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Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing

Part 2: Integration and mapping methodology

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TECHNICAL SPECIFICATION

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Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing —

Part 2: Integration and mapping methodology

Systèmes d'automatisation industrielle et intégration — Intégration des données industrielles pour l'échange, l'accès et le partage —

Partie 2: Méthodologie d'intégration et de «mapping»

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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;

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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 18876-2 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

This Technical Specification is organized as a series of parts, each published separately. The structure of this Technical Specification is described in ISO/TS 18876-1.

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0 Introduction

0.1 Overview of ISO 18876

This Technical Specification establishes an architecture, a methodology, and other specifications for integrating industrial data for exchange, access and sharing. It supports:

— data sharing and data integration;

— specification of mappings between models;

— data transformation.

ISO/TS 18876-1 provides an overview of the architecture and methodology of this Technical Specification.

0.2 Organization of this part of ISO 18876

The organization of this part of ISO 18876 is as follows:

— clause 1 specifies the scope and field of application of this part of ISO 18876;

— clause 2 identifies additional standards that, through references in this part of ISO 18876, constitute provisions of this part of ISO 18876;

— clause 3 defines terms used in this part of ISO 18876;

— clause 4 describes a number of usage scenarios for the application of the methods defined in this part of ISO 18876;

— clause 5 specifies the methods for integrating application models, and is supported by a detailed activity model presented in Annex B.

The methods specified in clause 5 are independent of modelling languages, mapping languages, and particular integration models. Annex C provides a checklist that can be used to ensure that all required stages in the integration and mapping process have been followed.

0.3 Target Audiences

The target audience for this document is modellers, analysts, systems integrators, and systems developers with a need to integrate application models across a range of systems and/or enterprise functions. The target audience for the introduction to this document is technical managers responsible for integration projects with a need to assess the applicability of this standard.

0.4 Conventions

This part of ISO 18876 includes provisions that indicate requirements strictly to be followed in order to conform to the standard. Such provisions are indicated through the use of the words “shall” and “shall not”. This part of ISO 18876 also includes provisions that indicate that among several possibilities one is recommended as particularly suitable. Such provisions are indicated through the use of the words “should” and “should not”. Additional material that illustrates the provisions of this part of ISO 18876 is presented in the form of notes, examples, and in the informative annexes B, C, and D.

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Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing —

Part 2: Integration and mapping methodology

1 Scope

This Technical Specification establishes an architecture, a methodology, and other specifications for integrating industrial data for exchange, access and sharing. Together these support the following activities:

— integrating data which may be:

  — from different sources or with different model contexts,

  — described by different models, or

  — defined in different modelling languages;

— sharing data among applications through systems integration architectures;

— resolving conflict between models developed with different objectives;

— translating data between different encodings;

— translating models between different modelling languages.

This part of ISO 18876 specifies methods for the following:

— creating and extending integration models;

— evaluating and selecting an integration model that can integrate two or more application models;

— creating an application model that is a constrained subset of an integration model to support particular application domain requirements for exchange, sharing, or both;

— creating a mapping specification between an application model and an integration model.

The following are within the scope of this part of ISO 18876:

— modelling language independent methods for creating and extending an integration model;

— methods for integrating an application model with an integration model;

— mapping language independent methods for mapping an application model to an integration model;

— criteria for the selecting modelling languages and mapping languages that can be used within the specified methods for integration and mapping.

The following are outside the scope of this part of ISO 18876:

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— the structure and content of particular integration models;

— methods for creating and extending particular integration models;

— methods for mapping application models to particular integration models.

NOTE The specific methods that apply to mappings between particular application models and integration models depend on the modelling paradigm(s) applied and on the structure and content of the models.

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 8824-1:1998, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*

ISO/TS 18876-1:2003, *Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing — Part 1: Architecture overview and description*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply; those taken or adapted from ISO 10303-1 and ISO/TS 18876-1 are repeated below for convenience.

NOTE 1 Definitions copied verbatim from other standards are followed by a reference to the standard in brackets, such as "[ISO 10303-1]". In these cases the definition in the referenced document is normative; its repetition here is informative and in the case of any discrepancy the definition in the referenced document has precedence. An explanatory note follows definitions that have been adapted from other standards. In these cases the definition given here is normative for the purposes of this part of ISO 18876.

3.1.1
application model (AM)
model that represents information used for some particular purpose

NOTE 1 Some application models are also integration models (see 3.1.15).

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NOTE 2 An application model is not necessarily a data model, but may be a model of some other sort, such as a logic based model.

[ISO/TS 18876-1]

3.1.2
class
category or division of things

NOTE There are a number of ways that class can be defined. This definition is intended to be as broad as possible, and is broader than that used in ISO 15926-2.

EXAMPLE Pump, power station, engineer, and fictional space vehicle are examples of classes.

[ISO/TS 18876-1]

3.1.3
concept
internal conception of some thing; general notion or idea of some thing

[ISO/TS 18876-1]

3.1.4
construct
representation of a concept in some formal notation system

NOTE A construct may be a part or the whole of a data model.

3.1.5
data
representation of information in a formal manner suitable for communication, interpretation, or processing by computers and possibly human beings

[ISO 10303-1]

3.1.6
data model
set of constructs that procvides the definition, structure, and format of data, whether physical or abstract in the sense of being bound to some recording medium

[ISO/TS 18876-1]

3.1.7
derived concept
concept in an integration model that is wholly defined in terms of primitive concepts

[ISO/TS 18876-1]

3.1.8
encoding transformation
transformation of the way data elements are represented for computer processing

EXAMPLE Conversion of data governed by an EXPRESS schema from an ISO 10303-21 file to an XML document is an example of an encoding transformation.

[ISO/TS 18876-1]

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3.1.9
extension
process or result of adding concepts to an integration model in order to increase the model scope, without changing the concepts already represented

[ISO/TS 18876-1]

3.1.10
foundation concept
primitive concept that determines the underlying world viewpoint of an integration model

NOTE There can be a number of integration models. Each will have its own modelling paradigm which is characterised by the primitive concepts that it contains.

EXAMPLE The concepts of class and individual are foundation concepts for a general integration model.

[ISO/TS 18876-1]

3.1.11
general concept
primitive concept that has very wide applicability, but is a specialization of some foundation concept

NOTE A concept may be considered to be a foundation concept by one community, while it is considered to be a general concept by another..

[ISO/TS 18876-1]

3.1.12
individual
thing that exists in space and time

NOTE This includes things that actually exist, or have existed, and things that possibly exist in the past, present or future.

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

[ISO/TS 18876-1]

3.1.13
information
facts, concepts, or instructions

[ISO 10303-1]

3.1.14
integration
activity that creates, modifies, or extends an integration model

[ISO/TS 18876-1]

3.1.15
integration model (IM)
application model that can represent the information that is represented by two or more application models

NOTE Being an integration model is about the role one model plays with respect to one or more application models.

[ISO/TS 18876-1]

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3.1.16
mapping
correspondence between instances of one model and instances of another model that represent the same meaning

NOTE 1 A mapping can be uni-directional or bi-directional.

NOTE 2 A mapping is the result of applying a mapping specification to particular models.

[ISO/TS 18876-1]

3.1.17
mapping specification
specification of the transformations necessary to take information governed by one model and represent it by information governed by another model with the same meaning

NOTE 1 A mapping specification can include data structure transformations, data value transformations, data encoding transformations, and terminology transformations.

NOTE 2 Mapping specifications can be procedural, or declarative, or a combination of these.

[ISO/TS 18876-1]

3.1.18
model
limited information representation of something suitable for some purpose

NOTE A model can be data, or a data model, or take some other form. See Annex D for further discussion of the relationship between models, data, and data models.

[ISO/TS 18876-1]

3.1.19
model context
sum of constraints that limit the possibility of adding to a model without changing any existing declarations

NOTE 1 The model context is therefore the class of all possible extensions to a model.

NOTE 2 This term is more general than application context as defined in ISO 10303-1.

[ISO/TS 18876-1]

3.1.20
model scope
range of information that an application model can describe

[ISO/TS 18876-1]

3.1.21
primitive concept
concept in an integration model that is not wholly defined in terms of other concepts

[ISO/TS 18876-1]

3.1.22
structural transformation
type of mapping specification that is a transformation to the structure of data

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NOTE The change in structure could be to the rearranging of attributes, the splitting of attributes across entity data types, or the creation of new attributes.

[ISO/TS 18876-1]

3.1.23
terminology transformation
transformation of the term used to refer to a thing

NOTE This could be between synonyms in one language, or between different languages.

[ISO/TS 18876-1]

3.1.24
transformation
change of form

[ISO/TS 18876-1]

3.1.25
view
model that is a constrained subset of another model

[ISO/TS 18876-1]

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

AM application model

NOTE In ISO 10303 the abbreviation AM is used for Application Module. An Application Module is not the same as an Application Model.

IM integration model

4 Usage scenarios

The methodology defined in this part of ISO 18876 is designed to meet requirements typified by the following usage scenarios:

— integrating two or more existing application models (see 4.1);

— integrating one or more existing application models with an existing integration model (see 4.2);

— defining an application model and its mapping to an integration model (see 4.3);

— integrating an application model with more than one integration model (see 4.4);

— improving an integration model (see 4.5).

4.1 Integrating application models

This component of the methodology integrates two or more application models by creating an integration model that is capable of representing all of the concepts and constraints of the application models. Such an integration model supports the communication of data between applications and users that operate using the application models.

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This requirement and its solution are illustrated in Figure 1 below.

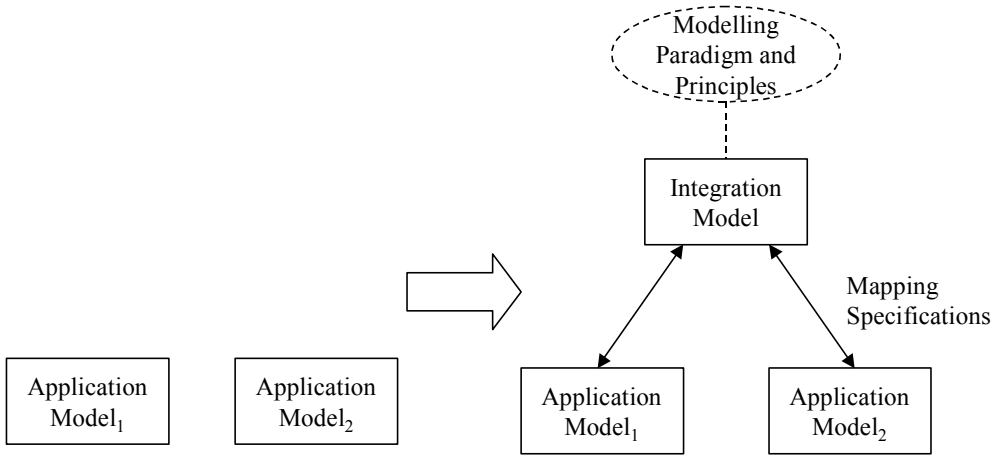

Figure 1 — Creating an integration model that integrates two application models

The inputs to the activity are as follows:

— two or more application models;

— the modelling paradigm and principles chosen for the creation of integration models.

NOTE The use of such principles is an important criterion in determining the future extensibility and reuse of an integration model.

The outputs of this activity are as follows:

— an integration model that represents the concepts and constraints of the input application models;

— mapping specifications that represent the relationships between constructs of each application model and their corresponding subsets of the integration model.

The mapping specifications include any constraints that apply for the application models. The subset of the integration model that corresponds to each application model includes concepts that are not explicit in the application model and have been discovered during the integration process.

4.2 Integrating application models with an integration model

This component of the methodology integrates one or more application models and an existing integration model. The purpose of this activity may be either or both of the following:

— integrating the application models;

— improving the quality of the application models by representing their concepts and constraints in a more consistent and extensible form and structure;

— To extend the model scope of the integration model.

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The nature and results of this activity depend on the nature of the integration model and the other application models that are to be integrated. This subclause describes the scenario in which the model context of the application models to be integrated is a subset of the model context of the integration model.

NOTE 1 See 4.5 for a description of the scenario in which the model context of the application models to be integrated is not a subset of the model context of the integration model. The relationship between scope and context of different models is explained in ISO/TS 18876-1:2003, 5.1.2.

This requirement and its solution are illustrated in Figure 2 below.

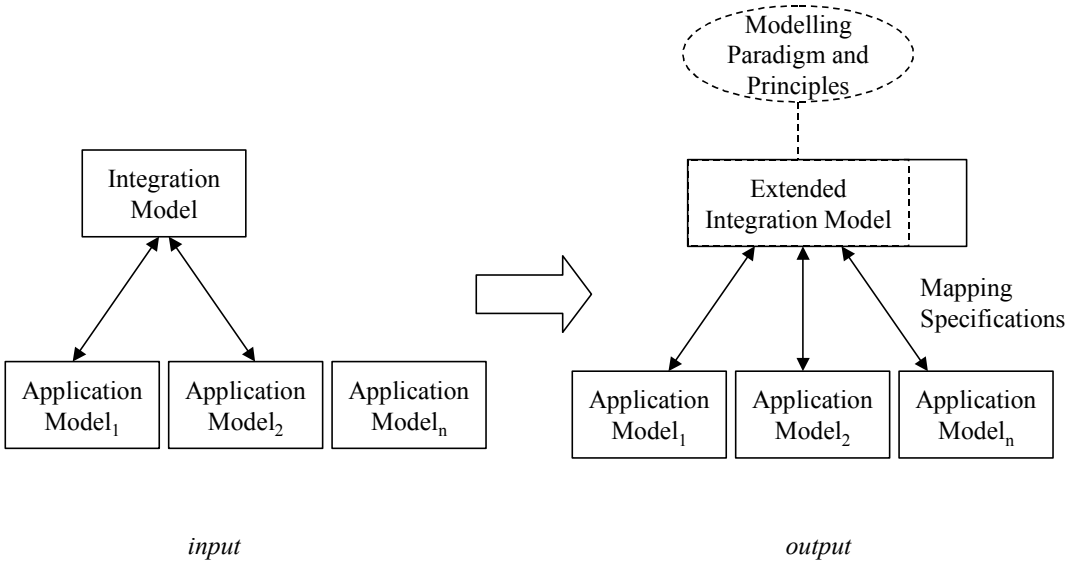

Figure 2 — Integrating an application model with an existing integration model

The inputs to the activity are as follows:

— an existing integration model;

— one or more application models that are integrated with the integration model, including the mapping specifications that relate each application model to its corresponding subset of the integration model;

— the modelling paradigm and principles used to create the integration model – these also determine how the integration model is extended to meet the requirements of the application model.

The outputs of the activity are as follows:

— an extended integration model (if the input integration model does not precisely satisfy the requirements of the application models);

NOTE 2 Extensions to an integration model do not make any change to the objects and relationships in the input integration model. The model scope of the integration model is increased. The context of a model cannot be increased except by removing constraints. This would be a change to the existing integration model, so the change would not be an extension.

— a mapping specification that represents the relationships between constructs of the application models and the corresponding subsets of the extended integration model;

— improvements to the application model (if appropriate).

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4.3 Defining an application model and its mapping to an integration model

This component of the methodology creates an application model together with its mapping to an integration model. The purpose of this activity is to enable use of the integration model in order to achieve integration amongst applications or a community of users that have common information requirements.

This requirement and its solution are illustrated in Figure 3 below.

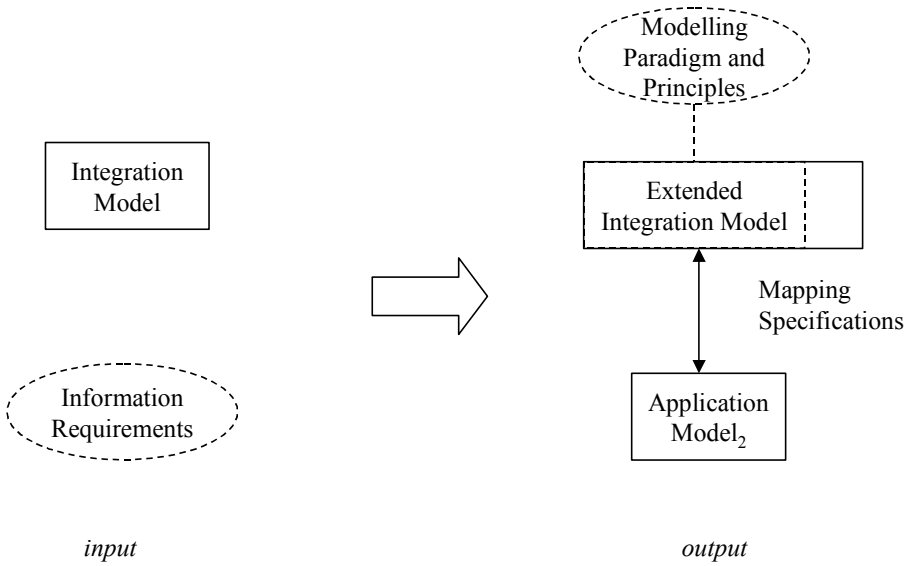

Figure 3 — Creating an application model and its mapping to an integration model

The inputs to the activity are as follows:

— information requirements, described by one or more of the following:

  — existing data;

  — existing models;

  — usage scenarios;

  — paper documents and forms;

  — results of interviews with users;

  — existing applications.

— an existing integration model;

— the modelling paradigm and principles used to create the integration model – these also determine how the integration model is extended to meet the stated information requirements.

The outputs of the activity are as follows:

— an extended integration model (if the input integration model does not precisely satisfy the stated information requirements);

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