IoD

Internet of DevOps

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Internet of DevOps

The IoD project aimed at addressing pain-points from large organizations in applying Continuous Integration (CI) methodologies and technologies for enhancing automation, lifecycle visualization tools, support for continuous developer feedback on software quality, and Big Data analytics of software development processes.

Main focus

This project focused on the use and enhancement of DevOps within large organizations developing Telecom & Cyber-Physical Systems (T-CPS). DevOps was introduced a decade ago to emphasize the integration between "development" and "operational" phases of the software design & delivery process. Important aspects of DevOps include communication and collaboration between involved stakeholders, and the adoption of agile development processes. DevOps is today a standard practice in IT systems but has been lacking behind in many T-CPS industries. The project had the ambition to provide DevOps solutions for these industries, thus addressing their specific requirements and pain-points, while drawing upon experiences with existing DevOps methodologies from the IT domain. The project focused on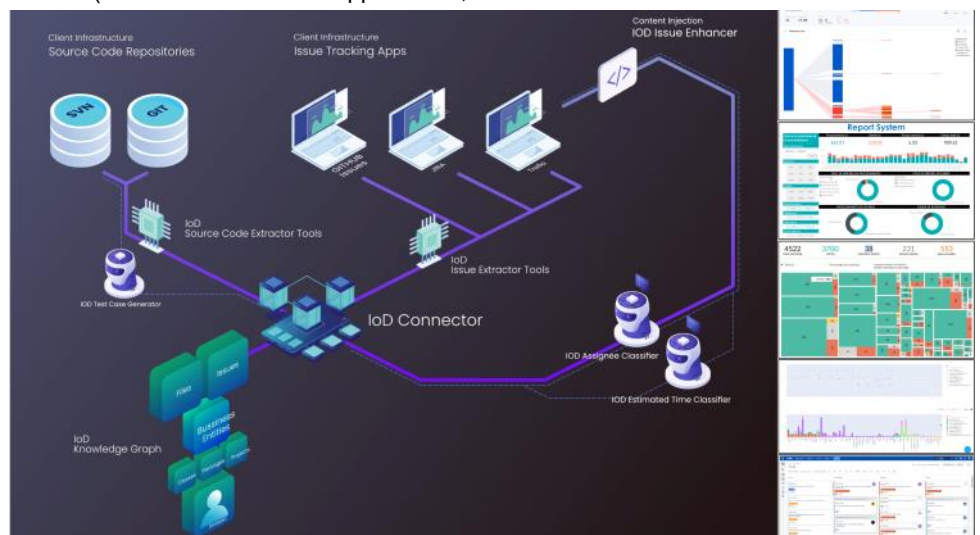 key application domains (from telecom & 5G applications, aerospace & defense industries, consumer electronics, and digital marketing sectors) with system examples.

Approach

The IoD consortium covered the main stakeholders' representatives of the value chain, i.e., problem owners (large companies from defense, consumer electronics, digital marketing, and telecommunication sectors), DevOps solution providers, and knowledge providers. These stakeholders worked together following a top-down approach for addressing the DevOps industrial requirements from the large companies. These requirements encompassed targeting the lack of knowledge and guidelines on how to apply DevOps principles in these organizations; the lack of traceability across development artefacts; the lack of DevOps quality metrics and automation support; the lack of continuous developer feedback and visualization tools; and the lack of connectivity across the T-CPS development tools and the operational ones.

Achieved results

From a technical perspective, our tool and solution providers focused their efforts on prototyping and enhancing existing software assets according to the main De-

vOps pain-points identified by our industrial partners. These assets encompassed the support of cross-cutting and application-agnostic DevOps services, semi-automatic configuration and deployments of development and monitoring tools, continuous and automatic testing, and information extraction, for software-intensive, but also to some extent, for hardware-dependent applications. Finally, data analytics and machine learning technics coupled with visualisation tools for continuous end-to-end feedback were also implemented. Most of these assets have been successfully deployed for evaluation in our industrial partners' software development pipelines, between Technology Readiness Levels (TRL) 3 to 7. Significantly positive assessment results for addressing their main initial industrial business pain-points have been reported, in particular regarding data gathering and analysis capabilities to incite optimization in DevOps industrial processes, automatic deployment and verification of software on product devices, and increased efficiency in the analysis of massive amounts of data. From a methodological perspective, the project also focused on the evaluation of the main industrial pain-points when it comes to applying DevOps principles in T-CPS industries, on the identification of emergent standards, and finally compiled lesson learned, opportunities and risks for these industries. As an

outcome of these activities, one of the IoD partners is currently investigating pushing forward standardization of DevOps principles in a Systems Lifecycle Management context. The project's results generated several key scientific publications in international journals and conferences on software engineering.

Impact

Around 20 new and improved products (in addition to 15 prototypes on field trials) have been released in the project consortium. These products have been designed and implemented according to our industrial partners' pain-points and their prioritized business capabilities. Some of them have been already assessed to significantly generate expected return on investment (RoI) within the next 3 years. Significant efforts have been also put by some of the IoD partners to publicly release open-source software. The project also significantly increased internal awareness around DevOps capabilities within our consortium's industrial partners, which will most likely result in follow-up EU R&D project proposals on these key topics for the European industry.

About Celtic–Plus

Celtic-Plus is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on a new „Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and belongs to the inter-governmental EUREKA network. Celtic-Plus is open to any type of company covering the Celtic-Plus research areas, large industry as well as small companies

or universities and research organisations. Even companies outside the EUREKA countries may get some possibilities to join a Celtic-Plus project under certain conditions.

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