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Automation systems and integration — Applications integration approach using information exchange requirements modelling and software capability profiling

Systèmes d'automatisation et intégration — Approche d'intégration des applications utilisant des exigences d'échange d'informations de modelage et un logiciel de capacité de profilage

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Foreword

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The committee responsible for this document is Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Architecture, communication and integration frameworks*.

Introduction

The motivation for ISO 16100 stems from the industrial and economic environment, in particular:

a) a growing base of vendor-specific solutions;

b) user difficulties in applying standards;

c) the need to move to modular sets of system integration tools;

d) the recognition that application software and the expertise to apply that software are assets of the enterprise.

ISO 16100 is an International Standard for the computer-interpretable and human readable representation of a capability profile. Its goal is to provide a method to represent the capability of manufacturing application software relative to its role throughout the life cycle of a manufacturing application, independent of a particular system architecture or implementation platform. This can lead to reduced production and information management costs to users and vendors/suppliers of manufacturing applications.

ISO 18435 provides a framework for harmonized use of industry and international standards in order to integrate control, diagnostics, prognostics, capability assessment, and maintenance applications. By using an ISO 15745 application integration modelling approach, key interoperability interfaces can be identified and concisely documented in terms of profiles.

ISO 18435 also provides the elements and the rules to describe the integration requirements of an automation application. The elements include the key aspects when integrating an automation application with other applications and the relationships of these key aspects. The rules include the information exchanges to support interoperability within an application and between applications.

This Technical Report describes a use case of modelling the smart pump application described in Annex A. The detailed manufacturing software unit profiling templates are described in Annex B. The detailed manufacturing software unit profiles are described in Annex C. The information exchanged among manufacturing software units in the smart pump application based on ISO 18435 methodology is described in Annex D.

Automation systems and integration — Applications integration approach using information exchange requirements modelling and software capability profiling

1 Scope

This Technical Report describes an approach for using ISO 16100 and ISO 18435 to specify information exchange requirements between applications. This approach is based on the use of ISO 18435 application interaction matrix element (AIME)/application domain matrix element (ADME) templates in conjunction with ISO 16100 manufacturing software unit (MSU) capability profiles.

This Technical Report also provides an example approach as applied to describing the interoperability requirements of the integrated smart pump application, which comprises the pump control application and the pump diagnostics application.

2 Normative references

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

ISO 16100-3:2005, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 3: Interface services, protocols and capability templates*

ISO 16100-5:2009, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 5: Methodology for profile matching using multiple capability class structures*

ISO 18435-2:2012, *Industrial automation systems and integration — Diagnostics, capability assessment and maintenance applications integration — Part 2: Descriptions and definitions of application domain matrix elements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16100-3, ISO 16100-5, ISO 18435-2, and the following apply.

3.1
application domain matrix element
ADME
entry in an application domain matrix to organize information exchange among applications

[SOURCE: ISO 18435-2:2012, 3.2]

3.2
application interaction matrix element
AIME
entry in application interaction matrix to denote the capabilities of the resource to support information exchange

[SOURCE: ISO 18435-2:2012, 3.4]

3.3
application interoperability profile
AIP
single specification referencing a group of profiles that reference parts of base specifications which may themselves be profiles

Note 1 to entry: The group of profiles can include process profile(s), information exchange profile(s), resource profile(s) and sometimes other AIPs.

[SOURCE: ISO 18435-2:2012, 3.5]

3.4
capability class
element within the capability profiling method that represents manufacturing software unit functionality and behaviour with regard to the software unit's role in a manufacturing activity, as denoted in a capability inheritance structure and as deployed in a capability aggregation structure

Note 1 to entry: The role of a MSU changes when used in different manufacturing activities; however, the MSU's corresponding capability class is positioned uniquely in an inheritance structure, but can assume different positions in an aggregation structure.

Note 2 to entry: In this Technical Report, a capability class template is identical to a capability template (ISO 16100-2:2003, 6.3, gives requirements for capability templates).

[SOURCE: ISO 16100-5:2009, 3.1, modified]

3.5
capability class structure
CCS
hierarchy of capability classes

3.6
capability profiling template
capability template
template
schema for a manufacturing software capability profile

Note 1 to entry: It could be partially filled.

[SOURCE: ISO 16100-3:2005, 3.1.14, modified]

3.7
manufacturing domain data
MDD
unified modelling language (UML) class representing information about manufacturing resources, manufacturing activities, or items exchanged among manufacturing resources within a particular manufacturing domain

[SOURCE: ISO 16100-5:2009, 3.3]

3.8
manufacturing domain model
MDM
particular view of a manufacturing domain, consisting of manufacturing domain data and relationships among them, corresponding to the domain's applications

[SOURCE: ISO 16100-5:2009, 3.5]

4 Abbreviated terms

ADID	Application Domain Integration Diagram
ADME	Application Domain Matrix Element
AIF	Application Integration Framework
AIME	Application Interaction Matrix Element
AIP	Application Interoperability Profile
CCS	Capability Class Structure
IG	Identification Guide
MDD	Manufacturing Domain Data
MDM	Manufacturing Domain Model
MSU	Manufacturing Software Unit
OTD	Open Technical Dictionary
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
UML	Unified Modelling Language
VFD	Variable Frequency Drive
XML	eXtensible Markup Language

5 Applications interoperability requirements modelling

5.1 Application integration framework in ISO 15745 and ISO 18435

The application integration framework (AIF) that is explained in ISO 15745-1 provides a basis for integrating an automation and control system architecture within a manufacturing application architecture.

An integrated manufacturing application can be modelled as a combination of a set of manufacturing processes, resources and a set of information exchange among the manufacturing resources, as shown in Figure 1. Manufacturing resources can be further divided as several types of communication networks, devices, software, equipment, material, and personnel necessary to support the processes and information exchanges required by the application.

A set of manufacturing resources that satisfy a set of interoperability and integration requirement is needed to realize a manufacturing application. An integrated manufacturing application is enabled by a manufacturing system consisting of a set of integrated manufacturing resources.

The categories of application domains of interest are enumerated in ISO 18435-1 and represented using an application domain integration diagram (ADID).

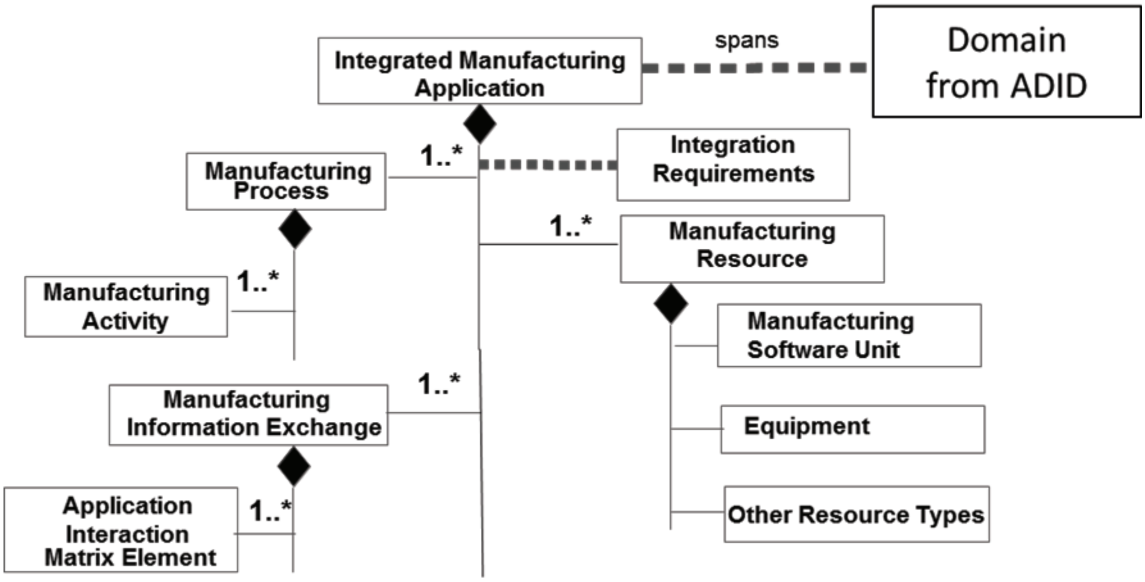

Figure 1 — Application integration model

5.2 Elements of information exchanges in ISO 18435

ISO 18435 focuses on integration of applications. ISO 16100 focuses on interoperability of MSUs, including manufacturing information exchange either within one application or within different applications. The information exchange among resources is represented by ISO 18435.

ISO 18435-1 provides an overview of the integration requirements of a manufacturing application. The focus is on the production operations and maintenance operations domains, including the capability assessment activities.

ISO 18435-2 provides the detailed definitions of the AIME and ADME structures and their relationships. General procedures for constructing AIMEs and ADMEs are also described.

An AIME represents capabilities provided by a set of resources of an application in order to exchange information with another set of resources associated with another application.

The set of AIMEs that represents the resource capabilities that meet the information exchange requirements to support the interoperability of two applications comprises a key part of an ADME. ADME that qualifies interoperability relationship between two applications is elaborated in Figure 2. Clause A.1 has an example of an integrated application which describes the smart pump application. The capability profiles of MSUs are obtained by filling adequate capability templates. Annex C shows the examples of capability profiles for the smart pump applications.

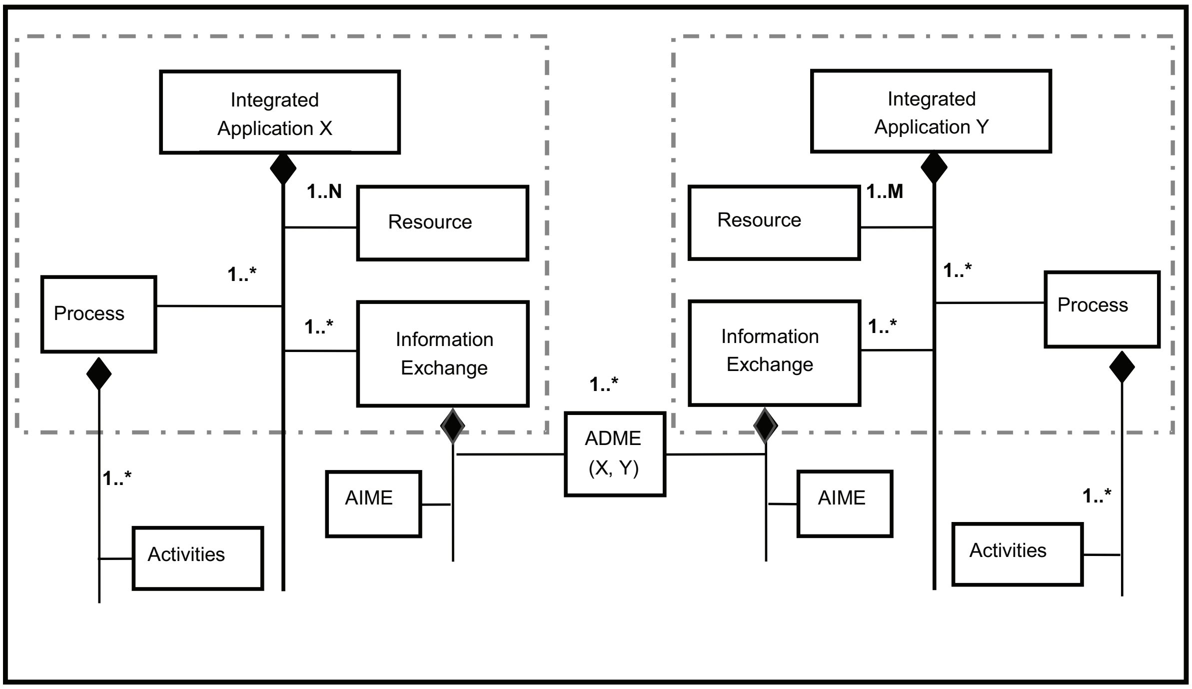

Figure 2 — AIME and ADME

The purpose of the ADME is to describe the interoperability and integration requirements that are required by the applications. The general concept of an ADME is to model the information exchanges between applications using the application interoperability profile (AIP) notation as described in ISO 15745-1. The ADME supports the information exchange between the applications based upon the capabilities identified in the AIMEs. The complete set of AIMEs that represents the information exchange requirements for realizing the interoperability of two applications comprises an ADME.

5.3 Context for information exchange requirements

The context for the information should be established using the application domain of interest as described in ISO 18435-1.

A manufacturing process is modelled as a set of activities that follow a specific sequence. Each activity is associated with a set of functions. The functions are implemented by manufacturing resources, such as MSUs shown as the left part of Figure 3. These MSUs enable information exchanges associated with the functions performed.

Context for the information exchange can be derived from the activities and capability class structure (CCS) shown in Figure 3. Clause A.2 has an example of CCS for the smart pump application. According to an ISO 16100 methodology, each capability class has a capability template. Examples of capability templates for the smart pump application are shown in Annex B.

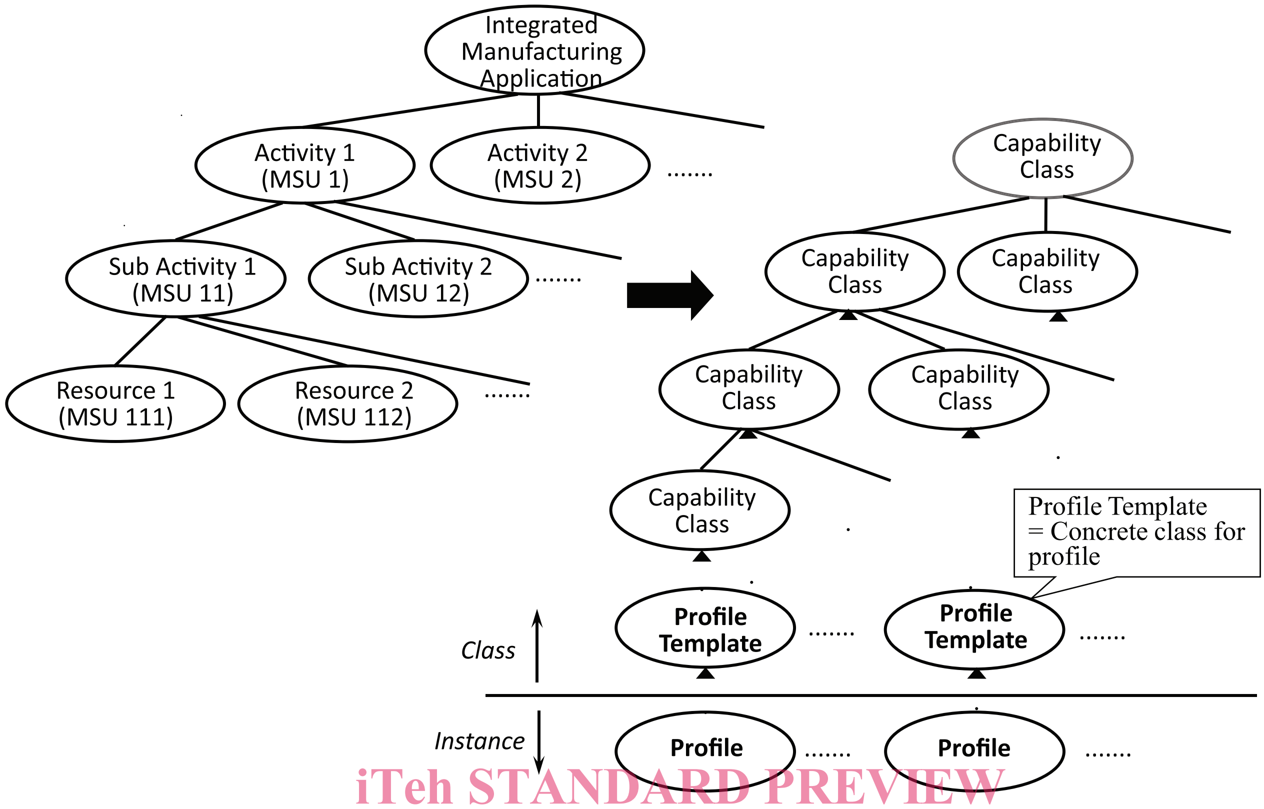

Figure 3 — Activity tree of an application

5.4 Content for information exchange requirements

5.4.1 Application requirements capability profile

The information exchanged between the MSUs provides the content for the ADME structure as described in the manufacturing domain data (MDD).

Application requirements capability profile in ISO 16100 describes an activity model in Figure 3. The activities also describe information exchange among the resources or MSUs involved in the activity. These information items exchanged typically include, input/output information in a MSU execution (such as recipes, geometric data, schedules, or other activity parameters needed to perform the application), control information (such as commands and requests for service), and status information (such as faults, equipment status reports, alerts, and quality information).

The manufacturing domain model (MDM) is a particular view of a manufacturing domain, consisting of MDDs and relationships among them, corresponding to the domain's applications as shown in Figure 4. A set of MDDs works like a terminology set in the applicable domain. MDDs represent different types of manufacturing information, including those that are exchanged between the resources within an application and between applications.

Information items pertaining to control of the actions of the equipment and device, e.g. the pump and the variable frequency drive (VFD) in Figure A.1, are usually handled by MSUs but are not included in this example.

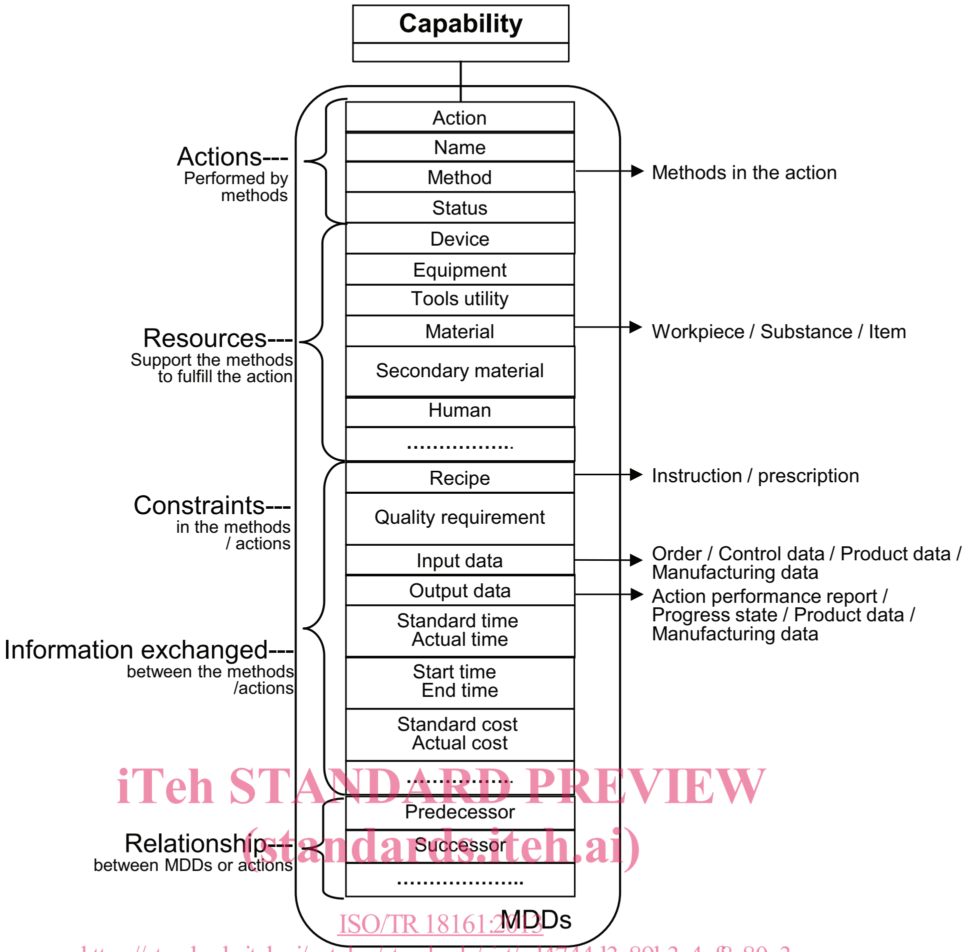

Figure 4 — Partial activity model represented by MDDs

5.4.2 MDDs used in ADME Content

Within a specific manufacturing domain, a manufacturing application can be represented as a set of MDDs. MDDs provide information about various aspects within a specific manufacturing domain. MDDs that represent information exchange between applications in the domain are used to enumerate the content section in the ADME. MDDs in Annex C are examples of ADME contents for the integrated smart pump application information exchange requirements.

5.5 Conveyance for information exchange

The ADME conveyance section captures resource types and specific configuration required to support information exchanges enumerated in the content section of the same ADME. Interoperability requirements expressed in the context section present the constraints to be addressed by the resource configurations. Clause D.4 shows one possible example of the conveyance section to support integration of the pump control and the pump diagnostics applications. The channel in the conveyance section is configured to support information exchange to meet the requirements of the integrated smart pump application.

5.6 ADME for the smart pump application

The context, content and conveyance section noted in 5.3, 5.4 and 5.5 form the ADME for expressing the information exchange requirements that support interoperability of the pump control and the pump diagnostics applications within the integrated application of the smart pump application.

