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

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HUman at home projecT

Motivation and Goals

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

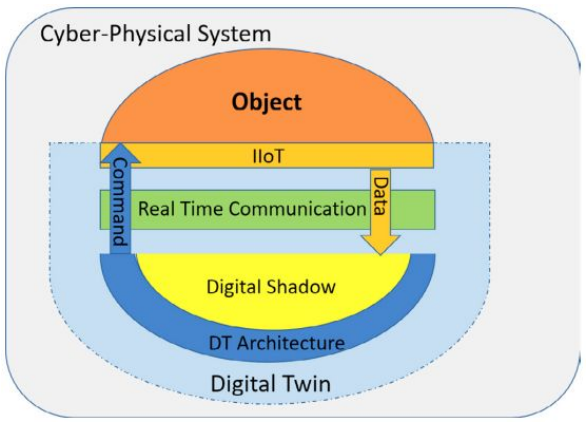
Its main equipment is an observatory apartment that collects data generated by daily life activities of voluntary occupants thanks to a large variety of sensors (e.g. temperature, hygrometry, CO2, light, presence, doors, electric and water consumptions).

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]

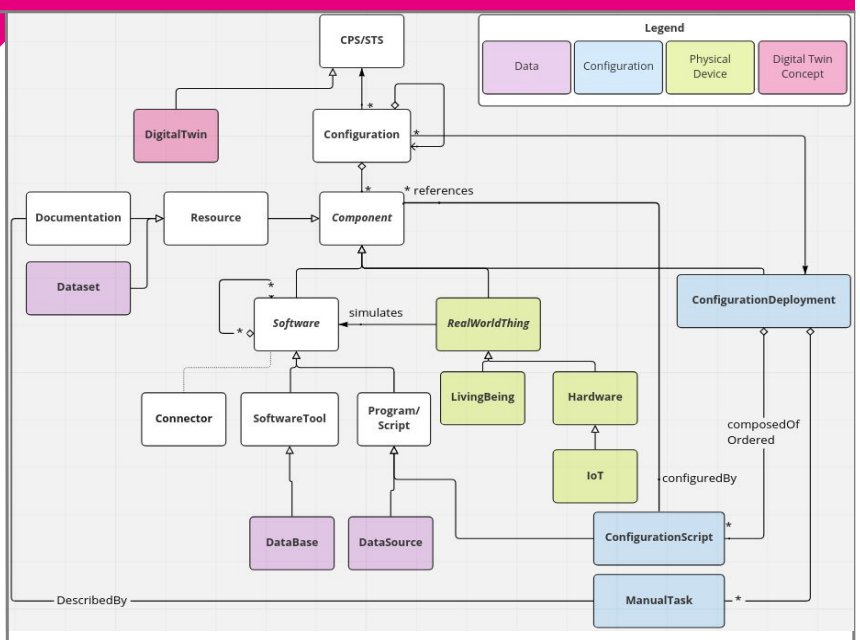
However, more concrete and operational models are still to be designed, for instance to manage the deployment of DTs [2].

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

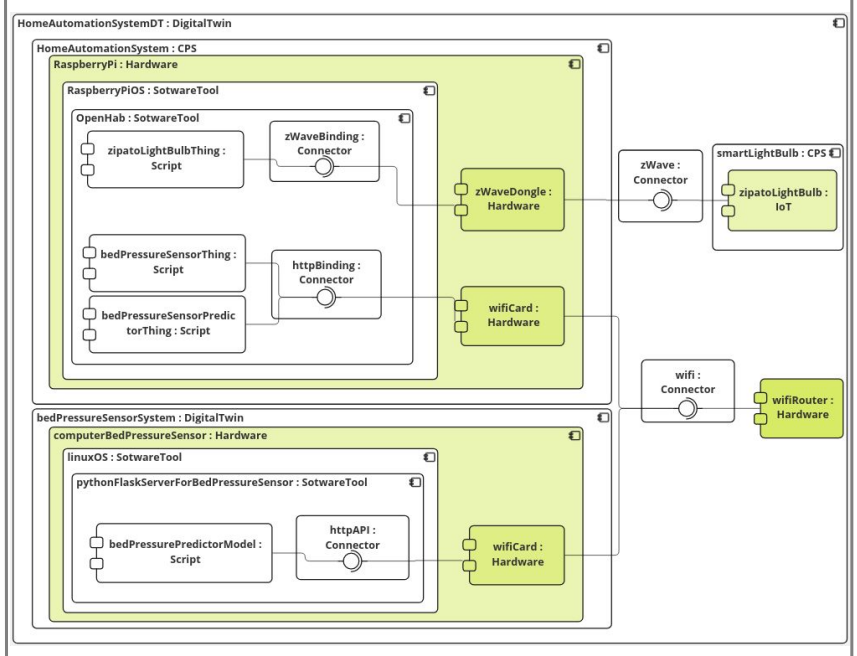
DT deployment encompasses many dimensions:

- 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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