QE LaB II – Quality Intelligence for Smart Software-Intensive Systems

Project Sketch Submission to the 6th FFG Call COMET K-Projekte

Today, competitiveness and innovation are heavily driven by the ability of organizations to flexibly interconnect information, services and devices. The resulting products, services and infrastructures are often called "smart", and include, for example, smart grids, smart vehicles or smart factories. They can create new markets and can offer creative solutions to societal challenges.

These developments have turned infrastructures, products and even corporations in short time to highly complex, dynamic, inter-organizational and inter-dependent digital business ecosystems, rising properties like personalization, situation-awareness, agility, collaboration, adaptiveness and autonomy to a new level. On the other hand, most of the arising smart services are attached with highest quality needs. **Safety**, **security** and **privacy** are quality requirements playing a dominant role in contexts where data of individuals and critical infrastructures are interconnected in the large.

As has been demonstrated, time and again, by high-profile incidents and system breakdowns quality of the new digital business ecosystems is an issue of highest business and societal relevance. Recent studies plainly show that organizations heavily struggle with questions like

- What level of quality is adequate for our organization/product?
- What is the actual level of quality and how can we achieve the target level with given resources?
- How can we efficiently and effectively react to changes?

The crucial challenge today is not so much to know how to prevent failures and incidents, but to know which incidents to prevent in a way that meets business goals and budgets.

Put in other words, the grand challenge of quality management today is to manage the overall set of interdependent evolving quality requirements both from a business oriented and technical perspective.

QE LaB[1] is the leading research centre worldwide focusing on an end-to-end perspective of quality management. It has been successfully run as competence centre at the University of Innsbruck in the context of the Laura Bassi Centres of Expertise initiative since 2009. In this time we have been able to establish **Quality Engineering as the discipline of end-to-end IT quality management** in an evolutionary and collaborative environment[2]. The goal of the submission to the 6th FFG K-Projects Call is to continue QE LaB by both driving forward the concept of **Quality Intelligence** and opening new application domains to the methods and tools developed within QE LaB.

[1] www.qe-lab.at

[2] cf. Ruth Breu, A. Kuntzmann-Combelles, M. Felderer: New Perspectives on Software Quality, in: IEEE Software 31(1):32-38 (2014), http://www.computer.org/csdl/mags/so/2014/01/mso2014010032.pdf

Quality Intelligence

Current methods and tools for quality management are still to a high degree static, manual and centrally controlled processes, forcing stakeholders to take decisions based on outdated, imprecise and incomplete information. **There is an urgent need to make the quality management process as smart as its target assets**. Similar to Business Intelligence which provides business decision makers with the necessary information to take informed decisions Quality Intelligence supports collaboratively acting quality decision makers through information of adequate **timeliness**, **precision** and **completeness** on the target assets (e.g. a product, infrastructure or corporation), their actual quality status, their target quality status and how it can be achieved in a cost-effective way.

The vision of QE LaB is to apply capabilities of smart systems – situation-awareness, personalization, adaptiveness, real-time responsiveness and automation – to the quality management process itself. That way, Quality Engineering can fulfil its role as an effective and flexible enabler for innovative software-intensive systems.

In the upcoming project period we will focus on the following areas:

Risk-driven Workflows
steering collaborative quality management activities through business-driven impact factors and technology-driven likelihood factors (e.g. within the test management process or security management process)
Certification Processes for Safety and Security
Efficiently managing safety and security requirements in evolving and/or multi-standard contexts
Situation-Aware Quality Requirements Monitoring
Enhancing situation-aware requirements tracking through flexibly integrating and analysing data from development, production and end-user environments
Model Management in Heterogeneous Contexts
Collaborative Management of evolving heterogeneous interconnected assets (e.g. service-oriented products, products with variants, enterprise architectures)

The methods developed will be compliant with existing frameworks, best practices and standards in areas such as IT management, software engineering, security and safety management.

Risk-Driven Workflows

Our goal in this area is to create concepts for situation-based dynamic steering of quality related actions based on the evaluation of risks. A risk-driven process considers both a business-driven impact and a technology-driven likelihood perspective to select adequate quality assessment procedures, propagate changes, assign responsibilities or provide personalized views.

Potential sub-topics:

- Risk-Based Workflows for Security Requirements Management
- Risk Driven Requirements Management and Testing
- Risk-Driven Security Testing

Certification Processes for Safety and Security

Eliciting requirements and giving evidence for their fulfilment counts to the most expensive and time-consuming tasks within the development of safety and security-critical systems. Our goal is to increase the efficiency of certification processes, in particular in the context of re-certification, compliance to multiple standards and the integration of safety and security evidence. Our solution concepts will comprise e.g. enhanced traceability, lifecycle tracking and meta-modeling support.

Potential sub-topics:

- Traceability of requirements for multiple standards compliance
- Integration of security and safety requirements analysis
- Efficient re-certification

Real-time Quality Requirements Monitoring

An essential constituent of Quality Intelligence and crucial weakness in current practice is the incorporation of real-time data to track requirements. is the monitoring of quality requirements. Quality Intelligence incorporates

- the connection of soft and hard sensors from the development or production environment with the quality management framework
- flexible correlation and aggregation of these data sources
- self-service visualizations supporting personalized analysis of the monitoring data
- automation capabilities enabling the autonomous monitoring of requirements

A crucial challenge in this context is the efficient and flexible handling of such environments. Therefore, we will e.g. develop a flexible model-based data infrastructure for connecting a quality management framework with data sources in a real-time manner and patterns for stakeholder-centric visualization of attributed, traceable and evolving quality requirements.

Model Management in Heterogeneous Contexts

Effective end-to-end quality management supports stakeholders with task-oriented views on the assets. In practice this requires the continuous integration and interlinkage of manifold data sources, e.g. originating from Enterprise Architecture Management tools, CMDBs, Matlab/Simulink models, software modelling tools or requirements management tools. Based on experience from previous work our focus is on collaborative management of assets in heterogeneous environments based on free meta model definition, stakeholder-centric interfaces and dynamic visualization capabilities.

Potential sub-topics:

- Integration and interlinkage of models in heterogeneous environments (e.g. hardware/software models)
- Variability modeling
- Model versioning
- Generation of configurations out of models
- Model querying and model analysis

Research Partner

The QE LaB Competence Center headed by Prof. Dr. Ruth Breu is located at the University of Innsbruck, Institute of Computer Science. QE LaB has been funded within the Laura Bassi Centres of Expertise initiative and industry partners since 2009. By carefully applying principles of Design Science QE LaB has been regularly awarded not only by its excellent scientific output but also by innovative methods and tools developed in close collaboration with its industry partners. Over the past years, QE LaB staff members have reached top international visibility and impact, proved e.g. through membership in international Boards (e.g. NIS platform of the EU Commission[3]) or regular presentations at top business-oriented events and journals (e.g. OOP, EuroStar, Objekt-Spektrum).

QE LaB is embedded in an environment fostering lively knowledge exchange between academia, education and practice. This e.g. includes

- Quality and Security Tirol[4], an initiative to foster practice-oriented education in the Bachelor and Master program of Computer Science (e.g. comprising labs with experts from industry)
- Workshops with practitioners on a regular basis (e.g. Software Engineering live[5], QE LaB Praxis Forum)

Selected QE LaB Members and their expertise:

- Prof. Dr. Ruth Breu: Security management, requirements engineering, quality management processes
- Dr. Michael Felderer: requirements engineering, test management processes, risk-based testing, empirical software engineering
- Dr. Matthias Farwick: Enterprise Architecture Management, asset modelling, model engineering, software engineering processes, continuous delivery
- Thomas Trojer M.Sc.: model engineering, security engineering, model engineering

The upcoming funding period will build upon previous research and development results. This e.g. comprises

- Adamant – A Framework for Efficient IT Security and Compliance[6]
- Txture – IT Landscape Intelligence[7]
- Risk-Based Testing – Empirical Analysis and Tool Support[8]

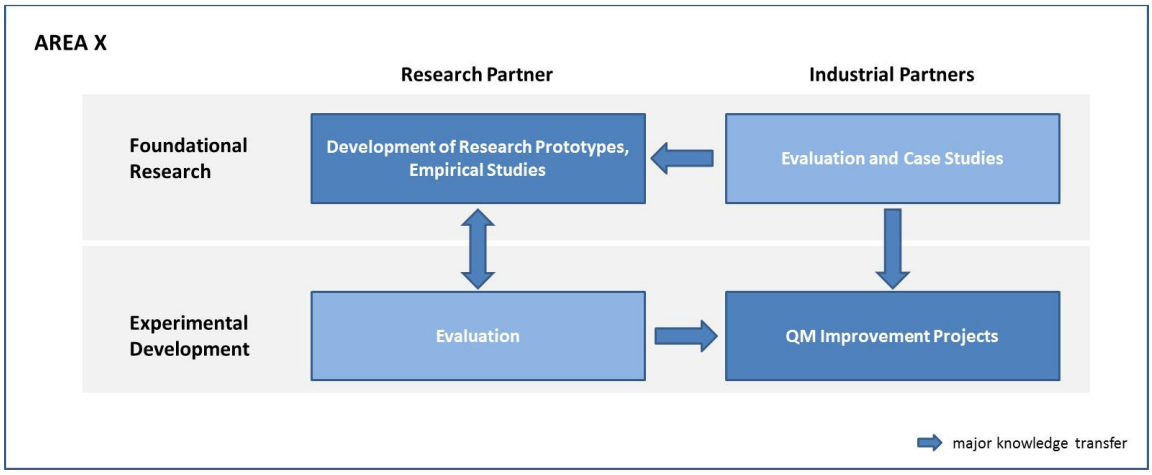
adamant txture

[3] https://resilience.enisa.europa.eu/nis-platform
[4] www.qsp-tirol.at
[5] www.se-live.org
[6] adamant.q-e.at
[7] www.txture.org
[8] E.g. http://www.sigs-datacom.de/fachzeitschriften/objektspektrum/online-themenspecials/artikelansicht.html?tx_mwjournals_pi1%5Bpointer%5D=0&tx_mwjournals_pi1%5Bmode%5D=1&tx_mwjournals_pi1%5BshowUid%5D=7737

Project Structure and Colllaboration

The K-Project will comprise different kinds of sub–projects explicating the way how industrial partners and research partner will collaborate.

- Industrial partners evaluate research prototypes developed by the research partners and provide input for empiricial studies (e.g. through participating in interviews, providing anonymized data).
- Industrial partners launch internal projects to push forward the Quality Management process in their own environment supported by the academic partner (e.g. through moderating workshops, evaluating commercial products, giving keynotes at the industrial partners´side)



Sample Setting: Sub-Project Risk-Based Security Workflows

- *QE LaB academic staff develops a novel research prototype for risk-based security workflows, industrial partner evaluates the research prototype (2-3 workshops/interviews per year)*
- *Industry partner implements selected concepts within the own organization (e.g. establishing risk-based metrics collection in the own management processes) accompanied by the academic partner (e.g. support to develop a risk metrics catalogue and guidelines).*

Within the project industrial partners spend roughly 80% of their inkind efforts on QM Improvement Projects and 20% on evaluating the research prototypes.

The project is organized as bilateral collaborations. PhD students regularly stay at your side, constant Post-Doc supervision is granted. This comprises constant contact persons with experience in conducting industrial collaborations

Benefits for the Industrial Partners

- Support and evaluation of own activities within the own Quality Management Process
- Development of novel Quality Engineering techniques customized to the needs of the own corporation
- Collaboration with a renown research partner with high visibility and impact in the field
- Possibility to conduct Bachelor and Master Theses in the context of the project to involve more juniors
- Possibility for joint publications in business oriented media (conferences, journals)

For the project submission we solicit industrial collaboration partners from the following (non-exclusive) domains:

- Factory 4.0
- Cyber-physical systems
- Critical infrastructures (e.g. telco, energy, finance, health care)
- Cloud services

Facts and Figures for Joining the Consortium

- Deadline for Submission: Spring 2015 (Call is not yet open)
- Runtime: 4 years, starting January 2016
- Consortium: 6-9 industry partners
- Funding Scheme: FFG COMET K-Projekte[9]
- Contribution per industry partner (negotiable):
    - Inkind efforts: 12 PM per year (0.5 PM evaluation, 11.5 PM improvement of own QM Process)
    - Cash effort: 25 kEuro per year
- QE LaB Service:
    - 1 PhD student working for the bilateral collaboration
    - Post-Doc supervision and project lead

Contact:

Prof. Dr. Ruth Breu
Institut für Informatik
Universität Innsbruck
ruth.breu@uibk.ac.at
Office: ++43/512/507-53200
Mobile: ++43/664/8125234

[9] https://www.ffg.at/content/comet-compentence-centres-excellent-technologies-k-projects