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Industrial automation systems and integration — Process specification language —

Part 44: Definitional extension: Resource extensions

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

Partie 44: Extension de définition: Extensions de ressource

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Foreword

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ISO 18629-44 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

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

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

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 specifications and properties related to manufacturing during all the stages of a production process.

This part of ISO 18629 provides a description of the definitional extensions of the language related to activity extensions defined within ISO 18629.

All parts of ISO 18629 are independent of any specific process representation model used in a given application. Collectively, they provide a structural framework for improving the interoperability of these applications.

Industrial automation systems and integration — Process specification language —

Part 44:
Definitional extension: Resource extensions

1 Scope

This part of ISO 18629 provides a specification of non-primitive concepts of the language, using a set of definitions written in the language of ISO 18629. These definitions 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:

— definitions of concepts specified in ISO 18629-11, ISO 18629-12 and ISO 18629-14 that are related to resources and resource sets and relations between resources and activities;

— definitions of concepts specified in ISO 18629-11, ISO 18629-12 and ISO 18629-14 that characterize relations between resources and activities.

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: 2004, *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: Outer core*

ISO 18629-14, *Industrial automation systems and integration – Process specification language – Part 14: Resource theories*

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. The concept of resource as defined in ISO 15531-1 includes an assumption seeing that resources 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 then do not belong to the system itself. That is not the case here. Furthermore ISO 15531-1 definition encompasses ISO 10303-49 definition but is included in the definition that applies for this part of ISO 18629 (In addition to ISO 15531 resources of this part of ISO 18629 resources include raw materials and consumables as well as in ISO 18629-14).

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

— **KIF** Knowledge Interchange Format.

4 General information on ISO 18629

Part 41 to 49 of ISO 18629[1] specify definitional extensions needed to give precise definitions and the axiomatization of non-primitive concepts of ISO 18629. Definitional extensions are extensions of ISO 18629-11 and ISO 18629-12 that introduce new items for the lexicon. The items found in definitional extensions can be completely defined using theories of ISO 18629-11 and ISO18629-12. The definitional extensions provide precise semantic definitions for elements used in the specification of individual applications or types of applications for the purpose of interoperability. Definitional extensions exist in the following categories:

— Activity Extensions;

— Temporal and State Extensions;

— Activity Ordering and Duration Extensions;

— Resource Roles;

— Resource Sets;

[1] Certain parts are under development

— Processor Activity Extensions.

Individual users or groups of users of ISO 18629 may need to extend ISO 18629 for specifying concepts that are currently absent in parts 41 to 49 of ISO 18629. They shall use the elements presented in ISO 18629 for doing so. User-defined extensions and their definitions constitute definitional extensions but shall not become part of parts 41 to 49 of ISO 18629.

Note: User-defined extensions must conform to ISO 18629 as defined in ISO 18629-1:2004, 5.1 and 5.2.

Parts 41 to 49 of ISO 18629 provide:

— the semantic definitions, using concepts in ISO 18629-11and ISO 18629-12, of elements that are specific to the six concepts outlined above;

— a set of axioms for constraining the use of elements in definitional extensions.

They do not address:

— definitions and axioms for concepts that are part of ISO 18629-11 and ISO 18629-12;

— elements that are not defined using the elements in ISO 18629-11 and ISO 18629-12;

— user-defined extensions.

5 Organization of this part of ISO 18629

The definitional extensions that constitute this part of ISO 18629 are:

— Resource Roles;

— Capacity-based Concurrency;

— Resource Sharability;

— Resource Set-based Activities;

— Substitutable Resources;

— Homogeneous Sets;

— Inventory Resource Sets;

— Resource Pools;

— Processor Activities;

— Resource Paths.

All theories in this part of ISO 18629 are extensions of ISO 18629-14, itself an extension of ISO 18629-12 and ISO 18629-11.

6 Resource roles

This clause characterizes all definitions pertaining to Resource Roles.

In the context of ISO 18629 an object is a resource only with respect to some activity that requires the resource. Therefore no axiomatization of any other properties of resources, such as the issue of discrete vs continuous resources, is provided . Resource roles are one way of formalizing the way in which an activity requires the resource. The intuition behind the axiomatization of resource roles is the classification of interactions among activities with respect to the resources that they share. In particular, the set of resource roles defined in this clause are a classification of interfering actions, i.e., the effects of one action falsify the preconditions of another action.

NOTE : In the context of the system theory that supports standards such as ISO 15531 the resources are the means at the disposal of the system to transform input into output. Therefore they can not be considered as input or output of the system. They appear as a subset of the resources as they are defined here. Accordingly, in standards such as ISO 15531 they are not associated a priori to a given activity. A resource may be idle, associated to an activity A in the process 1 or to activity B in process 2. That is obvious for human resources, but it is also true for a lathe (for example) that may be associated to the activity “manufacture a cylinder” in process 1 or to the activity “drill a hole” in process 2. Anyway all definitions of this part of ISO 18629 apply to this type of resources also.

6.1 Primitive lexicon of the Resource roles

No primitive relations are introduced by the lexicon of Resource roles.

6.2 Defined lexicon for concepts of Resource roles

The following relations are defined in this clause:

— (reusable ?r ?a);

— (possibly_reusable ?r ?a);

— (renewable ?r ?a);

— (weakly_reusable ?r ?a);

— (consumable ?a);

— (possibly_consumable ?r ?a);

— (weakly_consumable ?r ?a);

— (wearable ?r ?a).

Each concept is described by informal semantics and a KIF axiom.

6.3 Core theories required by Resource roles

This extension requires

— additive.th;

— requires.th;

— act_occ.th;

— complex.th;

— subactivity.th;

— occtree.th;

— disc_state.th;

— psl_core.th.

6.4 Definitional extensions required by Resource roles

No definitional extensions are required by the Resource roles.

6.5 Definitions of concepts for Resource roles

The following concepts are defined for Resource roles.

6.5.1 reusable

A resource ?r is reusable by an activity ?a if any other activity that also requires ?r is still possible to perform after ?a completes its occurrence, in every possible future.

EXAMPLE: A reusable resource is a machine that does not require setup between activities. As soon as one activity occurs, it is always possible to perform the next activity.

```
(forall (r ?a1 ?a2 ?a ?occ1 ?occ2) (iff (reusable ?r ?a1)
    (implies  (and  (common ?a1 ?a2 ?r)
                    (subactivity ?a1 ?a)
                    (subactivity ?a2 ?a)
                    (occurrence_of ?occ2 ?a1))
              (forall (?b)
                    (implies  (forall (?occ3)
                                    (implies  (and  (subactivity_occurrence ?occ3 ?b)
                                                    (occurrence_of ?b ?a)
                                                    (precedes ?occ2 ?occ3))
                                              (poss ?a2 ?occ3)))))))
```

6.5.2 possibly_reusable

A resource ?r is possibly reusable by an activity ?a iff for any other activity that also requires ?r is still possible to perform after ?a completes its occurrence, in some possible future situation.

EXAMPLE: A possibly reusable is a machine that requires some setup between different activities. After the first activity occurs, it is possible for the other activity, but only if the setup activity occurs first.