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

Part 1:

Framework for enterprise interoperability

iTeh STANDARD PREVIEW

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

ISO 11354-1:2011

Partie 1: Cadre pour l'interopérabilité d'entreprise

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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.

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 11354-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 310, *Advanced automation technologies and their applications*, in collaboration with Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement). This part of ISO 11354 is based on work carried out in European projects such as ATHENA^[1] and INTEROP NoE^[2].

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*

The following parts are planned:

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

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

Introduction

The ability of an enterprise to interoperate with others is not only a recognized quality and advantage for gaining competitiveness in today's market, but is becoming a question of survival for many companies, especially for small or medium size enterprises (SMEs). Enterprises require more interoperations during the entire life cycle of a product to reduce cost and shorten delays. Increased interoperations enable an enterprise to propose new products for the market in a network of organizations. Many stakeholders believe that enterprise interoperability is an area in which research can lead to outstanding results in terms of innovation, leading to economic growth and employment (see Reference [16]).

Enterprise interoperability as an engineering discipline is not yet well defined; interoperability is still a vague concept that has many definitions and connotations in different sectors and domains. This leads to communication difficulties and misunderstandings. Consequently, it is essential to define the concept of interoperability as relevant to enterprise interoperation.

Enterprise systems fail to interoperate because of barriers of various categories. Interoperability barriers are therefore an important concept, and this part of ISO 11354 identifies three categories of interoperability barriers, namely: conceptual, technological and organizational. Interoperability barriers need to be categorized in standard ways and existing interoperability knowledge and solutions need to be related to these barriers in order to facilitate interoperability in design and implementation for industry.

ISO 11354 considers interoperability as a generic concept, and it is assumed that common problems of interoperability failure and solutions to overcome them can be identified and developed for any particular enterprise. Therefore, ISO 11354 considers enterprise interoperability to be an engineering discipline, separating it from other business-related issues. Interoperability is seen as a necessary support to enable business collaboration, but interoperability is not the business collaboration itself.

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

Part 1: Framework for enterprise interoperability

1 Scope

The purpose of this part of ISO 11354 is to specify a Framework for Enterprise Interoperability (FEI) that establishes dimensions and viewpoints to address interoperability barriers, their potential solutions, and the relationships between them.

ISO 11354 applies to manufacturing enterprises, but can also apply to other kinds of enterprises. It is intended for use by stakeholders who are concerned with developing and deploying solutions based on information and communication technology for manufacturing enterprise process interoperability. It focuses on, but is not restricted to, enterprise (manufacturing or service) interoperability.

This part of ISO 11354 specifies the following:

- viewpoints for addressing stakeholder concerns for the exchange of entities (information objects or physical objects) at the operational levels of enterprises at which interoperability is required;
- a framework for structuring these stakeholder concerns (business, process, service, data), the barriers relating to enterprise interoperability (conceptual, technological, organizational) and the approaches to overcome barriers (integrated, unified, federated), with contents identifying the various kinds of solutions available to enable interoperability.

This part of ISO 11354 does not specify the specific mechanisms for the exchange of entities (information objects or physical objects), nor the manner in which interoperability solutions are implemented.

Three annexes provide additional information. Annex A describes how existing interoperability frameworks can be related to the concepts of this framework. Annex B shows examples of using the FEI to identify and categorize interoperability barriers, knowledge and solutions. Annex C provides a methodological guideline on how the FEI can be used in an interoperability engineering project.

2 Terms and definitions

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

2.1

enterprise interoperability

ability of enterprises and entities within those enterprises to communicate and interact effectively

NOTE 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.

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

NOTE This part of ISO 11354 defines three categories of barriers: conceptual, technological and organizational.

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

NOTE This part of ISO 11354 defines four areas of interoperability concerns: data, service, process and business.

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

NOTE This part of ISO 11354 defines three interoperability approaches: integrated, unified and federated.

3 Abbreviated terms

| | |
|---------|--|
| AIF | ATHENA Interoperability Framework ^[10] |
| ASA | Adaptive Software Architecture |
| ASOA | Advanced Service-Oriented Architecture |
| ATHENA | Advanced Technologies for Heterogeneous Enterprise Networks and their Applications ^[11] |
| BIF | Business Interoperability Framework ^[13] |
| CPD | Collaborative Product Development |
| EIF | European Interoperability Framework ^[15] |
| FEI | Framework for Enterprise Interoperability |
| FRISCO | Framework of Information System Concepts ^[17] |
| ICT | Information and Communication Technology |
| IS | Information System |
| IT | Information Technology |
| INTEROP | Interoperability Research for Networked Enterprises Applications and Software ^[20] |
| LISI | Levels of Information Systems Interoperability ^[22] |
| OSI | Open System Interconnection ^[8] |
| PPM | Product Portfolio Management |
| PSL | Process Specification Language ^[6] |
| SCM | Supply Chain Management |

| | |
|-----|---------------------------------|
| SME | Small or Medium size Enterprise |
| SOA | Service-Oriented Architecture |

4 Conformity with this part of ISO 11354

In order to claim conformity with this part of ISO 11354, any particular interoperability product (including methods and software) shall be able to be positioned within the FEI defined in this part of ISO 11354.

NOTE 1 In this part of ISO 11354, positioning is used to mean the activity of identifying correspondence connections between entities of the same kind.

This positioning shall include the related interoperability barriers, interoperability concerns and interoperability approaches. Additionally, the positioning shall also address the appropriate supplementary dimensions identified in this part of ISO 11354 and demonstrate their conformance to the normative requirements for each relevant interoperability approach identified.

NOTE 2 Annex A describes how existing interoperability frameworks can be related to the concepts of this framework. Examples of how such positionings can be achieved and documented are found in Annex B. Annex C provides a methodological guideline on how the FEI can be used in an interoperability engineering project.

5 Viewpoints addressed by the enterprise interoperability framework

5.1 General framework requirements

The framework shall enable the representation of the viewpoints as defined in this clause to represent concerns, barriers, and approaches relative to enterprise interoperability. The framework shall comprise the structures specified in Clause 6 to represent the relationships between the viewpoints and their elements.

Interoperability viewpoints shall express the needs of the enterprise stakeholder who is concerned with the following:

- a) identifying and resolving interoperability issues, and
- b) the structured representation of those needs and their fulfilments.

The latter can be achieved by the interoperability framework presented in this part of ISO 11354.

Stakeholder needs for enterprise interoperability refer to the ability of enterprises (or part of them) to interact through the exchange of information and other entities, such as material objects, energy, etc. Interoperability is a necessary support to enable business collaboration, but interoperability is not the business collaboration itself.

Enterprise interoperability can apply to both inter- and intra-enterprise needs and includes the concepts of extended enterprise, virtual enterprise and subsystems of one enterprise, be they distributed, networked or located in a single site, and whatever their production types (e.g. discrete, continuous), natures (e.g. manufacturing, service) or company size.

NOTE 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 "enterprise A is interoperable but enterprise B is not". It is important to establish how much interoperability is necessary, in terms of its extent and functionality.

5.2 Interoperability concern viewpoint

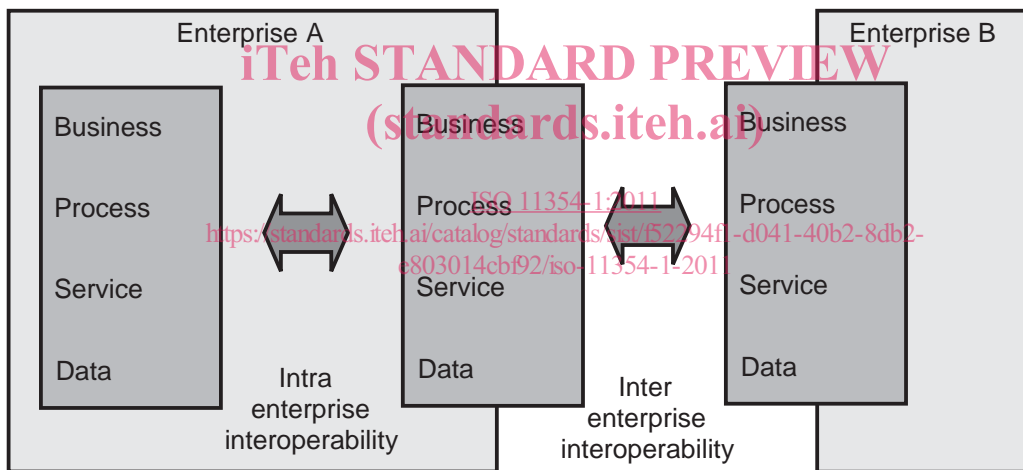
5.2.1 Categories of interoperability concerns

The interoperability concern viewpoint shall describe the categories of concerns that are relevant for enterprise interoperability. Although the descriptions are primarily related to ICT-based applications, they can apply to non-computerized systems as well.

When considering enterprise interoperability, the following four categories of interoperability concerns shall be identified, as illustrated in Figure 1:

- data,
- service,
- process, and
- business.

Data are used by services. Services are employed by processes to realize the business of the enterprise. From another perspective, the goal of an enterprise is to run its business. The business is realized through processes. Processes employ services that in turn need data to perform activities.



NOTE Source: ATHENA^[11].

Figure 1 — Interoperability concerns

NOTE Interoperability of communication is an essential condition to enable interoperability. However, for ICT systems, interoperability of communication is provided by communication protocols (e.g. from cable connection to the protocol of layers 1 to 4 of the OSI model in ISO/IEC 7498-1), and interfaces (layers 5 to 7 of the OSI model). Therefore, interoperability of communications is not subject of further description in this part of ISO 11354.

5.2.2 Data interoperability concern

Data interoperability refers to the ability of all kinds of entities to exchange data items. Therefore, concerns on the incompatibilities between partner data systems shall be described prior to any active collaboration. Data interoperability is crucial for most forms of enterprise interoperability because it is one of the following:

- a) the substance of the exchange, or
- b) a factual record of the exchange of entities, or
- c) a necessary capability for exchange negotiation.

The concern extends to both non-electronic data (e.g. physical documents, human conversations) and electronic data (e.g. data files, data stored in a database).

Data interoperability occurs when either

- a particular entity is capable of receiving and using needed data items provided by an external source, or conversely,
- an external source is capable of receiving and using needed data items from an entity within the enterprise.

EXAMPLE Two enterprises exhibit data interoperability when they engage in exchanging data files such as spreadsheet files, or in a more or less continuous manner in the case of process interoperability or service interoperability.

Data incompatibilities can arise between cooperating or collaborating business entities having different data systems using different data schemas with different syntax and semantics, different data models (e.g. informal, hierarchical, relational, etc.), different modes of control or different assignments of responsibilities and authorizations for data systems, operation and change management. Concerns about the incompatibilities between data systems shall be described prior to any active collaboration.

The description shall include the detailing of the differing data exchange needs of each business entity and related capabilities, and the explicit identification of all relevant responsibilities and authorizations. The description shall also document the data exchange incompatibilities that need to be resolved.

For data held in electronic form, data models and queries are structured in accordance with schemas (i.e. vocabularies and sets of data structures) that are associated with particular applications. In this case, the description of the interoperability of data shall include finding and mapping the schemas of possibly heterogeneous data structures, which can reside on different computing devices with different operating systems and different knowledge or information management systems.

NOTE Data interoperability is accomplished by resolving conceptual and any other differences between enterprise data systems (e.g. schema representation, differing responsibilities), as well as finding appropriate technology solutions.

5.2.3 Service interoperability concern

Service interoperability refers to the ability of business entities to request, provide, and utilize each other's services.

Service interoperability occurs when either

- a particular service is capable of requesting, receiving and using needed information provided by an external service, or conversely,
- an external service is capable of requesting, receiving and using needed information from a service within the enterprise.

Incompatibilities can arise for cooperating or collaborating business entities that have different service models, different modes of control and/or different assignments of responsibilities and authorization for service selection, operation and change management. Concerns about the incompatibilities between business entity services that are to be employed in any exchange of entities shall be described prior to any active collaboration, unless it is intended that the collaboration be achieved through the use of agent negotiation or similar technology.

The description shall include the detailing of the business services themselves, and the detailing of their assignment to different enterprise operational systems. It shall also include the detailing of those services that identify, compose and operate applications that have been designed and implemented independently. The description shall also document the service incompatibilities that need to be resolved.

NOTE 1 Service interoperability is accomplished by resolving conceptual and any other differences between enterprise services (e.g. service granularity, differing responsibilities), as well as finding appropriate technology.

NOTE 2 Service interoperation has three aspects:

- service use by a requestor of service from a service provider,
- service response from a service provider to a service requestor, and
- interconnecting different services to form a complex service (the last case is related to process interoperability as well).

NOTE 3 A service is performed by a resource (computer type, machine type, human type) to provide an operation.

5.2.4 Process interoperability concerns

Process interoperability refers to the ability of business entities to exchange information and other entities needed for process operation.

Process interoperation occurs when either

- a particular process is capable of receiving and using needed information and other entities provided by an external process, or conversely,
- an external process is capable of receiving and using needed information and other entities from a process within the enterprise.

Process incompatibilities can arise for cooperating or collaborating business entities that have different process models, different modes of control and different assignments of responsibilities and authorization for process operation and change management. Concerns about the incompatibilities between business processes that are to be employed in any exchange of entities shall be described prior to any active collaboration, unless it is intended that the collaboration be achieved through the use of agent negotiation or similar technology.

The description shall include the detailing of the process information and other entity exchange needs and the capabilities of each business entity, and the explicit identification of all relevant responsibilities and authorizations. The description shall also include the process incompatibilities that need to be resolved.

NOTE 1 Process interoperation is accomplished by resolving conceptual and any other differences between process information and other entity exchange needs and offerings, as well as finding appropriate technology solutions.

NOTE 2 Developing process interoperability means finding solutions to enable mapping, connecting, merging, and translations of possibly heterogeneous process models and applications. For interoperability reasons, these solutions are related to the points of interaction of the processes, not with the processes as a whole or with the internal details of the constituents of those processes. Developing process interoperability can also involve characterization of process capability in an externally accessible form to enable process discovery and utilization, thereby supporting interoperability rather than addressing the process concern directly.

Among the entities associated with process operation are process models. Process model interoperability shall be achieved by linking different process descriptions to form a collaborative process model, which could perform verification or simulation or execution of the overall process. These collaborative processes can use different process description languages and be defined in different process models for different purposes.

5.2.5 Business interoperability concerns

Business interoperability refers to the ability of enterprises to cooperate with partners for the conduct of business through necessary interactions of their respective organizations.

Business interoperation occurs when a particular business is understood and shared without ambiguity among interacting partners. Business interoperability is driven by value creation for participants and can rely upon less formal relationships in addition to contractual obligations. Often it is the case that agreements at lower organizational levels mirror those of business partners and thus appropriate business interoperability serves as a precursor for other interoperability concerns.

Business incompatibilities can arise for partners that cooperate or collaborate, but have different business models, modes of decision-making, methods of work, regulatory constraints, enterprise culture, commercial approaches, etc. Concerns about the incompatibilities between partner businesses involved in any exchange of entities shall be described prior to any active business interaction.

The description shall include the detailing of formal contracts, informal working arrangements, capabilities and capacity of each party to exchange necessary information and other entities, and the explicit identification of all relevant responsibilities and authorizations in partner organizations. The description shall also include the business incompatibilities that need to be resolved.

NOTE Business interoperation is accomplished by resolving conceptual and any other differences between business information exchange needs and offerings, as well as finding appropriate technology solutions.

5.3 Interoperability barrier viewpoint

5.3.1 Categories of interoperability barrier

The interoperability barrier viewpoint shall describe the incompatibilities and mismatches that obstruct the sharing and exchanging of information and other entities. Three categories of barriers shall be described:

- conceptual,
- technological,
- and organizational.

The notion of conceptual or technological comes also from engineering design where one distinguishes between conceptual design and technical design. A conceptual barrier describes incompatibilities that are independent from any technology, whereas technological barriers specify mismatches that are due to the implemented technology.

NOTE Many interoperability issues are specific to particular application domains, and require support for particular attributes, or particular access control regimes. In contrast, general barriers and problems of interoperability can be identified, and many of them are already being addressed (see References [15] and [21]).

5.3.2 Conceptual barriers

Conceptual barriers relate to the differences in the expression, definition, and understanding of exchanged items at various levels of abstraction, e.g. mismatched enterprise models of a company.

Conceptual barriers shall be detailed in terms of the syntactic, semantic, and semiotic incompatibilities of exchangeable items, particularly information and other knowledge assets.

- Syntactic incompatibility occurs whenever different people or systems use different expressions to represent information and knowledge. For example, service syntactic incompatibility occurs when there is a difference in the syntax used for the description of the service required and provided.

NOTE 1 Standards such as ISO 19440 aim to overcome syntactic incompatibility by providing a neutral model to enable mapping between different enterprise models built using different forms of syntactic expression.

- Semantic incompatibility occurs whenever the meaning of exchanged items is not sufficiently similar. In this case, there is no clearly defined common meaning to enable unambiguous interpretation of the information content. For example, process semantic incompatibility occurs when there is a difference in the semantics used in different process modelling languages.
- Semiotic incompatibility occurs when participating entities interpret the exchanged items, concerning both artefacts and relationships, differently in different contexts. For example, business semiotic incompatibility occurs when there is a difference in the partners' business vision and culture, value expectations or operational concepts.