SWC Software Construction

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Software Construction

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  (third-party funds position)

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  Information concerning our research and teaching activities can be found at:

  http://www-lufgi3.informatik.rwth-aachen.de

Overview

Research

The research group is doing basic research in the broad area of software construction. In particular we are engaged in the following topics

Product Line Development Product line development is a new software development approach aiming in significantly increasing reusability. The basic concept behind this approach is that all products of a product line share a common plattform. Accordingly, reuse not only covers code but includes all development artifacts, e.g. requirements or test cases. In order to successfully develop a product line the application domain has to be modeled especially showing the commonalities and the differences of all products. Currently we are interested in a method, corresponding languages, and tools supporting this modelling process. Furthermore we investigate the transition from the requirements model of a product line to its architectural design.

Testing Object-oriented Software Quality assurance measures play an important role in delivering high quality software. Experience shows that object-oriented and component based development needs new testing and validation techniques. We have developed a role based approach for testing object collaborations which are the essence of object oriented programs. This approach not only leads to better software quality but also increases the understanding of complex collaborations. Tools have been developed to support this kind of software testing.

The group is partly funded by industrial cooperations. Currently we are running three research projects. Since we work in close cooperation with our industrial partners our research projects have a strong practical orientation.

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 *Object-Oriented Software Construction*
- Seminars on various topics.

Research Projects

Role Based Test Bench

M. Schnizler, H. Lichter

The goal of this project is a more efficient testing approach for program family members. Today programs for related application areas are often developed as a family, in which different variants share a common core that implements the basic functionality. This way, parts of the implementation are reused across different programs saving considerable development effort. A family approach may also improve software quality, since reused parts have already been tested in previous variants. However, adaptations and extensions made for different program variants require testing each member individually. Unfortunately in practice, testing program family members remains laborious, often requiring new tests for each variant.

Role modelling has shown to be an effective means for describing object collaborations. Roles allow separating the different concerns that are set up by all collaborations, in which an object is involved. So the role model for a collaboration can be reused for any implementation of the very same collaboration. Consequently, test cases that are derived from role models can be reused for each program family member that contains identical collaborations. The project studies, how collaborations can be modelled with roles, and how test cases can be derived from such a role model. Additionally we investigate, how the constructed tests can be implemented using a testing framework, as for instance JUnit, for efficient regression testing, and how the whole process of test construction and implementation can be supported by tools making role-based testing an implementable approach.

Object Based Internet Search

A. Uhl, H. Lichter

External cooperation: Interactive Objects, Freiburg

Today's Internet search engines compute their centralized index by crawling web contents. This approach implies two major problems: large and relevant parts of the Internet content are not reachable by crawling and thus remain inaccessible for search engines ("deep web"), bandwidth and its growth impose harsh limits on central index currency and indexable share of vastly growing available information.

The obvious solution is a distributed approach to information retrieval that better leverages the available bandwidth in order to achieve higher index currency and improved

coverage, including deep web contents. Three essential tasks have to be solved:

- An infrastructure has to be defined which can serve as a platform for distributed Internet search.
- The scalability of the approach and the infrastructure in particular has to be proven, especially when compared to a centralized approach.
- Approaches to creating searchable content for such an infrastructure have to be developed. This has to include the integration of existing content as well as the creation of new searchable Internet information sources.

A formal model regarding the bandwidth comsumption of distributed search can be established which can then be used to optimize logical network topologies like trader distributions for efficient bandwidth use.

Internet content increasingly tends to be generated by online applications rather than by static documents. In order to integrate this content with a distributed search infrastructure, searchability has to be incorporated into modern, holistic application architectures like is already done for other items like persistence, transactions, or distribution. The benefits of model-driven development (see also OMG's Model Driven Architecture - MDA) can be leveraged for this purpose.

A prototype showing how this can be done has been brought online together with a white paper explaining the most important concepts.

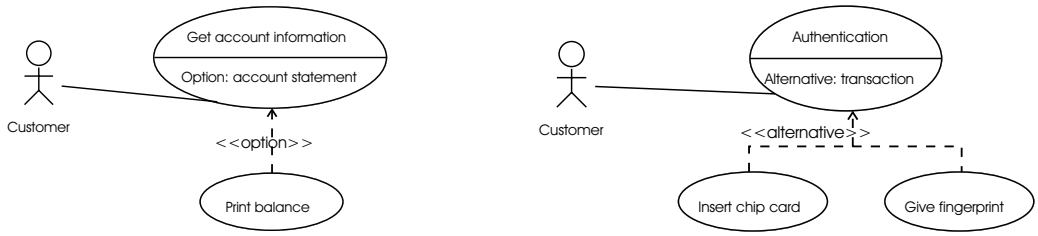
Requirements Engineering for Software Product Lines

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 statical 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.

Modeling 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 modeling elements to express variability.



Modeling variability with extended UML Use Case diagrams

In the context of this project we are developing a requirements engineering tool that supports variability modeling. It should combine statical and behavioral modeling practices to counteract the great complexity of developing SPLs. A first prototype has been released so far.

Architectures for Software Product Lines

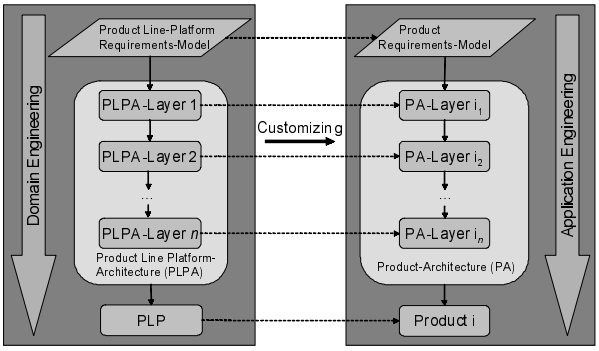
T. Weiler, H. Lichter

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.

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*



SPL architecture modelling process

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.

Other Activities

Speaker 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 *Modellierung 2002,* Tutzing, 25.-27.3.2002, *H. Lichter*

Organization of the anual workshop of *GI-Fachgruppe 2.1.6 Requirements Engineering,* Ulm, 28.-29.11.2002, *H. Lichter*

Member of the organization comittee of GI workshop *Requirements Engineering für Auftraggeber/ Auftragnehmer-Management*, 9.9.2002, Essen, *H. Lichter*

Assessor for *Fonds zur Förderung der wissenschaftlichen Forschung*, Wien, *H. Lichter*

Reviewer for dpunkt-Verlag Heidelberg and Cluver Academic Publishers, *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 2002, *H. Lichter, T. Weiler*

Member of the GI-Arbeitsgruppe *Requirements Engineering für Produktfamilien* of the GI-Fachgruppe 2.1.6 Requirements Engineering, *T. von der Maßen*

Member of the GI-Arbeitsgruppe *Testen objekt-orientierter Programme* of the GI-Fachgruppe 2.1.7, *M. Schnizler*

CMM Assessment at Access e.V. Aachen, *H. Lichter, T. Weiler*

Talks and Publications

Talks

H. Lichter: *Framework-based Software Development - Integration and Validation,* Computer Science Department, University Hannover

H. Lichter: *A Systematic Approach for Framework Integration Testing ,* Computer Science Department, Technical University Clausthal-Zellerfeld

H. Lichter: *Testautomatisierung am Beispiel des Unit-Test,* REGINA, Working Group Software Test

H. Lichter: *Prozessverbesserung auf Basis eines CMM Assessments,* Access e.V., Aachen

A. Uhl: *A UML variant for modeling system searchability,* 8th International Conference on Object-Oriented Information Systems OOIS '02, Montepellier, France

A. Uhl: *A bandwidth model for Internet search,* 28th International Conference on Very Large Data Bases (VLDB '02), Hongkong

T. von der Maßen: *Modeling Variability by UML Use Case Diagrams,* International Workshop on Requirements Engineering for Product Lines, Essen

T. von der Maßen: *Modellierung von Variabilitt mit UML Use Cases,* Annual Meeting GI-FG 2.1.6, Ulm

Publications

M. Becker, F. Fraikin, S. Jungmayr, M. Schnizler, A. Schoolmann, M. Winter: *Test von Komponenten,* Softwaretechnik-Trends, ISSN 0720-8928, Vol 22, Nr 3, 2002

T. von der Maßen, H. Lichter: *Modeling Variability by UML Use Case Diagrams,* Proceedings of International Workshop on Requirements Engineering for Product Lines, IEEE Joint International Requirements Engineering Conference (RE02), Essen, Technical Report: ALR-2002-033, September 2002

A. Uhl, H. Lichter: *A UML variant for modeling system searchability,* Proceedings of the 8th International Conference on Object-Oriented Information Systems OOIS ’02; Montpellier, France, September 2-5 2002, Lecture Notes in Computer Science.Springer-Verlag, September 2002, pp 199-210, ISBN 3-540-44087-9

H. Lichter, T. von der Maßen, T. Weiler: *Modelling Requirements and Architectures for Software Product Lines,* Technical Report AIB-2002-05, RWTH Aachen, 2002

A. Uhl: *A bandwidth model for Internet search,* Proceedings of the 28th International Conference on Very Large Data Bases (VLDB ’02). Morgan Kaufmann, Orlando, September 2002, URL http://www.cs.ust.hk/vldb2002/VLDB2002-papers/S15P03.pdf

A. Uhl: *System zur Modellierung und Generierung von translativen Softwaregenerierungssystemen, Europäisches Patentamt, Anmeldenummer 02000141.8, January 2002,*

T. Nakatoh, Y. Koga,A. Uhl, S. Hirokawa: *Automatic estimation of query syntax for search sites,* Pan-Yellow-Sea International Workshop on Information Technologies for Network Era, March 2002, URL http://www.db.is.kyushu-u.ac.jp/PYIWIT02

S.J. Mellor, K. Scott, A. Uhl, D. Weise: *Model-driven architecture,* D. Turk, R. France, B. Rump, G. Georg, editors, OOIS 2002 Model-Driven Approaches to Software Development Workshop, Springer Verlag, Lecture Notes in Computer Science, 2002, ISBN 3-540-44088-7

A. Blaszczyk, A. Uhl: *A contribution to industrial grid computing,* In Recent Advances in Parallel Virtual Machine and Message Passing Interface, LNCS 2474, 9th European PVM/MPI Users’ Group Meeting, Linz, Austria, September 29 - October 2, 2002