Software Construction

RWTH AACHEN UNIVERSITY

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Software Construction

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Overview

Our research focuses on the development of new methods, tools, and techniques in the broad area of software construction. Since real software engineering is done in industry, we always aim to develop software engineering research results that are 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:

- *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.
- *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.
- *Context-based Process Improvement*. Process repositories (e.g. CMMI, SPICE) are used by organizations to improve software processes. A systematic approach is developed to decide which parts of them are best suited for the intended improvement and how to work with multiple process repositories.
- *Model-based Software Architecture Evolution and Evaluation.* Software systems tend to evolve independently from their architecture description. We are developing an approach to monitor and evaluate the current state of the architecture and to support its rational, goal-based evolution.
- *Smart Integration Testing.* Dependencies between modules lead to huge integration problems. A smart continuous integration approach aims to overcome these problems.

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:

- HERMES (Harvest, Evolve, and Reuse Models Easily and Seamlessly)
- EMI (Enterprise Measurement Infrastructure) and SCREEN
- MosAIC (Model supported Adoption and Assessment of Improvement Concepts)
- ARAMIS (Architecture Analysis and Monitoring Infrastructure)

This year, we were intensively involved in collaboration with our colleagues from the chairs Software Engineering and Embedded Software in the organization of the German Multi-Conference Software Engineering, held at RWTH Aachen in February. Especially, we organized the collocated 13th workshop “Software Engineering im Unterricht der Hochschulen” (SEUH) and die Software Engineering Doctorial Symposium.

Simona Jeners, Horst Lichter and Carlos A.G. Rosenkranz received – with some delay – the IFP TC2 Manfred Paul Award for Excellence in Software: Theory and Practice for the best paper entitled *An Efficient Adoption and Assessment of Multiple Reference Models* presented at IFIP TC2 CEE-SET 2011.

Frederic Evers received the DASMA Future Award 2012 for his Master Thesis on *Konzeptionelle Erweiterung von Projektdashboards für unerfahrene Anwender* at Metrikon in Stuttgart.

Last but not least, Veit Hoffmann passed his Ph.D. exam and defense on June 11th. His topic was *Rapid Prototyping in der Use-Case-zentrierten Anforderungsanalyse*. Congratulations!

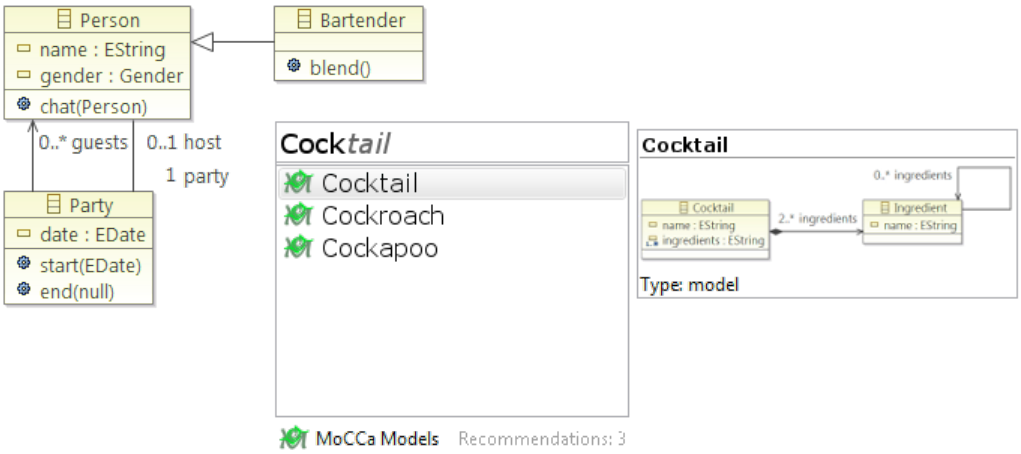
Research Projects

Reusing Domain Engineered Artifacts for Code Generation

A. Ganser, H. Lichter

Model driven architecture (MDA), and model driven engineering (MDE) are promising approaches to in-crease reuse and to reduce development time and effort. Both comprise of several methods which include 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.



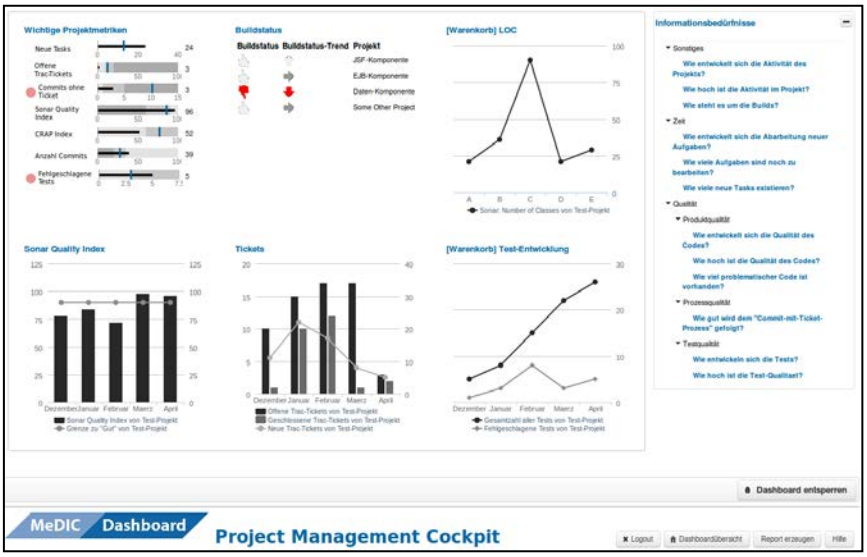
The goal of this research project is to bolster model reuse by providing mechanism to harvest, evolve, and reuse models. Therefore approaches for gleaning reusable artifacts into a model library, evolving them, and producing recommendations are under research. Therefore, models should not be treated as in an isolated world, but related to each other, knowing not only that these models worked 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.

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.

Context-based Process Improvement

S. Jeners, H. Lichter

External cooperation: ITERGO GmbH

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 process repositories (PRs) 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 PRs 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 single PRs can be overcome by the strengths of others.

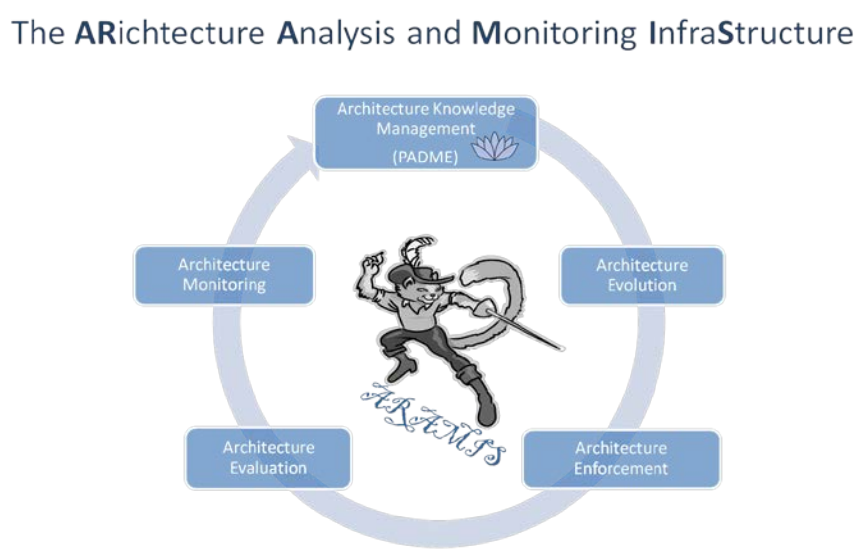
The aim of this project is to develop a model based approach that supports the adoption and assessment of multiple PRs in an organization. First, it provides an objective and semiautomatic selection of improvement practices of multiple PRs that best fit to an organization. To select the best suited practices the organizations resp. the context of software projects have to be considered. Based on factors that describe the software project context, improvement practices can be selected. For an efficient implementation of the PRs, the traces between the improvement practices and their corresponding PRs practices are also given. Secondly, the dependencies between the improvement practices and similarities with other practices from multiple PRs are identified to reveal the synergy effects and coordinate in an efficient way the adoption and assessment. Therefore, the approach supports a time efficient and effective adoption and assessment of improvement practices from multiple PRs.

Architecture Analysis and Monitoring Infrastructure

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. Architecture descriptions are usually elaborated at the beginning of a software project. However, after the initial version of the system has been constructed, the system 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 a 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, we will develop a method to continuously monitor and evaluate the state of the software architecture

on the one hand and to meaningfully manage the most important made architectural decisions on the other hand.

The continuous monitoring 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.

Furthermore, to meaningfully document the important decisions steering the software systems' evolution directions and make them available for reuse across projects, we are developing a process-based architectural decisions management environment (PADME), which will further enhance ARAMIS with knowledge-sharing capabilities.

Smart Continuous Integration Testing

M. Firdaus Harun, H. Lichter

External cooperation: KISTERS AG, Aachen

Delivery of multi release software products that share a common platform is a big challenge for software organizations. Very often, the products are tightly coupled with the platform which results in complex dependencies between modules and interfaces of the products and the platform. This leads to a couple of problems. For examples, any change of the code of any module during development may affect other modules that interact with the changed module. Sometimes this can cause deadlock scenarios that need a lot of effort to be solved. Especially, it may lead to a blocking stage of the testing phase.

Although defining a code freeze is one of the solutions to make the modules immutable, however, active development of specific products may affect the shared platform at the end (i.e. version conflicts of modules contained in the products and shared platform). Even though a continuous integration approach provides an end-to-end software delivery process model, the management of complex module dependencies and performing an adequate integration test in a multi-product environment have been neglected so far.

To overcome the aforementioned problems, a smart technique for dependency-aware integration testing will be proposed. At first, the technique performs a smoke test based on selected test case scenarios which contain the most fundamental functions and crucial modules in every commit stage. Any defects or inter-modules failures will be uncovered at this stage. Then, integration tests will be executed. Missing or unchanged modules will be simulated or mocked to facilitate the testing. Besides that, a new approach and infrastructure will be developed to manage the module dependencies that allow teams to test their code in isolation or in conjunction with other modules.

Model-Based Structural Testing of Web Applications

T. Sattaya-aphitan, H. Lichter

External cooperation: TOT Public Company Limited, Bangkok

Nowadays many organizations are increasingly using web applications for e-business/e-commerce purposes. Hence, it is important to ensure the required quality of web applications before deploying them.

This project aims to generate test cases for web application based on a structural testing approach. However, creating test cases for a web application is much more challenging than for non web applications due to its multi-tiered or client-server architecture. For the client side, input data validations or few calculations should be done via client-side scripting (e.g., JavaScript, VBScript). On the server side, the business logic is implemented via server-side components realized in various programming languages such as PHP, ASP, JSP, Java and VB. Thus, structural testing on web applications has to deal with exercising the program execution paths on both client and server side with different programming languages. Moreover, both sides are spatially separated and communicate with each other using the HTTP protocol, a stateless protocol, meaning that we have to take a special care of handling the passing of parameters among them. This behavior poses great challenge to structural testing on web applications.

Special Events

Workshop – Software Engineering im Unterricht der Hochschulen (SEUH)
Aachen, February 28 – March 1, 2013

In the context of the German Multi-Conference Software Engineering, we organized the 13th workshop "Software Engineering im Unterricht der Hochschulen" (SEUH), a workshop series where software engineering teachers from all kind of universities regularly discuss how to teach students the practices of software development best. This year the following topics were addressed:

In the session "Just- in-time teaching" some authors presented new course organization approaches. They aim to give students very fast feedback and on-going discussions help to deepen the presented topics.

That programming and software engineering education has many interfaces, is well known. In a dedicated session presenters and attendees of the workshop discuss how these interfaces can be used to the advantage of both education areas and how the close interaction can be advantageously implemented.

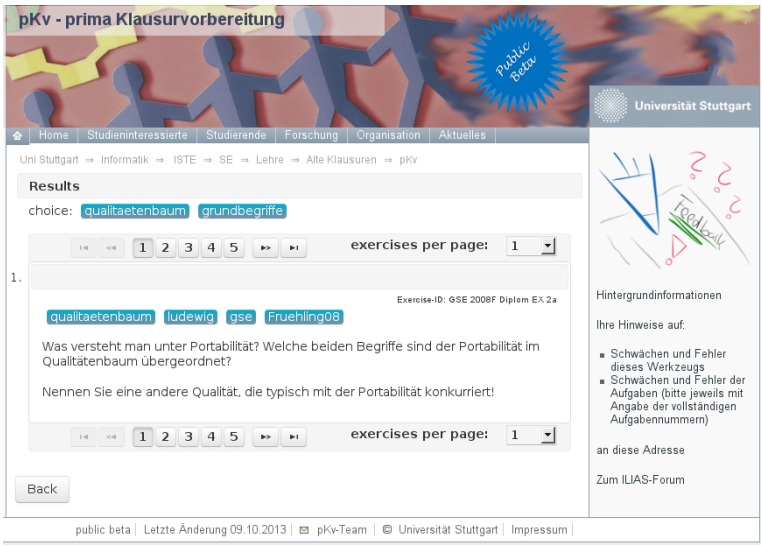
Agile methods have found their way in recent years in practice; they are validated and deployed there. The SEUH took up this topic in the session "Agile methods in the classroom". First interesting experiences were reported which had been the subject of intense discussions.

Tools play a major role in software engineering education, either to develop software or as a means to convey learning content efficiently and effectively. In this section, a tool for playful mediation of development processes and a tool for the selection and usage of metrics were presented.

A good tradition of the SEUH workshop series is that students who attend the workshop are invited to give feedback to the software engineering teachers at the end of the workshop.

The 14th SEUH workshop will be held end of February 2015.

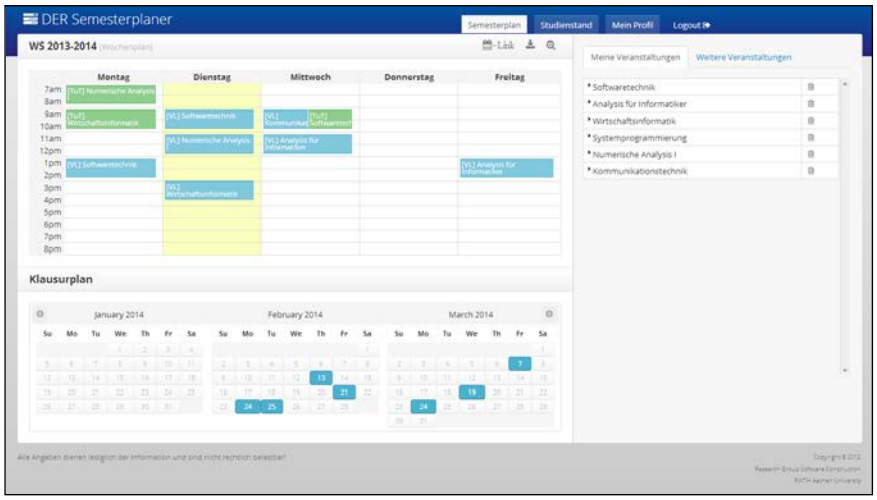
SWC XAM (eXercise and Assignment Management) at University of Stuttgart



In 2010 we started the project XAM to enable easy reuse and design of exams and exercises at our research group. The project prospered over several bachelor theses and was enhanced by accumulated efforts of our HiWis and scientific staff. In early 2013 we meet the Software Engineering group at the University of Stuttgart to talk about an online exercise cataloguing system. We quickly realized that the cataloguing system can be built on top of the existing XAM core. The team at University of Stuttgart then concentrated on building the cataloguing frontend and used the existing XAM backend to fill the system with data. The system will go live very soon; currently it is only accessible from inside Stuttgart University. In a next step the system will be extended to offer exercises based on the chapter structure of the text book: “Software Engineering – Grundlagen, Menschen, Prozesse, Techniken”.

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.



The development of the tool stretched far into 2013 and we were able to release it at July 1st 2013. Since then DER Semesterplaner is available at http://semesterplaner.informatik.rwth-aachen.de. Students who are enrolled in the Bachelor for either computer sciences or business administration can now plan the following semester and use all the features from the planer. This first phase was very promising and we now plan to integrate DER Semesterplaner even deeper into the existing infrastructure at RWTH Aachen University.

Other Activities

- Member of the international program committee, 28th Annual ACM Symposium on Applied Computing, Software Engineering Track, Coimbra, Portugal, , March 17-21, 2013, *H. Lichter*
- Organization and member of the program committee of PhD Symposium at Software Engineering 2013, Aachen, February 26, *H. Lichter*
- Member of the organization team and program committee, Multikonferenz Software Engineering 2013, Aachen, February 26 – March 1, 2013, *H. Lichter*
- Organization and member of the program committee of workshop Software Engineering im Unterricht der Hochschulen, Aachen, February 28 – March 1, *H. Lichter*
- Member of the international program committee, 7th IEEE International Conference on Software Security and Reliability (SERE),Washington D.C., June 18-20, 2013 *H. Lichter*
- Visiting Professor at Universiti Teknologi Malaysia, Johor Bahru and Kuala Lumpur, Malaysia, October 2013, *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*
- Lecturer for the "Kara, der programmierbare Marienkäfer" course at Helle Köpfe in der Informatik 2013, *H. Lichter*
- Member of the organization, Multikonferenz Software Engineering 2013, Aachen, February 26 – March 1, 2013, *A. Ganser*
- Organization of the Universal / Specialized Preparatory Courses in Computer Science 2013, *H. Lichter, A. Dyck, A. Ganser*
- Organization of Info-Café and Innovation-Lab talks at Generali Informatik Services, *H.Lichter, M. Vianden*

Talks and Publications

Talks

M. Vianden: *Towards a Maintainable Federalist Enterprise Measurement Infrastructure*, IWSM Ankara, Turkey, October 25th, 2013.

M. Vianden: Eine komponenten- und service-basierte Enterprise-Metrik-Plattform: Architektur und Werkzeuge, OODACH Annual Meeting, Sankt Augustin, September 27th, 2013.

H. Lichter: *Measurement in the Large: A component- and service-based Measurement Platform*, UTM Kuala Lumpur, Malaysia, October 9th, 2013.

H. Lichter: *Foundations auf Metrics and Measurement*, UTM Jahor Bahru, Malaysia, October 7th, 2013.

A. Ganser: *Proactive Quality Guidance for Model Evolution in Model Libraries*. MoDELS ME – Workshop Models and Evolution 2013 co-located with MoDELs Conference, Miami, Florida, USA, September 30th, 2013.

A. Ganser: *Enabling Model Recommenders for Command-Enabled Editors*. MoDELS MDEBE – International Workshop on Model-driven Engineering By Example 2013 co-located with MoDELS Conference, Miami Beach, FL, USA, September 29th, 2013.

A. Roth: *Staged Evolution with Quality Gates for Model Libraries*. International Workshop on Document Changes: Modeling, Detection, Storage and Visualization co-located with the 13th ACM Symposium on Document Engineering (ACM DocEng 2013), Florence, Italy, September 10th, 2013.

H. Lichter: *Measurement in the Large: Konzeption und Aufbau einer Enterprise-Metrik-Plattform*, Colloquium talk at Computer Science Departement, FAU Erlangen-Nürnberg, August 29th, 2013.

S. Jeners: *Harmonizing Software Development Processes with Software Development Settings – A Systematic Approach*. 20th EuroSPI Conference, Dundalk, Irland, June 25th, 2013.

S. Jeners: *Smart Integration of Process Improvement Reference Models Based on an Automated Comparison Approach*. 20th EuroSPI Conference, Dundalk, Irland, June 27th, 2013.

N. V. Tran: *Multi Back-Ends for a Model Library Abstraction Layer*. International Conference on Computational Science and Its Applications – ICCSA 2013, Ho Chi Minh City, Vietnam, June 24th, 2013.

A. Ganser: *Engineering Model Recommender Foundations*. Modelsward 2013, International Conference on Model-Driven Engineering and Software Development, Barcelona, Spain, February, February 20th, 2013.

A. Dragomir: *Model-based Architecture Evolution and Evaluation*, KoSSE-Symposium Application Performance Management (Kieker Days), Wissenschaftszentrum iWn Kiel, November 30th, 2012.

V. Hoffmann: *Rapid Prototyping in der Use-Case-zentrierten Anforderungsanalyse*, Informatik Oberseminar, Fachgruppe Informatik, RWTH Aachen, July 17th, 2013.

Publications

V. Hoffmann (2013): *Rapid Prototyping in der Use-Case-zentrierten Anforderungsanalyse*. Reihe: Aachener Informatik-Berichte, Software Engineering, Band: 15, Shaker, Aachen.

A. Roth, A. Ganser, H. Lichter, B. Rumpe (2013): *Staged Evolution with Quality Gates for Model Libraries*. Proceedings of the International Workshop on: Document Changes: modeling, detection, storage and visualization, September 10th, 2013, Florence, Italy, CEUR-ws.org, vol. 1008.

M. Vianden, H. Lichter, A. Steffens (2013): *Towards a Maintainable Federalist Enterprise Measurement Infrastructure*. In Proceedings of Joint Conference of the 23nd International Workshop on Software Measurement (IWSM) and the 8th International Conference on Software Process and Product Measurement (Mensura), 23-26 October, Ankara, Turkey.

N. V. Tran, A. Ganser, H. Lichter (2013): *Multi Back-Ends for a Model Library Abstraction Layer*. In Computational Science and Its Applications – ICCSA 2013 – 13th International Conference, Ho Chi Minh City, Vietnam, June 24-27, Proceedings, Part III, 160-174.

S. Jeners, H. Lichter (2013): *Smart Integration of Process Improvement Reference Models based on an Automated Comparison Approach*. In Systems, Software and Services Process Improvement, Proceedings of 20th European Conference EuroSPI 2013 Conference, 25.-27.06.2013, Dundalk, Ireland, Fergal McCaffery, Rory V. O'Connor, Richard Messnarz (Eds.), Springer -Verlag, Berlin Heidelberg, Communications in Computer and Information Science, Vol. 364, 143-154.

S. Jeners, P. Clarke, R. V. O'Connor, L. Buglione, M. Lepmets (2013): *Harmonizing Software Development Processes with Software Development Settings – A Systematic Approach*. In Systems, Software and Services Process Improvement, Proceedings of 20th European Conference EuroSPI 2013 Conference, 25.-27.06.2013, Dundalk, Ireland, Fergal McCaffery, Rory V. O'Connor, Richard Messnarz (Eds.), Springer -Verlag, Berlin Heidelberg, Communications in Computer and Information Science, Vol. 364, 167-178.

T. Krisanathamakul, C. Piyabunditkul, A. Methawachananont, H. Lichter (2013): *Towards a Systematic Approach for Objective based Software Process Tailoring*. In Industrial Proceedings 20th European Conference EuroSPI 2013 Conference, 25.-27.06.2013, Dundalk, Ireland (to be published), DELTA Series about Software Improvement, Denmark, 5.1-5.12.

S. Wagner, H. Lichter (ed.) (2013): *Software Engineering 2013 – Workshopband (inkl. Doktorandensymposium)*. LNI 215, GI 2013, ISBN 978-3-88579-609-1.

A. Spillner, H. Lichter (ed.) (2013): *Software Engineering im Unterricht der Hochschulen, SEUH 2013*. CEUR Workshop Proceedings 956, CEUR-WS.org.

A. Ganser, H. Lichter (2013): *Engineering Model Recommender Foundations – From Class Completion to Model Recommendations*. In Modelsward 2013, Proceedings of the 1st International Conference on Model-Driven Engineering and Software Development, Barcelona, Spain,19.-21- February 2013, S. Hammoudi, L. F. Pires, J. Filipe and R. C. das Neves (Eds.) , 135-142.

S. Jeners, H. Lichter, C. G. Rosenkranz (2013): Efficient Adoption and Assessment of Multiple Reference Models. In *e-informatica : software engineering journal*, Oficyna Wydawn. Politechn., Wroclaw, Vol. 7, 15-24.

V. Hoffmann, H. Lichter (2013): *A Model-Based Simulation Environment for Structured Textual Use Cases*. In Software and Data Technologies: 5th International Conference, ICSOFT 2010, Athens, Greece, July 22-24, 2010. Revised Selected Papers / edited by José Cordeiro, Maria Virvou, Boris Shishkov, Springer, Berlin ; Heidelberg, 109-124.

A. Dragomir, H. Lichter (2012): *Model-Based Software Architecture Evolution and Evaluation*. In Software Engineering Conference (APSEC), 2012 19th Asia-Pacific, Vol. 1, 697-700.

S. Jeners, H. Lichter, E. Pyatkova (2012): *Automated Comparison of Process Improvement Reference Models Based on Similarity Metrics*. In Software Engineering Conference (APSEC), 2012 19th Asia-Pacific, Vol. 1, 743-748.

B. Rumpe, H. Lichter (ed.) (2012): *Entwicklung und Evolution von Forschungssoftware : Tagungsband des Workshops*. Reihe: Aachener Informatik-Berichte Software Engineering, Rand 14. Shaker, Aachen.

M. Vianden (2012): *MeDIC – Eine Infrastruktur zum Verwalten, Dokumentieren und Visualisieren von Metriken*. In Entwicklung und Evolution von Forschungssoftware, Tagungsband, Rolduc; [10.-11.11. 2011] / Rumpe, Bernhard [Hrsg.] ; Lichter, Horst [Hrsg.], Shaker Verlag, Aachen, 19-22.

T. Kangwantrakool, A. Methawachananont, C. Piyabunditkul (2012): Technical Challenges of CMMI-based Assessment Team. In *JDCTA : International Journal of Digital Content Technology and its Applications*, AICIT, Gyeongbuk, Korea, Vol. 6 (21), 86-94.

M. Vianden, H. Lichter, K. Neumann (2012): Towards Systematic Reuse of Metric Specifications. In *JDCTA : International Journal of Digital Content Technology and its Applications*, AICIT, Gyeongbuk, Korea, Vol. 6 (21), 43-49.

C. Piyabunditkul, H. Lichter, T. Anwar, A. Methawachananont, C. Krootkaew, T. Krisanathamakul (2012): Design and Evaluation of a CMMI conformant Light-Weight Project Management Approach. In *JDCTA: International Journal of Sigital Content Technology and its Applications*, AICIT, Gyeongbuk, Korea, Vol. 6 (21), 1-10.

S. Jeners, H. Lichter, E. Pyatkova (2012): Metric based Comparison of Reference Models based on Similarity. In *JDCTA: International Journal of Digital Content Technology and its Applications*, AICIT, Gyeongbuk, Korea, Vol. 6 (21), 50-59.