



SmartDelta

An evolving perspective on software developments

To accurately analyse the quality implications of each change to a software system, the ITEA project SmartDelta (Automated Quality Assurance and Optimisation in Incremental Industrial Software Systems Development) developed a methodology and toolset for the automated quality assessment of product deltas in a continuous engineering environment.

Industrial software-intensive systems are not typically designed or built from scratch for each new customer and order, which makes software an evolving entity with different quality characteristics over time. However, as systems are developed and incremented with new features or updates, companies end up with a range of product versions and components for which certain quality aspects often begin to deteriorate. The management of product variants at scale also depends on the expertise and availability of engineers with knowledge of previous versions, leaving it prone to human error as system complexity grows.

In SmartDelta, a delta refers to any change in a software product that results in a new product instance with different functionality and/or quality properties. To manage the quality of such deltas, the project developed the SmartDelta Methodology and a rich toolset for its implementation and instantiation. This enables companies to address essential aspects of delta management in their software development process, offering a clear approach to incremental software system development that aligns with business goals and strategies. By automating the management of product variants at scale, SmartDelta aimed to improve the quality of multi-variant software systems while reducing both time to market and software waste. Efforts were also made to boost the industrial adoption of artificial intelligence (AI) in software development processes. Overall, this represents a shift from a

linear to a circular economy model for software products.

Technology applied

The SmartDelta Methodology provides a structured approach to incremental software development that emphasises adaptability to change, allowing companies to address essential aspects of delta management in a continuous engineering environment. This includes distinct phases that consolidate similar technical focus areas: requirements engineering, incremental development, quality assurance, recommendations and predictions, and monitoring and visualisation. Using stakeholder input and pre-existing development artifacts (such as source code, log files and requirement specifications) to guide the development direction, the process provides insights into quality improvements or degradation in and across product evolutions. On the basis of quality assurance data, delta-aware analysis and AI are used to generate predictive recommendations for the next build.

The methodology also suggests concrete tools that may help address specific challenges. As SmartDelta has developed a comprehensive toolset per phase, the resulting recommendations are easy to implement in different industries, as demonstrated via contextualisation and recommendations across 11 use-cases in eight industrial domains. These showcase highly diverse applicability, including quality in agile model-based system and product line engineering for railways

in Sweden, continuous improvement of code quality, security and performance in core banking software in Türkiye, and semantic matchmaking for enterprise software in Spain. Finally, SmartDelta supplemented its main results with an AI-based chatbot and a mini-game that engagingly introduces the methodology, toolset and use-case challenges to new users by presenting questions, awarding scores and allowing progression through different levels.



Making the difference

First and foremost, SmartDelta represents a perspective shift: software should not be regarded as one single product but in terms of evolution over time. By helping companies to understand the changing quality characteristics of their product deltas, the methodology and toolset give them the opportunity to increase their software's efficiency, quality and reusability. With nine tools now at TRL 5-6 and [24 exploitable results](#) in total, such benefits are already being felt. For instance, Alstom has applied the SmartDelta Methodology to optimise test case generation and thereby reduced their test suite sizes by over 80% while maintaining fault detection rates of 87%-100%. Arçelik, meanwhile, has decreased the number of bugs in their Connecta App

by 44%, indicating highly enhanced code quality.

A particular success story was Addiva and Mälardalen University's collaboration on the development of a Capella plugin based on SmartDelta's NALABS tool for requirements review. This has been shown to reduce the time to produce safety and security requirements by 10-50%, with estimated yearly savings of over EUR 90,000 for companies that make use of this framework. Notably, this saw one partner helping to commercialise the results of another partner, indicative of the excellent collaboration achieved despite a large consortium across nine countries. In this context, SmartDelta also saw impressive dissemination and human capital results, including the publication of 58 technical and scientific articles so far

and the creation of 20 new recruitment positions as a result of the project.

The future

By making the methodology and some of its tools available as open source, SmartDelta has ensured that its core results will remain widely accessible and adaptable to diverse industries beyond the original scope. Many SmartDelta partners are now involved in the ITEA project GENIUS, which aims to capitalise on the boom in generative AI by further developing their work in the direction of large language models. In doing so, SmartDelta's results and innovations will set the foundation for further follow-up projects, research and development while continuing to create commercial opportunities after SmartDelta's completion – a truly evolutionary project.

Major project outcomes

Dissemination

- > About 58 articles and publications produced
- > More than 22 new positions offered
- > Presentation at major software engineering conferences and workshops:
- > Cross-fertilisation with other EU/international projects
- > An interactive educational game to teach about the SmartDelta Methodology

Exploitation (so far)

- > SmartDelta Methodology to manage quality of product deltas
- > 41 tools and solutions for instantiation and implementation of the methodology, i.a.:
- > SoHist: a tool for managing technical debt through retro perspective code analysis
- > MUT4SLX: mutation testing for Simulink and Stateflow
- > Smellyzer: elevates software development quality by identifying and addressing inefficiencies within the code review and bug tracking processes
- > Jazure: the tool enables to link git requests and Jira work items to create insightful reports or dashboards
- > RADICLE: an LLM-based tool to detect ambiguities in requirements and provide rationale explanations to support the decision.
- > AirOPs: a tool for analysing QA metrics on cloud-based airfield software
- > DIA4M: allows to compare deltas for two different versions of the same microservice and for two different microservices.
- > NALABS: a tool designed to detect “bad smells” in requirements & test specifications
- > CSI: code Similarity Investigator (CSI) computes similarity between code sections
- > SEAFOX: combinatorial testing tool to automate test case generation for industrial control software
- > ReLink: a prediction-based PR-issue linking tool with additional visualisation features
- > K2: a state space exploration engine based on abstract state machines implemented in Java
- > DETANGLE: analysis suite for a holistic technical debt analysis over time by correlating various KPIs

Standardisation

- > Contributions to PLCOpen

Patents & IPR

- > Method for interaction mapping and detecting anomalies for microservice-based applications
- > 11 open-source contributions

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Partners

Austria

- > BEIA GmbH
- > c.c.com GmbH
- > University of Innsbruck

Belgium

- > University of Antwerp NEXOR

Canada

- > Cyberworks Robotics
- > eCAMION INC.
- > GlassHouse Systems
- > SmartCone Technologies Inc.
- > Team Eagle
- > University of Ontario Institute of Technology

Czech Republic

- > Czech Technical University in Prague
- > INVENTI

Finland

- > Hoxhunt Oy
- > Vaadin
- > WithSecure

Germany

- > AKKA Industry Consulting GmbH
- > Akkodis Germany Solutions GmbH
- > Cape of Good Code
- > Fraunhofer FOKUS
- > Institut für Automation und Kommunikation (IfAK)
- > Software AG
- > TWT GmbH Science & Innovation

Spain

- > IZERTIS SA
- > Sotec Consulting
- > University of Madrid Carlos III

Sweden

- > Addiva AB
- > ALSTOM Rail Sweden AB
- > Mälardalen University
- > RISE - Research institutes of Sweden

Türkiye

- > Arcelik A.S.
- > Dakik Yazilim Teknolojileri
- > ERSTE Software Limited
- > Kuveyt Turk Bank
- > Orion Innovation Information Technologies

Project start - end

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