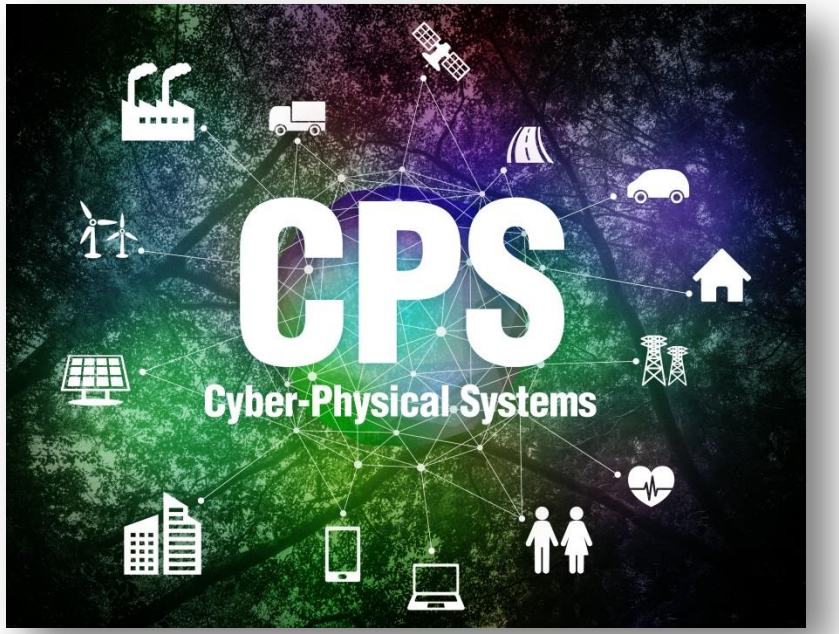
COSMOS

DevOps for Complex Cyber-physical Systems

Context

- Emerging Cyber-physical Systems **(CPS)** play a crucial role in the quality of life of European citizens and the future of the European "smart everywhere" economy

- **CPS relevant sectors**
  - Healthcare
  - Avionics
  - Automotive
  - Utilities
  - Railway
  - Manufacturing
  - Smart Cities
  - Many others…



Challenges

- Observability, testability, and predictability of behaviour of CPS is highly limited and, unfortunately, their usage in the real world can lead to fatal crashes sometimes tragically involving also humans

"Self-driving Uber kills Arizona woman in first fatal crash involving pedestrian"

"A simple software update was the direct cause of the fatal crashes of the Boeing 737"

- Contemporary DevOps practices and tools are potentially the right solution to this problem, but are currently not developed to be applied in CPS domains

Vision

- Develop **novel DevOps tools**, methodologies, and techniques that enable effective, **continuous development and evolution** of CPS
- **Increase** the level of **reliability**, dependability, trustworthiness, and **adaptability** of CPS
- Delivers **proven DevOps advantages** and benefits to Europe's CPS development community

Project Objectives

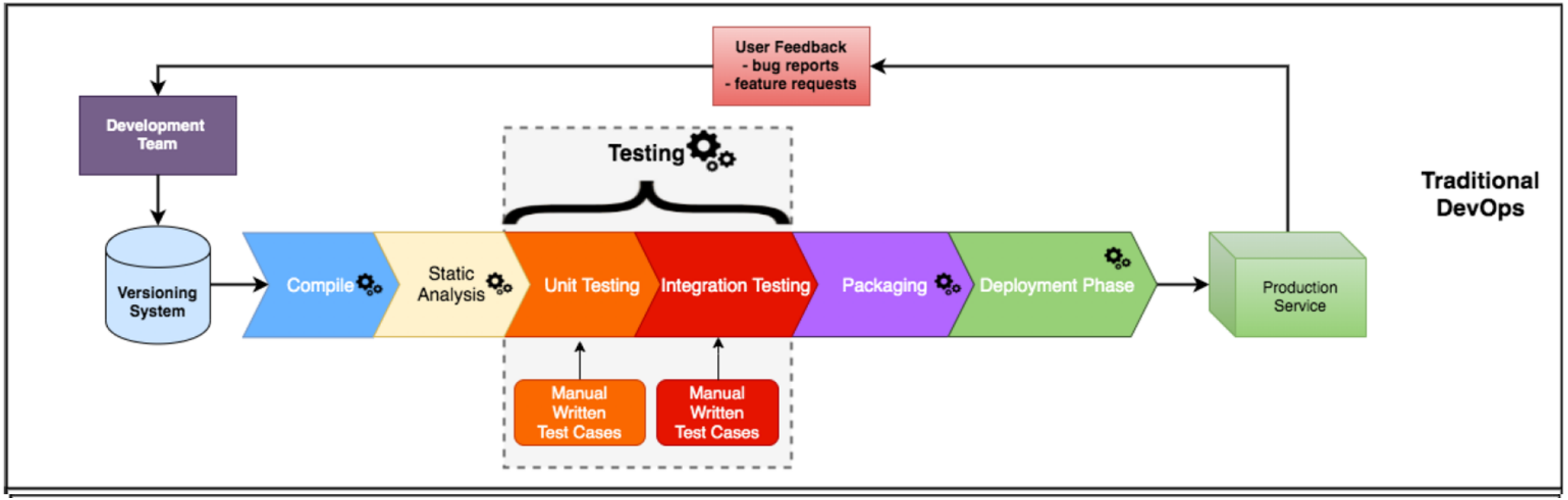
Technical objectives

- Realise innovative DevOps automation solutions specifically tailored for CPS
- Automate V&V and security assessment of CPS within DevOps pipelines to ensure high levels of dependability
- Enable monitoring and evolving CPS behaviour in the field to provide high adaptability of CPS to unexpected changes

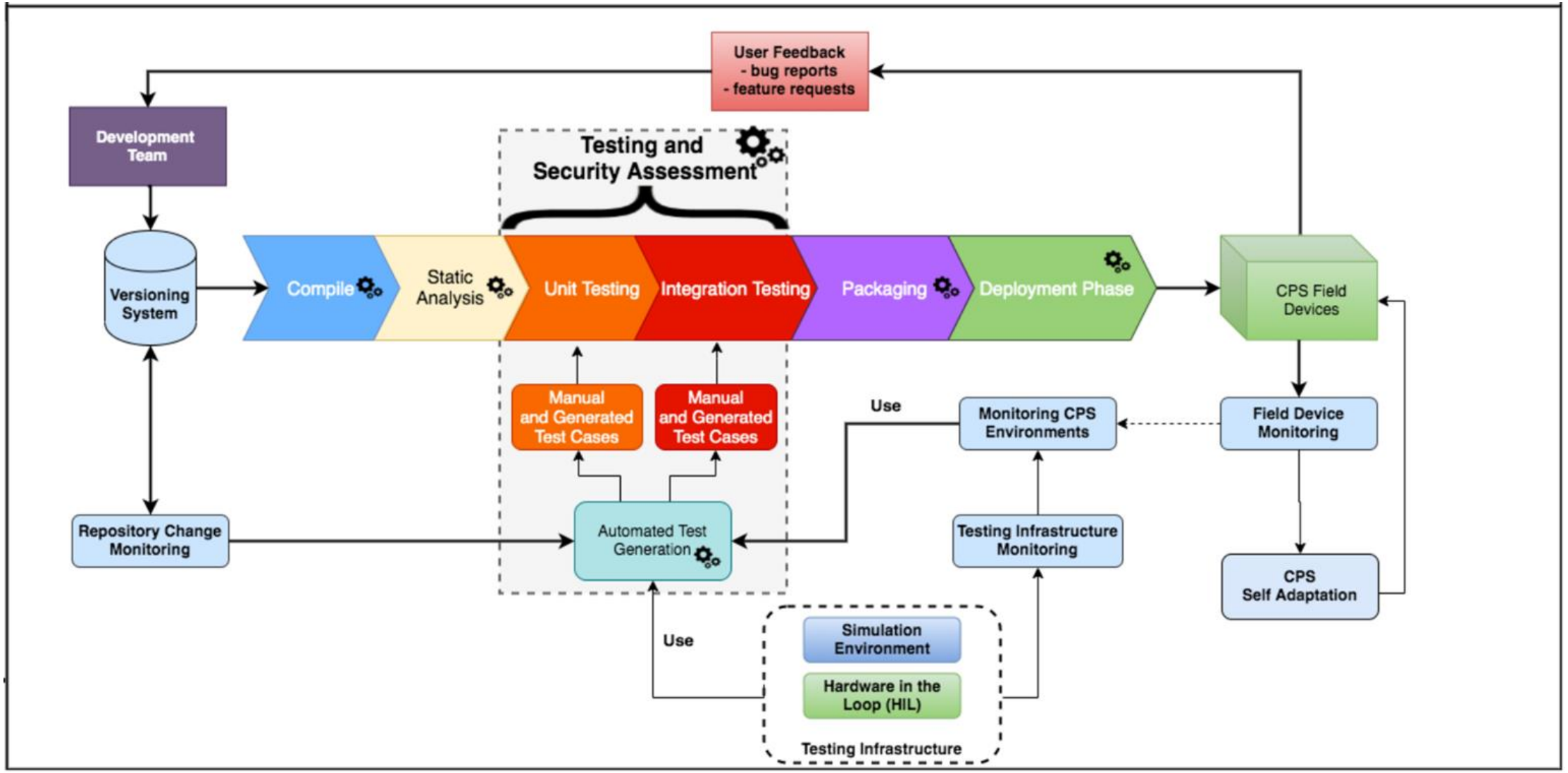
Integration and Evaluation objectives

- Develop and evolve COSMOS approaches, technologies, and services so they can be integrated into different DevOps and CPS toolchains
- Validate effectiveness of COSMOS technologies in 5 industrial demonstrators
- Broadly disseminate the COSMOS technologies to create a European DevOps for CPS ecosystem

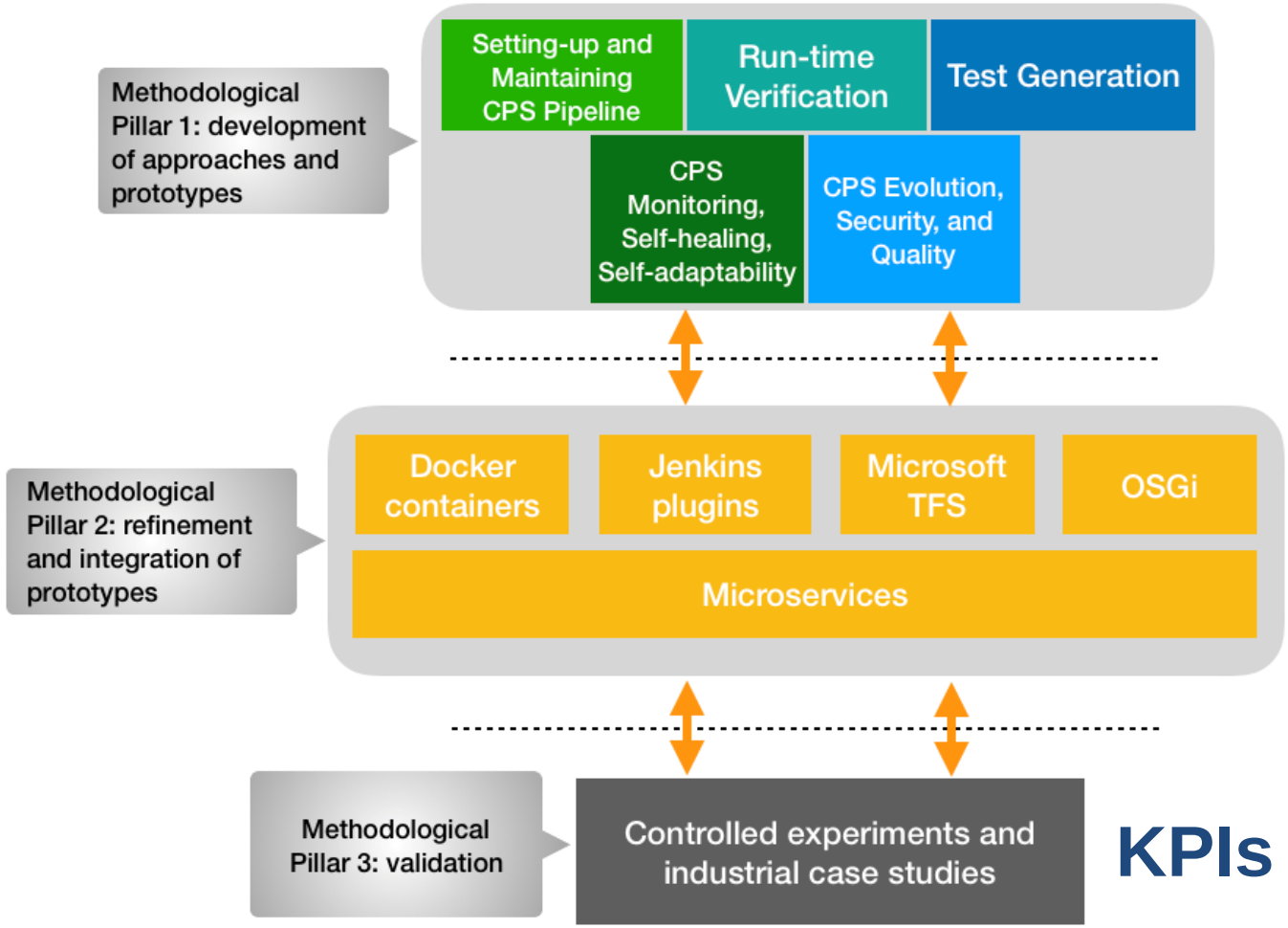
Traditional DevOps Pipeline



COSMOS DevOps Pipeline



Three Methodological Pillars

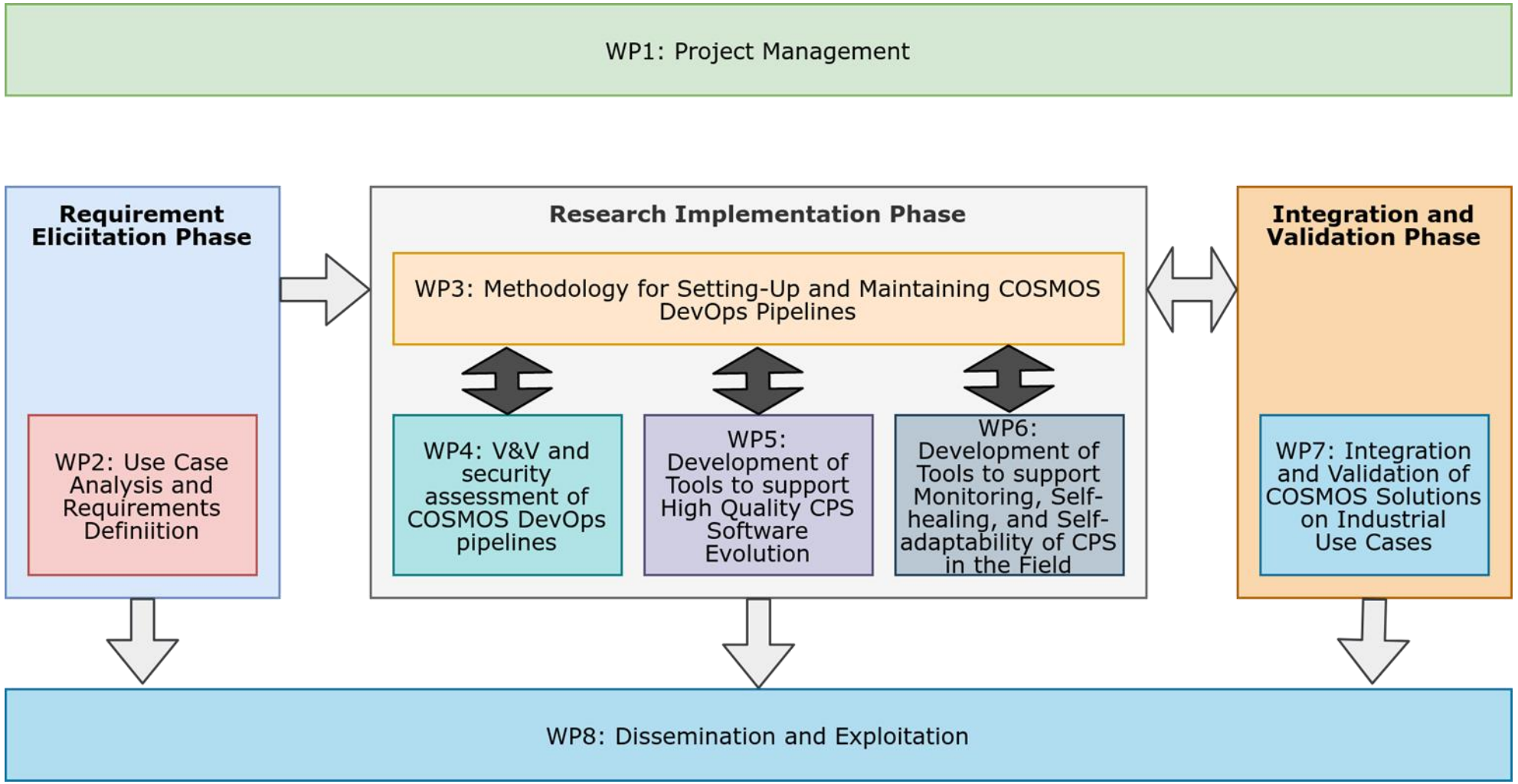


Scientific and Technological Foundations of COSMOS

DevOps Technological Foundations of COSMOS

Empirical Validation of COSMOS Innovations

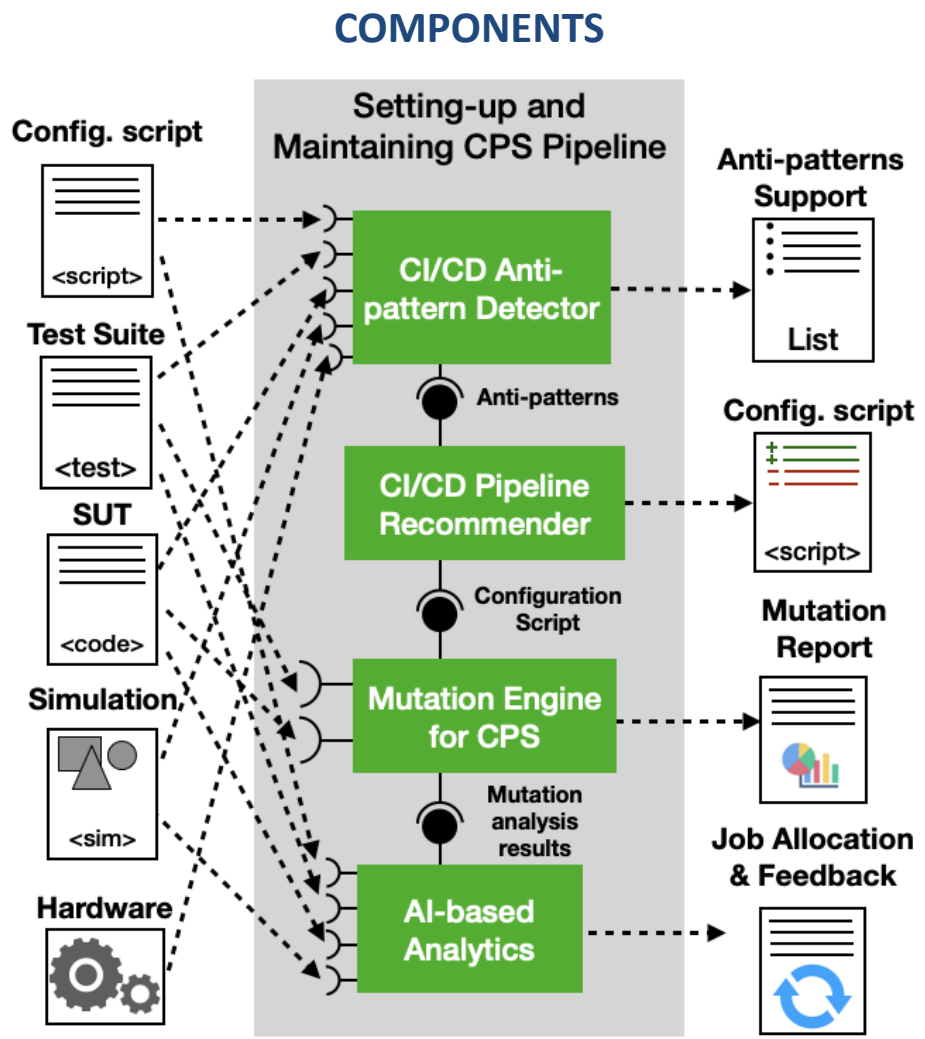
Work Packages Overview



Duration: 3 Years Project Costs / EU Funding: €5 Million

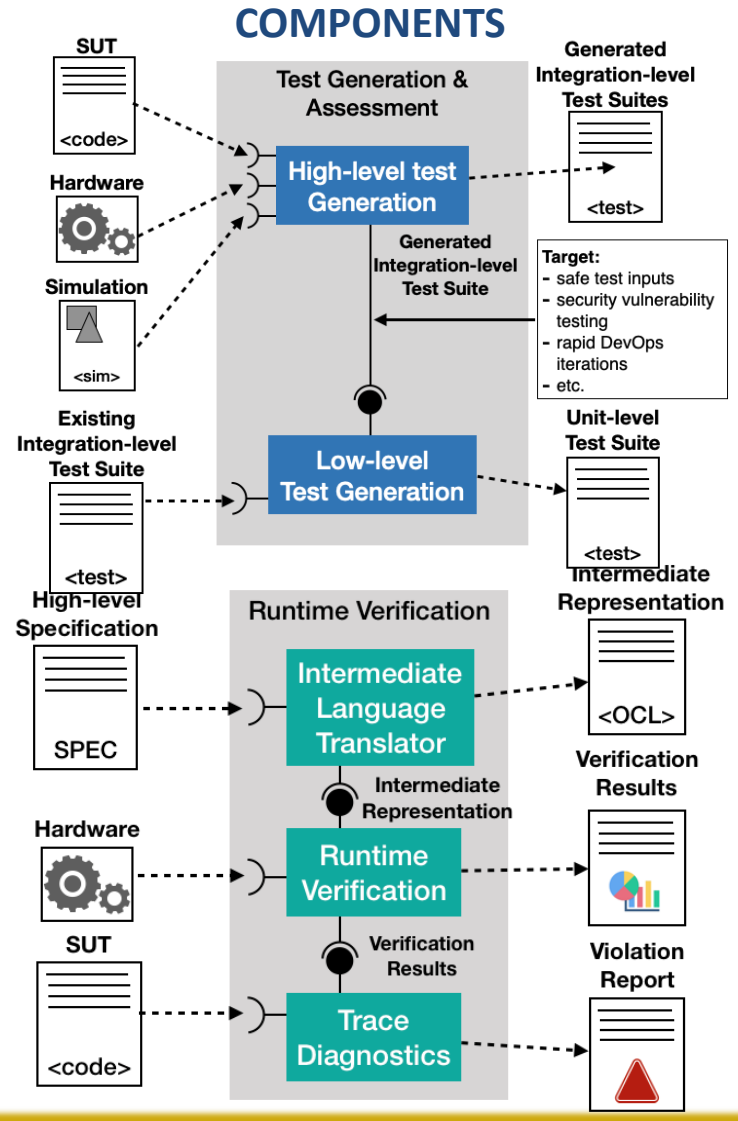
Innovation Area 1: DevOps Pipelines for CPS

- Identification of Barriers and Anti-patterns in CI/CD for CPS
- Definition of a DevOps-based Methodology to support the Development of Self-Adaptive CPS
- COSMOS Pipeline Optimization



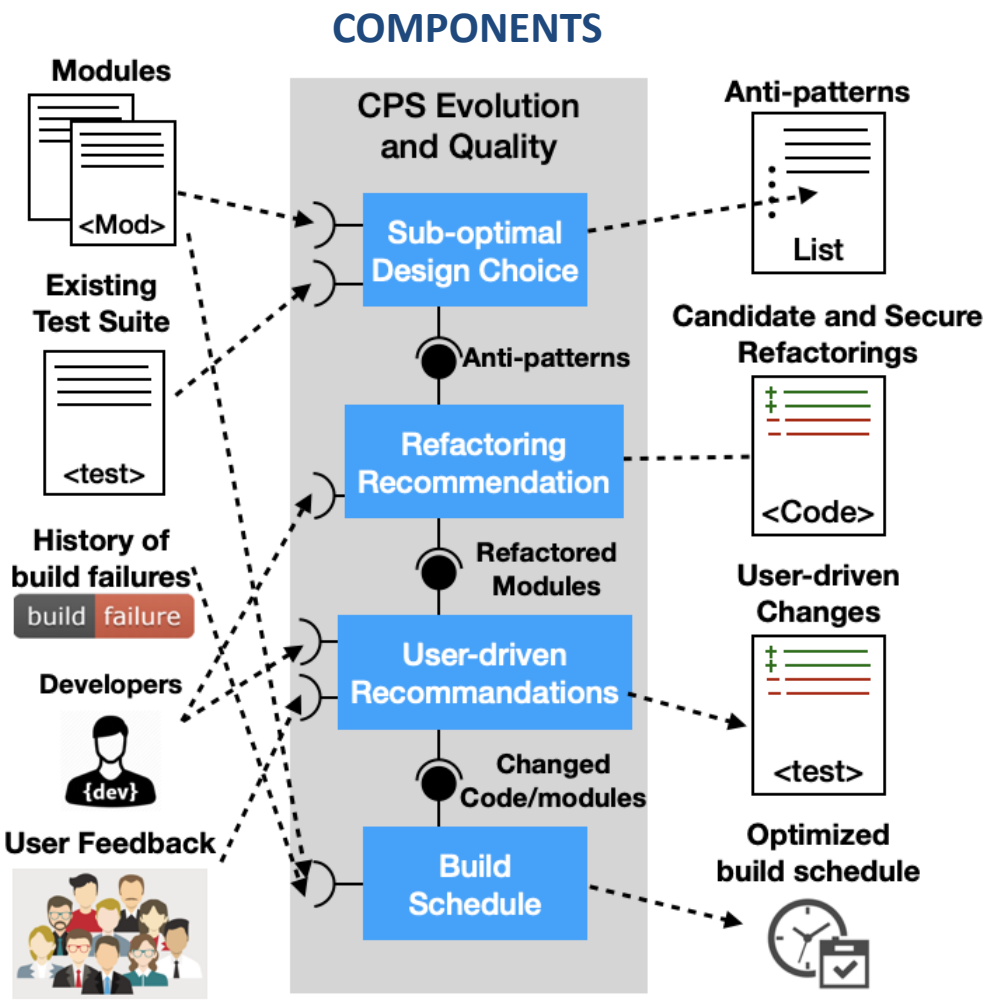
Innovation Area 2: V&V and Security Assessment of DevOps pipelines

- Development of Automated Techniques for Software Testing for CPS
- Development of Run-time Verification Techniques for Checking and Diagnosing CPS Executions
- Development of solutions for Detecting Security Vulnerabilities in CPS



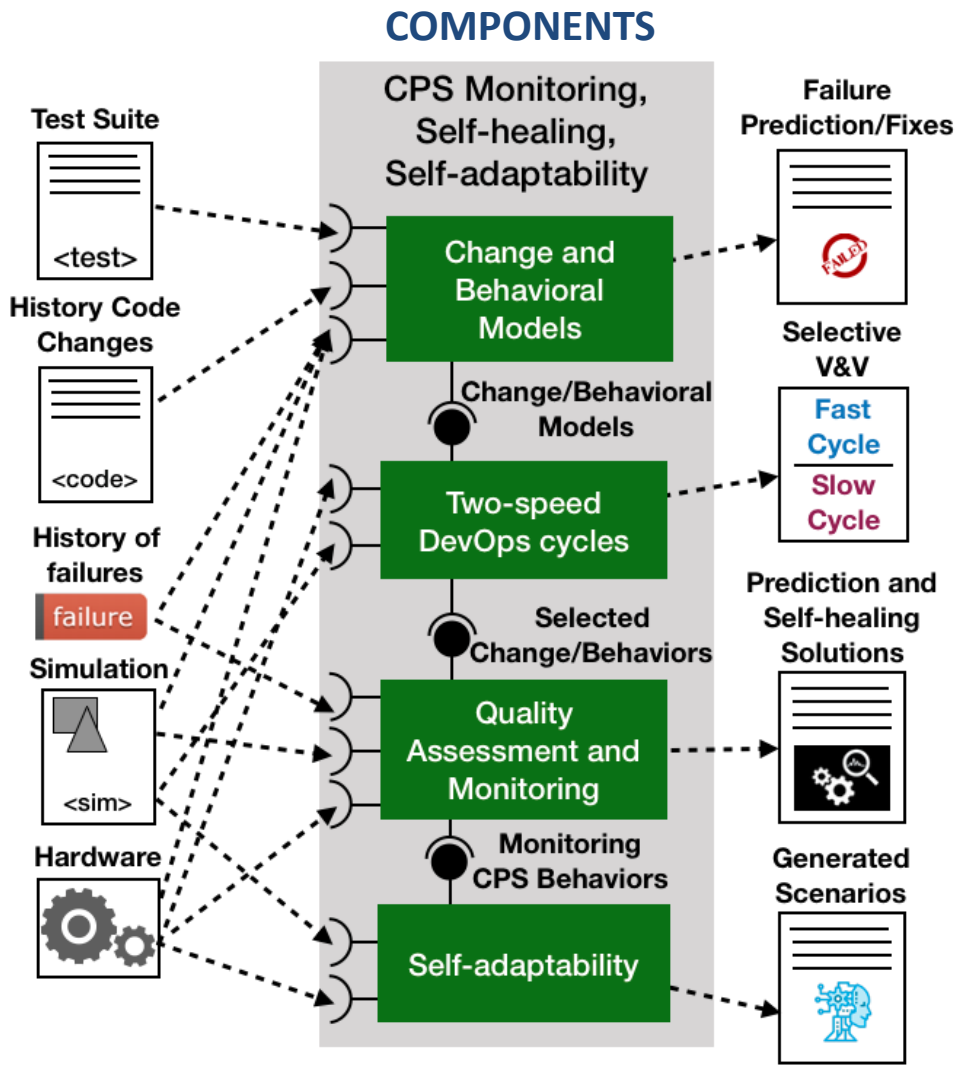
Innovation Area 3: Tools for High Quality CPS Software Evolution

- Development of a Refactoring Framework for Secure and Reliable CPS
- Development of Test Case Generation Tools for Rapid DevOps Iterations
- Development of Tools supporting User-oriented Maintenance and Testing



Innovation Area 4: Tools for Monitoring, Self-healing and Self-adaptability of CPS

- Development and Assessment of CPS Change & Behavioural Models
- Development of AI-based Solutions supporting Two-speed DevOps Cycles for CPS
- Automated Quality Assessment and Monitoring of CPS in the field
- Development of AI-based Solutions that increase CPS Self-adaptability to Diverse Contexts

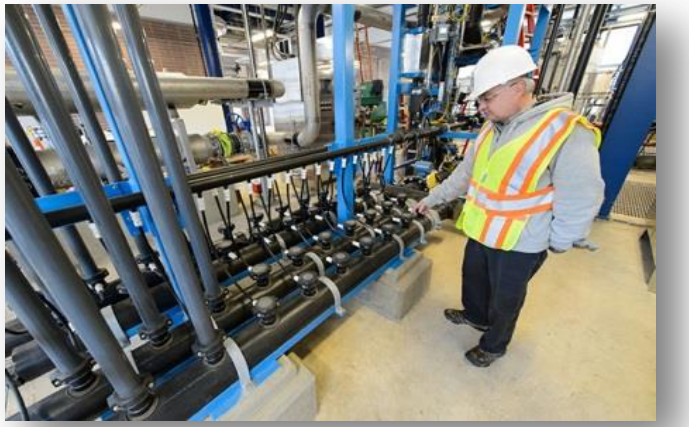


Industrial CPS Evaluations

Automotive

Medical

Avionics

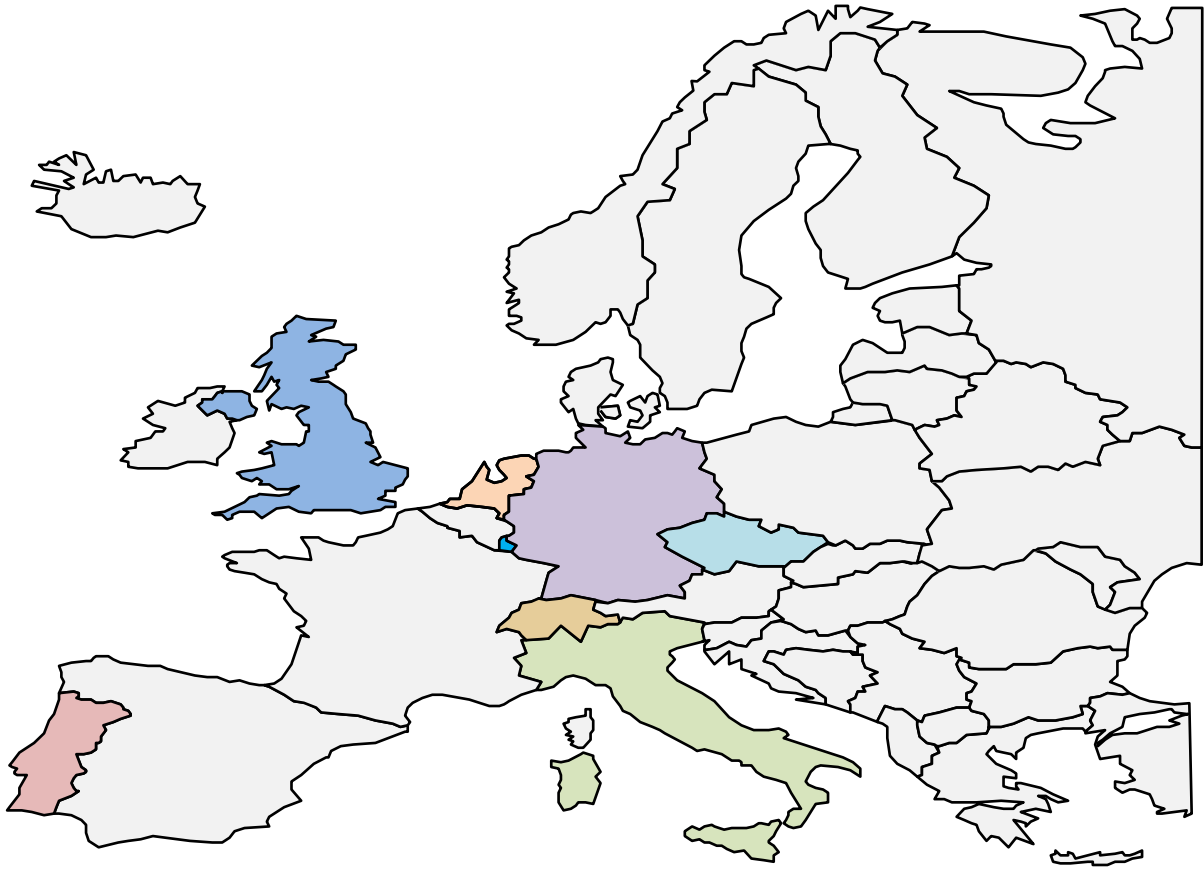


Utilities

Railways

Evaluations conducted at both mid-project and during final project months

Project Partners



Targeted Impacts

Industrial Impacts

- Decreasing percentage of changes that result in CPS failure
- Reducing CPS test execution time and computational resource consumption
- Replacing manually generated tests with automated CPS test coverage
- Improving test effectiveness through tests able to discover more bugs
- Reducing number of security vulnerabilities in CPS
- Reducing component integration and deployment time
- Reducing time to implement a change and make updated CPS operational
- Reducing downtime when deploying new CPS hardware or software

CPS DevOps Ecosystem

- Project technologies available in open source with actions to build a European community and ecosystem exploiting DevOps for CPS

Standardisation

- Use of existing industry standards and proposed new standards and extensions to ensure “plug-n-play” of DevOps tools for CPS development

COSMOS

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www.COSMOS-DevOps.org

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