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Reference Architecture for AI solutions' application within process industry - The s-X-AIPI experience

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Ref. No.:CWA 18211:2025 E

Contents

Page

European foreword

This CEN and CENELEC Workshop Agreement has been developed in accordance with the CEN-CENELEC Guide 29 “CEN/CENELEC Workshop Agreements – A rapid prototyping to standardization” and with the relevant provisions of CEN/CENELEC Internal Regulations - Part 2. It was approved by a Workshop of interested party representatives on 2025-02-14, the constitution of which was supported by CEN and CENELEC following the public call for participation made on 2025-01-08. This CEN and CENELEC Workshop Agreement does not necessarily include all relevant stakeholders.

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Introduction

Artificial Intelligence (AI) is increasingly recognized as a pivotal force in the industrial digital revolution, complementing advancements in data handling and robotics. AI applications, characterised by simplified interfaces, are designed to be robust and maintainable without the need for a highly specialized workforce. This accessibility extends the functional life of AI applications and reduces the expertise required for their operation.

The EU Horizon s-X-AIPI project aims to research, develop, test, and validate a bespoke suite of trustworthy self-X AI technologies tailored for process industries. This project, funded by the EU Horizon programme, seeks to bridge the gap between AI capabilities and traditional automation processes, ensuring that AI tools are both accessible and effective across various industrial applications. The core objectives of the project include providing state-of-the-art AI-based sustainability tools to existing process industries and their workforce, enhancing the longevity and user-friendliness of AI applications to minimize reliance on specialized technical skills, and deploying trustworthy AI technologies effectively within process industries (Figure 1 represents the s-X-AIPI main objective concept).

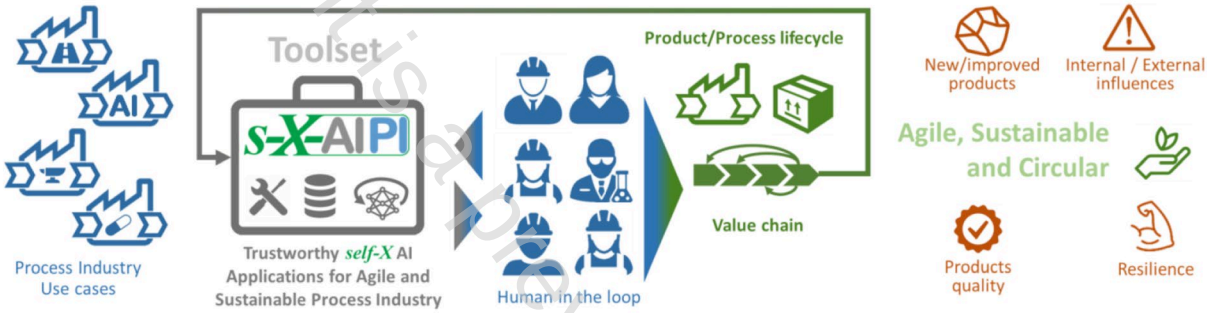

Figure 1 — s-X-AIPI main objective concept

At the heart of this project lies the integration of AI with an Autonomic Manager, utilizing the MAPE-K framework (Monitoring, Analyzing, Planning, Execution over a shared Knowledge base) to foster the development of self-improving AI systems. This approach facilitates a practical "learning by doing" model, where continuous adaptations enhance the system's efficacy in real-time applications. The project is distinguished by its incorporation of an AI data pipeline equipped with autonomic computing capabilities, designed to support four realistic use cases in the process industry sectors of asphalt, steel, aluminum, and pharmaceuticals.

A significant aspect of the s-X-AIPI toolset is its focus on accommodating the diverse skill levels of workers, integrating self-adaptation capabilities that respect and enhance the human-in-the-loop role. This ensures that the AI technologies developed are not only advanced but also aligned with the practical needs and profiles of the workforce involved.

The primary outcome of the s-X-AIPI project is to cultivate a portfolio of AI technologies that are trustworthy and integrated into an open-source toolkit for widespread industrial and research application; Autonomous, minimizing the need for human intervention in the development and operational processes; And broadly integrated across actual process industry value chains, demonstrating the versatile applicability of the developed technologies.

1 Scope

The scope of this CEN Workshop Agreement (CWA) is to define a Reference Architecture for the integration of AI technologies in process industries. This Reference Architecture aims to provide a comprehensive framework for implementing AI technologies across various sectors within process industries, establish guidelines for the adoption of advanced autonomic management systems, and ensure compatibility with existing European standards while fostering innovation.

The Reference Architecture contextualises the MAPE-K methodology, analyses relevant existing frameworks (including RAMI 4.0, IIRA, FIWARE, IDS RAM 4.0, BEinCPPS, and CAPRI), and addresses specific industrial implementation scenarios.

The scope limitations are as follows:

- The CWA does not develop requirements related to machinery safety.
- Safety-related requirements are outside the scope.
- The document is intended to be informative, complementing rather than replacing existing standards and mandatory production procedures.

2 Normative references

ISO/TS 15066:2016, *Robots and robotic devices — Collaborative robots*

CWA 17553:2020, *Community face coverings — Guide to minimum requirements, methods of testing and use*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 15066:2016 and CWA 17553:2020 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

4 Background and General Vision

4.1 Project Objectives

The impact of Artificial Intelligence (AI) is highly recognised as a key driver of the industrial digital revolution, alongside data and robotics. AI tools and applications are needed with simplified interfaces that do not require a highly skilled workforce, exhibit longer useful life and require less specialised maintenance.

The overall objective is to research, develop, test, and experiment an innovative toolset of custom trustworthy self-X AI technologies and applications. The specific technical objectives are:

- Provide existing process industries and their workers with state-of-the-Art AI-based sustainability tools.
- Ensure longer useful life of AI applications, deploy simplified interfaces without requiring a highly skilled workforce, and require less specialised maintenance (applications with minimal human expert intervention).