COMPACT

Faster, more efficient software through automation

From industrial automation to healthcare, Internet of Things (IoT) has impacted nearly every aspect of our lives. However, the cost pressure of making IoT devices as smart, cheap and energy efficient as possible affects both manufacturing and design costs, with software design accounting for around 45% of the overall System-on-Chip development effort. Fast and efficient software development is thus a key enabler of future growth within the IoT domain.

The ITEA project COMPACT—short for Cost-Efficient Smart System Software Synthesis—brought together 15 partners from Austria, Finland, and Germany to address these challenges. The project aimed to enhance IoT software development by automating code generation from abstract models. This approach not only increased productivity but also significantly reduced manufacturing costs and mitigated performance issues. Furthermore, the project optimised embedded software for semiconductor-based products by selecting the most effective solution from multiple design options aligned with system requirements.

Impact highlights

› Thanks to the developments in COMPACT, a 20-70% reduction in software development costs can be expected, depending on the degree of generation, without any performance loss or memory footprint of the software code. As designers can produce around 2,000 lines of code per year and a person-year costs roughly EUR 150,000, COMPACT predicts that each line of generated code will have a value of 75 euros. Generators for a new device family therefore pay off with their first use.

› Thanks to the COMPACT project, SparxSystems Software GmbH has increased its workforce by five employees and two trainees and revenues have increased by 15% in this domain. In addition, SparxSystems took over another company in the IoT domain in February 2024.

› Kasper & Oswald GmbH has trained two junior engineers to further extend platform support, one of whom has moved to a full-time role in the company. The results of COMPACT also feed into two follow-up projects.

› Visy Oy expect orders worth EUR 1.8 million for systems with technologies developed in COMPACT. Moreover, the newly developed computational technologies are an essential part of Visy Oy's offering to all customer sites, enabling more efficient edge computing.

› As a contribution to standardisation, a COMPACT extension to the IP-XACT standard was finalised and submitted to the Institute of Electrical and Electronics Engineers (IEEE). About 90% of the proposals have been included in the new standard.

Project results

COMPACT targeted tiny IoT devices, concentrating on low-level software components such as drivers and hardware abstraction layers. The main goal was to make software for these small devices, where the hardware is limited in power and size because it has to be affordable. COMPACT sought to create a connection between how a device is modelled and how its software is developed. The solution is automatic software generation based on models, for which a complete chain of tools was developed.

Major innovations were achieved in the areas of modelling, tooling and automation, and analysis and optimisation, all guided by the requirements, concepts, and use cases of industrial partners. Three demonstrators highlighted the project's relevance across various applications:

- Smart sensors: Model-based code generation workflow and virtual prototype-based software analysis.
- Vehicle detection: Utilisation of the IoT Platform Modelling Language within the Enterprise Architect tool.
- IoT sensor devices: Model creation and support for system architecture and functional interface refinement.

In terms of results, COMPACT exceeded expectations, achieving up to 90% faster and more compact software compared to manually written code. These advancements resulted in reduced memory usage, lower energy consumption, and decreased latency.

Exploitation

By embracing open software implementation for better dissemination, COMPACT has seen wide exploitation across various channels. SME software tool companies have been able to create new tools while large semiconductor companies and system houses have created software more efficiently. This has enabled these companies to maintain or expand their presence in the competitive IoT semiconductor market.

Leveraging COMPACT's innovations, SparxSystems developed a foundation for cybersecurity modelling that has become part of its core product, opening opportunities in the aviation and space industries. Further strategic investments in the direction of model transformation have resulted in additional research projects.

Similarly, Kasper & Oswald GmbH introduced its new COMPACT Crypto API (CCAPI) to several to automotive and home automation customers and incorporated parts of its innovations in internal product development.

In addition, Visy Oy's demonstrator featuring a vehicle model classifier and license plate recogniser is in use at four customer sites. The vehicle model recognition also led to vehicle colour recognition and is currently operational at 20+ customer checkpoints.

Finally, several COMPACT partners have continued their work with an expanded scope - strongly committed to the European Chips Act - in follow-up projects, and a new proposal has been submitted in ITEA Call 2024.

By automating IoT software development, COMPACT has reduced costs, enhanced energy efficiency, and improved security. These contributions to the IoT sector's technological and standardisation advancements are opening new markets, driving research, and expanding IoT applications that benefit everyday life.