



# **A Software Engineering Approach to Digital Twin Architecture: The HUMAN at home project and Twin Cooperation of roBOT and human project case studies**

Gaëlic Bechu, Antoine Beugnard, Caroline Gl Cao, Quentin Perez, Christelle Urtado, Sylvain Vauttier

## **► To cite this version:**

Gaëlic Bechu, Antoine Beugnard, Caroline Gl Cao, Quentin Perez, Christelle Urtado, et al.. A Software Engineering Approach to Digital Twin Architecture: The HUMAN at home project and Twin Cooperation of roBOT and human project case studies. ETFA 2022 - IEEE 27th International Conference on Emerging Technologies and Factory Automation, Sep 2022, Stuttgart, Germany. , 2022. hal-03895898

**HAL Id: hal-03895898**

**<https://imt-mines-ales.hal.science/hal-03895898>**

Submitted on 11 Jun 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

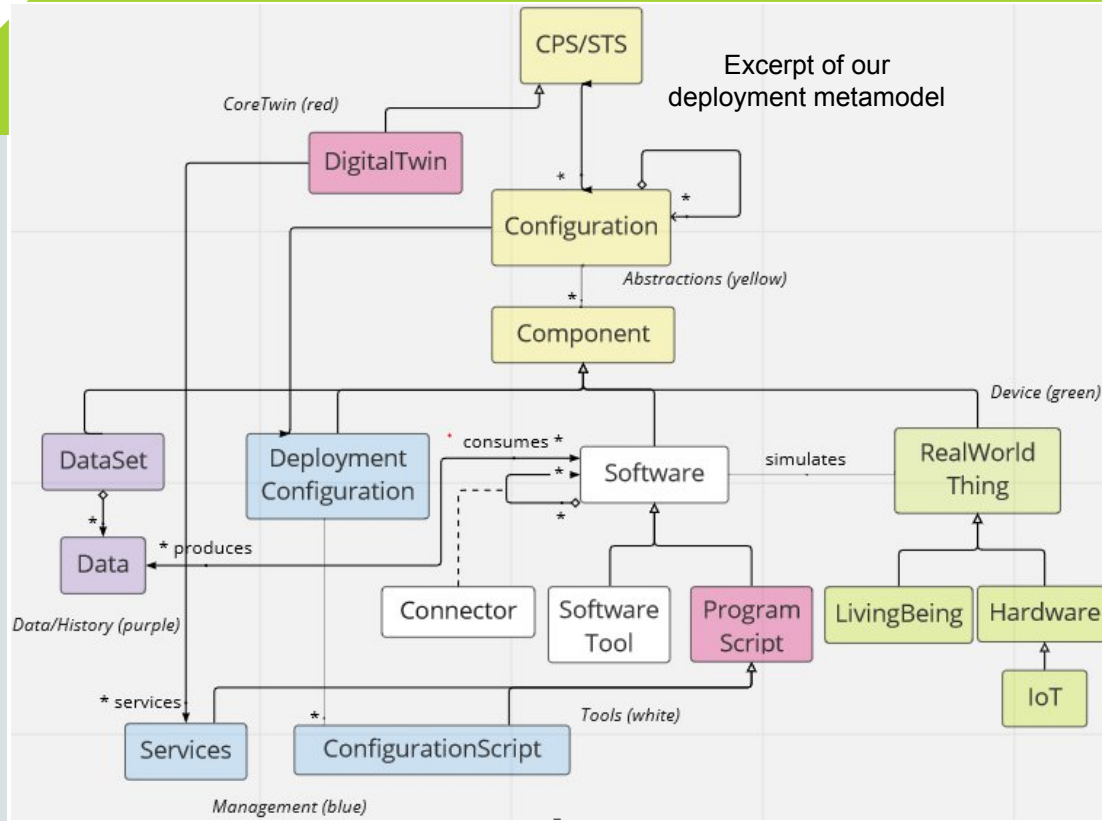
L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# A Software Engineering Approach to Digital Twin Architecture

The HUman at home project and Twin Cooperation of roBot and human project case studies

► **Motivation** – Digital twin (DT), Internet of Things and Artificial Intelligence are key emerging technologies in Industry 4.0. However, concrete and operational models are still to be designed to manage the deployment of DTs [1]. Our proposed metamodel is a first step towards a model-driven approach for DT deployment. It is derived from our previous work on ADLs [2, 3].

► **Objective** – Develop a metamodel that supports concrete operational descriptions of digital twins; Validate in two human-robot interaction case studies: a robotic arm and a home automation application.

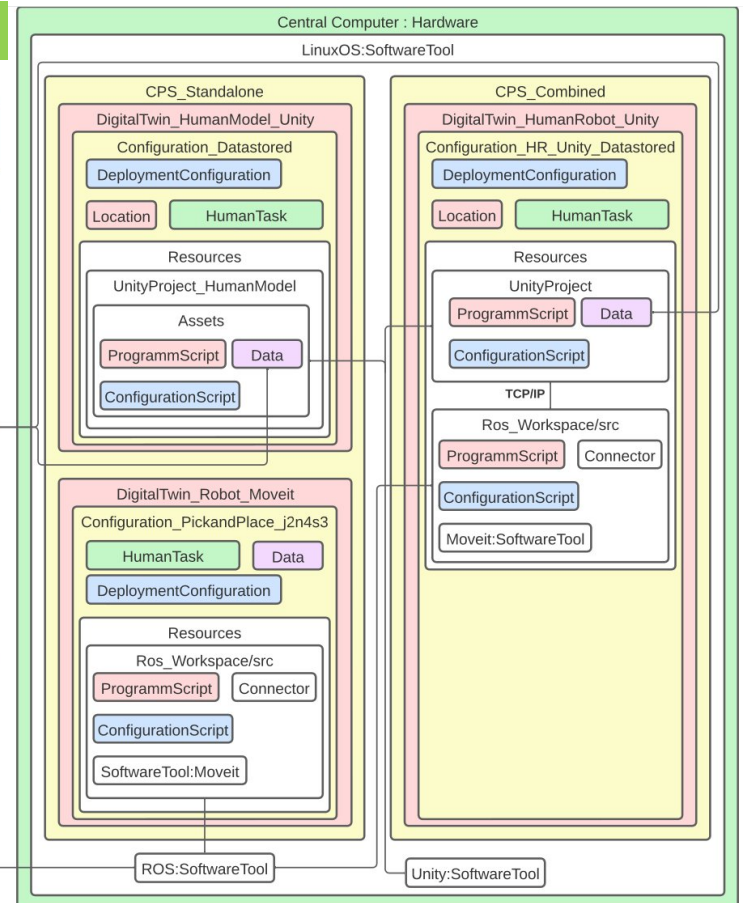
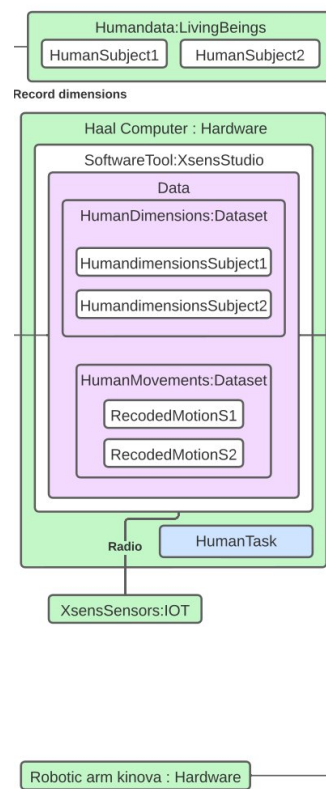


## Robotic arm application

In the robotic arm case study, DTs of the interacting human and robot are used for motion planning in pick-and-place tasks.

Our deployment metamodel can describe the combination of software and hardware used, including: ROS, Unity, Kinect, Xsens body suit, Kinova j2n4s300 robotic arm, etc.

The transformation of this model into executable deployment descriptors is being studied.



## Home automation application

In the home automation case study, DTs are used to handle and predict the interactions between a smart appartement and its inhabitants. The validation of our metamodel is here twofold:

- modeling of CPS architectures including DTs of sensors/actuators and AI models,
- full implementation as executable deployment descriptors of the modeled elements using Ansible scripts.

## References

- [1] Fei Tao, Meng Zhang, and Andrew Yeh Chris Nee. Digital twin driven smart manufacturing. Academic Press, 2019.
- [2] Abderrahman Mokni, Christelle Urtado, Sylvain Vauttier, Marianne Huchard, Zhang Huaxi Yulin. A formal approach for managing component-based architecture evolution. Science of Computer Programming, Elsevier, 2016, 127, pp.24-49.
- [3] Paul Perrotin, Nicolas Belloir, Salah Sadou, David Hairion, Antoine Beugnard. HoS-ML: Socio-Technical System ADL Dedicated to Human Vulnerability Identification. 26th International Conference on Engineering of Complex Computer Systems, Mar 2022, Hiroshima, Japan.

## Acknowledgements

We thank Christophe Lohr, Panagiotis Papadakis, and Alireza Asvadi for their expertise. This work is partly funded by:

- CARNOT MINES & TSN Institutes,
- Chair of Industry of the Future (Région de Bretagne and University of South Australia),
- GT VOCA of the HUman at home project (HUT) (FEDER and the Région Occitanie).