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Industrial automation systems and integration — Process specification language —

Part 1: Overview and basic principles

Systèmes d'automatisation industrielle et intégration — Langage de spécification de procédé —

Partie 1: Vue d'ensemble et principes de base

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Foreword

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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.

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ISO 18629-1 was prepared by ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

A complete list of parts of ISO 18629 is available from the Internet.

http://www.tc184-sc4.org/titles

Introduction

As the use of information technology in manufacturing has matured, the necessity for software applications to inter-operate has become crucial to the conduct of business and operations in organisations. To be competitive and maintain good economic performance, manufacturing organisations need to employ increasingly effective and efficient systems. Such systems should result in the seamless integration of manufacturing applications and exchange of manufacturing processes between applications. Organisations should also be able to preserve and retrieve on demand the knowledge contained in their business and operational processes, regardless of the applications used to produce and handle these processes.

Many manufacturing engineering and business software applications use process information, including manufacturing simulation, production scheduling, manufacturing process planning, workflow, business process reengineering, product realisation process modelling, and project management. However, each of these applications utilises process information in a different way, and each representation of process information inherent to these applications is also different. Thus interoperability is difficult to achieve. Consequently, these concerns have led to the development of a process specification language (PSL) that complements the process representations utilised in manufacturing engineering and business software applications. ISO 18629 provides a generic language for process specifications applicable to a broad range of specific process representations in manufacturing applications.

ISO 18629 provides semantics to the computer-interpretable exchange of information related to manufacturing processes. Taken together, all the parts contained in ISO 18629 a language for describing a manufacturing process throughout the entire production process within the same industrial company or across several industrial sectors or companies, independently from any particular representation model. The nature of this language makes it suitable for sharing process information related to manufacturing during all the stages of a production process.

The process representations used by engineering and business software applications are influenced by the specific needs and objectives of the applications. Therefore, the use of the process specification language also varies from one application to another. A major purpose of the Process Specification Language is to enable the interoperability of manufacturing processes between software applications that utilise different process models and process representations. As a result of implementing process interoperability, economies of scale are made in the integration of manufacturing applications.

This part and all other parts of ISO 18629 are independent of any specific process representation or model used in a given application. Collectively, they provide a structural framework for interoperability.

ISO 18629 describes what elements inter-operable systems should encompass, but not how a specific application implements these elements. It is not the purpose of ISO 18629 to enforce uniformity in manufacturing process representations. Objectives and design of software applications vary. Therefore the implementation of an interoperable application must necessarily be influenced by the particular objectives and processes of each specific application. This part of ISO 18629 provides an overview of the principal concepts contained in ISO 18629, and guidance on selection and use of its parts.

Industrial automation systems and integration — Process specification language — Part 1: Overview and basic principles

1. Scope

The scope of this part of ISO 18629 is the provision of an overview of the whole ISO 18629 and of the main underlying principles of the Process Specification Language. This part of ISO 18629 also specifies the characteristics of the various series of parts in ISO 18629 and the relationships among them.

The following are within the scope of this part of ISO 18629:

— general overview of ISO 18629 and of the main principles used;

— structure of ISO 18629 and relationships between the series of parts of which this standard is composed;

— definitions of terms used throughout ISO 18629;

— conformance criteria for process-related applications;

— conformance criteria for other ontologies;

— conformance criteria for parts of ISO 18629.

The scope of this part of ISO 18629 includes providing explanations addressing the following items:

— Annex B: Background to the development of ISO 18629;

— Annex C: Need for semantics;

— Annex D: Interoperability;

— Annex E: Architecture of PSL.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

— ISO/IEC 8824-1: *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation.*

— ISO 10303-1: *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles.*

— ISO 10303-11: *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual.*

— ISO 15531-1: *Industrial automation systems and integration — Industrial manufacturing management data — Part 1: General overview.*

— ISO 15531-31: *Industrial automation systems and integration — Industrial manufacturing management data — Part 31: Resource information model.*

— ISO 15531-32: —[1] *Industrial automation systems and integration — Industrial manufacturing management data — Part 32: Conceptual information model for resources usage management data.*

— ISO 15531-42:—[2] *Industrial automation systems and integration — Industrial manufacturing management data — Part 42: Manufacturing flow management data — Time model.*

3. Terms, definitions and abbreviations

3.1. Terms and definitions

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

3.1.1
axiom
well-formed formula in a formal language that provides constraints on the interpretation of symbols in the lexicon of a language

3.1.2
conservative definition
definition that specifies necessary and sufficient conditions that a term shall satisfy and that does not allow new inferences to be drawn from the theory

3.1.3
core theory
set of axioms for relation and function symbols that denote primitive concepts

[1] To be published
[2] To be published

3.1.4
data
a representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers

[ISO 10303-1]

3.1.5
defined lexicon
set of symbols in the non-logical lexicon which denote defined concepts

NOTE Defined lexicon is divided into constant, function and relation symbols.

EXAMPLE terms with conservative definitions.

3.1.6
definitional extension
extension of PSL-Core that introduces new linguistic items which can be completely defined in terms of the PSL-Core

NOTE: Definitional extensions add no new expressive power to PSL-Core but are used to specify the semantics and terminology in the domain application.

3.1.7
discrete manufacturing
production of discrete items

EXAMPLE Cars, appliances or computer.

[ISO 15531-1]

3.1.8
duration
length of a period of time, measured using a given unit of time

EXAMPLE 1 the 24 hours between Monday 1.00 p.m. and Tuesday 12.00 a.m.

EXAMPLE 2 every Monday of every week between January and July.

NOTE interval of time measures the distance between two points in time. In that case it is the length of the time domain that is bounded by the two points in time under consideration.

[ISO 15531-42]

3.1.9
extension
augmentation of PSL-Core containing additional axioms

NOTE 1 The PSL-Core is a relatively simple set of axioms that is adequate for expressing a wide range of basic

processes. However, more complex processes require expressive resources that exceed those of the PSL-Core. Rather than clutter the PSL-Core itself with every conceivable concept that might prove useful in describing one process or another, a variety of separate, modular extensions need to be developed and added to the PSL-Core as necessary. In this way a user can tailor the language precisely to suit his or her expressive needs.

NOTE 2 All extensions are core theories or definitional extensions.

3.1.10
grammar
specification of how logical symbols and lexical terms can be combined to make well-formed formulae

3.1.11
information
facts, concepts, or instructions

3.1.12
language
combination of a lexicon and a grammar

3.1.13
lexicon
set of symbols and terms

NOTE The lexicon consists of logical symbols (such as Boolean connectives and quantifiers) and non-logical symbols. For ISO 18629, the non logical part of the lexicon consists of expressions (constants, function symbols, and relation symbols) chosen to represent the basic concepts of the ontology.

3.1.14
manufacturing
function or act of converting or transforming material from raw material or semi-finished state to a state of further completion

[ISO 15531-1]

3.1.15
manufacturing process
structured set of activities or operations performed upon material to convert it from the raw material or a semifinished state to a state of further completion

NOTE Manufacturing processes may be arranged in process layout, product layout, cellular layout or fixed position layout. Manufacturing processes may be planned to support make-to-stock, make-to-order, assemble-to-order, etc., based on strategic use and placements of inventories.

[ISO 15531-1]

3.1.16
model
combination of a set of elements and a truth assignment that satisfies all well-formed formulae in a theory

NOTE 1 The word "model" is used, in logic, in a way that differs from the way it is used in most scientific and everyday contexts [7] : if a sentence is true in a certain interpretation, it is possible to say that the interpretation is a model of the sentence. The kind of semantics presented here is often called model-theoretical semantics.

NOTE 2 A model is typically represented as a set with some additional structure (partial ordering, lattice, or vector space). The model then defines meanings for the terminology and a notion of truth for sentences of the language in terms of this model. Given a model, the underlying set of axioms of the mathematical structures used in the set of axioms then becomes available as a basis for reasoning about the concepts intended by the terms of the language and their logical relationships, so that the set of models constitutes the formal semantics of the ontology.

3.1.17
ontology
a lexicon of specialised terminology along with some specification of the meaning of terms in the lexicon

NOTE 1: structured set of related terms given with a specification of the meaning of the terms in a formal language. The specification of meaning explains why and how the terms are related and conditions how the set is partitioned and structured.

NOTE 2: The primary component of a process specification language such as ISO 18629 is an ontology The primitive concepts is the ontology according to ISO 18629 are adequate for describing basic manufacturing, engineering, and business processes.

NOTE 3: The focus of an ontology is not only on terms, but also on their meaning. An arbitrary set of terms is included in the ontology, but these terms can only be shared if there is an agreement about their meaning. It is the intended semantics of the terms that is being shared, not simply the terms.

NOTE 4: Any term used without an explicit definition is a possible source of ambiguity and confusion. The challenge for an ontology is that a framework is needed for making explicit the meaning of the terms within it. For the ISO 18629 ontology, it is necessary to provide a rigorous mathematical characterisation of process information as well as a precise expression of the basic logical properties of that information in the ISO 18629 language.

3.1.18
Outer Core
set of core theories that are extensions of PSL-Core and that are so generic and pervasive in their applicability that they have been put apart

NOTE In practice, extensions incorporate the axioms of the Outer Core.

3.1.19
primitive concept
lexical term that has no conservative definition

3.1.20
primitive lexicon
set of symbols in the non-logical lexicon which denote primitive concepts

NOTE Primitive lexicon is divided into constant, function and relation symbols.

3.1.21
process
structured set of activities involving various enterprise entities, that is designed and organised for a given purpose

NOTE The definition provided here is very close to that given in ISO 10303-49. Nevertheless ISO 15531 needs the notion of structured set of activities, without any predefined reference to the time or steps. In addition, from the point of view of flow management, some empty processes may be needed for a synchronisation purpose although they are not actually doing anything (ghost task).

[ISO 15531-1]

3.1.22
process planning
analysis and design of the sequences of processes, resources requirements, needed to produce goods and services

NOTE This definition applies to discrete part manufacturing and continuous processes.

[ISO 15531-1]

3.1.23
product
a thing or substance produced by a natural or artificial process

[ISO 10303-1]

3.1.24
product information
facts, concepts, or instructions about a product

[ISO 10303-1]

3.1.25
proof theory
set of theories and lexical elements necessary for the interpretation of the semantics of the language

NOTE It consists of three components: the PSL-Core, the Outer Core and the extensions.

3.1.26
PSL-Core
set of axioms for the concepts of activity, activity-occurrence, time-point, and object

NOTE The motivation for PSL-Core is any two process-related applications shall share these axioms in order to exchange process information, and hence is adequate for describing the fundamental concepts of manufacturing processes. Consequently, this characterisation of basic processes makes few assumptions about their nature beyond what is needed for describing those processes, and the PSL-Core is therefore rather weak in terms of logical expressiveness. In particular, PSL-Core is not strong enough to provide definitions of the many auxiliary notions that become necessary to describe all intuitions about manufacturing processes.

3.1.27
resource
any device, tool and means, excepted raw material and final product components, at the disposal of the enterprise to produce goods or services

NOTE 1 Resources as they are defined here include human resources considered as specific means with a given capability and a given capacity. Those means are considered as being able to be involved in the manufacturing process through assigned tasks. That does not include any modelling of an individual or common behaviour of human resource excepted in their capability to perform a given task in the manufacturing process (e.g.: transformation of raw material or component, provision of logistic services). That means that human resources are only considered, as the other, from the point of view of their functions, their capabilities and their status (e.g.: idle, busy). That excludes any modelling or representation of any aspect of individual or common «social» behaviour.

NOTE 2 This definition includes ISO 10303-49 definition but is included in the definition that applies for ISO 18629-14 and ISO 18629-44 that includes raw materials and consumables.

[ISO 15531-1]

3.1.28
satisfiable
a set of sentences is satisfiable if there exists a model for the sentences

3.1.29
scheduling
act, function or result of planning occurrences of manufacturing activities

[ISO 15531-1]

3.1.30
structure
combination of a set of elements, a set of functions, and sets of tuples for each relation

3.1.31
theory
set of axioms and definitions that pertain to a given concept or set of concepts

NOTE this definition reflects the approach of artificial intelligence in which a theory is the set of assumptions on which the meaning of the related concept is based.

3.1.32
translation definition
a KIF sentence of the form (iff P Q) in which P is a term in the application's non-logical lexicon and Q uses only terminology from extensions in the ISO 18629 standard

NOTE iff is a KIF reserved word.