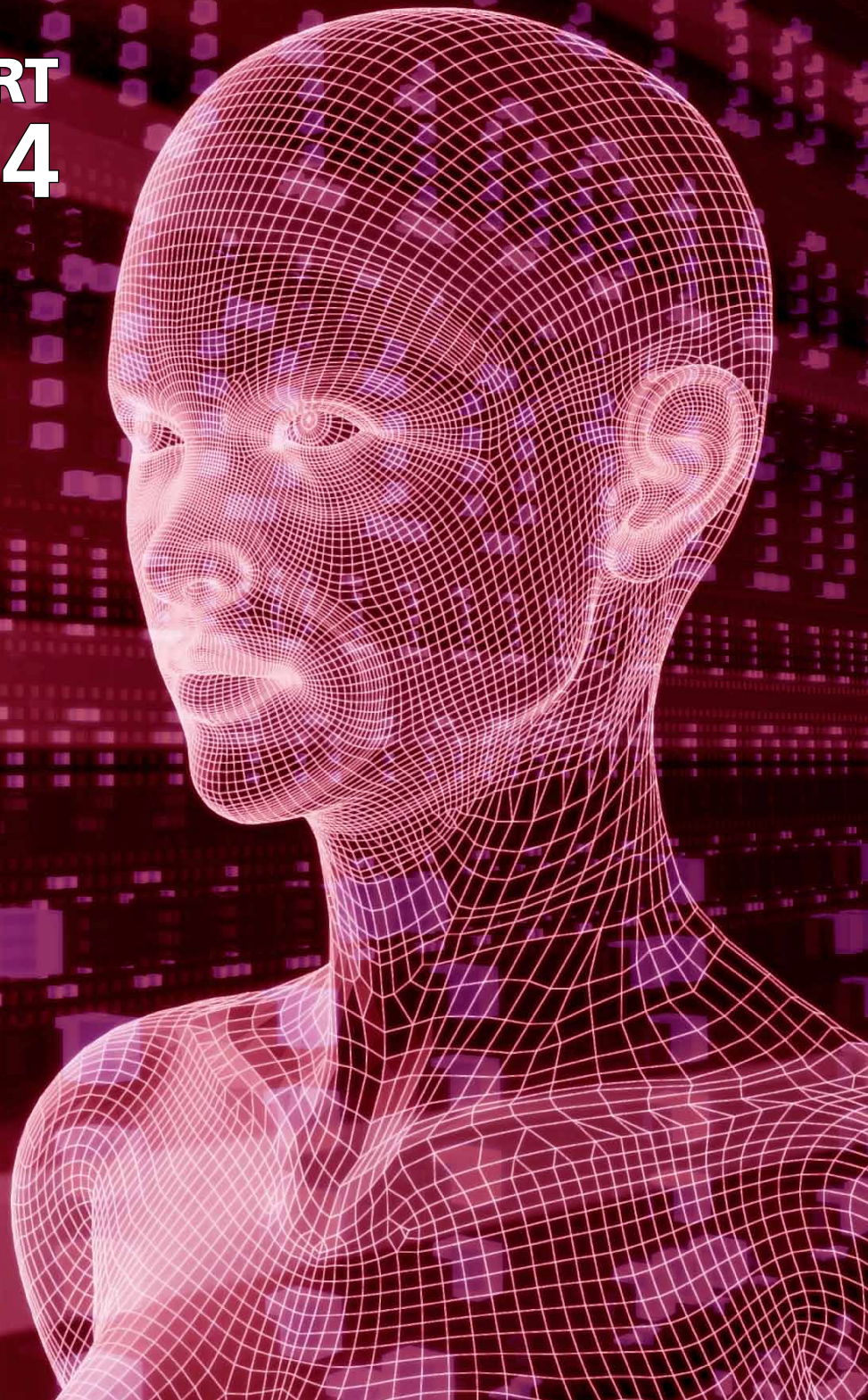# Fraunhofer

IESE

FRAUNHOFER INSTITUTE FOR EXPERIMENTAL SOFTWARE ENGINEERING IESE

ANNUAL REPORT
2013/2014

THE FRAUNHOFER INSTITUTE FOR EXPERIMENTAL SOFTWARE ENGINEERING IESE

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Software is a part of our lives. Embedded into everyday equipment, into living and working environments or modern means of transportation, countless processors and controllers make our lives simpler, safer, and more pleasant. We help organizations to develop software systems that are reliable in every aspect, and provide empirical proof of the necessary processes, methods, and techniques, emphasizing engineering-style principles such as measurability and transparency.

Fraunhofer IESE in Kaiserslautern is one of the worldwide leading research institutes in the area of software and systems engineering methods. A major portion of the products offered by its collaboration partners is defined by software. These products range from automotive and transportation systems via automation and plant engineering, information systems and health care to software systems for the public sector. The solutions allow flexible scaling. This makes the institute a competent technology partner for organizations of any size – from small companies to major corporations.

Under the leadership of Prof. Dieter Rombach and Prof. Peter Liggesmeyer, Fraunhofer IESE has spent the last fifteen years making major contributions to strengthening the emerging IT hub Kaiserslautern. In the Fraunhofer Information and Communication Technology Group, it is cooperating with other Fraunhofer institutes on developing trend-setting key technologies for the future.

Fraunhofer IESE is one of 60 institutes of the Fraunhofer-Gesellschaft. Together they have a major impact on shaping applied research in Europe and contribute to Germany's competitiveness in international markets.

EDITORIAL

Software Engineering & Big Data Analytics as Enablers of Innovations

Dear readers,

Software is increasingly used and perceived as an enabler of new, innovative services in all areas of business as well as in other sectors of society. If applied in the areas of mobility, energy supply, health care, production, or safety and security, such software must consistently comply with high quality standards. This can only be ensured if engineering-style development approaches are used.

New technological developments in the area of mobile communication as well as sensor technology have resulted in two different trends: On the one hand, we can observe a trend towards the integration of safety-critical embedded software and security-critical information systems into so-called Smart Ecosystems. On the other hand, a trend towards self-adaptation of software based on context recognition has evolved. These trends pose two fundamental new challenges for software engineering: the integration of safety and security on the one side, and the use of the potential of self-adaptation (so-called emergence) even for critical systems on the other side.

Fraunhofer IESE is a competent and reliable partner for businesses from all sectors of industry regarding the issue of "Software Engineering". We offer dependable methods and tools for the software development of embedded systems and information systems. In addition, the development of interconnected systems all the way to entire "Smart Ecosystems" as

well as process know-how for the successful adaptation and roll-out of such methods and tools in practice is another focus of Fraunhofer IESE. Furthermore, we support organizations with our interdisciplinary and cross-domain know-how when it comes to identifying new innovation ideas as well as the corresponding roadmaps (e.g., Fujitsu EST).

To stay ahead of the competition, you need innovative software and the leading software development expertise available in your domain. In an era where different system classes are interconnected, the challenges are becoming even greater, and dependable software requires professional development processes. Building on our competencies for smart ecosystems, including those for mobile devices, last year we focused on how to make more efficient use of Big Data. For example, we are supporting manufacturers of agricultural machinery (e.g., John Deere) in developing and testing integrated support for agricultural workflows through the use of different data sources and in evaluating the resulting added value.

In 2012, we drastically increased our preliminary research on the topic of "Smart Ecosystems" in the BMBF Software Cluster "Software Innovations for the Digital Enterprise". In 2013, we drove the development of methodologies for model-based safety development in the BMBF project SPES XT as well as in the EU project CRYSTAL. In 2014, a major focus of

our research will be on the smart usage of Big Data for Smart Ecosystems in the EU project RESCUER as well as in industry projects with various companies, including John Deere.

There is still much that remains to be done. Our focus lies on mastering the new challenges arising from the rapid techno-logical developments encountered today. We have many ideas for new projects with our collaboration partners and those wanting to cooperate with us in the future. Fraunhofer IESE enjoys global visibility. This is reflected in the rising number of international collaborations with partners from research and industry. In the USA, in Australia, and in Brazil we have already founded branches in recent years. You, too, can become a partner of Fraunhofer IESE! Make use of our competence and benefit from our international network. We will support you on your way towards more innovation and competitiveness through dependable software!

We hope you find this report both informative and inspiring –
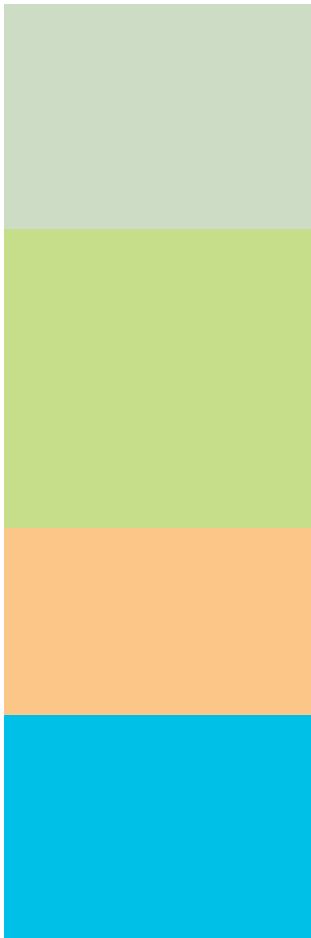

Dieter Rombach

Peter Liggesmeyer

Prof. Dr. Dieter Rombach

Prof. Dr. Peter Liggesmeyer

CONTENT

PROFILE OF FRAUNHOFER IESE

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HIGHLIGHTS OF THE YEAR 2013

Awards

With its numerous collaborations with small and medium-sized enterprises from the region, the Fraunhofer Center Kaiserslautern has been contributing to the stability of these enterprises on the global market as well as to their continual competitiveness. This commitment was rewarded with the 2013 Award for Start-Up Supporters presented by "KL gründet" ("KL Start-Ups"), a joint initiative by the political, business, and scientific communities in the Western Palatinate region. The award, which was given for the second time, represents a reward for individuals and institutions that have accompanied company founders on the path to independence and continue to advise them.

On 6 June 2013, Prof. Dieter Rombach celebrated his 60th birthday. Numerous leading personalities from science, business, and politics attended the official celebration in his honor on 7 June 2013 to pay tribute to his person, his achievements regarding progress in software engineering, and his great commitment to the interdisciplinary cooperation between business and science. On this occasion, Prof. Rombach was awarded the Fraunhofer Medal for his achievements in the Fraunhofer-Gesellschaft (Fig. 1). This medal, which has been awarded since the 200th birthday of Joseph von Fraunhofer, is given to individuals who have made special contributions to the Fraunhofer-Gesellschaft. Numerous internationally renowned software engineering experts met later that day for the scientific symposium "Perspectives on the Future of Software Engineering" held at the University of Kaiserslautern.

This year, another award went to the Fraunhofer IESE apprentice Thomas Schentarra. Every year, the Fraunhofer-Gesellschaft presents its best apprentices ("Azubis") with a certificate of honor as "Best Azubi of Fraunhofer" in the context of a ceremony (Fig. 2, center). His IESE instructor Markus Thum (left) also received a certificate of honor. Fraunhofer IESE itself was awarded the certificate "Distinguished Vocational Training Employer" by the Palatinate Chamber of Trade and Industry (IHK).

Distinguished Lecture Series

There was great response in 2013 to the "Distinguished Lecture" series held under the motto "Highlights and Trends in Software and Systems Engineering". In this series, Fraunhofer IESE and the University of Kaiserslautern are offering state-of-the-art knowledge from software and systems engineering research with internationally renowned lecturers from all around the world. The series started with Prof. Gordon Blair (Lancaster University, UK), followed by Prof. Manfred Broy (TU München) and then Prof. Lionel Briand (University of Luxembourg). The successful series will continue with three to four lectures throughout the year. For 2014, the following lecturers are planned: Prof. Jan Bosch (Chalmers University of Technology, Sweden), Prof. Neil Maiden (City University London), and Prof. John McDermid (University of York, UK).

President of the Gesellschaft für Informatik

The Gesellschaft für Informatik e.V. (GI; German Informatics Society) has elected Prof. Dr.-Ing. Peter Liggesmeyer, scientific director of the Fraunhofer Institute for Experimental Software Engineering IESE and professor at the University of Kaiserslautern, as its new president for the next two years. Having taken office on 1 January 2014, he is now heading the largest professional organization for computer science in the German-speaking world, with approximately 20,000 members.

Following his election, Liggesmeyer thanked the GI members for their trust in him and said that he was looking forward to this challenge. One of the primary goals of his presidency would be to increase the number of individual and corporate members of the GI and to offer them even more attractive services. Furthermore, he wants to increase public awareness of the GI and its presence in the media, and thereby further highlight the importance of computer science for all societal and technical issues. According to Liggesmeyer, contacts with related professional organizations and associations as well as with government and business should therefore be expanded.

Prof. Peter Liggesmeyer, born in 1963, holds the Chair for "Software Engineering: Dependability" at the Department of Computer Science of the University of Kaiserslautern and is scientific director of Fraunhofer IESE. His research interests are safety and dependability analysis techniques for embedded systems, software quality assurance, as well as diagnosis and visualization techniques. Prof. Liggesmeyer is the author of more than 100 professional papers and popular professional books, particularly the standard reference work "Software-Qualität" (2002, 2nd edition 2009). He has also been co-editor of "Informatik Forschung & Entwicklung" (Springer-Verlag), "information technology" (Oldenbourg-Verlag), and the GI edition "Lecture Notes in Informatics".

Safety through RESCUER

With the project RESCUER, Brazil commits itself to safety during the 2014 World Cup with a new communication platform intended to save lives. With the Soccer World Cup 2014 and the Olympic Summer Games 2016, Brazil will be hosting two major events. In addition to the infrastructure organization of such huge events, the safety of the visitors, in particular, is a central issue for the officials in charge, which is why the project "RESCUER" was initiated. With the help of intelligent information technology, an effective and efficient emergency and crisis management system shall be developed to ensure that the people visiting such major events will feel safe. The basis for this shall be mobile technologies, which almost everybody carries around with them these days in the form of smartphones or tablets. This is how the project leaders of RESCUER intend to support a "mobile crowdsourcing solution" with first responders and eyewitnesses at the place of an incident. In this case, "crowdsourcing" means that people voluntarily take over tasks and provide important information, with communication and coordination taking place primarily via the mobile Internet. By filtering, combining, and analyzing different pieces of crowdsourcing information, the emergency centers and emergency services can react better and faster to an emergency and make decisions that will save lives.

The project RESCUER is funded by the European Union and the Brazilian Ministry of Science, Technology and Innovation.

"Citizens Create Knowledge"

In 2013, the City of Kaiserslautern's initiative "Citizens Create Knowledge" called upon citizens to collect creative solution ideas for problematic issues in the city of Kaiserslautern. Over 60 proposals were submitted, and six of these topics were, resp. will be, pursued further.

One of these topics is how to improve traffic light control in Kaiserslautern by means of "intelligent traffic light systems". The coordination of this project lies with Fraunhofer IESE, which worked on this issue with the help of the Institute for Mobility and Traffic of the University of Kaiserslautern, the company Mobotix, and the German Research Center for Artificial Intelligence (DFKI) Kaiserslautern in collaboration with the City of Kaiserslautern. An intermediate result of this project was presented to the public in November.

Another presentation held in this series was about the project "parKLight App". This application shall make parking easier for the citizens. A prototype for Kaiserslautern could already be presented in October; the application possibilities can be transferred to other communities in Germany.

The idea series "Citizens Create Knowledge" was initiated by the City of Kaiserslautern to bring science and research in the city closer to its citizens. Ideas were to be submitted that would increase the quality of life in the city and for whose implementation the support of the research institutes is necessary. Three of the six best ideas were presented at the Fruchthalle on different evenings in 2013; the other three will be presented during the course of the year 2014. For this idea series, the City of Kaiserslautern received the award "City of Science 2013" in a national competition sponsored by the "Stifterverband für die Deutsche Wissenschaft", the business community's innovation agency for the German science system.

Visit of the Minister President

During a visit to the Fraunhofer Center, the Minister President of the state of Rhineland-Palatinate, Malu Dreyer, was given detailed information about current research topics and flagship projects of Fraunhofer IESE. In the contest of her visit to Kaiserslautern on Wednesday, 07 August 2013, Minister President Malu Dreyer also paid a visit to Fraunhofer IESE. She was delighted to learn that the city of Kaiserslautern has successfully evolved into a flourishing technology hub. Particularly small and medium-sized enterprises (SMEs) are nowadays increasingly faced with the challenge of having to keep pace with globalizing markets. New ideas are demanded ever more frequently, in ever shorter cycles. Direct access to state-of-the-art research results and product innovations is therefore absolutely crucial.

Support in this area of software engineering is provided by the successful collaboration model of the "Joint Research & Development Lab". Fraunhofer IESE also addresses important social issues, such as health and energy. Good examples of the successful collaboration between research and practice included, among others, the presentation of the "Central Statewide Treatment Capacity Indicator for Rhineland-Palatinate" (ZLB) and of the project "SUSI TD". Regarding the topic of energy supply, renewable energies are becoming ever more important. It can already be seen today that the energy turnaround will result in massive restructuring of the energy business, and that structural measures and smart energy management will be needed. Software, in particular, will play a central role in this area.

The Minister President was deeply impressed by the progress made in the research projects as well as by the wide range of topics covered by Fraunhofer IESE.

Supporting Young Talents

Kaiserslautern has evolved into an internationally renowned center for academia, research, and development in the area of information technology. The recognition that the city has long since become one of the main computer science hubs in Germany was underlined by the fact that the final round of the "31st National Computer Science Competition" for high school students took place here in September 2013. Following an exciting and eventful final round, Germany's five greatest computer science talents received their awards as the national winners of the National Computer Science Competition. The ceremony at the Fraunhofer Center in Kaiserslautern was attended by national, regional, and city representatives as well as by the winners' teachers and parents (Fig. 1). One talent from the Palatinate even won twice. The final round was organized by the German Research Center for Artificial Intelligence (DFKI), Fraunhofer IESE, the Max Planck Institute for Software Systems, and the Department of Computer Science of the University of Kaiserslautern.

Presenting computer science as the career field of the future was the intention of the high school student contest "IT'sAPP2you". Without IT, there would neither be smartphones nor any of the useful and highly popular apps. Under the motto "IT's APP2you", creative and inventive high school students in grades 9 to 13 were asked to collaborate with IT professionals to develop their own apps. The contest was coordinated by Fraunhofer IESE and was held under the patronage of Doris Ahnen, Minister of Education, Science, Continuing Education and Culture in Rhineland-Palatinate, whose ministry also funded the contest. Further support was provided by the universities and institutes of higher education in the state. The participating teams were invited to attend a "Spring Camp", where their app ideas were further developed. In June, a jury of experts selected the winning apps (Fig. 2), which then received awards at a big final party. The main prize was a visit to the European Engineering Headquarters of Google in Zurich, Switzerland (Fig. 3).

New Invention Patented

A new procedure patented jointly by Fraunhofer IESE and the University of Kaiserslautern contributes to the enhancement of technical communication in safety-critical applications. The highly technical living environment surrounding us nowadays is increasingly dependent on the interaction between different scientific application domains. Such complex cooperation requires optimal communication channels to ensure the functionality and safety of these systems.

The new procedure allows safe conversion of this mapping under exceptional circumstances. If a communication bus fails, another one can be converted from its normal operating mode to an emergency operating mode within predefined time constraints. This allows important communication channels to remain open. This is particularly relevant with regard to steer-by-wire and brake-by-wire systems, as in these technologies, no hydraulic connection exists anymore between the driver and the brakes, resp. the steering axles, and any communication failure would be catastrophic.

This invention demonstrates the efficient collaboration between universities and Fraunhofer, as promoted in the context of the Innovation Center for Applied System Modeling in Kaiserslautern. This collaboration enables efficient, interdisciplinary knowledge exchange, which reduces time to market for research results and makes these available faster to the public, as the successful patenting of this application shows.

Name of Patent: "Time- and Priority-controlled Sender-/ Receiver Node"
Patent Number: DE 102010039488 B4
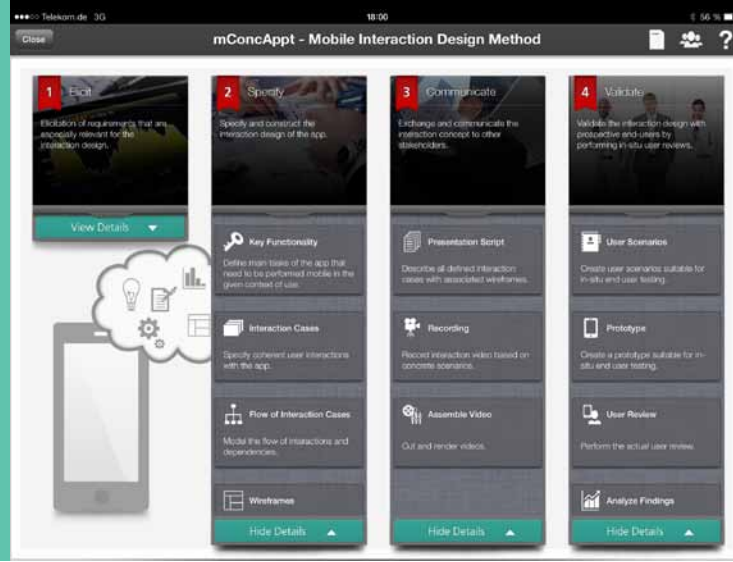
RE-Kompass

Has Requirements Engineering (RE) become an integral part of processes in business and industry? What is the value of RE in light of modern agile processes? In which areas is action still required?

These and similar issues were investigated by Fraunhofer IESE in cooperation with HOOD GmbH, Oberhaching, in the study "RE-Kompass", which was performed in early summer 2013. In an environment that is characterized by plurality of methods on the one hand and fixed concepts and processes on the other hand, the exact coordinates for individually navigating one's own way are often missing. The lessons learned from the RE-Kompass study shall help the community to recognize trends early on, to counteract wrong developments, and to react more flexibly to events. A total of 303 persons from a wide range of domains took part in the survey. 218 participants answered the complete catalog of questions.

The core results of the study demonstrate that Requirements Engineering is noticeably gaining importance. Particularly in the classical IT/software domain, in vehicle manufacturing, as well as in banks and insurance companies, there is a lot of interest regarding professional requirements elicitation, analysis, specification, and evaluation. The participants in the study primarily confirm improvements in product quality and in communication, both with external stakeholders such as customers and within their own organization. Still, what comes as a surprise is this: Even though RE is often motivated via cost explosions and schedule overruns, success features like lower development costs, faster time to market, and customer satisfaction are perceived as such by less than one third of the organizations surveyed.

IESE APP

Mobile applications have conquered the consumer market and have entered our daily lives. In the business environment, too, the potential of mobile business apps is used frequently. The development of such mobile business apps presents special challenges, such as the demand for high usability and user experience, short times to market, a clearly defined functional scope, integration into the existing IT infrastructure, and consideration of various devices and device platforms. Fraunhofer IESE has developed an iPad app that offers an attractive way to explore software engineering methods. The "mConcAppt" method, for example, explains the early phases of the construction of mobile business apps step by step. The Fraunhofer IESE "Engineering Software App" is available online in the Apple App Store.
Also see our Research Area "Mobile Software Engineering", page 18.

Market Analysis of BPM Suites

Together with the SP Consulting GmbH from Ludwigshafen, Fraunhofer IESE conducted a market analysis on the topic of "BPM SUITES". The results were presented in the context of a final event that took place at the Fraunhofer Center in Kaiserslautern on 10 December 2013.

The development of Business Process Management (BPM) has made rapid progress in the past five years. Particularly in the light of process automation, more and more companies are using corresponding tools – the BPM Suites. As numerous companies have been complaining about the lack of a qualitative market overview of BPM Suites, Fraunhofer IESE performed a market analysis in collaboration with the SP Consulting GmbH.

What do users have to take into account if they want to benefit from the advantages of BPM? What is new? What is the state of the practice? What do these programs offer? These and other questions were answered in detail in this study.

A total of nine relevant BPM product manufacturers took part in the study. Unlike some studies performed by other institutions in the past, this study was about "BPM Suites in use". Not only was the mere existence of features checked, but primarily non-functional aspects such as simplicity, modifiability, integratability, and usability were assessed in the context of everyday use.

In summary, the conclusion drawn from the results of the study is that currently neither a perfect nor a really bad BPM Suite can be found among the products investigated in the study. In general, it can be stated that process modeling, process implementation, and the integration of systems are implemented well, resp. very well, in all of the products included in the study. However, among all suppliers, improvement potential still exists in the areas of runtime management and process controlling.

Due to these results, a general recommendation for a particular BPM Suite makes no sense, nor is it objectively possible to make such a recommendation. However, since the products considered differ widely with regard to their strengths, weaknesses, target groups, and philosophies, a rough selection recommendation can already be derived on this basis.

Since small and medium-sized enterprises shall also benefit from the lessons learned in this study, which is being distributed in the context of the Transfer Agency for the Rhineland-Palatinate Software Cluster (TSC RLP), the study can be downloaded free of charge from the website of Fraunhofer IESE.

RESEARCH AREAS 2014

"SMART ECOSYSTEMS"

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In many organizations, software has already become the crucial driver for product and process innovations today. In the future, USPs and competitive advantages over business rivals will be increasingly generated from the interconnection of a company's own products with other systems.

The interconnection of software systems is an overarching trend that can be observed in many different application domains, for instance in the automotive industry (with Car-2-X communication), in production (with Industry 4.0 and the Smart Factory), in the energy industry (with Smart Energy), in medical technology (with Smart Health), or in agricultural technology (with Smart Farming). Increasing interconnection is a key factor for innovation and a major contributor to sustainable success.

Smart Ecosystems do not only integrate complex information systems and mobile applications, but also complex embedded systems. Business processes and technical processes are equally valuable and influence each other when it comes to achieving optimization from global perspectives.

The basis for the development of such systems is a paradigm shift: from monolithic single systems to open, interconnected, scalable, and service-oriented software ecosystems. In the future, software systems must be designed in such a way that cooperation with other systems that are totally unknown at development time is made possible. At the same time, high quality across systems must be ensured at all times from the beginning to the end of the system chain. To allow this to become a reality, the development organizations behind the systems must also change. Collaboration across organizational boundaries is therefore a key element for successful software development.

The physical world is becoming digital and smart; the Internets of Services, of Things, and of Data are merging with each other. The result is a unified whole, which dynamically uses context-dependent information to jointly accomplish superordinate goals (which no single system would be able to achieve on its own).

In the research area "Smart Ecosystems", we address the challenges that this entails for development organizations. We investigate methods and tools to support development organizations as a strategic partner. With reference architectures, sample solutions, technical proofs of concept, prototypes, or simulations, we help them to actually achieve their technical goals.

The topics we are working on in the research area "Smart Ecosystems" include, but are not limited to:

■ Smart ecosystem engineering method: The goal is to develop a software engineering methodology that covers all aspects of a smart ecosystem, including development, runtime, and operation.

■ End-2-end quality assurance: The quality of a single system and that of the smart ecosystem as a whole (i.e., the interaction between the single systems) must be ensured in order to guarantee smooth operation.

■ Scalable architectures: The backbone of smart ecosystems are scalable and open architectures of the single systems and of the dynamically changing ecosystem itself. Here, our focus is on the design and evolution of architectures.

■ Objective proofs: Recommendations for decisions and evaluations of properties must be underpinned by (empirical) data and / or analyses based on facts. To this end, existing methods and techniques are transferred and extended to Smart Ecosystems.

Smart Ecosystems:
Paradigm shift: from monolithic single systems to open, interconnected, scalable, and service-oriented software ecosystems

Competencies used in this Research Area:

"MOBILE SOFTWARE ENGINEERING"

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GoMobile

Further Information

Project Homepage
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Mobile business apps offer many opportunities for organizations that employ a mobile workforce and serve mobile customers. The workflows of mobile workers can be improved in terms of work efficiency and convenience. Both already existing and new, innovative services can be offered to mobile customers, resulting in higher revenues and more customer satisfaction. However, mobile business apps are more than mobile applications for managing personal information (such as email, calendar, etc. in mobile devices) or for using the Internet via a mobile browser.

Rather, these are custom-tailored solutions developed to support mobile workers in their particular workflows or tasks and mobile customers in the use of specific business services offered by an organization. For example: An airline may make mobile business apps available to its pilots or its cabin crews to support them during flight briefings or in providing inflight passenger services. It can also offer mobile business apps to its passengers, for example to enable them to book tickets from anywhere, or to check in without having to wait at the counter.

We are addressing challenges from a holistic perspective in the following sub-areas:

Mobile Quality Assurance

Mobile quality assurance focuses on the adaptation of existing and proven methods, tools, and techniques to the mobile context. Unlike classical quality assurance, there are often short release cycles and specific conditions in the mobile area (e.g., context dependencies, multitude of devices and platforms, scarce resources), which must be addressed in software engineering.

Mobile Requirements Engineering

Determining which apps are the right ones for your organization is another central issue. We are performing research into the evolution of our mPotential method for the systematic identification of those business processes where support with mobile apps makes sense. In addition, we are offering custom-tailored creativity workshops for innovative brainstorming. We are also working on a crowdsourcing solution for eliciting requirements via mobile devices.

Mobile Security

Particularly in the area of business software, data security is of central importance for mobile apps and devices. Here, our research centers especially on the area of data usage control, i.e., on implementing the best possible control over sensitive organizational data and user data. With the help of the IND^{2}UCE framework developed at Fraunhofer IESE, security policies are implemented when data are accessed via mobile devices.

Mobile Software Architecture

Our research focuses particularly on studying how non-functional requirements (e.g., performance, maintainability) can be supported by the architecture of the overall system in the best possible way. One of the subjects of our research in this area is how to design a sustainable architecture such that it can be extended as efficiently as possible – from the development of the first apps all the way to app ecosystems (systems consisting of apps from a wide variety of different providers, which access the same data and communicate with each other).

Mobile User Experience

The possibilities for designing a positive user experience in the business environment are far from being exhausted. Particularly in the case of mobile devices, the user interface is crucial for an app to set itself apart from its competitors. This must be systematically monitored and controlled using specially adapted user experience methods. The innovative design of user interfaces offering positive user experience for mobile apps is ensured by our customized methods.

Integration into Smart Ecosystems

Mobile software engineering is seen at Fraunhofer IESE as an interdisciplinary research trend combining, in particular, the challenges mentioned above and addressing them in the context of integration into Smart Ecosystems.

Example Projects:

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Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 67 institutes and research units. The majority of the more than 23,000 staff are qualified scientists and engineers, who work with an annual research budget of 2 billion euros. Of this sum, more than 1.7 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

Prof. Dr. Reimund Neugebauer
President of the Fraunhofer-Gesellschaft, Corporate Policy and Research Management

Prof. (Univ. Stellenbosch)
Dr. Alfred Gossner
Senior Vice President Finance, Controlling and Information Systems

Dr. Alexander Kurz
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The man behind the name:

Joseph von Fraunhofer

The Fraunhofer-Gesellschaft owes its name to Joseph von Fraunhofer (1787-1826), the successful Munich researcher, inventor and entrepreneur. Born of a family of modest means, the glass-grinding apprentice Joseph von Fraunhofer joined the institute for optics headed by privy councillor Joseph von Utzschneider, who put the young researcher in charge of glass manufacturing at the early age of 22. Joseph von Fraunhofer's major developments include new methods of glass production and processing.

The optical instruments he himself developed, such as the spectrometer and the diffraction grid, enabled Fraunhofer to conduct fundamental research in the fields of light and optics. He was the first scientist to measure the spectrum of sunlight and characterize the appearance of the dark absorption strips: the "Fraunhofer lines". His work as an autodidactic researcher earned him great respect in academia and government, leading to the former apprentice becoming a full-fledged member of the Bavarian Academy of Sciences and Humanities.

FRAUNHOFER IESE AND ITS NETWORK PARTNERS

International Research Networks

Fraunhofer IESE is a member of several international research associations. The International Software Engineering Research Network (ISERN) with approx. 50 members from science and industry plays an important role in Fraunhofer IESE's international research collaborations. ISERN is a forum for applied software engineering researchers for exchanging the latest research results and experiences.

Further Information:
http://isern.iese.de

ISERN
International Software Engineering Research Network
Quality Improvement

In addition, Fraunhofer IESE is affiliated with the Center for Empirically Based Software Engineering (CeBASE), a project of the National Science Foundation (NSF) in the United States.

Bilateral research and exchange programs for students and scientists exist with renowned institutions such as:

- Experimental Software Engineering Group at the University of Maryland, USA
- Center for Software Engineering at the University of Southern California, USA
- Universidade Federal da Bahia, Brazil
- Universidade Estadual da Paraíba, Campina Grande, Brazil
- Universidade de São Paulo, Brazil
- Carleton University, Toronto, Canada
- Clemson University, South Carolina, USA
- Kyungpook National University, South Korea
- National ICT Australia Ltd (NICTA), Sydney, Australia
- Bay Zoltan Foundation for Applied Research, Budapest, Hungary
- Poznań University of Technology, Poland

National Research Networks

The **Science Alliance Kaiserslautern e.V.** is a coalition of internationally renowned research facilities in Kaiserslautern. Together they form a highly specialized multidisciplinary network, which provides students, scientists, and cooperation partners from industry, business, and the public sector with innovative solutions based on the newest technologies and methods available.

Members of the Science Alliance are the University of Kaiserslautern, the University of Applied Sciences Kaiserslautern, and seven research institutes, some of which are spin-offs of successful research completed at the University of Kaiserslautern. The Commercial Vehicle Cluster GmbH and the Westpfalz-Klinikum are also part of the alliance. Their prolific work in the past years has added to the growing reputation of Kaiserslautern as a distinguished location for study, research, and technology.

Further Information:
www.science-alliance.de

SCIENCE ALLIANCE
KAISERSLAUTERN

SafeTRANS e.V. ("Safety in Transportation Systems") is a competence cluster combining research and development expertise in the area of complex embedded systems in transportation systems. SafeTRANS drives research in human-centered design, in system and software development methods for embedded systems, as well as in safety analysis and – for avionics and rail – its integration in certification processes, driven by a harmonized strategy addressing the needs of the transportation sector.

Further Information:
www.safetrans-de.org

SafeTRANS
SAFETY IN TRANSPORTATION SYSTEMS

The cluster **"Software Innovations for the Digital Enterprise"** (or **Software-Cluster** for short) focuses on the region around the software development centers Kaiserslautern, Darmstadt, Karlsruhe, Saarbrücken, and Walldorf. Its objective is to explore and develop the enterprise software of the future. This will enable companies that have only been using ICT as a tool to support their traditional processes to transform themselves into completely digital enterprises where ICT is the major driver for product and process innovations (also see page 72 for further details).

Further Information:
www.software-cluster.org

Engineering, Electrical Engineering and Computer Engineering, and Civil Engineering of the University of Kaiserslautern. The title of the Innovation Center reflects the strongly growing importance of mathematics and computer science in the engineering sciences, which increasingly base their innovations on software and information technology. Modeling, simulation, optimization, and their use in software and safety-relevant systems are indispensable components of quality assurance, prognosis, and decision-making support in product development and process optimization today - across domains.

Further Information:
www.applied-system-modeling.de

The **Transfer Agency for the Software-Cluster Rhineland-Palatinate (TSCrlp)** is responsible for facilitating technology transfer and communication between the Software-Cluster and small and medium-sized enterprises in Rhineland-Palatinate and for bringing their wishes and research needs to the Cluster. In addition, the Transfer Agency is dedicated to establishing regional networks.

Further Information:
www.tsc-rlp.de

The Kaiserslautern **Innovation Center Applied System Modeling for Computational Engineering (ASM4CE)** aims at promoting interdisciplinary and interinstitutional collaboration between the Fraunhofer Institute for Experimental Software Engineering IESE, the Fraunhofer Institute for Industrial Mathematics ITWM, and the Department of Materials Characterization and Testing of the Fraunhofer Institute for Physical Measurement Techniques IPM, as well as the Departments of Computer Science, Mathematics, Mechanical and Process

The **Fraunhofer Innovation Cluster Digital Commercial Vehicle Technology** with its focus on "Vehicle-Environment-Human-Interaction" is an R&D association of the two local Fraunhofer Institutes IESE and ITWM and industry partners from the domains trucks, busses, agricultural and construction machinery. It is part of the Commercial Vehicle Alliance Kaiserslautern, an expert network involved in technology transfer, research and teaching for the numerous commercial vehicle companies in the region. In the Commercial Vehicle Alliance, the Fraunhofer Institutes are cooperating with the Center for Commercial Vehicle Technology of the University of Kaiserslautern and the Commercial Vehicle Cluster Südwest.
In this innovation cluster, Fraunhofer IESE is studying future solution components for Smart Ecosystems and piloting these with the industry partners in application projects that live up to the special challenges of the domain in terms of reliability and productivity.

Further Information:
www.nutzfahrzeugcluster.de

**Software Technologie
Initiative Kaiserslautern e.V.**

Industrially-funded Collaborations

Fraunhofer IESE's industrial cooperation partners range from global players to small regional companies. They can be grouped into four categories:

- Large national and international organizations looking for support in their mid- to long-term strive for quality improvement in software development.
- Large national and international organizations with their own R&D department, who are looking for competent research partners.
- Medium-sized enterprises, who want to establish improvement programs or who must implement technology changes under very tight budget and schedule constraints.
- Small companies, who want to use proven technology that yields short-term return on investment.

Specialized Services for SMEs

The speed of modern innovations and the rapid changes of economic constraints place high demands on the management of IT companies. A company that wants to survive in the fierce competition is therefore well advised to continually improve both its own development processes and products and the qualification of its employees.

This is where the Software Technologie Initiative e. V. comes in. It offers all participants the opportunity to receive constant and first-hand information about current developments, trends, and background in the area of software engineering. Numerous events serve to acquire and consolidate applicable knowledge, while also offering the chance for people to get to know each other and to communicate with others. As a living network between research and practice, STI e. V. is the regional platform for direct, unfiltered exchange of knowledge, experience, and information in the area of software development.

Objectives:
- Promotion of software technology in small and medium-sized companies in the region
- Bundling of interests regarding the adaptation of research results in the area of software engineering
- Promotion of innovative software development approaches and their transfer into practice

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Thomas Jeswein

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IESE IN FRAUNHOFER GROUPS AND ALLIANCES

FRAUNHOFER INFORMATION AND COMMUNICATION TECHNOLOGY GROUP

Shorter innovation cycles have turned IT knowledge into a perishable commodity. The Fraunhofer Information and Communication Technology Group (ICT) provides support in the form of customized solutions, consulting, and contract research for new products and services. The Fraunhofer ICT Group comprises 19 institutes as full members (among them also Fraunhofer IESE), including three associated members, representing a workforce of roughly 5000 employees and a yearly budget of approximately 200 million euros. Its central office in Berlin serves as a one-stop shop, referring customers to the appropriate contacts.

The complementary focal fields of the participating institutes cover the entire value chain of the ICT industry. The business areas are:

- Digital Media
- E-Business
- E-Government
- Information and Communication Technologies
- Energy and Sustainability
- Medicine
- Production
- Security
- Financial Services
- Automotive

The alliance comprises the Fraunhofer Institutes for

- Algorithms and Scientific Computing SCAI
- Applied Information Technology FIT
- Applied and Integrated Security AISEC
- Industrial Engineering IAO
- Medical Image Computing MEVIS
- Digital Media Technology IDMT
- Experimental Software Engineering IESE
- Computer Graphics Research IGD
- Integrated Circuits IIS (associated member)
- Intelligent Analysis and Information Systems IAIS
- Communication, Information Processing and Ergonomics FKIE
- Telecommunications, Heinrich Hertz Institute, HHI (associated member)
- Open Communication Systems FOKUS
- Optronics, System Technologies and Image Exploitation IOSB
- Secure Information Technology SIT
- Software and Systems Engineering ISST
- Communication Systems ESK (associated member)
- Industrial Mathematics ITWM
- Transportation and Infrastructure Systems IVI

Chairman of the ICT Group

Prof. Dr. Matthias Jarke
Fraunhofer Institute for Applied
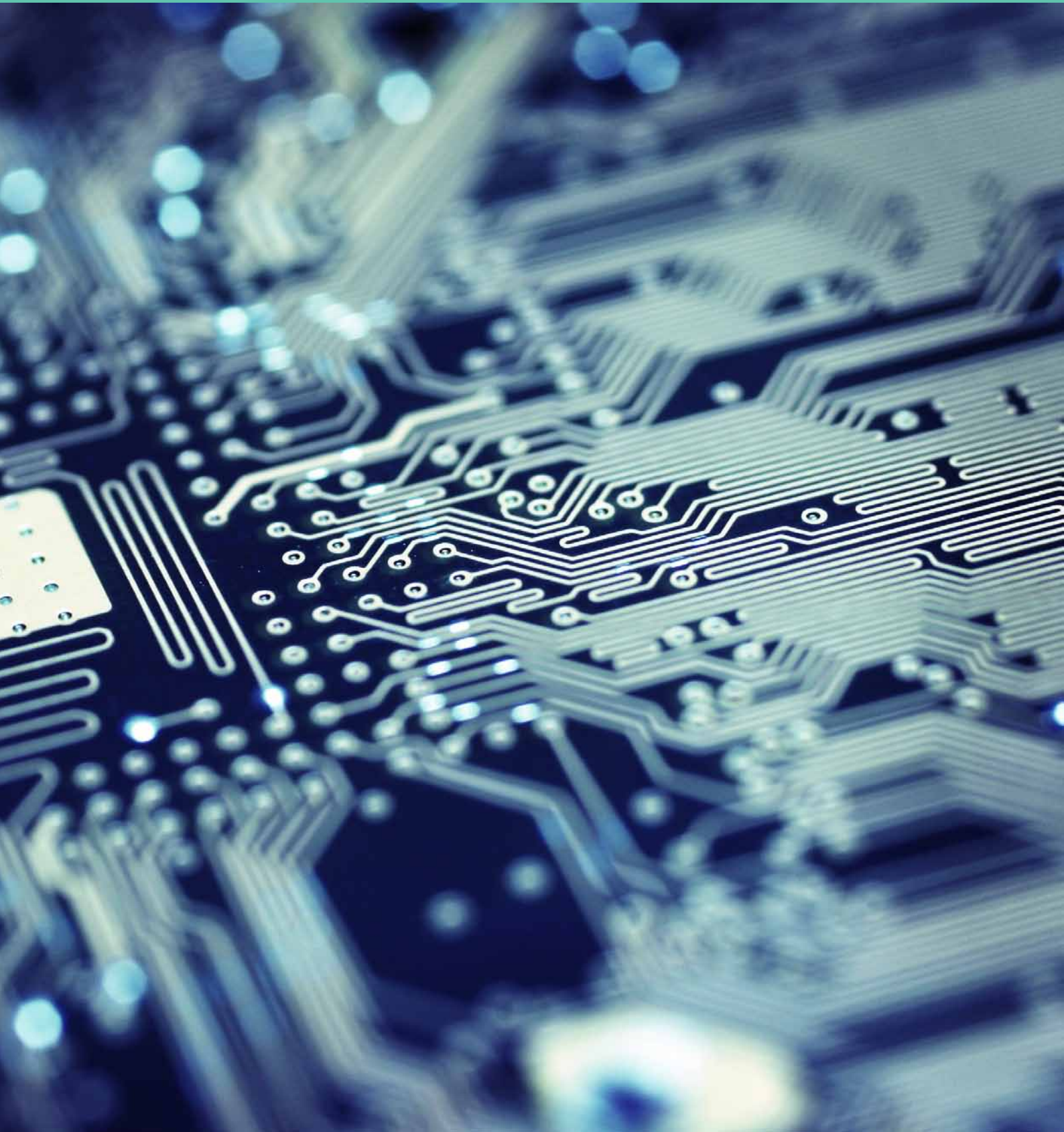Information Technology FIT

Contact at IESE

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Prof. Dieter Rombach

FRAUNHOFER ALLIANCE EMBEDDED SYSTEMS

Embedded systems constitute a central ingredient of technical products, e.g., in transportation, medical technology, automation technology, or in consumer electronics. In recent years, numerous product innovations and unique selling points of technical products "made in Germany" have been the result of integrating embedded systems. Especially in the area of high-tech, there is a strong dependency on embedded systems, which is why their economic significance is enormous. As a reaction to the growing requirements and the increasing complexity of embedded systems, the Fraunhofer ICT Group as the largest European research network for information and communication technology pushed the initiative for founding a Fraunhofer Alliance.

Isolated approaches quickly reach their limits when new systems are being developed. In addition to competence in the areas of information technology, electrical engineering, and mechanical engineering, interaction between these disciplines is an essential factor. The Fraunhofer institutes affiliated in the alliance have the necessary comprehensive expertise in practically all topics in the area of embedded systems. The Fraunhofer Alliance Embedded Systems bundles the respective required professional competencies and maps them to the areas of information technology, electrical engineering, and mechanical engineering. At the same time, the alliance acts as a central point of contact for partners from industry, research, government, and the media.

Due to its expertise in the area of embedded systems, Fraunhofer IESE in Kaiserslautern is predestined for a leading role in the alliance. For a long time, safety analyses, embedded systems certification, especially in critical application domains, as well as innovative development methods for embedded systems have been focal research areas of IESE.

The alliance comprises the Fraunhofer Institutes for
- Applied and Integrated Security AISEC
- Communication Systems ESK
- Applied Information Technology FIT
- Communication, Information Processing and Ergonomics FKIE
- Open Communication Systems FOKUS
- Telecommunications, Heinrich Hertz Institute, HHI
- Experimental Software Engineering IESE
- Factory Operation and Automation IFF
- Computer Graphics Research IGD
- Integrated Circuits IIS
- Optronics, System Technologies and Image Exploitation IOSB
- Production Technology IPT (Project Group Mechatronic Systems Design)

Spokesman of the Alliance

Prof. Dr. Rudi Knorr
Fraunhofer Institute for
Communication Systems ESK

Contact at IESE

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Prof. Peter Liggesmeyer

FRAUNHOFER AMBIENT ASSISTED LIVING ALLIANCE

The institutes of the Fraunhofer Alliance Ambient Assisted Living work together on developing holistic AAL and "personal health" system solutions for comfort, safety, and energy efficiency, for working and living, for health and social networking. The aim is to enable especially elderly or disabled persons or those requiring care to lead long, autonomous lives in their own homes.

The AAL environments being created for this purpose adapt to users' needs and goals unaided, in a proactive and situation-specific way. "Personal health" components for health-related applications in home or mobile environments allow person-centered, individualized forms of medical care.

The goal is a common system concept that integrates different technologies and applications into modular systems consisting of interoperable components. Accordingly, the AAL Alliance covers the entire value chain from the private user to the professional service provider. Accompanying activities of the AAL Alliance are going on in the areas of research coordination, business model development, and standardization.

The contribution of Fraunhofer IESE is mostly in the area of systematic development of software-intensive systems. For the context of AAL, this includes approaches to the systematic development of integrated AAL solutions with predictable quality, development approaches for adaptable and adaptive systems, system modeling, and analysis, e.g., regarding dependability and usability.

The alliance comprises the Fraunhofer Institutes for
- Applied Information Technology FIT
- Open Communication Systems FOKUS
- Computer Graphics Research IGD
- Digital Media Technology IDMT
- Experimental Software Engineering IESE
- Industrial Engineering IAO
- Integrated Circuits IIS
- Manufacturing Engineering and Automation IPA
- Microelectronic Circuits and Systems IMS
- Photonic Microsystems IPMS
- Reliability and Microintegration IZM
- Software and Systems Engineering ISST
- Telecommunications, Heinrich Hertz Institute HHI

Spokesman of the Alliance

Dr. Reiner Wichert
Fraunhofer Institute for Computer
Graphics Research IGD

Contact at IESE

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Dr. Thomas Kuhn

ORGANIZATIONAL STRUCTURE

Organizational Structure of the Fraunhofer Institute for Experimental Software Engineering IESE

Executive Director
Prof. Dr. D. Rombach

Scientific Director
Prof. Dr.-Ing. P. Liggesmeyer

Deputy Director
Prof. Dr. F. Bomarius

Business Areas

Automotive & Trans-portation Systems

R. Kalmar

Automation & Plant Engineering

Health Care

M. Ochs

Information Systems
Finance, ERP / Software, Telecommunication

eGovernment

Divisions

Embedded Systems (ES) Dr. Mario Trapp

Embedded Systems Development (ESY)
Dr. M. Becker

Embedded Software Development (ESW)
Dr. Th. Keuler

Embedded Systems Quality Assurance (ESQ)
S. Kemmann

Process Management (PM) Dr. J. Heidrich

Measurement, Prediction & Empiricism (MPE)
Dr. A. Jedlitschka

Process Compliance & Improvement (PCI)
R. van Lengen

Information Systems (IS) Dr. J. Dörr

Information Systems Development (ISD)
Dr. Marcus Trapp

Information Systems Quality Assurance (ISQ)
M. Eisenbarth

The Fraunhofer Institute for Experimental Software Engineering IESE

The Fraunhofer Institute for Experimental Software Engineering IESE performs application-oriented software engineering research and supports its customers with innovative constructive and analytical processes for the development of dependable software. These processes are successfully used in companies from all branches of industry to increase quality and decrease costs, thus adding business value. Currently, a large variety of collaborations exist with companies from the domains "Automotive and Transportation Systems", "Automation and Plant Engineering", and "Health Care" as well as from the IT and service industries "Financial Service Providers", "ERP and Software Producers", and "eGovernment". Fraunhofer IESE supports companies from all branches of industry in their efforts to achieve "innovation with dependable software""

Business Areas and Departments

The business areas of Fraunhofer IESE are found in industries where software is highly relevant in products and services and which are firmly rooted in Germany and Europe:

- Automotive and Transportation Systems
- Automation and Plant Engineering
- Health Care
- Information Systems, especially Financial Service Providers, ERP and Software Producers, Telecommunication
- eGovernment

These business areas are led by Business Area Managers who are responsible for customer business.

Fraunhofer IESE has organized its competencies into three divisions. Two divisions are home to the competencies for developing embedded systems with a focus on functional safety, reliability, and availability, and for developing information systems with a focus on usability and security.

- Embedded Systems division with the departments Embedded Systems Development, Embedded Software Development, and Embedded Systems Quality Assurance
- Information Systems division with the departments Information Systems Development and Information Systems Quality Assurance

In addition, the third division deals with the interdisciplinary competencies of measurement and process improvement:

- Process Management division with the departments Measurement, Prediction, and Empiricism; and Process Compliance and Improvement

These interdisciplinary competencies are necessary in order to firmly entrench processes for the development of embedded systems and information systems in an organization.

New competence areas are built up in so-called Living Labs, where research takes place concomitant with business model development. Examples of these areas are Smart Ecosystems or Energy Management.

Fraunhofer IESE receives guidance and counsel from an advisory board consisting of international experts from science and business. For many years, Fraunhofer IESE has been successful on the market. The level of acquisition of third-party funds is on a consistently high level, between 70 and 80%.

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Meeting of the Advisory Board on 7 November 2013

THE ADVISORY BOARD

The Advisory Board consists of representatives of research, industry, and government. The board members support the Institute Directors with advice and counsel.
(Chairman: Prof. Dr.-Ing. Heinrich Daembkes, Vice-Chairman: Prof. Dr. Jürgen Nehmer)

Research

Prof. Dr. Victor Basili
Institute for Advanced Computer Science
Department of Computer Science
University of Maryland
USA

Prof. Dr. Helmut Krcmar
Chair for Information Systems
Computer Science Department
Technische Universität München

Prof. Dr. John A. McDermid
Department of Computer Science
University of York
York
United Kingdom

Prof. Dr. Jürgen Nehmer
Vice-Chairman of the Advisory Board
Department of Computer Science
University of Kaiserslautern

Prof. Dr. Helmut Schmidt
President
University of Kaiserslautern

Industry

Dr. Reinhold E. Achatz
Head of Corporate Technology,
Innovation & Quality
ThyssenKrupp AG
Essen

Prof. Dr.-Ing. Heinrich Daembkes
Chairman of the Advisory Board
Vice-President
Executive Advisor Engineering
COE
CASSIDIAN - EADS Deutschland
GmbH
Ulm

Gerd Höfner
Managing Director and
Chief Executive Officer
Siemens Technology and
Services Pvt. Ltd.
Bangalore
India

Harald Hönninger
Head of Development
Research and Advance
Engineering
Robert-Bosch GmbH
Schwieberdingen

Dr. Nelson Mattos
Vice President
EMEA Product & Engineering
Google Switzerland GmbH
Zurich
Switzerland

Dr. Yuji Takada
CEO
Fujitsu Enabling Software Technology GmbH
Munich

Dr. Martin Verlage
Executive Director vwd group
Technology
vwd Vereinigte Wirtschafts-
dienste AG
Frankfurt

Government

Stefanie Nauel
Regierungsrätin
Ministry of Economic Affairs,
Climate Protection, Energy and
Regional Planning, *Land* Rhein-
land-Pfalz
Mainz

Dr. Carola Zimmermann
Ministry of Education, Science,
Continuing Education and Culture, *Land* Rheinland-Pfalz
Mainz

PERSONNEL AND BUDGET

Development of Budget (in T euro).

	2011	2012	Forecast 2013	Plan 2014
Total	10 361	11 352	11 795	13 576
Public Projects	47 %	42%	42 %	45 %
Industrial Projects	30 %	23 %	32%	35 %
Base Funding	23 %	35 %	26 %	20 %
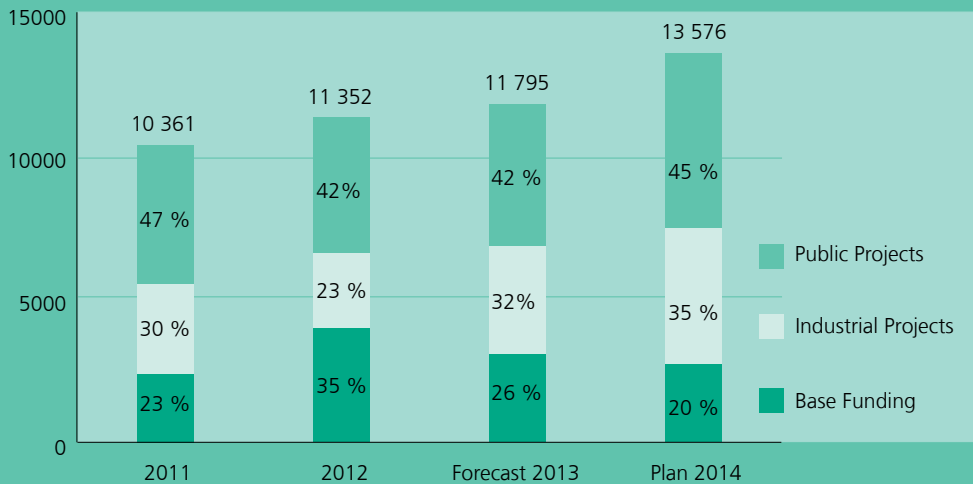
Development of Costs (in T euro).

	2011	2012	Forecast 2013	Plan 2014
Total	10 361	11 352	11 795	13 576
Operating Costs	26 %	29 %	28 %	30 %
Personnel Costs	74%	71 %	72 %	70 %
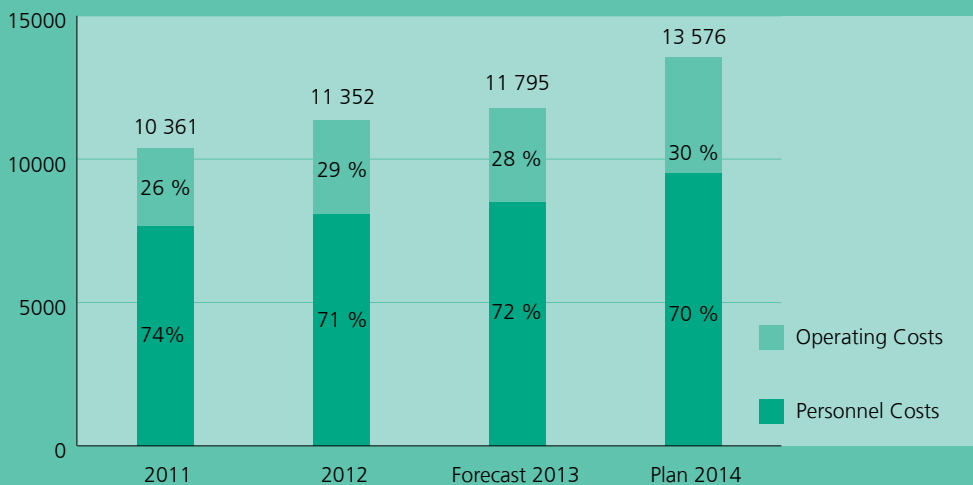
Development of IESE Personnel.

	2011	2012	2013	Plan 2014
Total	217	226	223	248
Students	62	71	66	80
Apprentices and Trainees	21	14	20	20
Guest Scientists	3	2	5	5
Scientists	101	107	101	110
Infrastructure	30	32	31	33
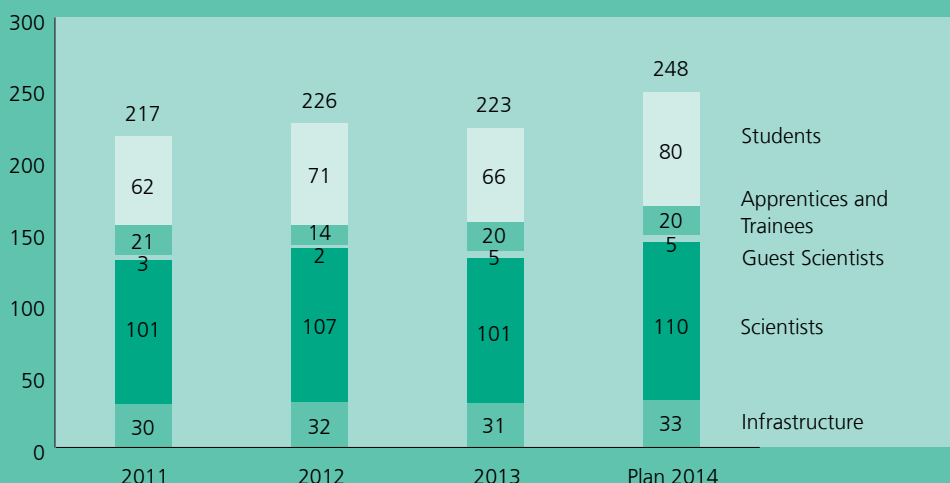
Staff and Budget Development

The year 2013 was characterized by significant investments into the equipment of the competence areas on the one hand and by staff transitions due to the institute's thematic adaptations on the other hand.

In 2014, we will continue to make significant investments into the establishment of innovative work areas and build up staff in strategic research topics. For these purposes, we also plan to use strategic funds.

The proportion of female employees rose from 27% to 30%.

BUSINESS AREAS

The successful implementation of research results in innovative products requires building a solid bridge between technology-oriented researchers and product-oriented companies. Bridging this gap in the best possible way is the task of the business areas of Fraunhofer IESE. Standards, financial constraints and time restrictions, number of items produced, and many other impact factors differentiate areas of application that at first glance appear similar to those not familiar with these topics. Automobiles, a mass product, are produced in much greater quantities than, for instance, airplanes – which are an investment asset. In both cases, we are dealing with transportation systems, but the differences between them have far-reaching consequences regarding the suitability of methods and techniques in software and systems engineering. Business area managers have the broad view necessary to assess research results in terms of their use in specific application areas and to combine them in the best possible ways. Fraunhofer IESE is currently setting its focus on business areas that are important for both technical and business application areas.

AUTOMOTIVE AND TRANSPORTATION SYSTEMS

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Example Projects:

Software Technology for a World in Motion

Modern vehicle assistance systems aimed at reducing consumption and increasing safety and comfort cannot be realized without electronics and software. In addition, future vehicles will be strongly interconnected with their environment and with other systems. This means great potential for smart interconnections between products/services and software. The business area "Automotive and Transportation Systems" bundles the offers of Fraunhofer IESE particularly for users and manufacturers in the areas of automotive and rail vehicle manufacturing, aerospace, as well as commercial vehicles of all kinds. The term automotive software engineering comprises processes, techniques, methods, and tools adapted specifically to the requirements of vehicle technology.

The services of Fraunhofer IESE address development activities throughout the entire lifecycle, starting from automobile-specific process models on the basis of established standards (ISO/IEC 12207, ISO 26262) and the use of maturity level models (ISO/IEC 15504, Automotive SPICE, CMMI). Product planning is supported through software product line engineering and architecture standards (keyword: AUTOSAR), which take into account possible variants as well as technology and market requirements.

Special tasks such as configuration of a tool chain, integration of security and safety, or assessment of software product qualities (ISO/IEC 25000) are issues solved by Fraunhofer IESE, as are evaluation of innovative technologies in prototypes or systematic technology transfer for individual process steps.

Customer Benefits:
■ Provable process and product qualities
■ Adherence to safety and quality requirements
■ Cost-efficient management of many product variants
■ Competitive development productivity

Competence in Software and Systems Engineering, Vertical Integration

Current and future systems are increasingly interconnected. The vertical integration from the IT system to the vehicle places high requirements on safety and reliability – a challenge that the software engineers of Fraunhofer IESE eagerly embrace.

SOFTWARE DEVELOPMENT

Requirements Management

We help you to structure even complex specifications and to ensure traceability in the process with tools such as DOORS™.

Requirements Analysis, Specification-based Quality Assurance

We support you in developing high-quality requirements and specification documents and in mastering especially non-functional requirements.

Systems Engineering

Uniform specification and modeling on the system level with SYSML helps to avoid dependencies, prevents defects in interfaces, and improves communication within the team. Our processes follow V-Modell® XT or ISO 15288.

Software Product Lines

We assist you in adapting software architectures to efficient reuse and in supporting variation management while taking advantage of cost- and quality-relevant effects.

Component Design

With our support, you can use efficient modern architectures and modeling languages such as Matlab® and develop runtime- or memory-critical applications without any problem.

SOFTWARE QUALITY MANAGEMENT

Process Assessments

We accompany you in planning and using data-based improvement programs on the basis of CMMiL and Automotive SPICE.

Software Architecture Evaluation and Restructuring

We support you in evaluating and restructuring your software architecture, taking into account special constraints such as runtime behavior or memory requirements.

Checking Techniques for Requirements, Design and Code

Software can already be checked before being tested semi-automatically by using either appropriate models or performing structured reviews. We show you how to do this.

Software Measurement Systems

We make software quality measurable with systematically derived metrics – which means benefits for you.

Testing and Test Automation

Many tests can be automated and repeated. We support you in selecting and using appropriate methods, such as model-based testing.

Safety Analyses

We support you in the safety design and analysis of systems that must comply with defined requirements, e.g., in accordance with ISO /IEC 61508 or ISO 26262.

Security Analyses

We perform thorough security analyses of your systems and help you to avoid vulnerability to external attacks.

AUTOMATION AND PLANT ENGINEERING

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Modern Software Development

Decentralized and intelligent control systems, modular plants, small lot sizes, individual manufacturing according to customers' wishes, extensive variation management – such tasks are increasingly taken over by software. However, the optimization potential of individual machines is largely exhausted, and significant improvements can only be made on the process level. In the future, the production process will therefore be controlled individually and dynamically – characterized by the term "Industry 4.0", a fourth industrial revolution is expected.

It goes without saying that quality must continue to be ensured during this development: The high standards that have existed for decades in terms of the quality of machines, plants, and automation technology must also apply to software, for example to software running on a tablet and parameterizing a machine. Only if software is developed according to comparable, engineering-style principles can it conform to the high expectations of the plant engineering and automation industries.

Fraunhofer IESE offers customers and research partners expertise in the entire range of modern engineering-style software development. From embedded systems to interactive systems – Fraunhofer IESE studies, develops, and adapts software development processes, measurement methods, test procedures, and algorithms in order to realize innovative products for and with its customers.

Customer Benefits:
- Modern, engineering-style software development
- Adherence to safety and quality requirements
- Controllable complexity and measurable quality

Competence in Software and Systems Engineering

Software engineering means developing software in an engineering-style, systematic manner in accordance with established or standardized processes and procedures. It allows measuring the quality of software and proving adherence to requirements, such as those regarding the safety and reliability of software-supported plants. Fraunhofer IESE offers the methodological competence, the creativity, and the spirit of research needed to develop modern concepts and innovative products with the help of software engineering.

SOFTWARE DEVELOPMENT

Our software and system construction offers you a variety of solutions that are easy to integrate and that will help you to ensure the required qualities already during the course of the development.

Software Product Lines

The reuse approach can be used in software, too, to reduce unnecessary complexity in variant-rich systems, to make strategic use of reuse potential, and thus to avoid expenses. Specific variants address special customer wishes – the challenge posed by the increasing complexity of your product world is met by Fraunhofer IESE with variation management processes.

Requirements Management

The documentation of functional requirements in requirements documents and specifications is important for software-controlled systems in order to allow efficient quality assurance of complex products. We support you with the methodology and the processes to ensure that the resulting solution is cost-efficient.

Usability Engineering and User Experience

Professional usability engineering measurably increases the satisfaction of the users of your hardware and software by ensuring that the structure and design of user interfaces are oriented towards their requirements, tasks, and wishes. Fraunhofer IESE considers usability and user experience as a precisely specifiable construction goal.

Model-based Development

Continuously model-driven development with SySML or UML allows controlling complex systems with the help of view creation, automatic analyses, and code generation. We assess and restructure complex software and system architectures for you, taking into account non-functional characteristics as well.

SOFTWARE QUALITY MANAGEMENT

Test Automation

Continuous, and especially automated, testing in conjunction with systematic reviews optimizes quality assurance in the software development process and allows saving costs thanks to early elimination of defects.

Software Process Improvement

The range of services offered by Fraunhofer IESE also includes systematic SWOT analyses and evaluation of your development processes, proofs of process conformance, well-grounded safety analyses, as well as support in increasing your process maturity (CMMI, SPICE). We plan and implement improvement measures for you.

Software Measurement Systems

Through the use of defined metrics, which we derive in a systematic manner adapted to your demands, quality aspects can be expressed in concrete statements. Furthermore, we develop customer-specific software measurement systems and measurement processes for your product and process goals.

HEALTH CARE

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Michael Ochs

Example Projects:

Software-based Systems for Health and Quality of Life

In Health Care, too, software allows increases in efficiency and effectiveness, such as better diagnostics and treatment or the optimization of medical and administrative processes in health care institutions.
There is hardly any other area of our daily lives where computer technology is so close to humans, and consequently, mistakes can have very serious effects. Reliability, security and safety, and data protection are essential for these systems.

Our software and systems engineering approach supports you all the way from the elicitation of requirements to validation. Together with our customers, we develop innovative solutions for software development that efficiently fulfill the requirements of IEC 62304, DIN EN 60601-1-4, and ISO 12207 for medical devices, and provide assistance in systematically implementing them in daily practice. We integrate future-oriented methods and techniques that ensure quality requirements (e.g., in accordance with ISO/IEC25000) efficiently and economically. Safety and security are the top priorities in this respect. We use new methods to support you in performing risk management according to ISO 14971 for software, and to use techniques such as Failure Mode and Effects Analyses (FMEA) and Fault Tree Analyses (FTA) for analyzing software safety. Custom-tailored quality management approaches (e.g., similar to ISO 13485) are defined as supporting processes.

Fraunhofer IESE provides support to all stakeholders in the health care sector when it comes to developing and testing software-based innovations, including, in particular, interconnections between devices and services. The institute assists its customers in developing complex information systems as well as in implementing domain-specific requirements, such as those of ISO 80001.

Customer Benefits:
■ Higher safety of the software and thus of the medical services
■ More efficient development and faster time to market
■ Reduction of development and quality assurance costs
■ Provable safety and quality requirements
■ Provable process and product quality

Competence in Software and Systems Engineering

Fraunhofer IESE provides support for manufacturers and users of software and medical devices in the health care sector during all phases of software and systems development.

SOFTWARE DEVELOPMENT

Requirements Management
We support you in eliciting requirements and in developing suitable requirements specifications as well as in managing the requirements.

Usability Engineering and User Experience
With our expertise, we support you in ensuring that usability is considered during development, and in integrating it into the software and systems lifecycle (IAW EN 60601-1-6 and 62366).

System and Software Architectures
The specification and implementation of future-oriented architectures is one of our core competencies. This also includes the evaluation and restructuring of your existing software architecture, taking into account special constraints such as runtime behavior or memory requirements.

Software Product Lines and Reuse
We support you in defining and introducing the idea of software product lines, and in defining suitable and safe reuse concepts.

SOFTWARE QUALITY MANAGEMENT

Risk Management
The team of Fraunhofer IESE supports you in the standard-compliant implementation of ISO 14971 requirements by defining and implementing a risk management process for software that is adapted to your context and the corresponding documentation.

Safety Analyses
We help you to select and use adapted techniques such as FMEA, FTA, or introduce modern processes such as component fault trees in your organization.

Development Processes
We support you in the standard-compliant definition (e.g., IEC 62304, ISO 12207, V-Modell), structuring, documentation, and implementation of development processes and in the selection of methods, tools, and techniques that are suitable for passing certification procedures.

Static Quality Checking Techniques
Together with you, we define appropriate and innovative processes for verification in parallel to development.

Model-based Testing and Test Automation
We support you in the design and introduction of model-based testing techniques for embedded software, focusing in particular on test automation aspects.

Quality Management
We support you in defining, structuring, and establishing a standard-compliant quality management system for your software development in the style of standards such as ISO 9000-3 or ISO 13485, or the FDA Quality System.

Software Measurement Systems
Through the use of defined metrics, which we derive in a systematic manner adapted to your demands, quality aspects can be expressed in concrete statements.

INFORMATION SYSTEMS

FINANCE – ERP / SOFTWARE – TELECOMMUNICATION

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Software in the Age of Information

Information systems have permeated our daily lives in many areas. Numerous everyday tasks are executed with the help of information systems. Company-internal information systems, in particular, such as ERP, CRM, accounting and billing systems, support and automate business processes and perform millions of transactions every day.

Cloud services, Big Data, and social media will integrate the existing systems and services in the near future and make them usable across domains, resulting in added value for users and organizations. Users do not pay much attention to the technology of these highly complex software-based systems and their multiple interactions, and yet, modern business life is simply inconceivable from the perspective of both providers and users without functional, secure, and user-friendly software operating in the background. Using existing potential to increase efficiency and quality in the development and operation of information systems helps to optimize business processes in a sustainable and cost-efficient manner. Mobile services and applications as part of multi-channel strategies are an important means for making information available to customers and users independent of place and time and provide optimal and reliable support for their actions and decisions, which leads to a significant increase in flexibility and agility.

The services offered by Fraunhofer IESE range from development activities for large, heterogeneous, distributed information systems via classical applications to mobile applications. This also comprises the design of systems on the level of coarse-grained and fine-grained requirements, taking into account non-functional requirements; usage designs that integrate business and user goals; user experience design and (service-oriented) software architectures. Agile principles as well as innovative and proven state-of-the-art methods are also used here to increase the benefits for you as a customer. In quality management, Fraunhofer IESE is your competent and reliable partner for process management and optimization, governance and compliance topics, and for the management of organizations and projects via key performance indicators (KPI) ranging from the strategic to the operational level. Here, too, we systematically integrate best practices from the area of agile methods with best practices from proven standards such as CMMI®, V-Modell® XT, SPICE, and ITIL. Goal-oriented quality assurance through integrated inspections and testing as well as IT security audits and the definition of security concepts round off our portfolio of services.

Example Projects:

Customer Benefits:

- Provable product quality in all important aspects starting from the design phase already
- Competitive productivity for software and application development
- Optimized, controllable, agile, and risk-minimizing IT and software processes
- Controllable complexity of systems and applications

Competence in Software and Systems Engineering

Consistent and economical processes characterize the work of our institute, which transfers state-of-the-art validated scientific results in combination with best practices into industrial practice – information systems and processes in top quality, ready for the future.

INFORMATION SYSTEMS DEVELOPMENT

Requirements Specification and Management. In half of all failed software projects, some of the reasons for the failure can usually be found in the requirements. We support you in eliciting and specifying requirements on the basis of our proven approach Satisfy. This guarantees traceability and minimalist documentation of the necessary requirements decisions. In addition, functional as well as non-functional requirements are taken into account.

User Experience. Today, good usability of information systems alone is no longer enough for achieving success among users. With our proven approach UXelerate, we support you in evaluating existing systems and improving them based on such an analysis, and also help you to develop information systems in such a way that the users will have a positive user experience.

Architecture-Centric Engineering. The architecture of your information system is the key to mastering complexity and to efficiently fulfilling many requirements. This is especially true for quality requirements and technical constraints. With our successful approach ACES we support you in defining and evaluating architectures even for complex information systems.

Business Goes Mobile. Multi-channel strategies and mobile services are becoming more and more important. We develop prototypes for mobile devices to help you make decisions and use these as a basis for developing an entire app. We are your competent partner for your mobile product and service strategy and for the selection of an adequate mobile software platform and development environment. Go mobile!

Variation Management. Complexity is often the result of a great multitude of variants and customer-specific configurations of software products. With our successful PuLSE™ approach, we support you in establishing, developing, and managing software variants.

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SOFTWARE QUALITY MANAGEMENT

Process Management. Processes constitute a success factor for the quality of software. Based on a process analysis, we detect strengths and weaknesses in your processes so that improvement potential and established best practices can be recognized. Actions for improving your processes can be defined systematically and can be implemented later on, which will increase the efficiency and quality of your processes in the long run.

Measurement, Key Performance Indicators, and Prediction Models. Transparency from the strategic to the operative level is an important factor for successful organizational control. We work with you on designing customized KPI systems that improve transparency and controllability – and enable you to predict certain attributes such as quality.

Effort Estimation and Benchmarking. We support you in estimating the effort required for your software projects, in identifying effort drivers, and in performing productivity benchmarking of projects. To do so, we use our proven CoBRA® method, which combines expert knowledge with measurement data and supports you in recognizing and controlling risks in a project early on.

Integrated Testing and Inspections. We help you to focus and reduce your testing efforts by coordinating testing activities with constructive activities such as requirements analysis. In addition, early quality assurance measures such as inspections provide important information on how to focus testing activities. We also support you in deriving test cases from requirements.

Security Audits and Security Concepts. Security standards such as PCI-DSS or IEC15408 keep coming up with ever new requirements on systems and development. Security gaps must be avoided, since they result in a loss of trust and can negatively affect a company's business success. We define security concepts and evaluate systems and concepts in terms of relevant security requirements.

eGOVERNMENT

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eGovernment Solutions for Public Sector and Business

The public sector with its more than four million employees represents one of the largest "business sectors" in Germany. It has to balance regulatory constraints, economic feasibility, and quality of service for its customers. Whether new IT solutions meet with success depends most of all on how well the public sector, business, government, and IT collaborate.

Whereas during the early years of eGovernment, the citizen as a customer of the public sector was the main focus of developments, recent years have seen a growing shift of this focus towards the interface between the public sector and business. This is where the highest gains in efficiency are expected.

ROI analyses performed prior to implementation projects ensure a project's return on investment. Using systematic and integrated requirements management and involving all stakeholders early on creates the prerequisites for high acceptance of a system. The adaptation of process models to a development organization and support for a standard-compliant process ensure that projects are performed efficiently. Service-oriented, standards-based architectures allow the integration of legacy systems and guarantee reuse and interoperability.

Customer Benefits:
- Needs-oriented and secure software systems
- Implementation of eGovernment strategies on the basis of empirically determined priorities
- Asset protection through future-proof, interoperable technologies
- Transparent design and development decisions

Competencies in Software and Systems Engineering

Fraunhofer IESE assists partners from all levels of government and public institutions on their way to becoming a high-performance service provider for business and citizens. It provides advice to the public sector and to businesses on how to optimize their business processes, focusing on proving the benefits for the user. Concentrating on selected business sectors allows responding to their specific requirements and bundling services in a way that is appropriate for each sector. A wide range of services provides support in planning and realizing needs- and future-oriented eGovernment solutions.

ROI Analyses

We use a screening method developed at Fraunhofer IESE to support you in identifying, evaluating, and prioritizing process chains between business and the public sector. Extended ROI analyses permit assessing the return on investment of your IT project. Effort estimates performed prior to development projects provide the basis for deciding whether to develop on one's own or join a development alliance.

Needs Analyses and Subcontractor Support

How well an information system is oriented towards the demands of the user is an important determinant for how well it will be accepted later on. We support you in eliciting these demands by involving all stakeholders and in formulating the functional and non-functional system requirements. Based on these requirements, we develop bidding documents and provide support during the subcontractor process.

Adaptation and Use of Process Models

The application of standardized process models increases the quality of the project results while minimizing project costs and risks. We support you in successfully planning and performing projects in accordance with well-known models. This also includes the adaptation of these models to the specifics of your software development organization.

System and Software Architectures

The use of open standards in the context of Service-oriented Architectures (SOA) ensures the interoperability of your systems. We support you in designing and implementing future-oriented architectures and in evaluating and restructuring your existing software architecture. We develop organization-specific concepts for the introduction and operation of SOA.

Security

We support you in designing secure software systems, in checking the security of your information systems in terms of compliance with BSI basic IT protection, and in planning and checking secure IT infrastructures, e.g., by simulating system attacks.

Usability

Deficiency analyses of user interfaces based on known usability problems as well as pilot tests with users from representative user groups permit us to provide a solid empirical assessment of the usability of your information systems.

DIVISIONS

The divisions and departments of Fraunhofer IESE are the central pillars on which the institute's research and technology topics are based. One division combines work on Embedded Systems, while another one encompasses activities in the area of Information Systems. For many industry partners, in particular, this structure makes it easy to find an ideal match with the structure of Fraunhofer IESE. Since Embedded Systems and Information Systems are merging into Cyber-Physical Systems and whole areas of our lives are experiencing comprehensive "computerization" in the sense of "Smart Ecosystems", we must also increasingly deal with cross-cutting issues. This is where processes are of crucial importance, the area of research of our Process Management division.

The divisions Embedded Systems and Information Systems are divided into three, respectively two, departments focusing on development methodology on the one hand and quality assurance on the other hand. This division corresponds to the structures found in industry and therefore facilitates direct bilateral collaboration. The division Process Management is divided into a department focusing on processes and another department focusing on measurement. This structure reflects the importance of suitable process contents on the one hand and their quantitative monitoring on the other hand.

DIVISION EMBEDDED SYSTEMS

Division Head

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Dr. Mario Trapp

Hidden in transportation systems, medical devices, consumer goods, and almost all other technical products, embedded systems are performing essential tasks that make our daily lives safer and more comfortable. Every year, more than three billion embedded components and devices are manufactured, incorporating 98% percent of all microprocessors built. Embedded systems are omnipresent, and our modern economy and society would be unable to survive without them.

The requirements regarding the reliability and functional safety of such systems are correspondingly high. Failures can rarely be tolerated – particularly when such failures might jeopardize people or the environment. At the same time, the systems are quickly becoming more complex, are highly interconnected, are developed in a distributed manner, and must also fulfill numerous, partly contradictory, functional and non-functional requirements at the same time. To master this challenge, the division "Embedded Systems" focuses on innovative methods and techniques for the cost-efficient development of highly dependable and safe systems. The division is organized into three departments dedicated to "Systems Engineering", "Software Engineering", and "Embedded Systems Quality Assurance".

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Department Embedded Systems Development (ESY)

It is crucial to look at Embedded Systems as a whole in order to be able to optimize them with regard to various quality properties. In doing so, it is important to keep system quality in focus right from the beginning. This calls for efficient support for the developers to allow them to keep on top of everything despite the rapidly increasing system complexity, and to make the right decisions based on facts. The department Embedded Systems Engineering supports its customers throughout the entire development lifecycle, from the system requirements to the transition to sub-disciplines such as software development, hardware development, and mechanics. During the further course of the development, too, the department supports its customers in managing the dependencies between different disciplines, in avoiding inconsistencies, and in enabling them to ensure interdisciplinary optimization of the desired system properties.

Competencies
■ Systems Engineering
■ Variation Management
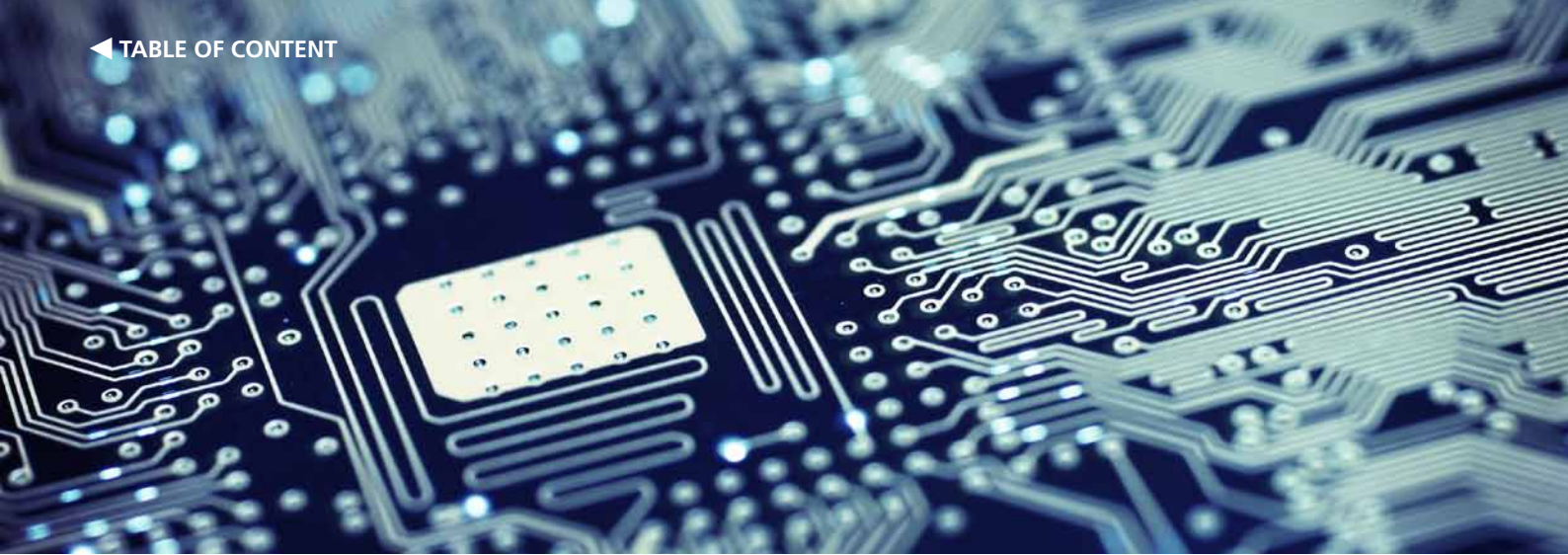
Department Embedded Software Development (ESW)

Many innovations in embedded systems are only made possible through software. Thus, the impact of software quality on major system properties such as safety, performance, and costs is correspondingly high. The software architecture plays a decisive role in this regard. It determines whether the desired quality properties can even be achieved cost-efficiently at all, or whether the product will be able to achieve the flexibility and extensibility required for the business model. The department Embedded Software Development therefore supports its customers throughout the entire software development lifecycle, with a particular focus on the appropriate definition, evaluation, and sustainable evolution of an architecture that is optimized to the desired quality properties. The support provided by the department is not only methodological in nature. The architectures for innovative software-intensive systems are also developed in cooperation with the customers – from elicitation of the requirements to implementation of the concrete platform software.

Competencies
■ Software Architectures & Platforms

Department Head

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Dr. Thorsten Keuler

Department Embedded Systems Quality Assurance (ESQ)

In order to assure product quality, a major portion of the development costs are invested into quality assurance. Particularly for complex systems, efficient methods are needed that make high quality requirements attainable and at the same time decrease the costs for quality assurance. The department Embedded Systems Quality Assurance offers its customers cost-efficient methods that allow assessing system quality effectively and demonstrably. A special focus is on assuring functional safety. In this area, the department supports its customers from the initial risk analysis via the development of safety concepts to the safety case. The department uses innovative quality assurance techniques to support its customers in performing quality assurance and in deriving the necessary evidences for an integrated safety case.

Competencies
■ Safety Engineering
■ Model-based Testing

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DIVISION PROCESS MANAGEMENT

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Dr. Jens Heidrich

"Process Management" deals with the establishment and maintenance of high-quality processes, with analyzing their performance and effectiveness, and with initiating corresponding improvement actions if needed. In principle, there are two major strategies for process improvement: processes can be improved based upon established best practices or in a continuous fashion, making use of measurement data to quantitatively analyze strengths and weaknesses. Within these two strategies, empirical methods are an underlying means for the systematic evaluation of research approaches and technologies used. Consequently, the area of process management can be broken down into the following competencies:

Measurement and Prediction

The competence Measurement and Prediction provides methods and tools for managing and improving processes based on measurement and quantitative approaches. This includes the ability to set up strategic measurement systems, to specify custom-tailored quality models for development processes, products, and projects, and to develop prediction models for project cost and other quality characteristics.

Fraunhofer IESE has a unique set of methods and tools in this area, enabling our customers to cover the complete range of measurement and analysis models from one source, from descriptive models (e.g., for describing the current quality of processes, products, and projects), via analysis models (e.g., for identifying improvement potential), comparative models (e.g., for internal and external benchmarking), and predictive models (e.g., for predicting effort and error proneness) to prescriptive models (e.g., for defining guidelines for proactive improvement).

Empiricism

The competence Empiricism provides methods and tools for defining and performing empirical studies aimed at evaluating software and systems engineering technologies in terms of their practical impact and benefits. This includes the ability to set up controlled experiments, industrial case studies, and surveys, to analyze and evaluate their outcome, and to build empirical models. Furthermore, Fraunhofer IESE supports its customers in empirically-based technology transfer and piloting, including experience management and sustainable roll-out of new technologies.
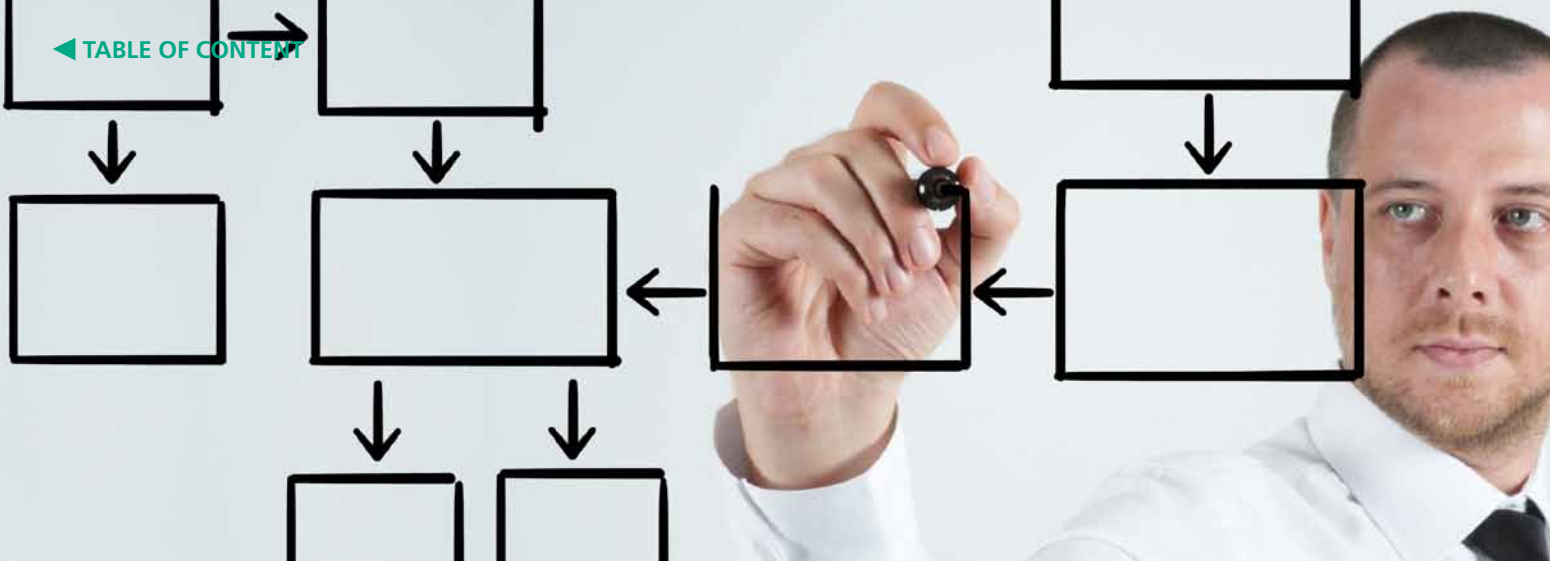
As one of the major founders and drivers of the world-renowned International Software Engineering Research Network (ISERN), Fraunhofer IESE collaborates with a unique network of more than 50 internationally renowned research groups actively involved in empirical research. Furthermore, Fraunhofer IESE combines technical knowledge related to computer science with experience from the social sciences.

Process Compliance and Improvement

The competence Process Compliance and Improvement provides methods and tools for setting up, managing, and improving process models for the development of software-intensive systems and services. This includes the ability to capture development processes into models, to tailor existing models to the specific needs of an organization, to analyze compliance with best practices and standards (such as CMMI, SPICE, or V-Modell® XT), and to initiate organization-wide process improvement programs based on the well-known Quality Improvement Paradigm (QIP) in order to optimize the development process with the help of measurement data.

A dedicated characteristic of our approaches is their scalability, which enables them to address the needs of large-scale organizations (e.g., process lines approach) as well as the needs of small and medium-size enterprises (e.g., integration of agile principles into the development process).

The three competencies are currently organized into two departments:

- The **Measurement, Prediction and Empiricism (MPE) department** focuses on providing quantitative approaches for managing and improving processes.

- The **Process Compliance and Improvement (PCI) department** focuses on providing means for setting up, managing, and improving processes based upon well-proven standards and best practices..

Close interaction and collaboration between the two departments and the combination of all three competencies is a key principle for providing competitive and holistic services in the area of process management.

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DIVISION INFORMATION SYSTEMS

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Dr. Jörg Dörr

Modern information systems and interactive systems are becoming ever more complex. Topics such as Big Data or Cloud Computing, but also increasingly more mature technologies (including technologies in the area of mobile devices) further increase the complexity of these systems. The challenges that our customers have to face frequently are the result of multi-layered project settings involving many stakeholders, interests, and systems as well as the complex workflows of one or several interconnected organizations. Other typical challenges include complex user interfaces, how to assure and prove required system qualities, and, last but not least, the wealth of variations and configurations found in our customers' systems.

The division Information Systems develops innovative methods and solutions for the development of complex information systems and interactive systems. In order to offer an immediate added value, we apply our methods directly in our customers' product development or transfer our methods and solutions to our customers. These include organizations that use software solutions for their business processes, e.g., from the banking and insurance industry or from the area of medical IT systems, organizations from the public service sector and the area of defense, as well as software-developing organizations (both large corporations and SMEs).

Department Head

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Dr. Marcus Trapp

Information Systems Development (ISD)

Nowadays, continuous innovation is one of the decisive factors for an organization to stand its ground on markets that are changing ever faster. One of our main goals is to help our customers establish a systematic innovation process that liberates the creativity potential of all their employees. To do so, we not only address the generation of new product ideas and product extensions, but also their fast realization all the way to market deployment by reducing development time. We also support our customers in evaluating and modernizing already existing software systems as well as in dealing with important issues regarding the selection of technologies and tools.

All of this is based upon our many years of experience in requirements elicitation, software architecture design, and user interface design. Our iterative, scenario-based procedure allows our customers to manage complexity and make reliable predictions about critical properties of a system early on. One of our particular strengths is that we also take into account non-functional (quality) requirements, which are hard to capture otherwise and which often affect the entire system. With the help of our clearly defined software development artifacts, we create links to both traditional and agile process models. Particularly for interactive information systems, the

interweaving of user experience and software architecture plays an increasingly important role. We therefore always take up the user perspective, the development perspective, and the organizational perspective. This is especially true for mobile business apps and for business process management (BPM), where the seamless interaction between our competencies is of special importance.

Competencies

- Requirements Engineering
- Software Architecture for Information Systems
- User Experience

Information Systems Quality Assurance (ISQ)

In order to attain and assess the required system quality, many projects expend more effort on their testing activities than necessary. With the help of our integrated quality assurance approach, we efficiently and effectively focus your testing efforts by balancing and integrating test activities with preceding software development activities such as requirements analysis or architecture design in agile as well as in traditional process models. By combining proven quality assurance methods and technologies with innovative test concepts we are able to address current and future challenges, e.g., regarding the testing of mobile applications or of distributed Big Data solutions. Here, one particular focus is on data security, which is becoming increasingly important for interconnected information systems. In modern IT applications and services, large amounts of business-critical and personal data are continually processed and exchanged. This may even happen inadvertently or without being noticed. It is therefore essential for an organization as well as for individual users to be able to control the usage (including the distribution) of confidential or sensitive data in order to avoid misuse right from the start. The IND²UCE framework developed by us comprises all the components needed to enable comprehensive data usage control in a company. It is based on common standards and its component-based structure allows custom-tailored security for all areas of deployment.

Competencies

- Integrated Quality Assurance
- Security Engineering – Distributed Data Usage Control

Department Head

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PROJECTS

The application orientation of Fraunhofer institutes is characterized by a large proportion of third-party funded projects with industry in which the competencies of an institute are used to transfer innovative methods into practice. At the same time, new competencies are developed in publicly funded projects.

With all three of its divisions, Fraunhofer IESE has established itself as a strategic and dependable partner both in public programs and in major sectors of industry.

On the following pages, the current competencies of Fraunhofer IESE are illustrated with concrete project examples.

Competence
Systems Engineering

Competence Contact

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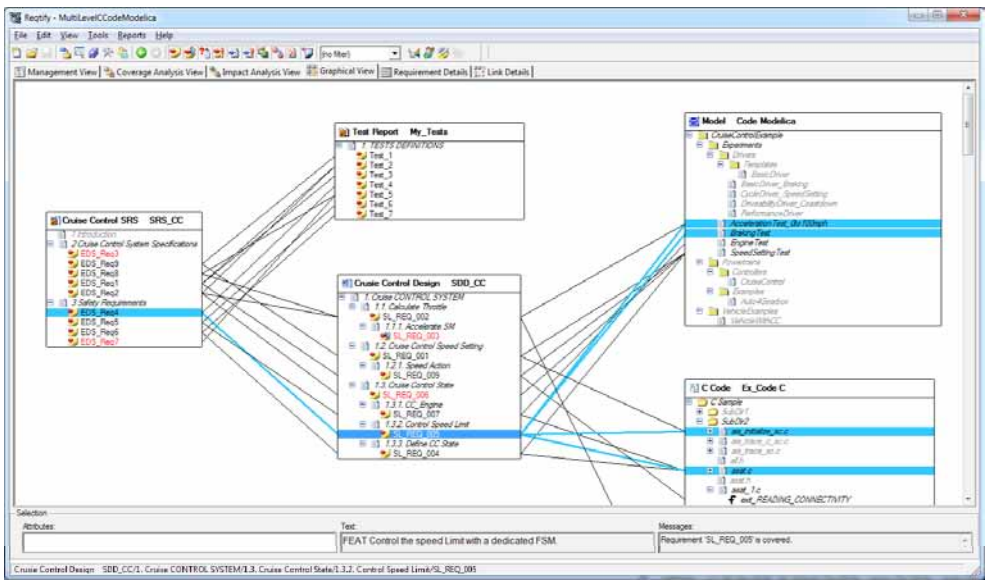christian.webel@iese.fraunhofer.de

Dr. Christian Webel

Complex embedded systems consist of many components provided by different organizational units and engineering disciplines, e.g., mechanics, pneumatics, electrics, and electronics including software. New system structures and the increasing relevance of software in these systems raise challenges for many development organizations. For instance, current engineering processes, practices, and methodologies used by our customers often do not reflect the rising importance of software – mechanical engineering still drives the overall system decomposition and causes a lot of negative interdependencies on the software parts. Other challenges are found in the area of system lifecycle management, in managing the complexity of integrated systems of systems, and in dealing with new (hardware) technologies. Systems Engineering is an interdisciplinary approach that concentrates on the specification and design of complex technical systems as a whole. It considers both the technical and the business needs of a customer, with the overall goal being the provision of a high-quality product satisfying all user needs.

Aligned with the Prognostics Center and the runtime quality assurance support, the competence Systems Engineering addresses the modeling of essential system capabilities in the requirements engineering and concept design phases and focuses on conceptual / functional aspects of the system. Based upon these models, early analyses and predictions can be rendered in a (semi-) automated way, e.g., for checking the completeness and consistency of models, for analyzing and simulating resulting system behavior, for optimizing the deployment of functions on subsystems, or for assessing the changeability of the system. With this, we support our customers with front-loading (i.e., enabling them to understand and manage essential system properties as early as possible in the system's lifecycle) and with runtime quality assurance.

Example Project

MKS180: Efficient Systems Engineering of Large Systems

In the project MKS 180, the Systems Engineering team of Fraunhofer IESE supports the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) in requirements specification, modeling, and analysis as well as in system modeling. The future multi-role combat ship MKS 180 is characterized by very high complexity and heterogeneity, as is typical of a "system of systems". There are, e.g., requirements from the areas platform, deployment system, logistics, and land-based facilities – elicited by the integrated Project Team MKS 180, which includes experts from a wide variety of domains in addition to the core team.

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Traceability of requirements across various artifacts in the development process is a basic prerequisite for the analysis of complex systems.

Systems Engineering as an Interdisciplinary Approach

In accordance with the definition of Systems Engineering, an interdisciplinary approach is used in a project of this size. In addition to requirements elicitation and definition as well as requirements management, an initial logical systems design is already derived in an early phase of the project, which can be used as an analysis model, e.g., for systematic change management or for cost estimation. Our tasks include in particular:

- Development and maintenance of a requirements and system model
- Requirements analysis and quality assurance in accordance with IEEE 830-1998
- Support in verification and validation procedures, e.g., through identification of assessment criteria, relevant requirements, and their impact on subsystems and components
- System modeling in accordance with the NATO Architecture Framework (NAF)
- Support in the evaluation of design studies and cost estimation
- Application of the V-Modell XT Bw, e.g., in the realization of the acquirer/supplier interface

"Our collaboration with Fraunhofer IESE in the analysis phase parts 1 and 2 of the pilot project MKS 180 successfully contributes to the implementation of the approaches of the new procurement process CPM (nov.) in this project. We would like to particularly emphasize the high competence of Fraunhofer IESE in systems and requirements modeling, which is being done for the first time for an overall system of such complexity. This will allow the Integrated Project Team MKS 180 to successfully continue the process in part 2 of the analysis phase. We are grateful for the open and trust-based collaboration, which we will continue in 2014."

Rudolf Braun, Head of Division S3.3 and Director IPT MKS 180, BAAINBw

Collaboration Partner

Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr (BAAINBw)
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Competence
Variation Management

Competence Contact

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The demand for customized and sustainable system solutions is growing tremendously in almost all market segments. Drivers of this trend are the globalization of companies, the ever-increasing pace of technological evolution, and the increasing market power of the customers. If products are developed and maintained in separate and independent projects, over time the effort for managing the product variants becomes a choking factor for innovation. This leads to the risk that the market is entered too late, with insufficient quality, or at costs that are too high.

More systematic and strategic approaches for managing the necessary product variants are required and are, indeed, available.

Companies looking for such approaches are faced with product line engineering, reuse platforms, component-based reuse, ecosystems, configurable and runtime-adaptable products, and with a plethora of corresponding technologies. Unfortunately, there is no silver bullet among them. Despite major improvements in the last decade regarding variant or variation management, the efficient and effective selection, customization, adoption, and migration of suitable variation management approaches is still challenging and error-prone for any company, maybe more so today than ever before.

Example Project

Knorr-Bremse: Strategic Variation Management

Further Information

Competence Homepage
www.iese.fraunhofer.de/
de/competencies/variation_
management.html

The Knorr-Bremse corporation is the leading manufacturer worldwide of braking systems for rail and commercial vehicles. As a technological pacesetter, the company has been a key agent in driving the development, production, sales, and service of modern braking systems for over a hundred years. Knorr-Bremse Systeme für Schienenfahrzeuge GmbH produces innovative pneumatic braking systems for rail vehicles in its business area, and is very successful in this area on the market. Due to different usage scenarios, customer wishes, and regulatory requirements, the braking systems are customized individually to each rail vehicle.

Knorr-Bremse recognized the impending challenges posed by rising complexity and increasing certification requirements early on and collaborated with Fraunhofer IESE in developing a more sustainable reuse approach. In terms of content, the approach offers reusable function components that can be selected according to a specific project and can be efficiently integrated into coherent overall solutions in accordance with predefined instructions for composition.
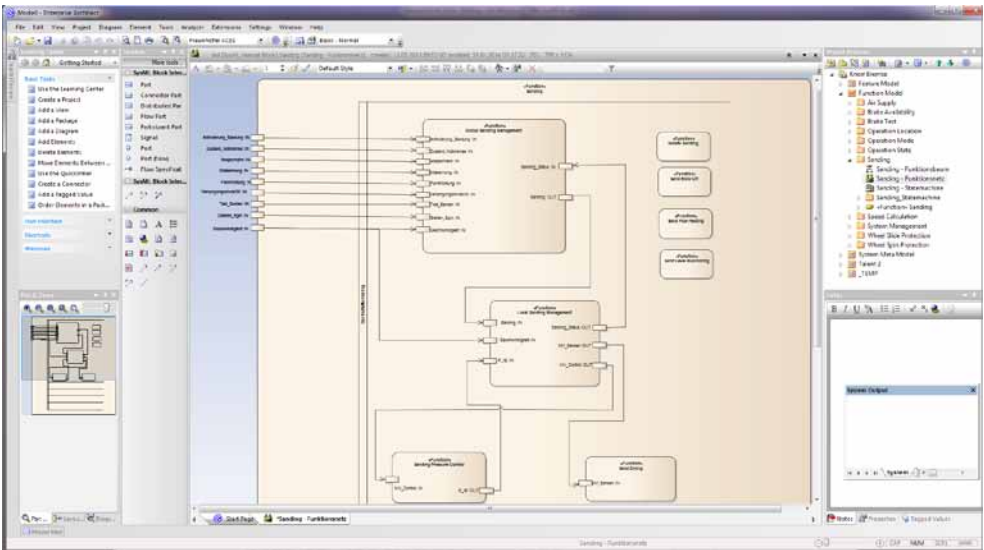
Excerpt of the function model

In the first step, characteristic features were identified in the existing system landscape. They were structured and evaluated and assigned to current as well as future products in a product-feature matrix. This enabled rapid identification of commonalities and differences and thus allowed determining the reuse potential for individual domains and components.

The functions of a braking system are strongly interconnected and at the same time realized in various disciplines. A generic system model was therefore developed in SysML/UML, which describes the functions down to the level of the technical realizations. The system model helps the project members use the available function components efficiently and effectively.
A feature model is used to accurately describe adaptation possibilities in the system model. It allows automatic adaptation of requirements, design, implementation, and quality assurance artifacts throughout the model. Once the sustainability of the approach has been demonstrated based on the first function components, the approach will be rolled out broadly to further functions in the next step.

"The collaboration with Fraunhofer IESE turned out to be a very good decision at all times. IESE developed very concrete and real solution approaches to allow us to master the impending challenges of increasing complexity as well as higher certification requirements. We are grateful for the open, pleasant, and very trustful collaboration and want to continue our successful collaboration in 2014 as well."
Robert Seitz, Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, System Functions & Architectures, CoC Brake Control

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KNORR-BREMSE «(K)»

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In order to be able to develop complex software systems with predictable quality in a cost-efficient manner, the software structures must be regarded holistically in the context of the development environment and the technologies used. In the light of rapidly growing system complexity, developers must be able to keep on top of the software in order to be able to make objective design decisions.

Particularly in distributed software development, a clearly communicated software architecture plays a crucial role. If many developer teams are to work in parallel on the same product, a clear separation of the functionality into components and interfaces is essential. This has a positive impact on concrete activities such as development and extension of software or modular testability. In addition, scaling effects can be achieved across the number of developers since architecture rules are implemented uniformly across the whole system.

Fraunhofer IESE is working on the development of systematic processes in combination with automated, tool-supported architecture analyses that can be adapted to the respective customer context. This makes it possible to evaluate existing and planned software architectures in order to constructively avoid architecture defects already during software development.

Example Project

John Deere: Using Architecture for Agile Software Development

Further Information

Competence Homepage
www.iese.fraunhofer.de/de/
competencies/architecture.
html

In modern agricultural technology, it has become impossible to conceive of products that do not include a major proportion of software. Current agricultural machinery in general, and tractors in particular, are usually equipped with a multitude of electronic control units, which take over tasks ranging from engine control via safety-relevant functions to interconnected agricultural applications. Many of the formerly purely mechanical operating elements have been replaced in modern tractors by interactive graphical displays. The largest manufacturer of agricultural machinery worldwide, John Deere, has recently started to develop display software in an "agile" manner. This is easy to understand if we look at the expectations regarding agile development: early customer feedback as well as shorter time to market due to fast release

The display as a communications hub on agricultural machinery of John Deere

cycles. If software development is changed to agile methods, in practice this entails more liberties for the development team. However, with regard to the distributed development of such displays, which in the case of John Deere takes place in the USA and in Kaiserslautern, the resulting liberties lead to additional challenges, which pose obstacles to smooth software development. In addition to challenges regarding communication and tool support, in agile software development the question quickly arises whether requirements regarding the implementation of particular development activities are necessary and how specific such requirements should and must be. Particularly the development and communication of a clear vision – supported by all developers – of the system and of the software architecture often turns out to be difficult to achieve for distributed teams developing software in an agile manner.

In their transition to agile development methods, John Deere ISG (Intelligent Solutions Group) was supported by Fraunhofer IESE experts in using architecture principles in such a way that communication across sites was improved in order to develop a joint vision of the software architecture and firmly establish it in the development process.

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Competence
Model-based Testing

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The high complexity of embedded systems and software, the involvement of numerous suppliers, tight project schedules, as well as stringent process and product standards require a systematic, effective, and efficient quality assurance process. The quality assurance of software-intensive technical systems calls for a combination of cost-efficient and effective test techniques, rigorous verification, as well as focused inspections and reviews on different levels and during different phases of the software and system development process.

The success of quality assurance greatly depends on the extent to which the heterogeneous quality and test objectives are covered by quality assurance activities as well as on their degree of automation. Model-based testing, which systematically exploits models for use in quality assurance, is our innovative solution for achieving both goals. A large proportion of the test objectives can be transformed into high-quality test models by using various modeling notations and appropriate model engineering techniques. Many manual black-box tests on the component, subsystem, and system levels are therefore covered by model-based testing.

Our goal is fully automated testing, i.e., automated test case generation from the models, fully automated test execution on the customer-specific target platform, and fully automated test evaluation. The test results and failures are fed back into test planning and test management in order to allow continual learning and improvement.

Example Project

VierForES2: Virtual and Extended Reality for Highest Safety and Reliability of Embedded Systems

In the German research project VierForES2, Fraunhofer IESE is collaborating with other industrial application partners and research institutes in doing research on innovative techniques for the development and quality assurance of embedded systems with high safety and reliability requirements. In the context of this project, model-based testing techniques were further evolved so that they can now also be applied efficiently to complex systems. Our approach for the industrial deployment and application of model-based testing consists of three steps:
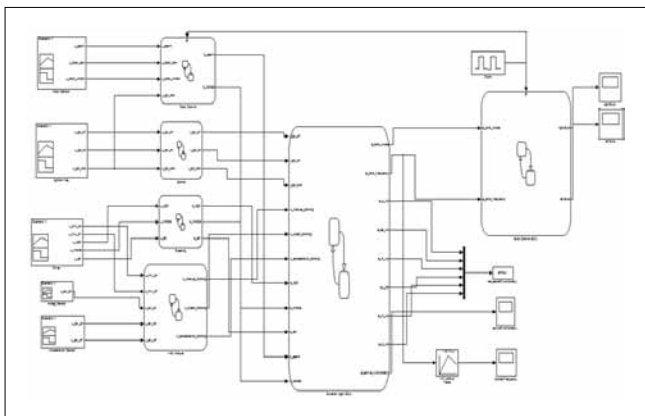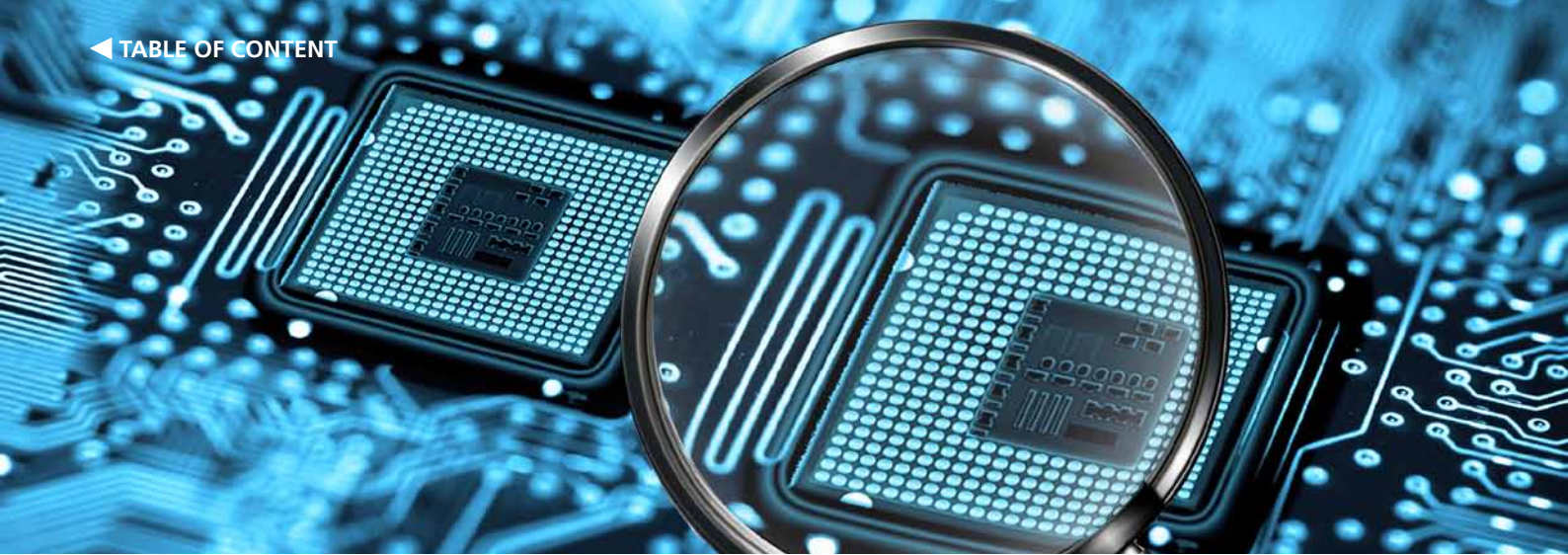
Excerpt of a typical test object (complex control software (automotive))

The starting point for the improvement and automation of testing processes is a detailed analysis of the testing process to identify problems and critical causes. On the basis of the constraints of the project and the future goals of an organization, we then develop an improvement strategy. For economic reasons, our goal is to automate the degree of test automation to the greatest extent possible and at reasonable costs.

In the second step, a feasibility analysis is performed and then a custom-tailored testing approach is developed with appropriate models and test case generation strategies. In this project, the focus was on fulfilling the requirements of the process and product standards for the development of embedded systems (such as IEC 61508, ISO 26262, DO 178-B, EN 50128) following systematic quality assurance. During the course of this process, the tool chain is also developed and adapted, which allows a high degree of automation on the customer-specific execution and testing platform. In this particular case, the focus was on early testing of complex systems at design time.

Finally, the systematic development of test artifacts is very important. High-quality models are the prerequisite for deriving a set of test cases that are sensitive to failures, while being both economically feasible and fulfilling the coverage criteria to the full extent. Our model-based testing approach takes into account various input sources (textual specifications, design models, existing test cases, and implicit expert knowledge), which may also contain incomplete and inconsistent information.

In the case studies performed in the context of this project, it could be demonstrated successfully that model-based testing increases the quality of the testing processes and test artifacts on the one hand and, on the other hand, reduces the costs thanks to a higher degree of automation of the process steps and the reuse of artifacts.

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ViERforES

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Competence
Safety Engineering

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Safety-relevant systems are increasingly common in our everyday lives. We expect the same flexibility and multi-functionality from these systems as we do in other areas. For safety engineering this means that we must support creative and innovative ideas and accompany their development without impeding or blocking them. In traditional development practice, safety is often regarded as a necessary evil that must be taken into account during product development.

With its innovative safety engineering solutions, Fraunhofer IESE helps you to focus on your products and the corresponding safety issues and to avoid unnecessary process and documentation overhead. In addition, this helps to increase the efficiency and effectiveness of your safety-relevant systems and software engineering by orders of magnitude. You are not only developing a safe system – the system is also being developed safely!

Fraunhofer IESE employs model-based safety engineering techniques that are tightly integrated into your systems and software engineering process. This enables direct traceability between systems engineering and safety engineering. Thus all decisions and strategies are directly reflected in both worlds, which has positive effects on overall product quality and helps you to develop a certifiably safe system.

Example Project

SPES_XT: Software Platform Embedded Systems "XT"

While the complexity of embedded systems increases rapidly, the innovation cycles are becoming shorter and shorter. In the meantime, this trend can also be increasingly observed in safety-relevant applications. To manage system complexity, the development methodology used has continually evolved in recent decades and has undergone various paradigm shifts during that time, such as most recently the introduction of model-based development. Safety engineers in practice, however, still have to rely on processes that have not changed significantly ever since their introduction almost 50 years ago, and which are hardly suited for efficiently managing the complexity of modern software-intensive systems. It does not come as a surprise then that

safety engineers increasingly have a hard time keeping up with the pace of development in their organization.

For these reasons, the BMBF-funded research project SPES XT has taken up these challenges in the context of one of six so-called Engineering Challenges. Under the scientific leadership of Fraunhofer IESE, model-based safety engineering processes are being developed that shall enable efficient modular and thus reusable safety cases. To achieve this, the safety case processes are integrated seamlessly into a model-based development methodology. The first project results already permit modular safety analyses, safety concepts, and safety cases to be specified and analyzed in a fully integrated manner in commercial modeling tools. The implemented modularization concepts decrease complexity and increase reusability. Furthermore, the seamless integration into model-based development allows for a high degree of automation, such as tool-supported consistency checks or the semi-automated generation of safety models. With these measures, the efficiency of safety engineering can be increased significantly.

The core of the results is the "Open Safety Model - OSM". With this model, the approaches developed in the project are no longer limited to single tools; instead, various safety case processes can be combined on the basis of different tools. For example, FMEAs (Failure Mode and Effects Analyses) and fault trees can easily be composed into an integrated system analysis, which is then seamlessly connected to a model-based safety concept and a requirements database. Even non-model-based tools can be connected to the Open Safety Model in order to benefit from the advantages of model-based development. Since this is an open platform, tool providers and users have a chance to connect their own tools and extend the approach, allowing the benefits of model-based approaches to be made available to safety engineers in practice as quickly and as maturely as possible.

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SPES XT
Software Plattform Embedded Systems 2020

Collaboration Partners

see Project Homepage
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Competence
Process Compliance and Improvement

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The development of software-intensive systems and services requires the use of new and innovative development techniques and methods, which must be sustainably integrated into the development process in order to ensure repeatable and long-term success. To achieve high process quality, the processes involved must be systematic and efficient. In many cases, a specific process based on solid lessons learned from practical application must be systematically proven to a customer.

Fraunhofer IESE supports you in establishing high-quality development processes and in measuring their performance while continually working on improving these processes systematically. In this regard, we are guided by both recognized industry standards and continuous improvement models. Goal-oriented measurement, customized process technologies, state-of-the-art prediction processes, and technology evaluations are core components of our service portfolio.

Example Project

SYLIS: System Lifecycle for Improved Standard Compliance and Verification / Validation

Further Information

Competence Homepage
www.iese.fraunhofer.de/
de/competencies/process_
compliance.html

The development of software-intensive systems and services in industrial environments is generally subject to a multitude of standards and norms. The variety of the standards applied ranges from very general works via specializations to explicitly industry-specific standards. In addition, domain-specific standards, which are partly again available as general and as industry-specific standards, must be taken into account. Prominent examples of this are ISO 26262 and IEC 61508, which deal with functional safety during the development of safety-relevant electrical, respectively electronic, systems.

Adherence to a standard-compliant behavior is demanded and monitored by companies. Systematic Compliance Management in these multi-standard / multi-norm scenarios has become more and more complex in recent years. This has led to exceptional challenges, in particular for small and medium-sized enterprises (SMEs) that are in a contractor relationship with a large enterprise. Unlike large companies, SMEs must adapt much more rapidly to changing constraints
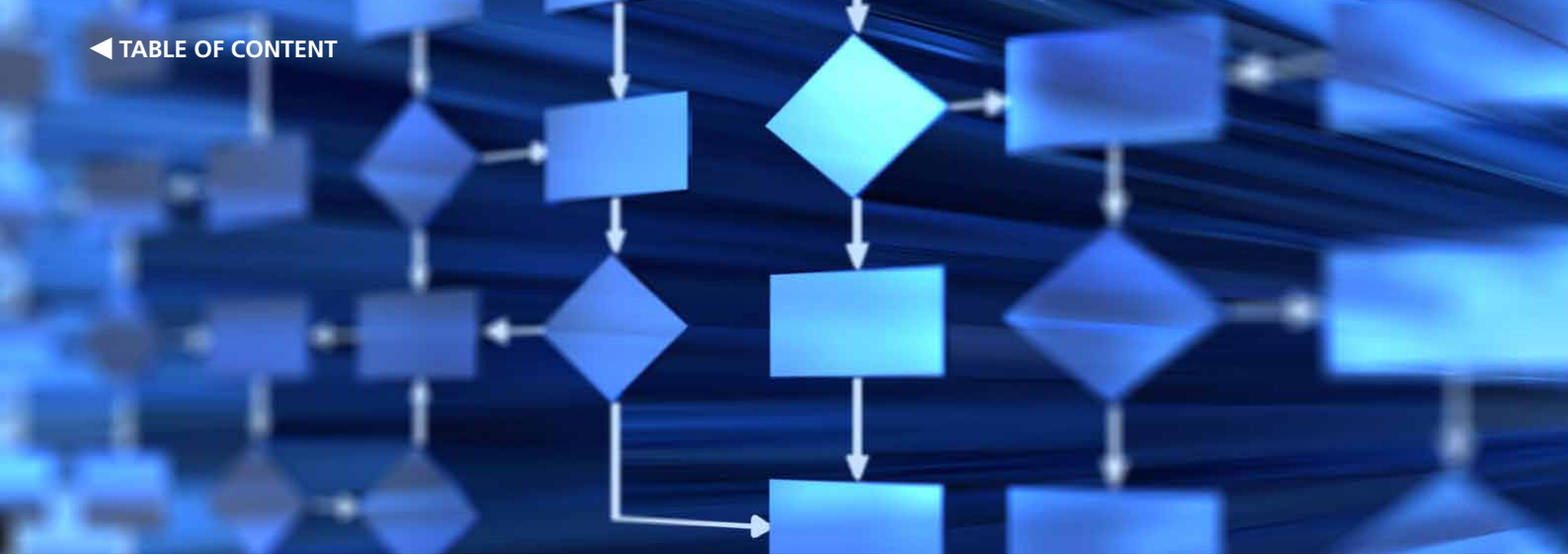
and conditions in order to ensure their long-term survival on the market. Ensuring and maintaining compliance with various standards in an efficient and at the same time cost-optimized manner becomes a crucial issue in this context.

Against this background, the goal of the project SYLIS (**SY**stem **L**ifecycle for **I**mproved **S**tandard Compliance and Verification / Validation) is the development of a tool-based approach that will support the participating SMEs (which produce test-intensive software for embedded systems) in their verification and validation processes on the one hand, and in classical Compliance Management on the other hand.

To achieve these goals, the relevant approaches described in the literature will be studied systematically and will be compared to the processes used by SMEs in defining and documenting their own processes. Furthermore, the domain-specific and other norms, resp. standards, in the area of embedded systems development will be compiled. Based on this information, typical scenarios will be developed in cooperation with the SMEs that are of interest in daily operation in product development. The lessons learned will then be incrementally implemented in a software tool.

SYLIS is a joint research project of Fraunhofer IESE and CETIC - Centre d'Excellence en Technologies de l'Information et de la Communication in Charleroi, Belgium. Five SMEs each in Belgium and Germany could be recruited as application partners and will advise the research consortium from an industry perspective with regard to the development. The project will start in the spring of 2014 and has a scheduled duration of two years.

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Competence
Measurement and Prediction

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Measurement is the key element of continuous improvement
Using engineering-style processes is indispensable for developing systems and services on time and in a cost-efficient way. Developing innovative software-intensive systems and services requires the application of new and innovative development techniques and methods that need to be integrated into the development process in order to make success repeatable and sustainable. In order to establish high-quality development processes and improve them continuously, their performance and effectiveness need to be measured.

Measurement enables learning from the past to make better decisions in the future
Quantitative measurement data allow understanding the factors that affect the quality of software processes, products, and services. This knowledge helps decision makers to foresee potential problems, address them proactively, and thus minimize the associated risks and make sustainable improvements.

Strategic measurement must be aligned with business needs to earn value
In today's competitive markets, an organization must be able to establish well-suited goals and strategies, communicate them across the organization, recognize when goals or strategies need to be changed, and understand the effects of those changes. Measurement is a key enabler that allows you to make the right strategic decisions to keep your organization on track.

Fraunhofer IESE supports you in systematically building up strategic measurement systems and models that pay off.

Example Project

Using Big Data for Improving Business Processes

The rapid advances in information technology (IT) have a number of effects on global business. One of these effects is that a large amount and variety of measurement data is produced at great speed. The availability of such "Big Data" creates a number of new opportunities for business but also entails numerous entirely new challenges.

Producers of consumer goods have recently recognized the potential benefits of using quantitative data for optimizing their business processes, e.g., for planning their product development and distribution. They noticed that simple data analyses and human expertise alone are not
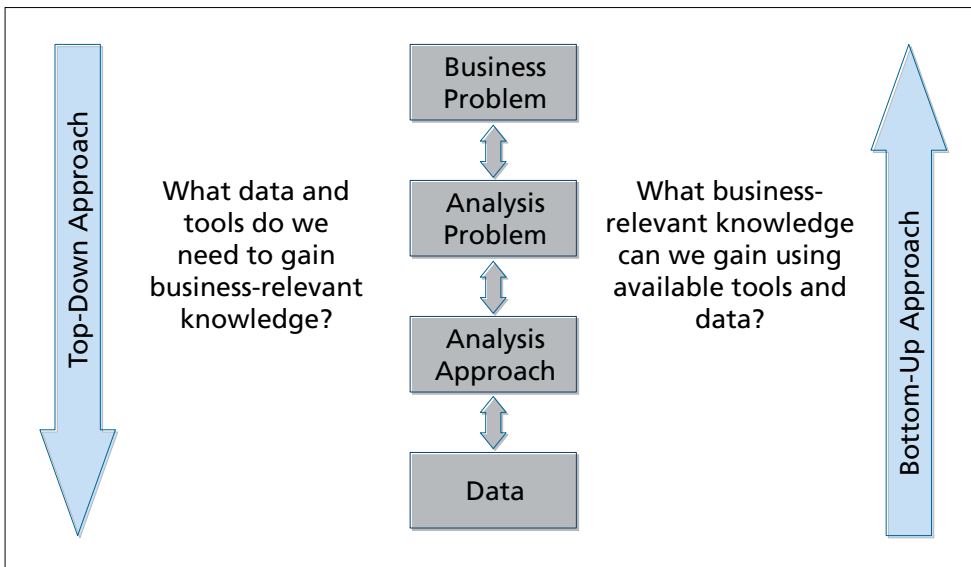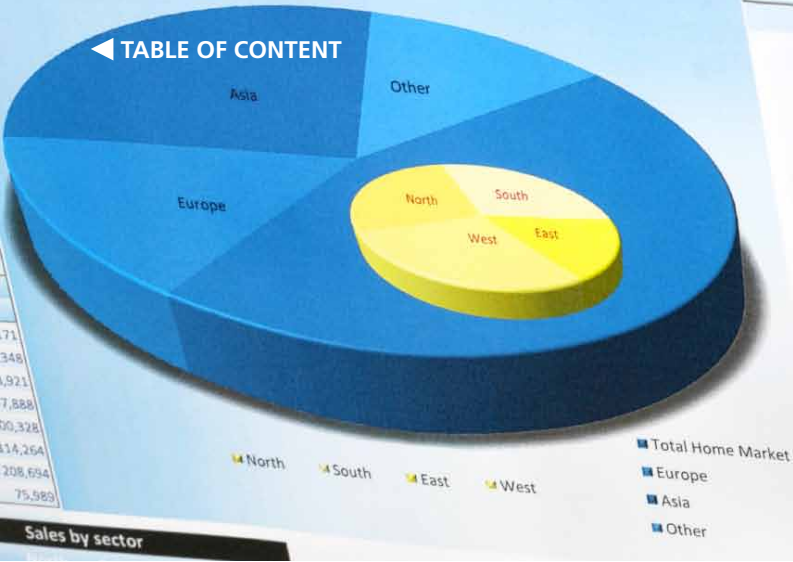
Combined approach to using Big Data for improving business processes

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sufficient for making effective decisions in the complex environment of global markets, where a number of mutually interacting factors influence business success. The challenges that need to be faced include selecting and preparing appropriate data, choosing appropriate analysis techniques and tools, and transforming data analysis results into business-relevant knowledge. In order to address these challenges, Fraunhofer IESE applies a combination of a top-down and a bottom-up decision-making approach in collaboration with its customers:

Top-Down Approach: aligns measurement and decision making to a specific business problem
- Specify the business problem
- Derive a suitable data analysis problem
- Derive an appropriate data analysis approach
- Derive appropriate metrics and collect the required data
- Apply the analysis approach and interpret its outcomes to solve the business problem

Bottom-Up Approach: explores existing data in order to gain new insights aimed at driving innovative business solutions
- Use available data and, if necessary, explore new sources
- Apply best-practice analysis approaches
- Identify significant patterns in the data
- Synthesize and interpret the discovered data patterns in order to gain business-relevant knowledge

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Competence
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Engineering-style software development requires methods and tools whose suitability for given project goals and characteristics has been systematically evaluated and whose costs, risks, and benefits are known. This is guaranteed by the empirical approach taken by Fraunhofer IESE. Empirical studies are an approved means for systematically evaluating the benefits and drawbacks of software and systems development methods and tools in a practice-oriented manner. If relevant and robust results are to be obtained, performing empirical studies in a professional manner requires systematic, goal-oriented planning, conduction, and analysis.

The general idea is similar to the medical area, where new treatments must pass comprehensive tests before being introduced to the public. In the same way, new software development methods must also be tested before being introduced into industrial practice. Insufficiently optimized, inefficient, or faulty methods may severely disrupt active development processes and demotivate employees. Empirical studies performed in advance can also check the usability and practical suitability of the respective methods beyond mere technical aspects and indicate potential areas of optimization.

Fraunhofer IESE supports you in systematically planning, conducting, and analyzing an evaluation of techniques, methods, and tools.

Example Project

Software-Cluster: SWINNG – Process Innovations in the Software Industry

How do very diverse organizations collaborate in a cluster network? Which demands exist in industry regarding emergent software? What is necessary for emergent software to be successful on the market? How can emergent software become a megatrend?

To answer these and other questions, a multitude of empirical methodologies is used. For about three years, Fraunhofer IESE has been pursuing these issues in the project SWINNG – Process Innovations in the Software Industry – and has been collaborating with 15 partners from industry and academia. By means of surveys, interviews, online studies, and group workshops, each issue and target group is addressed individually, and valuable information for the further development of the Software-Cluster itself as well as for the further development of emergent
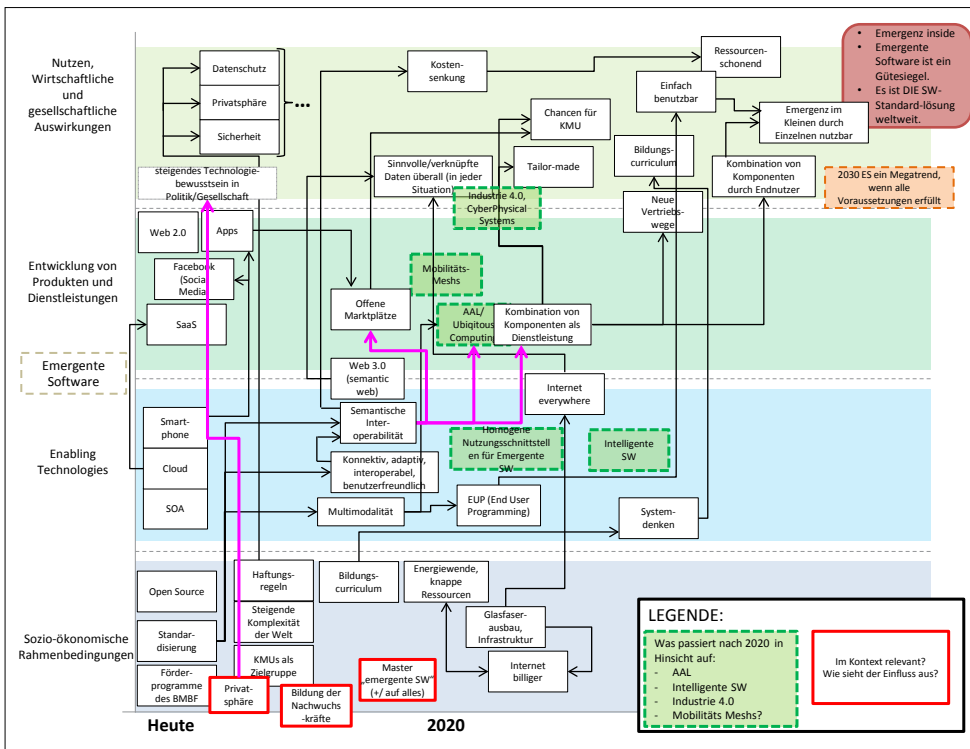
Structuring technique: Impact factors affecting the success of emergent software

software is made available. In total, three needs analyses, two network studies, and one study on emergent software as a megatrend have been implemented so far.

Structuring Technique: Making Trends and Strategies Visible

In order to analyze which factors have an impact on the economic success of emergent software, the structuring technique was employed in the context of a megatrend workshop. The goal was to identify impact factors, prerequisites, supporting or opposing trends (of a technological, social, political, or economic nature), as well as their dependencies for emergent software. The structuring technique allows expert knowledge to be quickly structured, condensed, and used for strategic decisions. From the workshop, a total of six correlations emerged that have an impact on the success of emergent software: Internet availability ("Internet everywhere"), Cloud technologies, standardization of software interfaces, continuing education of professionals and managers, security in information processing and transmission (privacy), as well as the market potential of custom-tailored software for small and medium-sized enterprises.

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Software-Cluster

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Engineering-style software development requires methods and tools whose suitability for given project goals and characteristics has been systematically evaluated and whose costs, risks, and benefits are known. This is guaranteed by the empirical approach taken by Fraunhofer IESE. Empirical studies are an approved means for systematically evaluating the benefits and drawbacks of software and systems development methods and tools in a practice-oriented manner. If relevant and robust results are to be obtained, performing empirical studies in a professional manner requires systematic, goal-oriented planning, conduction, and analysis.

The general idea is similar to the medical area, where new treatments must pass comprehensive tests before being introduced to the public. In the same way, new software development methods must also be tested before being introduced into industrial practice. Insufficiently optimized, inefficient, or faulty methods may severely disrupt active development processes and demotivate employees. Empirical studies performed in advance can also check the usability and practical suitability of the respective methods beyond mere technical aspects and indicate potential areas of optimization.

Fraunhofer IESE supports you in systematically planning, conducting, and analyzing an evaluation of techniques, methods, and tools.

Example Project

SPES_XT: Software Platform Embedded Systems "XT"

What distinguishes component-integrated fault trees (CFT) from classical fault trees (FT), which are the state of the practice, in terms of the quality of the safety models? How do engineers assess the consistency, clarity, and maintainability of the resulting safety models?

For about four years, Fraunhofer IESE has been investigating how the model-based development paradigm can be extended to the area of functional safety. One result of the research are CFT for the component-based representation of safety models. The competence area Empiricism, which is responsible for the empirical evaluation of the project results, took up the task of systematically evaluating the new form of representation. In order to answer the questions, an evaluation design was created and coordinated with the participating project partners. Together

Component Integrated Fault Trees (CFT)	Classic Fault Trees (FT)	
		Safety Analysis Model
		System Model
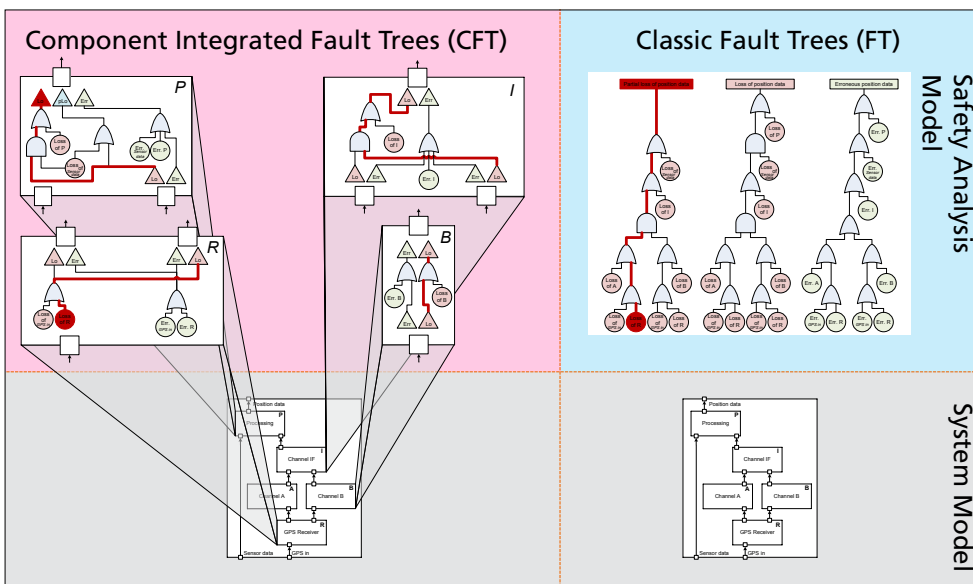
Comparison of component-integrated fault trees and classical fault trees

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with domain experts and method experts, a test booklet was developed that had to be worked on by the test persons. We were able to win engineers from companies involved in the project as participants for this survey. They were taught the necessary basics for the development of CFT in the context of a one-hour training session. Then they received an explanation of the system to be studied and the procedure. Each test person worked on a test booklet created specifically for him/her. The tasks were the same for all participants, but their sequence was chosen randomly. The tasks referred to typical tasks familiar to the engineers, such as adding a new component or changing an existing component. Each task had to be modeled with FT and with CFT. Following each task, the test persons were asked to assess the consistency, clarity, and maintainability of the FT- resp. CFT-based safety model. The finished tasks were evaluated by an expert using the following categories: correct, incorrect, non-existent. Although we were unable to determine a statistically significantly higher proportion of correct solutions when CFT were used, the participants assessed the modeling capacity of CFT with regard to consistency, clarity, and maintainability of the resulting safety models as significantly higher. The result of this evaluation demonstrates the potential of CFT as a model-based representation for safety models.

Further Information

Project Homepage
http://spes2020.informatik.
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home.html

Collaboration Partners

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competencies/requirements_
engineering.html

Satisfying or even exceeding customer expectations is what characterizes successful organizations. In order to assure that expectations can be satisfied by a software system, they must be known first. Requirements Engineering (RE) is the basis for assuring that a piece of software can actually deliver what it is supposed to do, and that it can be used successfully without any problems. However, Requirements Engineering is not done with a one-time elicitation of technical software features! Rather, Requirements Engineering is a holistic design and decision process that supports the entire software (development) lifecycle.

For this reason, it is essential that requirements are considered from all perspectives involved in a project. Fraunhofer IESE's integrated approach "Satisfy" assures that the goals and requirements of customer organizations and end users as well as development engineers are elicited and aligned explicitly. The corresponding methods and broad experience we have developed in this regard will therefore result in the best possible support for your requirements processes.

Besides a large portfolio of services in the area of requirements elicitation, analysis, specification, validation, and management, our thematic focus lies on the integrated design of business and IT, on innovative and user-centric software, as well as on the optimization and tailoring of requirements processes based on lean principles. We therefore support both organizations that develop software and organizations that use software by offering consulting, outsourcing, coaching, and technology transfer. This also includes an industry-proven approach for engineering innovative product ideas by using a broad portfolio of creativity techniques in a systematic process.

Example Project

Fujitsu EST: Sustaining Innovation in Product Development

Fujitsu is the leading Japanese information and communication technology (ICT) company offering a full range of technology products, solutions, and services. Approximately 170,000 Fujitsu people support customers in more than 100 countries. Fujitsu EST is an innovation-centered software product subsidiary of the Fujitsu group based in Munich. As an international subsidiary of Fujitsu's technology organization, Fujitsu EST undertakes core software product management and development activities, forming an important bridge between the company's technology groups and its international customers and partners.
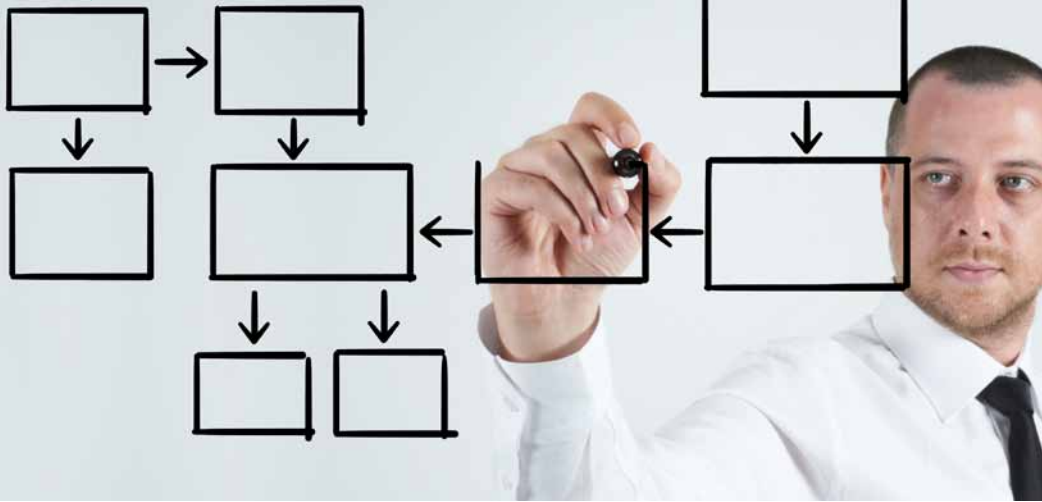
Fujitsu EST is currently in the process of redefining its future product portfolio and strategic roadmap. In this process, Fraunhofer IESE has supported Fujitsu EST in optimizing the product innovation process. For this purpose, Fujitsu EST wanted to create innovative product ideas on the one hand and establish a strategic and effective way to use creativity techniques in the existing Fujitsu EST innovation process on the other hand. To achieve these goals, the project was performed in two phases.

In the first phase, a creativity workshop was tailored by Fraunhofer IESE to the needs of Fujitsu EST and performed with moderation by requirements experts from Fraunhofer IESE. In an initial workshop, Fraunhofer IESE elicited relevant information to understand the Fujitsu EST context, the core goals, and the scope for the creativity workshop. Fraunhofer IESE then prepared, conducted, and moderated a two-day creativity workshop. As a result, the Fujitsu EST employees created a large set of potential product ideas that were evaluated in the workshop. The most promising idea was then enhanced and improved in a set of further creativity workshops. During this process, the whole creative power of all Fujitsu EST participants was used to add maximum benefit to the product idea, as creativity techniques were applied efficiently by all employees.

During the second stage of the project, Fraunhofer IESE trained and coached Fujitsu EST employees in performing creativity workshops by themselves. Systematic guidelines on how to perform key techniques as well as coaching in the systematic planning and conduction of workshops by Fraunhofer IESE personnel enabled Fujitsu EST to perform and moderate this and future workshops independently and successfully.

The benefit of the collaboration project for Fujitsu EST was twofold: First, by conducting the creativity workshops, innovative product ideas were derived that appear to be promising for creating future business. Following initial validation procedures, the most promising idea has already received a Fujitsu-internal innovation award. Currently, this idea is in the process of being prototyped at EST. During the second phase, Fraunhofer IESE transferred its know-how regarding how to perform creativity techniques to EST. A series of further creativity workshops were performed and moderated by EST personnel on their own. Fujitsu EST has now successfully established the planning and performance of such creativity workshops as part of their innovation process. Furthermore, these techniques are being shared and rolled out across the organization as a whole, empowering staff and supporting EST as it moves beyond single innovation activities and towards a more creative culture at all levels.

In the words of Dr. Yuji Takada, CEO of Fujitsu EST, "*Fraunhofer fully understood our desire to treat innovation as a process rather than an event and worked hard to transfer the knowledge necessary to turn our naturally creative organization into a repeatable innovation center.*"

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Competence
Software Architecture for Information Systems

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Architecture is a key factor for success in the development and evolution of software systems. The realization of excellent software systems requires the use of architecture as the central vehicle for communication, prediction, analysis, planning, and control. Effective architecting helps you to plan the features and quality properties of a system in a predictable way. You can control the realization at the code level and keep systems maintainable. This allows managers to fulfill business constraints such as time and budget. Consequently, architecture is the means for making the right decisions at the business level as well as at the technology level.

It is absolutely crucial that architecture does not become an end in itself, but is rather seen as an investment justified by clear purposes.

We support you in making your system and your architecture fit for the future and ready to deliver high performance. We also help you to systematically improve and effectively entrench architecture competence in your organization.

Example Project

Daimler FleetBoard: Architecture in the Agile Context

Further Information

Competence Homepage
www.iese.fraunhofer.de/de/
competencies/architecture.
html

Daimler FleetBoard develops and sells telematics-based Internet services for efficient fleet management. Telematics devices in trucks as well as vehicle and transport management services and their operation are part of its portfolio. With the telematics solutions of Daimler FleetBoard, transport companies can save up to 15 percent fuel in construction-site, distribution, and long-distance traffic and can manage their logistics processes better.

For its telematics products, Daimler FleetBoard is developing software for embedded systems and for information systems. For several years the development has been following agile principles and has been built on SCRUM. In order to manage the complexity and quality of the products, a strong focus is placed on software architecture. For this purpose, architecting has been organized similar to SCRUM and has been integrated into the development process.

In order to evaluate architecting in the agile context and possibly improve it, Daimler FleetBoard commissioned Fraunhofer IESE with the performance of an independent review. In this review, it was checked to which extent the current practices serve to accomplish the goals at Daimler FleetBoard and to which extent best practices are adhered to.

Intelligent processing of transport tasks using FleetBoard

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As a basis of the evaluation, Fraunhofer IESE worked with about 20 stakeholders to elicit the most important goals to be accomplished by architecting. In summary, these are high product quality and suitable standards for the development. Based upon this, practices in the following areas were discussed:

- Organizational design, teams, and roles
- Processes, activities, and tools used (e.g., architecture requirements, -design, -documentation, -implementation, -evaluation, terminology)
- Development artifacts and results

Results & Conclusions

- Whereas the realization that agile development does not work without adequate architecting is only gaining ground slowly in general, Daimler FleetBoard already realized this years ago and invested in architecting. Also, the work is consistently aligned with the goals.
- Daimler FleetBoard understands architecture as work in progress and covers all important activities.
- Daimler FleetBoard has explicitly established an "Architecture Steering Committee", which is organized in accordance with agile principles.

"By intensifying its architecting process, Daimler FleetBoard chose the right path several years ago and is continuing to work on further improvements based on recommendations following the review."
Thomas Kindler, Manager Server Platform, Daimler FleetBoard

Collaboration Partner

Daimler FleetBoard
www.fleetboard.de

FLEETBOARD®

Competence
User Experience

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Functionality and good usability of a software system alone are no longer enough for a company to be successful with its users. Innovative companies design their systems in a way that does not only provide users with effective and efficient support, but also generates a positive user experience (UX). Nowadays, product success is mainly defined via the experience a user has while using a product, the so-called user experience.

Success through positive user experience

A positive user experience regarding your business applications
- leads to higher-quality work results
- increases the quality and efficiency of your employees' work
- results in a stable, positive, and enjoyable working atmosphere among your employees
- increases the acceptance of the business applications to be used and the willingness to use these applications
- leads to your customers being able to identify with your product and remain loyal to it for a long time.
- ensures that your products can provide inspiration.

Example Project

UID4Mobile: Scalable User Interface Design for Mobile Applications

Further Information

Competence Homepage
www.iese.fraunhofer.de/
de/competencies/user_
experience.html

Mobile business applications (apps) are ubiquitous in our daily lives today. In our private lives, we use apps in online banking, at airports and train stations when we travel, when we explore our current environment, or when we enjoy multimedia entertainment. In our jobs, apps increasingly support us in performing our workflows. An organization's presence in app markets such as Apple App Store, Google Play Store, or Windows Marketplace is often already expected as a given, and has an impact on a company's image. The app markets are growing continually, and the challenge is to stand out positively from the crowd.

One major success factor for apps is therefore very high user experience and availability in all relevant app stores, if possible.

Methodological work with the i2ME framework

These are the reasons why two tools were developed in the project UID4Mobile to design apps for different mobile platforms efficiently and with a large degree of platform-specific UX:

I2ME Framework (Interactive Mockup Building for Mobile Environments)

The i2ME framework allows fast and efficient development of cross-platform, interactive mockups during the design of an app. It focuses on quickly and effectively developing mockups that can be tested by the user on his device.

Mobile User Experience Pattern

Mobile user experience patterns support the design of apps for various platforms as well as the transfer of an app from one platform to others, taking into account platform standards and positive user experience.

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Competence
Distributed Data Usage Control

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In modern enterprise networks, sensitive data are stored, processed, and exchanged around the clock via distributed services, processes, and employees. The megatrend towards Cloud Computing brings additional complexity and leads to new challenges in the area of data security. Here, control over sensitive data is particularly important since the boundaries between domains, systems, and services are becoming more and more blurred in the Cloud. In addition, employee mobility is increasing in many business processes. Business life without mobile devices has become inconceivable. However, this does not only open up improvement potential for business processes, especially in the area of smartphones, but also entails various potential risks.

Distributed data usage control allows controlling the dissemination and usage of data beyond the initial access. Data usage control extends established access control and digital rights management solutions and offers added value in the area of data security.

The IND²UCE (Integrated Distributed Data Usage Control Enforcement) framework of Fraunhofer IESE comprises all components that will lead to comprehensive data usage control in your company. Thanks to its component-based structure, IND²UCE allows customized security for any usage area. Depending on the use case, new components can thus be integrated seamlessly into an existing IND²UCE framework.

Example Project

SECCRIT: SEcure Cloud computing for CRitical infrastructure IT

Requirements on the Cloud, such as high levels of availability, resilience, and IT security, are indispensable for the use of Cloud technologies in the area of critical infrastructures, as is the guarantee that these will actually be delivered. However, the guaranteed implementation of these requirements continues to present a challenge.

The correct specification of security policies is an error-prone process and can often only be performed by security experts in collaboration with domain experts. In addition, suitable tools for specifying security policies in a simple and user-friendly manner are currently still missing. Furthermore, existing security solutions do not dynamically adapt to the current usage context, which can result in suboptimal behavior of the Cloud environment. Undifferentiated treatment may ultimately lead to insecure service delivery.
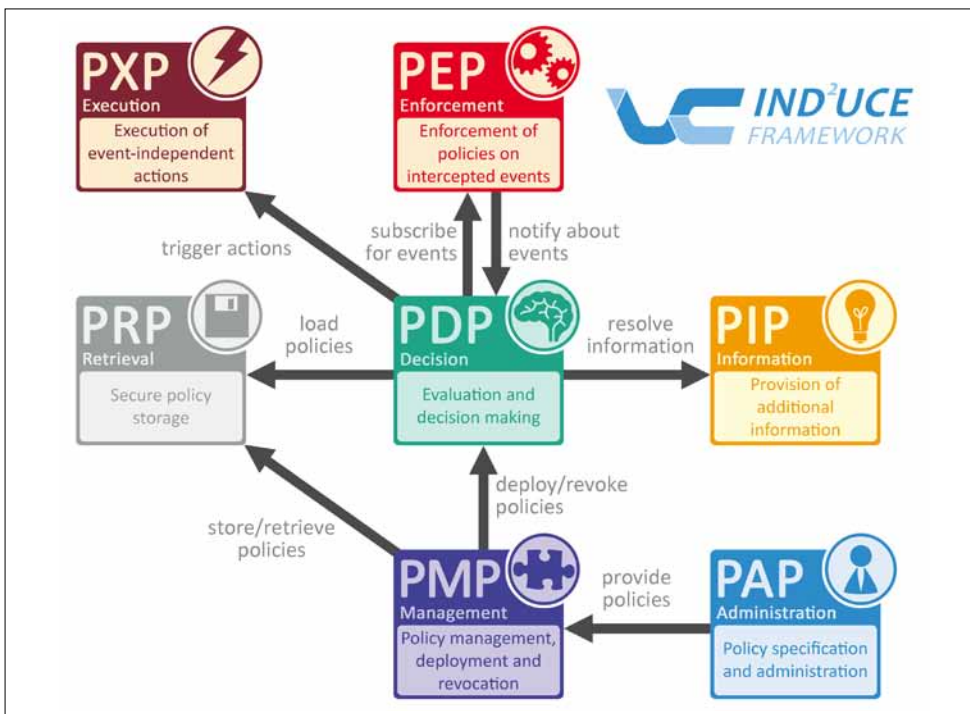
IND²UCE Framework

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Among other things, Fraunhofer IESE is performing research into how context-dependent security policies can be specified in a simple and user-friendly manner on the one hand and enforced in established Cloud environments on the other hand. Here, an interesting research question is which context information must be exchanged between the infrastructure and the service level to enforce security policies dynamically. For example, it is possible to define security policies that require the separation of critical or competing services, that enforce the storage of data in a particular place, or that only allow migration of services within Europe.

The goal is to adapt the components of the IND²UCE framework to Cloud technologies and to integrate them into these. With the help of specific components of the IND²UCE framework, context information from different levels of abstraction, for example, are brought together and security decisions are made in a context-sensitive way. To reduce complexity during specification, templates for security policies are also created in the application domains being considered. In this regard, a uniform taxonomy is to be used as a basis. In the context of the research, a Cloud testing environment (Cloud Lab) is being set up at Fraunhofer IESE.

Further Information

Project Homepage
www.seccrit.eu

Collaboration Partners

see Project Homepage
www.seccrit.eu/consortium

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Many projects expend more effort on testing activities than necessary. In order to avoid this, Fraunhofer IESE focuses test activities, for example with the help of the "In2Test" approach, by performing inspections and using the results from these in addition to early quality assurance for controlling the test, which helps to save effort and also increases overall quality. Different types of inspections that already allow quality assurance of documents at an early stage of the software lifecycle can be selected jointly with Fraunhofer IESE and can be adapted to the context at hand. For further support, the Fraunhofer tool DETECT can be used, which supports manual inspections, for example by offering appropriate reading support.

In addition, the competence Integrated Quality Assurance together with other competencies is involved in ensuring different qualities such as Security or User Experience (UX), as well as in addressing particular types of defects (such as inconsistent data) or the systematic derivation of test cases from requirements. This competence also covers quality assurance in new areas such as mobile applications or agile development.

We offer you help in evaluating quality assurance as well as in the selection, adaptation, introduction, optimization, and performance of quality assurance.

Example Project

MBAT: Combination of Analysis and Test

Quality assurance is an integral part of modern software development. High-quality software is often a must, particularly in the numerous software systems surrounding us everywhere today, for instance in the automotive, rail, and aviation industries. In such systems, which are often extensive and complex, failures can have serious consequences (e.g., financial losses, loss of trust, or risk for human lives). Various quality assurance activities are applied to models or to code. However, quality assurance is often an expensive and time-consuming endeavor, and in the end, the quality of the software is often still bad. New approaches are therefore needed to deal with these challenges. An emerging trend is stronger integration of different quality assurance techniques instead of isolated application, the aim being the exploitation of additional synergy effects such as higher effectiveness, efficiency, or coverage.
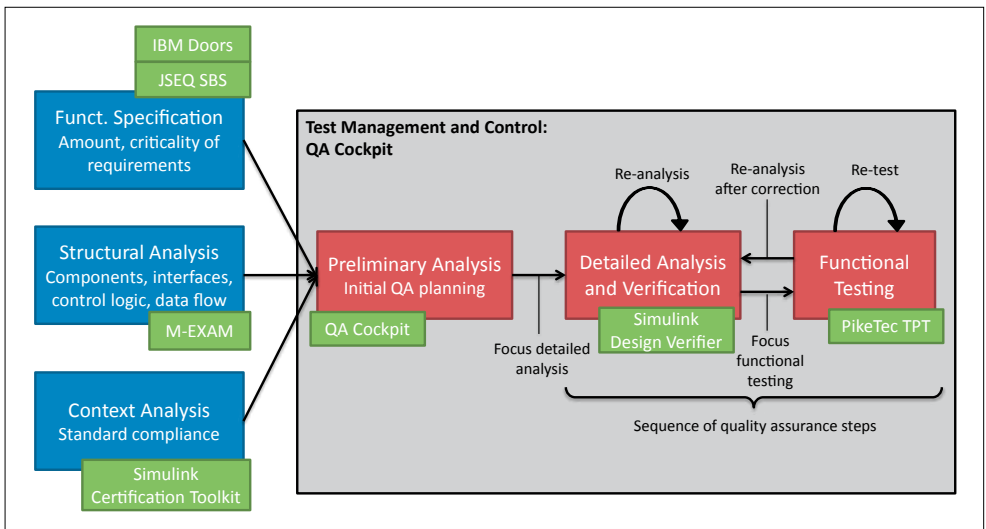
Combination of analysis and test with support by different tools

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In the MBAT project, Fraunhofer IESE is working on a concrete possibility of integrating different analysis and testing activities. Based on the "In2Test" approach, which combines especially inspections and testing, concepts are generalized and used to enable different combinatorial possibilities for analyses and tests: for example using test results to employ analysis as a complementary measure in a goal-oriented way, or the parallel use of these techniques to cover more types of defects. In particular, Fraunhofer IESE is working on a solution with which static analyses can be used for performing tests in a more goal-oriented manner. In addition, a tool chain is being developed with the help of various prototypes, which will enable the development of models for analyses and tests, and commercial as well as open source tools are being integrated that allow analyses and tests to be performed. A tool prototype for the visualization of a wide variety of quality assurance data completes the tool landscape. This prototype helps to focus tests by means of selection rules.

In addition to the development of models and tools, Fraunhofer IESE is not only involved in the evaluation of the sketched solution, but also in the evaluation of the solutions of other partners from the MBAT project. Quantitative data as well as qualitative knowledge is collected and packaged by Fraunhofer IESE and used for deriving recommendations for many different possible combinations of analyses and tests, making it possible to offer added value in software development and quality assurance in other contexts.

Further Information

Project Homepage
www.mbat-artemis.eu

Collaboration Partners

see Project Homepage
www.mbat-artemis.eu/home/
index.php/partners

INNOVATIVE OFFERS OF FRAUNHOFER IESE

In addition to its project activities, Fraunhofer IESE is also involved in other forms of collaboration and technology transfer. Besides offering various seminars, e.g., in the areas of software architecture, variation management, security and safety, the institute is a partner in the systematic continuing education of software engineers for embedded systems. This unique distance study Master's degree program was designed in close cooperation with the University of Kaiserslautern and has been running successfully for several years.

Innovative is also the right term for describing the collaboration model "Joint Research & Development Lab", which is particularly tailored to the needs of small and medium-sized enterprises (SMEs) and builds a bridge between future-oriented research and innovative software development. Here, the method competence of the researchers of Fraunhofer IESE meets the product competence of the software developers of an organization. Close cooperation in concrete projects accelerates the technology transfer.

In the area of Embedded Systems, a competence center is being created with the "Prognostics Center", which offers online decision support and risk assessment in strategic questions, such as porting to multicore hardware platform.

For several years, Fraunhofer IESE has also been positioning itself successfully as a partner and moderator of interdisciplinary innovation workshops. Here, the aim is to support companies in developing product visions and roadmaps (see page 76).

Prognostics Center at Fraunhofer IESE

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Prognostics is the principle of combining the prognosis of quality attributes and diagnostics based on models in early development stages. The artificial word Prognostics characterizes the necessity to substantiate decisions in systems and software engineering with sound facts. The Prognostics Center at Fraunhofer IESE implements analysis methods that are based on virtual prototypes to derive those facts for relevant architectural decisions.

How to port a system to multicore processors? How to safeguard a system? How to achieve the planned business goals with the system design?

Central design decisions are often made very early in the course of development processes. Even though these decisions have a significant impact on the system architecture, they are often made on the basis of opinions and experiences. There are rarely any tools that can reliably predict the impact of such decisions.

To support these decisions, virtual system prototypes are being developed at the Prognostics Center at Fraunhofer IESE. These allow the use of our simulation and analysis tools for predicting the impact of architecture-relevant decisions with the help of facts. Examples are support for the parallelization of existing code on multicore platforms and validation of safety concepts prior to the implementation of the system. This saves time and money since defects and wrong decisions are detected and eliminated early on with the help of the virtual prototype.

The Prognostics Center at Fraunhofer IESE uses newly developed modeling, analysis, and simulation techniques for predicting the behavior of embedded systems and embedded software. A Prognostics evaluation is performed in four phases:
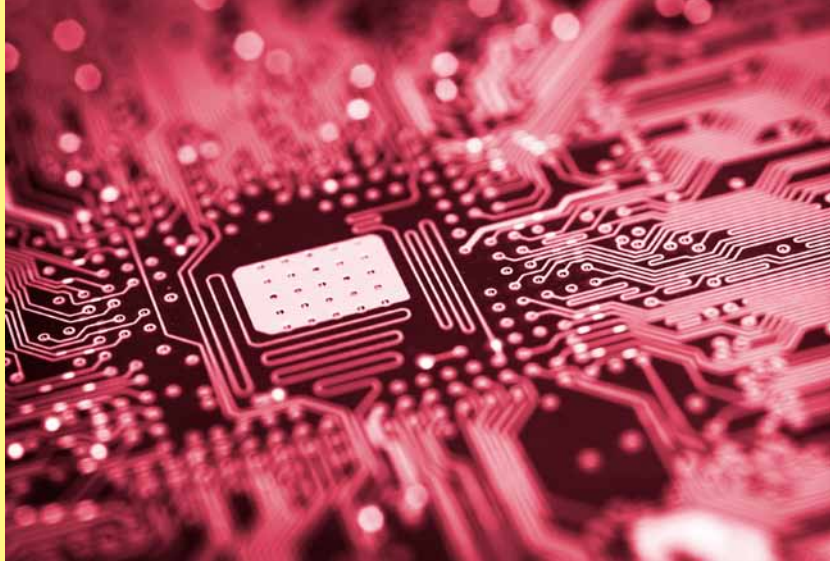
- Model construction: Based on the available information, an analysis model of the system is developed with our modeling technologies and domain-specific languages.
- Analysis: Simulation and analysis tools of Fraunhofer IESE are used to predict the impact of design decisions and to generate measurable results.
- Evaluation: The results of the analysis phase are evaluated and assessed.
- Optimization: Based on the results of the evaluation, decisions are reviewed together with the customer in order to achieve the best possible results.

The following areas are addressed by the Prognostics Center at Fraunhofer IESE:

- How to port a system to multicore platforms? Data dependencies and potentially concurrently used functions of a system are determined with specialized analysis tools. Possible distributions of the existing code are analyzed, code blocks and accesses that must be adapted if parallelization is performed are identified. Together with developers and domain experts, the system architecture is optimized to make it fit for future multicore platforms. This works for non-classified systems as well as for safety-relevant systems and system components.
- How to safeguard a system? Integrated functional models and safety analysis models of a system are created with specially developed modeling approaches. These models are analyzed and evaluated in order to detect possible weak points early on and to optimize the system design.
- Can a system achieve the planned business goals? Regardless of whether open interfaces of a system must be safeguarded, or whether a new variation concept is installed – the resulting design decisions are of strategic importance. Virtual prototypes are used to investigate the impact of these decisions on the basis of system models, and measurable facts are generated to support these decisions. This provides optimal support for strategic decisions.

Joint Research & Development Lab

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Small and medium-sized enterprises (SMEs), in particular, are increasingly faced with the challenge of having to keep up with the pace of globalizing markets. Innovation is a crucial factor for accomplishing this. On the one hand, innovative products must be brought to market in order to be able to compete with business rivals, and, on the other hand, innovative development methods must be applied in order to make the products available on the market as early as possible and with high quality. Against this background, the systematic use of engineering-style methods, techniques, and tools (software engineering) is becoming much more important, particularly in software development.

In order to achieve market maturity early on, lessons learned from science and research are indispensable. This is also true for a product's level of innovation. Vice-versa, industry provides science with important lessons learned from practical application, which serve to identify research needs and to test the practical applicability of research results. There exists a close interdependence between research and industry when it comes to successfully placing an innovative product on the market.

In Germany, SMEs play an important role, but are also faced with a multitude of possibilities and even more challenges. Unlike other domains, software developing companies do not require an expensive development infrastructure. The advantage – and disadvantage – of this fact is that SMEs thus can, respectively must, compete directly with large corporations. In order to be able to hold their own in this competition, SMEs are exposed to substantial financial pressure.

Large companies often have their own research departments. SMEs, however, usually do not have the necessary financial means that would allow them to establish their own research departments. Even if a highly specialized research activity exceeds the capacity of its own research department, a large company can still enter into a research contract with an external research institution. This does, of course, entail costs, which are generally not feasible for SMEs.

In this situation, help comes from the novel cooperation model of the "Joint Research & Development Labs (Joint R&D Lab)" offered by Fraunhofer IESE, which creates a bridge between future-oriented research and innovative software development. Here, the method competence of the researchers of Fraunhofer IESE meets the product competence of the software developers of a company. This is particularly beneficial for SMEs, since this investment is far more cost-efficient than operating one's own research department. The Joint Research & Development Lab offers a suitable alternative in this situation. In specially equipped laboratory facilities at Fraunhofer IESE, the project teams, consisting of Fraunhofer IESE staff and employees of the collaborating software manufacturer, are working on new ideas, are eliciting requirements, de-
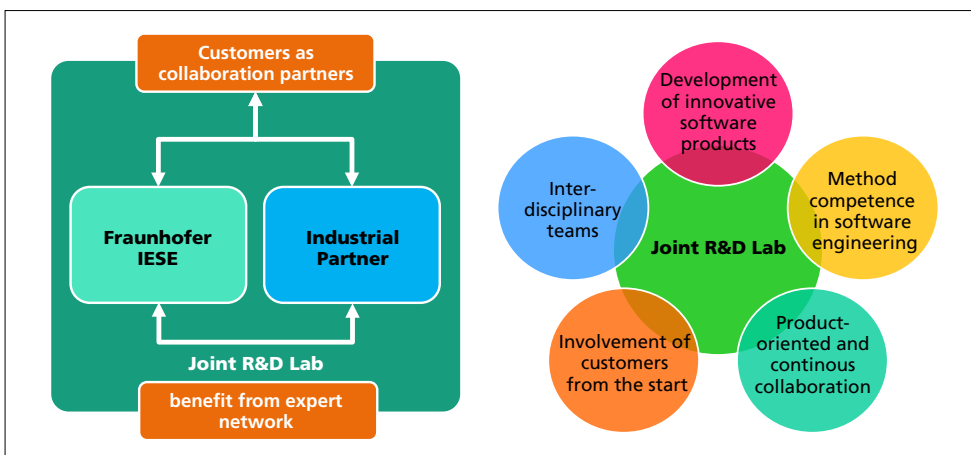
The concept of the Joint Research & Development Lab, showing close cooperation (left) and resulting in numerous benefits (right).

signing software architecture, developing and evaluating the quality of the resulting software. Throughout this entire process, particular emphasis is placed on involving the end customers of the industry partners as early and as continually as possible. This involvement of decision makers and users helps to focus on aspects that are important for customers and increases quality by enabling early feedback. End customers can also be included in creativity workshops performed in the Joint R&D Lab. With the help of selected creativity techniques, innovative product, feature, or method ideas are developed in these workshops.

This allows the researchers of Fraunhofer IESE to identify improvement potential in the cooperation partner's product and process and provide direct support. This is of crucial importance, as every company uses its own development methodology, which has been adapted to its specific context. In order to improve the development, adaptations must therefore be performed individually for each company. Such adaptations can be implemented faster and better if the scientists are able to collaborate directly with the company's developers in a real development situation.

The goal of the collaboration in the Joint R&D Lab is direct cooperation throughout the entire development cycle of state-of-the-art software products. The combination of a company's competencies with the supplementary knowledge of a research institute creates an innovative edge and ensures competitiveness, both nationally and internationally.

In the first Joint Research & Development Lab, Fraunhofer IESE is successfully collaborating with Insiders Technologies GmbH in Kaiserslautern in the development of the product "smartCOCKPIT".

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Fraunhofer Academy: Seminar "Software Architecture" Successful again in second year

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If state-of-the-art research knowledge is to fulfill its innovative potential in a company, clever minds are needed that know how to use this knowledge. The requisite qualification of specialists and managers is offered by the Fraunhofer Academy, which is the Fraunhofer-Gesellschaft's professional provider of career-compatible continuing education. Specialists and managers benefit from a unique knowledge transfer from Fraunhofer research into industry.

With more than 50 projects and a total of more than 30 person-years of project experience, the instructors of Fraunhofer IESE have packaged their approach ACES (Architecture-Centric Engineering Solutions) and are offering this knowledge in the context of the Fraunhofer Academy as "Software Architecture" seminars.

Practical experiences combined with the fundamentals of applied research make the seminar "Software Architecture" an event for experienced architects from a practical background and those aspiring to be such architects. In this seminar, the participants learn about the tools of successful software architects and benefit from the comprehensive expertise of the instructors. In accordance with the philosophy of Fraunhofer, the seminar is characterized by very high practical relevance, interactivity, and a large proportion of exercises in which the participants apply what they have learned in practice.

Since 2012, Fraunhofer IESE has been offering the seminar at the Fraunhofer Center in Kaiserslautern twice a year (in April and in November). Here, participants from different domains come together. In addition to the knowledge taught, the exchange between the participants, in particular, is perceived as positive. Fraunhofer IESE also offers customized in-house seminars, where the instructors hold the seminar at the customer's site. In such cases, the contents can be combined individually for the respective customer, and case examples from daily business can be discussed in the practical exercises.

In 2013, more than 30 participants attended the seminar "Software Architecture". As in the previous year, the participants were all very satisfied with the seminar itself, with the packaging of the contents, as well as with the learning atmosphere. In 2014, too, regular seminars will be offered and the instructors will be available for in-house seminars. A particular characteristic of all seminars is that the instructors always discuss current issues and trends as well. The instructors Thorsten Keuler, Jens Knodel, and Matthias Naab are looking forward to further interesting seminars with many participants eager to discuss software architecture issues.
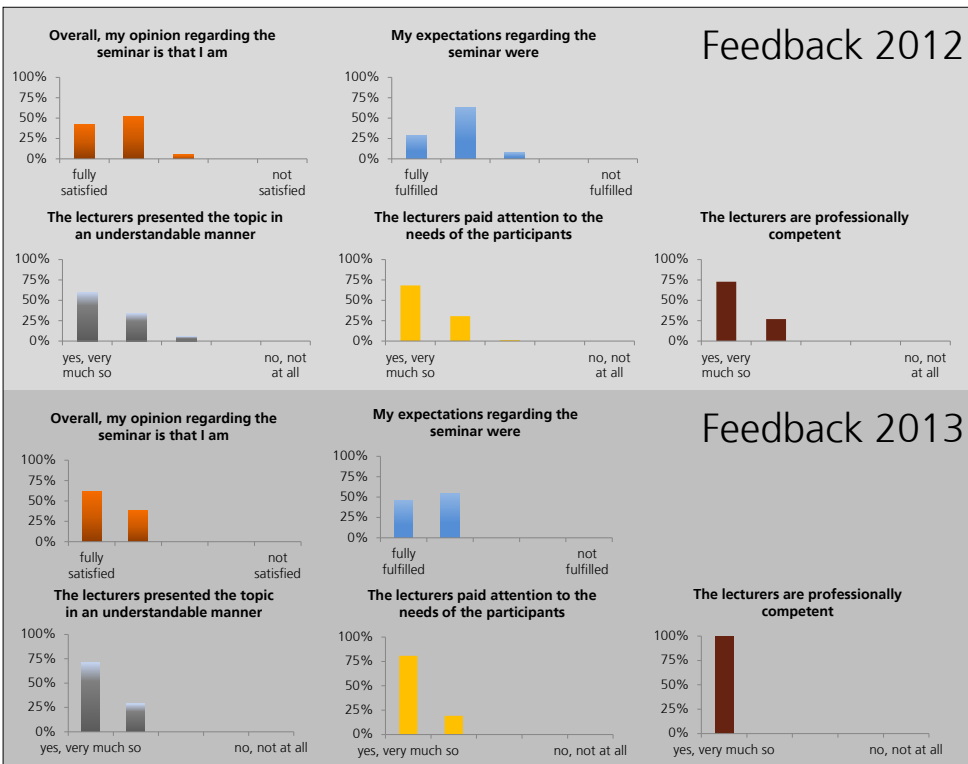
Top: Practical exercises during an Academy seminar; participants and instructors of the Academy seminars 2013

Left: Feedback by the seminar participants in 2012 and 2013

Comments from participants of the 2013 "Software Architecture" seminars at IESE:

■ *"A very good mixture of theory and practice with guaranteed success"*

■ *"Very good basic course on the topic of software architecture, methodology, and tools"*

■ *"You get a complete overview of all aspects of software planning & architecture, without practical issues being neglected"*

■ *"Structured, systematic, and holistic examination of software architecture"*

■ *"For me, the contents and the representation led me to expand my horizon with regard to software architecture"*

■ *"The seminar provides an excellent overview of the topic area of "Software Architecture", presents a practical guideline on how to address this area (ACES methodology), and rounds off everything with tool support."*

Collaboration Partner

Fraunhofer Academy
www.academy.fraunhofer.de

Fraunhofer
ACADEMY

Distance Study Degree Program: Software Engineering for Embedded Systems (M.Eng.)

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Progress in medical technology or in the automotive industry, which used to be determined by mechanics and electronics, is nowadays achieved to a large extent through software. This results in tight interconnections between hardware and software components, so-called "embedded systems". The methods and tools for embedded systems have significantly evolved in recent years and pose new professional challenges for people in charge of development and management departments.

For this reason, the Fraunhofer Institute for Experimental Software Engineering IESE and the Distance and Independent Studies Center (DISC) of the University of Kaiserslautern have joined forces and have been offering a career-integrated English-language distance study degree program specialized for "Embedded Systems" ever since the winter semester 2008/2009.

The goal of the program is to familiarize engineers in positions of responsibility with current fundamentals and techniques from research and practice. The Master's degree program "Software Engineering for Embedded Systems" does not only teach the theoretical basics, but also project management skills and skills for the development of complex, software-intensive systems as well as the application of "best practice" methods, techniques, and tools.

The internationally oriented, English-language program is aimed at computer scientists as well as mechanical and electrical engineers with at least two years of relevant professional experience in software development. Mathematicians and physicians who want to expand their qualification profile with skills in software development and new technologies can also open up new job areas for themselves by attending this program.

Collaboration Partners

Distance & Independent
Studies Center (DISC)
http://www.zfuw.de

Fraunhofer Academy
www.academy.fraunhofer.de

TU Kaiserslautern
www.zfuw.uni-kl.de/
fernstudiengaenge/science-
engineering/software-
engineering-for-embedded-
systems

The curriculum is taught in English as a distance study program, and the theoretical and methodological knowledge is practically applied during two classroom phases held at the software engineering laboratory of Fraunhofer IESE. On average, 20 students enroll every year for this continuing education program. The students come from all European countries; a third of them now come from Asia.

The four-semester study program ends with the degree Master of Engineering (M. Eng.) awarded by the University of Kaiserslautern.

The program is accredited by the Accreditation Agency for Study Programs in Engineering, Informatics, Natural Sciences and Mathematics ASIIN. In 2014, the program will be re-accredited.

In mid-2009, the Fraunhofer Academy included the Master's degree program "Software Engineering for Embedded Systems" in its portfolio "First-Rate Continuing Education Programs".
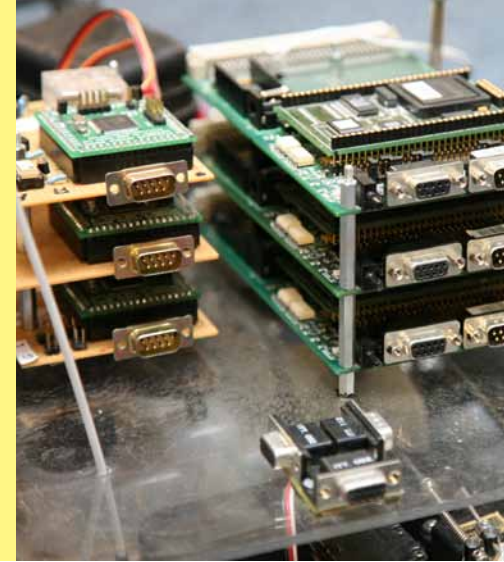
Master-Thesis	
Semester 4	

Classroom Session E.2

Real-Time Systems	Dependability Engineering

Component-based Software Development	Model-based Component Engineering	Software Development Studio
		Semester 3

Classroom Session E.1

Requirements Engineering	Software Product Line Engineering

Software Quality Assurance	
	Semester 2

Classroom Session 1

Software Development for Embedded Systems	Project Management

Software Engineering Introduction	
	Semester 1

At a Glance:

Career-Integrated Distance Study Program

Degree: Master of Engineering (M.Eng.)

Duration: 4 semesters (career-integrated)

Costs per Semester: 1950 €
+ currently 90 € social fees

Start: each winter semester (1 October)

Language of Instruction: English

Study Organization:
Self-directed study and classroom modules at the software engineering lab of Fraunhofer IESE

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN
DISTANCE AND INDEPENDENT STUDIES CENTER

ASIIN e.V.
akkreditierter Studiengang

"Nowadays, engineers for "Embedded Systems" must be able to deal professionally with mechanics, electronics, and increasingly also with software. In this program, experienced professionals learn about state-of-the-art software engineering for "Embedded Systems" on the basis of the most up-to-date research results of Fraunhofer IESE."
Prof. Dr. Dieter Rombach, Executive Director, Fraunhofer Institute for Experimental Software Engineering IESE, Kaiserslautern

Fraunhofer
IESE

**Fraunhofer CESE
USA**

**Project Center
Brazil**

**Project Center
Australia**

INTERNATIONAL ACTIVITIES

Fraunhofer IESE has a very strong international orientation. This is not only reflected in the fact that IESE currently employs staff from ten different nations and that the language of the institute is English, but can also be seen in the growing number of international projects.

Fraunhofer IESE has established subsidiaries in the strategically important countries USA, Australia, and Brazil (so-called Centers resp. Project Centers):

■ Fraunhofer Center for Experimental Software Engineering (CESE) at the University of Maryland, College Park, MD, USA (since 1998)
■ Fraunhofer Project Center on Transport & Logistics at NICTA, Sydney, Australia (since 2010)
■ Fraunhofer Project Center for Software and Systems Engineering in Salvador, Bahia, Brazil (since 2012)

From the perspective of Fraunhofer IESE, these subsidiaries pay off for various reasons: additional competencies, which we can in turn offer to our customers in Germany and in Europe; additional third-party industry project funds; and the acquisition of highly qualified staff. Examples of additional competencies are the development of the reverse engineering tool SAVE or the business alignment method GQM$^+$Strategies® together with Fraunhofer CESE in the USA. Various collaboration projects exist in the context of the European Union and beyond, e.g., with Brazil and Japan. Personnel acquisition is currently most promising via our contacts in Brazil.

In the following, we present our subsidiaries and describe some selected international projects:

Fraunhofer

USA

Fraunhofer Center for Experimental Software Engineering CESE, Maryland

Director: Prof. Dr. Rance Cleaveland

The Fraunhofer Center for Experimental Software Engineering, Maryland (CESE) is located in College Park, Maryland, and conducts applied research in software engineering processes and technologies. It collaborates with private-sector organizations, government agencies, and academic and research institutions to develop innovative, practical approaches to software development and management issues.

Fraunhofer CESE has affiliations with the University of Maryland at College Park and the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern, Germany.

The Center's project portfolio includes a mixture of research efforts into new software technologies and empirical evaluations of existing tools and processes, and service-provision contracts to assist clients with software development and acquisition needs. Customers include government agencies such as NASA and the US Food and Drug Administration; large multi-national companies such as Johnson & Johnson, Agilent, and Robert Bosch; and small and medium-sized companies with software needs in the Washington, D.C. – Baltimore, Maryland corridor.

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Competencies

- Measurement and Knowledge Management
  Contact: Dr. Madeline Diep
- Software Management and Process Improvement
  Contact: Michele Shaw
- Software Architecture and Embedded Software
  Contact: Dr. Mikael Lindvall
- Software Verification and Validation
  Contact: Prof. Rance Cleaveland

Business Areas

- Aerospace / Defense
  Contact: Frank Herman
- Automotive
  Contact: Prof. Rance Cleaveland
- Medical
  Contact: Dr. Mikael Lindvall

University Partners

- University of Maryland at College Park
- University of Maryland at Baltimore County
- University of Kaiserslautern

Other Partners

- NASA Goddard Space Flight Center
- NASA IV&V Center
- Battelle

PROJECTS IN PROGRESS

**NASA Space Network Ground Segment Sustainment
(Competencies: Measurement, Project Management)**

The NASA Space Network (SN) is a communication signal relay system that provides tracking and data-transfer services between user platforms and user Mission Operations Centers (MOCs). The SN was established in the early 1980s to replace NASA's worldwide network of ground tracking stations and consists of a constellation of data relay and tracking satellites and associated ground systems. This space-based relay system can provide essentially unlimited communication services for altitudes ranging from 73 km to 9000 km, a capability that is unique within the civilian and commercial space industry. In addition, limited communication services can also be provided for customer platforms located on the ground and ocean/ sea surfaces (e.g., ships) as well as airborne platforms (e.g., atmospheric balloons).The fleet of Tracking and Data Relay Satellites (TDRS) in geosynchronous orbit serves as a data relay system between SN ground system and user platforms.

The SGSS project replaces a majority of the existing SN Ground Segment with modern technology in order to fulfill the following objectives:
1. Monitor and control the SN Flight and Ground Segments; including management of the configuration, health, and safety of the TDRS spacecraft fleet and SN Ground Segment elements.
2. Provide SN user service planning and scheduling.
3. Relay user signals in forward and return directions between the ground and user platforms.

4. Distribute user data on the ground using NASA Integrated Services Network (NISN) services, user-provided networks, and local interfaces (LIs).
5. Provide tracking services for TDRS and user spacecraft.

The heart of Fraunhofer CESE's SGSS research is the collection and analysis of software progress and quality metrics from the SGSS development contractors. Software progress metrics include measures such as requirements decomposed; requirements volatility; components designed, coded and tested; etc. Software quality measures include defects found, defects corrected, etc. The analysis of these metrics permits Fraunhofer CESE to identify areas of risk and opportunities for improvement of contractor outputs delivered to NASA. Fraunhofer CESE also uses the metrics analysis to research new technologies and to infuse those that demonstrate risk reduction, better cost/schedule adherence or software technology improvement into both the NASA Project Team and the SGSS development contractors. Specific technologies that Fraunhofer CESE is researching include software cost and schedule estimation and tracking, software defect detection and Reliability Growth Models, Service Oriented Architectures (SOA), and software metrics presentation techniques.

Fraunhofer CESE has also played key roles in 2013 in various critical design reviews for the SGSS project, and it has been instrumental in using its metrics-based performance research to provide feedback and insight to NASA staffers on the performance of the main software subcontractor.
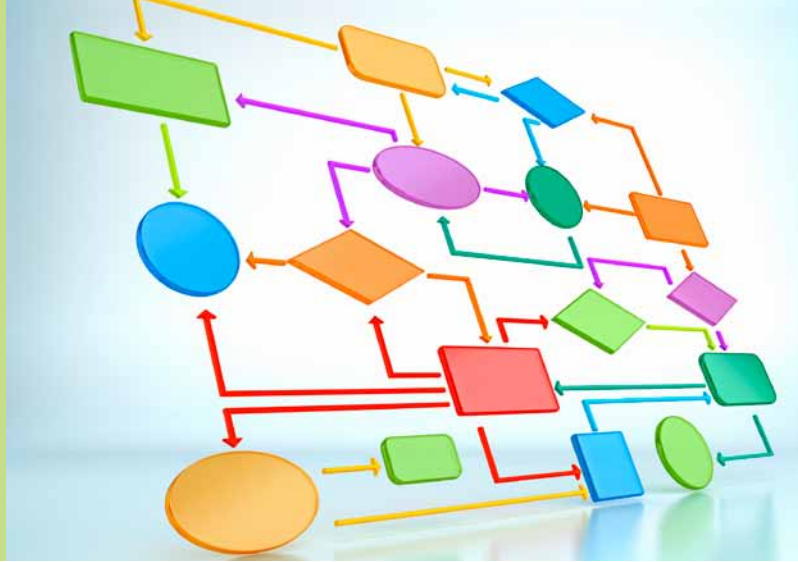
**Keymind Process Improvement
(Competencies: Measurement, Process Improvement)**

A long-time Fraunhofer CESE process improvement customer, Keymind, a division of Luminpoint, Inc., has worked closely with Center staff since 2004 to improve its software processes. Fraunhofer CESE provides support for Keymind's improvement initiative, which includes defining and implementing high-maturity, quantitatively-based processes, sustaining their maturity ratings as defined by the CMMI for Development (CMMI-DEV) framework, and performing other process-related work focused on achieving positive impacts on Keymind's business goals and project objectives. Keymind achieved a CMMI Maturity Level 5 rating with help from the Center's innovative application of empirical methods and tools.

Central to any process-improvement initiative is the idea that the selection and application of appropriate processes using empirical methods produces good products. This empirical mindset provides a basis for choosing the appropriate processes, analyzing the effects of those selections, and packaging the resulting knowledge for reuse and evolution; it drives an effective process improvement initiative. The work at Keymind exemplifies some of the important factors that differentiate the Fraunhofer CESE approach, including:

1. Tying the measurement of technical processes specifically back to the organizational and strategic goals, to give both technical leads and managers a "top-to-bottom view" that helps them understand how their specific projects further the overall goals of the organization.
2. Eliciting context-specific quality indicators that can be applied to projects to identify potential risk areas, and which can be refined by capturing feedback from the teams and objective measures of impact.

3. Creating automated approaches to data collection, reporting, and analysis that can greatly reduce the time and effort required for the organization to gain insight about their projects.
4. Using innovative visualization tools that allow organizations to intuitively gain an understanding of the important points, including tools such as the CodeVizard application that Fraunhofer CESE has helped develop. CodeVizard automatically analyzes and provides an interactive visualization of the whole history of a software project, allowing developers to explore how often quality indicators have been fulfilled and what corrective actions have been taken.

In accomplishing all of those goals with Keymind, Fraunhofer CESE is applying technologies that resulted from several NSF-funded research projects as well as internal research undertaken in partnership with its sister institute, Fraunhofer IESE. Through their application in the context of a highly mature customer with a commitment to software quality, this work has also provided peer-reviewed results that add to the state of the art in the area.

**Modeling and Analysis of Cyber-Physical Systems
(Competencies: Software Architecture, Embedded Systems)**

With the University of Maryland and a team of universities around the US, researchers at Fraunhofer CESE have been working on techniques for modeling cyber-physical systems (CPS). CPS consist of physical components and computing infrastructure; examples include control systems in automobiles and airplanes. Major research efforts in the US and Europe are devoted to the development of better mechanisms for designing, implementing, and validating such systems. The consortium that includes Fraunhofer CESE has been funded by the National Science Foundation to develop novel modeling strategies and verification techniques for CPS.

At Fraunhofer CESE, efforts have focused on the use of software architecture concepts to simplify and standardize the modeling of hybrid systems; the development of machine-learning-based methods for reconstructing requirements specifications for such models, and the use of formal-methods verification techniques, such as model checking, to verify the safety of medical-device controllers.

**The Fraunhofer Approach to Software Testing (FAST)
(Competencies: Software Architecture, Verification and
Validation)**

Since 2011, Fraunhofer CESE researchers have been developing FAST, which is a method for testing software from different domains such as aerospace, medical devices, and web software.

FAST is based on two fundamental technical principles. The first is Design for Testability. Based on extensive experience in working on large-scale software systems, Fraunhofer CESE staff members have collected an informal corpus of knowledge encompassing principles that are used by the best software engineers at NASA and JHU/APL to enhance the ease of testing software. These best practices dramatically improve the testability of the final product.

The second technical foundation for the FAST is Model-based Testing (MBT). MBT is a new technology developed in the research community that has attracted attention among practitioners. In MBT, tests are specified as abstract, programming-language-independent models. A translator maps abstract test specifications to concrete tests. The advantages of this approach are as follows:

1. Such test models are insulated from changes in the source code, thus radically reducing maintenance costs.
2. One creates a test specification only once in terms of a model and executable test cases are automatically generated without programmer intervention.
3. Models are much easier to understand than code for humans and allow all stakeholders to understand how the SUT is being tested.
4. Tests automatically generated from behavioral models cover aspects of system behavior in a much more complete manner compared to manually written tests.

The FAST approach currently relies on models developed as state machines or as Simulink® diagrams, and uses tools such as JUMBL, GraphWalker, and Reactis® to generate model-level tests that the FAST framework then translates into code-level test scripts. The technology has been used in several projects to date, including:

1. Center researchers continued to uncover previously unknown critical issues in NASA ground systems and flight-software systems. While the detected defects were

reported to NASA, these testing projects were also docu-
mented and used as tutorials and presentations that have
been used to demonstrate the technology's capabilities.

2. Center staff also continued to use the FAST approach
to test several commercial software systems, resulting
in different types of detected software errors. Using the
FAST approach, software may be improved for testability
and then systematically tested because of the structured
approach to software testing it facilitates.

**Measuring and Monitoring Technical Debt
(Competencies: Measurement, Project Management, Pro-
cess Improvement)**

In collaboration with the University of Maryland-Baltimore
County (UMBC), a Fraunhofer CESE research group has been
engaging with a number of different organizations on ques-
tions related to technical debt. This term refers to the tradeoff
that occurs when developers focus on achieving short-term
gains (like delivering an increment of the software on time)
at the expense of long-term benefits (like keeping software
code maintainable and well structured). Project researchers
have been working with a number of different teams to look
at what strategies can be effective for them with respect to
identifying and deciding what to do about technical debt.

It should not be a surprise to anyone that what constitutes
technical debt can vary greatly from one project to another –
as do the tradeoffs that teams are willing to make regarding
it. The common thread that has been found across all of this
work is that projects should devote some time to understand-
ing what kinds of technical debt are of interest and how the
accumulation of the debt can be measured. Some examples
include the following:

1. Fraunhofer CESE researchers worked with a team at a
multi-national company that provides document-related
business solutions, products, and services. The team was
working on device drivers for the company's high-end
products, and due to the size and variety of the customer
base, maintainability and portability were a must. To find
areas where the code had decayed, the Fraunhofer CESE
staff investigated computer-assisted support for detecting
"code smells," anti-patterns formulated by Kent Beck as
a way to help identify areas where good design principles
were breaking down. Although some tailoring of the
heuristics was necessary, these "smells" turned out to be
a useful way of identifying areas the team agreed were
accumulating technical debt.

2. With a mid-sized, local software development company
that focuses on database-driven web applications, Center
researchers found that they highly value the use by their
projects of a reference architecture. In this case, instances
where developers design their own solutions and avoid
reuse represent technical debt, since redesigning the
system to be in compliance is expected to lead to greater
understandability and maintainability over time in the
future. In this same context, Fraunhofer CESE also had
some promising results with finding potential code smells
and out-of-date documentation as indicators of technical
debt.

3. With a team developing high-performance code for
supercomputers, Center scientists noticed that they solve
the difficulty involved in making optimal use of the parallel
processors by strongly separating calls to the parallelization
libraries from the code doing scientific simulation – thereby
allowing both the computer scientists and the domain
experts to focus on what they know best. Instances where
this separation of concerns breaks down should be treated
as technical debt – that is, by detecting and fixing where

the planned architecture of the system is not followed, Fraunhofer CESE can help the developers create a more maintainable, more flexible system.

In all cases, the research team has developed a process that is bearing fruit for these teams: Find some initial examples of what appears to constitute technical debt for the development team; show those examples and have a group discussion about whether it would be useful to take some time to "pay down that debt"; then either find additional examples that seem to fit the same mold or update relevant definitions of debt in this environment.

GQM⁺Strategies®
(Competencies: Measurement, Project Management)

Scientists from Fraunhofer CESE and Fraunhofer IESE have jointly developed the GQM⁺Strategies® methodology to provide a framework for connecting business-level goals with software-project-specific technical metrics and management artifacts. Fraunhofer CESE and IESE staff members have collaborated on delivering GQM⁺Strategies® services to ECOPET-ROL S.A., a Colombian oil company. Fraunhofer CESE has also used the approach on projects with NASA, MITRE, and Axiom, the parent of the Keymind company referred to above.

Fraunhofer CESE continues to collaborate with Fraunhofer IESE to refine the GQM⁺Strategies® methodology, and to package the technology so that it can be used to improve staff efficiency in the measurement-related project work that is a core capability for both CESE and IESE. The collaboration continues to build a unique and marketable Fraunhofer capability, which will address one of the organizations' business areas and facilitate projects at both CESE and IESE. Both CESE and IESE have developed a set of assets that are reusable for both centers, including: a training course for use with customers and collaborators, a process description, a tool for visualizing the GQM⁺Strategies® outputs, and case studies – all of which stem from the knowledge, experience, and expertise resulting from the various engagements involving CESE and IESE with customers.

Fraunhofer CESE in Figures

Fraunhofer CESE revenues in 2013 were flat compared to those in 2012; there was no growth, but also no decline. The lack of growth may be attributed to ongoing turmoil in the budget of the US federal government. Indeed, due to an impasse among the governing parties, the entire government shut down for almost two weeks in October 2013. For this reason, several Fraunhofer CESE project starts were delayed, and other proposals deferred. While the final figures for 2013 were not available as of the writing of this report, the Center will likely experience a small loss for the year. The Center's ample retained earnings will have no trouble covering this loss.

Important new project wins in 2013 included a major five-year, $7.5m NASA project; various efforts in the medical-device sector, both industrial and governmental; research projects through NASA's Software Assurance Research Program; and new work with a major private-sector company in the testing and measurement industry.

Total revenues (in T US dollars).

Year	Value
2011	4 058
2012	4 331
2013 Forecast	4 345
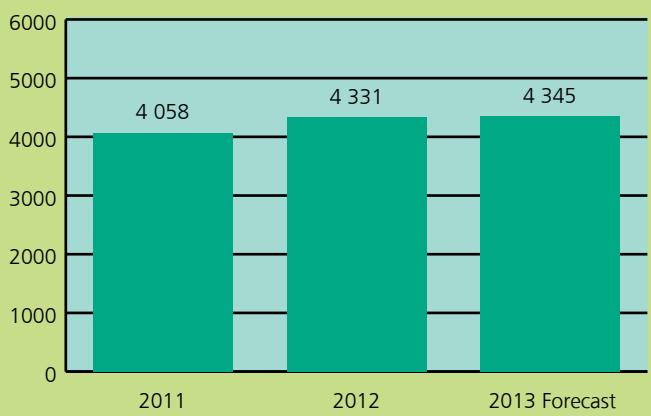
Third-party revenues (in T US dollars).

Year	Value
2011	2 936
2012	2 876
2013 Forecast	2 872
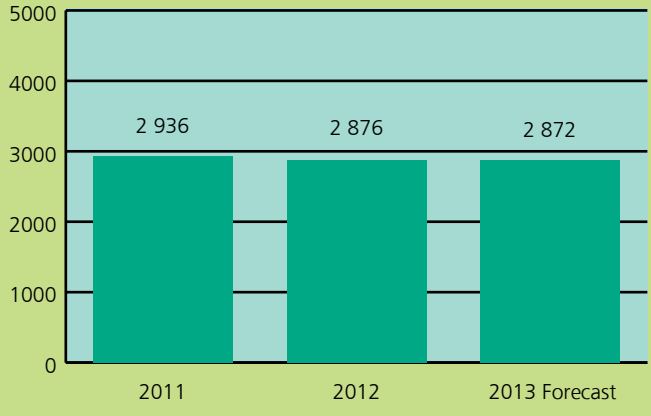
Retained earnings (in T US dollars).

■ Cumulative retained earnings   ■ Profit/Loss

Year	Cumulative retained earnings	Profit/Loss
2011	990	16
2012	1 130	140
2013 Forecast	1 030	-100

105
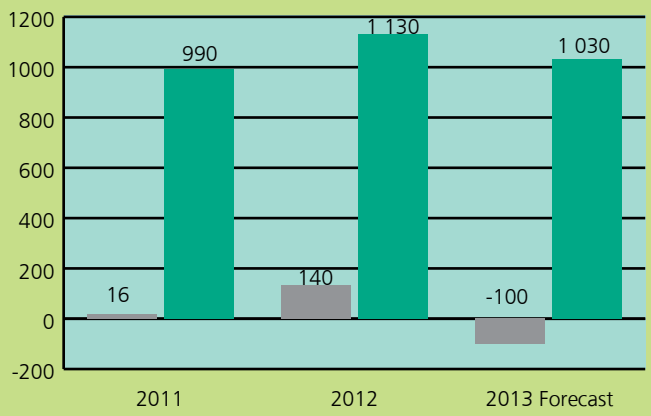
Fraunhofer Project Center for Transport and Logistics in Australia

Director: Dr. Glenn Geers, NICTA
Deputy Director: Michael Eisenbarth

Contact

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Phone +49 631 6800-2181
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Michael Eisenbarth

Further Information

Homepage of the Living Lab
www.futurelogisticslivinglab.
com

In 2010, the Fraunhofer Institute for Experimental Software Engineering IESE and the National Information and Communication Technology Research Centre of Excellence in Australia (NICTA) founded the Project Center on Transport and Logistics, officially called the "Fraunhofer Project Center on Transport and Logistics at NICTA" (FPC), with the aim of transferring current and future research results from both research institutions in the area of transport and logistics into industry and thus advancing the state of the practice. Under the leadership of Dr. Glenn Geers (NICTA) and Michael Eisenbarth (IESE), the Project Center has been offering research and consulting services in the area of information and communication technologies (ICT) for logistics and intelligent transport management. The Fraunhofer Project Center is an important address for the Australian transport and logistics industry and currently the only branch of a German applied research institution in Australia.

The core of the Project Center is the Future Logistics Living Lab. The goal of the Living Lab is the prototype realization of novel types of systems, products, and processes together with representatives from research and industry as well as users, aimed particularly at identifying new application scenarios and making it possible to address them in the future. This allows introducing the products and services offered by the Project Center to potential customers and opening up new markets in the area of transport and logistics in an industry-oriented manner. Tangible demonstrators are being developed, which are characterized, on the one hand, by strong interaction with industry and users and, on the other hand, by the needs and requirements of both industry and users. Since the founding of the Living Lab, 547 guided tours have been organized through the exhibits of the Living Lab, with more than 1300 visitors and external interested parties. The participants in these guided tours came from the following categories of industries:
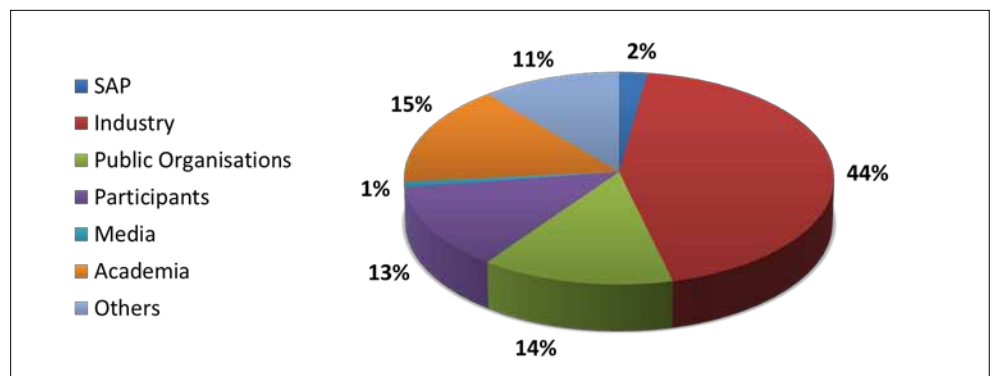
Number of visitors of the Future Logistics Living Lab

Future Logistics Living Lab and App (left)

In order to further increase the visibility of the Living Lab and to create a new communication platform, a mobile application for the iPhone was developed. With this app, the user can get information about news, projects, and events concerning the Living Lab. In addition, all the exhibits of the Living Lab are explained and illustrated with pictures. This app does not only serve for external representation, but also helps to connect the Community around the Lab and the issues of transport and logistics. To achieve this purpose, the social business network LinkedIn was integrated into the application. In a separate "Future Logistic Living Lab" group, new topics can be discussed and contacts can be made. It is also possible to subscribe to a newsletter about specific topic areas.

In 2013, HTS (Household Travel Surveys) was launched as a new project of the FPC. Although the various state transport authorities of Australia collect similar kinds of household travel data, they vary in detail. There can be immense value in aggregating that data across jurisdictions for broader management and analysis. However, often it is not feasible to define or impose a central repository for that data, nor even to define or impose a uniform standard for the data schemas. Through funding from the Australian Urban Research Infrastructure Network (AURIN) this project aims to develop, trial, and validate an automated open-source tool to create transport and recreational walkability indices at user-specified scales (i.e., suburb, Census Collector District and user-specified road network and radial buffers) across national boundaries.

Collaboration Partner

NICTA
www.nicta.com.au

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Fraunhofer Project Center for Software and Systems Engineering in Brazil

Director: Prof. Dr. Manoel Mendonça, UFBA
Deputy Director: Dr. Karina Villela, Fraunhofer IESE

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Dr. Karina Villela

Further Information

Project Center Homepage
fpc.dcc.ufba.br

**Fraunhofer Project Center
for Software and Systems Engineering
at UFBA**

In cooperation with

The Fraunhofer Project Center for Software and Systems Engineering at UFBA (FPC-UFBA) brings together the research competence and industrial practice of the partners Fraunhofer IESE and the Software Engineering Laboratory of the Federal University of Bahia (UFBA) to boost the development of innovative software solutions for the Brazilian industry. The center was established in 2012 and it offices are located in the Technological Park of Bahia, which hosts companies such as IBM, Portugal Telecom Innovation, as well as several large Brazilian companies.

In 2013, FPC-UFBA performed several activities together with UFBA aimed at boosting the development of innovative software solutions for the Brazilian industry. The first highlight was the coordination of nine partners (five European and four Brazilian organizations) in the writing of a project proposal for the ICT EU-Brazil Coordinated Call on the topic "Smart Services and Applications for a Smarter Society". The project proposal was selected as the best proposal on the aforementioned topic and received a grant of 1.3 million euros from the European Commission and approx. 2.8 million Brazilian Reais (approx. 864,000 euros) from the Brazilian Ministry of Science and Technology. The goal of the 2.5-year project is to develop a reliable and smart solution to support emergency and crisis management based on mobile crowdsourcing information (RESCUER, see page 114). FPC-UFBA is the core framework for the success of this project, as it provides the basic infrastructure for the joint coordination of the project by Fraunhofer IESE (on the European side) and UFBA (on the Brazilian side).

The second highlight was the organization of several workshops in Brazil aimed at bringing together representatives from the Brazilian industry and experts from Fraunhofer IESE in discussing the most promising software approaches for developing critical information business systems. The workshops were part of the German-Brazilian Year 2013-2014 and took place in Salvador, São Paulo, and Porto Alegre. Several large as well as small and medium-sized companies participated in the workshops and had the opportunity to discuss their specific challenges in separate meetings with Fraunhofer IESE experts following presentations on these topics:

- Software as a Competitive Business Enabler
- Engineering Mobile Business
- Variation Management: Efficiency in Providing Customized Solutions
- Beyond Access Control – How Data Usage Control can Effectively Protect Business Assets
- Architecture as the Hub in Engineering Business Software

The third highlight was the establishment of a partnership with SENAI-BA to strengthen FPC-UFBA. SENAI is the Brazilian National Service for Industrial Apprenticeship, which has organizational units in all Brazilian states. It has been extending its activities to include high-level education and applied research. SENAI-BA (BA stands for the state of Bahia) is a pioneer on this path and has focused its applied research on computer technologies applied to automation and manufacturing. In this partnership, FPC-UFBA is supporting SENAI-BA in developing innovative software for several customers. In particular, our contribution to the current projects includes:

- Mobility potential analysis and development of a mobile concept for e-Kanban and Production Leveling
- Development of a BPM suite evaluation concept and application of the developed concept in the evaluation of BPM suites for the manufacturing industry

In addition, the Fraunhofer Project Center in Brazil has been collaborating with UFBA on the development of an improvement model for variation management practices and infrastructure, a portability and variation management strategy for mobile applications, and a context simulator for mobile applications to support testing of mobile applications.

Collaboration Partners

UFBA/LES
www.ufba.br

SENAI-BA
www.senai.fieb.org.br

CRYSTAL:
Critical System Engineering Acceleration

Contact

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Fax +49 631 6800-9 2246

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Dr. Martin Becker

The process of developing, governing, and operating modern safety-critical embedded systems is highly complex and requires specialized tools supporting different activities throughout the entire product lifecycle. Therefore, OEMs and suppliers are typically operating a large set of COTS tools from different vendors, often complemented by custom in-house solutions. The overall process can only be effective and efficient if it supports collaboration among its stakeholders and, consequently, interoperability between the tools they are using. Furthermore, the interoperability aspect between tools integrated into such an environment is becoming more and more crucial for successful product engineering. Today, tool integration is often done in an ad-hoc manner by creating proprietary bridges between each pair of tools. Such an approach does not scale, since the number of required bridges grows exponentially with the number of employed tools. Moreover, the resulting system becomes extremely vulnerable to common changes such as version upgrades from tool vendors, and sooner or later the effort for maintaining a large set of bridges is no longer acceptable. The main technical challenge in addressing this problem is the lack of open and common interoperability technologies supported by the different tools that generate and provide access to data covering the entire product lifecycle of safety-critical embedded systems.

The ARTEMIS Joint Undertaking project CRYSTAL (**CR**itical s**YST**em engineering **A**cce**L**eration) has identified this need and takes up the challenge to establish and push forward an Interoperability Specification (IOS) and a Reference Technology Platform (RTP) as a European standard for safety-critical systems. This standard will allow loosely coupled tools to share and interlink their data based on standardized and open Web technologies that enable common interoperability among various lifecycle domains. This reduces the complexity of the entire integration process significantly. Compared to many other research projects, CRYSTAL is strongly industry-oriented and will provide ready-to-use integrated tool chains having a mature technology readiness level (up to TRL 7). In order to reach this goal, CRYSTAL is driven by real-world industrial use cases from the automotive, aerospace, rail and health sector and builds on the results of successful predecessor projects like CEASAR, iFEST, and MBAT on the European and national levels.

Creating and establishing a new standard on a large scale in an already consolidated market cannot be achieved by small individual organizations. With a budget of more than 82 million euros and 71 partners from ten different European countries, CRYSTAL has the critical mass to accomplish this endeavor. The project consortium is made up of participants from all relevant stakeholders, including OEMs, suppliers, tool vendors, and academia.

Within CRYSTAL, Fraunhofer IESE contributes to tool and method integration in the fields of Safety Engineering (C²FT and SCT modeling methods), Requirements Engineering (model-based

Industrial domains & technology brick groups addressed by CRYSTAL

requirements engineering in SysML), Variability Management (System Family Engineering Framework and Variant Analysis), and Virtual Prototypes (holistic system simulation). The contributions to IOS and RTP are being developed in close collaboration with industrial partners in the automotive and aerospace application domains.

Throughout the entire project, CRYSTAL will stay in close contact with standardization organizations like ASAM, ProSTEP iViP, OASIS, OMG, CENELEC, and others in order to build on existing achievements and join forces by collaborating in the standardization process. The aims of CRYSTAL are ambitious and the expected results will have significant economical and societal impacts. OEMs will benefit from the reduced system design costs due to the improved integration of system analysis, safety analysis, and system exploration tools. In addition, the CRYSTAL IOS will increase flexibility for all stakeholders and has the potential to deeply impact the market on a global level. OEMs can easily combine tools from different vendors, and tool vendors will be able to find new market opportunities in an open and extensible environment.

Further Information

Project Homepage
www.crystal-artemis.eu

Collaboration Partners

see Project Homehomepage
www.crystal-artemis.eu/
partner.html

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JAXA: Evaluating the Quality of Safety-Critical Software Systems

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Dr. Jens Heidrich

Continuously managing software product quality is an integral part of software project management and especially crucial for the development of safety-critical systems. Software quality models capture the knowledge and experience with respect to what quality characteristics are of interest (such as reliability, maintainability, or safety), what measurement data to collect (such as results from a static code analysis), and what mechanisms to use for assessing the quality of the software as a whole (such as building up evaluation thresholds and baselines). Nowadays, it is still a challenge to come up with suitable quality models for an organization: First, there is no universal model that can be applied in every environment because quality is heavily dependent on the application domain, the stakeholders, the usage purpose, and the concrete project context. In practice and research, a variety of different quality models exist. Finding the "right" model depends on a clear picture of the goals that should be obtained from using the model. Second,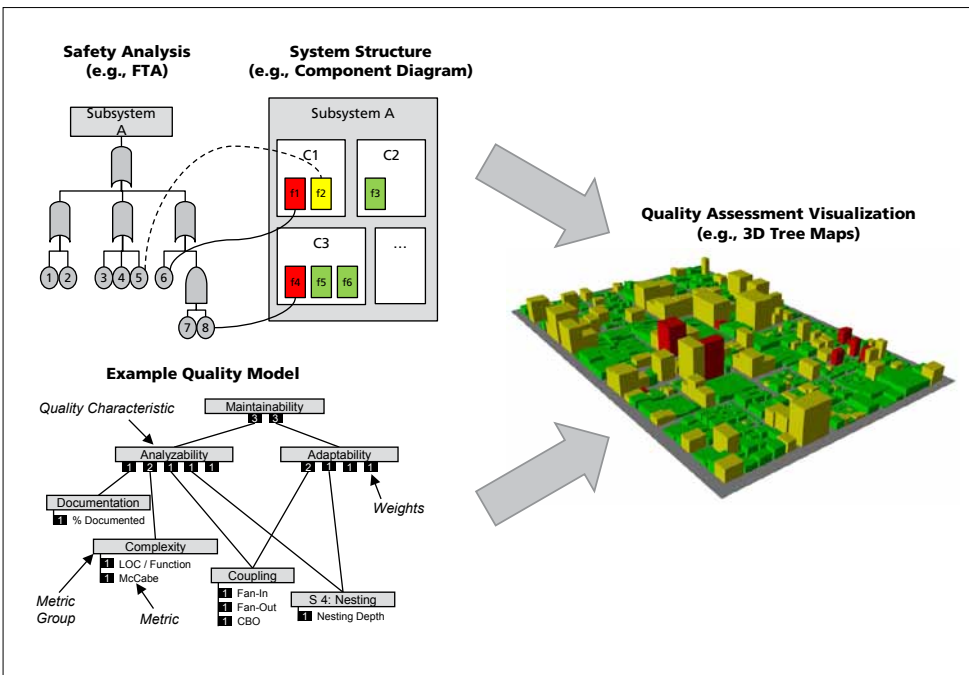 quality models needs to be tailored to company specifics and must be supported by corresponding tools. Existing standards (such as the ISO/IEC 25000 series) are often too generic and hard to fully implement in an organization. Third, in order to create sustainable quality models, the contribution to and value for organizational goals must be clarified and the models need to be integrated into the development processes (e.g., by defining appropriate quality gates).

As part of ongoing strategic collaboration with the Japan Aerospace Exploration Agency JAXA, the focus from 2012 to 2013 was on developing a model for evaluating the quality of safety-critical software of satellite systems delivered by external suppliers. The main idea was to combine the results from a classical safety analysis with a static code analysis for identifying safety-critical software functions and components with bad code quality and thus with a high risk of failure. Having such a model allows JAXA to systematically evaluate the source code delivered by their suppliers and to focus quality assurance activities on those parts of the code that are rated as safety critical and as having bad software quality. This effort should further increase the quality of the supplied safety-critical software and, in turn, enable JAXA to use high-quality software in satellites and thus achieve its main mission.

For that purpose, a quality model was developed together with JAXA experts with a focus on quality characteristics, as well as corresponding metrics for measuring those characteristics that have proven to have a strong impact on functional safety. The initial model was created based on information from the literature as well as with the help of external experts for the development of safety-critical systems. Afterwards, the model was tailored to the specific needs of JAXA and enriched with information from a classical Fault Tree Analysis (FTA) based on a

Safety Analysis (e.g., FTA)

System Structure (e.g., Component Diagram)

Quality Assessment Visualization (e.g., 3D Tree Maps)

Example Quality Model

Integration of results from a classical safety analysis with results from the application of a quality model. The visualization maps software components to building blocks in a city metaphor. For instance, high blocks colored in red represent safety-critical components with bad software quality and thus with a high risk of failure.

mapping table between the identified root causes for a system failure and the functions related to those causes.

In 2012, the quality model was implemented using the Fraunhofer M-System measurement framework, which allows for retrieving data from static code analysis tools and provides visualization means for browsing the analysis results and interacting with the visualization (e.g., drilling down into the data). In 2013, the model was applied to an example system provided by JAXA and was initially evaluated in terms of its practical usage.

In 2014, following the integration of the final improvement recommendations, it is planned to broaden the scope of the model usage to software that is actually part of recent JAXA satellite systems and to enable JAXA to perform the quality evaluation of safety-critical software systems on a larger scale. Furthermore, integration of further aerospace-relevant standards and regulations will be evaluated in terms of extending the functionality of the original quality model.

Collaboration Partner

Japan Aerospace Exploration Agency JAXA
http://www.jaxa.jp

RESCUER:
Reliable and Smart Crowdsourcing Solution for Emergency and Crisis Management

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RESCUER

European Collaboration Partners

DFKI
www.dfki.de

UPM
www.gatv.ssr.upm.es

VOMATEC
www.vomatec.de

FireServ
www.fireserv.at

If a critical situation, such as a fire or a conflict between opposing crowds, happens during a large-scale event, fast and informed reaction is required in order to avoid, or at least reduce, adverse consequences. Two such upcoming large-scale events in Brazil, the FIFA World Cup 2014 and the Olympic Summer Games 2016, motivated Brazil and Europe to join efforts in the development of a smart and interoperable computer-based solution to support emergency and crisis management based on mobile crowdsourcing information. RESCUER (**Re**liable and **S**mart **C**rowdsourcing Sol**U**tion for **E**mergency and C**R**isis Management) is not only intended to help deal with emergencies in large-scale events, but also with emergencies in industrial plants, where the most relevant incidents are fires, explosions, and substance spills. On the one hand, RESCUER will support eyewitnesses and first responders in reporting the current status of an incident to the emergency dispatch center by providing interaction schemes and interfaces specifically developed to be used under stress and time pressure. On the other hand, RESCUER will make the work of the emergency dispatch center and the emergency service personnel more efficient and effective by semi-automatically extracting information that is relevant for the emergency dispatch center from the information received from the crowd.

Fraunhofer IESE is the coordinator of the European consortium involved in RESCUER, and UFBA, our partner at the Fraunhofer Project Center at UFBA in Brazil (see page 108), is the coordinator of the Brazilian consortium in RESCUER. The two consortia include two user organizations: COFIC, responsible for security and safety in the Industrial Complex of Camaçari, the largest integrated industrial complex south of the equator, and FIRESERV, a consulting company in Linz, Austria, working in the field of disaster and crisis management with customers in industry and government agencies, fire departments, emergency services, and law enforcement forces. The project kickoff meeting took place in November 2013, in Salvador da Bahia, Brazil, in the presence of Rodrigo Silveira, Director of Operations Camaçari of Dow Brasil S.A., a subsidiary of The Dow Chemical Company, as well as firefighters and members of the Public Security Secretary of the State of Bahia. In Europe, a workshop in December 2013 was attended by members of the police, the Austrian rescue forces, and people responsible for security and safety at the Chemical Park of Linz. The active participation of potential user organizations in RESCUER meetings and workshops demonstrates the relevance of the project's expected results. Rodrigo Silveira commented: *"The widespread use of cell phones and smartphones by the population causes unofficial and inaccurate information to be spread quickly in an uncontrolled and dangerous way. RESCUER offers the technological antidote, by supporting the emergency dispatch center in quickly providing official and accurate announcement of emergencies."*
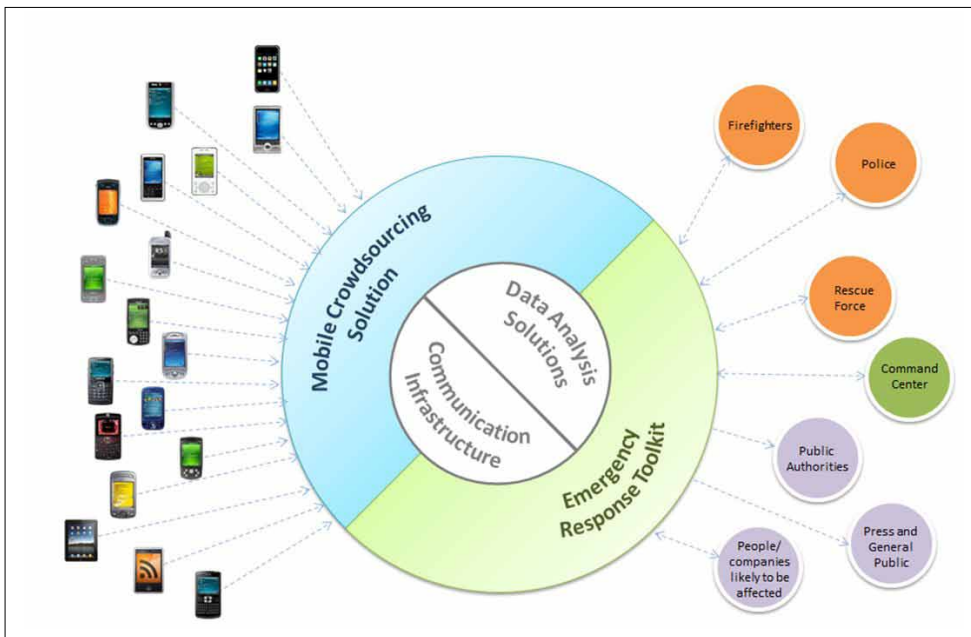
The four components of the RESCUER solution

The technical contribution of Fraunhofer IESE to the RESCUER project will be in these areas:

- Definition of a portability and variation management strategy to address not only the challenge of dealing with a huge diversity of mobile devices and various mobile platforms and communication protocols, but also the need for adapting the behavior of the RESCUER platform according to several aspects, such as: the emergency scenario (industrial area or large-scale event) and the specific emergency situation, the degree of danger the reporting person is exposed to, and whether she/he is part of the crowd or a first responder.
- Identification of appropriate interaction concepts and development of user interface guidelines that support human instinctive behavior when interacting with a mobile device during an emergency situation and thus avoid cognitive overload of the user. We will also explore how to use mobile devices to gather information from the crowd in an emergency situation and how to support follow-up interactions between eyewitnesses and the emergency dispatch center in an optimized and context-sensitive way.
- Quality specifications for multimedia data points to ensure minimum confidence in the scenario description resulting from the data fusion and analysis of emergency-related crowdsourcing information.

Brazilian Collaboration Partners

UFBA
wiki.dcc.ufba.br/LES

USP
www.icmc.usp.br

MTM
www.mtmtecnologia.com.br

COFIC
www.coficpolo.com.br

CONTACT

HOW TO FIND US
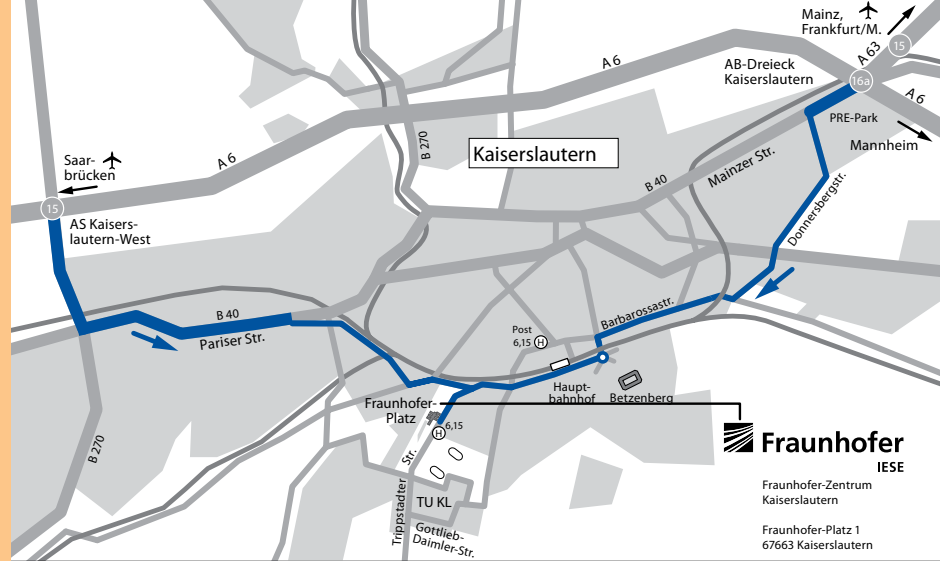
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Phone +49 631 6800-6000
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www.iese.fraunhofer.de

By car
Coming from the West on Autobahn A6, take the exit Kaiserslautern-West (15), then go towards downtown and follow the signs towards the university. Before you get to the university, you will reach the building complex of the Fraunhofer Center a few hundred meters down Trippstadter Strasse, on the right side of the street.

Coming from the East on Autobahn A6, go to the Autobahn Interchange ("Autobahndreieck") Kaiserslautern, and take the exit Kaiserslautern-Centrum (16a). Then first follow the signs towards Betzenberg Soccer Stadium, then towards the university. It is best to use the detour behind the train station via Zollamtstrasse; at the end of the street, continue straight ahead into Trippstadter Strasse. The building complex of the Fraunhofer Center is located approx. 500m down the street on the right side.

Getting there by means of electronic navigation:
Since the Fraunhofer-Platz might not be listed yet in some electronic navigation systems, we recommend using "Trippstadter Strasse 125" as the destination instead. The Fraunhofer Center is located directly across the street.

By rail and bus
Proceed to the main train station, Kaiserslautern Hauptbahnhof, and then either take a taxi or take TWK city bus no. 106 (towards Mölschbach) or no. 115 (towards Universität), getting off at the stop "Fraunhofer-Zentrum".

By air
From Frankfurt Rhein Main Airport, either by train (approx. 2 hours) or by rental car (approx. 1.5 hours).

MARYLAND
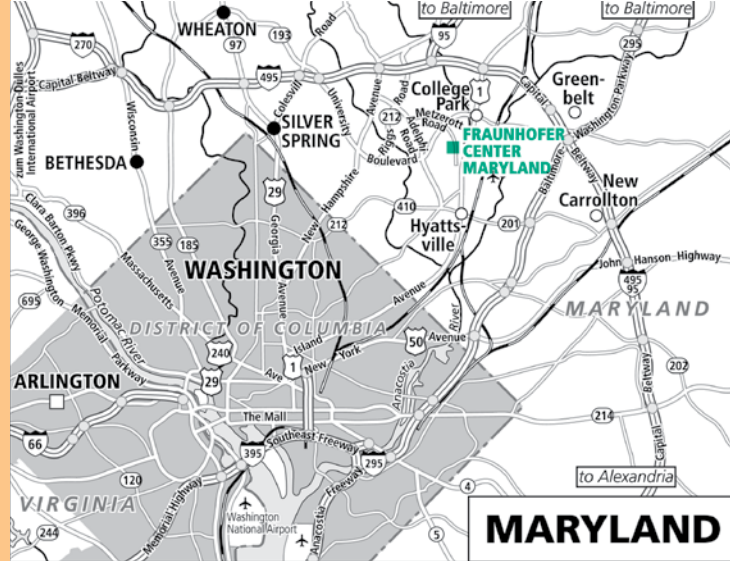
Fraunhofer USA Center for Experimental Software Engineering

5825 University Research Court

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USA

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www.fc-md.umd.edu

By Car

Directions from the North

Take Interstate 95 (I95) South (East part of Washington Beltway, I495). Take Route 201, Kenilworth Avenue exit. At the end of the exit ramp, go right.
Continue past the light for Paint Branch Parkway / Good Luck Road through one more light. Turn right at light for River Road. After crossing over a small bridge, turn right onto University Research Court.
Our building is at the end of University Research Court on the right. Go in the front doors in the center of the building.
We are on the first floor, past the elevators, and to the left.

Directions from the South – traveling northbound on Interstate 95 (I95)

Take I95 North to the Washington Beltway – I 495, going North or towards College Park. Take the exit for Route 50, going west, towards Washington, DC. Take the exit for Route 410, Veterans Highway. At the end of the exit ramp, go right. Continue on 410, crossing through the traffic light at Route 450. The road will come to a "T", turn left, following the signs for 410. You will pass under the Baltimore/Washington Parkway and through several lights.

At the light for Route 201 Kenilworth Avenue, turn right.
Turn left onto River Road.
After crossing over a small bridge, turn right onto University Research Court.
Our building is at the end of University Research Court on the right. Go in the front doors in the center of the building.
We are on the first floor, past the elevators, and to the left.

Directions from the Washington, DC area

Take DC-295 North, following signs for the Baltimore/Washington Parkway. Exit at Riverdale Road/Route 410, turning left onto Riverdale Road, which becomes East-West Highway. Go to Route 201 Kenilworth Avenue and turn right.
Turn left onto River Road.
After crossing over a small bridge, turn right onto University Research Court.
Our building is at the end of University Research Court on the right. Go in the front doors in the center of the building.
We are on the first floor, past the elevators, and to the left.

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ATP Research Laboratory & Corporate Head Office
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Level 5, 13 Garden Street
Eveleigh NSW 2015
Australia

www.nicta.com.au

Main Phone: +61 2 9376 2000
Main Fax: + 61 2 9376 2300

By Car
The entrance to the Australian Technology Park car park is from Henderson Road, Eveleigh. A Pay and Walk ticketing system has been installed for your convenience. Collect a ticket from the boom gate and drive through to the car park located on ground floor of 8 Central Avenue (Media City Building).

Event/ Visitor car parking is available at 8 Central Ave (Media City Building). Collect a ticket from the boom gate and drive through to the Car Park, located at Ground Floor, 8 Central Ave.

By Rail
CityRail operates frequent train services between Redfern Station (adjacent to the Australian Technology Park) and other major Sydney stations including Central, Town Hall, Wynyard and Circular Quay.
For information about travelling by rail, including timetable information, call the Transport Infoline on 131 500 or visit www.131500.com.au.

From Redfern Station
Exit via Platform 10 at Redfern Station. Walk past the WaterTower apartment block and follow the walkway through to the Australian Technology Park. Pedestrian access to the Locomotive Workshops are through Bays 1, 4 and 8. For information relating to specific building and tenant location, enter through the side door of Bay 1 and proceed to ATP Precinct Management offices, located on Level 1/Bay 4 Atrium or phone (02) 9209 4220 for further assistance.

By Bus
There are frequent bus services to the Australian Technology Park from the city and Sydney's domestic and international airport. The bus stop closest to the Australian Technology Park is on the corner of Boundary and Regent Street. For bus timetables call the Transport Infoline on 131 500 or visit www.131500.com.au.
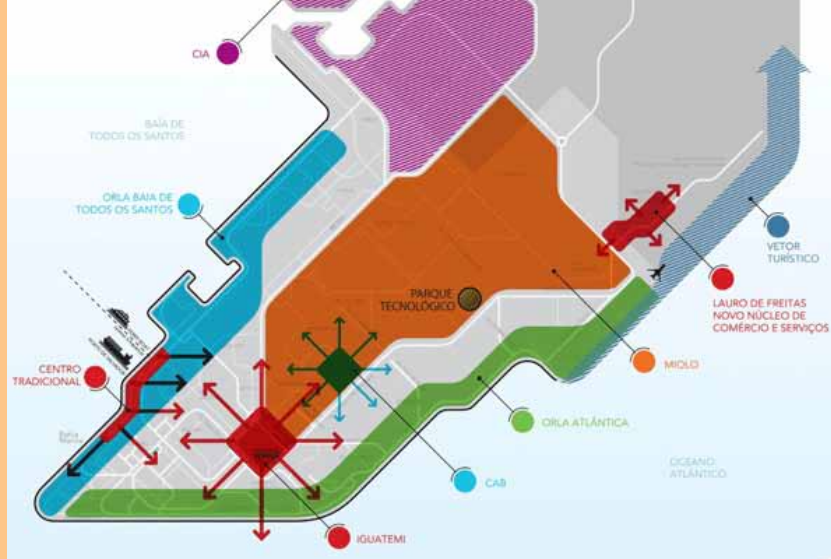
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Systems Engineering
Parque Tecnológico de Salvador
Avenida Luiz Viana Filho
Loteamento Colinas do Jaguaribe, Lote M
Salvador, Bahia,
Brazil

fpc.dcc.ufba.br

Contact
Prof. Dr. Manoel Mendonça
Phone: + 55 71 3283-6311
Email: manoel.mendonca@ufba.br

By car
Coming from Salvador
Follow the Avenida Luiz Viana Filho (also known as Paralela) in the direction of the airport. The Technology Park is located approximately at the level of the former "Wet´n Wild" waterpark and current festival area on the left side.
Shortly after the exit "Bairro da Paz" (do not use this exit!), you can make a U-turn ("Retorno") on the left side to get on the opposite lane leading back into the city. Make this U-turn and take the first exit on the right to get to the Technology Park.
Follow the driveway up to the large orange building in which our offices are located. Parking is available in front of the building.

Coming from the airport
Exit the airport towards the center of Salvador using the Avenida Luiz Viana Filho (also known as Paralela). After about 6 kilometers, the entrance to the Technology Park is on the right side.
Follow the driveway to the large orange building in which our offices are located. Parking is available in front of the building.

Remarks
Taking a bus is not recommended, as no adequately developed public transport system exists yet in the area of the Technology Park.
Instead, we recommend taking a taxi. It is a little more expensive, but also safer to take a taxi using the official taxi companies situated inside the airport building (or ask at the information booth). If you are arriving from the city, pre-order a taxi by telephone.

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Germany

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Fax +49 631 6800-1099

Further Information

☐ Annual Report 2013/2014 of Fraunhofer IESE, print version (German)

☐ Annual Report 2013/2014 of Fraunhofer IESE, print version (English)

☐ Annual Report 2013/2014 of Fraunhofer IESE, CD-ROM version (German & English)

☐ Short films of Fraunhofer IESE, DVD, German

☐ Short films of Fraunhofer IESE, DVD, English

☐ 60 Years of Fraunhofer-Gesellschaft

☐ Annual Report of Fraunhofer-Gesellschaft

☐ STI Software Technologie Initiative Kaiserslautern e. V.

☐ Please add my address

A PDF file of the Fraunhofer IESE Annual Report 2013/2014 with included Appendix and other publications (press releases, previous Annual Reports) are available at

www.iese.fraunhofer.de

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Department

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Zip Code / City

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Fax

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APPENDIX

NETWORK IN SCIENCE AND INDUSTRY

INDUSTRIAL PARTNERS[1]

- 1&1 Internet AG, Karlsruhe
- Absint Angewandte Informatik GmbH, Saarbrücken
- adidas AG, Herzogenaurach
- Agentilo GmbH, Kaiserslautern
- Agentur Barth Marketing, Kommunikation und Design GmbH, Kaiserslautern
- Agritechnical Basic Research for Advanced Innovation GmbH, Wallenhorst
- Airbus Operations GmbH, Hamburg
- ALENIA SIA SPA, Turin, Italy
- ALSTOM Transport S.A., Levallois Perret, France
- Ansaldo Sts, Genova, Italy
- Audi AG, Ingolstadt
- Audi Electronics Venture GmbH, Gaimersheim
- AVL LIST GmbH, Graz, Austria
- AVL Schrick GmbH, Remscheid
- AVL Software and Functions GmbH, Regensburg
- BASF SE, Ludwigshafen
- Berner & Mattner Systemtechnik GmbH, Munich
- Binder Elektronik GmbH, Sinsheim
- BTC Embedded Systems AG, Oldenburg

- Carl Zeiss Microscopy GmbH, Jena
- Cassidian Systems, Immenstaad am Bodensee
- COFIC - Camaçari Industrial Development Committee, Camaçari, Brazil
- Comlet Verteilte Systeme GmbH, Zweibrücken
- CON.ECT Eventmanagement GmbH, Vienna, Austria
- Continental Automotive GmbH, Hanover
- Continental Teves AG & Co. oHG, Frankfurt
- CosmosDirekt, Saarbrücken
- CSL Behring, Marburg
- Daimler AG, Ulm
- DENSO AUTOMOTIVE Deutschland GmbH, Eching
- Diehl Aerospace GmbH, Überlingen
- DIOCert GmbH, Erkrath
- EADS Deutschland GmbH, Munich
- Elektrobit Automotive GmbH, Erlangen
- FireServ e.U., Linz, Austria
- Vitaphone GmbH, Mannheim
- FIRU mbH, Kaiserslautern
- ForTISS GmbH, Garching
- Fujitsu Enabling Software Technology GmbH, Munich
- Fujitsu Laboratories of Europe Ltd., Hayes, UK
- Hapag-Lloyd AG, Hamburg

- Hella KGaA Hueck & Co, Lippstadt
- ICT Solutions AG, Trier
- igr AG, Rockenhausen
- INCHRON GmbH, Potsdam
- Insiders Technologies GmbH, Kaiserslautern
- Itemis AG, Lünen
- ITK Engineering AG, Kuhardt
- ITTI Sp. Z o.o., Poznań, Poland
- John Deere European Technology Innovation Center, Kaiserslautern
- John Deere Moline Technology Innovation Center, Moline, USA
- Knorr-Bremse AG, Schwieberdingen
- Lufthansa Systems Passenger Services GmbH, Raunheim
- MBTECH Group GmbH & CO KGAA, Sindelfingen
- Mittelrheinische Treuhand GmbH, Koblenz
- Morpho, Paris, France
- MTM Informatics Services, Salvador, Brazil
- Murex S.A.S., Paris, France
- OpenSynergy GmbH, Berlin
- Parametric Technology GmbH, Unterschleißheim
- Polarion Software GmbH, Stuttgart
- Porsche Engineering Group GmbH, Weissach
- proALPHA Software AG, Weilerbach

- pure-systems GmbH, Magdeburg Rand Europe, Cambridge, UK
- Robert-Bosch GmbH, Schwieberdingen
- Roche Diagnostics GmbH, Mannheim
- R&D-Ware Oy, Espoo, Finland
- SAP AG, Walldorf
- Scheer Group GmbH, Saarbrücken
- Siemens AG, Munich
- s IT Solutions AT Spardat GmbH, Vienna, Austria
- SMS-Siemag AG, Hilchenbach
- Software AG, Darmstadt
- Sysgo AG, Klein-Winternheim
- Testing Technologies I S T GmbH, Berlin
- Testo AG, Lenzkirch
- UplinkIT GmbH, Kaiserslautern
- Vallomed GmbH, Castrop-Rauxel
- WIKON Kommunikationstechnik GmbH, Kaiserslautern
- Wind River GmbH, Ismaning
- Wittenstein AG, Igersheim
- Volkswagen Aktiengesellschaft, Wolfsburg
- VOMATEC International GmbH, Bad Kreuznach
- WWK Lebensversicherung AG, Munich
- ZF Friedrichshafen AG, Friedrichshafen

1) Industrial Partners are located in Germany unless stated otherwise.

NATIONAL RESEARCH PARTNERS

- Albert-Ludwigs-Universität Freiburg (University of Freiburg), Freiburg
- CyberForum e.V., Karlsruhe
- DESY Deutsches Elektronen-Synchrotron, Hamburg
- Deutsches Forschungszentrum für Künstliche Intelligenz GmbH (DFKI) (German Research Center for Artificial Intelligence GmbH), Kaiserslautern
- Deutsche Stiftung für chronisch Kranke, Fürth
- Fachbereich Maschinenbau, Fachhochschule Kaiserslautern (Department of Mechanical Engineering, Kaiserslautern University of Applied Sciences), Kaiserslautern
- Zentrum für Mensch-Maschine-Systeme (Centre of Human-Machine Systems), Technische Universität Berlin
- House of IT e.V., Darmstadt
- Institut für Informatik IV, Technische Universität München (Institute for Computer Science, TU München), Munich
- KIT Karlsruher Institut für Technologie (Karlsruhe Insitute of Technology), Karlsruhe

- Lehrstuhl für Software Systeme, Universität Duisburg-Essen (Institute for Computer Science and Information Systems, University of Duisburg-Essen), Essen
- OFFIS, Oldenburger Forschungs- und Entwicklungsinstitut für Informatik-Werkzeuge und -Systeme, Oldenburg
- Regierungspräsidium Gießen (Gießen Regional Administrative Authority), Gießen
- Stadt Kaiserslautern (City of Kaiserslautern)
- Technische Universität Darmstadt, Darmstadt
- Technische Universität Kaiserslautern (University of Kaiserslautern), Kaiserslautern
- Technologie-Initiative SmartFactory KL e.V., Kaiserslautern
- Universität des Saarlandes (Saarland University), Saarbrücken
- Universität Trier (Trier University), Trier
- Westpfalz-Klinikum GmbH, Kaiserslautern

INTERNATIONAL RESEARCH PARTNERS

- Aalborg Universitet, Aalborg, Denmark
- Experimental Software Engineering Group of the University of Maryland (UMD/ESEG), University of Maryland, College Park, USA
- Instituto de Ciencias Matemáticas de Computacao, Universidade de Sao Paulo, Sao Paulo, Brazil
- Japan Aerospace Exploration Agency JAXA, Tokyo, Japan
- National ICT Australia (NICTA), Australian Technology Park, Eveleigh, Australia
- Poznań University of Technology, Poznań, Poland
- Technische Universität Graz (Graz University of technology), Graz, Austria
- Technische Universität Wien (Vienna University of Technology), Vienna, Austria
- TNO, Delft, Netherlands
- Universidade Estadual da Paraíba, Campina Grande, Brazil
- Universidade Federal da Bahia, Salvador, Brazil
- Universidad Politécnica de Madrid, Madrid, Spain

INTERNATIONAL SOFTWARE ENGINEERING NETWORK (ISERN)

- Aalto University School of Science and Technology (TKK), Dept. of Computer Science and Engineering, Finland
- ABB Corporate Research, USA
- Avaya Labs Research, Software Technology Research Dept., USA
- Blekinge Institute of Technology (BTH), Sweden
- COPPE/Rio de Janeiro Federal University, Brazil
- Fraunhofer Center for Experimental Software Engineering Maryland CESE, USA
- Fraunhofer Institute for Experimental Software Engineering IESE, Germany
- Free University of Bolzano - Bozen, Italy
- Information-technology Promotion Agency (IPA), Japan
- Institute of Software, Chinese Academy of Sciences (ISCAS) - Lab for Internet Software Technology, China
- IT University Copenhagen, Denmark
- Japan Manned Space Systems Corporation (JAMMS), Japan
- Japan Aerospace Exploration Agency (JAXA), Japan
- Kalemun Research Inc., Canada

- Leiden University, The Netherlands
- Lund University, Sweden
- Massachusetts Institute of Technology, USA
- Microsoft Research, USA
- Nara Institute of Science and Technology, Japan
- Naval Postgraduate School, USA
- North Carolina State University, USA
- Northrop Grumman, USA
- Norwegian University of Science and Technology, Norway
- NTT Data Corporation, Japan
- Osaka University, Japan
- Queens University, Belfast, UK
- Robert BOSCH GmbH, Germany
- Simula, Norway
- SINTEF, Norway
- Universidad Politécnica de Madrid, Spain
- Universidad Politécnica de Valencia, Spain
- Università degli Studi dell'Insubria, Italy
- Università degli Studi di Roma Tor Vergata, Italy
- University of Alabama, USA
- University of Alberta, Canada
- University of Bari, Italy
- University of Calgary, Canada
- University of Castilla-La Mancha, Spain

- University of Kaiserslautern, Germany
- University of Maryland-Baltimore County, USA
- University of Maryland-College Park, USA
- University of New South Wales, Australia
- University of Oslo, Norway
- University of Oulu, Finland
- University of Sheffield, UK
- University of Southern California, USA
- University of Stuttgart, Germany
- University Politecnico di Torino, Italy
- University of Uruguay (ORT), Uruguay
- Vienna University of Technology, Austria
- VTT Electronics, Finland

VISITORS HOSTED

Dr. Emanuela Cartaxo, Post-Doctoral Fellow, Department of Systems and Computation, Federal University of Campina Grande, Campina Grande, Brazil
November 1, 2012 - August 31, 2013

Devina Vyas, Bachelor student, C. G. Swami Vivekanand Technical University, Bhilai, India
1 June - 29 August 2013

Eva Nicouleau, Bachelor student, INP (Institut National Polytechnique de Toulouse), Toulouse, France
1 July - 31 August 2013

Prof. Rangel Junior, President of Universidade Estadual da Paraíba (UEFB); Prof. Dr.-Ing. Misael Morais, Head of Department Computer Science, Universidade Estadual da Paraíba (UEFB), Campina Grande, Brazil
August 15, 2013

Marília Freire, Guest Scientist, Computer Science Department (DIMAp), Federal University of Rio Grande do Norte (UFRN), Natal, Brazil
October 21 - December 19, 2013

Dr. Amal Al-Hashmi, Head of Stroke Medicine, Dept. of Neurology, Muscat Royal Hospital Sultanate of Oman, Muscat, Oman
September 30, 2013

Prof. Gordon Blair, Head of Department Distributed Systems, School of Computing and Communications, Lancaster University
Lancaster, UK
June 20, 2013

Prof. Dr. Dr. h.c. Manfred Broy, Chair for Software & Systems Engineering, Institut für Informatik, TU München
Munich
November 6, 2013

Prof. Tim Kelly, Dept. of Computer Science, University of York
York, UK
November 25, 2013

Prof. Yiannis Papadopoulos, Dept, of Computer Science, University of Hull
Hull, UK
January 9 - 10, 2014

Prof. Lionel Briand, Head of the Software Verification and Validation Laboratory, SnT/FSTC, Centre for ICT Security, Reliability, and Trust (SnT), University of Luxembourg, Luxembourg
January 30, 2014

PROFESSIONAL CONTRIBUTIONS

LECTURING ASSIGNMENTS

Bomarius, F.:
Laboratory Exercises
OOSE - Objektorientiertes SW Engineering, Mechatronics, University of Applied Sciences Kaiserslautern
Winter 2013/2014

Lecture
PDA- Programmierung und Datenstrukturen, Mechatronics, University of Applied Sciences Kaiserslautern
Winter 2012/2013
Winter 2013/2014

Lecture
SEES- SW Engineering für eingebettete Systeme, Mechatronics, University of Applied Sciences Kaiserslautern
Winter 2012/2013
Winter 2013/2014

Lecture
OOSE- Objektorientiertes SW Engineering, Mechatronics, University of Applied Sciences Kaiserslautern
Summer 2013

Lecture
RA- Einführung in Rechnerarchitekturen, Mechatronics, University of Applied Sciences Kaiserslautern
Summer 2013

Dörr, J.:
Lecture
Requirements Engineering, Computer Science Dept., University of Kaiserslautern
Winter 2012/2013
Winter 2013/2014

Goepfert, B.:
Lecture
Organization of Internal Information Centers, Faculty III Media, Information and Design, University of Applied Sciences and Arts of Hanover
Winter 2012/2013

Heidrich, J.:
Lecture
Process Modeling, Computer Science Dept., University of Kaiserslautern
Summer 2013

Knodel, J.:
Lecture
Master Seminar Informatik, Computer Science Dept., University of Applied Sciences Mannheim
Summer 2013

Lecture
Software Evolution, Computer Science Dept., University of Applied Sciences Mannheim
Summer 2013

Lecture
Software Architecture, Computer Science Dept., University of Applied Sciences Mannheim
Summer 2014

Lecture
Systemanalyse, IMBIT, Baden-Wuerttemberg Cooperative State University, Mannheim
Summer 2014

Liggesmeyer, P.:
Lecture
Sicherheit und Zuverlässigkeit eingebetteter Systeme, Computer Science Dept., University of Kaiserslautern
Winter 2012/2013
Winter 2013/2014

Lecture
Software-Qualitätssicherung, Computer Science Dept., University of Kaiserslautern
Winter 2012/2013
Winter 2013/2014

Luiz, T.:
Lecture
Rolle der IT und Logistik in der Notfallmedizin, Ambulante Medizin, Westpfalz-Klinikum / Heidelberg University
Winter 2012/2013

Maier, A.:
Single Lecture
Software Ergnomie und Usability - Barrierefreiheit, Computer Science Dept., University of Applied Sciences Mannheim
June 2014

Naab, M.:
Seminar
Software Architecture, Fraunhofer Academy
April 2013
October 2013

Putz, W.:
Lecture
XML-Sprachfamilie, Informatik, University of Applied Sciences Darmstadt
Winter 2012/2013
Summer 2013

Rombach, D.:
Lecture
Grundlagen des Software Engineering, Computer Science Dept., University of Kaiserslautern
Winter 2012/2013
Summer 2013
Winter 2013/2014

Lecture
Master Project Software Engineering, Computer Science Dept., University of Kaiserslautern
Winter 2013/2014

Lecture
Process Modeling, Computer Science Dept., University of Kaiserslautern
Summer 2013

Lecture
Product Line Engineering, Computer Science Dept., University of Kaiserslautern
Winter 2013/2014

Lecture
Project Management, Computer Science Dept., University of Kaiserslautern
Winter 2013/2014

Lecture
Requirements Engineering, Computer Science Dept., University of Kaiserslautern
Winter 2013/2014

Lecture
Software Architectures for Distributed Systems; Computer Science Dept., University of Kaiserslautern
Summer 2013

Lecture
Software Project and Process Management; Computer Science Dept., University of Kaiserslautern
Summer 2013

Lecture
Empirical Model Building and Methods, Computer Science Dept., University of Kaiserslautern
Summer 2013

Uenalan, Ö.:
Seminar
Requirements Engineering Schulung, Computer Science Dept., Bundeswehr Academy Mannheim
June 4-6, 2013

Rost, D.:
Seminar
Software Architecture, Fraunhofer Academy
October 2013

Wessner, M.:
Lecture
Ambient Intelligent Systems - MP5, Media Dept., University of Applied Sciences Darmstadt
Winter 2012/2013
Winter 2013/2014

Lecture
Business Systems - MP4, Media Dept., University of Applied Sciences Darmstadt
Summer 2013

EDITORIAL BOARDS

Bomarius, F.:
Member, Editorial Board, Ph.D. Theses in Experimental Software Engineering, Fraunhofer IRB Publishing Company, since 2001

Dörr, J.:
Journal Reviewer, Business & Information Systems Engineering, since 2010

Journal Reviewer, Requirements Engineering Journal, since 2011

Journal Reviewer, The Computer Journal, since 2011

Journal Reviewer, Information and Software Technology Journal, since 2012

Journal Reviewer, Empirical Software Engineering Journal, since 2012

Journal Reviewer, Journal of Software and Systems Modeling, since 2012

Klaus, A.:
Member, Editorial Board, International Journal on Advances in Systems and Measurements, since 2012

Knodel, J.:
Journal Reviewer, Journal of Systems and Software (JSS), since 2005

Journal Reviewer, Software: Practice and Experience (SPE), since 2012

Journal Reviewer, Requirements Engineering Journal (REJ), since 2013

Liggesmeyer, P.:
Editor, Informatik – Forschung und Entwicklung, Springer, since 2000

Editor, it – information technology, Oldenbourg-Verlag, München, since 2003

Member, Editorial Board, Lecture Notes in Informatics (LNI) , Gesellschaft für Informatik GI Springer, since 2003

Member, Editorial Board, Ph.D. Theses in Experimental Software Engineering, Fraunhofer IRB Publishing Company, since 2004

Member, Editorial Board, Informatik-Spektrum, since 2012

Luiz, T.:
Coordinating Editor, Medizinische Gefahrenabwehr, since 2009

Journal Reviewer, Der Anästhesist, since 2010

Journal Reviewer, Notfall und Rettungsmedizin, since 2010

Member, Editorial Board, Notfall und Rettungsmedizin, since 2013

Rombach D.:
Member, Editorial Board, International Journal of Software Process: Improvement and Practice, John Wiley and Sons, since 1994

Associate Editor, International Journal of Empirical Software Engineering, Springer, since 1996

Member, Editorial Board, Ph.D. Theses in Experimental Software Engineering, Fraunhofer IRB Publishing Company, since 2001

Member, Editorial Board, International Journal of Software and Informatics, Institute of Software, Chinese Academy of Sciences, Beijing, since 2007

Member, Editorial Board, "IM Die Fachzeitschrift für Information Management und Consulting", since 2011

Trapp,Mario.:
Journal Reviewer, IEEE Transactions on Software Engineering, since 2008

Journal Reviewer, Elsevier Journal on Systems and Software, since 2010

Journal Reviewer, IEEE Software, since 2010

Journal Reviewer, IEEE Transactions on Reliability, since 2010

Journal Reviewer, IEEE Transactions on Systems, Man, and Cybernetics, since 2010

Journal Reviewer, Springer - Software and Systems Modelling, since 2013

Trendowicz, A.:
Associate Editor, e-Informatica Software Engineering Journal (EISEJ), Nov. 2013

Wessner M.:
Member, Editorial Board, Journal of Educational Multimedia and Hypermedia, Association for the Advancement of Computing in Education, Chesapeake, USA, since 2005

Member, Editorial Review Board, "Journal of Educational Multimedia and Hypermedia", since 2005

Member, Editorial Board, "International Journal of Computer-Supported Collaborative Learning", since 2008

Member, Editorial Review Board, "Journal of Interactive Learning Research", since 2009

COMMITTEE ACTIVITIES

Adam, S.:
PC Member, 14th Working Conference on Business Process Modeling, Development, and Support, BPMDS 2013, Valencia, Spain
June 17, 2013

Diebold, P.:
Short Papers Program Committee, PROFES 2013, Phaphos, Cyprus
June 12-14, 2013

Session Chair, Short Papers 1, PROFES 2013,
Phaphos, Cyprus
June 12-14, 2013

Dörr, J.:
Program Co-Chair, 19th International Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ'13), REFSQ 2013, Essen
April 8-11, 2013

PC Member, 3rd IEEE International Workshop on Empirical Requirements Engineering (EmpiRE 2013), IEEE International Requirements Engineering Conference,
Rio de Janeiro, Brazil
July 15, 2013

PC Member, 3rd Workshop on Creativity in Requirements Engineering (Creare 2013), REFSQ 2013, Essen
April 8, 2013

PC Member, 7th International Workshop on Software Product Management (IWSPM), REFSQ 2013, Essen
April 8, 2013

PC Member, ERP Future Summit, Vienna, Austria
November 11-12, 2013

PC Member, First International Workshop on Conducting Empirical Studies in Industry (CESI 2013), ICSE 2013, San Francisco, USA
May 20, 2013

PC Member, Reconf 2013, Reconf 2013, Munich
March 11-14, 2013

Elberzhager, F.:
PC Member, Euromicro Conference, Santander, Spain
September 4 - 6, 2013

5th Software Quality Conference (SWQD 2013), SWQD Conference, Vienna, Austria

Hess, S.:
PC Member, 2nd International Conference on Design, User Experience and Usability, DUXU 2013, Las Vegas, USA
July 21-26, 2013

PC Member, Fifth International Conference on Mobile Computing, Applications and Services, MobiCASE 2013, Paris, France
November 7-8, 2013

Lampasona, C.:
PC Member, PROFES 2014, Phaphos, Cyprus
June 12-14, 2013

Luiz, T.:
Member, Review Committee, Forschungspreis, Fachtagung der DRF Stiftung Luftrettung, Dortmund

Liggesmeyer Peter:
PC Member, SE 2013, Aachen
February 26 - March1, 2013

PC Member, RISK 2013, Maribor, Slovenia
March 6-7, 2013

PC Member, ERST 2014, Toulouse, France
Feb 5-7, 2014

Kläs, M.:
Organizer/Chair, Doctoral Symposium, METRIKON 2013, Kaiserslautern
November 13-15, 2013

PC Member, "EsPRESSE - Estimation and Prediction in Software & Systems Engineering", SEAA 2013, Santander, Spain
September 4-6, 2013

PC Member, PROFES 2013, Phaphos, Cyprus
June 12-14, 2013

PC Member, Software Process and Product Improvement (SPPI), SEAA 2013, Santander, Spain
September 4-6, 2013

PC Member, Software & Web Engineering, 40th Intl. Conf. on Current Trends in Theory and Practice of Computer Science,
High Tatras, Slovakia
January 25-30, 2014

Workshop Co-Chair/Organizer, PROFES 2013, Phaphos, Cyprus
June 12-14, 2013

Klaus, A.:
PC Member & Research Industry Liaison Chair, The Fifth International Conference on Advances in System Testing and Validation Lifecycle (VALID) 2013,
Venice, Italy
October 27 - November 1, 2013

Knodel, J.:
Tutorials Chair, 17th European Conference on Software Maintenance and Reengineering (CSMR 2013), Genova, Italy, March 5-8, 2013

Organizer, GI FG Architektur - Jahrestagung 2013, Kaiserslautern, Germany
July 1-2, 2013

Organizer, The 1st International Workshop on Software Ecosystem Architectures (WEA), 9th Joint Meeting of the European Software Engineering Conference and the ACM SIGSOFT Symposium on the Foundations of Software Engineering (ESEC/FSE 2013), St. Petersburg, Russia
August 19, 2013

PC Member, 17th European Conference on Software Maintenance and Reengineering (CSMR 2013), Genova, Italy
March 5-8, 2013

PC Member, Eighth International Conference on Software Engineering Advances (ICSEA 2013), Venice, Italy
October 27 - November 1, 2013

PC Member, 29th IEEE International Conference on Software Maintenance (ICSM 2013),
Eindhoven, The Netherlands
September 22-28, 2013

PC Member Tools Track, 29th IEEE International Conference on Software Maintenance (ICSM 2013),
Eindhoven, The Netherlands
September 22-28, 2013

PC Member, 20th Working Conference on Reverse Engineering (WCRE 2013), Koblenz
October 14-17, 2013

PC Member, CSMR-18/ WCRE-21, (Software Evolution Week - Joint 18th European Conference on Software Maintenance and Reengineering / 21st Working Conference on Reverse Engineering), Antwerp, Belgium, February 3-6, 2014

PC Member, Industry Track, 22nd Annual International Conference on Program Comprehension (ICPC 2014), Hyderabad, India
June 3-4, 2014

PC Member, Ninth International Conference on Software Engineering Advances (ICSEA 2013), Nice, France, October 12-16, 2014

PC Member, 30th IEEE International Conference on Software Maintenance and Evolution (ICSME 2014), Victoria, British Columbia, Canada
September 28 - October 3, 2014

PC Member, First Workshop on Software Architecture Erosion and Architectural Consistency (SAEroCon2014), Working IEEE/IFIP Conference on Software Architecture (WICSA) 2014, Sydney, Australia
April 8, 2014

Schwarz, R.
PC Member and Reviewer, 7th International Conference on Information Security and Assurance (ISA 2013), Cebu, Philippines
April 26-28, 2013

Trapp, Mario:
Organizer, CARS: 2nd Workshop on Critical Automotive applications: Robustness & Safety, 32nd SAFECOMP 2013 - The International Conference on Computer Safety, Reliability and Security, Toulouse, France
September 24-27, 2013

PC Member, CPS Week 2014, Cyber-Physical Systems, Berlin
April 14-17, 2014

PC Member, Models 2013, Miami, USA
September 28-October 4, 2013

PC Member, Models 2014, Valencia, Spain
September 28 - October 3, 2014

Conference Chair, Safetronic 2013, Stuttgart
November 5-6, 2013

Conference Chair, Safetronic 2014, Safetronic 2014 Stuttgart
November 11-12, 2014

Villela, K.:
PC Member, 7th International Workshop on Variability Modelling of Software-intensive Systems, VaMoS 2013 Pisa, Italy
January 23-25, 2013

PC Member, SBQS 2013 – XII Brazilian Symposium on Software Quality
Salvador, Brazil
July 1-5, 2013

PC Member, 8th International Workshop on Variability Modelling of Software-intensive Systems, VaMoS 2014 Nice, France
January 22-24, 2014

Wessner, M.:
PC Member, CSEDU 2014, Barcelona, Spain
April 1-3, 2014

PC Member, CSCL 2013, Madison, USA,
June 15-19, 2013

PC Member, DeLFI 2013, Bremen
September 8-11, 2013

PC Member, DeLFI 2014, Freiburg
September 15-17, 2014

PC Member, E-Learn 2013, Las Vegas, USA
October 21-25, 2013

PC Member, e-learning 2013, Prague, Czech Republic
July 23-27, 2013

PC Member, eLmL 2014, Barcelona, Spain
March 23 - 27, 2014

PC Member, Information Systems 2013, Lisbon, Portugal
March 13-15, 2013

PC Member, KMIS 2014, Rome, Italy
October 21-24, 2014

Reviewer, ICLS 2014, Boulder, USA
June 23-27, 2014

SCIENTIFIC AND TECHNOLOGICAL ADVISORY BOARDS

Dörr, J.:
Spokesperson (& Member), Gesellschaft für Informatik / Fachgruppe Requirements Engineering, since 2010

Member, Steering Committee, Intl. Conference on Requirements Engineering: Foundation for Software Quality (REFSQ), since 2011

Göpfert, B.:
Member, Fraunhofer AG "Information to Go" Fraunhofer-Gesellschaft e.V., Munich, since October 2012

Klaus, A.:
Member, VDI Fachausschuss "Qualitätssicherung für Software in der Medizintechnik", Düsseldorf, since 2009

Liggesmeyer, P.:
Chair, GI Special Interest Group "Softwaretechnik" since 1999

Member, Steering Committee, Gesellschaft für Informatik, since 2009

Member, Fraunhofer Allianz Embedded Systems since 2010

Member, University Council, University of Applied Sciences Darmstadt, since 2011

President, Gesellschaft für Informatik e.V. (GI), Bonn since 2014

Rombach, D.:
Coordinator, ISERN (International Software Engineering Research Network) since1996

Member, Advisory Board, Fraunhofer Center Maryland, College Park, USA
since 1998

Member, Advisory Board, Otto A. Wipprecht-Stiftung
since 1999

Member, Advisory & Expert Group for the Minister President of Rhineland-Palatinate
since 2002

Member, Scientific Advisory Board, NICTA (National Information and Communications Technologies Australia), Australia, since 2006

Member, Steering Committee, KIST (Korea Institute of Science and Technology) Europe Forschungsgesellschaft mbH, Korea, since 2006

Chair, IEEE Harlan D. Mills Award, since 2009

Chair, SEI Process Achievement Award, USA
since 2009

Member, Advisory Board, fortiss, Munich
since 2009

Member, Advisory Group to the Minister President of Rhineland-Palatinate on "Digital Development and Culture", ince 2013

Member, Global Technology Innovation Advisory Council, John Deere, since 2013

Schwarz, R.:
Founding Member, International Secure Software Engineering Council (ISSECO), Potsdam, since 2008

Wessner, M.:
Member of Steering Board, "Special Interest Group on E-Learning of the ""Gesellschaft für Informatik"" (GI)" since 2002

MEMBERSHIPS IN INDUSTRIAL ADVISORY BOARDS

Rombach, D.:
Member, Advisory Board, Siftung der Gasanstalt, Kaiserslautern, since 2002

Member, Advisory Board, Stadtsparkasse Kaiserslautern, Kaiserslautern, since 2004

Chairman of the Board, 1. FC Kaiserslautern (Professional Soccer Club), Kaiserslautern, since 2008

Member, Global Technology Innovation Advisory Council, John Deere, since 2013

Member of the Board, Science Alliance Kaiserslautern, Kaiserslautern, since 2013

Schwarz, R.:
ISECCO, International Secure Software Engineering Council e. V., Potsdam, since 2012

PARTICIPATION IN DELEGATIONS

Luiz, T.:
Member, Delegation, State Ministry of Economics, State of Rhineland-Palatinate, Dubai, UAE
January 27-30, 2013

MEMBERSHIPS IN PROFESSIONAL ASSOCIATIONS

AAL-Allianz

Access SOS Emergency

ACL – A-ssociation for Computational Linguistics

ACM – Association of Computing Machinery

AGBC – American-German Business Club Deutschland e.V.

AMS – American Mathematical Society

ASQF e.V. – Arbeitskreis Software-Qualität in Franken

Bitkom – Arbeitskreise: Barrierefreiheit und Usability; Cyber-Physical Systems; Mobile; Software Architektur; Software Engineering; Qualitätsmanagement

BV-Päd. – Bundesverband der Diplom-Pädagoginnen und Diplom-Pädagogen e.V.

CAST e.V.

CVC – Commercial Vehicle Cluster

DASMA – German Software Metrics and Effort Estimation Association

DGI – Deutsche Gesellschaft für Informationswissenschaft und Informationspraxis e.V.

DIN – Deutsches Institut für Normung

Förderverein Informatik TU KL/FIT

Fraunhofer Academy

Freundeskreis TU KL

GC UPA – German Chapter of the Usability Professionals' Association

GDM – Gesellschaft für Didaktik der Mathematik

German UPA - Arbeitskreis User Research

GFaI – Gesellschaft zur Förderung angewandter Informatik e.V.

GFFT – Gemeinnützige Gesellschaft zur Förderung des Forschungstransfers e.V.

GI – Gesellschaft für Informatik, Gi-Fachgruppen Automotive Software Engineering und Requirements Engineering

idw – Informationsdienst Wissenschaft

IEEE – Institute of Electrical and Electronic Engineers

IMA – Institute of Mathematics and its Application

ISQI (Weit e.V.)

ISSECO – International Secure Software Engineering Council

IuK – Fraunhofer Information and Communication Group

LAP – Liberty Alliance Project

MedTech Pharma

NEGZ – Nationales E-Government Kompetenzzentrum

OMG – Object Management Group

SafeTRANS – Safety in Transportation Systems

Science Alliance Kaiserslautern e.V.

STI – Software Technologie Initiative e.V.

Tekom – Fachverband für technische Kommunikation und Dokumentation

Uni-KiTA

VDMA – Arbeitskreis Mobile Apps & Co.

VDR – Verband Deutsches Reisemanagement e.V.

Softwareforen Leipzig GmbH

XING AG

KEYNOTES

Dörr, J.:
Requirements Engineering
– Fit für die Zukunft, Swiss
Requirements Day,
Zurich, Switzerland
June 19, 2013

Knodel, J.:
Mitigating the Risk of Soft-
ware Change in Practice -
Retrospective on More than
50 Architecture Evaluations
in Industry, IEEE CSMR-WCRE
Software Evolution Week,
Antwerp, Belgium
February 5, 2014

Liggesmeyer, P.
Von Embedded Systems zu
Cyber-Physical Systems: He-
rausforderungen und Chan-
cen, Konferenz Softwaretests,
Wolfsburg
February 8, 2013

Big Data – Datenschätze in
der Wissenschaft und Wirt-
schaft, bcc, Berlin
March 3, 2013

Quality and Functional Safety
Management for Automo-
tive Software-based Systems,
VDA, Berlin
June 14, 2013

Verlässliche und effiziente
Nutzfahrzeuge und Nutzfahr-
zeugbünde: Herausforde-
rungen und Lösungsansätze,
CVC-Jahrestagung, Wörth
October 25, 2013

Herausforderungen im Um-
gang mit der Zukunftstech-
nologie Big Data, GI-Netzver-
band, Berlin
November 1, 2013

Big Data und das Internet der
Dinge- Strategische Heraus-
forderungen für das System-
und Software-Engineering,
Fraunhofer IuK, Berlin
November 11, 2013

Rombach, D.:
Software as Business Enabler
for all Sectors of Industry,
USP (São Paulo), PUC-RS
(Porto Alegre), UFBA (Sal-
vador), and COPPE (Rio de
Janeiro), Brazil,
July 4-15, 2013

Empirical Software Engineer-
ing: History, Status & Plans,
Metrikon 2013,
Kaiserslautern
November 14, 2013

PRESENTATIONS

Adam, S.:
Anforderungserhebung im
Umfeld wiederverwendungs-
basierter Softwareentwick-
lung, Talk, Reconf 2013,
Munich
March 11, 2013

Effective Requirements Elicita-
tion in Product Line Applica-
tion Engineering – An Experi-
ment, Talk, FrfSQ 2013, Essen
April 11, 2013

Wo stehen wir und wo wol-
len wir hin? Erfüllungsgrade
von RE-Praktiken 2013, Talk,
GI Fachgruppentreffen RE
2013, Ilmenau
November 28, 2013

Incorporating Software
Product Line Knowledge
into Requirements Processes,
Guest Presentation,
University of Twente,
Enschede, The Netherlands
June 4, 2013

Adam, S.; Riegel, N.:
Wenn Prozesse laufen ler-
nen..., Talk, SEACON 2013,
Hamburg
May 16, 2013

Diebold, P.:
How to Configure SE Devel-
opment Processes Context-
Specifically, Conference Paper
Talk, PROFES 2013,
Paphos, Cyprus
June 12-14, 2013

Einsatz agiler Praktiken bei
Medizinsoftware in deut-
schen KMUs?,
Method Report, MEDCONF,
Healthcare Knowledge
GmbH, Munich
October 15-17, 2013

Media Maturity Model für
öffentliche Schulen M³PS,
Conference Talk, Metrikon
2013, DASMA, Kaiserslautern
November 14, 2013

Dörr, J.:
Towards Acceptance of Socio-
technical Systems – An Em-
phasis on the Requirements
Phase, Talk, First Workshop
on Sozioinformatik at Infor-
matik 2013, Gesellschaft für
Informatik, Koblenz
September 16, 2013

Kritische Qualitätsanforde-
rungen vollständig spezifi-
zieren? Und es geht doch...,
Invited Talk, 6th Requirements
Engineering Forum, Swiss
Association for Quality (SAQ),
Zurich, Switzerland
November 12, 2013

Elberzhager, F.:
Durchdringung der Welten
– wie Tests praxistauglich
werden, Talk, Iqnite, SQS
Software Quality Systems AG,
Düsseldorf
April 23 - 25, 2013

Inspektionen, Talk, STI-Veran-
staltung, Software Technolo-
gie Initiative, Kaiserslautern
September 17, 2013

Feth, D.:
Smart Ecosystems, Talk,
CeBIT, Deutsche Messe
Hannover, Hanover
March 5-9, 2013

Usage Control, Talk, IT-SA,
TeleTrusT - Bundesverband IT-
Sicherheit e.V., Nuremberg
October 8-10, 2013

Usage Control, Talk, DNT-Workshop, Fraunhofer IESE, Kaiserslautern,
April 24, 2013

Göpfert, B.:
Marktrecherche in der Praxis am Beispiel des Fraunhofer IESE, Seminar, Fraunhofer Marketing Netzwerk: Seminar Marktrecherche - Informationen als Erfolgsfaktor, Fraunhofer-Gesellschaft, Berlin
May 13, 2013

Fraunhofer-AG Information to Go, Presentation, Fraunhofer-Jahrestagung der Fachinformationsmanager 2013, Fraunhofer-Gesellschaft, Munich
October 16, 2013

Hess, S.:
Herausforderungen und Potentiale beim Einsatz mobiler Geräte, Presentation, Workshop Interaktive Fahr- und Betriebssimulation, Fraunhofer IESE, Kaiserslautern
June 11, 2013

Von der Mobilitätspotentialanalyse zur Konzeption von Apps, Presentation, Mobile TechCon, Berlin
September 2, 2013

Engineering UX – Systematisch von der Produktvision zum fertigen Design, Presentation, Usability Kongress 2013, Frankfurt
October 10-11, 2013

Interaction Design – Relevanz und Entwicklung des Dialoges zwischen Mensch und Maschine, Presentation, Bitkom AK Apps und Mobile Services, BITKOM, Nuremberg
December 5, 2013

Hess, S.; Kiefer, F.:
Ich weiß was Du bei der letzten App nicht getan hast, Tutorial, Karlsruher Entwicklertag, Karlsruhe
June 5 - 7, 2013

Hess, S.; Müller, C.; Breiner, K.:
Usability und User Experience für Geschäftsanwendungen, Presentation, STI-Veranstaltung, Software Technologie Initiative, Kaiserslautern
October 29, 2013

Hess, S.; Riegel, N.:
To App or not to App, Presentation, Reconf 2013, HOOD Group, Munich
March 11-14, 2013

Analyse und Konzeption mobiler Geschäftsapplikationen, Workshop, Reconf 2013, HOOD Group, Munich
March 11-14, 2013

Hess, S.; Dörr, J.:
Requirements Engineering und Konzeption von „Gamified" Apps, Presentation, GI Fachgruppentreffen RE 2013, Ilmenau
November 28-29, 2013

Holl, K.:
An Efficient Quality Assurance Method for Mobile Business Application Development Projects, Talk, Metrikon 2013, DASMA / Fraunhofer IESE, Kaiserslautern
November 13-15, 2013

Jedlitschka, A.:
Measurement in the Context of a Dissertation, Doctoral Symposium Technical Talk, Metrikon 2013, DASMA, Kaiserslautern
November 14, 2013

Jeswein, T.:
Emergente Software auch für die Verwaltung, Talk, 14. Kongress neue Verwaltung, dbb akademie, Leipzig
June 4-5, 2013

Kostenexplosionen in Softwareprojekten: Kontrolle durch verbessertes Anforderungsmanagement, Talk, 14. Kongress neue Verwaltung, dbb akademie, Leipzig
June 4-5, 2013

Technologietransfer in regionale KMU, Talk, Visit of Minister President Malu Dreyer at IESE, Fraunhofer IESE, Kaiserslautern
August 7, 2013

Technologie- und Kompetenztransfer in Ihr Unternehmen, Vortrag, Businessmesse Pfalz (formerly mediamit), IHK Pfalz, Kaiserslautern
September 18, 2013

Technologie- und Kompetenztransfer in Ihr Unternehmen, Talk, IT-Fachmesse Loc@l bit, Stadt Koblenz unter Federführung des Amtes für Wirtschaftsförderung in Zusammenarbeit mit der Koblenz-Touristik und dem Verein IT Stadt Koblenz e.V., Koblenz
October 24, 2013

P23R, Talk, IT meets Government, Darmstadt
December 11, 2013

Jung, C.:
Context-aware Policy Enforcement for Android, Talk, SERE 2013, Washington, USA
June 18, 2013

Kläs, M.:
Beyond Herding Cats: Aligning Quantitative Technology Evaluation in Large-Scale Research Projects, Conference Paper Talk, PROFES 2013, Paphos, Cyprus
June 12-14, 2013

Klaus,A.:
Analyse und Test konkurrierender Zugriffe auf Daten bei Geschäftsanwendungen, Talk, Metrikon 2013 - Doctoral Symposium, DASMA / Fraunhofer IESE, Kaiserslautern
November 13-15, 2013

Funktionale Validierung der Nutzerzufriedenheit, Talk, 4. Workshop Integration von Fahrzeugen, Dienstleistungen und IT, Fraunhofer IESE, Kaiserslautern
November 19, 2013

Lampasona, C.:
Document Analysis as Extension of the GQM⁺Strategies® Approach to Support Evaluation, Conference Talk, Metrikon 2013, DASMA, Kaiserslautern
November 14, 2013

Factors Influencing Perceived Project Success in Large R&D Projects: An Exploratory Study, Conference Talk, Metrikon 2013, DASMA, Kaiserslautern
November 14, 2013

Early Validation of Software Quality Models with respect to Minimality and Completeness: An Empirical Analysis, Conference Talk, Metrikon 2013, DASMA, Kaiserslautern
November 15, 2013

Luiz, T.:
The project ivet4Health, Invited Lecture, Symposium on stroke unit certification, medical education and diabetes, Dubai Health Authority, Dubai, VAE
January 29, 2013

Der Zentrale Landesweite Behandlungskapazitätsnachweis (ZLB) – Informationstechnologie für die golden hour disease, Presentation, Wissenschaftliche Arbeitstage Notfallmedizin der Deutschen Gesellschaft für Anästhesiologie und Intensivmedizin, Kiel
February 4, 2013

Einführung der elektronischen Einsatzdokumentation im Rettungsdienst – Konzeption und Ergebnisse von Feldversuchen in Rheinland-Pfalz, Presentation, Wissenschaftliche Arbeitstage Notfallmedizin der Deutschen Gesellschaft für Anästhesiologie und Intensivmedizin, Kiel
February 4, 2013

Der Zentrale Landesweite Behandlungskapazitätsnachweis (ZLB) – Informationstechnologie für die golden hour disease, Invited Lecture, Frühjahrstagung Rettungsdienst, Arbeitsgemeinschaft der Leiter der Berufsfeuerwehren, Hanover
March 13, 2013

Das Krankenhaus beim Massenanfall von Verletzten, Presentation, Anästhesiologische Fortbildung, Westpfalz-Klinikum GmbH, Kaiserslautern
April 10, 2013

Notfallmedizinische Betreuung der Zuschauer in deutschen Fußballarenen, Poster Presentation, Deutscher Anästhesie Congress, Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin, Nuremberg
April 20, 2013

Wie sind deutsche Fußballarenen in medizinischer Sicht auf Großschadenslagen vorbereitet?, Poster Presentation, Deutscher Anästhesie Congress, Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin, Nuremberg
April 20, 2013

Grenzenlose Rettung – wie die Zusammenarbeit zwischen Leitstellen optimiert werden kann, Invited Lecture, 15. Hauptstadtkongress 2013 der DGAI für Anästhesiologie und Intensivtherapie, Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin, Berlin
September 19-21, 2013

Notarzt – quo vadis: Ergebnisse der Analyse Notarztversorgung, Invited Lecture, Notfallmedizinisches Landessymposium, Land Rheinland-Pfalz, Kaiserslautern
October 26, 2013

Luftrettung – Basisversorgung oder subsidiäre Rolle im Rettungswesen?, Invited Lecture, Fachtagung Luftrettung, ADAC Luftrettung, Mainz
October 29-31, 2013

Müller, C.; Magin, D.:
Workshop User Experience Workshop, bit Information, Trier
December 9-10, 2013

Naab, M.:
Unter die Haube geschaut: Architekturbewertung bei der IT-Beschaffung, Talk, Medizinische Informatik Up2Date, Universitätsklinikum Gießen, Gießen
January 23, 2013

Zukunftssichere Software Systeme mit Architekturbewertung: Wann, Wie und Wieviel?, Tutorial, SE 2013, Gesellschaft für Informatik, Aachen
February 26 - March 1, 2013

Architekturbewertung in der Praxis. Gesammelte Erfahrungen aus mehr als 50 Bewertungen, Talk, Software Engineering Live, German Chapter of the ACM e.V., Achenkirch, Austria
April 25-26, 2013

All Architecture Evaluation is not the same: Lessons Learned from more than 50 Architecture Evaluations in Industry, Talk, SATURN 2013 Software Architecture Conference, Software Engineering Institute, Minneapolis USA
April 29 - May 3, 2013

Architekturbewertung in der Praxis. Gesammelte Erfahrungen aus mehr als 50 Bewertungen, Talk, GI Architekturen 2013, Fraunhofer IESE, Kaiserslautern
July 1-2, 2013

Software Architecture Documentation for Developers: A Survey, Talk, ECSA 2013, Montpellier, France
July 1-5, 2013

Naab, M.; Rost, D.:
Welche Architekturdokumentation wollen Entwickler? 147 Praktiker sagen es uns..., Talk, 3. Symposium Softwarearchitektur, Technische Akademie Esslingen, Ostfildern/Stuttgart
September 26, 2013

Riegel N.:
Guiding Requirements Elicitation using a Prioritization Framework, Workshop Paper Talk, RePriCo '13, Universität Duisburg-Essen, Essen
April 8, 2013

A Methodological Framework with Lessons Learned for Introducing Business Process Management, Conference Paper Talk, BPMDS 2013, Universitat Politécnica de Valencia, Valencia, Spain
June 25-26, 2013

Riegel, N.; Hess, S.:
Analyse und Konzeption mobiler Geschäftsapplikationen, Tutorial, ReConf 2013, Munich
March 11, 2013

To App or not to App, Conference Talk, ReConf 2013, Munich
March 12, 2013

Rombach, D., Madler C. et al.: Ambient Assisted Living Technologien – Wie können sie Gesundheitsrisiken älterer Menschen im häuslichen Umfeld reduzieren?, Ringvorlesung Telemedizin, Universitätsmedizin Mainz, 30 January 2013

"Informatik – Chancen & Risiken", Fireside Chat, Ramsen
February 19, 2013
Von Cyber-Physical Systems über Smart Ecosystems zur Digitalen Gesellschaft 2.0, CeBIT Lab Talk, CeBIT, Hanover
March 6, 2013

Arbeitsmarkt der Informatiker, Seminar, Arbeitsagentur Kaiserslautern, Kaiserslautern
March 13, 2013

"Innovation mit Fraunhofer", German-Brazilian Business Days, Panel Talk
São Paulo, Brazil
May 14, 2013

Smart Ecosystems: Potenziale & Herausforderungen in Software Engineering, Talk, Innovationskongress Technology Review, Berlin
November 5, 2013

Zukunftspfade Digitales Deutschland 2020", Panel Talk, Bundespresseamt, Berlin
November 4, 2013

Industrie 4.0 – Wenn reale und virtuelle Welten eins werden, Talk, IHK Südlicher Oberrhein, Lahr
November 25, 2013

Innovation und Wertschöpfung durch verlässliche Software, Talk, CIO Summit, 16th Summit for Information Technology, Berlin
December 1-3, 2013

Rost, D.:
Software Architecture for Developers - A Survey, Talk, ECSA 2013,
Montpellier, France
JUly 1-5, 2013

Rudolph, M.:
Mobilty Meets Security - Research @ Fraunhofer IESE, Talk, CON.ECT Industrietag "Mobile Strategien & Applikationen im Enterprise", Vienna, Austria
April 22-23, 2013

Public Key Infrastruktur, Presentation, Master Lecture "Kryptographie", University of Applied Sciences Mannheim
December 2, 2013

Schwarz, Reinhard:
Systematische Herleitung von Security Requirements, Talk, STI-Veranstaltung, Software Technologie Initiative, Kaiserslautern
August 2013

Trapp, Marcus:
Big Data in Smart Ecosystems, Talk, InnovVisions Day "Big Data - Big Business", InnoVisions, Berlin
March 19, 2013

mConcAppt – Systematisch zu Mobile Business Apps mit hoher UX, Talk, Mobile IT, Mainz
June 10, 2013

mPotential –Mobilitätspotentiale systematisch analysieren und ausnutzen, Talk, Mobile IT, Mainz
June 10, 2013

Addressing Animated Transitions already in Mobile App Storyboards, Conference Talk, HCII, Las Vegas, USA
July 26, 2013

Was würde Dr. House tun?, Presentation, UX Day, Mannheim
October 24, 2013

Apps in der Produktion – Anwendungsszenarien und Potentiale, Talk, Smart Devices als Fenster in Ihre Produktion, VDMA, Frankfurt
November 11, 2013

11 Freunde – Staurückzieher mit Videobeweis, Presentation, Bürger schafft Wissen, City of Kaiserslautern, Kaiserslautern
November 24, 2013

Innovation im Produkt durch Innovation in der Entwicklung, Talk, Fachforum "Innovation durch IT", Versicherungsforen Leipzig, Leipzig
November 26, 2013

Trapp, Mario:
Modellbasiertes Safety Engineering, Talk, Bosch, Stuttgart
May 5, 2013

Funktionale Sicherheit im Projekt E-Performance, Talk, Safe Emobility 2014, Hanser Verlag, Karlsruhe
June 18, 2013

Qualitätssicherung, Talk, VDI-Seminar, VDI, Karlsruhe
October 18, 2013

Safetronic, Talk, Safetronic, Hanser Verlag, Stuttgart
November 6, 2013

Internet-of-Everything, Talk , Medienakademie Köln, Düsseldorf
February 20, 2014

Embedded Software Engineering in Fahrzeugen, Talk, VDI-Seminar, VDI, Köln
March 17-18, 2014

Embedded Software Engineering in Fahrzeugen, Talk, VDI-Seminar, VDI, Munich
June 23-24, 2014

Embedded Software Engineering in Fahrzeugen, Talk, VDI-Seminar, VDI, Stuttgart
October 15-16, 2014

SCIENTIFIC CONTRIBUTIONS²

BOOKS

Arnold, Rolf (Ed.); **Bomarius, Frank (Ed.); Heintz, Matthias; Steinbach, Silke; Weber, Sebastian:**
Leitfaden zur Gestaltung interaktiver Lernangebote in der Altenbildung: Erfahrungen und Best Practices aus dem Projekt „Lernend Altern".
Baltmannsweiler: Schneider Verlag Hohengehren, 2013. (Grundlagen der Berufs- und Erwachsenenbildung; 74).
ISBN 978-3-8340-1219-7

Münch, Jürgen (Ed.); Schmid, Klaus (Ed.):
Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin: Springer-Verlag, 2013. (The Fraunhofer IESE Series on Software and Systems Engineering).
ISBN 978-3-642-37394-7
DOI 10.1007/978-3-642-37395-4

Trendowicz, Adam:
Software Cost Estimation, Benchmarking, and Risk Assessment: The Software Decision-Makers' Guide to Predictable Software Development.
Berlin: Springer-Verlag, 2013. (The Fraunhofer IESE Series on Software and Systems Engineering).
ISBN 978-3-642-30763-8
DOI 10.1007/978-3-642-30764-5

ARTICLES IN BOOKS

Doerr, Joerg:
Modeling Complex Information Systems.
In: Münch, Jürgen (Ed.); Schmid, Klaus (Ed.): Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin: Springer-Verlag, 2013, 95-109. (The Fraunhofer IESE Series on Software and Systems Engineering).
DOI 10.1007/978-3-642-37395-4_7

Heidrich, Jens:
Continuous Process Improvement.
In: Münch, Jürgen (Ed.); Schmid, Klaus (Ed.): Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin: Springer-Verlag, 2013, 111-129. (The Fraunhofer IESE Series on Software and Systems Engineering).
DOI 10.1007/978-3-642-37395-4_8

Heintz, Matthias; Weber, Sebastian:
Fallstudie LEA-Lernsystem.
In: Arnold, Rolf (Ed.); **Bomarius, Frank (Ed.); Heintz, Matthias; Steinbach, Silke; Weber, Sebastian**: Leitfaden zur Gestaltung interaktiver Lernangebote in der Altenbildung: Erfahrungen und Best Practices aus dem Projekt "Lernend Altern". Baltmannsweiler:
Schneider Verlag Hohengehren, 2013, 37-100. (Grundlagen der Berufs- und Erwachsenenbildung 74).

Heintz, Matthias; Weber, Sebastian:
Perspektive der Technik.
In: Arnold, Rolf (Ed.); **Bomarius, Frank (Ed.); Heintz, Matthias; Steinbach, Silke; Weber, Sebastian**: Leitfaden zur Gestaltung interaktiver Lernangebote in der Altenbildung: Erfahrungen und Best Practices aus dem Projekt "Lernend Altern". Baltmannsweiler:
Schneider Verlag Hohengehren, 2013, 15-35. (Grundlagen der Berufs- und Erwachsenenbildung 74).

Jedlitschka, Andreas; Guzman, Liliana; Jung, Jessica; Lampasona, Constanza; Steinbach, Silke:
Empirical Practice in Software Engineering.
In: Münch, Jürgen (Ed.); Schmid, Klaus (Ed.) Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin: Springer-Verlag, 2013, 217-233. (The Fraunhofer IESE Series on Software and Systems Engineering).
DOI 10.1007/978-3-642-37395-4_15

Kohler, Kirstin; **Trapp, Marcus:**
Mit der richtigen User-Interface-Strategie mehr erleben.
In: Lang, Michael (Hrsg.; Scherber, Stefan (Hrsg.): Perfekte Softwareentwicklung: Prozesse, Technologien und Methoden für erfolgreiche Softwareprojekte. Düsseldorf: Symposion Publishing, 2013, 295-322.

Priggouris, Nikolaos; **Silva, Adeline de Sousa;** Shawky, Markus; Persson, Magnus; Ibanez, Vincent; Machrouh, Joseph; Meledo, Nicolas; Baufreton, Philippe; Rementeria, Jason Mansell:
The System Design Life Cycle.
In: Rajan, Ajitha (Ed.); Wahl, Thomas (Ed.): CESAR - Cost-efficient Methods and Processes for Safety-relevant Embedded Systems. Wien Springer-Verlag, 2013, 15-67.
DOI 10.1007/978-3-7091-1387-5_2

Rombach, H. Dieter:
Empirical Software Engineering Models: Can They Become the Equivalent of Physical Laws in Traditional Engineering?.
In: Münch, Jürgen (Ed.); Schmid, Klaus (Ed.): Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin Springer-Verlag, 2013, 1-12. (The Fraunhofer IESE Series on Software and Systems Engineering).
DOI 10.1007/978-3-642-37395-4_1

Rombach, H. Dieter:
Integrated Software Process and Product Lines.
In: Münch, Jürgen (Ed.; Schmid, Klaus (Ed.): Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**.
Berlin Springer-Verlag, 2013, 359-366. (The Fraunhofer IESE Series on Software and Systems Engineering).
DOI 10.1007/978-3-642-37395-4_22

2) Names of Fraunhofer IESE and CESE members appear in bold.

Trapp, Mario; Schneider, Daniel; Liggesmeyer, Peter: A Safety Roadmap to Cyber-Physical Systems. In: Münch, Jürgen (Ed.); Schmid, Klaus (Ed.): Perspectives on the Future of Software Engineering: Essays in Honor of **Dieter Rombach**. Berlin Springer-Verlag, 2013, 81-94. (The Fraunhofer IESE Series on Software and Systems Engineering). DOI 10.1007/978-3-642-37395-4_6

ARTICLES IN JOURNALS

Benzinger, P.; Lindemann, U.; Becker, C.; Aminian, K.; Jamour, M.; **Flick, Simone**: Geriatric rehabilitation after hip fracture: Role of body-fixed sensor measurements of physical activity. In: Zeitschrift für Gerontologie und Geriatrie. (2013), Published Online: June 2013. DOI 10.1007/s00391-013-0477-9

Bouillon, Elke; Güldali, Baris; Herrmann, Andrea; **Keuler, Thorsten**; Moldt, Daniel; Riebisch, Matthias: Leichtgewichtige Traceability im agilen Entwicklungsprozess am Beispiel von Scrum. In: Softwaretechnik-Trends. 33 (2013), 1, 29-30.

Elberzhager, Frank; Kremer, Stephan; Münch, Jürgen; Assmann, Danilo: Focusing Testing by Using Inspection and Product Metrics. In: International Journal of Software Engineering and Knowledge Engineering. 23 (2013), 4, Article No. 433. - DOI 10.1142/S0218194013400093

Ferenc, Rudolf; **Knodel, Jens**; Winter, Andreas: Introduction to the Special Issue of the 13th European Conference on Software Maintenance and Reengineering - CSMR 2009. In: Journal of Software: Evolution and Process. 25 (2013), 2, 111-112. DOI 10.1002/smr.522

Feth, Denis; Hess, Anne; Kalmar, Ralf; Knodel, Jens: Erprobung zukünftiger Software Ecosystems im Living Lab Smart Farming. In: gis.BUSINESS. (2013), 3.

Forster, Thomas; Keuler, Thorsten; Knodel, Jens: Recovering Runtime Structures of Software Systems from Static Source Code. In: Softwaretechnik-Trends. 33 (2013), 2, 21-22.

Galster, Matthias; Weyns, Danny; Avgeriou, Paris; **Becker, Martin**: Variability in Software Architecture. Views and Beyond. In: ACM SIGSOFT Software Engineering Notes. 38 (2013), 1, 46-49. - DOI 10.1145/2382756.2382768

Gerber, Tobias; **Webel, Christian**: Unternehmensübergreifende Steuerung von Prozessen. In: Nachrichten aus der Chemie. 61 (2013), 4, 443-445. - DOI 10.1002/nadc.201390130

Hack, Marco; Feth, Denis; Zimmermann, Fabian: PUSH - jetzt auch in Grün!. In: Mobile Technology. 10 (2013), 1, 28-32.

Herrmann, Andrea; Houdek, Frank; **Doerr, Joerg**; Knauss, Eric; Schneider, Kurt: Bericht vom Treffen der Fachgruppe 2.1.6. "Requirements Engineering" am 29./30.11.2012 in Nürnberg. In: Softwaretechnik-Trends. 33 (2013), 1, 1-2.

Hess, Anne; Rombach, H. Dieter; Carbon, Ralf; Murphy, Daniel F.; Höh, Michael; Bartolein, Christian: The Role of Collaborative Capstone Projects - Experiences from Education, Research and Industry. In: The International Journal of Engineering Education. 29 (2013), 5, 1088-1099.

Hess, Anne; Maier, Andreas; Löffler, Diana: Die IBIS-Methode. Eine RE-Methode zur Entwicklung intuitiver Nutzungsschnittstellen. In: Softwaretechnik-Trends. 33 (2013), 1, 17-18.

Hess, Steffen: mConcAppt - Methode zur Konzeption von mobilen Business Apps. In: Softwaretechnik-Trends. 33 (2013), 1, 15-16.

Jedlitschka, Andreas; Juristo, Natalia; **Rombach, H. Dieter**: Reporting experiments to satisfy professionals' information needs. In: Empirical Software Engineering. (2013), Published Online: 11 Aug 2013, 35 S. DOI 10.1007/s10664-013-9268-6

Kuhn, Thomas; Kalmar, Ralf; Yu, Jiabin: Qualitätsbewertung von Modellen. In: HANSER Automotive electronics + systems. 12 (2013), 1-2, 52-53.

Kemmann, Sören; Kalmar, Ralf; Schwarz, Reinhard:
Sicher in vernetzten Systemen. Integrative Betrachtung von funktionaler Sicherheit und Security.
In: Automobil-Elektronik. (2013), 01, 38-40.

Knodel, Jens; Schneider, Daniel:
Sicher vernetzt. Funktionssicherheit von vernetzter Software am Beispiel Smart Farming.
In: Mobile Maschinen. (2013), 3, 2 S.

Knodel, Jens; Webel, Christian:
Softwareentwicklung 2020: Cyber-Physical Systems, emergente Software, Smart Ecosystems - was ändert sich wirklich?.
In: Business Technology. (2013), 1, 38-43.

Löffler, Diana; **Hess, Anne**; Hurtienne, Jörn; Lange, Kristin; **Maier, Andreas**; Schmitt, Hartmut:
Gestaltung intuitiv benutzbarer Softwareanwendungen mit der IBIS Methode. In: i-com. Zeitschrift für interaktive und kooperative Medien. 12 (2013), 2, 48-54.
DOI 10.1524/icom.2013.0016

Luiz, Thomas; Braun, Thomas; Fischer, Philipp; Kleber, Christian; Frank, Christian:
Innerklinische Bewältigung von Großschadensereignissen. In: Notfallmedizin up2date. 8 (2013), 1, 53-70.
DOI 10.1055/s-0032-1324960

Luiz, Thomas; Preisegger, T.; Madler, Christian:
Massenanfall Verletzter : Vorsorge deutscher Fußballarenen.
In: Der Anaesthesist. 62 (2013), 4, 278-284.
DOI 10.1007/s00101-013-2162-1

Nakagawa, Elisa Yumi; **Antonino, Pablo; Becker, Martin**; Maldonado, José Carlos; **Storf, Holger; Villela, Karina; Rombach, H. Dieter:**
Relevance and perspectives of AAL in Brazil.
In: The Journal of Systems and Software. 86 (2013), 4, 985-996; First Published Online: 18 October 2012.
DOI 10.1016/j.jss.2012.10.013

Pedrocchi, Alessandra; Ferrante, Simona; Ambrosini, Emilia; Gandolla, Marta; Casellato, Claudia; Schauer, Thomas; Klauer, Christian; Pascual, Javier; Vidaurre, Carmen; Gföhler, Margit; Reichenfelser, Werner; Karner, Jakob; Micera, Silvestro; Crema, Andrea; Molenti, Franco; Rossini, Mauro; Palumbo, Giovanna; Guanziroli, Eleonora; **Jedlitschka, Andreas; Hack, Marco**; Bulgheroni, Maria; D'Amico, Enrico; Schenk, Peter; Zwicker, Sven; Duschau-Wicke, Alexander; Miseikis, Justinas; Graber, Lina; Ferrigno, Giancarlo:
Mundus project: MUltimodal Neuroprosthesis for daily Upper limb Support.

In: Journal of NeuroEngineering and Rehabilitation. 10 (2013), 1, Article No. 66, 20 S.
DOI 10.1186/1743-0003-10-66

Riegel, Norman:
Modellbasierte Priorisierung in geschäftsprozessgetriebener Softwareentwicklung.
In: Softwaretechnik-Trends. 33 (2013), 1, 9-10.

Schneider, Daniel; Trapp, Mario:
Conditional Safety Certification of Open Adaptive Systems.
In: ACM Transactions on Autonomous and Adaptive Systems - TAAS. 8 (2013), 2, Article No. 8, 20 S.
DOI 10.1145/2491465.2491467

CONTRIBUTIONS TO CONFERENCE PROCEEDINGS

Adam, Sebastian; Schmid, Klaus:
Effective Requirements Elicitation in Product Line Application Engineering - An Experiment.
In: **Doerr, Joerg** (Ed.); Opdahl, Andreas L. (Ed.): Requirements Engineering: Foundation for Software Quality. 19th International Working Conference, REFSQ 2013 - Proceedings. Berlin: Springer-Verlag, 2013, 362-378. (Lecture Notes in Computer Science 7830).
DOI 10.1007/978-3-642-37422-7_26

Adam, Sebastian; Riegel, Norman; Koch, Matthias:
A Methodological Framework with Lessons Learned for Introducing Business Process Management.
In: Nurcan, Selmin (Ed.); Proper, Henderik A. (Ed.); Soffer, Pnina (Ed.); Krogstie, John (Ed.); Schmidt, Rainer (Ed.); Halpin, Terry (Ed.); Bider, Ilia (Ed.): Enterprise, Business-Process and Information Systems Modeling. 14th International Conference, BPMDS 2013, 18th International Conference, EMMSAD 2013, Held at CAiSE 2013 - Proceedings. Berlin: Springer-Verlag, 2013, 78-93. (Lecture Notes in Business Information Processing 147).
DOI 10.1007/978-3-642-38484-4_7

Adam, Sebastian; Riegel, Norman; Hess, Anne; Uenalan, Oezguer; Darting, Simon; Maier, Andreas; Villela, Karina:
Formalizing Requirements Engineering by a "Requirements Engineering House".
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Adam Trendowicz
The Fraunhofer IESE Award 2013 for Research Excellence

Sebastian Adam
The Fraunhofer IESE Award 2013 for Doctoral Thesis Excellence

Dominik Magin
The Fraunhofer IESE Award 2013 for Master Thesis Excellence

Simon André Scherr
The Fraunhofer IESE Award 2013 for Bachelor Thesis Excellence

Thomas Schentarra
The Fraunhofer IESE Award 2013 for Excellence in Apprenticeship

Sonnhild Namingha
The Fraunhofer IESE Award 2013 for Infrastructure Excellence

Simone Mieger
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Klaus, A.:
Best Paper Award, The Fourth International Conference on Advances in System Testing and Validation Lifecycle (VALID), Lisbon, Portugal January 2013

Orth, A.:
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Rombach, D.:
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Best Azubi of Fraunhofer-Gesellschaft, Fraunhofer-Gesellschaft, Munich November 2013

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