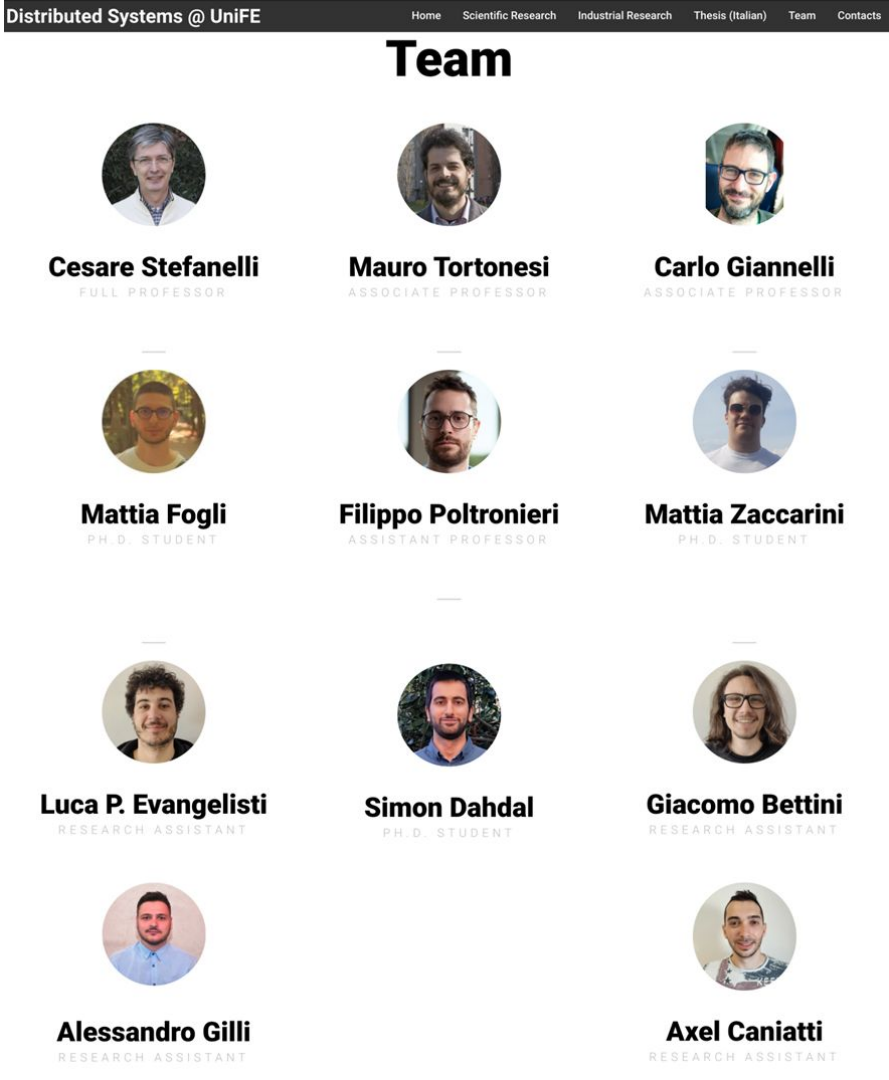
Digital Twin Orchestration in the Cloud-to-Edge Continuum

Carlo Giannelli, **Mattia Fogli**
Distributed Systems Research Group
University of Ferrara, Italy

Distributed Systems Research Group

- 1 full professor
- 2 associate professors
- 1 assistant professor
- 1 postdoc
- 2 Ph.D. students
- 4 research associates

http://ds.unife.it



Funded projects and collaborations

Funded projects

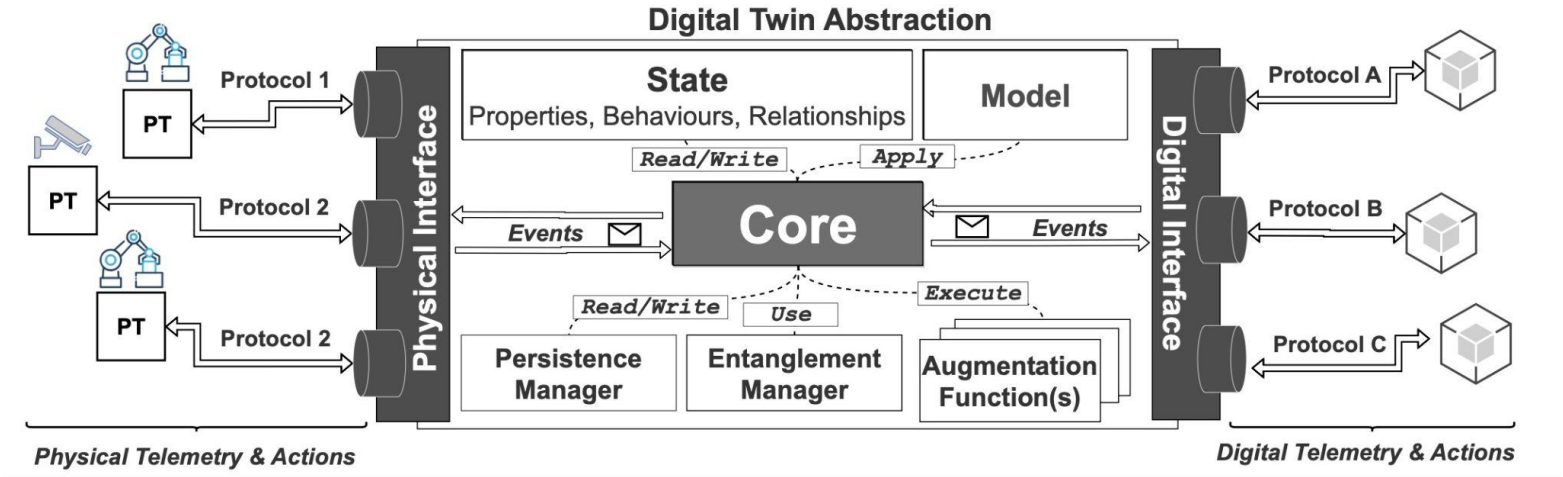
- **5GConnect**: innovative solutions for integrating traffic steering and shaping within industrial production plants
- **IGNITE 5.0**: IntelliGent and secure Networking in IndusTrial Environments: towards Industry 5.0
- **C4SI**: Cybersecurity for Smart Industry C4SI
- **CRI4.0**: Cyber Range for Industrial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

Collaborations

- **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 (MEC provided by Telecom, connected over a one-hop link to Google cloud).
- North Atlantic Treaty Organization (**NATO**) 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.

Our vision of digital twin

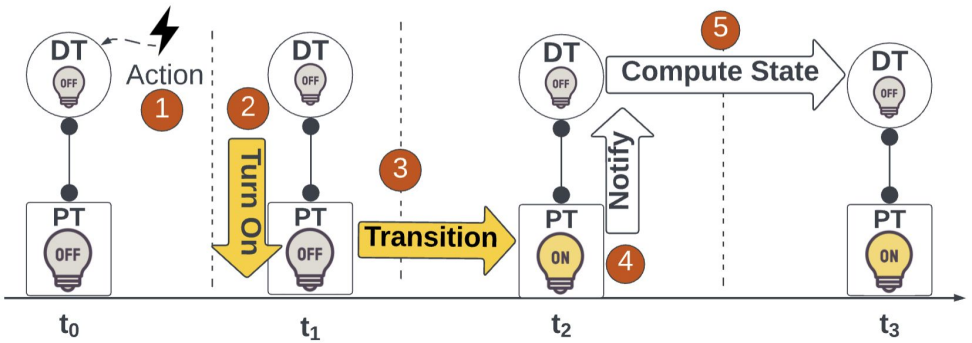
- Provides a (augmented) **virtual representation** of an object
- Works as a **gateway** to send commands to the object
- Has a **model** to conjecture about what might happen or might have happened

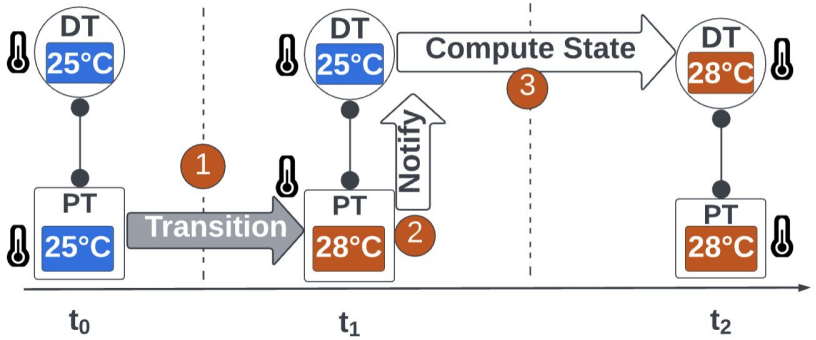


P. Bellavista, N. Bicocchi, M. Fogli, C. Giannelli, M. Mamei and M. Picone, **Exploiting Microservices and Serverless for Digital Twins in the Cloud-to-Edge Continuum**, Future Generation Computer Systems, Submitted for Publication.

Entanglement in cyber-physical systems

From physical to digital



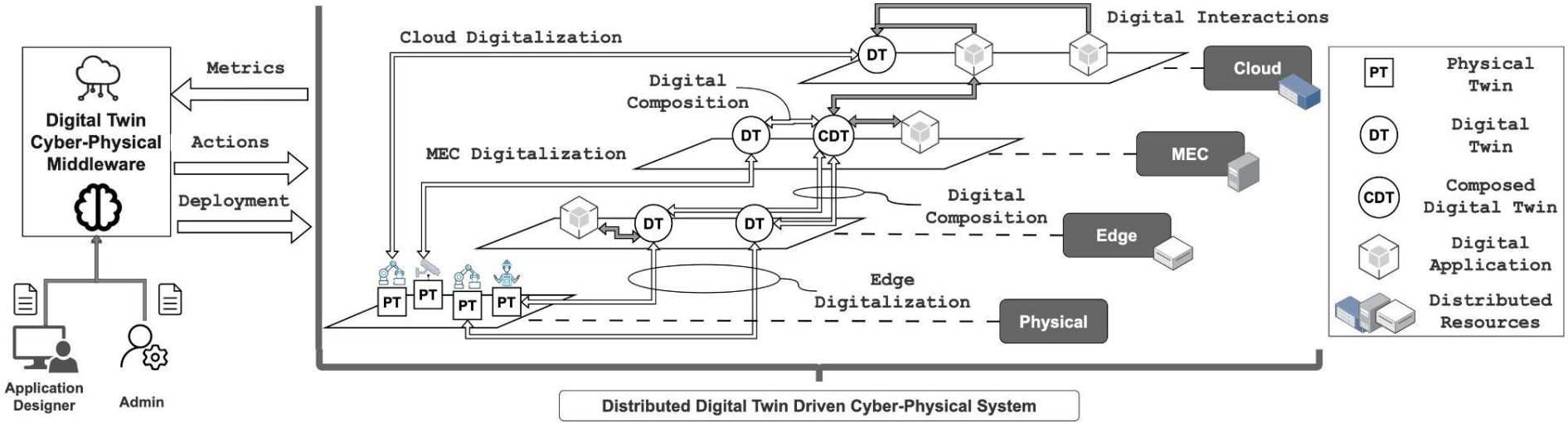


From digital to physical

P. Bellavista, N. Bicocchi, M. Fogli, C. Giannelli, M. Mamei and M. Picone, **Measuring Digital Twin Entanglement in Industrial Internet of Things**, ICC 2023 - IEEE International Conference on Communications, Rome, Italy, 2023.
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, Submitted for Publication.

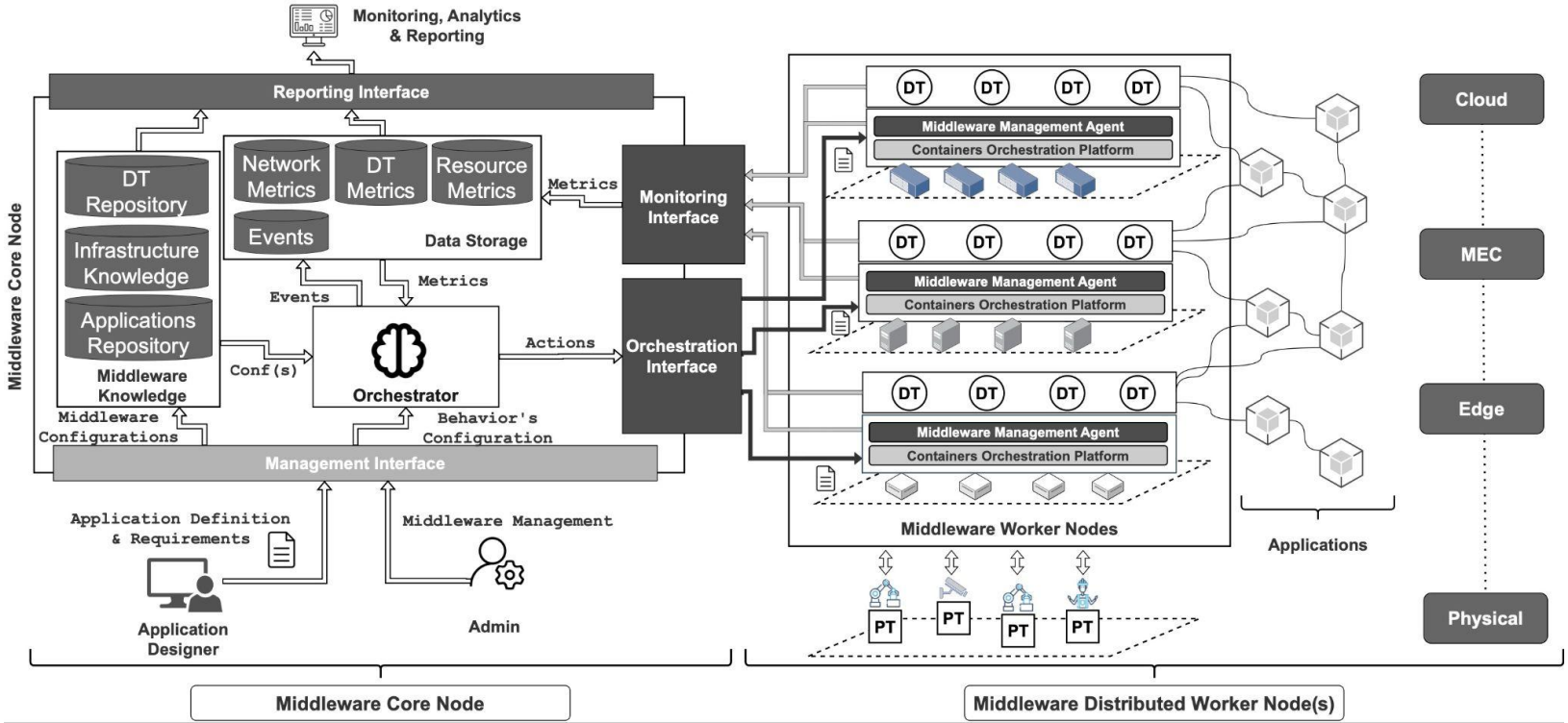
What we are working on: Scenario

Orchestration of microservices and serverless digital twins in the continuum



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, Submitted for Publication.

What we are working on: Architecture



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Contacts

Distributed Systems Research Group
Department of Mathematics and Computer Science
University of Ferrara, Italy

Carlo Giannelli
carlo.giannelli@unife.it
https://ds.unife.it/people/carlo.giannelli/
https://www.scopus.com/authid/detail.uri?authorId=22334279900

Mattia Fogli
mattia.fogli@unife.it
https://ds.unife.it/people/mattia.fogli/
https://www.scopus.com/authid/detail.uri?authorId=57218998714

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, Submitted for Publication.
- 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, Submitted for Publication.
- 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, Submitted for Publication.
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- 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**, (2023) Computers in Industry.
- Fogli, M., Giannelli, C., Poltronieri, F., Stefanelli, C., Tortonesi, M., **Chaos Engineering for Resilience Assessment of Digital Twins**, (2023) IEEE Transactions on Industrial Informatics.
- Bellavista, P., Giannelli, C., Mamei, M., Mendula, M., Picone, M., **Digital twin oriented architecture for secure and QoS aware intelligent communications in industrial environments**, (2022) Pervasive and Mobile Computing.