



Industrial Manufacturing strategies for distributed control and resilient, rapidly responsive, and reconfigurable supply chains.

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## Semantic interoperability and uplifting in MODUL4R

The MODUL4R Project performs research and innovation actions that lead to offering a holistic framework applicable to both new and existing manufacturing lines to achieve flexibility, rapid responsiveness, and sustainability. One cornerstone of the MODUL4R system is the achievement of semantic interoperability for manufacturing processes data (e.g., those coming from sensors, devices, legacy systems, etc.), enabling an enriched flow of information from the field to the upper modules in charge of possible prognostic and diagnostic actions.

In this context, the concept and vision of interoperability can be defined as "the ability of two or more systems/components to exchange and use information", where data providers are e.g. machines and assets of a production environment and information consumers are data-driven services such as demand-supply matching, predictive operations, virtual commissioning, decision support system, etc.

The approach, proposed by Holonix in MODUL4R and implemented in the Semantic Data Management Tool, focusses on the semantic uplifting of data to information using a domain semantic model: data are "transformed" into information using an ontology (translatable into OWL-DL language, ensuring compatibility and interoperability) and meta-information is enhanced to achieve complete samples. A wrapper can allow generic access to a type of system (e.g. database), its setup provides a "self-description" of the considered system and enables the exchange of information about a system. The approach guarantees the separation of data sources and dependent tool chains, leading to more robust information flows.

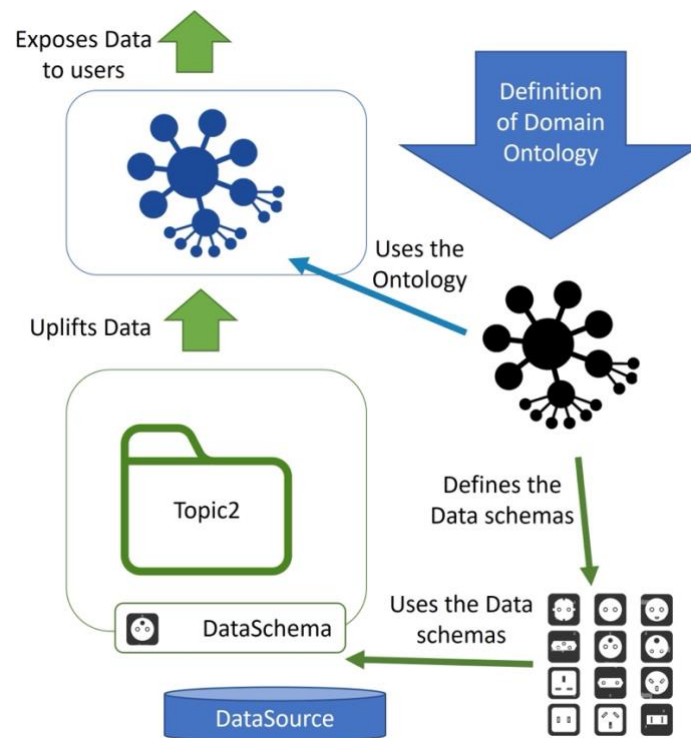


Figure 1: Semantic up-lifting approach

Accordingly, the Semantic Data Management Tool is basically responsible for a universal cross-pilot data transformation and transforms the json files into the MODUL4R json schema to achieve interoperability, uplifting the information. The transformation results in richer data independently from the data source format and it provides the same data structure for possible data analyses to be executed by other modules.

Summarizing, flow of information of the MODUL4R pilot can leverage the Semantic Data Management Tool to enable the following key functions:

- Identifying relevant data based on domain ontology.
- Uplifting pilot specific data to align with the defined domain ontology.
- Enabling the seamless semantic integration of various pilot-specific data.
- Facilitating the sharing and provision of other diagnostics modules with relevant data, formatted as required, such as in json.

The proposed approach streamlines the process, automating various tasks and significantly reducing the need for human involvement: e.g., data analysts only need a comprehension of the domain ontology in their work, with no necessity to consider the possible various pilot-specific data structures. Additionally, the semantic data management tool can enable to reduce the possible manual effort required for data integration.

A first application has been performed in FFT use case considering the need to address in a systemic and structured way all the geometrical data of the parts of the capacitors. In the first area of FFT manufacturing line, a precise quality check is performed on capacitors and a lot of information is collected. Requirement is mainly related to capacitor components positioning accuracy: optical sensors detect joining positions, features and geometries of the capacitors and

their elements, generating data from which added-value information can be extracted through the proposed semantic approach.

For further info about Semantic interoperability and uplifting in MODUL4R, please write to [stefano.borgia@holonix.it](mailto:stefano.borgia@holonix.it) (Stefano Borgia, Holonix Srl).

## About the project

**Project Title:** Industrial Manufacturing strategies for distributed control and resilient, rapidly responsive, and reconfigurable supply chains.

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For additional information please contact

**Project Coordinator:**

Fraunhofer IWU | Markus Wabner | [Markus.Wabner@iwu.fraunhofer.de](mailto:Markus.Wabner@iwu.fraunhofer.de)

**Communication & Dissemination Manager:**

CORE Innovation Center | Ilia Kantartzi | [ikantartzi@core-innovation.com](mailto:ikantartzi@core-innovation.com)

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