COSMOS
DevOps for Complex Cyber-physical Systems

COSMOS will design and develop novel DevOps methodologies, techniques, and tools that will enable effective, continuous development and evolution of cyber-physical systems, while providing substantial increases in the reliability, trustworthiness, and adaptability of complex software and hardware systems on which European industry, citizens and society heavily rely. Project innovations will be validated in industrial applications from the Healthcare, Avionics, Automotive, Utilities and Railways sectors.

AT A GLANCE

Project Title
DevOps for Complex Cyber-physical Systems

Project Coordinator
The Open Group (UK)

Partners
Aicas (DE)
Delft University of Technology (NL)
GMV Skysoft (PT)
Intelligentia (IT)
Q-media (CZ)
Siemens (DE)
Siemens Healthcare (DE)
University of Luxembourg (LU)
University of Sannio (IT)
Unparallel Innovation (PT)
Zurich University of Applied Sciences (CH)

Duration
01.2021 – 12.2023

Total Cost
4.998.571 €

EU Contribution
4.998.571 €

Programme
H2020-ICT-2020-1 / Software Technologies

Further Information
www.COSMOS-DevOps.org

Context and Motivation

Cyber-physical Systems (CPS) – from robotics, transportation, to medical devices – will play a crucial role in the quality of life of European citizens and the future of the European economy. One specific example is the public transport system where the percentage of fully automated operation is expected to increase from today's 30% to 70% by 2030: CPS is a key enabler in this and many other industrial and societal evolutions. Increasing automation to such an extent, however, gives rise to many challenges, at the crux of which lies the hardware and software symbiosis.

Several new challenges arise from the increasing complexity of CPS software, seamless connectivity, abundant compute power, and hardware heterogeneity. Emerging CPS are characterised by an evolving development that never ends, and engineering practitioners in the field are facing fundamental development challenges: observability, testability and predictability of the behaviour of emerging CPS is highly limited and, unfortunately, their usage in the real world can lead to accidents, sometimes tragically also involving humans.

DevOps practices and tools are potentially the right solution to this problem, but they have not been developed to be applied in CPS domains. COSMOS takes on these challenges by delivering the technological and methodological advances necessary to enable DevOps for development of complex, trustworthy and reliable CPS solutions.

Challenge

A key challenge in applying DevOps practices to CPS domains is that it requires specific development and verification strategies able to include Hardware-in-the-Loop (HiL) capabilities. Also, embedded systems design, manufacturing, and testing have different, longer lead times and cycle times than enterprise software, leading to longer V&V procedures and higher testing costs (typically over 25% of total development costs). Therefore, CPS are far more difficult to integrate, and testing the hardware is not always practically possible: the final version of the hardware is often available late and testing on the hardware directly can be expensive.

A typical approach to dealing with this is to develop hardware proxies, such as prior system hardware versions/simulators and digital twins. However, this approach is flawed and is not sufficient to operate a V&V process that provides high levels of verifiability, trustworthiness, and confidence in the CPS behaviours.

Solution

COSMOS will overcome the challenges of developing and evolving high-quality, dependable CPS by employing two key technologies: DevOps and Artificial Intelligence (AI). The collaborative project will:

- Design, develop, and validate solutions that continuously improve the overall efficiency/quality of CPS, reducing the number of post-release defects and security vulnerabilities.

- Develop solutions that enable CPS to autonomously adapt to unexpected run-time behaviours due, for example, to unexpected operating contexts.

- Investigate the extent to which DevOps concepts can be applied in CPS domains over a diversified set of complex industrial case studies.

Key technology challenges that will be addressed in applying DevOps for CPS include:

- Simulation and Hardware in-the-Loop (HiL)

- Representative inputs from signals originating from heterogeneous sensors

- Run-time verification from distributed logs, data and event streams

- Security assessment of CPS vulnerabilities

- Monitoring and self-adaptability of CPS

- Evolving CPS for faster DevOps cycles

COSMOS will provide software developers with methodological guidelines aimed at: (i) mitigating barriers when adopting CI/CD in the context of CPS, and (ii) methodological and automated support to help DevOps cope with bad practices. In particular, COSMOS will be able to identify misuses (e.g. poor configuration) of the pipeline, and to automatically recommend appropriate solutions.

COSMOS will make generous use of software-defined infrastructures to allocate the resources necessary to fulfil industrial testing needs. More specifically, the developed pipelines will make use of software-defined infrastructures of Cloud platforms as necessary to run complex test processes, dynamically scaling infrastructure resources as needed using optimisation mechanisms to minimize overall testing time and costs, whilst ensuring tests are performed in a timely manner.

Expected Impact

The key industrial impacts targeted by the COSMOS project technologies and innovations are:

- Reduction the human effort and costs pertaining to the development, verification, validation, and evolution activities of CPS.

- Reduction in CPS fault-proneness to security threats, thus contributing to increased trustworthiness and dependability.

- Evolving CPS to be able to autonomously adapt (or react) to unexpected behaviour.

COSMOS innovations are driven by development and deployment requirements from five industrial partners providing CPS solutions to key European sectors of Healthcare, Avionics, Automotive, Utilities and Railways.

The project will take specific actions to encourage and support the creation of a European ecosystem for exploiting DevOps for CPS, including open source distribution of project results and an open and transparent industry process for the evolution of the COSMOS DevOps technologies.

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