
**Automation systems and
integration — Interoperability of
capability units for manufacturing
application solutions —**

**Part 2:
Capability templates and software unit
cataloguing**

*Systèmes d'automatisation et intégration — Interopérabilité des
unités de capacité pour les solutions d'applications industrielles —*

Partie 2: Modèles de capacités et cataloguage des unités logicielles



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*.

A list of all parts in the ISO 16300 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 16300 series addresses requirements of users and suppliers of manufacturing software regarding the interoperability of software in the area of industrial automation.

User interoperability requirements include:

- integrating an automation application system by combining capabilities of a set of software components provided by various sources;
- integrating the capability of a software unit from one resource system platform to another platform;
- validating and verifying the capability of a software unit to meet the automation application system requirements.

Supplier requirements include:

- representing the set of capabilities provided by a software component used in a software unit;
- verifying software component capability as a part of a required software unit capability;
- cataloguing a software unit in terms of its capability for interoperability in an automation application system to support wide distribution.

The ISO 16300 series also addresses software interoperability services, which include:

- access to the description of a software capability to enable interoperability assessment;
- enabling the search and location of candidate software units and components, preferably automatically, using search engines;
- representing the dependencies between software components for an automation application hosted on a particular system platform.

Software capability is first defined as a set of functions and services with a set of criteria for evaluating the performance of a capability provider. It is then expressed and represented as facts about the software, how and what it can do. The ISO 16100 series, which deals with manufacturing software capability profiling for interoperability, was developed with the aim of providing a standardized method to describe capabilities of manufacturing software in terms of the Manufacturing Software Unit (MSU) capability profile. In the ISO 16100 series, the software component is included in the MSU. The ISO 16100 series also provides a way to exchange an MSU's capability as information by means of a capability profile. Software capability profiling is the basis for providing the above-mentioned software interoperability services. The ISO 16100 series is used and applied as the foundation for the ISO 16300 series.

To establish the ISO 16300 series, a number of steps were required. The initial step shows what interoperability services are enabled by using software capability profiles. The subsequent steps develop concrete methods and mechanisms to provide these interoperability services. The resulting output from ISO 16300 is divided into the following parts.

- ISO 16300-1 specifies a framework for describing an automation solution in terms of a set of capabilities provided by a set of MSUs. The framework also defines a set of capability elements and composition rules to represent the interoperability criteria in terms of the automation system capability requirements of an enterprise application.
- This document (ISO 16300-2) specifies the template definition to describe the capability of a software unit of an automation solution that can be mapped to the functional requirements of a target manufacturing application. This document also specifies mapping rules for composing the contents of a software unit catalogue item in terms of the properties of the capability.
- ISO 16300-3 specifies the framework for verifying interoperability of capability units associated with application requirements and system solutions.

- ISO 16300-4 specifies the search methodology for acquiring candidate capability units which satisfy the manufacturing application requirements from the software unit catalogues. It also describes the structure of the report.

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Automation systems and integration — Interoperability of capability units for manufacturing application solutions —

Part 2: Capability templates and software unit cataloguing

1 Scope

This document specifies a set of template definitions to describe the capability of a software unit of an automation solution that can be mapped to the functional requirements of a target manufacturing application.

This document specifies how to develop and manage a software unit catalogue in terms of capability properties and defines mapping rules from capability profiles to a software unit catalogue.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16100-1:2009, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 1: Framework*

ISO 16100-2, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 2: Profiling methodology*

ISO 16100-3, *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 16100-6:2018, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 6: Interface services and protocols for matching profiles based on multiple capability class structures*

ISO 16300-3, *Automation systems and integration — Interoperability of capability units for manufacturing application solutions — Part 3: Verification and validation of interoperability among capability units*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16100-1, ISO 16100-6 and ISO 16300-3 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

**3.1
capability**

<software> set of functions and services with a set of criteria for evaluating the performance of a capability provider

Note 1 to entry: This definition differs from that given in ISO 15531-1 and ISO 19439, where capability is defined as the quality of being able to perform a given activity. See IEC 62264-1 for a general definition of capability.

[SOURCE: ISO 16100-1:2009, 3.4]

**3.2
capability profile**

instance of a *capability template* (3.6) filled with the values corresponding to the target *manufacturing software unit* (3.8)

[SOURCE: ISO 16300-1:2018, 3.4]

**3.3
capability profiling**

selection of a set of offered services defined by a particular interface within a software interoperability framework

[SOURCE: ISO 16100-1:2009, 3.5]

**3.4
capability class**

element within the *capability profiling* (3.3) method that represents *capabilities* (3.1) with regard to the software unit's role in a manufacturing activity

**3.5
capability class structure**

CCS
hierarchy of *capability classes* (3.4)

Note 1 to entry: This structure is intended for modelling capability aggregation hierarchies in the target domains of ISO 16100-1:2009, Figure 2.

[SOURCE: ISO 16100-6:2018, 3.2, modified — The abbreviated term "CCS" has been added.]

**3.6
capability template
template**

schema representing a *capability class* (3.4)

[SOURCE: ISO 16300-1:2018, 3.6]

**3.7
capability template repository**

database to store *capability templates* (3.6)

**3.8
manufacturing software unit**

MSU
class of software resource, consisting of one or more manufacturing software components, performing a definite function or role within a manufacturing activity while supporting a common information exchange mechanism with other units

Note 1 to entry: A software unit can be modelled using UML as a software object.

Note 2 to entry: In this document, "capability unit" stands for "manufacturing software unit (MSU)".

[SOURCE: ISO 16100-1:2009, 3.18, modified — The abbreviated term "MSU" has been added and Note 2 to entry has been added.]

3.9

manufacturing domain data

MDD

information about manufacturing resources, manufacturing activities, or items exchanged among manufacturing resources within a particular manufacturing domain

3.10

capability element

element used to indicate that a particular *capability* (3.1) is supported by the entity or *manufacturing software unit* (3.8) to which the element belongs

[SOURCE: ISO 16300-1:2018, 3.3]

3.11

manufacturing domain model

MDM

particular view of a manufacturing domain, consisting of *manufacturing domain data* (3.9) and relationships among them, corresponding to the domain's applications

[SOURCE: ISO 16100-5:2009, 3.5, modified — The abbreviated term "MDM" has been added.]

3.12

software capability description dictionary

collection of *manufacturing domain data* (3.9) in *capability elements* (3.10) to describe the *capability* (3.1) of software, where all manufacturing domain data are uniquely identified

3.13

software unit catalogue

collection of *capability profiles* (3.2) using the same *capability template* (3.6) representing one or more *manufacturing software units* (3.8) for the same manufacturing activity in the activity tree

3.14

software unit cataloguing

procedure to make a *software unit catalogue* (3.13)

3.15

MSU provider

entity that provides the *manufacturing software units* (3.8) which are registered in the *software unit catalogue* (3.13)

4 Overview of software unit catalogue

4.1 Capability profiling defined in the ISO 16100 series

According to ISO 16100-5, the following four templates are used in MSU capability profiling when there are multiple capability class structures:

- the capability class structure (CCS) template (see ISO 16100-5:2009, 6.2);
- the capability template (see ISO 16100-5:2009, 6.3);
- the manufacturing domain model (MDM) template (see ISO 16100-5:2009, 6.4);
- the manufacturing domain data (MDD) template (see ISO 16100-5:2009, 6.5).

Figure 1 shows the relationship between MDM, MDD (including its relationship with other MDDs), capability class, capability template, capability profile and MSU.

- MDM is a particular view of the specific manufacturing domain, consisting of MDDs and their relationships.
- MDD represents the following items:
 - manufacturing resources (e.g. MSU, equipment, automation devices, personnel, material, work-in process inventory);
 - manufacturing processes (e.g. operations, activities);
 - manufacturing information exchanged (e.g. product data, recipe, manufacturing data, quality data);
 - relationships existing between the resources, processes and information exchanged (e.g. data flow, network configuration, work flow).
- The capability class shall be a capability externally represented as a capability template.
- The capability profile shall be an instance of a capability template filled with the concrete values corresponding to the target MSU.
- Therefore, the capability of MSU is described by MDDs in the capability template.

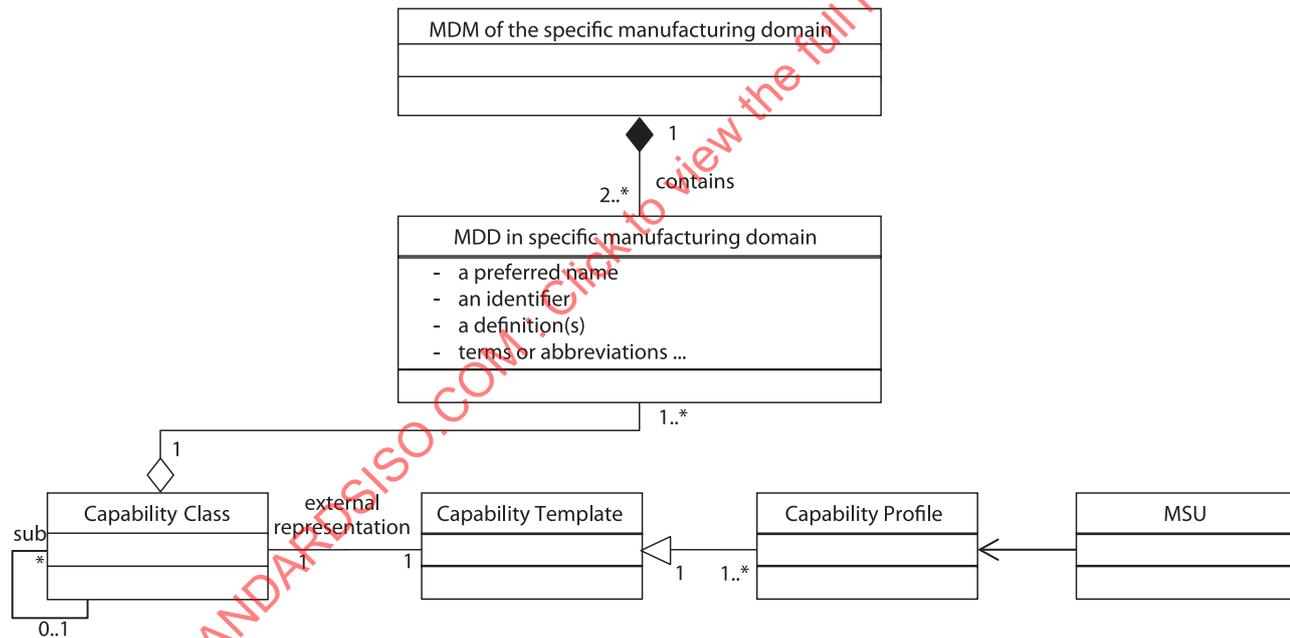


Figure 1— Relationship between MDM, MDD, capability template and capability profile

Figure 2 shows an example of capability profiling for MSU using MDD. In Figure 2, MSU (x) and MSU (y) of MSU provider A and MSU provider B are profiled using the same capability template using MDD. Therefore, there exists only one profile for each MSU and this provides the manufacturing software reusability and the interoperability of the application integrated through the selected MSUs.

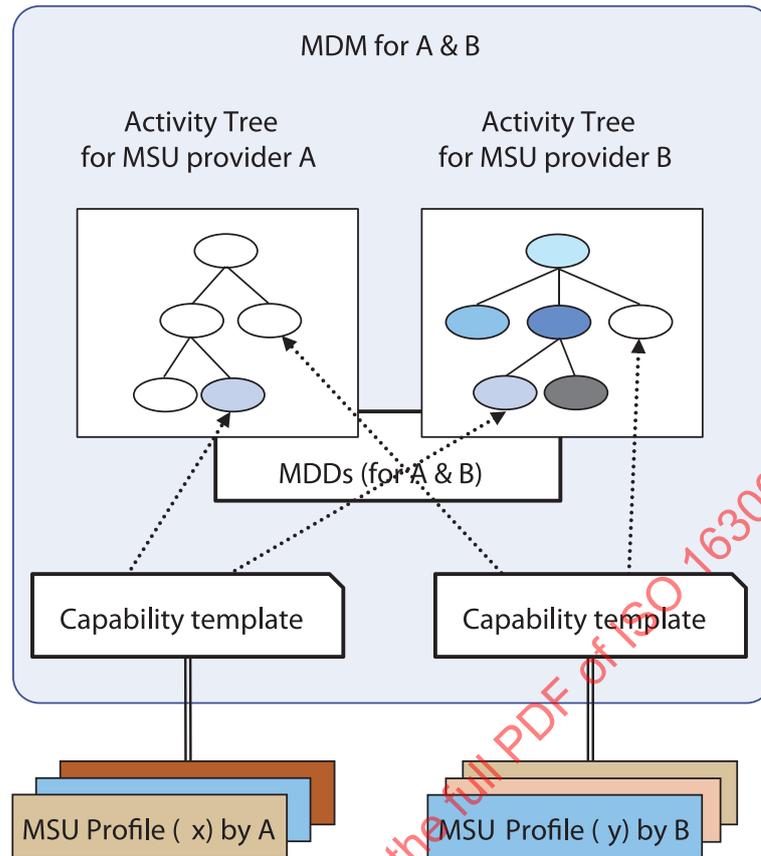


Figure 2 — Capability profiling using MDD

4.2 Objectives of the software unit catalogue

Even if MDD-based capability profiling provides the manufacturing software reusability and the interoperability of the applications, inconsistent capability profiling for the same MSU can still exist.

Figure 3 shows an example of the inconsistent capability profiling of MSU (x) where capability template Cx provided by MSU provider C resides in a different place from MDM of MSU provider A and MSU provider B.

In Figure 3, different capability templates ABx and Cx are used to profile MSU (x) that provides the same capability, and this results in different profiles for the same capability.

Capability template ABx for MSU (x) provides the manufacturing software reusability and the interoperability of the applications in MDM for only MSU provider A and MSU provider B, as explained in 4.1.

Considering MSU provider C, there are different capability templates for the capability [MSU (x)] and this can break the rule of only one profile for the same capability.

The objectives of the software unit catalogue are:

- to enhance the manufacturing software reusability and the interoperability of the applications;
- to provide a mechanism for creating one capability profile of the same MSUs on the same manufacturing activity in the activity tree using the same capability template.

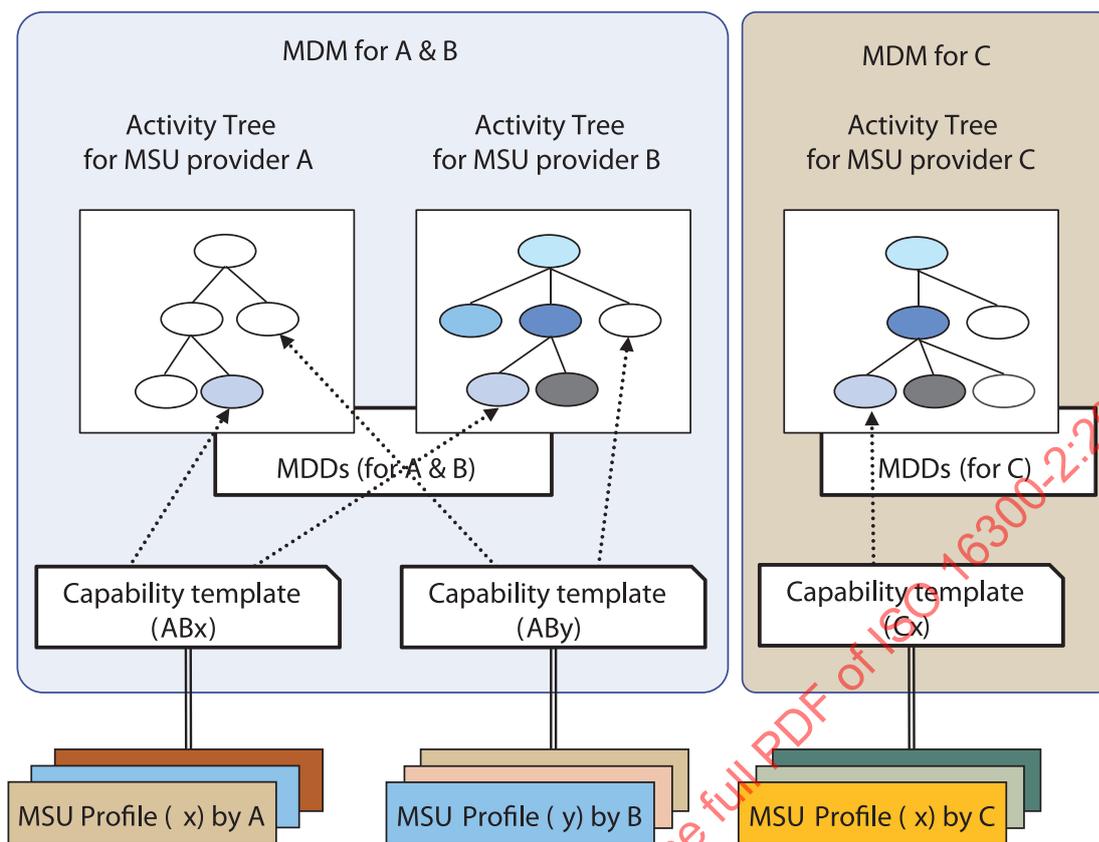


Figure 3 — Inconsistent profiling for the capability MSU (x)

For these objectives, this document defines a software capability description dictionary for capability elements to describe the capability of software in [Figure 4](#).

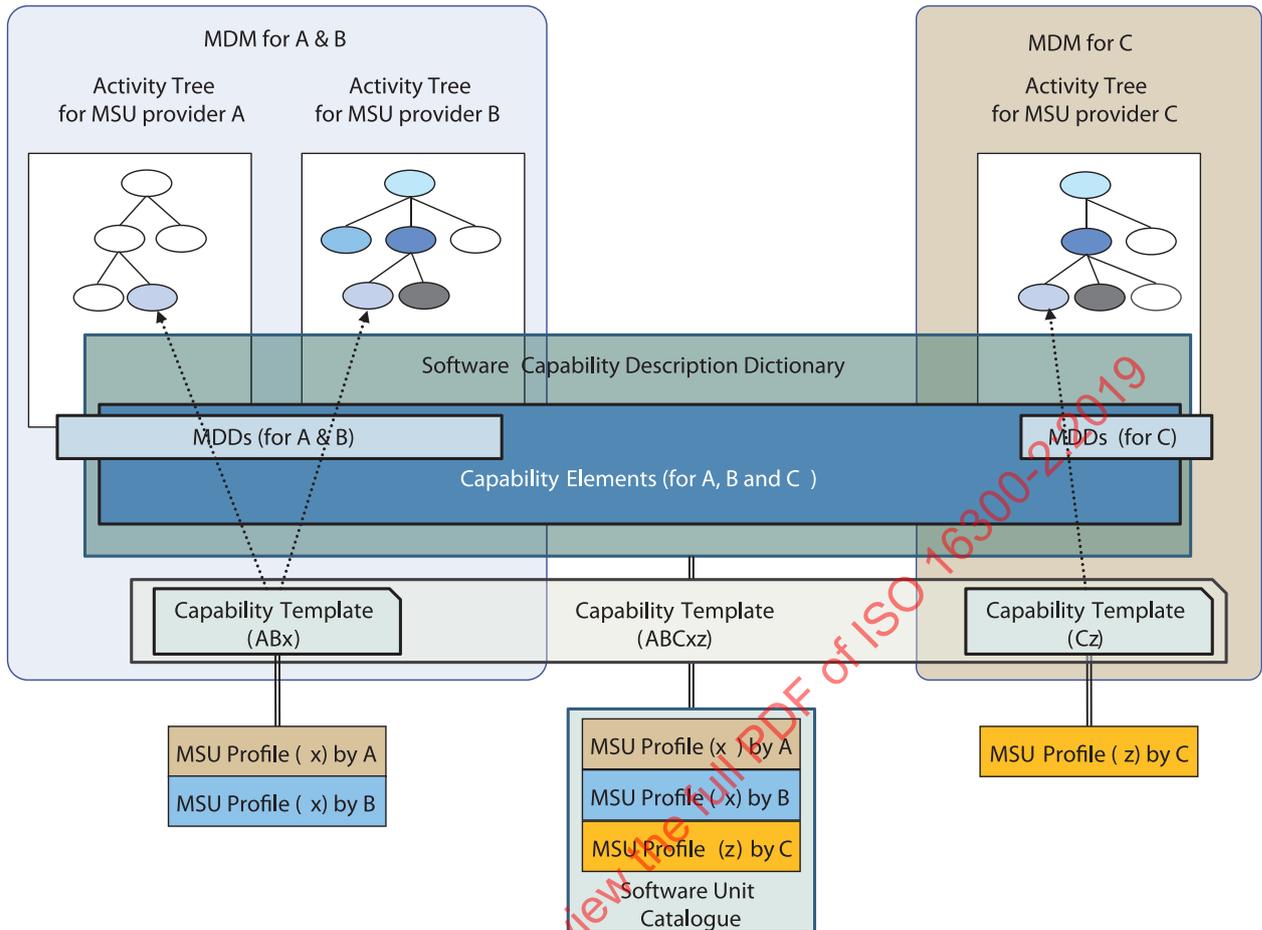


Figure 4 — Concept of software capability description dictionary

The software capability description dictionary shall provide the mutual understanding of the semantics of capability templates that can be understood by referencing the different sources of capability elements. This can be done by providing the reference to the target capability element where all terms necessary for understanding the semantics of the capability template are defined.

5 Software unit catalogue and software capability description dictionary

The relationships between the software unit catalogue and the software capability description dictionary are shown in [Figure 5](#). The software unit catalogue shall be coded using the concepts in the software capability description dictionary and shall conform to the constraints in the capability templates of ISO 16100-2, ISO 16100-3 and ISO 16100-5. The reference dictionary name in the common part of the template shall be filled with information of the software capability description dictionary.

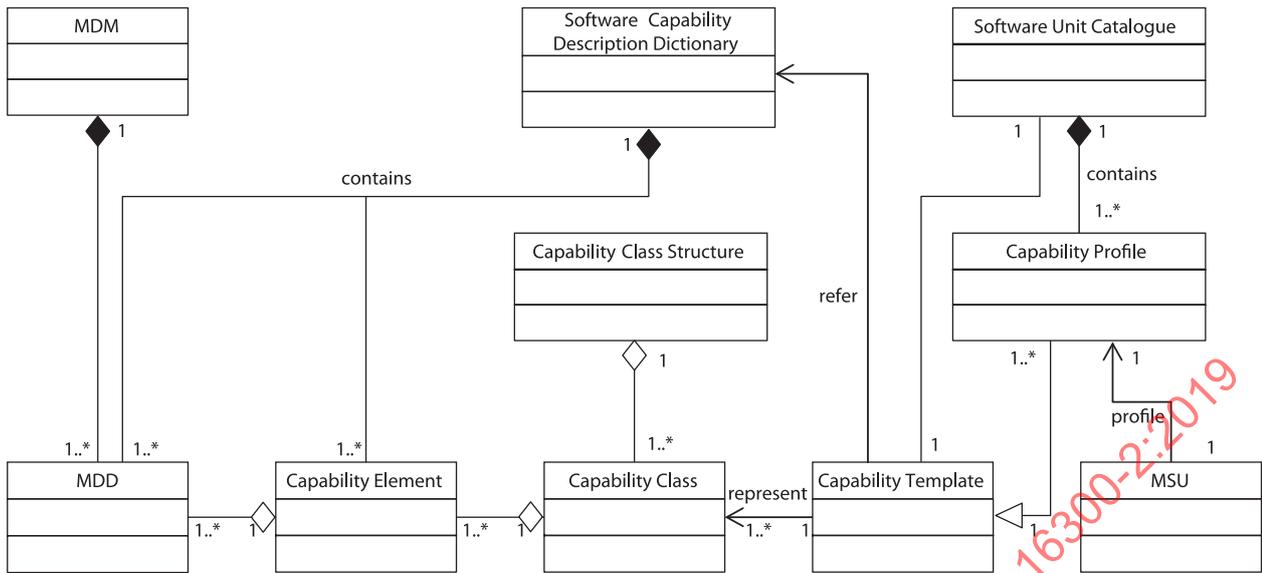


Figure 5 — Relationship between software unit catalogue and other components

Figure 5 represents the relationship between the software unit catalogue, the software capability description dictionary, the capability template, the capability profile, the capability class, the capability class structure and the capability element. Each capability element is represented by MDD(s) to indicate a particular capability in an MSU. The capability element shall have a name, a reference MDM name and a list of MDD (see Annex A).

The software unit catalogue shall refer to the software capability description dictionary to translate the semantics of the capability template and the capability profiles. Each MSU has one capability profile and each capability profile belongs to one capability template in the software unit catalogue.

6 Procedure for software unit cataloguing

6.1 Overall procedure of software unit cataloguing

Figure 6 shows the overall procedure of software unit cataloguing.

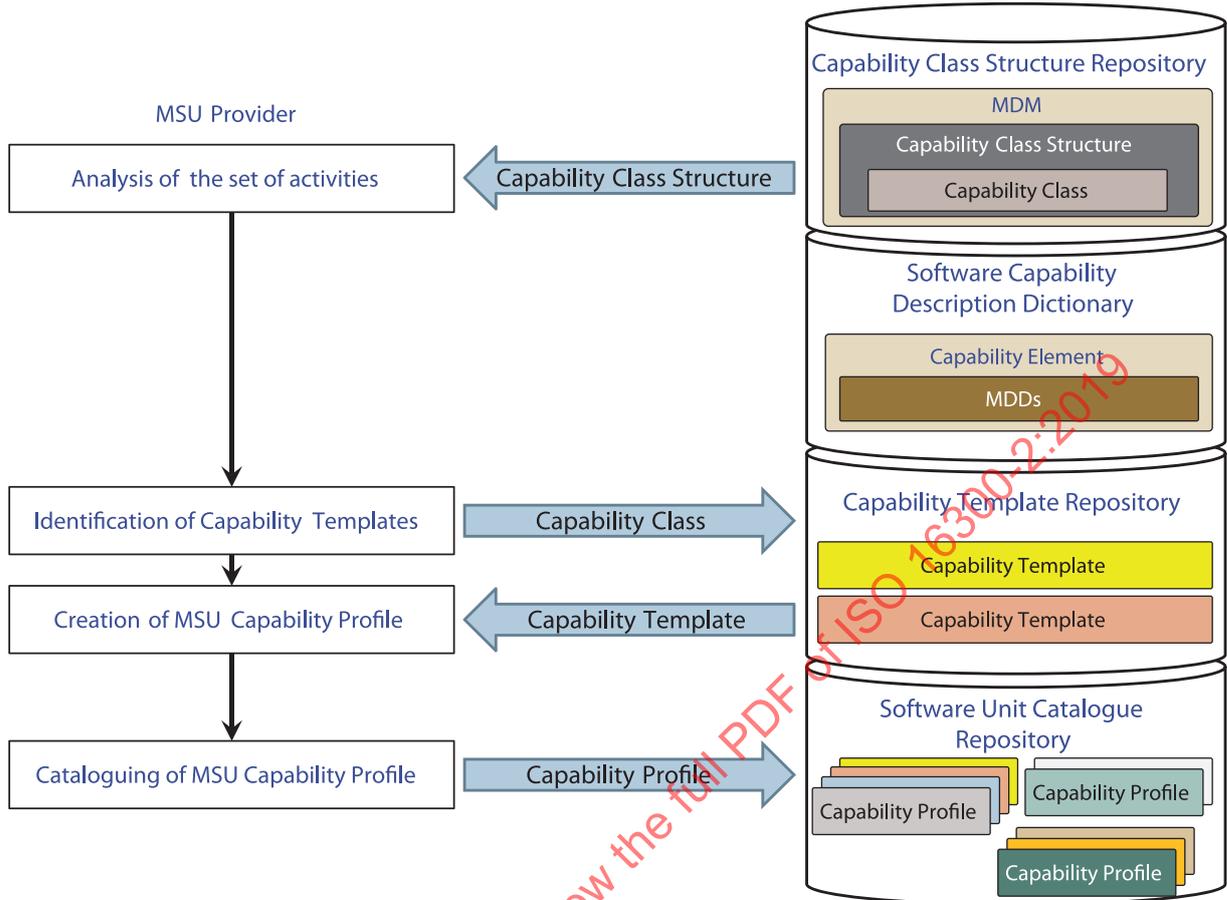


Figure 6 — Overall procedure for software unit cataloguing

The procedure for software unit cataloguing shall be as follows.

- a) Analyse the set of activities that the MSU enables. The MSU can enable one or more activities.
- b) The capability template for each capability class is identified with the reference to the software capability description dictionary.
- c) Create the MSU capability profile by filling in the template(s) selected in b).
- d) The MSU provider registers the MSU capability profile in the software unit catalogue. The software unit catalogue should be managed by an appropriate data base system.

6.2 Capability profiling using software unit catalogue

[Figure 7](#) depicts capability profiling using a software unit catalogue resulting from software unit cataloguing defined in [6.1](#). The box at the bottom shows the software unit catalogue.

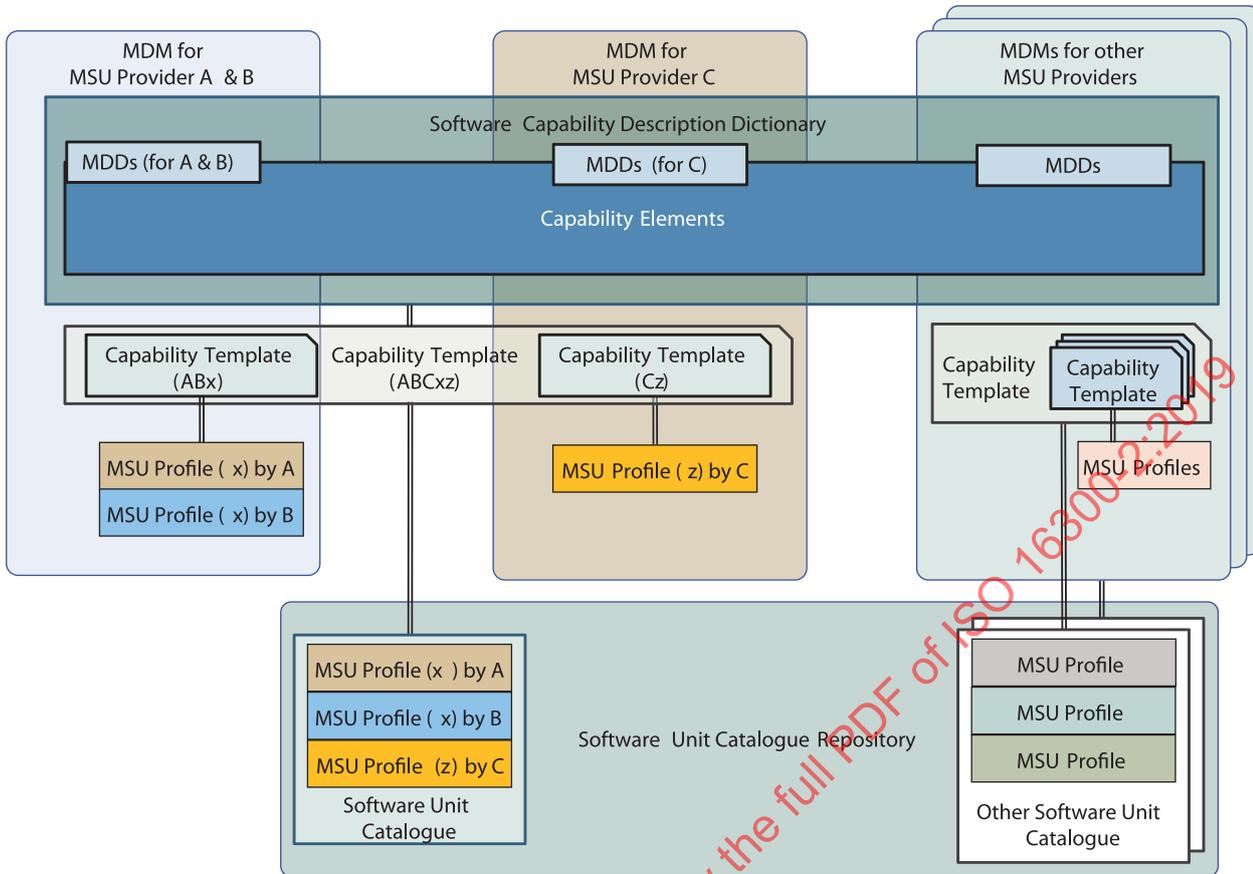


Figure 7 — Software unit catalogue

Figure 8 shows the software unit cataloguing procedure. Software unit cataloguing shall be as follows.

- a) An appropriate manufacturing domain is selected.
- b) Requirements for a new software unit are decomposed into several primitive requirements by reference to the activity tree in the domain activities.
- c) A capability class that satisfies the requirements is created or reused in cases where the existing capability class meets the requirements.
- d) An appropriate capability template corresponding to the capability class is set up. For setting up a capability template, it shall be retrieved whether the capability template exists in the capability template repository with reference to the software capability description dictionary or not.
- e) If no corresponding capability template is found in the capability repository, a new capability template shall be created with the same formal structure of the capability template defined in ISO 16100-3.
- f) Upon creation of a new capability template, the capability template shall be registered in the capability template repository.
- g) A capability template shall be filled with concrete values to create a capability profile.
- h) A capability profile shall be registered in the corresponding software unit catalogue. If there is no corresponding software unit catalogue, a new software unit catalogue shall be created to register the capability profile.

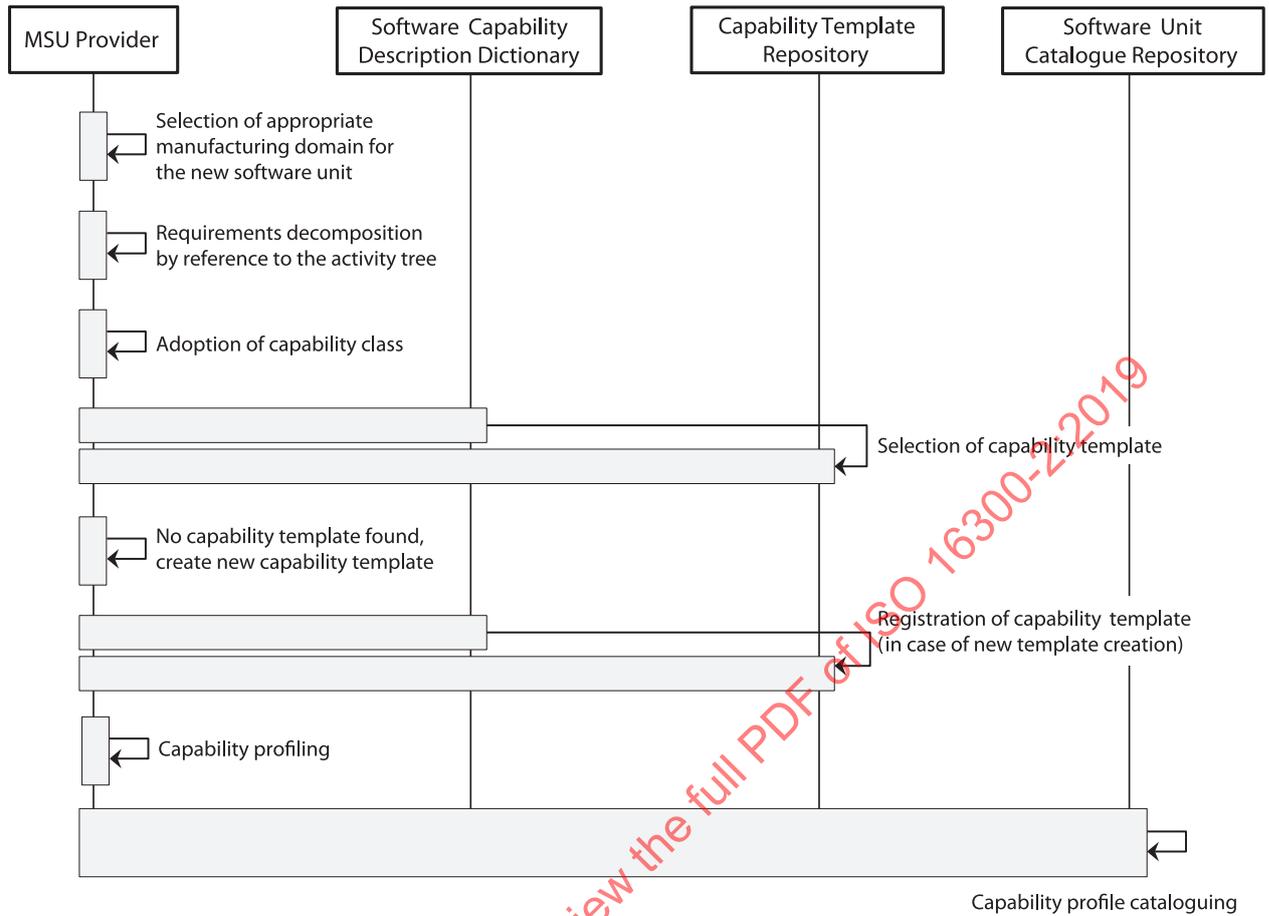


Figure 8 — Software unit cataloguing

Table 1 shows an example of two capability profiles coded without/with a software capability description dictionary.