Software Construction

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Overview

Our research focuses on the development of new and advanced methods, tools, and techniques in the broad area of software construction. Since software engineering is done in software developing organizations, we always try to develop and deliver software engineering support that is applicable under industrial software development conditions. Hence, most of our research projects are performed in close cooperation with industrial partners. Currently we are actively working in the following areas:

- *Metric-based Project and Process Management*. Like in other engineering disciplines, measuring is a prerequisite to determine the performance of processes and products. We are aiming to develop an integrated highly customizable measurement infrastructure.
- *Goal-based Process Improvement*. Reference models (e.g. CMMI, SPICE) are used by organizations to improve software processes. A systematic approach is developed to decide which combinations of them are best suited for the intended improvement.
- *Interactive Use Case based Prototyping*. Since prototypes are typically created manually we develop a generative approach to automatically create interactive prototypes from use case based requirements specifications.
- *Reusing Domain Engineered Artifacts for Code Generation.* Model driven engineering uses certain diagrams to foster code generation. But these diagrams are rarely reused; overcoming this is one goals of this project.
- *Architecture Evolution and Evaluation.* Software tends to evolve independently from their architecture description. We are developing an approach to monitor and evaluate the state of the architecture and to support the goal-based evolution of the software system.

Since appropriate tools are often the door opener to transfer research ideas to practice we are developing dedicated tool support for those areas. Currently we offer the following tools:

- ViPER (Visual Tooling Platform for Model-Based Engineering, www.viper.sc)
- QMetric and BugzillaMetrics (www.qmetric.org)
- OpenUMF (Use Case based Requirements Modeling Framework)
- MeDIC (Metric - Documentation, Integration, and Configuration)
- MoCCa (Model Composition and Combination Vault)

In 2012 we received the Best Paper Award of EuroSPI 2012, Vienna for the paper ***"****Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction"* written by Simona Jeners, Horst Lichter and Ana Dragomir**.**

Teaching

We offer the following courses on graduate level:

- Lecture Software Quality Assurance
- Lecture Object-Oriented Software Construction
- Lecture Software Project Management
- Seminars and Practical Labs

Research Projects

Reusing Domain Engineered Artifacts for Code Generation

A. Ganser, H. Lichter

Model driven architecture (MDA), and model driven engineering (MDE) are promising approaches to increase reuse and to reduce development time and effort.. Both comprise of several methods which include a domain specific modeling (DSM). This methodology brings about figures which maps the objects under consideration to models. Among these models are class diagrams as know from UML which are called domain models in these contexts.

While both approaches take these domain models as inputs for code generation, only MDE includes reuse in DSM. But this reuse remains rather rudimentary. Taking a closer look at model repositories one might suppose that these repositories are meant to store models so they can be reused rather easily in different projects. But the goals for these tools are totally different! All the available repositories (by and large) only consider versioning, migration, transformation, conflict detection, merging and search. This means, models are not related to each other, there is barely a description of models, no examples are present how the models could be used or no interfaces are defined which point to the most important aspects that could help reusing a particular model.

The goal of this research project is to bolster model reuse by providing interfaces attaching descriptions and providing examples and models by means of recommender systems. Furthermore, models should not be treated as in an isolated world, but related to each other, knowing not only that these models worked out together but even how they did. These relationships cross borders and overcome the usual reuse obstacles and unleash the full power of previously modeled knowledge.

Goal-based Process Improvement

S. Jeners, H. Lichter

External cooperation: Generali Informatik Services, Aachen

Nowadays, the software market is expanding and clients are requesting better, faster, and cheaper software products. One important impact factor to project success is the quality of the applied IT-processes. Hence, more and more organizations are obligated to identify, structure, and improve their processes systematically. There is a variety of improvement reference models (IRMs) known as maturity-, process- and quality-models as well as standards, norms, etc. that can be used. Organizations have to decide which of these models they want to use. The adoption of multiple IRMs allows an organization to exploit synergy effects between them. On the one hand organizations can address co-coordinately different and common

areas. On the other hand the weaknesses of a single IRM can be overcome by the strengths of others.

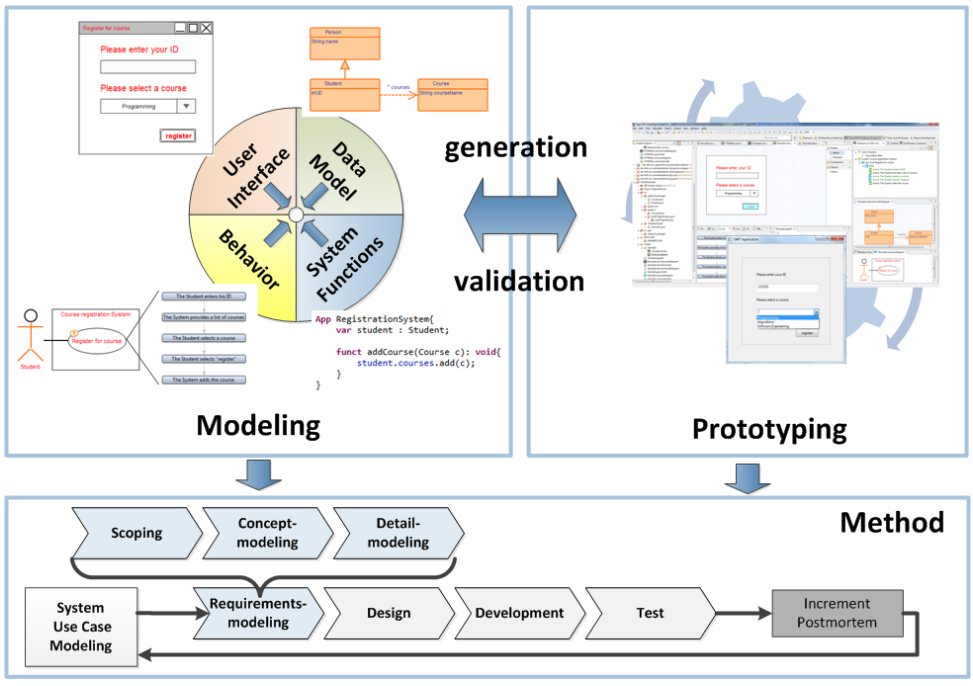
The aim of this project is to develop a model based approach that provides an objective and semiautomatic selection of improvement practices of multiple IRMs that best fit to an organization. To select the best suited practices the organizations' internal processes, wishes, problems, environment etc. have to be considered. The selected practices have to address the improvement potentials of the internal processes and the organizations' wishes. These are reflected by the goals of the organization. The selected practices should also be evaluated and filtered according to their return on investment. According to goals and on this analysis improvement practices can be selected that are extracted from similar or standalone practices from a build-in repository of all considered IRMs. For an efficient implementation of the IRMs, the traces between the improvement practices and their corresponding IRM' practices and the dependencies between the improvement practices are also given. For efficient adoption and further selection of improvement practices, the implementation of the improvement practices should be continuously monitored considering the given goals.

Interactive Use Case based Prototyping

V. Hoffmann, H. Lichter

Nowadays prototypes are typically created manually and they are not directly connected to other requirements specification documents. Therefore we have devised a generative approach to derive interactive prototypes automatically from a use case based requirements specification.

Our approach is based on an integrated requirements model that combines functional use case models with user interface prototypes and domain concept models. Additionally we have defined a formal token-flow based execution semantic for this model.



Based on this requirements model we have created a fully automated transformation approach that is able to generate interactive behavior prototypes. The simulation runs are performed on UI mockups derived from user interface prototypes. This enables non technical stakeholders to experience the behavior in a simple intuitive fashion and can additionally be used as basis for feasibility studies. Because of a specific structure of our generation approach we are moreover able to use the simulation proactively during requirements modeling.

Model-based Testing of Web Applications

T. Sattaya-aphitan, H. Lichter

External cooperation: TOT Public Company Limited, Bangkok

In contrasts to traditional software, there are many aspects of web applications that are different. First, web applications typically implement a 3-tier-architecture comprising web browser, web server and database tier which are communicating by stateless protocols such as HTTP request and HTTP response. Second, each tier is implemented using a diversity of programming languages (e.g. HTML, JavaScript, JSP, PHP, ASP). Third, web pages are often generated from prior dynamic web pages which depend on their previous inputs and server's states.

There are many published approaches to test Web application. However, none of these approaches reflects the complete behavior of web applications. This project aims to develop a new model-based testing approach using structural analysis methods, called white–box testing. The basic idea is to transform the source code into an intermediate model which is used to generate test cases, test setup information and test oracle information. In addition, our proposed approach introduces a novel coverage metric called "Content Coverage". The generation procedure ensures that there are no duplicated and no un-executable test cases as well as 100% content coverage. The approach should guide testers to setup the test environment before running the test cases (e.g. selecting input data and parameters needed to run the tests) and aims to produce expected results which can be automatically compared to the actual program execution.

Strategic Release Management of Platform-based Architecture

M. Firdaus Harun, H. Lichter

To deliver software products on schedule, development teams struggle focusing on the build, deploy, test, and release process. In general, development teams employ ad hoc release plans or reuse release processes that are based on personnel experiences and previous projects. This practice can lead to severe problems.

As software systems and their development processes grow more complex, the release processes also become complicated. The structure of the software can be modeled by components and modules and their interdependences. Sometimes components are built from

different platform for e.g. .Net, EJB, J2EE, etc. Therefore, a deep understanding of the designed architectures and the constraints of the applied software development is a must to specify and set up appropriate release processes in order to always ship the right version of components or elements into deployment environments and to release the software on time.

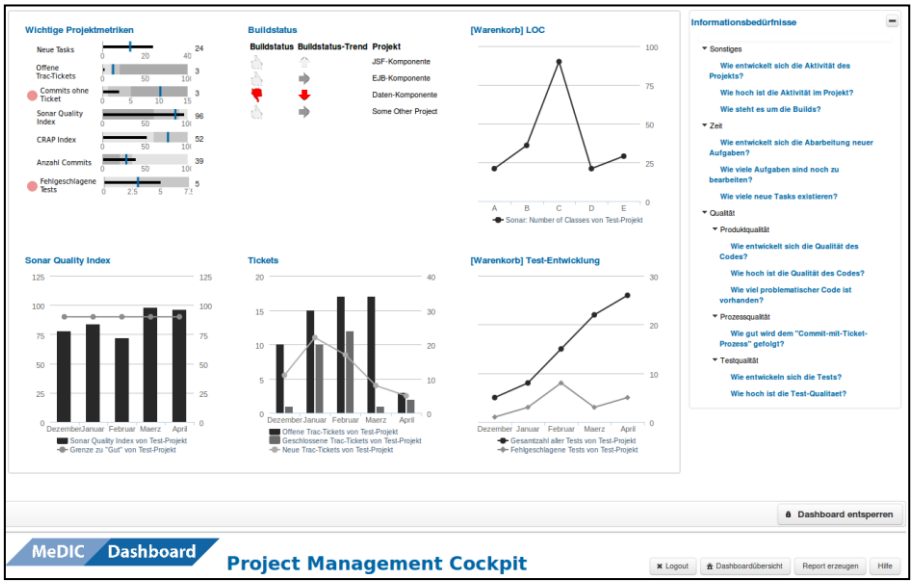
This research project aims to investigate what are factors and constraints that influence release processes. Finally, we want to propose a strategic and holistic approach to release management to deal with the multifaceted constraints.

Metric-Based Project and Process Management

M. Vianden, H. Lichter

External cooperation: Generali Informatik Services, Aachen

It is commonly known, that projects management greatly benefit by the application of metrics. However, research shows that it is demanding to find the right metrics; 58% of all project managers and 50% of all senior managers find it difficult to collect, analyze, and use the right metrics. On the one hand, metric frameworks like GQM help to derive metrics from abstract goals for the project. On the other hand, defining measures just for one project (in a multi project organization with a lot of similar projects) is costly and ineffective. Hence, it is wise to reuse metric experience (metric definitions, evaluations, and models) as all experience can and should be reused.



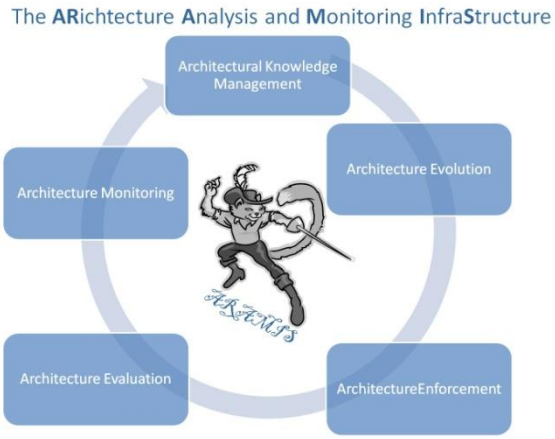
Although considerable research has been devoted to the modeling of metrics and metric frameworks, rather less attention has been paid to investigating how the results of this research (metric meta models, metric frameworks, and metric experience bases) can lead to a sound concept for metric reuse. Therefore, the aim of this project is to develop such a concept for metric reuse. The concept should be enriched by metric processes which include metric reuse as well as dedicated tool support for metric documentation, metric reuse and metric calculation.

Model-based Software Architecture Evolution and Evaluation

A. Dragomir, H. Lichter

External cooperation: Generali Informatik Services, Aachen

The architecture of software systems directly influences crucial quality attributes and therefore should be considered whenever important decisions regarding their evolution must be taken. However, up-to-date descriptions that correctly reflect the static, dynamic and deployment view of the system's architecture rarely exist. On the one hand, architecture descriptions are usually elaborated at the beginning of a software project. On the other hand, after the initial version of the system has been constructed, it tends to evolve independently from its architecture description. Changes to the system are rarely documented properly and originally imposed rules are gradually violated. In extreme cases, it can become completely unclear how the software system performs its use-cases.



The aim of the ARAMIS project is to develop an approach that supports the model-based evolution and evaluation of the architecture of a software system. To achieve this, a method to continuously monitor the state of the software architecture will be employed. This will produce up-to-date architecture descriptions at various levels of abstraction and from various points of view, to support the needs of all the involved architecture stakeholders. Also, we will investigate how to enable stakeholders to easily create rules that should be imposed on the software architecture and then use these rules to periodically check if the architecture is still conformant with them. Furthermore, we will research if currently existing metrics can be used to regularly evaluate the state of the architecture, or if new ones should be developed. As a result, we plan to offer a continuous overview of the quality evolution of the architecture of the software system. Finally, we intend to develop a method for defining architecture variants and then employ the previously-mentioned metrics to analyze which of the evolution variants is better.

Special Events

Workshop – Entwicklung und Evolution von Forschungssoftware (EEFSW)

Rolduc, November 10-11, 2012

Many research projects use software systems to solve problems and perform tasks in order to successfully work on the research goal. However, these software systems are influenced by a lot of factors. Some of the systems are just used for a short time and are not needed after that. At the same time, a lot of systems grow over years and become important research platforms or even become products which are used in the industry. Consequently, we need to organize research oriented software development different than classic product focused software development.

The workshop started with the introduction of 12 different research projects from different domains and different software engineering backgrounds. On the one hand, some of the software systems are very established and maintained for a long time (older than 25 years). On the other hand, we got introduced to the problems associated with very young projects.

Based on the (good and negative) experiences from these presentations we decided what topics we like to address and discuss in the working sessions on the second day. The results of these sessions were presented to all participants of the workshop and thoroughly discussed. The most interesting result of the workshop was the development of a process framework for the integration of thesis into a standard development process.

DER Semesterplaner

Based on the task of our lab in summer term 2012 we started the Semesterplaner project with 6 student volunteers from the lab. The goal is to provide a tool that assists students with the planning of their upcoming courses. This assistance is provided by showing an integrated view of the average week in the next semester and an overview of the exam months. Hence, the student can check if an exam is too close to another one as well as being aware of collisions of weekly events like lectures or exercises. In a later version of the tool we also want to include an overview of the progress of the student in his/here field of study, therefore, enabling the student to quickly get an overview of the courses that are currently missing to complete a curtain field of study.

Other Activities

- Organization of Forum Informatik Workshop Entwicklung und Evolution von Forschungssoftware, Rolduc, November 10-11, 2012, *H. Lichter, V. Hoffmann, M. Vianden, A. Ganser*.
- Member of the international program committee, 3rd International Workshop on Formal Methods and Agile Methods, Thessaloniki, Greece, October 2, 2012, *H. Lichter*
- Member of the international program committee, 2tth Annual ACM Symposium on Applied Computing, Software Engineering Track, Riva del Garda (Trento), Italy, March 26-30, 2012, *H. Lichter*
- Member of the international program committee, 6th IEEE International Conference on Software Security and Reliability (SERE),Washington D.C., June 20-22, 2012 *H. Lichter*
- Member of the program committee, Software Engineering 2012, Berlin, February 27 – March 2, 2012, *H. Lichter*
- Member of the program committee PhD Symposium at Software Engineering 2012, Berlin, *H. Lichter*
- Member of the program committee Modellierung 2012, March 14.-16, 2012, Bamberg, *H. Lichter*
- Head of program committee and organization of International Workshop on CMMI based Software Process Improvement in Small and Medium Sized Enterprises (SPISME 2011), December 11, 2011, Johor Bahru, Malaysia, *H. Lichter*
- Member of the international program committee of 5th International Malaysian Conference on Software Engineering, December 12-14, 2011, Johor Bahru, *H. Lichter*
- Panel Member of 3rd Software Engineering Postgraduates Workshop, December 12, Johor Bahru, Malaysia, *H. Lichter*
- Visiting Professor at Universiti Teknologi Malaysia, Johor Bahru, Malaysia, December 2011, *H. Lichter*
- Reviewer for dpunkt-Verlag Heidelberg and computing reviews, *H. Lichter*
- Organization of the Computer Science Department's mentors program, *H. Lichter*
- Member of the Computer Science Department's committee for Lehre and Service-Lehre, *H. Lichter*
- Member of the examination board of Computer Science, *H. Lichter*
- Member of workgroup "Zusammenarbeit Hochschule und Industrie", GFFT, Gesellschaft zur Förderung des Forschungstransfers, *H. Lichter*
- Member of the board of management AFST, Association for Social Technologies e.V., Aachen, *H. Lichter*
- Organization of the Universal / Specialized Preparatory Courses in Computer Science 2012, *H. Lichter, A. Ganser*
- Project lead conducting "Personalisiertes Lernen von fachlichen Grundlagen und Studientechniken in Vorkursen" (Exploratory Teaching Space), 2012, *H. Lichter, A. Ganser*

- Member of Preparatory Course Task Force, 2012, *A. Ganser*
- Member of Computer Science Faculty Committee, 2012, *A. Ganser*
- Member of RWTH Aachen University Scientific Staff Committee, 2012, *A. Ganser*
- Member of Steering Committee Computational Science Center RWTH, 2012, *A. Ganser*
- Member of Steering Committee ZLW/IMA, 2012, *A. Ganser*
- Contributor to Mentoring Program for beginners in Computer Science, 2012, A. Ganser
- Member of workgroup "Qualität von textuellen Anforderungen", GI, Gesellschaft für Informatik – Fachgruppe Requirements Engineering , *V. Hoffmann*

Talks and Publications

Talks

H. Lichter: Software Processes in an Agile World. Proceedings of International Workshop on CMMI based Software Pr.ocess Improvement in Small and Medium Sized Enterprises (SPISME 2011), Johor Bahru, Dec-12, 2011.

H. Lichter: Software Engineering Research and Industry Cooperations, Department Software Engineering, Chulalongkorn University, Bangkok, February 9, 2012.

S. Jeners: Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction**.** 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06. 2012.

M. Vianden: MeDIC - Eine Infrastruktur zum Verwalten, Dokumentieren und Visualisieren von Metriken. Workshop Entwicklung und Evolution von Forschungssoftware, Rolduc, November 10-11, 2012.

C. Piyabunditkul,: SPI through Process Tailoring Framework with Objective-based Scoring Metric. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, June 25-27, 2012.

Publications

Simona Jeners, Horst Lichter, Ana Dragomir (2012): Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction**.** 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06.2012, in Winkler, Dietmar, O'Connor, Rory V., Messnarz, Richard (Eds) Systems, Software and Services Process Improvement, Communications in Computer and Information Science, vol 301, 978-3-642-31199-4, Springer Berlin Heidelberg, pp 205-216,

Tisanai Krisanathamakul, Chayakorn Piyabunditkul, Apinporn Methawachananon, Pawarat Nontasil (2012): SPI through Process Tailoring Framework with Objective-based Scoring Metric. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06.2012, R. Messnarz et al. (Eds.), Industrial Proceedings, DELTA, Denmark, pp 11.23-11.31, ISBN 978-87-7398-154-2.

T. Thanarukvudhikorn, A. Ganser, H. Lichter, T. Anwar (2011): RIOT: Rapid, Iterative and Off-The-Shelf Tool-Evaluation, 5th Malaysian Conference on Software Engineering, MySEC 2011, 12-14 December, Johor Bahru, Malaysia, pp. 489-494, doi: 10.1109/MySEC.2011.6140722.

D. Homchuenchom, C. Piyabunditkul, H. Lichter, T. Anwar (2011): SPIALS: A light-weight Software Process Improvement Self-Assessment Tool, 5th Malaysian Conference on Software Engineering, MySEC 2011, 12-14 December, Johor Bahru, Malaysia, pp. 195-199, doi: 10.1109/MySEC.2011.6140668.

H. Lichter, T. Anwar (eds.) (2011): Proceedings of International Workshop on CMMI based Software Process Improvement in Small and Medium Sized Enterprises (SPISME 2011), Johor Bahru, Dec-12, 2011, ISBN 978-967-0194-14-1.

H. Lichter (2011): Software Processes in an Agile World. Proceedings of International Workshop on CMMI based Software Process Improvement in Small and Medium Sized Enterprises (SPISME 2011), Johor Bahru, Dec-12, 2011, ISBN 978-967-0194-14-1, pp 7-12.

Meiliana, M. Vianden, H. Lichter (2011): Variability Model towards a Metric Specification Process. International Conference on Computer Science and Information Technology (ICCSIT'2011), Pattaya Dec. 17-18, PSRC – Planetary Scientific Research Center, ISBN 978-81-922428-2-8, pp 76-79.

O. Sarkoses, M. Vianden, H. Lichter (2011): Evaluating Presentation Layer Development Frameworks for EJB Applications in J2EE Architecture. International Conference on Computer Science and Information Technology (ICCSIT'2011), Pattaya Dec. 17-18, PSRC – Planetary Scientific Research Center, ISBN 978-81-922428-2-8, pp 37-41.