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Automation systems and integration — Assessment on convergence of informatization and industrialization for industrial enterprises —

Part 1: Framework and reference model

Systèmes d'automatisation et d'intégration — Évaluation de la convergence de l'informatisation et de l'industrialisation pour les entreprises industrielles —

Partie 1: Cadre et modèle de référence

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Foreword

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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 22549 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

Convergence of informatization and industrialization (CII) refers to a process that integrates information technology into industrial production. The purpose of convergence is to improve productivity and resource allocation by digital transformation.

This improvement consists of:

— increasing the integration of production and resource allocation (internally and with each other);

— making production and resource allocation more dynamic and responsive to external changes;

— optimizing production and resource allocation.

The purposes of this document include is to provide industrial enterprises guidance for:

— assessing the current situation of CII;

— finding weakness within the CII;

— identifying ways to improve CII.

The intended users of this document can be grouped into the following categories:

— independent third-party, e.g. a consulting company or government department, that assesses the maturity of CII;

— organization in charge of production management department, quality management department, inventory management department, etc., which sponsors an assessment of itself or a subordinate organization;

— any other enterprises who have interest in digital transformation.

Automation systems and integration — Assessment on convergence of informatization and industrialization for industrial enterprises —

Part 1:
Framework and reference model

1 Scope

This document defines the basic principles for an assessment concerning the convergence of informatization and industrialization (CII) in industrial enterprises, including the following:

— assessment framework definitions;

— assessment reference model definitions;

— assessment reference model components.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
industrialization
procedure of increasing productivity using sequential task allocation to automated or semi-automated methods, or to individuals

3.2
informatization
procedure of generating information from data within a given context using computing and communication technologies

3.3
convergence of informatization and industrialization
CII
integrating information technology into industrial production, which promotes the development of industry towards a higher value-added direction through wide application of information and restructuring of traditional industry

3.4
domain application
application of information technology in a single business activity that has a well-defined and identifiable boundary of responsibility and authority for subordinate activities

3.5
Level 4
level containing functions involved in the business-related activities needed to manage a manufacturing organization

Note 1 to entry: See Annex B.

[SOURCE: IEC 62264-1:2013, 3.1.16, modified — "level containing" has been added before functions.]

3.6
Level 3
level containing functions involved in managing the workflows to produce the desired end-products

Note 1 to entry: See Annex B.

[SOURCE: IEC 62264-1:2013, 3.1.17, modified — "level containing" has been added before functions.]

3.7
Level 2
level containing functions involved in monitoring and controlling of the physical process

Note 1 to entry: See Annex B.

[SOURCE: IEC 62264-1:2013, 3.1.17, modified — "level containing" has been added before functions.]

3.8
business activity
partially ordered set of enterprise activities on Level 3 and Level 4 of functional hierarchy defined in IEC 62264

3.9
comprehensive integration
process of linking together functional applications within an enterprise

3.10
collaborative integration
process of linking together functional applications between different enterprises

3.11
reference model
abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts produced by an expert or body of experts in order to encourage clear communication

Note 1 to entry: A reference model can represent the component parts of any consistent idea, from business functions to system components, as long as it represents a complete set. This frame of reference can then be used to communicate ideas clearly among members of the same community.

3.12
assessment objective
statement, provided as part of the assessment input, which defines the reasons for performing the assessment

[SOURCE: ISO/IEC 33001:2015, 3.2.6]

3.13
assessment expert team
group of one or more professional individuals who jointly perform an assessment process

[SOURCE: ISO/IEC 33001:2015, 3.2.10, modified — the word "professional" has been added before individuals.]

3.14
assessment framework
schema for use in characterizing an industrial enterprise quality characteristic of an implemented industrial enterprise

4 Abbreviated terms

CII convergence of informatization and industrialization

OPM object-process methodology

5 Overview of assessment

5.1 General

The assessed objects of a CII assessment include enterprise manufacturing activities, enterprise business activities and enterprise infrastructure. Manufacturing activities are associated with manufacturing operations management. Enterprise business activities are associated with activities on Level 3 and Level 4 of functional hierarchy. Enterprise infrastructure is associated with capital investment, equipment and facilities etc.

For assessment of CII, data shall be acquired from Level 2, Level 3 and Level 4 to answer questionnaires. Annex B provides further information for each Level in detail. However, this document covers enterprise activities beyond Level 4 that support the enterprise but are not directly related to manufacturing and are therefore not addressed by the IEC 62264 functional hierarchy.

5.2 Enterprise assessing system

Figure 1 depicts the architecture of the enterprise assessing system and describes the relationship of enterprise assessing process with its input and output objects which combine into extent of CII using the aggregating process.

NOTE The figures in this document use the graphical notation of object-process methodology, as defined in ISO/PAS 19450. See Annex A.

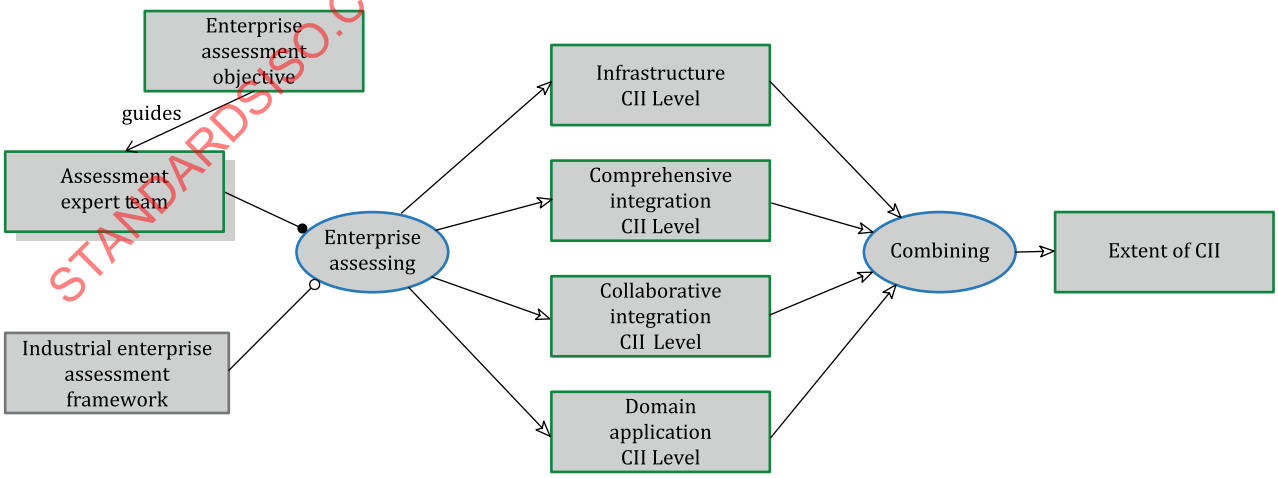


Figure 1 — Enterprise assessing system

Assessment expert team enables enterprise assessing, which requires industrial enterprise assessment framework.

Enterprise assessment objective guides assessment expert team.

Enterprise assessment objective includes:

a) assessment of the current situation of CII,

b) identification of weakness within the CII,

c) identification of ways to improve CII.

The extent of CII shall be assessed in terms of infrastructure, domain application, comprehensive integration and collaborative integration within that enterprise by the enterprise assessing process. Enterprise assessing process results are the infrastructure CII level, domain application CII level, comprehensive integration CII level and collaborative integration CII level which combine into extent of CII.

5.3 Industrial enterprise assessment framework

The industrial enterprise assessment framework consists of evaluation questionnaires, maturity model, and assessment reference model. Assessment reference model supports evaluation questionnaires and maturity model, as shown in Figure 2.

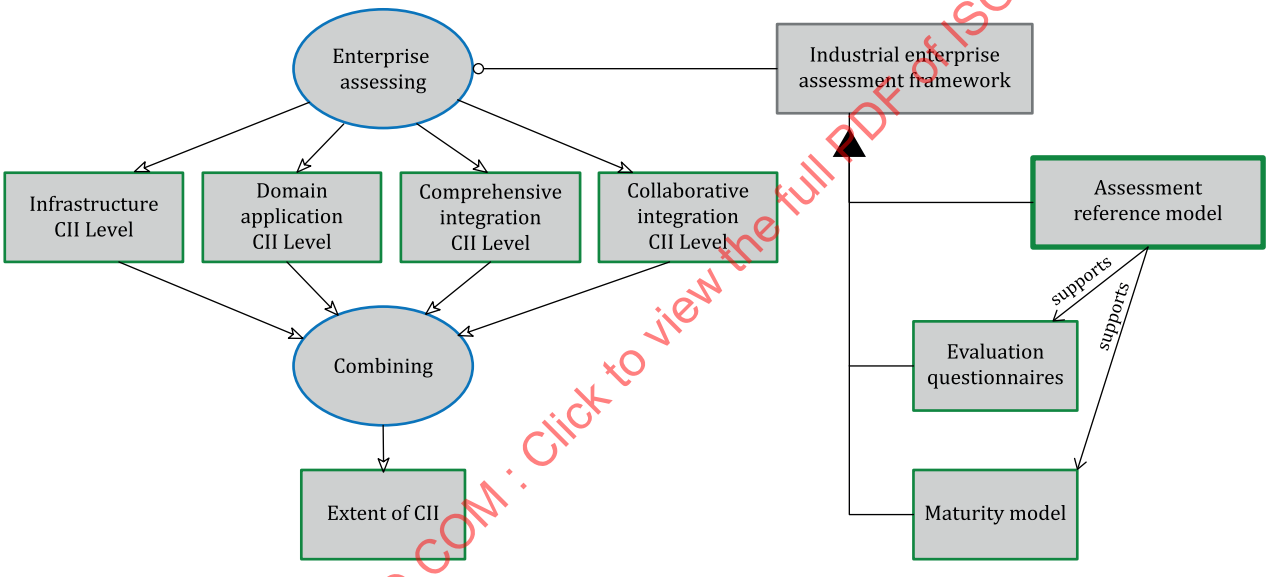


Figure 2 — Industrial enterprise assessment framework

6 Assessment reference model definitions

Figure 3 presents the structure of assessment reference model. The enterprise assessing process shall refer to the following aspects:

— infrastructure;

— domain application;

— comprehensive integration;

— collaborative integration.

Four aspects are grouped by short-dashes (blue) line and twenty-four subordinate components to four aspects are grouped by long-dashes (red) line.

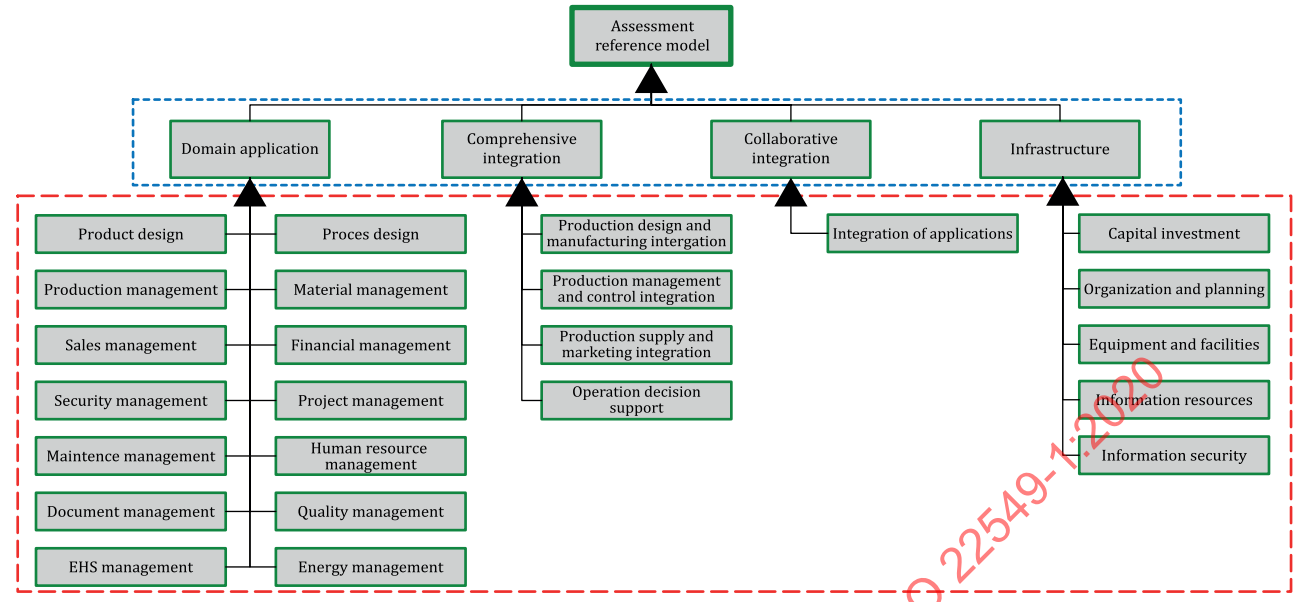


Figure 3 — Assessment reference model (aspect and its subordinate component)

Infrastructure consists of capital investment, organization and planning, equipment and facilities, information resources, and information security.

The assessment of infrastructure shall consider the construction of the infrastructure and conditions related to CII.

Domain application consists of product design, process design, production management, materials management, sales management, financial management, security management, project management, maintenance management, human resource management, document management, quality management, environment, health and safety management, and energy management.

The assessment of domain application shall consider the application of information technology in a single business activity that has a well-defined and identifiable boundary of responsibility and authority for subordinate activities.

Comprehensive integration consists of product design and manufacturing integration, production management and control integration, production supply and marketing integration, and operation decision support.

The assessment of comprehensive integration shall consider the process of linking together functional applications within an enterprise.

The assessment of collaborative integration shall consider the process of linking together functional applications between different enterprises.

7 Assessment reference model components

7.1 Infrastructure

7.1.1 Capital investment

The assessment of CII shall examine the application of information technology for capital investment such as:

— the investment in construction of automation and informatization,

— the investment in the operation and maintenance of the information system,

— the investment in the research and development.

7.1.2 Organization and planning

The assessment of CII for organization and planning shall examine: the establishment of the organization, the qualifications of the team, the authority for defining the strategy related to the field of automation and informatization.

7.1.3 Equipment and facilities

The assessment of CII for equipment and facilities shall examine: information equipment and facilities, industrial equipment and facilities related to the informatization.

7.1.4 Information resources

The assessment of CII shall examine the application of information technology for construction of the information resources such as:

— collection,

— standardization,

— accumulation,

— integration,

— analysis, and

— management of information resources.

7.1.5 Information security

The assessment of CII shall examine the application of information technology for protection of information security such as:

— implementation of protection of the information security,

— computer and networking security,

— information resources security and disaster preparedness,

— system security,

— security management and construction of the prevention mechanism.

7.2 Domain application

7.2.1 Product design

The assessment of CII shall examine the application of information technology for product design and design processing such as:

— digitalized model of the product,

— digital examination,

— comprehensive design and optimization,

— and intelligent design of a product.

7.2.2 Process design

The assessment of CII shall examine the application of information technology for process design and process execution such as:

— design of process flow or planning,

— analysis of dynamic simulation,

— process control and parameter optimization and integrated process design.

7.2.3 Production management

The assessment of CII shall examine the application of information technology for production activities such as:

— production planning and scheduling,

— production management,

— material requirement planning,

— distribution management, and

— outsource planning and management.

7.2.4 Materials management

The assessment of CII shall examine the application of information technology for materials management such as:

— management of purchasing,

— inbound logistics, and

— management of suppliers in the materials management of product as well as the e-commerce purchasing.

7.2.5 Sales management

The assessment of CII shall examine the application of information technology for sales management such as:

— management of sales,

— management of the inventory of finished products,

— logistics distribution,

— after-sales services and management of suppliers in the sales management of the product as well as the e-commerce sale.

7.2.6 Financial management

The assessment of CII shall examine the application of information technology for financial management such as:

— accounting management,

— capital management,

— accounting statement and analysis,

— cost management and financial budgeting management.

7.2.7 Security management

The assessment of CII shall examine the application of information technology for security management such as:

— information technology construction and application of security management,

— emergency response for early warning about major sources of hazard,

— and forecasts of new hazards.

7.2.8 Project management

The assessment of CII shall examine the application of information technology for project management such as:

— research and manufacturing of product and engineering construction emphasizing the business scope,

— application of the informationalized management of both project planning and authorization,

— the business scope and contents of the informationalized management of project design, planning and budgeting, and

— the business scope and contents of the informationalized management of project implementation.

7.2.9 Maintenance management

The assessment of CII shall examine the application of information technology for maintenance management such as:

— informationalized management of the equipment maintenance.

7.2.10 Human resource management

The assessment of CII shall examine the application of information technology for human resource management such as:

— management of human resource planning and recruiting,

— training and development of the human resources,

— emoluments,

— benefits,

— achievement, and

— employee relationship.

7.2.11 Document management

The assessment of CII shall examine the application of information technology for document management of the documents collected from the enterprise to be assessed.

7.2.12 Quality management

The assessment of CII shall examine the application of information technology for quality management to assure proper product quality.

7.2.13 Environment, health and safety management

The assessment of CII shall examine the application of information technology for providing healthy, safe and sustainable manufacturing environments.

7.2.14 Energy management

The assessment of CII shall examine the application of information technology for assuring low energy consumption.

7.3 Comprehensive integration

7.3.1 Product design and manufacturing integration

The assessment of CII for product design and manufacturing integration shall examine the bidirectional flow of information between research and design, and manufacturing of product, such as data definition, data exchange and management of product specification.

7.3.2 Production management and control integration

The assessment of CII for production management and control integration shall examine the integration between operation management, manufacturing execution of the plant and process control of the manufacturing enterprises.

7.3.3 Production, supply and marketing integration

The assessment of CII for production, supply and marketing integration shall examine the integration of production, supply and marketing such as production according to the order, optimization of production arrangement and dynamic scheduling, integrated operation of the supply chains and the traceability on the entire process of product quality.

7.3.4 Operation decision support

The assessment of CII for operation decision support shall examine the analysis of business information, knowledge mining and accumulation, business decision of the enterprises, building of the credibility of enterprises and risk management and control.

7.4 Collaborative integration

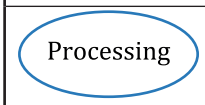
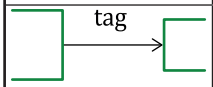
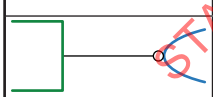
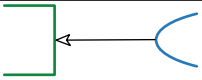
The assessment of collaborative integration shall consider the process of linking together functional applications between different enterprises.

Annex A
(informative)

Convention for using ISO/PAS 19450

This document utilizes object-process methodology (OPM) to describe enterprise assessing system and industrial enterprise assessment framework. OPM is a compact conceptual approach, language, and methodology for modelling and knowledge representation of automation systems and their interoperation. OPM is also a formal yet intuitive paradigm for systems design, engineering, development, life cycle support, communication, and evolution. OPM notation supports the conceptual modelling of systems. Its holistic approach can describe the functional, structural and behavioural aspects of a system. Table A.1 defines the OPM notations used in this document.

Table A.1 — OPM notation used in this document

Symbol	name	Definition
	Informatical object	An object is an item that exists or can exist once constructed, physically or informatically. Associations among objects shall constitute the object structure of the system being modelled, i.e., the static, structural aspect of the system.
	Physical object	Physical object is an item that exists or can exist once constructed, physically. Associations among objects shall constitute the object structure of the system being modelled, i.e., the static, structural aspect of the system.
	Process	A process is an item that expresses the behavioural, dynamic system aspect: how processes transform objects in the system and how the system functions to provide benefit. Processes complement objects by providing the dynamic, procedural aspect of the system.
▲	Aggregation-participation relation link	The fundamental structural relation Aggregation-Participation is a source item that aggregates one or more other participant items, the destination items, into a meaningful whole.
	Unidirectional tagged structural link	A unidirectional tagged structural link shall have a user-defined semantics regarding the nature of the relation from one thing to the other thing. A meaningful tag, in the form of a textual phrase, shall express the nature of the structural relation between the connecting objects or connecting processes.
	Agent link	Agent is a human or a group of humans who enables the occurrence of the process to which it is linked but is not transformed by that process.
	Instrument link	Instrument is an inanimate object that enables the occurrence of the process to which it is linked but is not transformed by that process.
	Result link	A result link shall be a transforming link specifying that the linked process creates (generates, yields) the linked object, which is the resulted.
	Consumption link	A consumption link shall be a transforming link specifying that the linked process consumes (destroys, eliminates) the linked object.