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## Model-driven deployment of Digital Twins for Smart Environments - The HUMAN at home projecT case study

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# Model-driven deployment of Digital Twins for Smart Environments

## The HUMAN at home project case study

### Motivation and Goals

HUT is a multidisciplinary project that aims at studying the impact of smart environments on well-being.

Its main equipment is an observatory apartment that collects data generated by daily life activities of voluntary occupants thanks to a large variety of sensors (e.g. temperature, hygrometry, CO2, light, presence, doors, electric and water consumptions).

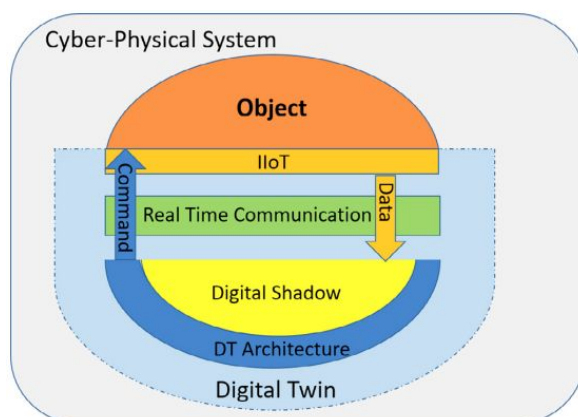


The observatory apartment of HUT

**How to use these datasets for studying the integration of AI components in smart environments?**

**How to continue these experiments after the end of the HUT project?**

The concept of Digital Twin (DT), as studied for Industry 4.0, is a potential solution. DT is now more precisely defined as the combined IoT and software parts of a cyber-physical system that provides virtual real-time representations of its physical parts [1].



Conceptual definition of a DT [1]

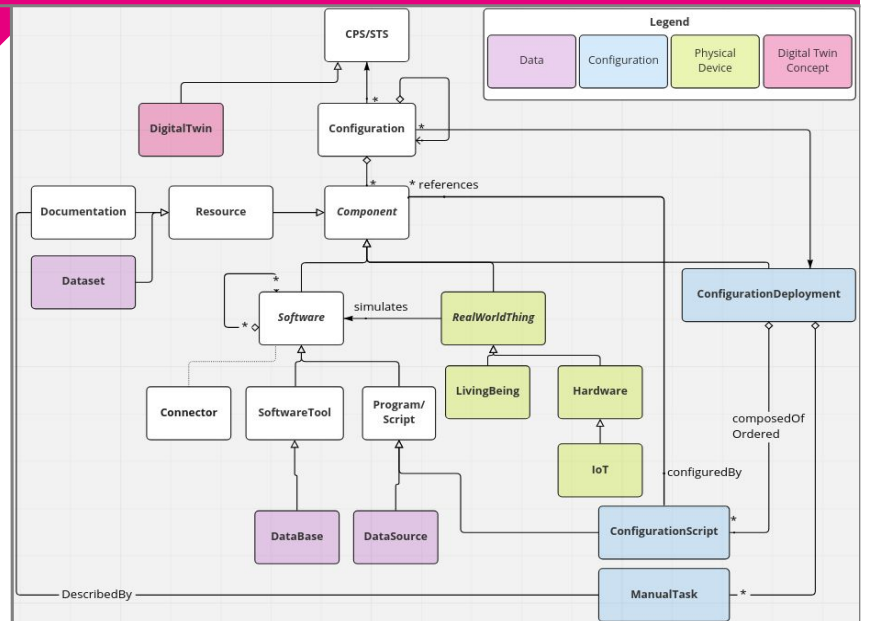
However, more concrete and operational models are still to be designed, for instance to manage the deployment of DTs [2].

Our proposed metamodel is a first step towards a model-driven approach for DT deployment. It is derived from our previous work on ADLs [3, 4].

### Modeling the Deployment of DTs

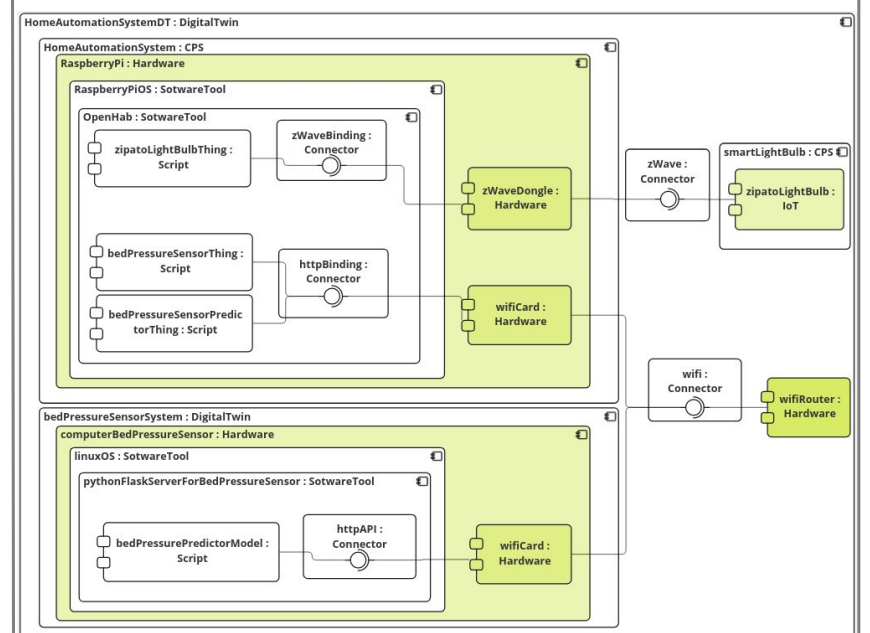
DT deployment encompasses many dimensions:

- ▶ variable configurations, adapting architectures to environment,
- ▶ hierarchical composite architectures, mixing various types of software / hardware components / resources,
- ▶ deployment processes, defining ordered tasks for installing, executing, configuring or instantiating the architectures and their supporting environments.



Excerpt of our deployment metamodel

### Metamodel Validation



Deployment model for a BedPressure Sensor DT for the HUT case study

On the HUT case study, the validation of our metamodel is twofold:

- ▶ modeling of CPS architectures including DTs of sensors and AI,
- ▶ fully implemented and executable deployments of the modeled elements as Ansible scripts.

Another case study is also currently run for extended / cross validation, implying the DT of a Cobot for pick and place tasks.

### Future Work

- ▶ Refine and extend the metamodel with architectural and design patterns for DTs,
- ▶ Design and implement DSLs, transformations and formal semantics for full-fledged MDE,
- ▶ Study composition and evolution mechanisms to support reuse in DT deployment definitions.

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