FACTLOG
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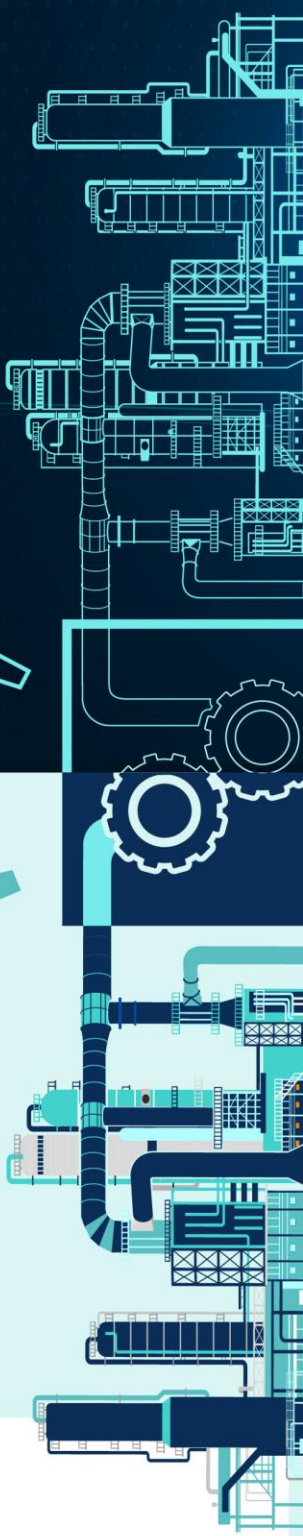
ENERGY-AWARE FACTORY ANALYTICS FOR PROCESS INDUSTRIES

Deliverable D8.7

Standardisation Activities Report V1



Version Version 1.0	**Lead Partner** EPFL
Date 24/01/2022	**Project Name** FACTLOG – Energy-aware Factory Analytics for Process Industries

FACTLOG has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 869951

Call Identifier H2020-NMBP-SPIRE-2019	**Topic** DT-SPIRE-06-2019 - Digital technologies for improved performance in cognitive production plants
Project Reference 869951	**Start date** November 1st, 2019
Type of Action IA – Innovation Action	**Duration** 42 Months

Dissemination Level

X	**PU**	Public
	CO	Confidential, restricted under conditions set out in the Grant Agreement
	CI	Classified, information as referred in the Commission Decision 2001/844/EC

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Executive Summary

Based on the D8.3, an updated version of standardisation activities report is presented based on given standards, including ISO 23247, ISO 42010 and BFO ontology specification. In this new version, a given ontology framework is proposed as input to D4.2 as a basic to develop knowledge graph models.

Revision History

Revision	Date	Description	Organisation
1.0	24/01/2022	First draft of this documents.	EPFL

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1 Introduction

1.1 Purpose and Scope

This document describes the outcomes of Task 8.7 which is a pre-requisite for a broad adoption of the resulting FACTLOG system and its main objective is to push forward standardization activities with regard to project contents, where this is considered as beneficial for further application of the implemented solutions in the respective industries. In this way, this document will ensure that the project's decisions are aligned to current developments, in relative standardization bodies and will pave the way for the wider adoption of its achievements and maximization of its impact.

As several aspects of the technological innovations created by FACTLOG imply strong connection to standards and standardization, this document will be used for FACTLOG carefully to monitor developments in standardization and compare its use cases and requirements with the goals pursued in relevant standardization bodies, e.g. It will help FACTLOG to make standardization bodies aware of its requirements and will actively contribute with its project results to standardization.

1.2 Relation with other Deliverables

Input from D8.3 and output to D4.2.

1.3 Structure of the Document

This document first introduces the objective of this document. Then standardization strategy is demonstrated with the related standards. Contributors are demonstrated with future plan. Finally, the conclusion is offered.

2 Objectives

The objectives of this document include:

- Develop a standardization strategy for FACTLOG project. This strategy will be adopted across the entire project to identify the stakeholders and interests-of-system about the FACTLOG pilots. Moreover, it supports to construct the FACTLOG Framework and to define FACTLOG terminologies. Furthermore, it aims to guide the Factlog development using a unified standardization.

- Formalize the FACTLOG Framework using ISO 42010 and ISO 23247. In ISO 42010, FACTLOG is considered as one system whose architecture is defined. Views and viewpoints are used to conform the stakeholders' concerns in the pilots. In ISO 23247, digital twins in FACTLOG are defined in order to make the digital twins in all the FACTLOG pilots under a unified framework.

- Formalize the knowledge graph modeling using IoF and BFO. Based on these two specifications, an ontology framework for developing FACTLOG ontology for each pilot is defined. Based on the FACTLOG ontology, knowledge graph models are built.

3 Standardization

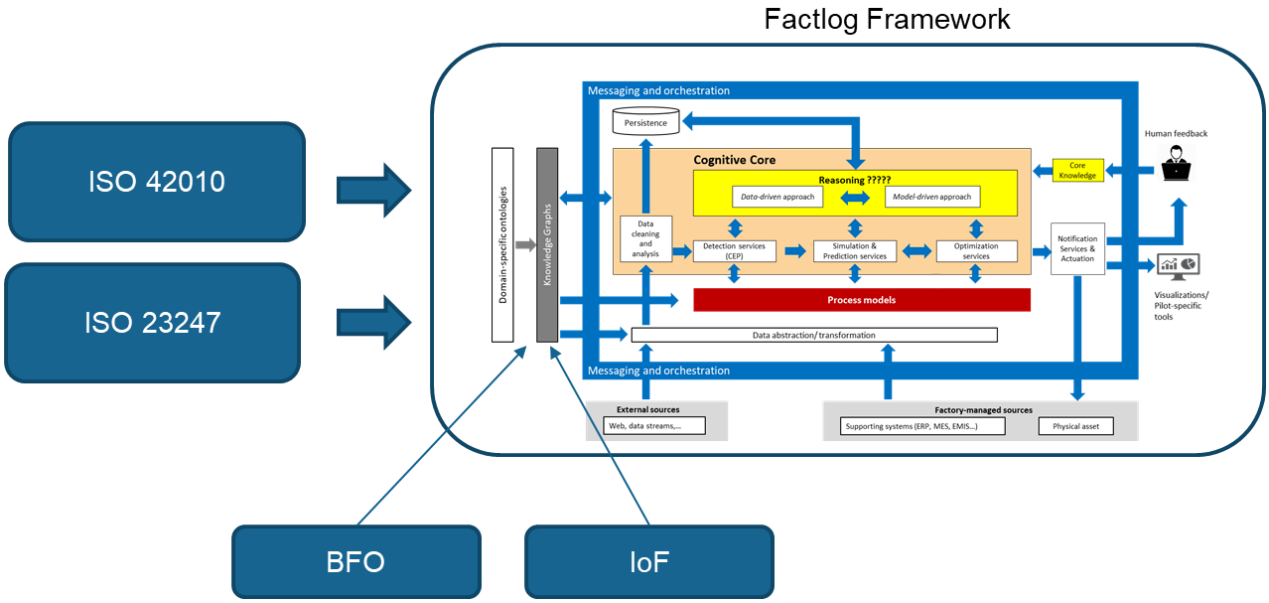

Figure 1 – FACTLOG standardization Strategy

As shown in Figure 1, the FACTLOG standardization strategy is demonstrated. ISO 42010 and ISO 23247 are used to design the FACTLOG Framework as the basic references of the standardization. Moreover, Basic formal ontology (BFO) and Industrial Ontologies Foundry (IoF) are used to develop ontology definition in FACTLOG and implement knowledge graph modeling.

3.1 Overview

Table 1 – Standards

Standards	Description	Purpose
ISO 42010	Systems and software engineering — Architecture description is an international standard for architecture descriptions of systems and software	Support FACTLOG architecture development
ISO 23247	Automation systems and integration — Digital Twin framework for manufacturing	Support FACTLOG terminology definition including DT. FACTLOG Digital Twin architecture (as part of the overall system architecture) follows the standard.
BFO	The Basic Formal Ontology (BFO) is a small, upper level ontology that is designed for use in supporting information retrieval, analysis and	Support FACTLOG KG development

Standards	Description	Purpose
	integration in scientific and other domains	
IoF	Industrial Ontologies Foundry (IOF) ontology definition	Support Factlog KG development

3.2 Standards

3.2.1 ISO 23247

ISO 23247 is an ISO standard named Automation systems and integration — Digital Twin framework for manufacturing. It defines a framework to support the creation of Digital Twins of observable manufacturing elements including personnel, equipment, materials, manufacturing processes, facilities, environment, products, and supporting documents.

In FACTLOG, this standard is used to support digital twin definition. Also this standard is used to define the main components and functions of the Digital Twin implementation defined in Deliverable D1.3 (system specifications and architecture).

3.2.2 ISO 42010

ISO 42010 is an ISO standard named Systems and software engineering — Architecture description. ISO/IEC/IEEE 42010:2011 defines requirements on the description of system, software and enterprise architectures. It aims to standardize the practice of architecture description by defining standard terms, presenting a conceptual foundation for expressing, communicating and reviewing architectures and specifying requirements that apply to architecture descriptions, architecture frameworks and architecture description languages.

In Factlog, this standard is used to support architecture description of FACTLOG.

3.2.3 BFO ontology specification

Basic Formal Ontology (BFO) is an upper-level (formal, domainneutral) ontology to support the creation of lower-level domain ontologies. Basic Formal Ontology is currently being used by over 100 ontology-based research projects in biomedical informatics and increasingly in other fields. The course will provide an introduction to the content and use of BFO in ontology development. Attendees will acquire knowledge of the ontology and of its use as top-level ontology in multiple ontology development projects in a variety of fields. They will learn about the most recent developments in the ontology and acquire basic knowledge of the draft version 2.0.

In FACTLOG, this standardized ontology is used as the basic reference to define FACTLOG ontology.

3.2.4 IoF ontology specification

Standardization activities will be driven through involvement with Industry Ontology Foundry (IOF) group and regular participation with their workshops. IOF is an international foundry aiming at:

- providing principles and best practices by which quality ontologies can be developed that will support interoperability for industrial domains

- creating a suite of open and principles-based ontologies from which other sub-domain or application ontologies can be derived in a modular fashion, remaining 'generic' (i.e., non-proprietary, non-implementation specific)
- instituting a governance mechanism to maintain and promulgate the goals and principles
- providing an organizational framework and governance processes that ensure conformance to principles and best practices for development, sharing, maintenance, evolution, and documentation of IOF ontologies.

The intent of these reference ontologies is to allow extensions to be progressive to more specific or constrained sub-domains. For this reason, it has set up several domain sub-groups and one of them is the maintenance IOF working group.

In FACTLOG, this standardized ontology is used as the basic reference to define FACTLOG ontology.

3.3 Ontology framework based on BFO

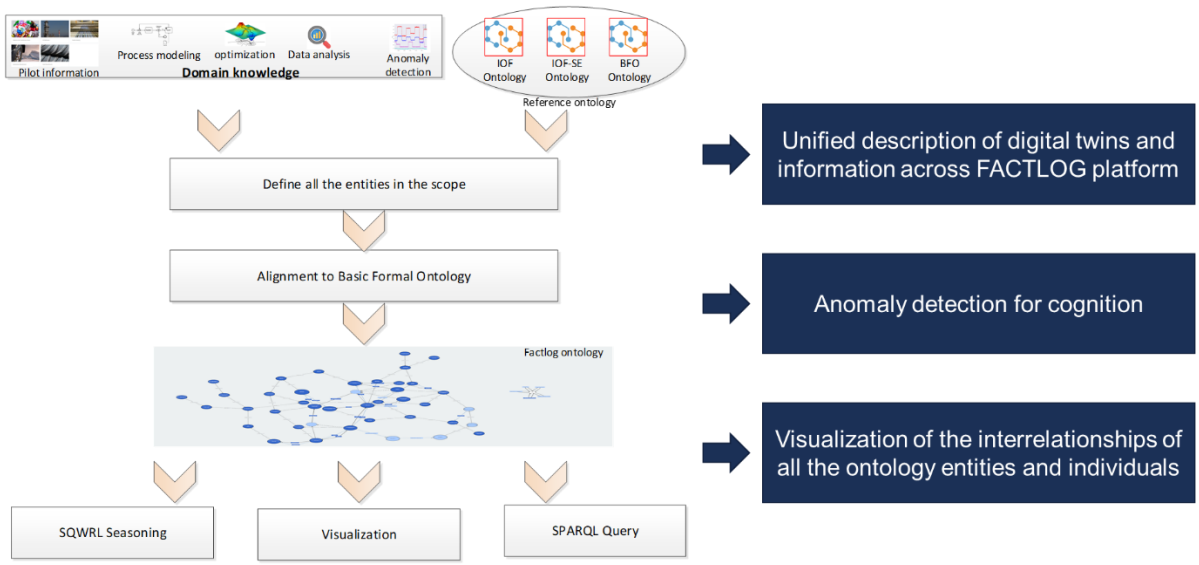

Figure 2 – Ontology development workflow

In order to design the unified ontology for developing knowledge graph models supporting cognitive capabilities, the one of the well- known systems thinking development methodology through domain knowledge has been applied to define the domain knowledge including: (i) pilot information; (ii) process modelling; (iii) optimization; (iv) data analysis; (v) anomaly detection. IoF ontology, BFO ontology and IoF SE ontology are three main reference ontology. By composing a top-level overview, abstract concepts form domain specific knowledge from FACTLOG pilots and technical views. After the extraction of entities from FACTLOG pilots, the list of classes was updated in a comparison with existing ontology such as IOF-SE ontology, and IOF ontology. And then, all the entities were rearranged in the BFO structure. Finally, the SQWRL and SPARQL are used to support reasoning and query of the OWL models.

All the ontology concepts are manly used for three aspects:

1. Unified description of digital twin and information across the Factlog platform.
2. Ontology reasoning for anomaly detection.
3. Visualization of the interrelationships of all the ontology entities and individuals.

4 Future Plans

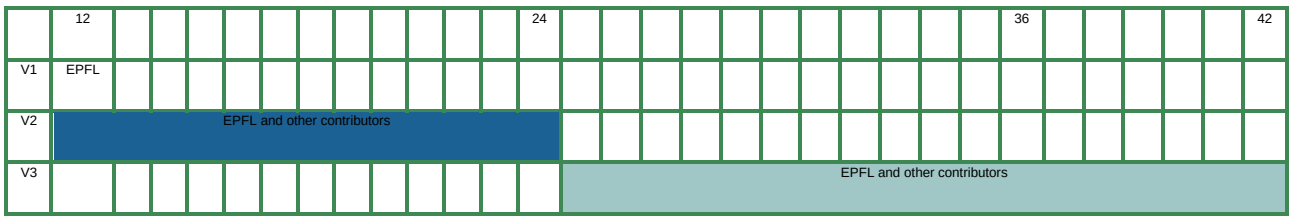

Figure 3 – Future plan

The deliverables include three versions:

- D8.11: Standardisation Activities Report V3 [42] （EPFL with other contributors）

This deliverable will report on the standardisation activities during the last period of the project.

5 Conclusion

This report demonstrates the standardization strategy of the Factlog project. Moreover, several standards are introduced in the standardization strategy including ISO 42010 and ISO 23247 for constructing Factlog framework and IoF and BFO for ontology definition and knowledge graph modelling. Then a new ontology framework is proposed to develop knowledge graph models. Finally the plan for finishing this deliverables is illustrated.

References

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