjacent phases are needed. But the abstraction needed for these transformations results in information loss.

By providing a methodology which minimizes the information loss between the single phases of the software engineering process, traceability of Modeling decisions can be ensured. This results in a better documentation of the process and its products which in turn eases the evolution of the products and ensures return of investment.

Feature Modeling can assist this task by providing an input for the design process to identify components and structures of the PLPA. Because this process will rarely be a one to one mapping between features and architectural components, we are developing guidelines on how to identify architectural components based on feature models and how to structure them. The methodology developed in this step will later also be integrated in the PLA-Editor.

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).

Process and Tool Support for the Maintenance of Hierarchical Product Lines

H. Schackmann, H. Lichter

External cooperation: Kisters AG, Aachen

The parallel development and maintenance of multiple customer specific products within a product line requires serious efforts for coordination and monitoring. This is especially the case, when different product lines are based on a set of common assets and must share the development resources. The particular products may have different release plans that must be fulfilled. Development resources must be shared efficiently between product development projects and platform development. The common platform, as well as the platform of each product line based on it, must serve the sometimes diverging needs of the products. But it must be prevented that this results in different variants of a platform that are maintained in parallel. Under these circumstances adequate processes with suitable tool support are necessary to take advantage of the synergies in product line development.

In our current work we inspect how the structure of the product line can be considered in processes for change request, task management and configuration management. This approach should facilitate the identification of the many dependencies that exist in the maintenance of the product line. An improved transparency of the different activities and their progress will support the product-line wide coordination and planning.

Other Activities

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

Member of the program comittee, GI-Conference *Modellierung 2004*, Marburg, 24.-26.3.2004, *H. Lichter*

Organization of the workshop *Einsatz der Feature-Modellierung bei der Produktentwicklung*, Marburg, 25.3.2004, *H. Lichter, T. von der Maßsen)*

Organization of the D.A.CH workshop, RWTH Aachen, 20.-21.9.2004, *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*

Member of the examination board of Computational Material Science, *H. Lichter*

Organization of the Beginner's Course in Computer Science 2004, *H. Lichter, T. Weiler*

Head of the REGINA working group Software Test, *H. Lichter*

Member of the program comittee, *Workshop: Einsatz der Feature-Modellierung in der Produktentwicklung*, In Verbindung mit der Tagung „Modellierung 2004",Marburg, 25.3.2004, *H. Lichter, T. von der Maßen*

Organization of *Workshop: Einsatz der Feature-Modellierung in der Produktentwicklung*, In Verbindung mit der Tagung „Modellierung 2004", Marburg, 25.3.2004, *H. Lichter, T. von der Maßen*

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

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*

Research stay at ABB Corporate Research Germany, Ladenburg, June 2004, *A. Nyßen*

Talks and Publications

Talks

H. Lichter: *Die Hochschule als Karriereziel,* ABB Corporate Research, Ladenburg

H. Lichter: *Software-Prozessmodelle - Chancen und Risiken für KMU,* Workshop Entwicklung von Individualsoftware für den Mittelstand, Forschungsinstitut für Rationalisierung, Aachen

H. Lichter: *Feature-Modellierung - Ein Überblick,* Workshop Einsatz der Feature-Modellierung in der Produktentwicklung, Modellierung 2004, Marburg

T. von der Maßen: *Anforderungen an Requirements Engineering Werkzeuge für Produktlinien,* Jahrestreffen der GI-Fachgruppe Requirements Engineering, November, Kaiserslautern

T. von der Maßen: *Key challenges in Industrial Product Line Engineering,* Multikonferenz Wirtschaftsinformatik, März, Essen

T. von der Maßen: *Deficiencies in Feature Models,* Variability Management for Product Derivation - Towards Tool Support Workshop, In Verbindung mit der 3rd Software Product Line Conference, August, Boston

T. von der Maßen: *Einsatzgebiete der Feature-Modellierung*, Workshop: Einsatz der Feature-Modellierung in der Produktentwicklung, In Verbindung mit der Modellierung 2004, März, Marburg

T. von der Maßen: *RequiLine - A Requirements Engineering Tool for Product Lines*, Technical Demonstration, In Verbindung mit der 3rd Software Product Line Conference, August, Boston

Publications

T. von der Maßen: *Anforderungen an Requirements Engineering Werkzeuge für Produktlinien*, Software-Technik Trends, Band 24, Heft 4, ISSN 0720-8928, 2004

A. Nyßen, P. Müller, J. Suchotzki, H. Lichter: *Erfahrungen bei der systematischen Entwicklung kleiner eingebetteter Systeme mit der COMET-Methode*, in Hesse, Rumpe (Hrg.) Lecture Notes in Informatics (LNI) Modellierung 2004, Marburg, Volume P-45, p 229-234

T. von der Maßen, A. Birk, G. Heller, I. John, S. Joos, K. Müller, K. Schmid: *Key challenges in Industrial Product Line Engineering*, Proceedings of Multikonferenz Wirtschaftsinformatik (MKWI) 2004, Band 1, March 2004, ISBN 3-89838-049-1

M. Schnizler: *Rollenbasierter Test objektorientierter Programme*, Dissertation RWTH Aachen, 2004

T. von der Maßen, H. Lichter: *Deficiencies in Feature Models*, Proceedings of the Software Variability Management for Product Derivation - Towards Tool Support, Int. Workshop of SPLC 2004, Boston. August 2004, ISBN: 951-22-7218-0

T. von der Maßen, A. Birk, G. Heller, I. John, S. Joos, K. Müller, K. Schmid: *Herausforderungen bei industriellen Produktlinien-Entwicklungen*, OBJEKTspektrum, Ausgabe September/Oktober 2004, pp. 69-75

T. Maßen, Horst Lichter: *RequiLine: A Requirements Engineering Tool for Software Product Lines*, in Frank van der Linden (ed.) Software Product-Family Engineering: 5th International Workshop, PFE 2003, LNCS vol 3014, pp. 168 - 180

F. Houdek, H. Lichter: *Einsatz der Feature-Modellierung in der Produktentwicklung*, in Hesse, Rumpe (Hrg.) Lecture Notes in Informatics (LNI) Modellierung 2004, Marburg, Volume P-45, p 267

T. von der Maßen, H. Lichter: *RequiLine - Ein Requirements Engineering Werkzeug für Software Produktlinien*, Software-Technik Trends, Band 24, Heft 1, ISSN 0720-8928, 2004