TECHNICAL SPECIFICATION

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Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities —

Part 8: Implementation methods for the integration of distributed systems: Web Ontology Language (OWL) implementation

Systèmes d'automatisation industrielle et intégration — Intégration de données de cycle de vie pour les industries de «process», y compris les usines de production de pétrole et de gaz —

Partie 8: Méthodes de mise en œuvre pour l'intégration de systèmes distribués: Mise en oeuvre du langage d'ontologie du Web (OWL)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50% of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 15926-8 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

ISO 15926 is organized as a series of parts, each published separately. The structure of ISO 15926 is described in ISO 15926-1.

Each part of ISO 15926 is a member of the following series: data model, reference data, implementation methods, conformance testing methodology and framework, characterization methods, abstract test suites. This part of ISO 15926 is a member of the implementation methods series.

A complete list of parts of ISO 15926 is available from the following URL:

`http://www.tc184-sc4.org/titles/OIL_GAS_Titles.htm`

Introduction

ISO 15926 is an International Standard for the representation of process plant life-cycle information. This representation is specified by a generic, conceptual data model that is suitable as the basis for implementation in a shared database or data warehouse. The data model is designed to be used in conjunction with reference data: standard instances that represent information common to a number of users, process plants, or both. The support for a specific life-cycle activity depends on the use of appropriate reference data in conjunction with the data model.

ISO 15926 is organized as a number of parts, each published separately. This part of ISO 15926 specifies the Web Ontology Language (OWL) implementation, using World Wide Web Consortium (W3C) Semantic Web technologies.

This part of ISO 15926 deals with the translation of ISO/TS 15926-4 classes, reference data and the ISO/TS 15926-7 template methodology to Resource Description Framework (RDF) and Web Ontology Language (OWL), which can be used in data modelling, integration and interoperability methods. This part of ISO 15926 is independent of infrastructure and test methods.

This part of ISO 15926 serves as the basis for data integration and interoperability infrastructure and test methods.

This part of ISO 15926 addresses:

— the method of translating ISO/TS 15926-4 classes to RDF/OWL;

— the method of translating ISO/TS 15926-7 templates to RDF/OWL;

— the constructs of specialized templates;

— the use of object information models;

— the constructs of metadata.

Readers of this part of ISO 15926 require an understanding of conceptual data models and of ISO/TS 15926-7.

The target audiences for this part of ISO 15926 are as follows:

— technical managers wishing to determine whether ISO 15926 is appropriate for their business needs;

— implementers wishing to make interface software between legacy systems and ISO 15926 compliant systems;

— implementers wishing to make software internally ISO 15926-compliant for the purpose of data integration.

In this part of ISO 15926, the same English language word might be used to refer to a real world thing, to an EXPRESS representation of the real world thing, or to an RDF/XML representation of the real-world thing. These uses are distinguished by the following typographic conventions:

— if a word or phrase occurs in normal typeface, it refers to the real-world thing;

EXAMPLE 1 cooling water pump

— if the word or phrase occurs in **bold** typeface with underscores, it refers to the EXPRESS representation from the ISO 15926-2 data model;

EXAMPLE 2 **class_of_inanimate_physical_object**

— if the word or phrase occurs in **bold** typeface and in CamelCase, it refers to a subtype axiom as defined in ISO/TS 15926-7;

EXAMPLE 3 **ClassOfInanimatePhysicalObject**

— if the word occurs in *italic* typeface, it refers to an RDF/RDFS/OWL native entity type.

EXAMPLE 4 *rdfs:subClassOf*

References to identifiers in examples are fictitious.

Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities —

Part 8: Implementation methods for the integration of distributed systems: Web Ontology Language (OWL) implementation

1 Scope

This part of ISO 15926 specifies implementation methods for integration, sharing, exchange, and hand-over of life-cycle information about process plants, based on the data model of ISO 15926-2 and the template methodology of ISO/TS 15926-7.

The following are within the scope of this part of ISO 15926:

— defining rules for applying RDF and OWL in the context of this part of ISO 15926;

— mapping of the data model of ISO 15926-2 from its EXPRESS format to OWL-2;

— defining a methodology for creating an OWL ontology for the ISO/TS 15926-4 reference data;

— defining an OWL ontology based on the base templates and the initial set of core templates;

— defining a methodology for creating an OWL ontology for "specialized templates" (see 2.1.32) that defines the types of information for any given instance of **possible_individual** during its lifetime.

The following are outside the scope of this part of ISO 15926:

— the specific type of rule language used to implement the first order logic;

— the decision as to whether data storage and exchange is done using lifted data or by use of lowered template instances and objects only.

NOTE This is a business decision.

2 Terms, definitions, and abbreviated terms

2.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1.1
base template
template with only entity types in the expansion of its template axiom

[ISO/TS 15926-7:2011, definition 2.1.1]

2.1.2
class
category or division of things based on one or more critera for inclusion and exclusion

NOTE 1 A class need not have any known members (things that satisfy its criteria for membership).

NOTE 2 Because of the spatio-temporal paradigm used to define individuals in ISO 15926, all classes are non-well-founded sets.

NOTE 3 Adapted from ISO 15926-1:2004, definition 3.1.1.

2.1.3
core class
class that is a commonly used subdivision corresponding to terms used in common language

NOTE The conditions for membership are often not formally defined; understanding of the class may be conveyed by example.

EXAMPLE Pipe, floor, pump, and light bulb are all core classes.

[ISO 15926-1:2004, definition 3.1.4]

2.1.4
core template
RDL template for which all reference data items in the expansion of its template axiom are core classes

[ISO 15926-7:2011, definition 2.1.6]

2.1.5
data store
computer system that allows data to be stored for future reference

[ISO 15926-1:2004, definition 3.1.6]

2.1.6
data type
domain of values

[ISO 10303-11:2004, definition 3.3.5]

2.1.7
data warehouse
data store in which related data are merged to provide an integrated set of data containing no duplication or redundancy of information, and which supports many different application viewpoints

[ISO 15926-1:2004, definition 3.1.7]

2.1.8
entity
class of information defined by common properties

[ISO 10303-11:2004, definition 3.3.6]

2.1.9
entity data type
representation of an entity

NOTE 1 An entity data type establishes a domain of values defined by common attributes and constraints.

NOTE 2 In this part of ISO 15926 the entity data types are as defined in the data model of ISO 15926-2.

NOTE 3 Adapted from ISO 10303-11:2004, definition 3.3.7.

2.1.10
entity instance
named unit of data which represents a unit of information within the class defined by an entity

NOTE 1 It is a member of the domain established by an entity data type.

NOTE 2 Adapted from ISO 10303-11:2004, definition 3.3.8.

2.1.11
first-order logic
symbolized reasoning in which each sentence, or statement, is broken down into a subject and a predicate

NOTE 1 The predicate modifies or defines the properties of the subject. In first-order logic, a predicate can only refer to a single subject.

NOTE 2 First-order logic is also known as first-order predicate calculus or first-order functional calculus.

[ISO 15926-7:2011, definition 2.1.13]

2.1.12
individual
possible_individual
thing that exists in space and time

NOTE 1 In this context, existence could be within the world we live in, or some "possible" world that can be imagined. This therefore includes actual, hypothetical, planned, expected, or required individuals.

EXAMPLE A pump with serial number ABC123, Battersea Power Station, Sir Joseph Whitworth, and the Starship Enterprise are examples of individuals.

NOTE 2 Adapted from ISO 15926-2:2003, definition 3.1.6.

2.1.13
individual template
template for making statements about individuals

[ISO/TS 15926-7:2011, definition 2.1.14]

2.1.14
instance
named value

[ISO 10303-11:2004, definition 3.3.10]

2.1.15
interoperability
ability of different types of computers, networks, operating systems, and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner

2.1.16
life-cycle information
information about a **possible_individual** (2.1.12), collected at any point in time during the life-cycle of that individual

NOTE Adapted from ISO/TS 15926-7:2011, definition 2.1.17.

2.1.17
Manchester syntax
user-friendly compact syntax for OWL 2 ontologies which is frame-based, as opposed to the axiom-based other syntaxes for OWL 2

NOTE See Reference [21].

2.1.18
metadata
data that describes and defines other data

[ISO/IEC 11179-1:2004, definition 3.2.16]

2.1.19
N-triple
line-based, plain text format for encoding an RDF graph

2.1.20
object information model
OIM
ontology of classes and relations for which a particular class is singled out for characterization

NOTE In Description Logic terminology, it is a TBox (see Annex G).

2.1.21
ontology
<computer and information science> formal representation of a set of concepts within a domain and the relationships between those concepts

NOTE 1 Ontologies are usually used to reason about the properties of that domain, and can be used to define the domain.

NOTE 2 Ontologies are usually expressed in a logic-based language, but this is not a requirement, neither is the need for reasoning capability. In addition to relationships, classes, properties, instances and axioms can be used.

2.1.22
OWL native
modelling style in which a relationship is expressed as an RDF predicate

2.1.23
punning
declaring a class and an individual, having the exact same identifier, in order to use them in different model constructions, which would be illegal to use if applied to one object

NOTE Punning can also be applied to two property declarations of different property types.

2.1.24
RDF graph
graph structure formed by a set of RDF triples

2.1.25
RDF schema
language for describing vocabularies in RDF which is a semantic extension of RDF, providing mechanisms for describing groups of related resources and the relationships between these resources

2.1.26
RDF/XML
format with an XML syntax for RDF, as defined in the W3C recommendation "RDF/XML Syntax Specification (Revised)"

2.1.27
reference data
process plant life-cycle data that represents information about classes or individuals which are common to many process plants or of interest to many users

[ISO 15926-1:2004, definition 3.1.18]

2.1.28
reference data library
RDL
managed collection of reference data

[ISO 15926-1:2004, definition 3.1.19]

NOTE In this part of ISO 15926, "RDL" and "ontology" are used interchangeably.

2.1.29
reification
modelling style in which a relationship is expressed as an object class

EXAMPLE The relation Employed-by is reified by the object Employment which is connected to the objects Employee and Organization. The meaning of the relation with cardinalities at both ends is "an organization has zero or more employees". The reified Employment object can be subject in other relations, defining it.

NOTE The relational entity data types of ISO 15926 are all the entity data types which have exactly two attributes, except `class_of_relationship`.

[ISO/TS 15926-7:2011, definition 2.1.21]

2.1.30
signature
named, ordered and typed list of template roles

2.1.31
SPARQL endpoint
conformant to SPARQL protocol service as defined in W3C's SPARQL Protocol for RDF (SPROT)

NOTE In Reference [23], "endpoint" is defined as "An association between a fully specified InterfaceBinding and a network address, specified by a URI [IETF RFC 2396], that may be used to communicate with an instance of a Web Service. An endpoint indicates a specific location for accessing a Web Service using a specific protocol and data format."

2.1.32
specialized template
set of statements about individuals or classes, that is subclass of a core template or another specialized template, and which has one or more restrictions on its roles

2.1.33
taxonomy
collection of controlled vocabulary terms organized in a hierarchical structure, where each term is in one or more parent/child (broader/narrower) relationship to other terms in the taxonomy

2.1.34
template
set comprising of a first-order logic predicate for which a definition is stated as an axiom, a template signature and a template axiom expansion

[ISO/TS 15926-7:2011, definition 2.1.22]

2.1.35
template
n-ary predicate, represented in OWL reified form as a class with one functional property (*role*) per variable

2.1.36
template axiom
axiom in the template language defining the interpretation of template statements

[ISO/TS 15926-7:2011, definition 2.1.25]

2.1.37
template instance
ordered list of entity instances of which a template is true

NOTE 1 In OWL, the template instance is an individual with *role* relationships to the individuals that instantiate the template. The atomic/ground statement is made by replacing the variables of the template with OWL individuals.

NOTE 2 Adapted from ISO/TS 15926-7:2011, definition 2.1.26.

2.1.38
template language
axioms in first-order logic extending the ISO 15926-2 data model

[ISO/TS 15926-7:2011, definition 2.1.27]

2.1.39
template role
named and numbered argument in a template with required type given as entity data type, data type, or reference data class

NOTE Adapted from ISO/TS 15926-7:2011, definition 2.1.28.

2.1.40
template statement
statement made by instantiating the roles of a template with entity instances

[ISO/TS 15926-7:2011, definition 2.1.30]

2.1.41
core RDL
set of RDLs that only hold core classes and reference individuals

NOTE Part of the content is normalized.

2.1.42
triple
RDF triple
representation of a relation between the objects or data that it links

NOTE A triple comprises at least:

— an object called "subject";

— a predicate (also called property) that denotes a relationship between a subject and an object;

— an object or data called "object".

2.1.43
triple store
data store capable of storing **triples** (2.1.42)

2.1.44
value
unit of data

[ISO 10303-11:2004, definition 3.3.22]

2.2 Abbreviated terms

DL	description logic
FOL	first order logic
OIM	object information model
OWL	Web Ontology Language
RDF	Resource Definition Framework
RDFS	RDF Schema