Towards FAIR ICT Data Sharing in the Circular Economy with Knowledge Graphs

Anelia Kurteva

Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands a.kurteva@tudelft.nl

The Need for Circular ICT

- The ICT sector is responsible for 3-6% of global CO_2 emissions (comparable to the cement industry). Predicted increase of up to 14% in 2040, without sustainable interventions [2].
- ICT such as laptops and data servers are being used on average for 3 and 4-5 years [2] respectively, while research shows that they should last 7 years before replacement [1].
- Digitization has a growing demand for critical materials as well. 15 of the 30 critical materials identified by the European Union are used in the production of ICT hardware.

Barriers

- Limited **availability**, **accessibility** and **interoperability** of ICT, materials and Circular Economy (CE) data across organisations.
- Lack of digital infrastructures and tools that support **knowledge exchange** and interpretation between sustainability, ICT and technology experts in a **standardised** human and machine-readable formats.
- Lack of process transparency and data traceability along supply chains.

Knowledge Graphs (KGs) - RePlanIT's FAIR Data Solution

To support findable, accessible, interoperable, reusable (FAIR) [6] ICT data sharing, based on our research [5], we present:

- RePlanIT's ontology [4] for semantically representing and interlinking the ICT, materials and CE domains.
- Machine-readable ICT Digital Product Passports (DPPs) as KGs [3], which can capture dynamic ICT life-cycles in the CE.

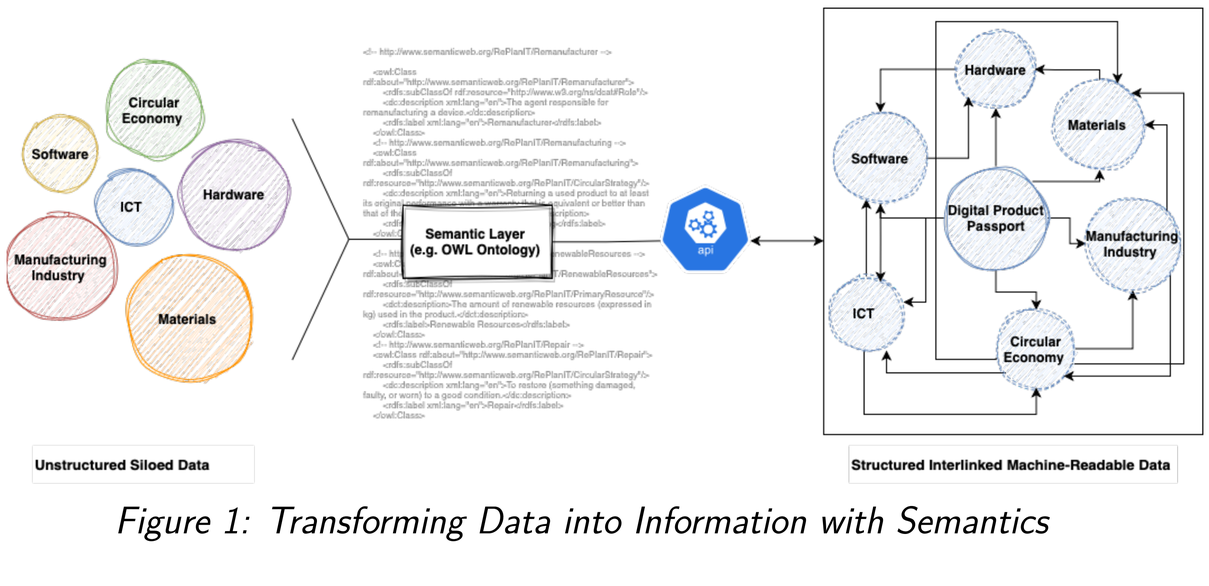

Figure 1: Transforming Data into Information with Semantics

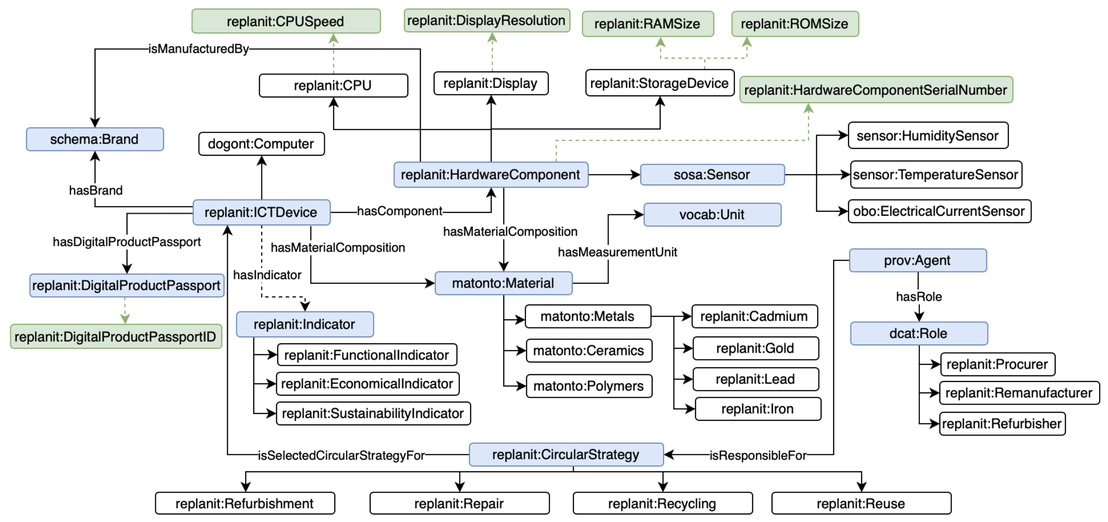

Figure 2: RePlanIT DPP Ontology Overview

Applications

- The RePlanIT DPP ontology can be used as a stand-alone data model that guides the standardisation of ICT DPPs.
- The KG can be used to support human-decision making such as sustainable procurement of ICT hardware in organisations.
- KG-based semantic DPPs such as our can contribute to automated CE recommendations and context-aware predictive maintenance at scale.

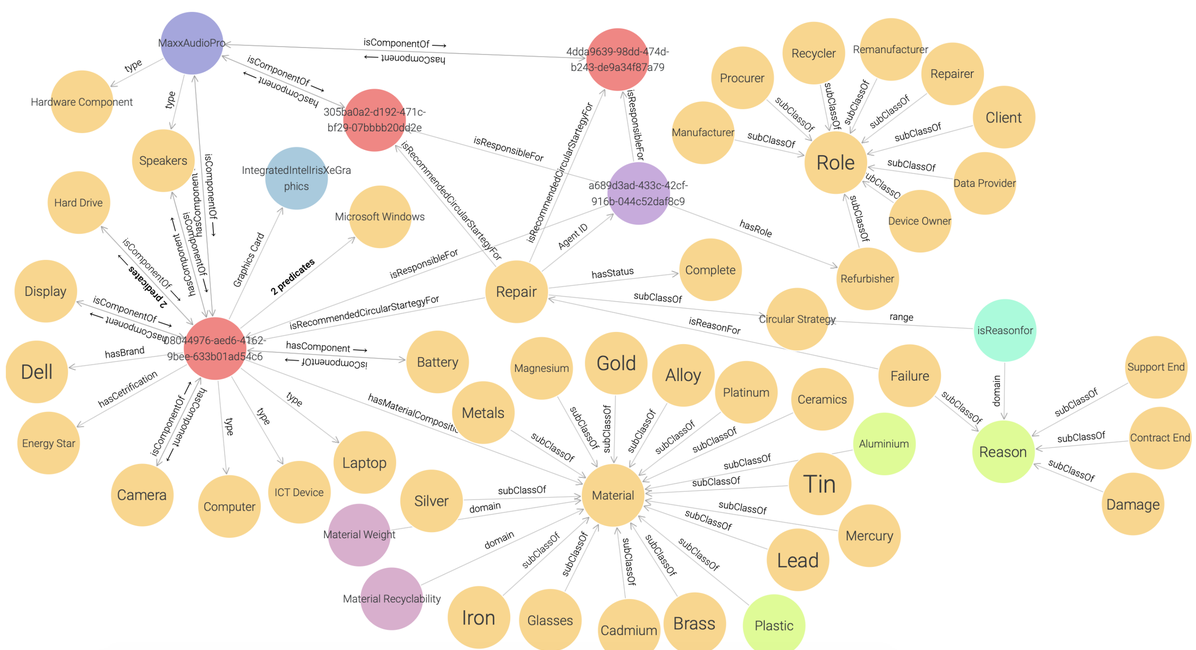

Figure 3: Representing ICT DPPs with RePlanIT's KG.

References

[1] Conny Bakker et al. "Products that go Round: Exploring Product Life Extension through Design". In: *Journal of Cleaner Production* 69 (2014), pp. 10–16.

[2] Joppe van Driel. *Naar een circulaire keten voor ICT-hardware [Towards a Circular Chain for ICT Hardware]*. Available at https://usi.nl/wp-content/uploads/2021/02/Eindrapport-Naar-een-circulaire-keten-voor-ICT-def.pdf. 2020.

[3] Dieter Fensel et al. "Introduction: What is a Knowledge Graph?" In: *Knowledge Graphs: Methodology, Tools and Selected Use Cases* (2020), pp. 1–10.

[4] Anelia Kurteva. *The RePlanIT Digital Product Passport Ontology for ICT in the Circular Economy*. Available at https://kind.io.tudelft.nl/replanit/docs/. 2023.

[5] Anelia Kurteva et al. "Semantic Web and Its Role in Facilitating ICT Data Sharing for the Circular Economy: State of the Art Survey". In: *Semantic Web* (2023). (In Review), Available at https://www.semantic-web-journal.net/system/files/swj3381.pdf.

[6] Mark D Wilkinson et al. "The FAIR Guiding Principles for Scientific Data Management and Stewardship". In: *Scientific Data* 3.1 (2016), pp. 1–9.

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TU Delft Delft University of Technology

Faculty of Industrial Design Engineering