Zero Trust Architecture in MEC-based industrial environments

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DTCS: Digital Twin & CyberSecurity Lab

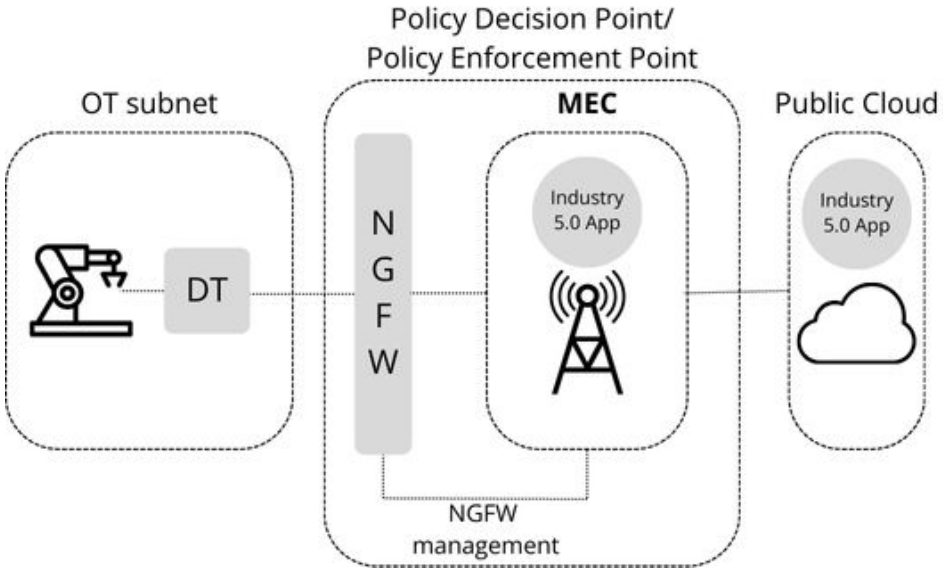
- Primary topics: Industrial IoT, Cybersecurity, Cloud Computing, Blockchain, Networking
- **Digital Twin (DT)** orchestration in the edge-to-cloud continuum: entanglement and trustworthiness
- **Zero Trust Architecture (ZTA)** for Cybersecurity in the industry landscape

https://dtcs.unife.it/

DT and ZTA in MEC-Based Industrial Environments

- **Edge-to-Cloud architecture:**
  - **containerized DT** tightly integrated with industrial machinery
  - **orchestrated Industry 4.0 applications** deployed on MEC and Private/Public Cloud

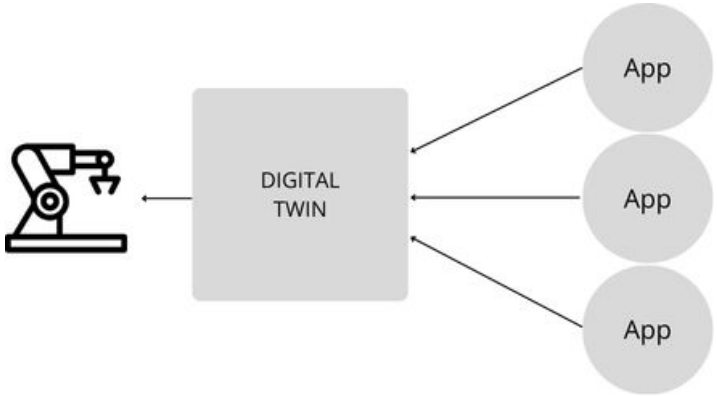
- **Zero Trust Architecture:** NGFW to enforce security
  - strict and flexible segmentation
  - dynamic and fine-grained access policies
  - continuous verification



MEC provided by Telecom Italia in collaboration with Bi-Rex Competence Center https://bi-rex.it/en/

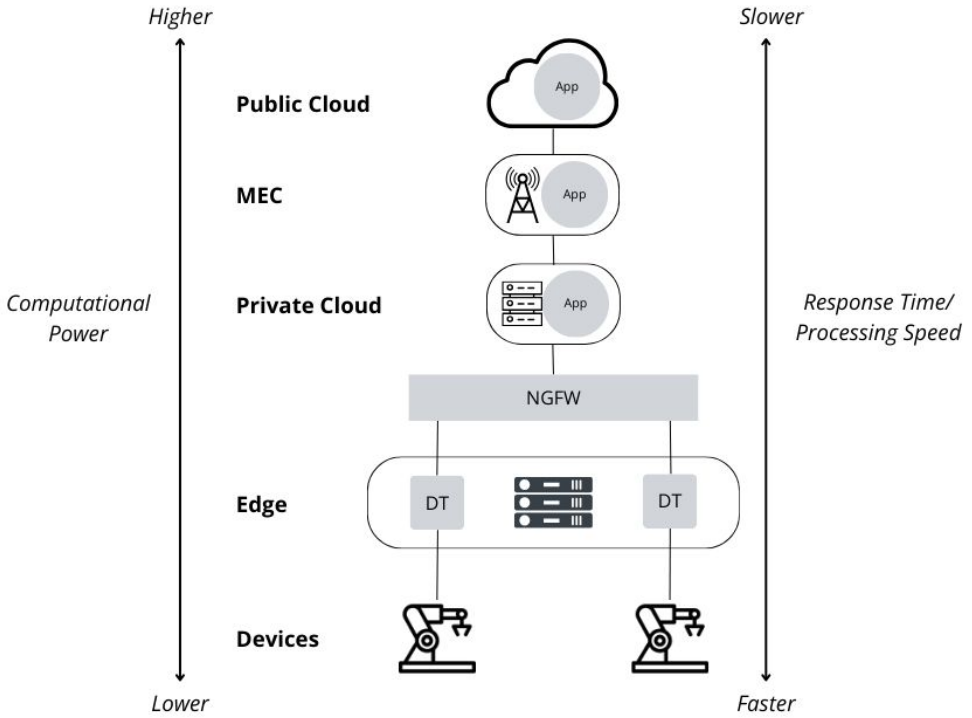
Digital Twins in the industrial context

- **Uniform Data Exposure**: DTs abstract machinery heterogeneity, providing data via a common protocol
- **Single Access Point**: external apps access DTs, reducing load on machinery and networks
- **Model-Aware**: DTs coupled with machinery, filtering harmful commands and representing their behavior
- **Augmentation**: DTs enable data processing (prediction, prevention, analysis) and new services like retrofitting



Deployment in the Cloud-to-Edge Continuum

- DT and industrial applications **containerized**
- DT on **Edge Node**, tightly coupled with machinery
- **NGFW** installed on VM in edge node
- Multiple **deployment** options across the **cloud-to-edge continuum**:
  - Private Cloud
  - MEC
  - Public Cloud



Possible collaborations

Our know-how:

- Digital Twin design, deployment, and monitoring
- Integration with industrial machinery
- Containerization and orchestration
- Zero Trust Architecture in industrial environments
- Adoption of NGFW, SIEM, IDPS, OT DMZ, and other cybersecurity tools and best practices

What we are looking for:

- Industrial partners interested in adopting Digital Twin principles
- Large-scale deployment trials to test Edge-to-Cloud orchestration
- Extensive security logs to gather, normalize, and analyze with AI

Funded projects and current collaborations

Funded projects

- **5GConnect**: innovative solutions for integrating traffic steering and shaping within industrial production plants
- **IGNITE 5.0**: IntelliGent and secure Networking in IndusTrial Environments: towards Industry 5.0
- **C4SI**: Cybersecurity for Smart Industry C4SI
- **CRI4.0**: Cyber Range for Industrial Security
- **DATRUST**: Connecting the physical and DigitAl worlds through TRUSTworthy data-flows
- **CURSA**: Blockchain-based tracking of seafood products

Collaborations

- **Alstom**, on cybersecurity with the Bologna team https://www.alstom.com/alstom-italy
- **Bi-Rex**, the Industry 4.0 Competence Center of Emilia-Romagna region (Italy) https://bi-rex.it/, on entanglement-aware digital twin orchestration in the cloud-to-edge continuum.
- **NATO** (North Atlantic Treaty Organization) Information Systems Technology (**IST**)**-193** on “Edge Computing at the Tactical Edge” https://www.sto.nato.int/Lists/test1/activitydetails.aspx?ID=17065
- Florida **Institute for Human and Machine Cognition** (IHMC), Pensacola, Florida, United States, on microservices orchestration in tactical networks

Recent scientific papers

- P. Bellavista, N. Bicocchi, M. Fogli, C. Giannelli, M. Mamei and M. Picone, **ODTE: A Metric for Digital Twin Entanglement**, IEEE Open Journal of the Communications Society, 2024.
- P. Bellavista, N. Bicocchi, M. Fogli, C. Giannelli, M. Mamei and M. Picone, **An Entanglement-Aware Middleware for Digital Twins**, ACM Transactions on Internet of Things, 2024.
- P. Bellavista, N. Bicocchi, M. Fogli, C. Giannelli, M. Mamei and M. Picone, **Exploiting Microservices and Serverless for Digital Twins in the Cloud-to-Edge Continuum**, Future Generation Computer Systems, 2024.
- N. Bicocchi, M. Fogli, C. Giannelli, M. Picone, A. Virdis: **Requirements and Design Architecture for Digital Twin End-to-End Trustworthiness**, IEEE Internet Computing, 2024.
- Bellavista, P., Bicocchi, N., Fogli, M., Giannelli, C., Mamei, M., Picone, M., **Requirements and design patterns for adaptive, autonomous, and context-aware digital twins in industry 4.0 digital factories**, Computers in Industry, 2023.
- Fogli, M., Giannelli, C., Poltronieri, F., Stefanelli, C., Tortonesi, M., **Chaos Engineering for Resilience Assessment of Digital Twins**, IEEE Transactions on Industrial Informatics, 2023.
- Bellavista, P., Giannelli, C., Mamei, M., Mendula, M., Picone, M., **Digital twin oriented architecture for secure and QoS aware intelligent communications in industrial environments**, Pervasive and Mobile Computing, 2022.

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