Certus

Centre for Software Verification & Validation

Certus Centre for Software Verification and Validation

Research Council of Norway project no. 203461/030

Annual Report 2011

sfi Senter for forskningsdrevet innovasjon

Contents

1. Summary

The Certus Centre for Research-based Innovation is a 5 – 8 year research project within the area of software validation and verification. The project engages Simula Research Laboratory as host institution and primary research partner, and Kongsberg Maritime, FMC Kongsberg Subsea, Norwegian Customs and Excise, Cisco and Esito as user partners. The project is supported by the RCN with up to 78,4 million NOK over the up to 8-year project period.

The Certus Centre formally started operations 1 October 2011. The three months of operation in 2011 have included three main activities:

1. Research in the continuation of earlier established collaboration between Simula and Kongsberg Maritime, FMC and Cisco, respectively.
2. Identification and prioritization on research and exploitation activities in collaboration between Simula, Norwegian Customs and Excise and Esito.
3. Strategy development and planning for the long term and for 2012 in particular.

The Centre has by 31 December 2011 filled all positions at the host institution, including planned PhD students and post. doctors, related to the work in item 1 above. Regarding item 2, this work is still in the planning phase and the centre works to hire one senior scientist and one PhD student by fall 2012.

2. Vision

The maiden flight of Ariane 5 on 4 June 1996 failed, with the rocket self-destructing after 37 seconds, because of a malfunction in the control software. History is full of examples: airplanes have crashed, patients have died, financial systems have broken down, and cars have been recalled from the market due to software failures.

In 2010 Toyota had to recall about 130,000 of its Prius hybrid vehicles and 10,000 Lexus cars in the U.S. because the braking system software did not function correctly.

In 2002, the US National Institute for Standards and Technologies (NIST) estimated that the direct cost of software failures in the American economy reached USD 60 billion annually. NIST claimed that most software verification and validation activities are poorly managed and not supported by systematic and automated technologies that would be necessary to increase system dependability.

These shortcomings are not only the result of inadequate technologies and management techniques, but they are also due to a lack of technology transfer from the research community to industrial practice as well as a superficial understanding of industrial V&V challenges by many academic researchers.

Vision
Model-driven software verification and validation made industry best practice

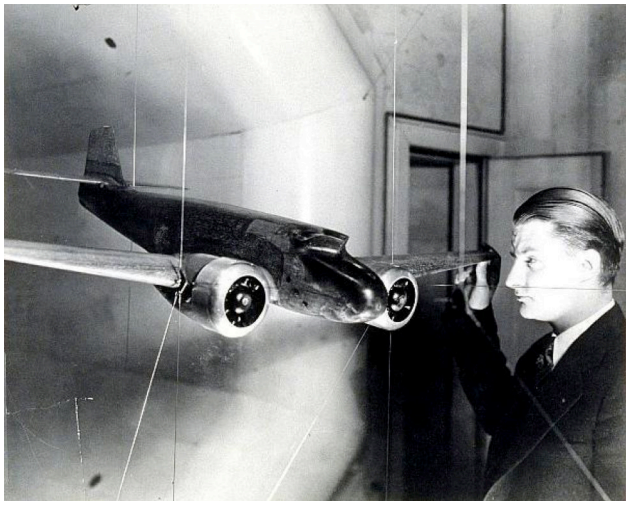
Software V&V needs to be systematic and automated to be cost-effective. It must be systematic to be predictable and it must be automated to be scalable to large and complex systems and systems of systems.

We regard model-driven techniques as the most promising way to provide systematic and automated support for software V&V.

Our vision is a global industry where model-driven software verification and validation technologies are used and viewed as industry best practices. Our ambition is to make contributing steps in the direction towards this vision in order to improve on a situation that has remained mostly unchanged over the last decade.

3. Objectives, Strategy and Research Plan

Substantial research has been performed on software V&V over the last three decades. However, despite the existence of commercial environments for test scripting and execution and a handful of tools for model-based testing, little of the research has ever made it to industrial practice. Further, little is known about the cost-effectiveness of most V&V technologies because limited empirical evidence exists regarding their benefits and cost. Scalability is a particularly acute issue because many proposed analysis techniques and software testing strategies often do not scale up to the size and complexity of modern systems.



As in other engineering disciplines, models should play a central role to enable abstraction, separation of concerns, and early analysis of requirements, architecture, and design.

Model-driven engineering (MDE) is the primary technique that the Certus Centre employs to address these challenges. Extensive international standards, widely supported by commercial tools, now exist to model software and software-intensive systems. The objectives of the Certus Centre are to leverage on international standards and existing modelling tools, and to extend and develop model-driven engineering technologies that support systematic and automated software V&V in industrial contexts.

A central activity in 2011 has been to develop Certus' strategy and research plan, which is embedded in the Annual Work Plan for 2012. Three central elements of this strategy are to:

1. Adopt model-driven engineering as the main approach to software verification and validation.
2. Focus on a limited number of research areas as prioritized by the user partners.
3. Address industrial exploitation already from the first year of operation.

Objectives
To leverage on in existing standards and tools to develop model-driven software verification and validation technologies for industrial settings

The corresponding work programme consists of 8 projects. These projects define confined work areas representing stable and long term efforts over a substantial part, if not the full, 5 – 8 year SFI period. Due to the long-term horizon of these projects, they are formed with the main goal of defining mutually agreeable directions of work within the consortium. The concrete short-term planning, involving deliverables, milestones and effort estimates are confined to the sub-project level made up of tasks. Tasks have short to medium durations and new tasks under the project headers will be introduced as the work plan is updated from year to year.

The 8 projects in the work programme are titled as follows:

Project 1. Management
Project 2. Industrial Exploitation
Project 3. Training and Knowledge Transfer
Project 4. Dissemination and Communication
Project 5. Model-based Engineering for Highly Configurable Systems
Project 6. Safety Analysis and Certification of Embedded Systems
Project 7. Testing of Data-intensive Systems
Project 8. Testing of Real-time Embedded Systems

The projects 5 - 8, which dominates the volume of work in the program, entails the four major research areas of the centre. These projects focus on both upstream activities of the software life cycle, such as requirements quality assurance and architecture analysis, as well as downstream validation and verification activities, primarily software testing.

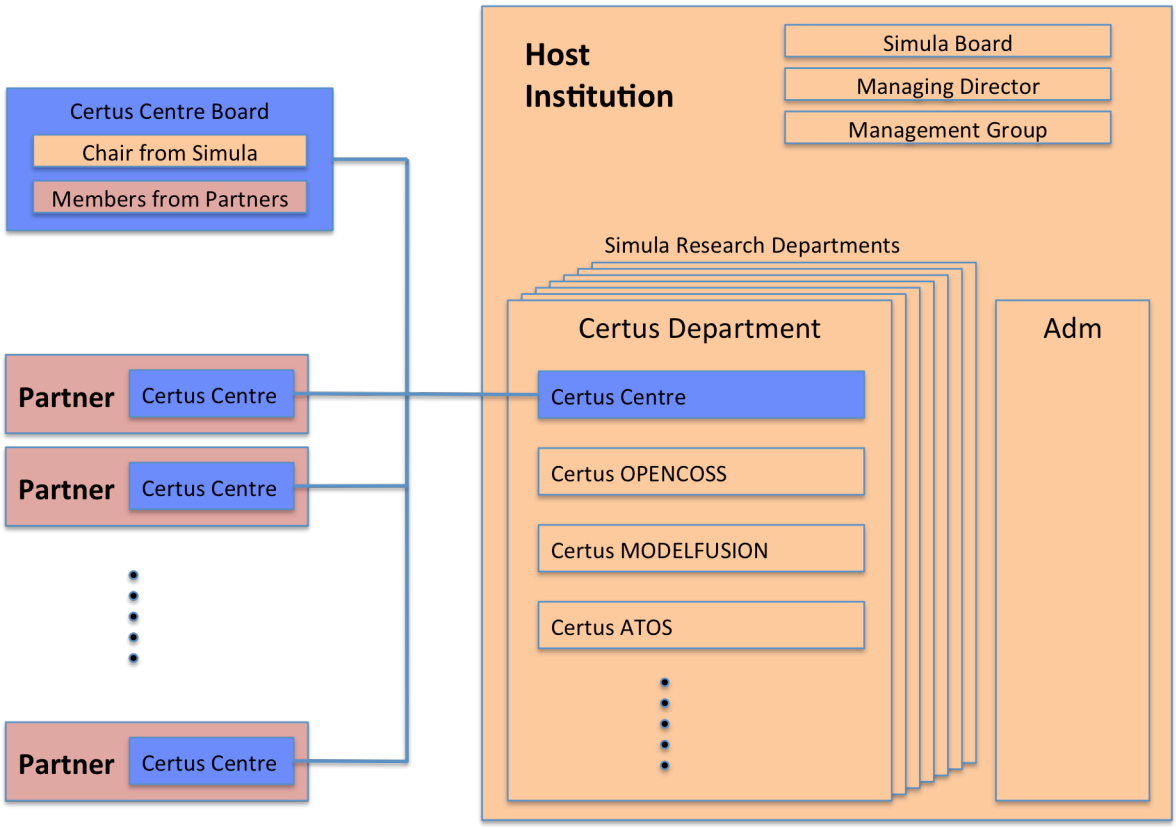
4. Organisation

Formally, the Certus Centre for Research-based Innovation is a collaboration project between a set of independent legal units, the partners and host institution. Together, these units are referred to as the Certus Consortium, for which the principles for collaboration are governed by the Certus Consortium Agreement.

The Certus Consortium is made up of the following legal units:

Simula Research Laboratory	Host institution
Esito	User partner
Norwegian Customs and Excise	User partner
FMC Kongsberg Subsea	User partner
Kongsberg Maritime	User partner
Cisco	User partner

Being the host institution, SRL receives the SFI grant from the RCN and has accepted the overall responsibility for the project as outlined by the Grant Agreement between the SRL and RCN. In case of conflict, the Grant Agreement takes priority over the Consortium Agreement.



The Certus Department is one of several research departments in SRL, while the Certus Centre is one of several projects in the Certus Department. Thus the department is an organisational unit, while the centre is a project. The term Certus SFI is also used as a synonym for the term Certus Centre.

As a collaborative project, the Certus Centre has activities at the user partners as well as at the host institution. In 2011, the work in the Certus Centre had a 75/25 distribution between the host institution and user partners. For 2012, this ratio is budgeted to change to 54/46. From the host's perspective, the Certus Centre accounts for just above half of the total project activity in the Certus Department.

The other projects in the Certus Department also target aspects of software validation and verification and are scientifically related closely to the activities in the Certus Centre. The Certus Centre is conducting its project planning and execution with the ambition to optimize benefits from the total resource pool managed by the Certus Department to the extent legally and practically possible.

The Certus Centre's activities are governed by the Certus Board, which is composed of one representative from each user partner and one from the host institution. The representative from the host is the leader of the board. In 2011, the central management personnel in the Certus Centre have been the following:

Lionel Briand	Simula	centre leader
Erlend Arge	Simula	administrative manager
Are Magnus Bruaset	Simula	board leader

Mette Wam	Esito	board member
Katrine Langset	Customs and Excise	board member
Henrik Auster	FMC Kongsberg Subsea	board member
Merethe Gotaas	Kongsberg Maritime	board member
Marius Liaaen	Cisco	board member

Arnaud Gotlieb replaced Lionel Briand as centre leader 1 February 2012.

In accordance with the work programme structure as outlined in Section 3, individual project members take positions as leaders for projects and tasks, such that the task managers report to the project managers, which in turn report to the centre leader.

5. Scientific Activities

The Certus Centre aims to provide software V&V techniques that scale up to real systems, and which ensure long-term cost effectiveness in real organizations. In line with the priorities of the user partners, Certus targets three types of systems:

1. Real-time embedded software systems, i.e., SW/HW integrated systems with limited resources and means of communication with their environment. Typically, these systems embed a set of dedicated applications running over a Real-Time Operating System (RTOS) and are subject to a set of real-time constraints;
2. Highly-variable software systems, i.e., families of HW/SW software systems for which software reuse is a major concern, because they are subject to a lot of commonalities and variability in their structure. These families are advantageously represented with a variability model that captures their various features;
3. Data-intensive software systems, i.e., software applications which are built on one or several Data Base Management Systems (DBMS) and which have to deal with large amounts of data. These applications typically have to store, retrieve and process millions of data entries.

The selected research areas related to these systems, corresponding to the four scientific projects of the work programme, are the following:

- Project 5. Model-Based Engineering for Highly Configurable Systems, i.e., the application of Model-Driven Engineering (MDE) techniques to the modelling and configuration of subsea integrated control systems, which can be regarded as highly variable software systems. A specific focus in this project will be made on requirement handling and analysis through the usage of families of structural and behavioural models;
- Project 6. Safety Analysis and Certification of Embedded Systems, i.e., the application of Model-Driven Engineering (MDE) techniques to the certification of embedded software application of the maritime domain. The project will address a major scientific area in software engineering, which concerns the certification process of critical systems and the problems related to the interpretation of current certification standards. A special focus will be made on proposing ways to automate the performance requirement verification of embedded systems;
- Project 7. Testing of Data-Intensive Systems, i.e., the improvement of existing regression testing techniques to handle large database-centric applications. Test suite

reduction and test cases prioritization when large DBMS are involved will be the two first research directions explored in this project, but, we expect other directions such as test oracle generation to be explored as well;

- Project 8. Testing of Real-Time Embedded Systems, i.e., the management of testing activities of families of real-time embedded systems. Variability management in the generation of test configurations and test cases is a major issue we will address in this project, using technique such variability modelling and combinatorial interaction testing.

Certus started its operations formally 1 October 2011. After receiving the formal notice of the grant from the RCN in January 2011, Simula conducted a negotiation period with the partners resulting in the signature of the Consortium Agreement and Grant Agreement in September 2011. In parallel with the negotiation, the scientific work was initiated, partly funded by the SFI grant and partly as continuation of other projects in which Simula collaborated with the user partners, primarily Kongsberg Maritime, FMC and Cisco.

Configuration of Subsea Production Systems

FMC Kongsberg Subsea is a major provider of subsea installations for the offshore oil and gas industry. In context of FMC, Certus was focusing on model-driven techniques for modelling and configuring FMC subsea production systems, which are typical large-scale and highly configurable integrated control systems (ICSs). We have performed a comprehensive domain analysis to identify characteristics of ICS families, configuration challenges and configuration requirements in the ICS domain, based on which we derived a set of modelling requirements that are expected to be addressed by a modelling solution.

The subsea control system controlling an oil well as known as a Christmas three. This is an example of a subsea construction delivered by FMC that is subject to extreme requirements to operational dependability that should last for up to 25 years.

To address these modelling requirements, Certus proposed a product line architecture modelling methodology (named as SimPL), which is the foundation to support semi-automated, user-interactive configuration processes. SimPL has been evaluated by an industrial case study, i.e. a family of FMC subsea production systems. To solve the configuration challenges and meet the configuration requirements of ICS families, as the subsequent step of the project, we proposed a semi-automated configuration solution with tool support. The configuration engine of the tool takes SimPL models as input to interactively guide a user to derive a particular product specification complying with the SimPL models of the ICS family. A constraint solver is used in the tool to automatically infer configuration decisions and to ensure that software and hardware configurations are consistent. In 2011, Certus also initiated work with FMC on model-based requirements engineering of large-scale ICSs. The objective of this project is to improve the current practice of FMC in terms of requirements specification and quality assurance.

Safety Certification of Marine Applications

Kongsberg Maritime provide solutions for among other merchant marine, offshore, subsea, navy and coastal marine applications. Certus' work with KM throughout 2011 was centred on the goal of identifying certification challenges and providing scalable solutions to such challenges in selected KM application areas. Specifically, the work focused on (1) improving requirements and architecture documents for safety certification, and (2) tool-supported methodology for requirement-to-design traceability.

For the first project, Certus developed a flexible approach to assist safety engineers in determining what evidence needs to be collected in order to demonstrate compliance to a safety standard in a particular context. This approach is model-based in the sense that it assumes that the safety standard of interest is expressed via a conceptual model. This model enables suppliers and certifiers to systematically develop an agreement about the necessary evidence information, and further provides a basis for checking the completeness and consistency of the agreement.

For the second project, we provided a framework for specifying and automatically extracting design aspects relevant to safety requirements. Our framework has focused on functional safety and safety-relevant requirements and is grounded on the System Modelling Language (SysML). It includes a traceability information model, a methodology to establish traceability, and mechanisms to use traceability for extracting slices of models relevant to a particular safety requirement. The framework has been applied to a case study from the KM domain. The results of this case study are going to be used in the next round of certification within KM.

Testing of Video Conferencing Systems

Certus' work with Cisco Systems Norway has included the development of a scalable modelling methodology to support robustness testing in Cisco's video conferencing systems (VCS), which has significantly reduced modelling effort (98% on average), improved readability (28% on average), reduced modelling errors, and improved model quality. The methodology was empirically evaluated via controlled experiments and case studies. Certus also developed a search-based test generator, which was empirically evaluated on an industrial case study for robustness testing. The results showed to be promising and significantly better than the existing methods in the literature. Finally, we developed methods for robustness test case generation from the models developed. In preliminary experiments, the execution of test cases found one critical, robustness fault in a deployed industrial system. Another research direction in Certus work with Cisco addresses the problem of variability testing of Cisco's highly configurable video conferencing systems. The work in this area focuses on the development of techniques for

Certus has in 2011 worked with Cisco on system testing and fault detection in Cisco's video conferencing systems.

managing the product variability in test configuration generation and execution. Particularly, we focus on the following aspect: (1) modelling the VCS software product line/test cases using feature/family models, (2) development of the techniques for generating the minimum-size set of test configurations for highly-configurable software, (3) development of techniques for automatic test execution dispatching and scheduling for the variants of the software product line.

Testing of Public Service Database Systems

The Norwegian Customs and Excise (NCE) is a public service operating data-centric software systems with complex and changing business logics. The requirements to system correctness and public trust are very high and the acceptance for faults, bugs and errors are low. The NCE is a leader in system testing using significant resources on manual, but costly, testing procedures. The ambition of the work in Certus is the to reduce testing costs while maintaining the high testing quality developed over years of practice and refinements.

The NCE systems are responsible for all Norwegian customs and excise handling including the management of a revenue-flow of more than 300 billion NOK annually distributed over millions of database transactions.

NCE, Esito and Simula have in 2011 collaborated to suggest and analyse possible methods to reduce testing costs at NCE. The initial approaches will be to (1) analyse current practices for the purpose to further optimize the manual procedures, and (2) to improve and implement existing technologies for regression testing in the context of NCE systems. Regarding the technologies for regression testing, Simula has in an earlier project, in collaboration with another public service, developed similar regression testing technologies that have entered regular production use. Thus, the application of this technology in the NCE setting is a combined research and technology transfer task, and accounts for the major part of the exploitation work planned for Certus in 2012.

As evident from the above described research activities, software V&V is by itself a large research field with many specialist areas and sub-disciplines. Special competencies are thus required for positions related to the prioritized work areas at the user partners. The Centre has by 31 December 2011 filled all positions at the host institutions, including planned PhD students and post. doctors, related to scientific projects 5, 6 and 8. Regarding project 7, the Centre works to hire one senior scientist and one PhD student fall 2012. With these employments, the employment plan is completed. Projects 1 – 4 are managerial projects to which all project members contribute resources.

In January 2012, professor Lionel Briand, Certus Department head and Certus Centre leader in 2011, entered an 80 % leave scheduled to last one year. In this leave, Briand is building a research group at the University of Luxembourg within similar areas as Certus. Certus collaborates closely with Briand and the collaboration is planned to be formalized with a

collaboration agreement in 2012. A decision for whether Briand will return to Simula is still to be taken.

6. Communication, Dissemination and Exploitation

Apart from establishing a initial web site for the centre in 2011 and attending to scientific conferences, the concrete communication, dissemination and exploitation acidity for the centre was limited in 2011. Mostly, the work in this area went into planning for such activities. In the planning process the centre has defined separate projects addressing these activities (projects 2 and 4).

In particular, Certus acknowledges the challenges involved in achieving true industrial exploitation and adoption of research results. To increase the possibilities for such success we will approach exploitation on several levels in 2012. The ambition is to establish realistic expectations to what level of exploitation that will be possible to achieve with the current committed resources, and to establish an understanding of what mix of competence, funding and external resources that will be necessary in order to reach the level of exploitation we aim for.

Concrete dissemination and communication planned for 2012 include the further development and maintenance of the SFI's web service, authoring of tertiary feature articles and authoring of the annual report. The task plan also implements the dissemination of scientific and industrialized research results in international conferences in 2012.

Appendiks A. Personnel

The personnel listed below include personnel working at the host institution fully or partially funded by the Certus Centre in 2011. Personnel at user partners are not listed as well as personnel working at the host institution with general administrative services.

Key Researchers					
Name	**Institution**	**Topic**			
Lionel Briand	Simula	Software Engineering			
Mehrdad Sabetzadeh	Simula	Software Engineering			
Shiva Nejati	Simula	Software Engineering			
Tao Yue	Simula	Software Engineering			
Arnaud Gotlieb	Simula	Software Engineering			
Richard Torkar	Simula	Software Engineering			
Visiting Researchers					
Name	**Nationality**	**Topic**	**Sex M/F**	**Affiliation**	**Period**
Postdoctoral researchers with financial support from the SFI budget					
Name	**Nationality**	**Topic**	**Sex M/F**		
Shaukat Ali	Pakistan	Software Engineering	M		20111120 - 20141119
Postdoctoral researchers working on projecs in the SFI with financial support from other sources					
Name	**Nationality**	**Topic**	**Sex M/F**		**Period**
Jose Gonzales	Spain	Software Engineering	M		20111001 - 20140930
Marijan Dusica	Serbia	Software Engineering	F		20110815 - 20140814
PhD students with financial support from the SFI budget					
Name	**Nationality**	**Topic**	**Sex M/F**		**Period**
Shokoofeh Hesari	Irak	Software Engineering	F		20110901 - 20140831
Shuhai Wang	China	Software Engineering	M		20110901 - 20140831
PhD students working on projecs in the SFI with financial support from other sources					
Name	**Nationality**	**Topic**	**Sex M/F**		**Period**
Erik Rogstad	Norway	Software Engineering	M		20100701 - 20140831
Muhammad Zohaib Iqbal	Pakistan	Software Engineering	M		20090613 - 20120612
Razieh Behjati	Irak	Software Engineering	F		20090601 - 20120531
Stefano Di Alesio	Italy	Software Engineering	M		20110601 - 20140531
Sunil Nair Mohan	India	Software Engineering	M		20111001 - 20140930
Administative					
Name	**Nationality**	**Topic**	**Sex M/F**		**Period**
Erlend Arge	Norway	Software Engineering	M		

Appendiks B. Accounts

The Certus Centre annual accounts for 2011 shown below are presented in the standard setup used by the Research Council of Norway. In particular regarding funding, Own financing refers to funding provided by the host institution, other public funding refers to funding provided by the Norwegian Customs and Excise while other private funding refers to funding provided by the remaining four user partners.

Cost in NOK	2011
Payroll and indirect expenses	5 803 784
Procurement of R&D services	-
Equipment	-
Other operating expenses	265 542
Totalts	6 069 326

Cost in NOK	2011
Trade and industry	1 315 668
Independent research institute	4 601 658
University and university colleges	-
Other sectors	152 000
Abroad	-
Totals	6 069 326

Funding in NOK	2011
Own financing	415 140
International funding	-
Other public funding	152 000
Other private funding	1 315 668
From Research Council	4 186 518
Totals	6 069 326

Appendiks C. Publications

The list of publications shown below are related to work involving the Certus Centre user partners funded by the Certus Centre as well as other collaborating projects in 2011 with the same partners ahead of the opening of the Certus Centre.

R. Behjati, T. Yue, S. Nejati, L. Briand, and B. Selic. Extending SysML with AADL Concepts for Comprehensive System Architecture Modeling, In: 7th European Conference on Modelling Foundations and Applications, ed. by Robert B. France, Jochen M. Kuester, Behzad Bordbar, Richard F. Paige, pp. 236-252, Springer (ISBN: 978-3-642-21469-1), 2011.

R. Behjati, T. Yue, L. Briand, and B. Selic. SimPL: A Product-Line Modeling Methodology for Families of Integrated Control Systems , Simula Research Laboratory, Technical Report (2011-14 (V. 2)), 2011.

R. Behjati, T. Yue, S. Nejati, L. Briand, and B. Selic. An AADL-Based SysML Profile for Architecture Level Systems Engineering: Approach, Metamodels, and Experiments, Simula Research Laboratory, Technical Report (2011-03), 2011.

L. Briand, D. Falessi, S. Nejati, M. Sabetzadeh, and T. Yue. Research-Based Innovation: A Tale of Three Projects in Model-Driven Engineering, Simula Research Lab, Technical Report (2011-18), 2011.

H. Hemmati, A. Arcuri, and L. Briand. Achieving Scalable Model-Based Testing Through Test Case Diversity , Accepted for publication in ACM Transactions on Software Engineering and Methodology (TOSEM), 2011

H. Hemmati, A. Arcuri, and L. Briand. Empirical Investigation of the Effects of Test Suite Properties on Similarity-Based Test Case Selection, In: 4th International Conference on Software Testing, Verification and Validation (ICST2011), ed. by , pp. 327 - 336, IEEE Computer Society (ISBN: 978-1-61284-174-8), 2011.

S. Ali, L. Briand, and H. Hemmati. Modeling Robustness Behavior Using Aspect-Oriented Modeling to Support Robustness Testing of Industrial Systems, Accepted for publication in the Journal of Software and Systems Modeling, Springer, 2011.

S. Ali, L. Briand, A. Arcuri, and S. Walawege. An Industrial Application of Robustness Testing using Aspect-Oriented Modeling, UML/MARTE, and Search Algorithms, In: ACM/IEEE 14th International Conference on Model Driven Engineering Languages and Systems (Models 2011), ed. by Jon Whittle, Tony Clark, Thomas Kühne, pp. 108-122, ACM/IEEE, Springer-Verlag Berlin, Heidelberg (ISBN: 978-3-642-24484-1), 2011.

S. Ali, M. Z. Iqbal, A. Arcuri, and L. Briand. A Search-based OCL Constraint Solver for Model-based Test Data Generation, In: Proceedings of the 11th International Conference On Quality Software (QSIC 2011), ed. by , pp. 41-50, IEEE Computer Society (ISBN: 978-0-7695-4468-7), 2011.

T. Yue, S. Ali, and L. Briand. Automated Transition from Use Cases to UML State Machines to Support State-based Testing, In: In Seventh European Conference on Modelling Foundations and Applications (ECMFA) 2011, ed. by Robert B. France, Jochen M. Kuester, Behzad Borbar and Richard F. Paige, pp. 115-131, Springer-Verlag Berlin, Heidelberg (ISBN: 978-3-642-21469-1), 2011.

S. Ali, M. Z. Iqbal, A. Arcuri, and L. Briand. Solving OCL Constraints for Test Data Generation in Industrial Systems with Search Techniques, Simula Research Laboratory, Technical Report(2010-16), 2011. (Submitted to a Journal)

S. Ali, T. Yue, and L. Briand. Empirically Evaluating the Impact of Applying Aspect State Machines on Modeling Quality and Effort , Simula Research Laboratory, Technical Report (2011-06), 2011. (Submitted to a conference)

S. Ali, T. Yue, and L. Briand. Does Aspect-Oriented Modeling Help Improve the Readability of UML State Machines?, Simula Research Laboratory, Technical Report(2010-11), 2011. (Submitted to a Journal)

S. Ali, T. Yue, and Z. Malik. On Understandability of Aspect State Machines for Robustness Testing: A Controlled Experiment, Simula Research Laboratory, Technical Report (2011-02), 2011. (Submitted to a conference)

D. Falessi, S. Nejati, M. Sabetzadeh, L. Briand, and A. Messina. SafeSlice: a model slicing and design safety inspection tool for SysML., In: SIGSOFT/FSE'11 19th ACM SIGSOFT Symposium on the Foundations of Software Engineering (FSE-19) and ESEC'11: 13rd European Software Engineering Conference (ESEC-13), ed. by Tibor Gyimóthy, Andreas Zeller, ACM (ISBN: 978-1-4503-0443-6), 2011.

M. Sabetzadeh, S. Nejati, L. Briand, and Anne-H. Evensen Mills. Using SysML for Modeling of Safety-Critical Software-Hardware Interfaces: Guidelines and Industry Experience, In: 13th IEEE International High Assurance Systems Engineering Symposium (HASE'11), 2011.

R. K. Panesar-Walawege, M. Sabetzadeh, and L. Briand. Using UML Profiles for Sector-Specific Tailoring of Safety Evidence Information, In: 30th ACM International Conference on Conceptual Modeling (ER), ed. by Springer , vol. 6998/2011, pp. 362-378, ACM, Springer (ISBN: 978-3-642-24605-0), 2011.

R. K. Panesar-Walawege, M. Sabetzadeh, and L. Briand. A Model-Driven Engineering Approach to Support the Verification of Compliance to Safety Standards, In: 22th IEEE International Symposium on Software Reliability Engineering (ISSRE 2011), ed. by IEEE, pp. 30-39, IEEE, IEEE (ISBN: 978-0-7695-4568-4), 2011.

R. K. Panesar-Walawege, M. Sabetzadeh, and L. Briand. Using Model-Driven Engineering for Managing Safety Evidence: Challenges, Vision and Experience, In: the 1st Intentional Workshop on Software Certification (WoSoCER) at 22th IEEE International Symposium on Software Reliability Engineering. , ed. by Springer , Springer (ISBN: 978-0-7695-4568-4), 2011.

R. K. Panesar-Walawege, T. Skyberg Knutsen, M. Sabetzadeh, and L. Briand. CRESCO: Construction of Evidence Repositories for Managing Standards Compliance, In: 30th ACM International Conference on Conceptual Modeling (ER2011), ed. by Springer , Springer (ISBN: 978-3-642-24574-9), 2011