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Industrial automation systems and integration — Process specification language —

Part 14:
Resource theories

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

Partie 14: Théories de ressource

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Foreword

The International Organisation for Standardisation (ISO) 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 organisations, 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.

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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.

Attention is drawn to the possibility that some of the elements of this part of ISO 18629 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18629-14 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration,* Subcommittee SC4, *Industrial data.*

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Introduction

ISO 18629 is an International Standard for the computer-interpretable exchange of information related to manufacturing processes. Taken together, all the parts contained in the ISO 18629 Standard provide a generic 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.

This part of ISO 18629 provides a description of the core elements of the language defined within ISO 18629.

All parts of ISO 18629 are independent of any specific process representation or model proposed in a software application in the domain of manufacturing management. Collectively, they provide a structural framework for improving the interoperability of these applications.

Industrial automation systems and integration — Process specification language —

Part 14:
Resource theories

1   Scope

This part of ISO 18629 provides a representation of the concepts that belong to the outer core of the language, through a set of axioms and definitions. These axioms provide an axiomatization of the semantics for terminology in this part of ISO 18629.

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

— resource;

— relationships between resources and activities;

— resource sets;

— additive quantities.

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) — Part 1: Specification of basic notation.*

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

ISO 18629-1 : *Industrial automation systems and integration ─ Process specification language ─ Part 1: Overview and basic principles.*

ISO 18629-11: 2005, *Industrial automation systems and integration ─ Process specification language ─ Part 11:PSL-core.*

ISO 18629-12 : *Industrial automation systems and integration ─ Process specification language ─ Part 12:PSL Outer core.*

3   Terms, definitions, and abbreviations

3.1   Terms and definitions

For the purpose 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

[ISO 18629-1]

3.1.2
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.

[ISO 18629-1]

3.1.3
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.

[ISO 18629-1]

3.1.4
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.

[ISO 18629-1]

3.1.5
grammar
specification of how logical symbols and lexical terms can be combined to make well-formed formulae

[ISO 18629-1]

3.1.6
language
combination of a lexicon and a grammar

[ISO 18629-1]

3.1.7
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.

[ISO 18629-1]

3.1.8
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]

3.1.9
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]

3.1.10
primitive concept
lexical term that has no conservative definition

[ISO 18629-1]

3.1.11
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.

[ISO 18629-1]

3.1.12
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]

3.1.13
resource
any device, tool and means at the disposal of the enterprise to produce goods or services

NOTE 1 Adapted from ISO 15531-1, so that resources as defined in ISO 15531-1 except raw material, products and components that are considered from a system theory point of view as parts of the environment of the system and do not belong to the system itself. Furthermore This definition includes ISO 10303-49 definition but is included in the definition that applies for ISO 18629-14 and ISO 18629-44 that also include raw materials and consumables as well as ISO 18629-13.

NOTE 2   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.

[ISO 15531-1]

3.1.14
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.

[ISO 18629-1]

3.2   Abbreviations

For the purpose of this part of ISO 18629, the following abbreviations apply:

FOL   First-Order Logic

BNF   Backus-Naur form

KIF   Knowledge Interchange Format

PSL   Process Specification Language

4   General information on ISO 18629

ISO 18629 specifies a language for the representation of process information, which is a process specification language. It is composed of a lexicon, an ontology, and a grammar for process descriptions.

NOTE 1   PSL is a language for specifying manufacturing processes based on a mathematically well defined vocabulary and grammar. As such, it is different from other languages such as EXPRESS (defined in ISO 10303-11) and used for example in ISO 10303-41, ISO 10303-42, ISO 10303-49, ISO 13584, ISO 15531 and ISO 15926, that are modelling languages. In the context of an exchange of information between two processes, PSL specifies each process independently of its behaviour. For example, an object viewed as a resource within one process can be recognised as the same object even though it is viewed as a product within a second process.

NOTE 2 PSL is based on Mathematical Set Core theory and Situation Calculus (see annex B). As such it follows a significantly different method of description from the method used by existing languages defined in ISO 10303. The meaning of the concepts within PSL follows from a set of axioms and supporting definitions rather than from a formal set of defined terms. A set of supporting notes and examples are provided to aid the understanding of the primitive lexicon of the language.

The parts 11 to 19 of ISO 18629[1] specify core theories needed to give precise definitions and the axioms of the primitive concepts of ISO 18629, thus enabling precise semantic translations between different schemes.

The following are within the scope of parts 11 to 19 of ISO 18629:

— the representation of the basic elements of the language;

— standardized sets of axioms that correspond to intuitive semantic primitive concepts adequate to describe basic processes;

— the set of rules to develop other core theories or extensions in compliance with PSL-Core.

The following is outside the scope of parts 11 to 19 of ISO 18629:

— the representation of information involving concepts that are not part of core theories.

5   Organization of this part of ISO 18629

The core theories in this part of ISO 18629 are:

— Resource requirements theory (requires.th);

— Resource set theory (res_set.th);

— Additive quantity theory (additive.th).

All theories in this part of ISO 18629 are extensions of ISO 18629-12 and ISO 18629-11. The Resource set theory is an extension of the Resource requirements theory.

6   Resource requirements theory

This core theory provides axioms for characterizing resource requirements. The notion of resource is a relation between an object and an activity – an object is a resource if it is required by some activity.

NOTE The notion of resource here, that in fact is related to resource requirement, is basically different from the notion of resources from ISO 15531 that in conformity with the system theory excludes raw material , component and final product, that are transformed by the system. Then raw material, components, final products are not part of the system itself. They are part of its environment. Furthermore, in ISO 15531, a resource is defined independently of any activity (that is especially true for human resources) and is related to a given activity only in the framework of the system described, when the resource becomes the physical system in charge of the activity it has to perform. Before its participation in the system a resource is just idle and available for any kind of activity its able to perform. A Human resource may participate in a milling system on Monday and participate in a carrying system on Tuesday, or wait for any activity on Wednesday. See annex D of ISO 15531-31.

6.1   Primitive relations of the Resource requirements theory

The nonlogical lexicon of the Resource requirements theory contains one primitive relation symbol:

— requires.

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[1] Certain parts are under development.

6.2 Primitive functions of the Resource requirements theory

The nonlogical lexicon of the Resource requirements theory contains three primitive function symbols:

— resource_point;

— demand;

— agg_demand.

6.3 Defined relations of the Resource requirements theory

The nonlogical lexicon of the Resource requirements theory contains one defined relation symbol:

— resource.

6.4 Core theories required by Resource requirements theory

This theory requires the following core theories:

— additive.th;

— act_occ.th;

— complex.th;

— subactivity.th;

— occtree.th;

— disc_state.th;

— psl_core.th.

6.5 Definitional extensions required by Resource requirements theory

No definitional extensions are requires by the Resource requirements theory.

6.6 Informal Semantics of the Resource Requirements theory

6.6.1 requires

KIF notation for res_requires:

(res_requires ?a ?r)

Informal semantics for res_requires:

(res_requires ?a ?r) is TRUE in an interpretation of Resource Requirements theory if and only if ?r is an object that participates in an occurrence of the activity ?a such that ?r constrains the activities that contain ?a as a subactivity.