INSIDE Connect
Málaga, 04.09.2025

INSIDE
Industry Association

Digital Twinning and Copiloting

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HOLA

I am interested in

interoperability of cyber-physical system of systems,

5G / 6G mobile networks, and AI/ML applications in Industry5.0

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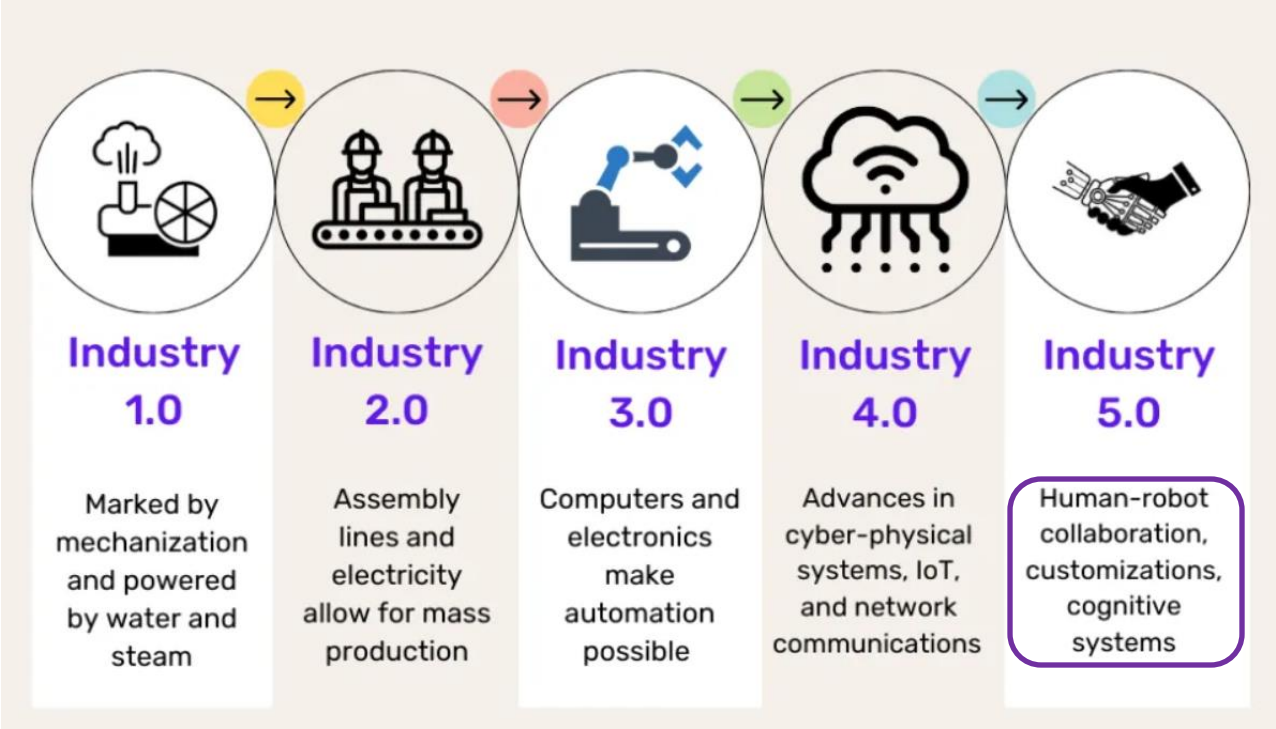
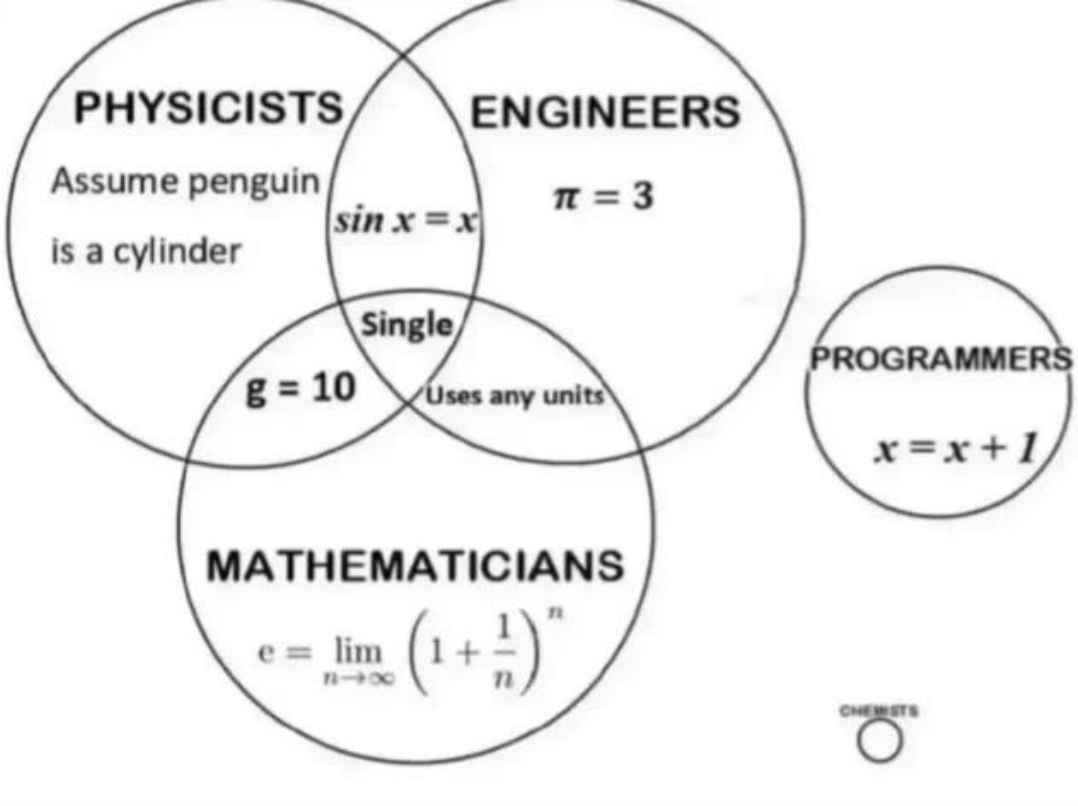
Towards Industry5.0



Source: Google images

Oh, Engineers



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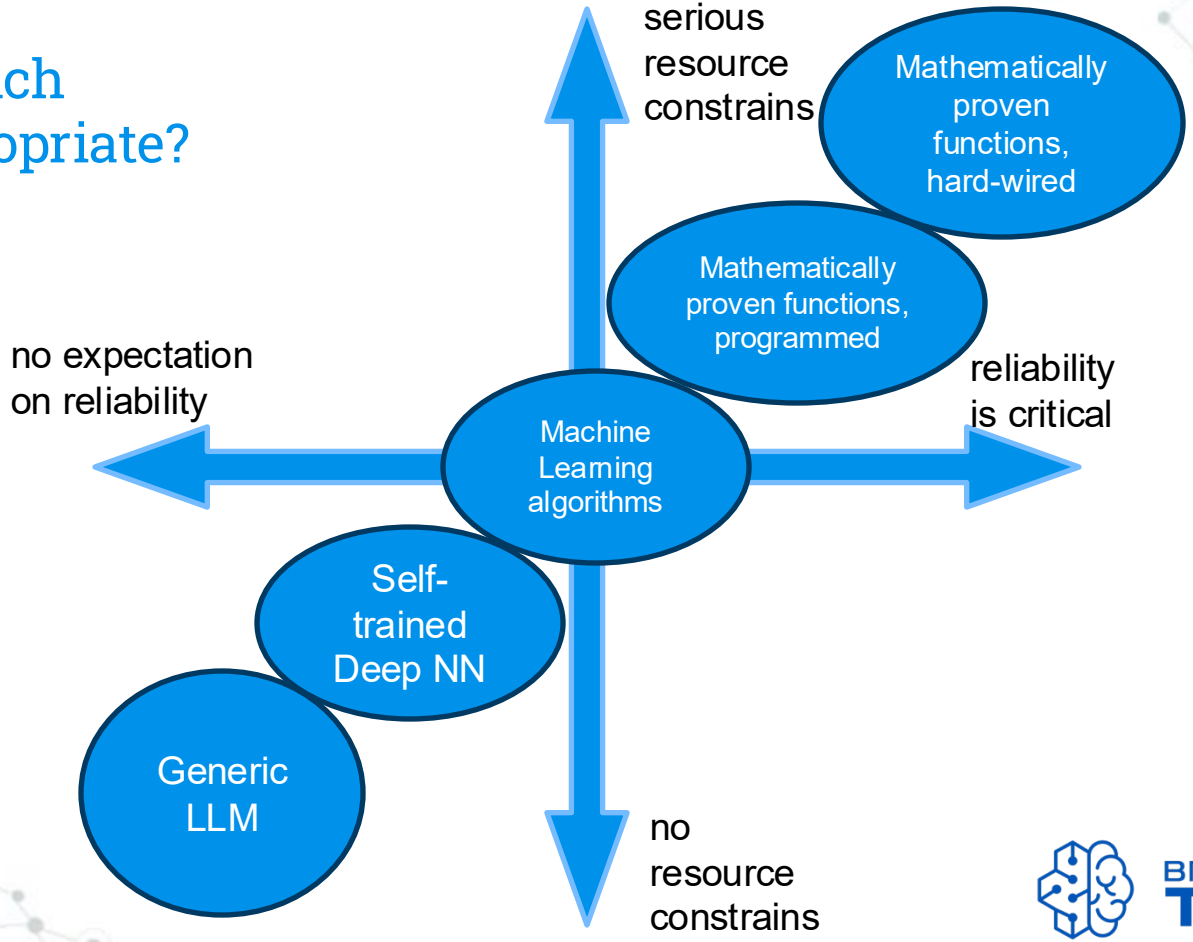
Engineers:

What approach may be appropriate?



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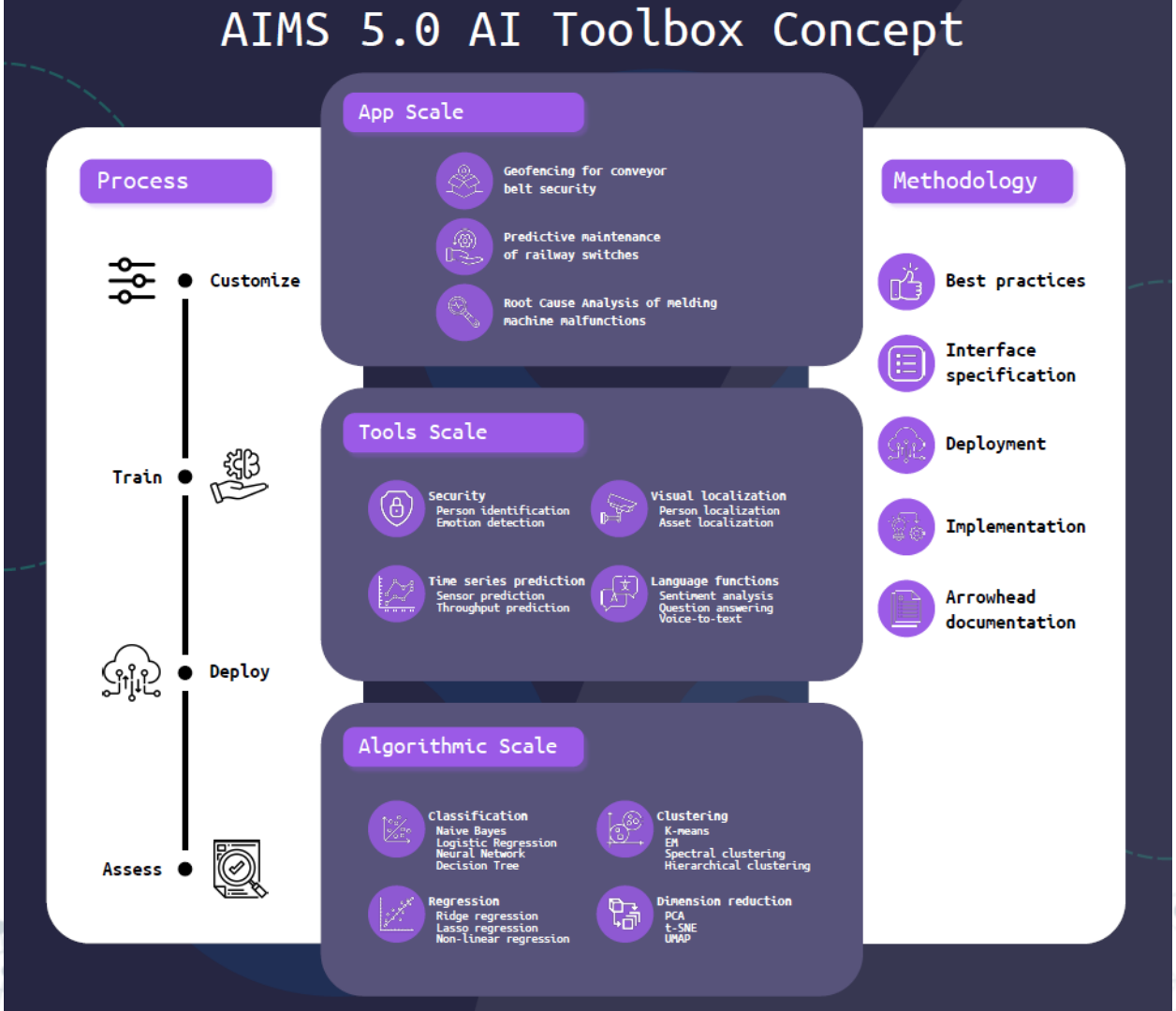

Hollósi, G., Ficzere, D., Frankó, A., Bancsics, M., AlMahasneh, R., Lukovszki, C., & Varga, P. (2024, May). AIMS5. 0 AI Toolbox: Enabling Efficient Knowledge Sharing for Industrial AI. In *NOMS 2024-2024 IEEE Network Operations and Management Symposium* (pp. 1-6). IEEE.

Design, Develop, Deploy with Digital Twins by Default

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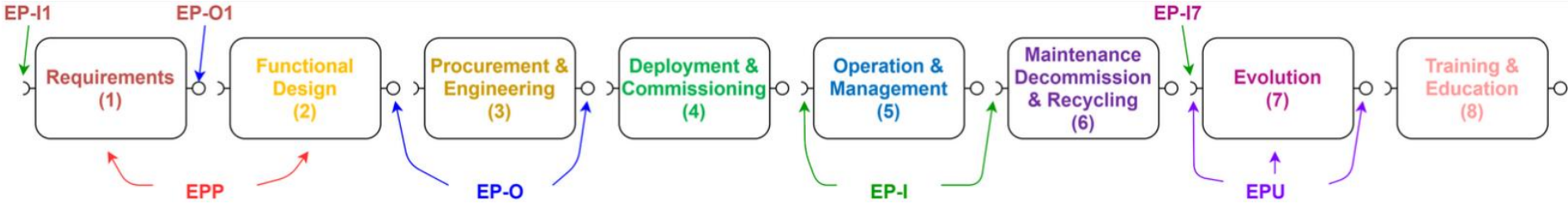
Any industrial CPSoS lifecycle is better when executed with a **Digital Twin–first** approach.



G. Urgese, P. Azzoni, J. van Deventer, J. Delsing, A. Macii, and E. Macii, “A SOA-based engineering process model for the life cycle management of system-of-systems in industry 4.0,” Appl. Sci., vol. 12, no. 15, p. 7730, Aug. 2022.

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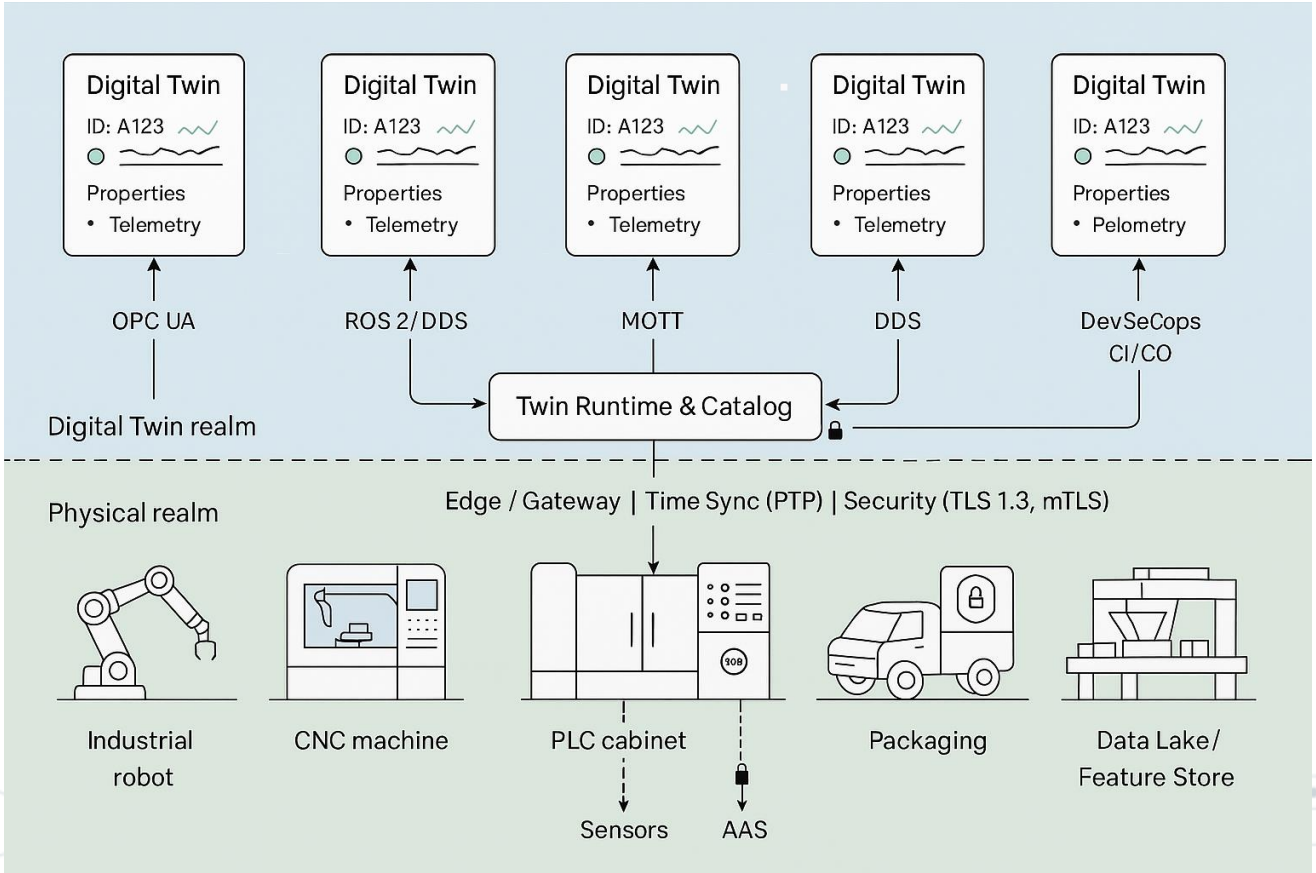
Execute the life-cycle elements on the DT-level first!



What DT-by-Default changes (vs. traditional)

- **Closed-loop engineering**
  - Live telemetry → model updates → prescriptive actions → verified outcomes
- **Shift-left validation**
  - Virtual commissioning & HW-in-the-Loop **reduce** floor time, rework, and ramp-up risk
- **SoS composability**
  - AAS/semantics let you assemble twins of assets, lines, and supply chains
- **Governed performance**
  - Contracts + SLOs for latency, jitter, loss; evidence for audits (safety, GDPR/AI-Act)
- **Human-centric**
  - Copilots, explainability, and safe handover for operators (Industry 5.0)

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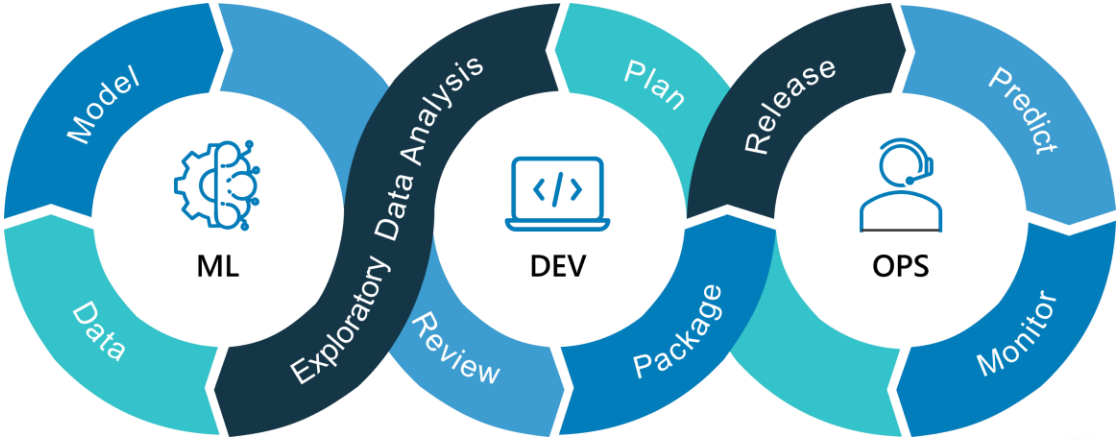
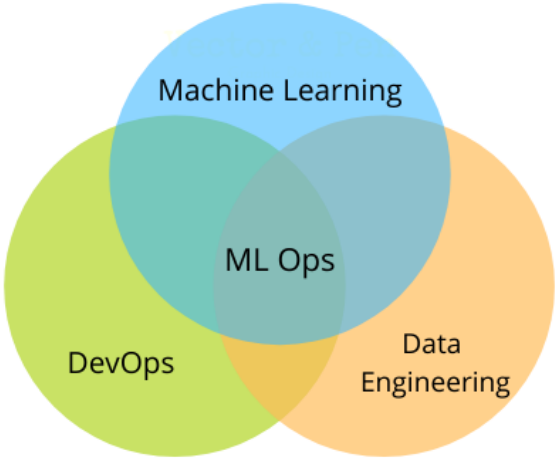
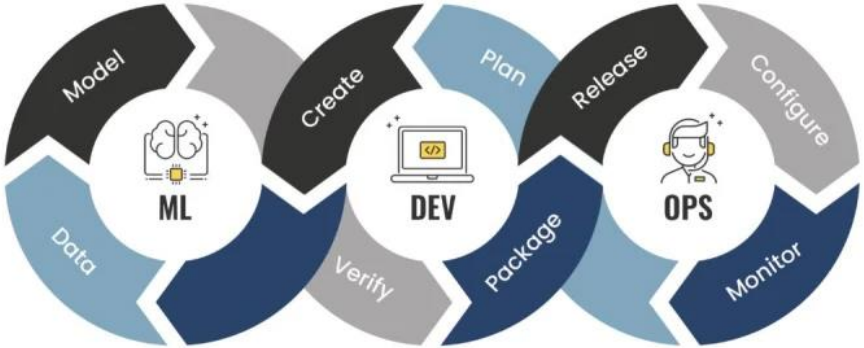
DevOps and MLOPs extended for Digital Twins

MLOps – Deploying ML models in Cloud infrastructures with Hyperautomation



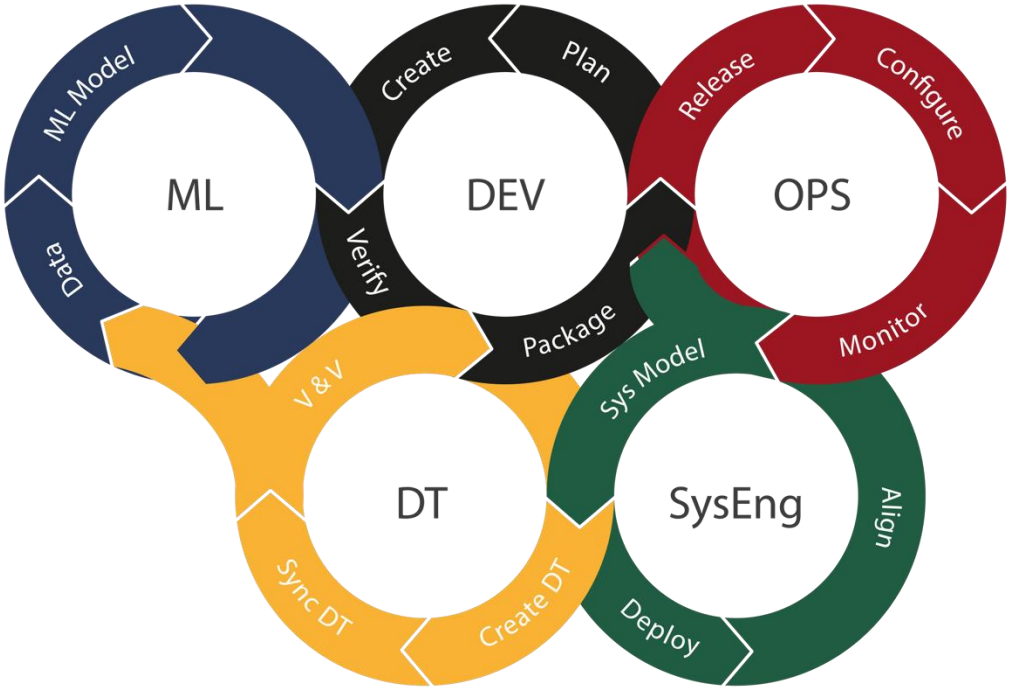


https://sourceforge.net/software/mlops/



https://canonical.com/blog/what-is-mlops

CPS OPS: Extending MLOps to Cyber-Physical Systems



Cs. Hegedűs, P. Varga –
Tailoring MLOps Techniques for Industry 5.0 Needs
IEEE CNSM, Niagara Falls, Canada, 2023

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Intent-based management of Cyber-physical System of Systems

Main goals and Key components of Intent-based CPS

High-level Objectives: Translates human-defined business and operational goals into technical configurations.

AI-Driven Automation: Uses machine learning to optimize system performance.

Continuous Adaptation: Dynamically adjusts operations based on real-time data.

Intent Specification: Clear definition of goals & operational needs.

Automated Orchestration: Automatic translation of intents into configurations.

Automated Execution: Capabilities and calling tools.

Real-Time Monitoring: Continuous evaluation and adjustments to meet defined intents.

Multi-agent behavior

Why Intent-based CPSoS management matters

Growing Complexity:
CPSoS “networks” are evolving with cloud, edge, and asset interoperability.

Error Reduction:
Decreases manual configuration errors significantly.

Business Alignment:
Directly matches infrastructure and asset behavior with business goals.

Operational Efficiency:
Accelerates CPSoS changes and reduces response times.

Intent-Based Workflow

Intent Specification:

Users define business goals in simple language.

Automatic Translation:

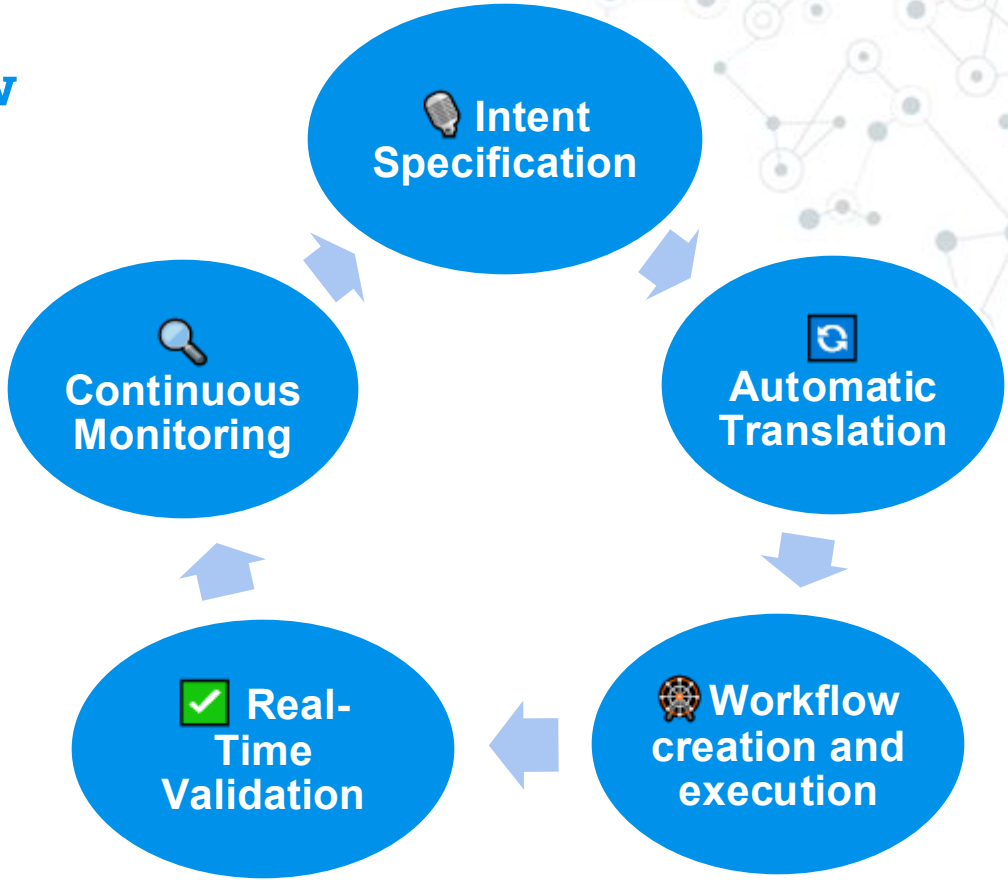
AI translates intents into detailed commands and configurations.

Real-Time Validation:

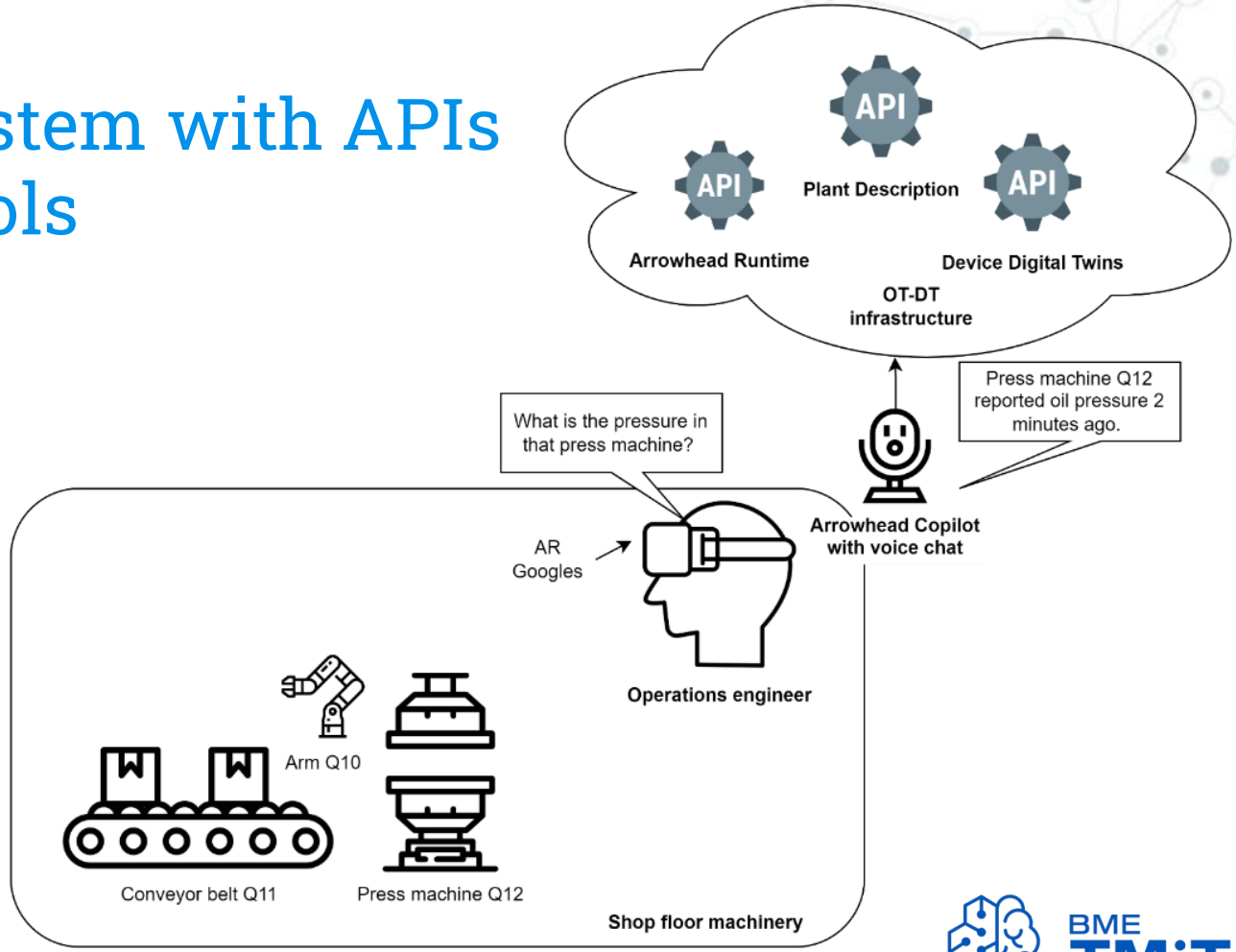
“DT” or CPS continuously validate behavior against defined intent.

Continuous Monitoring:

AI-driven systems adjust configurations dynamically for optimal performance.



Co-pilot system with APIs towards tools



Use-cases for Industry5.0

Use Case: Smart Manufacturing

Automated Production: Self-optimizing assembly lines adapting to intent-driven objectives.
Downtime Reduction: Proactive maintenance driven by intent-based predictive analytics.
Flexible Operations: Seamless integration and modification of manufacturing workflows.

Use Case: Autonomous Vehicles

Dynamic Route Management: Optimal route planning based on real-time data and intent.
Traffic Safety: Intent-driven safety - adjusting vehicle behavior.
Energy Efficiency: Real-time optimization of energy usage.

Security and Reliability in CPS

Proactive Threat Detection: Identification & mitigation based on security intents.
Fault Management: AI-driven systems automatically adjusting to minimize disruptions.
Data Integrity: Ensuring data reliability and compliance.

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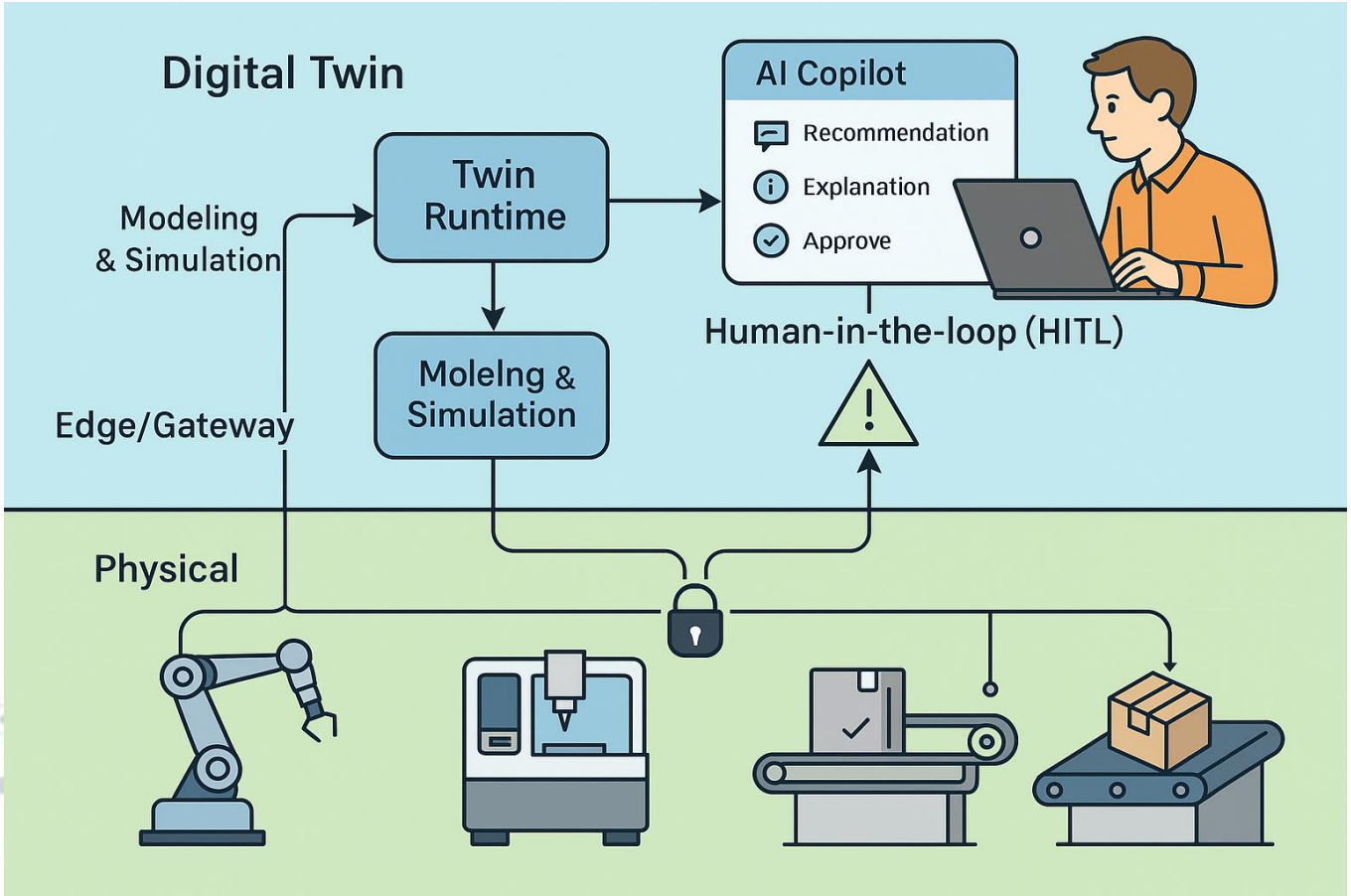
Use Copilot with Digital Twins




Your AI Copilot,
Your Digital Twin.
Now it’s Your Turn.

Gracias por tu atención ☺

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