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Advanced automation technologies and their applications — Requirements for establishing manufacturing enterprise process interoperability —

Part 2:
Maturity model for assessing enterprise interoperability

Technologies d'automatisation avancées et leurs applications — Exigences relatives à l'établissement d'un processus d'interopérabilité pour les entreprises de fabrication —

Partie 2: Modèle de maturité pour l'évaluation de l'interopérabilité d'entreprise

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 11354-2 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 310, *Advanced automation technologies and their applications* (as CEN/TS 16658:2014) and was adopted, under a special "fast-track procedure", by ISO/TC 184 *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*, in parallel with its approval by the ISO member bodies.

ISO 11354 consists of the following parts, under the general title *Advanced automation technologies and their applications — Requirements for establishing manufacturing enterprise process interoperability*:

— *Part 1: Framework for enterprise interoperability*

— *Part 2: Maturity model for assessing enterprise interoperability*

The following parts are planned:

— *Part 3: Requirements for information and communication technology-enabled enterprise interoperability*

Introduction

This part of ISO 11354 is based on ISO 11354-1, which describes the background and motivation for ISO 11354, and provides a framework for enterprise interoperability (FEI) for describing and representing concerns, barriers and approaches to enabling enterprise interoperability. It identifies four levels of concern (business, process, services, data) and three kinds of barriers (conceptual, technological, organizational) that are significant for enterprise interoperability, and specifies three approaches (integrated, unified, federated) to address these concerns and overcome these barriers.

This part of ISO 11354 is also based on work carried out in European projects such as ATHENA[9],[10] and INTEROP NoE[14].

The barriers and concerns identified in ISO 11354-1 are used to characterize five levels of interoperability maturity. For each combination of barriers and concerns, for all levels of interoperability maturity, mechanisms are specified to enable an enterprise to assess its interoperability capabilities, and to evaluate these against characterizations of maturity level. Two methods are then specified for overall assessment:

a) by concern and barrier, or

b) by maturity level.

An illustrative method is provided to show how concern and barrier assessments can be combined into a graphical representation, so providing an overall indication of existing enterprise capability to interoperate with others ("as is"). Additionally this analysis and representation can identify where capabilities that are needed to achieve desired higher levels of interoperability are insufficient and consequently investment or reengineering is required ("to be").

ISO 11354 focuses on, but is not restricted to, enterprise (manufacturing or service) interoperability. It is intended for use by people who are concerned to assess capabilities for enterprise interoperability and identify areas where those might need to be improved to meet the needs and ambitions of the enterprise.

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Advanced automation technologies and their applications — Requirements for establishing manufacturing enterprise process interoperability —

Part 2:
Maturity model for assessing enterprise interoperability

1 Scope

This part of ISO 11354 specifies:

— levels to represent the capability of an enterprise to interoperate with other enterprises;

— measures for assessing the capability of a specific enterprise to interoperate with other enterprises;

— methods for combining these measures into two kinds of overall assessment:

— maturity level by concern and barrier, and

— assessment relative to four designated maturity levels;

— a method for representing concern and barrier overall assessments in a graphical form and for identifying where capabilities are required to achieve desired higher levels of interoperability.

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 11354-1:2011, *Advanced automation technologies and their applications — Requirements for establishing manufacturing enterprise process interoperability — Part 1: Framework for enterprise interoperability*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
enterprise
one or more organizations sharing a definite mission, goals, and objectives to offer an output such as a product or service

Note 1 to entry: This term includes related concepts such as extended enterprise or virtual enterprise.

[SOURCE: ISO 15704:2000, 3.6]

3.2
enterprise interoperability
ability of enterprises and entities within those enterprises to communicate and interact effectively

Note 1 to entry: Interoperability is considered as significant if the interactions can take place in at least one of the four areas of interoperability concerns: data, service, process and business.

[SOURCE: ISO 11354-1:2011, 2.1]

3.3
enterprise interoperation
interactions between enterprise entities

3.4
maturity level
decimal in the range of 0 to 4 providing a numeric representation of the highest level of enterprise interoperability maturity achieved for a particular combination of interoperability concern and interoperability barrier

Note 1 to entry: A maturity level represents the degree of ability of the set of enterprise ICT-related capabilities that determine the ability of the enterprise to interoperate with other enterprises. Other enterprises may be suppliers, customers, partners, subsidiaries or others.

Note 2 to entry: The five maturity level integer values of 0, 1, 2, 3 and 4 are designated to have the following meanings: 0 – unprepared, 1 – defined, 2 – aligned, 3 – organized, 4 – adaptive, possibly with intermediate values representing partial and intermediate states between these levels. These five level values are further specified in 7.2.

3.5
interoperability approach
manner in which interoperability problems are solved and barriers are overcome

Note 1 to entry: ISO 11354-1 defines three interoperability approaches: integrated, unified and federated.

[SOURCE: ISO 11354-1:2011, 2.4]

3.6
interoperability barrier
incompatibility between entities within the enterprise that obstructs the exchange of information and other items, the utilization of services or the common understanding of exchanged items

Note 1 to entry: ISO 11354-1 defines three categories of barriers: conceptual, technological and organizational.

[SOURCE: ISO 11354-1:2011, 2.2]

3.7
interoperability concern
aspect of interaction or interoperation that is of interest to an enterprise stakeholder

Note 1 to entry: ISO 11354-1 defines four areas of interoperability concerns: data, service, process and business.

[SOURCE: ISO 11354-1:2011, 2.3]

3.8
interoperability practice measure
assessment, evaluated relative to each of the five specific maturity level values 0 to 4, for each of the four kinds of interoperability concern (business, process, service and data) of an enterprise's practices and hence capability to overcome each of the three kinds of interoperability barrier (conceptual, technological, organizational), expressed in terms of the most appropriate interoperability level

3.9
interoperability practice classification
enterprise practice classification corresponding to each combination of concern, barrier and level

3.10
maturity model
representation of degree of the ability of the set of enterprise ICT-related capabilities to interoperate with other enterprises

Note 1 to entry: The model will cover only those parts (entities) of the enterprise, which are to be involved in the information exchange.

4   Abbreviated terms

ATHENA   Advanced Technologies for Heterogeneous Enterprise Networks and their Applications

FEI   Framework for Enterprise Interoperability

ICT   Information and Communication Technology

INTEROP   Interoperability Research for Networked Enterprises Applications and Software

SME   Small or Medium size Enterprise

5   Conformity with this part of ISO 11354

In order to claim conformity with this part of ISO 11354, any particular interoperability solution shall address the normative requirements of Clauses 7, 8 and 9.

6   Basic concepts of enterprise interoperability

6.1   Enterprise interoperability

The concept of enterprise interoperability refers to the ability of enterprises (or part of them) to interact with other enterprises (or other parts of the same enterprise) through the exchange of information and other items such as material objects, energy, etc. Interoperability is seen as a necessary support to allow business collaboration to happen, but interoperability is only a means and not the business collaboration itself. It should also be noted that the concept of enterprise interoperability generally applies to both inter- and intra-enterprise activities and includes extended enterprise, virtual enterprise and sub-systems of one enterprise, be they distributed, networked or located in a single site, and whatever their type (discrete or continuous production), nature (for example manufacturing or service) or scale (large companies or SMEs).

NOTE 1   Enterprise interoperability is not an all or nothing situation. There are different extents and different kinds of enterprise interoperability. It is not appropriate to say that enterprise A is interoperable but that enterprise B is not. One needs to say how much interoperability (what extent? which functionality?) exists or is needed within the appropriate business context and the tasks on hand.

NOTE 2   Enterprise interoperability is not aiming at providing interchange ability for the enterprise system as a whole, but at providing the necessary means only for those parts directly involved in the interaction.

A high level of interoperability cannot be achieved for free. It is generally costly and time consuming. Each enterprise shall define its needed interoperability requirements and the maturity level to reach. It is not recommended that all enterprises seek to reach the highest interoperability level regardless of their needs. An enterprise will need to carry out an assessment of the benefits, costs and impacts of making such a move, and the particular need to consider environmental aspects in that assessment by reference to the CEN environmental checklist and similar documents.

6.2   Framework for enterprise interoperability

ISO 11354-1 defines a three-dimensional framework (illustrated in Figure 1) that allows one to identify and relate causes and effects of interoperability problems, and to identify relevant approaches and potential solutions for those problems.
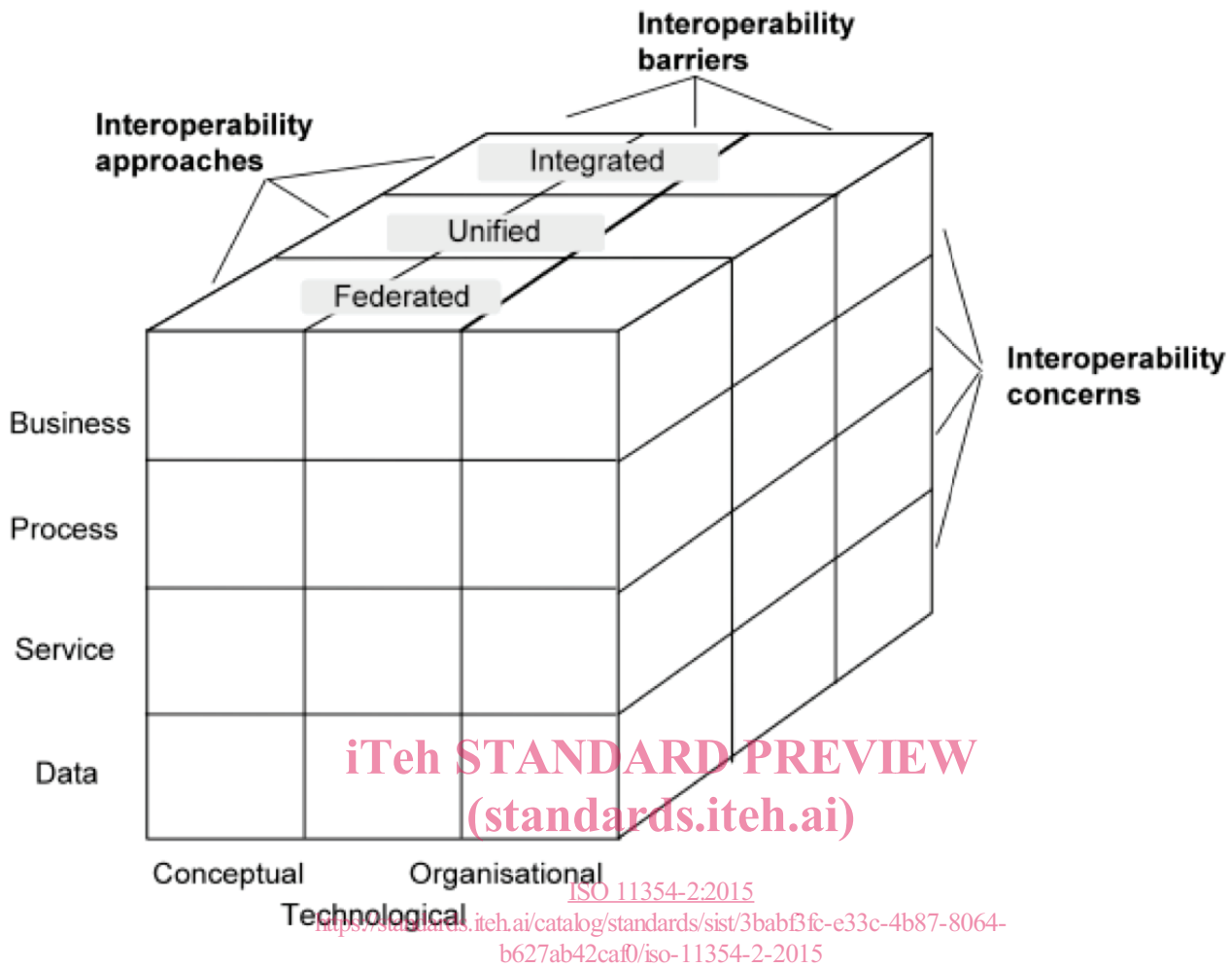
Figure 1 — Framework for enterprise interoperability

7 The maturity model for enterprise interoperability (MMEI)

7.1 Scope of model

The MMEI covers the two main dimensions of the Framework for Enterprise Interoperability (four kinds of interoperability concern and three kinds of interoperability barrier). It also considers relations to the dimension of the interoperability approach (integrated, unified or federated).

7.2 Overview of the levels of interoperability maturity

Enterprise interoperability maturity can be evaluated in two situations:

a) *a priori*, where the evaluation relates to the interoperability potentiality (i.e. with a possible future other enterprise whose identity is not known at the moment of evaluation), or

b) *a posteriori*, where interoperation between known other enterprises is needed and the assessment is concerned with the existing interoperability situation (i.e. considering the incompatibilities between two known systems).

The five specific levels of enterprise interoperability maturity shall be defined as shown in the Table 1 and further detailed in Clause 8. Each level identifies a certain degree of capability required to establish or improve interoperability.

Enterprise interoperability maturity can be represented in two different ways:

— relative to each combination of concern and barrier, or

— relative to each of the five specific maturity level values of 0 to 4.

Table 1 — Enterprise interoperability maturity levels

Maturity level	Capability for interoperation
Level 0 - Unprepared	The enterprise has no capability for or intention to enable interoperation
Level 1 - Defined	The enterprise is capable of properly modelling and describing its systems to prepare for limited interoperation
Level 2 - Aligned	The enterprise is capable of making necessary changes to align its operation to common formats or standards
Level 3 - Organized	The enterprise is capable of using meta modelling to achieve the mappings needed to inter-operate with other compatible enterprises
Level 4 - Adaptive	The enterprise is capable of negotiating with and dynamically accommodating any other enterprise

Levels 0 and 1 correspond to the situation where there are no or only ad hoc interoperations. From levels 2 to 4, levels of maturity are defined corresponding to the interoperability approach dimension of the FEI (integrated, unified and federated).

Table 2 shows the mapping between maturity levels and interoperation environments created according to the different approaches identified in the framework.

Table 2 — Maturity levels vs. interoperation environments

Maturity level	Interoperation environments
Level 0 - Unprepared	Isolated: The interoperation environment can exchange information only through manual mechanisms (document, fax, etc.)
Level 1 - Defined	Connected: In the interoperation environment information can be exchanged only though simple electronic exchange such as messaging
Level 2 - Aligned	Integrated: The interoperation environment has a commonly agreed format (or standard) to which all other enterprises can build their systems or components thereof
Level 3 - Organized	Unified: The interoperation environment uses meta-models, so allowing heterogeneous systems to be mapped one to another
Level 4 - Adaptive	Federated: The interoperation environment has no pre-defined format or meta-models, instead interoperation can adjust and accommodate dynamically using information which has been defined a priori (e.g. available capability and capacity, entity profiles)

Each level of maturity also corresponds to a degree of interoperability ranging from no interoperability to full interoperability as shown in Table 3.

Table 3 — Maturity levels and degree of interoperability

Maturity level	Interoperability degree
Level 0 - Unprepared	Interoperability is non-existent or required manual intervention
Level 1 - Defined	Interoperability is limited with only some ad hoc interoperations
Level 2 - Aligned	Interoperability is restricted to peer-to-peer relations that use a common format or standard
Level 3 - Organized	Interoperability is extended, allowing many-to-many relations with multiple hetero-geneous other enterprises
Level 4 - Adaptive	Interoperability is generally achieved, allowing full interoperability with many other enterprises