Executive Summary

A Digital Twin is a virtual representation of a physical system that stays synchronized with it through real-time data. Most DTs are built for one system and tied to its domain, a technology or a toolchain, which makes them hard to extend to new subsystems. The TU/e DT Lab proposed an ontology-based DT architecture and five-step framework to address this, and RISE, within the Horizon Europe project TWINLOOP, needs an open reference approach for EV DTs.

Problem and Objective
Before this project, the architecture existed only as a concept, with no applied example of a working and maintainable DT. The objective was to verify whether an ontology-based architecture can enable a maintainable DT, through a BEV PoC focused on the SoC of the traction battery.

Approach
The five-step framework was followed from ontology selection to a running twin. The project produced a vehicle ontology built on three published ontologies, a design of the six architectural layers that is independent of the vehicle, and a BEV DT built with open-source tools.

Key Findings

- **The twin operates end-to-end.** It was shown live to the project stakeholders on separate computers in two buildings of the campus.
- **The twin can be extended.** A new subsystem domain was added as new components, while the existing ones stayed as they were.
- **Visualization is independent of the twin.** A web and two 3D visualizers implemented in collaboration with the DT Lab staff.
- **The twin answers an engineering question.** In simulated drives, it showed how vehicle mass and ambient temperature affect the SoC of the battery.

Recommendations
The campus DT and the BEV DT are two Digital Twins, built on different architectures, that already work together. The DT Lab can extend its Unity visualization with the vehicle decomposition defined in the ontology. RISE can use the method and the layered design as a reference for the MyEV architecture. For functional safety, values returned by the twin to the vehicle can first be evaluated against the corresponding vehicle measurements.

Conclusion
The results provide evidence that an ontology-based architecture can produce a working and maintainable DT. A platform can implement the layered design once and serve any twin whose ontology is composed as this work describes. It therefore forms an initial foundation for the DT generation platform the TU/e DT Lab aims to build. The application of the framework by another team remains to be confirmed.