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A hybrid approach of semantic modeling and co-simulation for a better consideration of the physics of physical phenomena in a smart building

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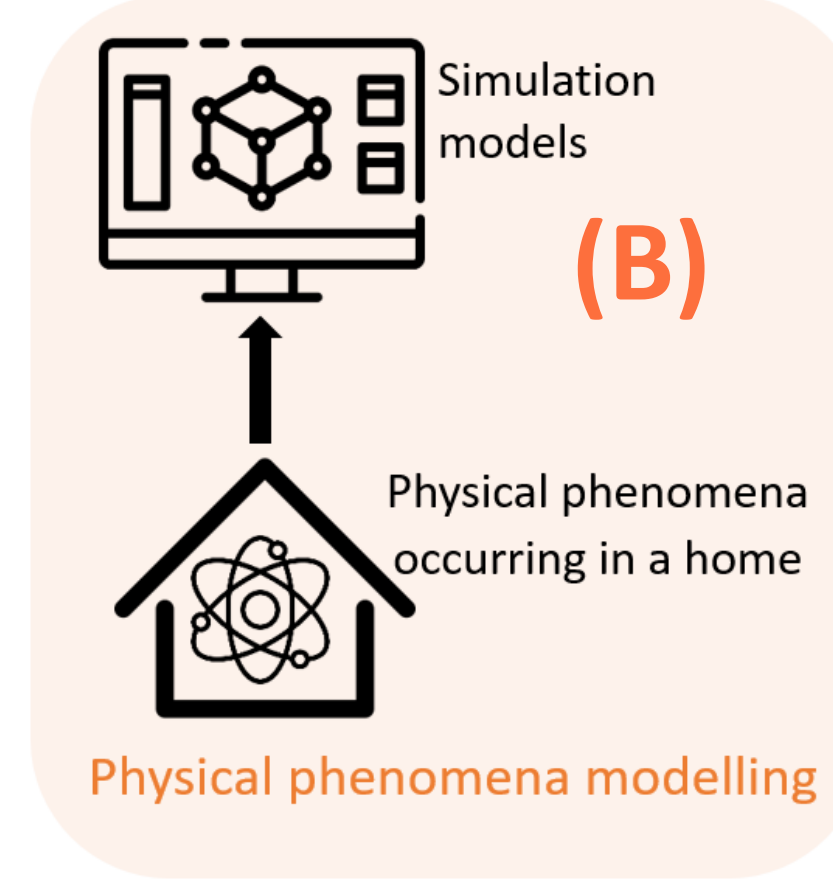
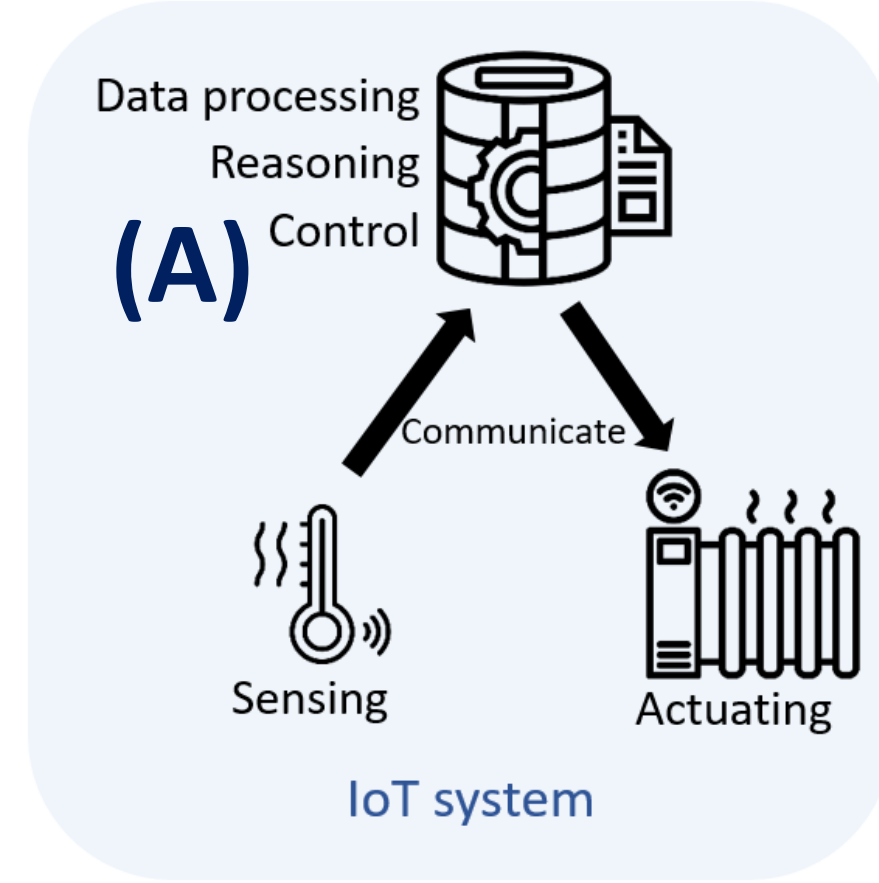
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Context

(A) : physical phenomena occurring in a complex and heterogeneous cyber-physical system, such as a smart building, are poorly reflected in current IoT applications [1]



(B) : in digital twins, simulation of these physical phenomena allows to anticipate the temporal evolution of a cyber physical system [2].

Motivation

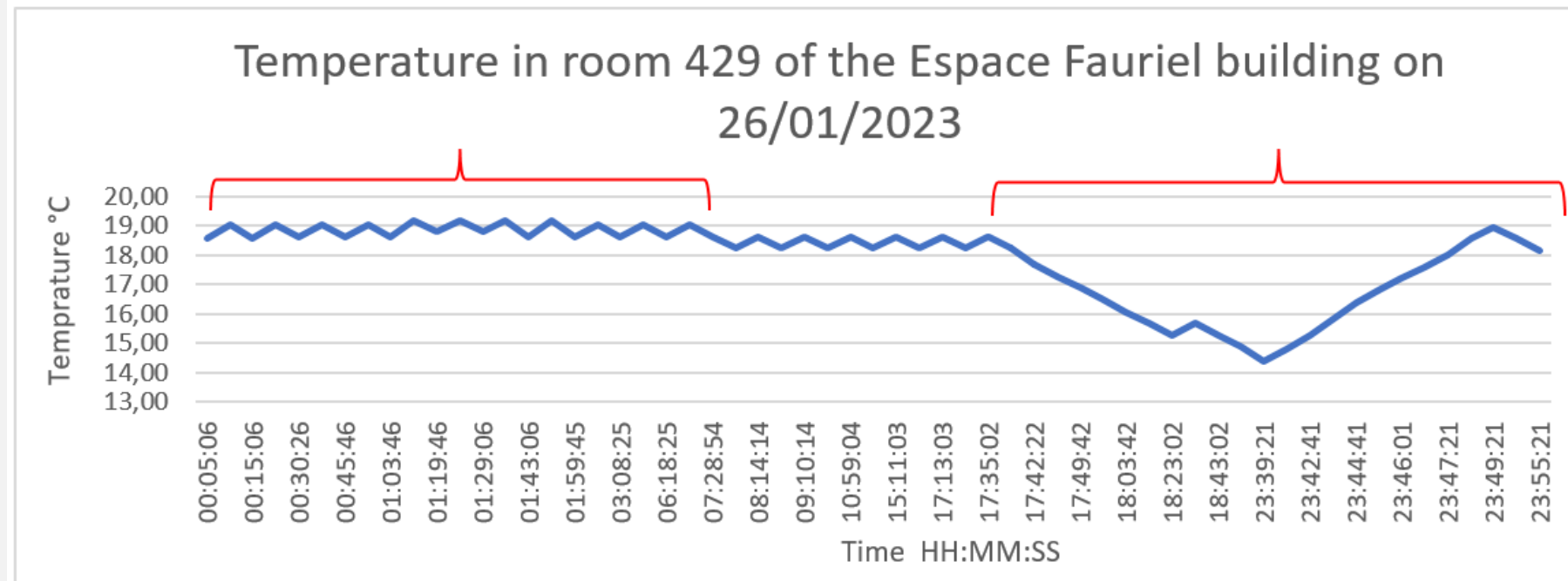
Combination of simulation and semantic knowledge of the physical phenomena will improve decision-making process of IoT systems deployed in smart buildings

Use case EMSE

Contribute to the improvement of the IoT control system in the DigitalTwin of Espace Fauriel building

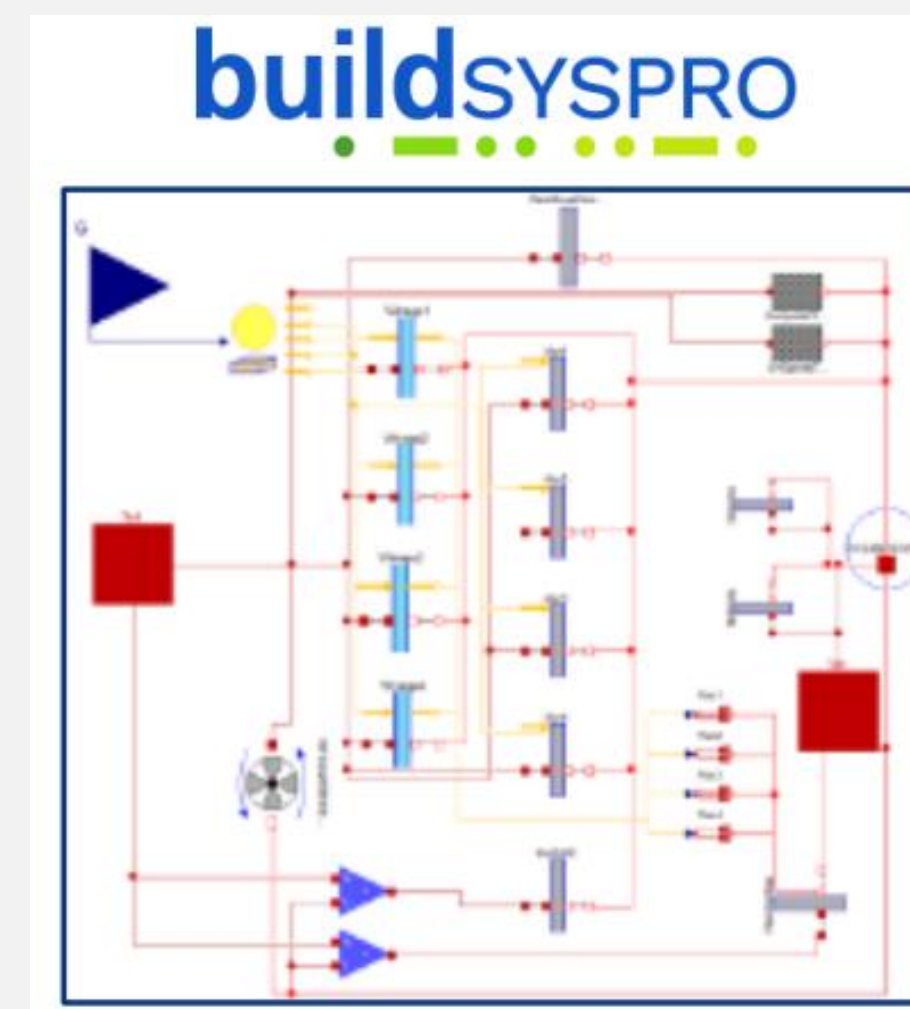


When to heat the building to reach the desired temperature at a given time.



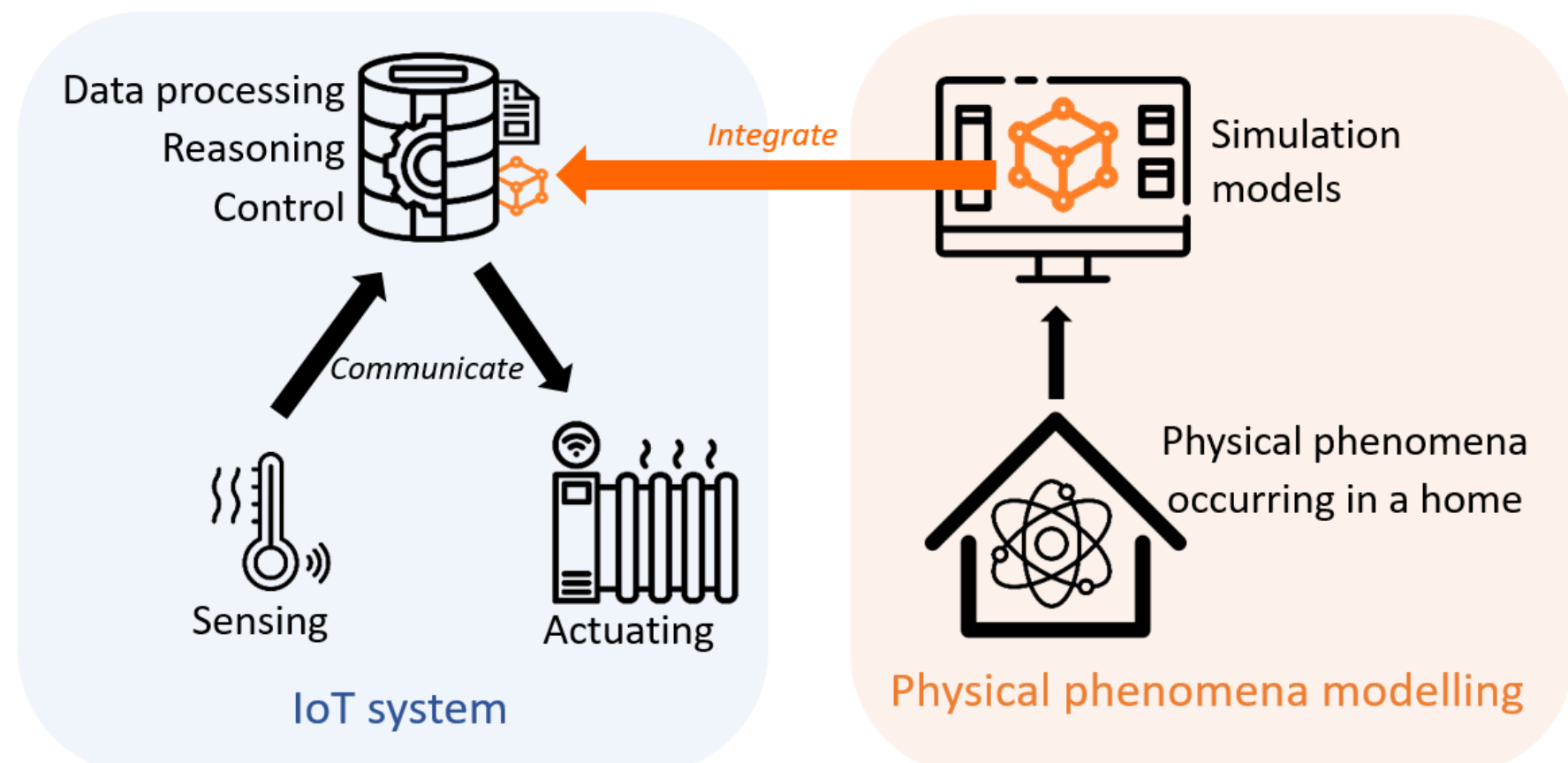
Use case EDF

Integrate the simulation models of the K15 building in EDF Lab Les Renardières into its building performance management system



Objective 1

Integrating physical phenomena simulation in IoT system

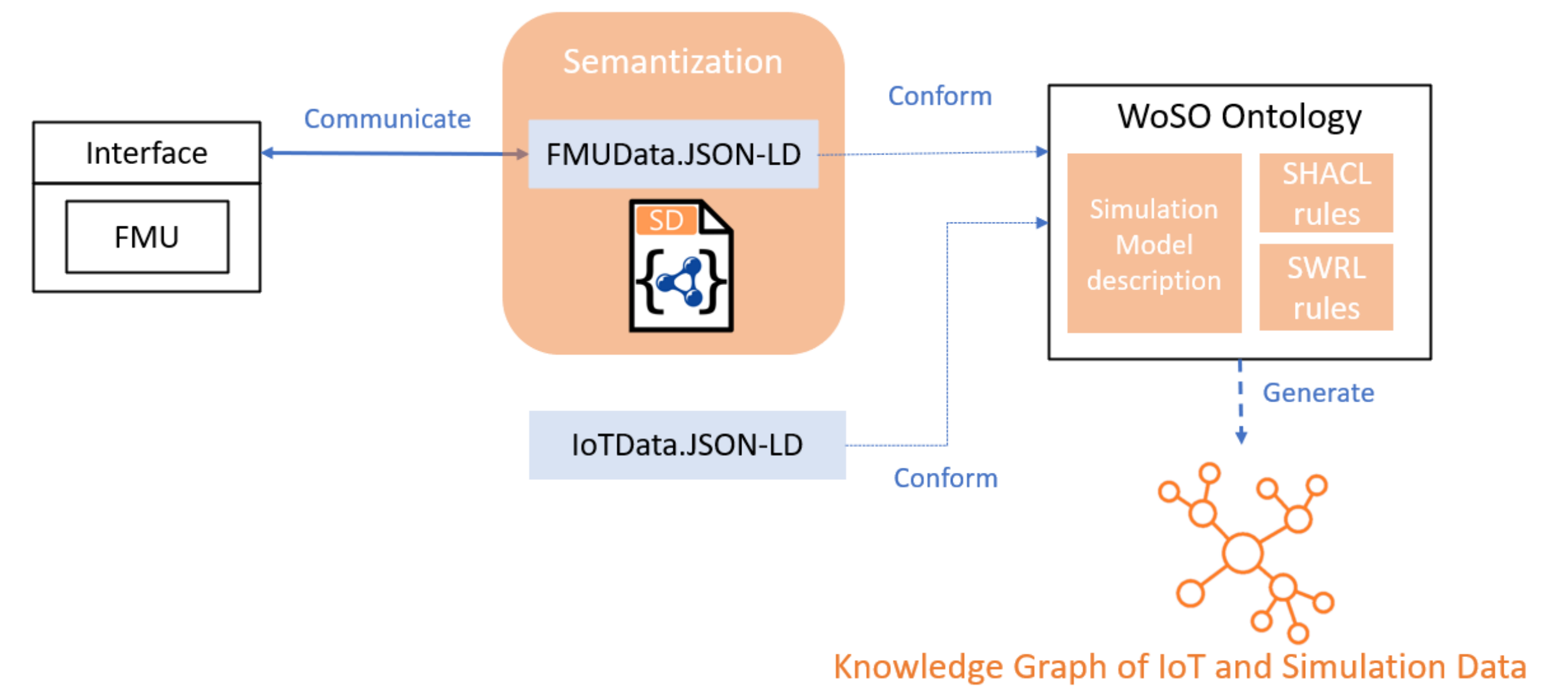


Hypothesis: Integrating physical phenomena simulation in IoT systems would improve the accuracy of the reasoning system and the power efficiency.

Question: How to enable the interoperability between the simulation model and the reasoning system?

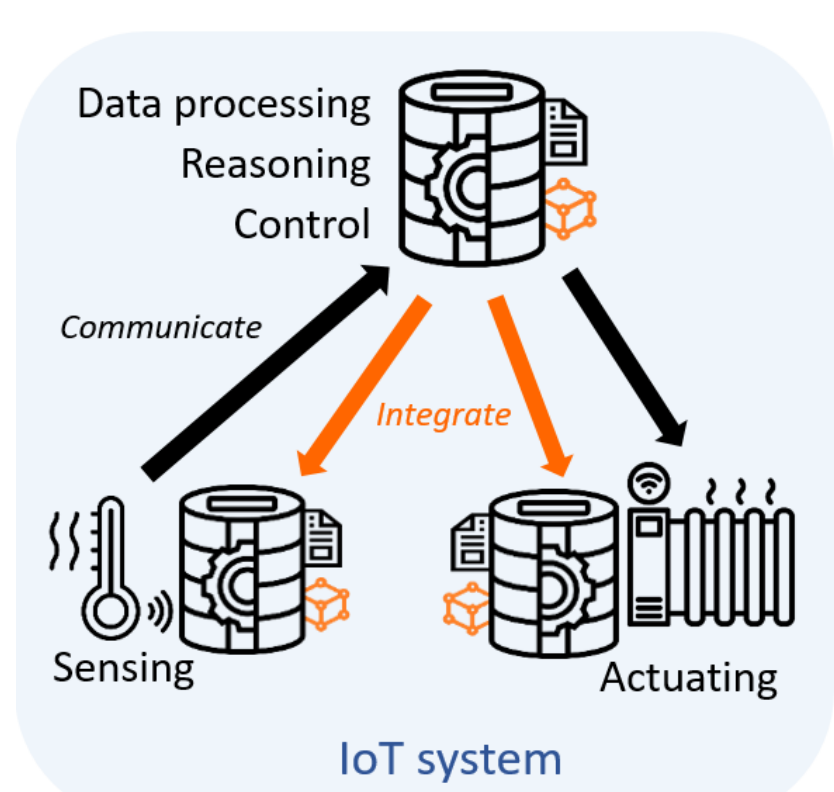
Semantic Interoperability

Web of Simulations Ontology (WoSO) is a high-level description of simulations and IoT system that relies on the standard Functional Mock-up Interface (FMI) and extends a reference IoT ontology (SAREF) [3]



Objective 2

Integrating simulation in constrained IoT device

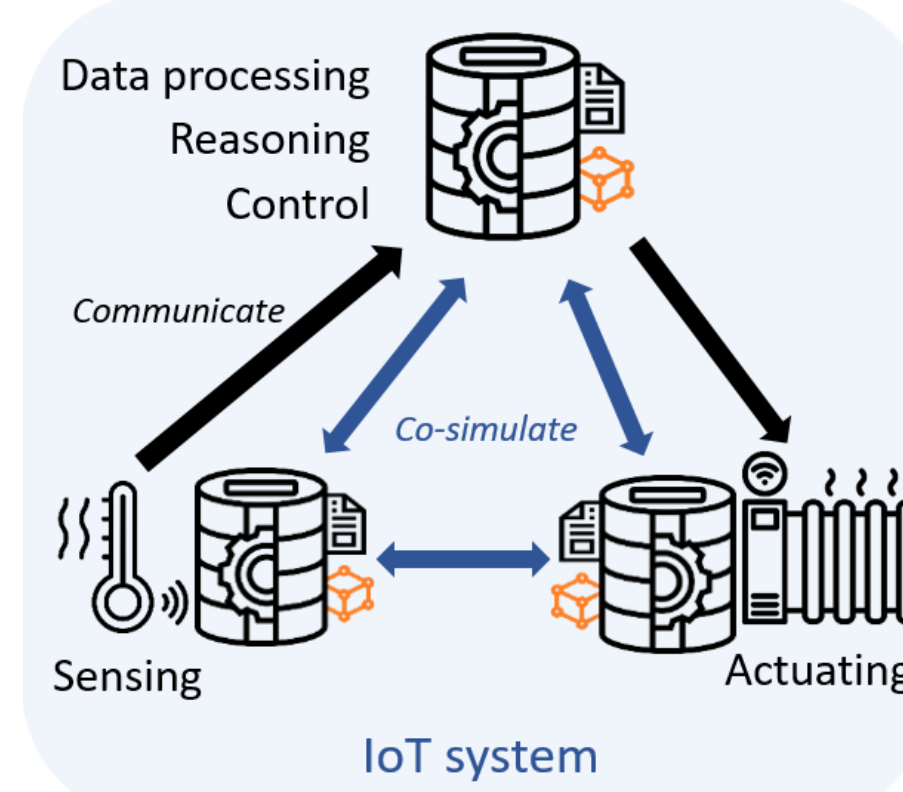


Hypothesis : Embedding the simulation in the constrained IoT devices would reduce the response time and ensure the minimum system operation in case of communication problems.

Question : How to make the simulations tailored to constrained device resources and architecture?

Objective 3

Co-simulating distributed simulations in IoT system



Hypothesis : Co-simulating distributed simulations using semantic web technologies would improve the interoperability of the IoT system.

Question : How to handle the data exchange between interdependent simulations using semantic web technologies?

References

- [1] Zhan, S., Lei, Y., Jin, Y., Yan, D., & Chong, A. (2022). Impact of occupant related data on identification and model predictive control for buildings. Applied Energy.
- [2] Singh, M., Fuenmayor, E., Hinchy, E. P., Qiao, Y., Murray, N., & Devine, D. (2021). Digital twin: Origin to future. Applied System Innovation.
- [3] Hounas, Z., Lefrançois, M., Zimmermann, A., Traverson, B. (2024). Semantic approach for integration of building performance simulations in IoT systems : Web of simulation Ontology (WoSO). LDAC2024 - Linked Data in Architecture and Construction.