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METHODS AND TOOLS FOR THE ENGINEERING, CONTAINS DEPLOYMENT AND OPERATION OF INDUSTRIAL DIGITAL TWINS

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ABSTRACT

This minisymposium addresses methods and tools for the Engineering contains deployment and operation of industrial digital twins, a cornerstone technology for smart manufacturing and transformation of industrial processes. The conceptions of industrial digital twins are complex and multidisciplinary systems that integrate physical assets, data, models, and services, raising significant challenges in interoperability, cybersecurity, and scalability. The session aims to present and discuss applied research contributions that tackle these challenges through structured engineering approaches and open, interoperable platforms.

The minisymposium will highlight results from the JNI applied research program led by IRT SystemX, which brings together academic and industrial partners from sectors including aerospace, energy, mobility, telecommunications, and defense. Contributions will showcase methodological framework for designing and implementing digital twins of complex industrial systems, emphasizing the coordination of domain expertise with systems and software engineering practices and a cyber-by-design approach [1].

Specific topics covered in the session include reference architecture and standards for industrial digital twins, data management and traceability based on the industry 4.0 Asset Administration Shell. Several workflow models for orchestration, simulation, and the integration of analytics and artificial intelligence services will be presented. Particular attention will be given to open and interoperable platforms, zero-trust architectures, and standards such as the industry 4.0 Asset Administration Shell [2].

Through representative industrial processes such as predictive maintenance, smart energy management, and secure autonomous systems, the minisymposium aims to illustrate how these methods and tools enable robust, secure, and scalable digital twin implementations. Overall, the session seeks to foster knowledge exchange between researchers and practitioners, identify best practices, and contribute to the maturation of engineering approaches for industrial digital twins. It also encourages discussions on validation, lifecycle management, governance, and sustainability of digital twins, while aligning industrial expectations with emerging research results and supporting the creation of trustworthy, reusable, and evolvable digital twin ecosystems across academic and industrial communities.

REFERENCES (Not mandatory, maximum 2 references)

[1] CHOUBIK, N., BELFADEL, A., LETAILLEUR, J., BAJAN, P. M., CREFF, S., & HAMIDA, A. B. (2026, FEBRUARY). TOWARDS CYBER-BY-DESIGN SECURITY FOR DIGITAL TWINS: IMPLEMENTING ZERO TRUST ARCHITECTURE. IN 2026 28TH INTERNATIONAL CONFERENCE ON ADVANCED COMMUNICATIONS TECHNOLOGY (ICACT) (PP. 1-9). IEEE.

[2] BELFADEL, A., CREFF, S., & BEN HAMIDA, A. (2024, JULY). ADVANCING INDUSTRIAL DIGITAL TWINS: TOWARDS AN OPEN PLATFORM ALIGNED WITH STANDARDS. IN IFIP INTERNATIONAL CONFERENCE ON PRODUCT LIFECYCLE MANAGEMENT (PP. 110-124). CHAM: SPRINGER NATURE SWITZERLAND.