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

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References

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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 (temperature, hygrometry, CO_2, 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].
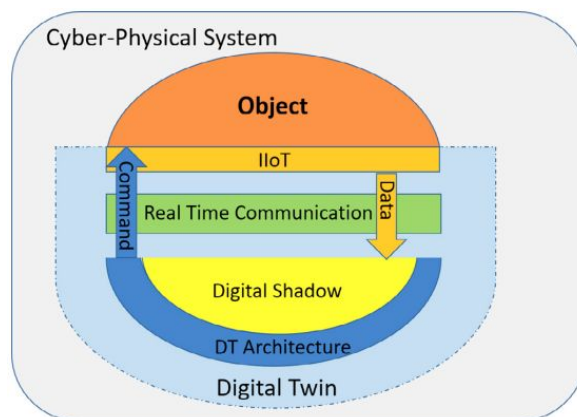
Conceptual definition of a DT [1]

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 environments

► 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
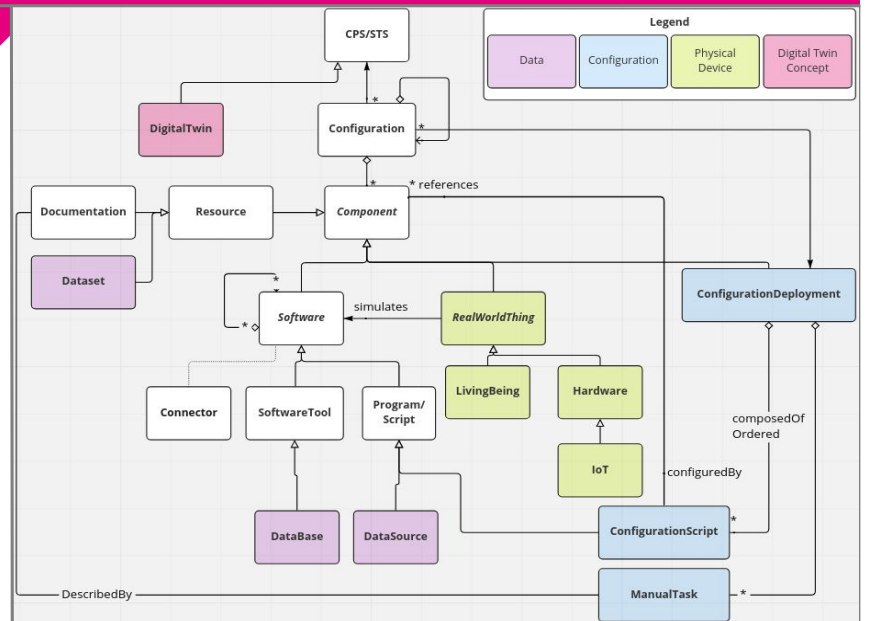
Excerpt of our deployment metamodel

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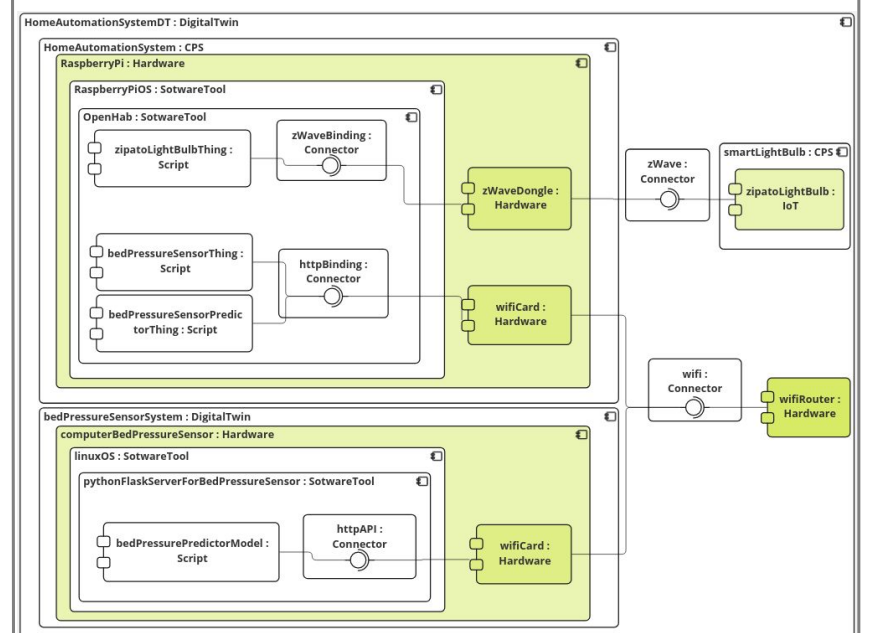
Deployment model for a BedPressure Sensor DT for the HUT case study

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

► description 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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