Annual Report

2012

Certus

sfi = Centre for
Research-based
Innovation

Arnaud Gotlieb
Leader of the Certus Centre
Head of the Software Engineering Department,
Simula Research Laboratory

THE CERTUS SOFTWARE VALIDATION & VERIFICATION CENTER is a Centre for Research-based Innovation (SFI) which is funded by the Norwegian Research Council. The Certus Centre is hosted by Simula Research Laboratory, with FMC Technologies, Esito, Kongsberg Maritime, Cisco, ABB Robotics and Norwegian Customs and Excise as consortium partners.

The goal of the Certus Centre, and the SFI program, is to promote innovation by supporting long-term research through close cooperation between R&D intensive companies and a prominent research institution. The Certus center develops technologies to automate the testing of safety-critical embedded software systems, communication systems, and data-intensive systems. Certus is internationally recognised as a leading scientific and innovative centre in the modelling, certification and testing of highly-configurable software systems.

Contents

Solving important real-life problems

Simula Research Laboratory is dedicated to tackling scientific challenges of genuine importance to real life. This ambitious goal calls for high scientific quality, long-term focus and commitment, and the ability to pick relevant research questions. It also requires close collaboration with the best partners, in Norway and abroad. In particular, we depend on fluid interaction with those who own the problems we set out to solve. Only these problem owners can guide us to the specific insight on which to build innovative and robust solutions.

Since its inception in 2001, Simula has been involved in many research projects, both of traditional academic nature and in collaboration with industrial companies and public agencies. For instance, along this path we have been successful in building a long-term collaboration in computational geoscience with Statoil, establishing a Norwegian Centre of Excellence in biomedical computing, serving national interests in assessing and improving the robustness of communication networks, and playing central roles in two Centres for Research-based Innovation (SFI) on information access technology and on ultrasound systems for cardiology, respectively.

The most recent addition to the list above is the establishment of Certus in 2011 as an SFI focused on testing and verification of mission-critical software systems. The SFI scheme is designed to merge the scientific competence of the research partners with the needs and experience of user partners. For Certus, the user partners count Cisco Systems Norway, Esito, FMC Kongsberg Subsea, Kongsberg Maritime, and the Norwegian Customs and Excise (Toll-og avgiftsdirektoratet). At the first glance, these partners are extremely diverse, but their needs intersect: they are deeply involved in the development and maintenance of complex software systems that have to work non-stop, year after year. To this end, clever use of the resources available for software testing is paramount. The ultimate results to be delivered by Certus are methods, tools, and experience that can boost this cleverness.

At Simula, eight years of collaborative experience with Statoil has matured into a well-functioning model for how to work successfully in partnership with industry. In particular, we have observed that a balanced blend of long-term research and shorter-term technology development strengthens collaboration in at least two ways: firstly, it provides a mutual boost to both components – research and development; and secondly, it cements a constructive and positive relationship between Simula and industry.

These observations align well with our experience from the three SFIs in which Simula is involved. Although these experiences were made in an industrial context, we strongly believe that the principle of balancing short-term and long-term goals is transferable to any situation where our competence is used to solve problems originating from an external stakeholder. In Simula's strategy for the next decade, we explicitly state
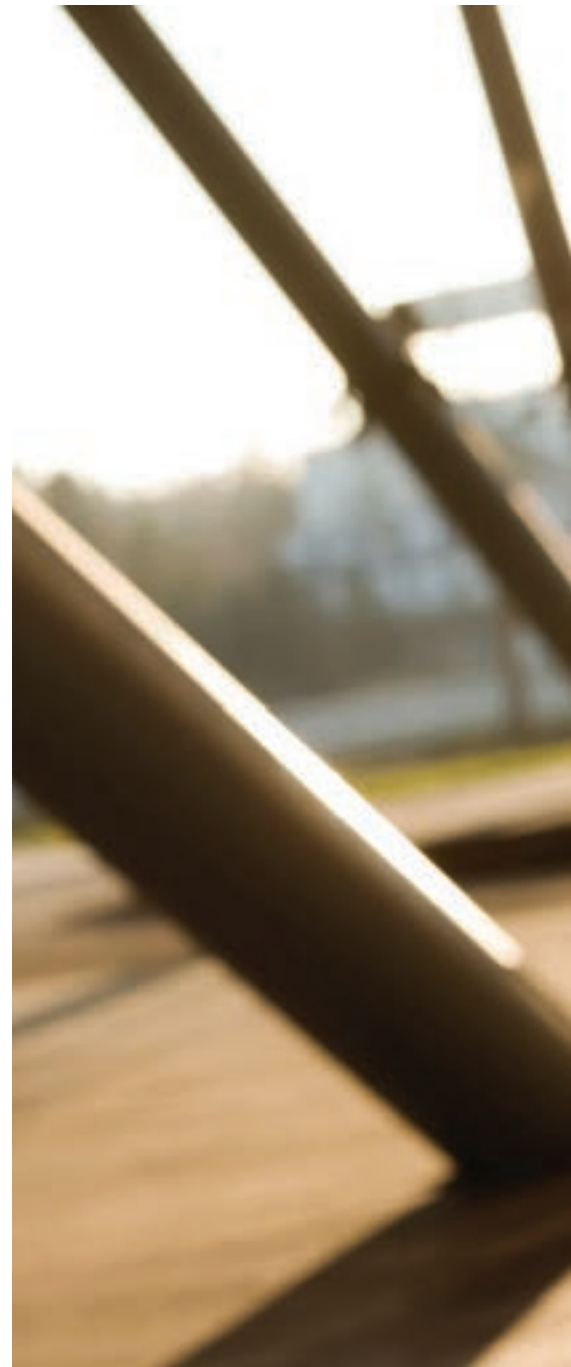
that we want to transfer the best practices from these existing cases to future collaborations with industry and other problem owners. Certus stands out as a particularly important element in this strategy.

We are determined that Certus shall provide substantial value to its partners, and that the resulting experiences will gravitate into our way of researching, educating, and innovating. These and complementing experiences will bring us closer to the goal of solving scientific problems that are genuinely important to real life – to you and me.

Professor Are Magnus Bruaset
Chair of the Board, Certus
Director of Research,
Simula Research Laboratory

Addressing strategic V&V research challenges

In response to the continually increasing demand for dependable systems and ways to bring software validation and verification costs under control, the Certus Centre was established in 2011.

The Certus Centre has established a body of methods and tools for the validation and verification (V&V) of software-intensive systems. Working in close cooperation with Certus' five founding user partners, the centre's researchers have analysed and produced innovative methods to validate the following types of systems:

REAL-TIME EMBEDDED SOFTWARE SYSTEMS

Software and hardware (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.

HIGHLY CONFIGURABLE SOFTWARE SYSTEMS

Families of SW/HW systems for which software reuse is a major concern, due to the fact that there exist a large number of commonalities and variabilities across products of a product family. Facilitating such reuse will significantly improve the overall quality and productivity of product development.

DATA-INTENSIVE SOFTWARE SYSTEMS

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.

In 2012, the Centre undertook collaborative research to solve complex challenges proposed by the user partners. The working activities were divided into eight projects, including administrative, scientific and exploitation projects.

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 project structure was defined to facilitate the various research, exploitation, dissemination and communication activities. The combination of these four pillars has contributed to Certus' innovative environment.

An organisation dedicated to research-driven innovation

THE CERTUS CENTRE

The Certus Centre is a centre for research-based innovation (SFI), funded by the Research Council of Norway (RCN). Simula Research Laboratory (Simula), which is the host institution, as well as the user partners: Esito, Norwegian Customs and Excise (Customs), FMC Kongsberg Subsea (FMC Technologies), Kongsberg Maritime, and Cisco Systems Norway (Cisco). In 2013, ABB Robotics Stavanger will join the Certus Centre as a full partner.

The partners are independent legal units and the Certus Centre is a collaboration project between the partners. This partnership is governed by the Certus Consortium Agreement. As the host institution, Simula receives the SFI-grant from the research council and accepts overall responsibility for the project, as outlined by the grant agreement between Simula and RCN. In the case of any conflict, the grant agreement takes priority over the consortium agreement.

MANAGEMENT OF THE CERTUS CENTRE

The Certus Centre is administrated by the centre leader and the administrative manager, who report to the Certus Board. The board, which consists of representatives from each of the centre's partners, approves the annual budget and the work plan, and governs the centre. The board also has the oversight of all of the projects, workshops and activities in the centre. Most importantly, the board ensures that the long-term goals and ambitions of the centre

are matched with concrete actions in order to achieve those goals. In 2012, the board included:

Are Magnus Bruaset (Chair, Simula), Mette Wam (Esito), Geir Magne Merkesvik (FMC Technologies), Marius Liaanen (Cisco), Merethe Gotaas (Kongsberg Maritime), Katrine Langset (Customs and Excise).

The administration of the centre includes Arnaud Gotlieb (Certus leader, Simula) and Stein Erlend Arge (administrative manager, Simula), who has now been replaced as administrative manager by Christian Hemmestad Bjerke.

The individual scientific projects form the basis of the collaboration between the partners. However, in order for Certus to function as a true centre, it is crucial that knowledge is shared between all of the partners. For this reason, twice a year, Certus organises workshops for the user partners. These workshops are important arenas for sharing knowledge and discussing common issues and challenges. They are also vital to creating a common understanding of the activities in the centre and to foster mutual learning.

KEY FIGURES

The Certus Centre annual accounts for 2012 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	2012
Payroll / indirect expenses	10 025 304
Procurement of R&D services	-
Equipment	59 700
Other operating expenses	5 094 735
Totals	15 179 739

Funding in NOK	2012
Own financing	2 350 000
International funding	-
Other public funding	826 000
Other private funding	3 530 324
From the Research Council	8 473 415
Totals	15 179 739

The Certus Centre

Host Institution

[simula . research laboratory]

SIMULA RESEARCH LABORATORY
is a non-profit, public utility enterprise performing leading international research within selected ICT fields. In 2011 Simula was ranked as the world's most productive institution in systems and software engineering research, and in 2012 received the highest score in a national ICT evaluation. Certus' long-term perspective and strong industrial profile gives Simula a unique opportunity to further expand and enhance its position as a leader in software verification and validation research. The Certus Centre is one of several research projects at Simula within software verification and validation. Together, these projects are organised through Simula's Department of Software Engineering.

KONGSBERG

KONGSBERG MARITIME is one of the largest suppliers of programmable marine electronics worldwide. They deliver systems for dynamic positioning and navigation, marine automation, cargo management and level sensors, maritime training simulators and position reference systems. These products are paramount to ensuring reliability and correct functioning of offshore and shipyard systems.

TOLL CUSTOMS

CUSTOMS AND EXCISE is an agency under the Ministry of Finance. Customs and Excise assesses and collects customs and excise duties, value added tax on imported goods and special taxes for the state treasury. The agency also carries out a number of enforcement tasks related to the import and export of goods. Customs delivers and maintains a large portfolio of systems for handling customs and excise in Norway. Their systems have high requirements regarding data integrity, availability and security.

CISCO

CISCO SYSTEMS NORWAY specialises in video conferencing systems and manufactures a broad selection of products designed to realise telepresence. Cisco's communication systems play a central role in several business and safety-critical domains including healthcare and energy. As companies become more global, effective ways to support remote collaborations and minimise traveling become essential.

= esito

ESITO is an IT company that has developed a model-based software development tool mainly used to develop administrative, mission-critical applications. Esito develops and markets the tool, which is called Genova. Esito's vision is to give its customers lower costs and better quality in the development and maintenance of their applications.

FMC Technologies

FMC TECHNOLOGIES is a leading global provider of technology solutions for the energy industry. One of its key technologies is Subsea Production Systems, which are large-scale, integrated, and highly configurable systems of systems for managing exploitation of oil and gas production fields. The subsea industry's need for high quality and improved recovery rates has led FMC Technologies to utilise software to further improve its subsea technology.

ABB

ABB ROBOTICS, to join Certus in 2013, is a market leader in painting systems embedded into industrial robots. These systems are integrated control software systems that pilot the paint process applied to various industrial objects, such as car bodies or aircraft wings. The company produces systems in such a way that allows the operator to control both the motions and the painting process of the robot. In order to deliver market-leading products, ABB Robotics has made system validation and verification a high priority. The company will complement and strengthen Certus´ position in software validation and verification by opening a new line of research collaborating work in this area.

Modelling, certifying and testing software-intensive systems

Certus' scientific activities focus on the modelling, certification and testing of software-intensive systems. In 2012, the centre developed a unique competence on variability testing of highly-configurable software systems (see definition top right) through partnership with Cisco, FMC Technologies, Kongsberg Maritime and the Norwegian Customs and Excise department. With assistance from Esito, the centre also developed a technology for testing data-intensive systems. By analysing industrial case studies and experimenting solutions, Certus has constructed a body of industrial-strength methods and prototype tools that address and solve concrete, real-life software-intensive system engineering problems. Regarding research activities, Certus has developed four scientific projects in close collaboration with the user partners.
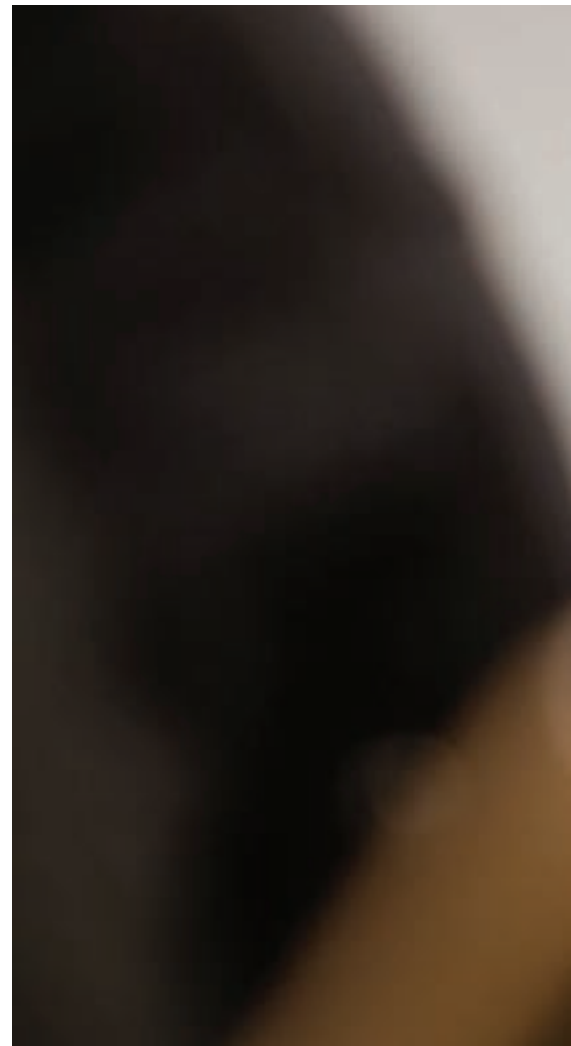
MODEL-BASED ENGINEERING FOR HIGHLY-CONFIGURABLE SYSTEMS

This project applies Model-Driven Engineering (MDE) techniques to the modelling and configuration of highly-configurable subsea production systems. During the last year, Certus researchers have focused on requirements specification, verification and validation (see fact box), by employing system structural and behavioural models of the product family of subsea production systems.

TESTING OF DATA-INTENSIVE SYSTEMS

This project improves existing regression testing techniques and enables them to handle large database-centric applications. In 2012, Certus researchers explored automatic test-suite generation and test coverage visualization on large data sets.

"Certus has constructed a body of industrial-strength methods and prototype tools that address and solve concrete, real-life software-engineering problems.

HIGHLY-CONFIGURABLE SOFTWARE SYSTEMS are systems that can be tailored in many different ways to fit distinct customer needs. These systems usually facilitate software reuse through distinct configurations.

REQUIREMENT ENGINEERING is, according to IEEE, the process of formulating conditions or capabilities that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document.

SAFETY ANALYSIS AND CERTIFICATION OF EMBEDDED SYSTEMS

This project applies Model-Driven Engineering techniques to the certification of embedded software applications within the maritime domain. In 2012, Certus researchers addressed the certification process of safety-critical systems and the challenge related to the interpretation of distinct certification standards. In addition, the researchers have proposed to automate the verification of the performance requirements required by these standards.

TESTING OF REAL-TIME EMBEDDED SYSTEMS

This project focuses on managing the testing of families of real-time embedded systems. In 2012, Certus researchers addressed variability management in the generation of test configurations and test cases, using variability modelling and combinatorial interaction testing.

Case: Modelling highly-configurable systems

Subsea oil and gas production systems (FMC Technologies) and Video Conference Systems (Cisco) are typical examples of complex cyber-physical systems. Such systems associate SW/HW components, and may consist of a large numbers of sub-systems, typically geographically distributed and connected through a network. Model-Based Engineering (MBE) technologies offer a promising approach to reduce the complexity of developing cyber-physical systems. They improve the quality and productivity of a product development process by capturing information at a higher level of abstraction, providing a knowledge-sharing platform for communication among stakeholders, and enabling automated analysis.

ACTIVITIES
In 2012, Certus applied MBE technologies to address three industrial challenges:

1) Handling the complexity of the requirements engineering practice in order to improve the overall quality and productivity of product development.

2) Handling error-prone and costly product configuration, which is common when developing highly-configurable cyber-physical systems.

3) Constructing models of cyber-physical systems' product families, in order to support automated model-based testing.

RESULTS
Regarding the first task, Certus conducted a systematic domain analysis. The results of that analysis provide an opportunity to develop practical solutions for the centre's industrial partners. To address the second challenge, Certus proposed a model-based configuration approach, with tool support. This approach enables consistency of configurations, automatically infers up to 50 per cent of the configuration decisions, and makes configuration decisions simpler. Certus also developed a methodology for modelling the behaviour of a family of Cisco's video conferencing systems. Results show that this methodology drastically simplifies the modelling and configuring of these systems. These results make a strong case for the industry adoption of Certus' model-based testing technologies.

> Certus' approach enables consistency of configurations, automatically infers up to 50 per cent of the configuration decisions, and makes configuration decisions simpler.
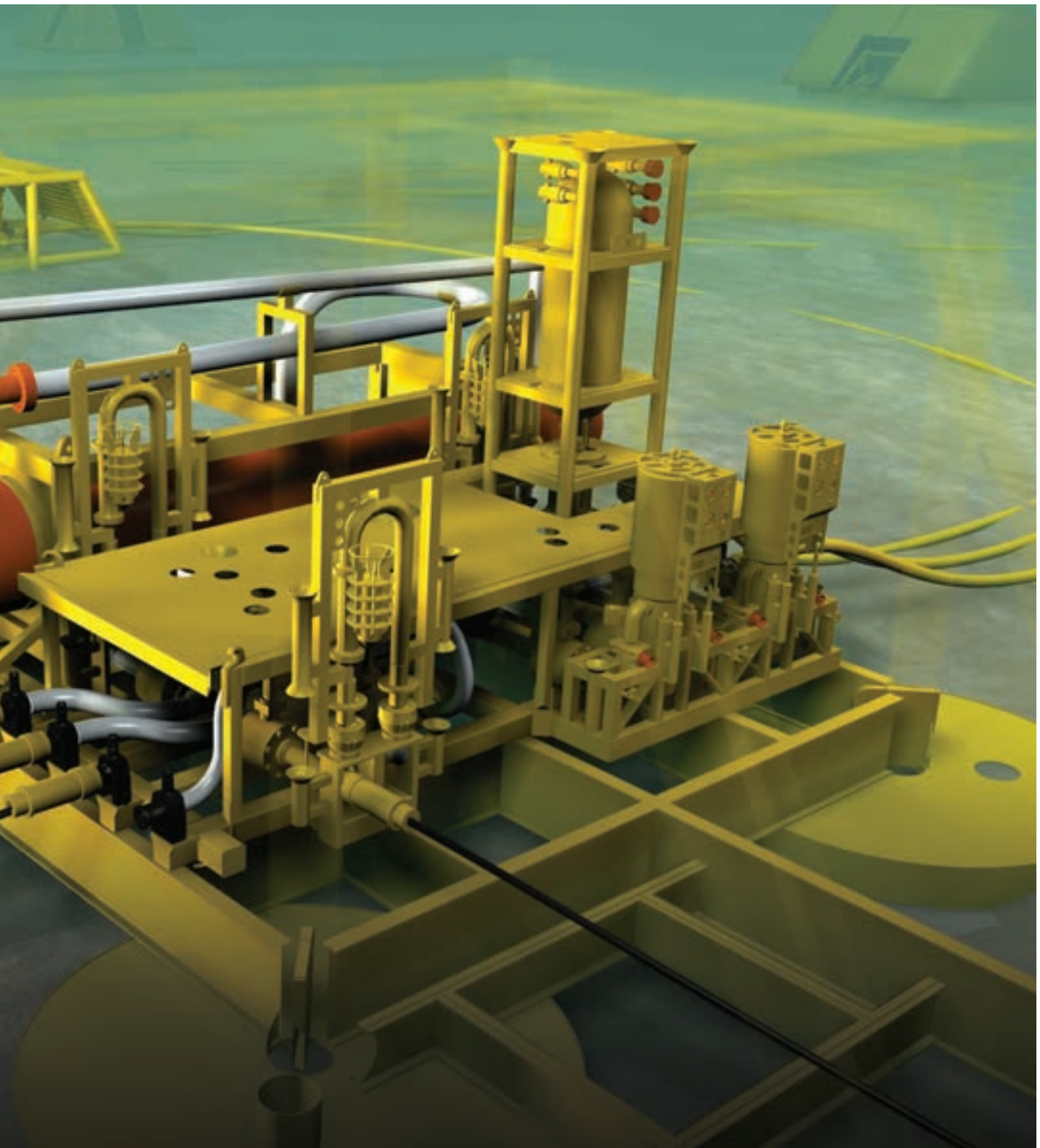
Courtesy of FMC Technologies

Case: Improving the testing of data-intensive systems

BACKGROUND

Norwegian toll collects customs and excise duties and value added tax on imported goods, amounting to around NOK 200 billion going into the state treasury each year. TVINN is the software system at the heart of this operation that processes about 30,000 declarations a day. TVINN strives to accurately compute and collect taxes, prevent criminal activities such as the importation of counterfeit goods, and protect the people of Norway from imports of potentially hazardous substances. Testing TVINN entails detecting faults due to interactions between fields across multiple database tables in TVINN. At the moment, this process is performed manually. Nearly 40 per cent of test managers' time is spent maintaining TVINN at a high-level of quality.

ACTIVITIES

In 2012, Certus researchers and Customs jointly decided to introduce automated testing in the hope reducing testing efforts by 20 per cent. First, researchers developed a common database schema to transfer real-world customs declarations' data from TVINN to an in-house database. The first challenge was to populate the common database schema with comprehensive test data. This was essential for initial testing before the use of real data from TVINN. To this end, Certus developed Faktum, a combinatorial interaction-testing tool to generate data for databases that compactly contains all possible interactions between a set of fields.

As a second challenge, Certus also developed a protocol to export real data from TVINN to the in-house database mentioned above, by filtering out confidential information about customers. The second challenge addressed was the visualisation of interaction coverage by records in real data. For this purpose, Certus also developed a tool to graphically visualise coverage of interactions in dense data.

RESULTS

The approach proposed by Certus researchers was well received by Customs' test managers. Working in close interaction has not only led the researchers to get a deep understanding of the challenges to testing TVINN, a data-intensive system, but also guided the research team towards the development of an industry-strength tool that is ready for potential exploitation.

COMBINATORIAL INTERACTION TESTING is a set of software testing techniques that invent test cases for covering all pairs or all subsets of tuples of values for the input parameters of a system.

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Bringing cutting-edge software testing techniques to Norwegian government agencies.
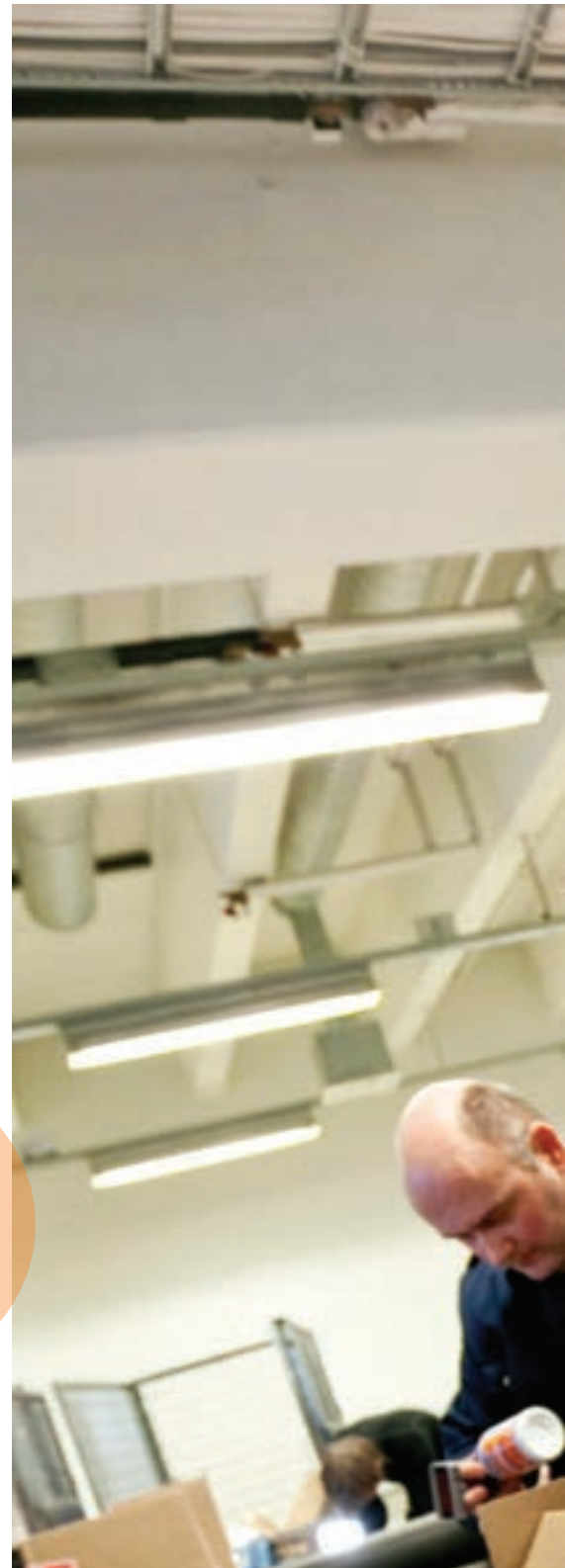
Courtesy of nyebilder.no/Tollvesenet

Case: Certifying safety-critical software systems

BACKGROUND

The tendency toward software-based automation is creating a proliferation of embedded systems. Increasingly this automation is in areas where the failure of an embedded system can lead to loss of life or damage to the environment. Such systems usually undergo a process of certification to assure that the system is safe to operate in a specific context. This project improves the accuracy and cost-effectiveness of the safety analyses and certification required in the assurance of embedded systems.

Model-driven engineering has been selected as the enabling technology for improving the design of safety-critical software found in embedded systems. Models are used for two specific purposes: 1) to develop systematic procedures for analysing the safety properties of the embedded software and 2) to develop solutions for managing safety evidence.

Courtesy of Kongsberg Maritime

ACTIVITIES

Software certification involves checking that the software design meets the software safety requirements. In practice, manual inspection is performed to ensure that the safety requirements are satisfied by the design. In a model-driven development context, this means inspecting large models in order to understand them and identify the safety-related fragments – a time-consuming and error-prone process. To address this problem Certus developed a tool called, SafeSlice, that enables the automatic extraction of the safety-related fragments of design models. This work has been validated through two case studies and a control experiment.

With regards to the management of safety evidence, Certus has developed a method that automatically verifies whether a particular system complies with a safety standard. This method enables a supplier of safety-critical systems to systematically collect evidence. The supplier can then show how their system development complies with a safety standard. This is done by providing step-by-step guidance on how to create a link between the system artefacts and those required by the standard.

At times, systems are certified according to sector-specific standards, which originated to create a generic standard in a particular domain. There are many certification issues that arise from poorly stated or implicit relationships between generic standards and their sector-specific interpretations. To tackle this issue Certus created a method for explicitly showing the relationship between a generic and a sector-specific standard.

Finally, two tools have been created to support the collection and management of safety evidence. The first aids in the planning of the evidence that needs to be collected for compliance. The second provides infrastructure for storing that evidence outside of modelling environments.

SAFETY-CRITICAL SOFTWARE SYSTEMS are HW/SW systems whose failure or malfunction can severely harm people's lives, environment or equipment.

Case: Testing of real-time embedded systems

BACKGROUND

It is vital to Certus' industrial partners that real-time embedded systems (RTES) are reliable, robust, safe, and efficient, in order to avoid posing undue risks to users and the environment. This project aims to devise cost-effective, automatic testing techniques to improve the quality of RTES.

ACTIVITIES

The project consists of two separate activities. The first activity focuses on an automated test case selection process for new Video Conferencing products developed by Cisco. Certus has developed an automated approach to test case selection, based on specialised models. This method could potentially replace the current practice of manual test selection.

The second activity focuses on testing non-functional behaviour of product lines of RTES. This includes testing their robustness, reliability, and safety, as well as their nominal behaviour. Certus has developed a modelling methodology to support automated testing. This method reduces the modelling effort required for testing. The methodology is investigated in the context of Cisco's Video Conferencing Systems.

RESULTS

For the first activity, Certus conducted qualitative and quantitative studies to evaluate the modelling solution using Cisco's case study. The proposed solution is fully automated. It reduces test selection time by 65 per cent and manual work by 50 per cent, and improves test coverage by 30 per cent. The centre also has developed a tool called Import Plugin and Transformation (IPT), which implements variability testing for highly-configurable software systems. This tool is in the process of
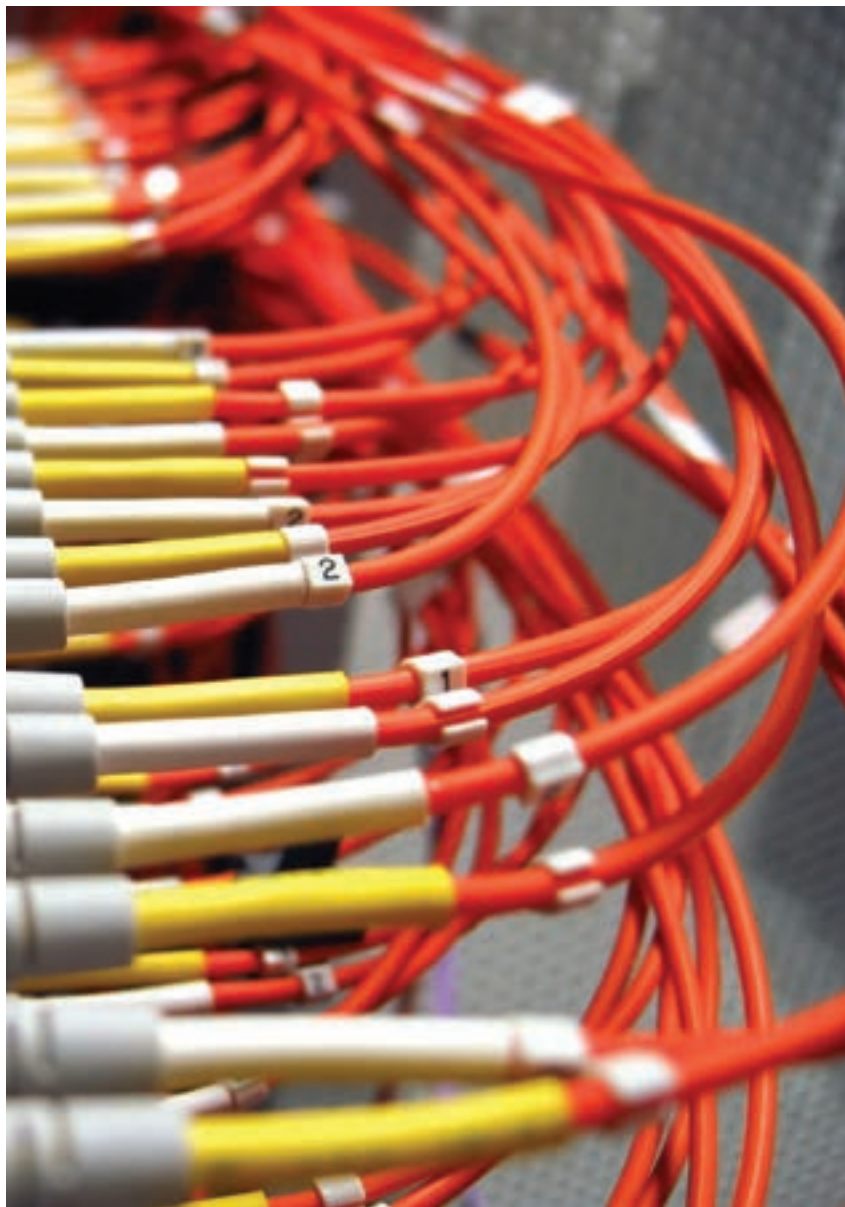
Courtesy of Shutterstock

transferring to Cisco.

The method designed in the second activity significantly reduces the amount of effort used to develop models required for automated testing. Experiments reveal that the modelling solution provides more complete and less redundant modelling, as compared to existing solutions. It also significantly reduces the chance of modelling errors.

VARIABILITY TESTING
is a software testing technique aiming at generating test configurations for systems that can be configured in many different ways.

From research to industry innovations

The Certus Centre uses the knowledge gained in the scientific projects to address its partners' everyday problems. Since its creation, Certus has developed a long-term innovation strategy, which identifies potential technologies for exploitation by the centre's user partners.

This exploitation strategy ensures that the centre´s research activities are eventually put to industrial use; going from theoretical and basic research to innovations in industry is no easy process. There are several criteria to achieving successful industrial exploitation, such as:

- Ensuring that the goals of exploitation activities are clearly defined
- Tailoring specific research and development activities to reach these goals
- Having a mutual understanding of the partners' competences and needs
- Evaluating exploitation potential throughout the process
- Developing a clear relationship between the involved parties

ACTIVITIES

The work on the exploitation strategy was a recurring theme at Certus in 2012. Achieving industrial adoption of research results is only possible with realistic expectations for what level of exploitation that is possible. This is an on going process that will continue to be high on the Centre´s agenda. Three exploitation case studies, from Certus user partners, were conducted to assess the exploitation potential of various software prototype tools. The experience gained from these case studies revealed different aspects of the process, such as the necessary early adoption of the proposed innovative technologies by the user partners and showed how important it is to carefully plan the centre's exploitation strategy.

RESULTS

In 2012, Certus focussed on the exploitation of three technologies, namely **DART**, **VERDE** and **TRUST**.

DART is a regression testing tool for DBMS, designed by researchers at the Norwegian Tax department, who use it on a daily basis. In 2012, Esito developed a version of **DART**, as part of a model-based development tool, to be exploited by Customs. Simula's researchers designed **VERDE** and **TRUST**, two model-based testing technologies. Cisco and another industrial partner, in partnership with Simula, evaluated these technologies through large-scale industrial case studies.

In 2012, Certus conducted a thorough analysis of Intellectual Property Rights of these technologies to prepare their exploitation. The **DART**, **VERDE** and **TRUST** case studies revealed opportunities for, and threats to, successful transfer, which can be used to build up a long-term innovation strategy and exploitation policies.

THE INNOVATION AND VALUE CREATION GOALS OF THE CERTUS CENTRE INCLUDE:

- The user partners will reduce their V&V costs by at least 20 %

- The user partners will be able to achieve a sufficient level of confidence in the dependability of their software-based systems

- The user partners will improve the estimation accuracy of their V&V activities by at least 20 %

- User partners and spin-off companies will implement and commercialize the research results through marketable tools and services

International cooperation and standardisation effort

Certus prioritises an international approach in order to recruit the best researchers, promote the centre's activities and have access to the latest research results.

In 2012, Certus established and strengthened global scientific partnerships with leading software engineering groups, including:

BEIJING UNIVERSITY OF AERONAUTICS AND ASTRONAUTICS (BUAA) is a major public research university, with a heavy focus on high level technological and scientific research. BUAA is one of China's leading universities and has a great influence on China's aeronautical and astronautical industry. Certus works together with BUAA on model-based development and testing.

THE UNIVERSITY OF LUXEMBOURG is a research-oriented university with Security, Reliability and Trust in Information Technology as one of its main strategic priorities. The Interdisciplinary Centre for Security, Reliability and Trust (SnT) spearheads this work effort. SnT collaborates with Certus on stress testing of real-time systems and model-based configuration.

THE NATIONAL INSTITUTE FOR RESEARCH IN COMPUTER SCIENCE AND CONTROL (INRIA) is a French national research institution focusing on computer science, control theory and applied mathematics. As one of the leading institutions in its field INRIA has created a number of widely used programs. Researchers from INRIA collaborate with Certus on on generating test configurations and certifying tax computations.

THE UNIVERSITY OF PARMA (UNIPR) is one of the oldest universities in the world, founded in the 11th century. The university´s continuous effort to renew itself has turned it into a reserach-intensive university. UNIPR works together with Certus on generating automatic test data for embedded systems.

Certus researchers have played an integral role in organising and running software engineering conferences around the world. This is done through programme chairing, participating in program committees and other taking on other leading positions in the organisation of conferences.

Certus is actively engaged in a number of international standards that are relevant to its partners. In particular, it has provided significant input to the latest revision of the widely used Unified Modeling Language (UML) standard (version 2.5) issued by the Object Management Group (OMG). In addition, Certus representatives are playing leadership roles in several other OMG standards associated with model-based engineering, such as the MARTE profile for real-time and embedded systems and the upcoming new issue of the OMG testing standard.

Demanding tasks require excellent staff

The Certus Centre is composed of a team of highly skilled researchers, who work closely with engineers employed by the centre's partners.

In 2012, Certus recruited an expert research scientist in variability testing of data-intensive systems to strengthen its expertise in this field. As part of the centre's strategy to support innovation, a senior research engineer also joined the team in 2012. The engineer's role is to improve the centre's ability to exploit the technology it develops. By combining international research experience and specialist knowledge, with the enthusiasm of PhD students, the centre has created a strong team, which is dedicated to excellence in research and innovation.

GENDER DISTRIBUTION

Simula is committed to recruiting females into software engineering. Certus funds two PhD-students, one male and one female. Considering only 15 per cent of MSc-level software engineering graduates (prerequisite for PhD study) are women, recruitment is a challenge. Through systematic work Certus has succeeded in achieving a gender balance. There are currently seven full-time scientists working in Certus. Of these, three are female and four are male. The Certus Board has a 50-50 gender distribution.

Certus attracts the best research minds from around the world.

Personnel in 2012

Certus Leader
Arnaud Gotlieb . . . . Took over in February 2012
Lionel Briand . . . . Until January 2012

Administrative Manager
Stein Erlend Arge

In February 2012 Arnaud Gotlieb
took over as Certus Centre leader.

Key Researchers
Arnaud Gotlieb
Tao Yue
Sagar Sen . . . . Started September 2012
Andrea Arcuri . . . . Started June 2012 (20 %)
Lionel Briand . . . . Until December 2012 (20 %)
Mehrdad Sabetzadeh . . . . Until August 2012
Richard Torkar . . . . Until Febuary 2012
Shiva Nejati . . . . Until August 2012

Postdoctoral researchers with financial support from the SFI budget
Marijan Dusica
Shaukat Ali

Postdoctoral researchers working on projects in the SFI with financial support from other sources
Jose Gonzales
Razieh Behjati . . . . Started May 2012

PhD students with financial support from the SFI budget
Shokoofeh Hesari
Shuai Wang

PhD students working on projects in the SFI with financial support from other sources
Erik Rogstad
Stefano Di Alesio
Sunil Nair Mohan
Razieh Behjati . . . . Finished May 2012
Muhammad Zohaib Iqbal . . . . Finished June 2012

Certus´ Administrative Manager
Erlend Arge strongly contributed to
the success of the centre in 2012.

Publications

PhD Thesis defended in 2012 in relation with Certus activities

Shaukat Ali on 20 Jan. "Scalable Model-based Robustness Testing: Novel Methodologies and Industrial Application";

Rajwinder Panesar Wallawege on 3 August "Using Model-Driven Engineering to Support the Certification of Safety-Critical Systems" ;

Muhammad Zohaib Iqbal on 18 September "Environment Model-based System Testing of Real-Time Embedded Systems";

Nina Holt on 28 September "Empirical Evaluations on the Cost-Effectiveness of State-Based Testing: Industrial Case Studies and Extensible Tool";

Aiko Yamashita on 15 October "Assessing the Capability of Code Smells to Support Software Maintainability Assessments: Empirical Inquiry and Methodological Approach";

Razieh Behjati on 9 November "A Model-Based Approach to the Software Configuration of Integrated Control Systems";

Articles in peer-reviewed journals

A. Arcuri and L. Briand. Formal Analysis of the Probability of Interaction Fault Detection Using Random Testing. IEEE Transactions on Software Engineering (TSE), vol.38, N°5, Sep.-Oct., pp 1088-1099, 2012.

N. Lazaar, A. Gotlieb, and Y. Lebbah. A CP Framework For Testing CP, Constraints Journal, 17(2):123-147, 2012.

A. Arcuri, Z. Iqbal and L. Briand. Random Testing: Theoretical Results and Practical Implications. IEEE Transactions on Software Engineering (TSE), 38(2), Mar.-Apr., pp.258 - 277, 2012.

S. Ali, T. Yue, and L. Briand. Modeling Robustness Behavior Using Aspect-Oriented Modeling to Support Robustness Testing of Industrial Systems, Springer Software and Systems Modeling (SoSyM), 11(4), Oct., pp 633-670, 2012

A. Gotlieb. Tcas software verification using constraint programming, The Knowledge Engineering Review 27(3), 2012.

A. Arcuri: A Theoretical and Empirical Analysis of the Role of Test Sequence Length in Software Testing for Structural Coverage. IEEE Trans. Software Eng. 38(3): 497-519, 2012

D. Falessi, M. Sabetzadeh, L. C. Briand, E. Turella, T. Coq, R. Kaur Panesar-Walawege: Planning for Safety Standards Compliance: A Model-Based Tool-Supported Approach. IEEE Software 29(3): 64-70, 2012.

Shiva Nejati, Mehrdad Sabetzadeh, Davide Falessi, Lionel C. Briand, Thierry Coq: A SysML-based approach to traceability management and design slicing in support of safety certification: Framework, tool support, and case studies. Information & Software Technology (IST), 54(6): 569-590, 2012.

S. Nejati, M. Sabetzadeh, M. Chechik, S. Easterbrook, and P. Zave. Matching and Merging of Variant Feature Specifications, IEEE Transactions on Software Engineering (TSE), 38(6), Nov.-Dec., pp. 1355 - 1375, 2012.

J. Al Dallal and L. Briand. A Precise Method-Method Interaction-Based Cohesion Metric for Object-Oriented Classes, ACM Transactions on Software Engineering and Methodology (TOSEM) 21(2), 2012.

M. Shousha, L. Briand, and Y. Labiche. UML/MARTE Model Analysis Method for Uncovering Scenarios Leading to Starvation and Deadlocks in Concurrent Systems, IEEE Transactions on Software Engineering (TSE), 38(2), Mar.-Apr., pp. 354 - 374 , 2012.

Articles in proceedings of peer-reviewed international conferences

S. Bardin and A. Gotlieb. FDCC: A combined approach for solving constraints over Finite Domains and Arrays, In: Proceedings of Constraint Programming-Artificial Intelligence-Operations Research (CPAIOR'12), May, 2012, Nantes, France.

M. Carlier, C. Dubois, and A. Gotlieb. A first step in the design of a formally verified constraint-based testing tool: FocalTest, In: Proceedings of the Tests And Proofs Conference (TAP'2012), Mar., 2012, Prague, Czech Republic.

M. Delahaye, L. Briand, A. Gotlieb, M. Petit. µTIL: Mutation-based Statistical Test Inputs Generation for Automatic Fault Localization, In Proceedings of the 6th Int. Conference on Software Security and Reliability (SERE'12), Jun. 2012, Washington, USA.

S. Ali and T. Yue. Studying the Understandability of Aspect State Machines through the Weaving Activity, In Proceedings of the 19th Asia-Pacific Software Engineering Conference (APSEC'12), ed. by Karl Leung and Pornsiri Muenchaisri, 2012.

M. Z. Iqbal, S. Ali, T. Yue, and L. Briand. Experiences of Applying UML/MARTE on Three Industrial Projects, in ACM/IEEE 15th International Conference on Model Driven Engineering Languages & Systems (MODELS'12), Sept.-Oct., 2012,Innsbruck, Austria

R. Behjati, T. Yue, and L. Briand. A Modeling Approach to Support the Similarity-Based Reuse of Configuration Data, in ACM/IEEE 15th International Conference on Model Driven Engineering Languages & Systems (MODELS'12), Sept.-Oct., 2012,Innsbruck, Austria

S. Ali, T. Yue, and L. Briand. A Product Line Modeling and Configuration Methodology to Support Model-based Testing: An Industrial Case Study, in ACM/IEEE 15th International Conference on Model Driven Engineering Languages & Systems (MODELS'12), Sept.-Oct., 2012,Innsbruck, Austria

R. Behjati, S. Nejati, T. Yue, A. Gotlieb, and L. Briand. Model-based Automated and Guided Configuration of Embedded Software Systems, in 8th European Conference on Modelling Foundations and Applications (ECMFA'12), Jul., 2012, Technical University of Denmark, Kgs. Lyngby, Denmark

T. Yue and S. Ali. Bridging the Gap between Requirements and Aspect State Machines to Support Non-Functional Testing: Industrial Case Studies, in 8th European Conference on Modelling Foundations and Applications (ECMFA'12), Jul., 2012, Technical University of Denmark, Kgs. Lyngby, Denmark

L. Briand, D. Falessi, S. Nejati, M. Sabetzadeh, T. Yue, Research-Based Innovation: A Tale of Three Projects in Model-Driven Engineering, in ACM/IEEE 15th International Conference on Model Driven Engineering Languages & Systems (MODELS'12), Sept.-Oct., 2012,Innsbruck, Austria

S. Ali, T. Yue, Z. Malik, Comprehensively Evaluating Conformance Error Rates of Applying Aspect State Machines for Robustness Testing, In Proceedings of the 11th International Conference on Aspect-oriented Software Development, (AOSD'12), Mar. 25-30, 2012, Potsdam, Germany.

P. Scandurra, A. Arnoldi, T. Yue and M. Dolci, Functional Requirements Validation by Transforming Use Case Models into Abstract State Machines, In Proceedings the 27th ACM Symposium on Applied Computing (SAC), Mar., 2012, Riva del Garda (Trento), Italy.

M. Carlier, C. Dubois, and A. Gotlieb. A certified constraint solver over finite domains, In: Proceedings of Formal Methods (FM'12), Paris, Aug. 2012, 2012.

A. Hervieu, B. Baudry, and A. Gotlieb. Managing Execution Environment Variability during Software Testing: an industrial experience, In: Proceedings of the 24th IFIP Int. Conference on Testing Software and Systems (ICTSS'12), ed. by Springer Verlag, LNCS, 2012.

Muhammad Zohaib Z. Iqbal, Andrea Arcuri, Lionel C. Briand: Empirical investigation of search algorithms for environment model-based testing of real-time embedded software. In Proceedings of International Symposium on Software Testing and Analysis (ISSTA'12), Jul. 2012, pp.- 199-209, Minneapolis, USA

G. Mussbacher, W. Al Abed, O. Alam, S. Ali, A. Beugnard et al. Comparing six modeling approaches, In Models in Software Engineering, LNCS 7167, pp.- 217-243, 2012.

A.M. Vasconcelos, J.L. de la Vara, J. Sánchez, and O. Pastor. Towards CMMI-Compliant Business Process-Driven Requirements Engineering, In Proceedings of the 8th International Conference on the Quality of Information and Communications Technology (QUATIC 2012), Sep. 2012, Lisboa, Portugal, IEEE

Jean-Marie Mottu, Sagar Sen, Massimo Tisi, Jordi Cabot: Static Analysis of Model Transformations for Effective Test Generation. International Symposium on Software Reliability Engineering (ISSRE'12), Nov. 2012, pp.-291-300, Dallas, Texas

Gordon Fraser, Andrea Arcuri: Sound empirical evidence in software testing. In Proceedings of International Conference on Software Engineering (ICSE'12), Jun 2012, pp.- 178-188, Zurich, Switzerland.

Gordon Fraser, Andrea Arcuri: The Seed is Strong: Seeding Strategies in Search-Based Software Testing. In Proceedings of International Conference on Software Testing (ICST 2012), Apr. 2012,pp.- 121-130, Montreal, Canada.

Muhammad Zohaib Z. Iqbal, Andrea Arcuri, Lionel C. Briand: Combining Search-Based and Adaptive Random Testing Strategies for Environment Model-Based Testing of Real-Time Embedded Systems. In Proceedings of 4th Symposium on Search Based Software Engineering (SSBSE'12), Sep. 2012, pp.- 136-151, Trento, Italy.

Shiva Nejati, Stefano Di Alesio, Mehrdad Sabetzadeh, Lionel C. Briand: Modeling and Analysis of CPU Usage in Safety-Critical Embedded Systems to Support Stress Testing. ACM/IEEE 15th International Conference on Model Driven Engineering Languages & Systems (MODELS'12), Sept.-Oct. 2012, pp.- 759-775,Innsbruck, Austria

Nina Elisabeth Holt, Richard Torkar, Lionel C. Briand, Kai Hansen: State-Based Testing: Industrial Evaluation of the Cost-Effectiveness of Round-Trip Path and Sneak-Path Strategies. In Proceedings of International Symposium on Software Reliability Engineering (ISSRE'12), Nov. 2012, pp.- 321-330, Dallas, USA

Articles in peer-review international workshops

D. Marijan, A review of two experiences from applying model based testing in practice, In 23rd International Symposium on Software Reliability Engineering Workshops (ISSREW'12), Nov. 2012, pp. 231-236, Dallas, USA.

S. Di Alesio, A. Gotlieb, S. Nejati, and L. Briand. Testing Deadline Misses for Real-Time Systems Using Constraint Optimization Techniques, In: ICSTW Workshop on Constraints in Software Testing, Verification, and Analysis (CSTVA'12), Apr. 2012, 8 pages, Montreal, Canada.

A. Gotlieb, A. Hervieu, and B. Baudry. Minimum pairwise coverage using constraint programming techniques, In: ICSTW Workshop on Constraints in Software Testing, Verification, and Analysis (CSTVA'12), Apr, 2012, 2 pages, Montreal, Canada

S. Wang, A. Gotlieb, M. Liaaen, and L. Briand. Automatic selection of test execution plans from a Video Conferencing System Product Line, In VARiability for You (VARY'12), workshop of the MODELS Conference, Oct. 2012, Innsbruck, Austria.

J. L. de la Vara, S. Nair, E. Verhulst, J. Studzizba, P. Pepek, J. Lambourg, and M. Sabetzadeh. Towards a Model-Based Evolutionary Chain of Evidence for Compliance with Safety Standards, In the International Workshop on Next Generation of System Assurance Approaches for Safety-Critical Systems (SASSUR 2012), workshop of SAFECOMP'12, Sep. 2012, Magdeburg, Germany.

J. L. de la Vara, L. Hoyos, E. Collado, and M. Sabetzadeh. Towards Customer-Based Requirements Engineering Practices, In the 2nd IEEE International Workshop on Empirical Requirements Engineering (EmpiRE 2012) , Sep. 2012, Chicago, USA

N. Lazaar, N. Arribi, A. Gotlieb, and Y. Lebbah. Dfa-based formulation for constraint negation. In the 11th Int. Workshop on Constraint Modelling and Reformulation (ModRef'12), workshop of Int. Conf. on the Principles and Practice of Constraint Programming, Oct. 2012, Quebec City, Canada

G. Mussbacher, O. Alam, M. Alhaj, S. Ali et. al, Assessing Composition in Modeling Approaches. In the Comparing Modeling Approaches Workshop (CMA '12), workshop of MODELS, Oct. 2012, Innsbruck, Austria.