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# Systems and software engineering — Life cycle management

## Part 6: System integration engineering

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## National foreword

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# Systems and software engineering — Life cycle management —

## Part 6: System integration engineering

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# Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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 document 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 and IEC 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 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

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Systems and software engineering*.

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# Introduction

This document was developed in response to a need for consistent terminology, definitions and guidance that elaborates the area of system integration, taking into account the context of use and the proven practices for the development of systems.

ISO/IEC/IEEE 15288 includes an integration process that focuses on physically assembling the implemented system elements composing a system to obtain an "integrated system". This process interfaces directly to other technical processes and indirectly to activities and tasks of other technical processes, in particular, the processes that define the system requirements, architecture and design.

The purpose of this document is to facilitate the usage of the integration process of the latest revision of ISO/IEC/IEEE 15288 by providing guidance on system integration.

This document describes the integration engineering activities dealing with planning, performing and managing the integration of a system, including the related activities of other technical processes, in particular, verification and validation processes. These are real practices in industry, i.e. the integration of a system is technically engineered and managed as a project (included in the system development project). Although these practices are performed, they were not formalized in a standard or a guide when this document was written.


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# Systems and software engineering — Life cycle management —

# Part 6: System integration engineering

## 1 Scope

This document

— specifies activities and processes to be implemented for engineering the integration of systems-of-interest throughout the life cycle (systems made of products and/or services; see Note 1),

— provides guidance for the integration process and its relationships to other system life cycle processes as described in ISO/IEC/IEEE 15288,

— specifies the information items to be produced through the implementation of the integration engineering (integration process and its relationships to other system life cycle processes),

— specifies the contents of the information items, and

— provides guidelines for the format of the information items.

This document can be applied to

— those who use or plan to use ISO/IEC/IEEE 15288 on projects dealing with man-made systems, software-intensive systems, products and services related to those systems, regardless of project scope, methodology, size or complexity, and

— anyone performing integration engineering activities to aid in ensuring that the application of the integration process and its relationships to other system life cycle processes conform to ISO/IEC/IEEE 15288.

NOTE 1 Systems concerned within this document are those as defined in ISO/IEC/IEEE 15288, i.e. systems that are man-made and can be configured with one or more of the following: hardware, software, data, humans, processes (e.g. processes for providing service to users), procedures (e.g. operator instructions), facilities, materials and naturally occurring entities.

NOTE 2 This document is intended to be consistent with the other parts of ISO/IEC 24748.

## 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/IEC/IEEE 15288:2015, *Systems and software engineering — System life cycle processes*

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# 3 Terms, definitions and abbreviated terms

## 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC/IEEE 15288 and the following apply.

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

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

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

**3.1.1**
**acquirer**
stakeholder that acquires or procures a product or service from a *supplier* (3.1.9)

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.1]

**3.1.2**
**aggregate**
composition of several implemented *system elements* (3.1.11) that are *assembled* (3.1.3), on which a set of *verification actions* (3.1.17) and/or *validation actions* (3.1.15) is applied

**3.1.3**
**assemble**
activities for combining and connecting implemented *system elements* (3.1.11) or *aggregates* (3.1.2) to support specific goals, i.e. *integration* (3.1.5), *verification* (3.1.16), *validation* (3.1.14), manufacturing and production.

**3.1.4**
**enabling system**
*system* (3.1.10) that supports a *system-of-interest* (3.1.12) during its life cycle stages, but does not necessarily contribute directly to its function during operation

EXAMPLE When a system-of-interest enters the production stage, a production enabling system is required.

Note 1 to entry: Each enabling system has a life cycle of its own. ISO/IEC/IEEE 15288 is applicable to each enabling system when, in its own right, it is treated as a system-of-interest.

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.18]

**3.1.5**
**integration**
activities of combining several implemented *system elements* (3.1.11) and activating the *interfaces* (3.1.8) to form a realized system (product or service) that enables interoperation between the system elements and with other *systems* (3.1.10) to satisfy system requirements, architecture characteristics and design properties

Note 1 to entry: In this document, the term "integration" is limited to the integration of the implemented system elements which compose a system and the necessary life cycle related activities. Integration may occur to connect a *system-of-interest* (3.1.12) with external interoperating systems and/or *enabling systems* (3.1.4).

Note 2 to entry: The process of combining software components, hardware components or both into an overall system (ISO/IEC/IEEE 24765).


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**3.1.6**
**integration engineering**
set of activities that defines, analyzes and executes *integration* (3.1.5) across the life cycle, including interactions with other life cycle processes

Note 1 to entry: The application of the system life cycle processes and knowledge of the *system-of-interest* (3.1.12) are necessary in order to integrate a set of *system elements* (3.1.11) into a *system* (3.1.10).

**3.1.7**
**integration management**
set of activities that plans, assesses and controls the integration activities and all related activities

Note 1 to entry: It helps ensure that the process outcomes are achieved and that the integration related information items are identified, documented, maintained, communicated and traced throughout the life cycle of the concerned *system* (3.1.10).

**3.1.8**
**interface**
set of logical and/or physical characteristics required to exist at a common boundary or connection between *system elements* (3.1.11)

Note 1 to entry: As examples of interface definition, refer to ISO/IEC/IEEE 24765.

**3.1.9**
**supplier**
organization or individual that enters into an agreement with the *acquirer* (3.1.1) for the supply of a product or service

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.45]

**3.1.10**
**system**
combination of interacting elements organized to achieve one or more stated purposes

Note 1 to entry: A system may be considered as a product or as the services it provides.

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.46]

**3.1.11**
**system element**
member of a set of elements that constitute a *system* (3.1.10)

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.47]

**3.1.12**
**system-of-interest**
*system* (3.1.10) whose life cycle is under consideration in the context of this document

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.48]

**3.1.13**
**user**
individual or a group that benefits from a *system* (3.1.10) during its utilization

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.52, modified]

**3.1.14**
**validation**
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: A *system* (3.1.10) is able to accomplish its intended use, goals and objectives (i.e. meet stakeholder requirements) in the intended operational environment. The right system was built.

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[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.53]

**3.1.15**
**validation action**
action that describes what is to be validated (the element as reference), on which item the action is performed, the expected result from the performance of the action, the validation technique to apply and at which level of decomposition of the *system-of-interest* (3.1.12)

**3.1.16**
**verification**
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.54]

**3.1.17**
**verification action**
action that describes what is to be verified (the element as reference), on which item the action is performed, the expected result from the performance of the action, the verification technique to apply and at which level of decomposition of the *system-of-interest* (3.1.12)

## 3.2 Abbreviatied terms

IES Integration Enabling System

NDI Non-Developmental Item

SEI Software Engineering Institute

SoI System-of-Interest

# 4 Conformance

## 4.1 Intended usage

This document provides requirements and guidance for the execution of ISO/IEC/IEEE 15288 processes and activities that deal with integration engineering. This document also provides definition of the content and recommendations for the format of the information items or documentation that result from the implementation of the related processes.

## 4.2 Conformance to processes

This document provides requirements and recommendations for a number of integration engineering processes and related activities suitable for usage during the life cycle of a system (made of products and/or services).

The requirements and recommendations for processes in this document are contained in Clause 6.

## 4.3 Conformance to information item content

This document provides requirements and recommendations for a number of integration engineering information items to be produced during the life cycle of a system (made of products and/or services).


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The requirements and recommendations for information items in this document are contained in Clause 7.

NOTE In this document, for simplicity of reference, each information item is described as if it were published as a separate document. However, information items are considered as conforming if they are unpublished, but available in a repository for reference, divided into separate documents or volumes or combined with other information items into one document. It is not required to treat every topic in this document in the same order, using the same wording as its title or with the same level of detail. This will depend on the nature of the system, implementation methods, life cycle model and scope of the project; for example, test and Integration plan, a system engineering management plan containing integration plan information.

## 4.4 Full conformance

A claim of full conformance to this document is equivalent to claiming conformance

— to the provisions contained in 6.2 and 6.3, and

— to the information items cited in Clause 7.

## 4.5 Tailored conformance

### 4.5.1 Processes

This document does not make provision for tailoring processes. ISO/IEC/IEEE 15288:2015, Annex A provides normative direction regarding the tailoring of system life cycle process.

### 4.5.2 Information items

Information items described in this document are requirements and recommendations that can be adapted depending on the type of system, implementation methods, life cycle model and scope of the project.

# 5 Concepts and principles

## 5.1 General

This clause presents concepts and principles that apply to integration engineering and to the information items generated at all levels of the system-of-interest during the execution of the concerned processes. They also apply to the processes used in the integration itself and to management of the integration of a system.

## 5.2 Integration fundamentals

### 5.2.1 Terms and approaches

#### 5.2.1.1 Fundamental concept behind the term “integration”

As stated in 3.1.5, the term “integration” is defined as activities of combining several implemented system elements and activating the interfaces to form a realized system (product or service) that enables interoperation between the system elements and with other systems to satisfy system requirements, architecture characteristics and design properties. The execution of these activities provides something integrated that becomes a whole. Integration of the system involves its functions.

EXAMPLES

— The engine is integrated with chassis and suspension to form the vehicle.

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— Integrated repository: a repository for storing all information pertinent to the System Engineering Plan (SEP) to include all data, schema, models, tools, technical management decisions, process analysis information, requirement changes, process and product metrics and trade-offs (IEEE 1220-2005, 3.1.18).

— Integrated team: group of people with complementary skills and expertise who are committed to delivering specified work products in timely collaboration (ISO/IEC/IEEE 24765).

— Integrated circuit: a small piece of semiconductive material that contains interconnected electronic elements (ISO/IEC 2382)

The opposite of the verb "to integrate" is "to segregate" which means to take apart (synonyms: disassemble, separate).

To make the link with the term "system", it is notable that a system deals with a whole, without using explicitly the term whole in its ISO/IEC/IEEE 15288 definition (combination of interacting elements organized to achieve one or more stated purposes; see 3.1.10).

#### 5.2.1.2 Integration engineering approach

The concept of wholeness is key to integration engineering. Holistically, a system is more than the sum of its parts. So too, integration is more than mere assembly.

Integration engineering encompasses all activities throughout the life cycle of a system-of-interest that are linked to the integration of the implemented system elements to form the system-of-interest. This includes the following:

— the definition, preparation and performance of the assembly of the implemented system elements to form aggregates until obtaining the defined system-of-interest;

— the definition and performance of actions applied to aggregates in order to check the assembly focusing in particular on interfaces;

— the definition and performance of verification and validation actions applied to aggregates in order to check conformance of the assembly to the system requirements, architecture and design;

— the integration of the formed system into its context of use (environmental context); integration is recursive and so applies to the integration of the system-of-interest into the next level of the system structure.

It also includes the activities of other technical processes that influence and/or constrain, guide, serve and enable these previous activities.

It also includes the integration of the system-of-interest with interoperating systems and enabling systems. It is related to the engineering of enabling systems (set of enabling products and/or services) that support the integration of the system-of-interest (see 5.3.2).

The management of all these activities is part of the overall project management of the system-of-interest.

NOTE The system-of-interest can be composed of layers of system elements. A system element can be considered as a system or as a non-decomposable element. The system-of-interest is the highest abstraction in the decomposition into levels of systems.

While the system-of-interest is the highest level of abstraction in the decomposition of a particular system structure, systems can be abstracted up with respect to their interactions as part of one or more systems-of-systems. This perspective is necessary to aid the integration of the system-of-interest with the interoperating systems and enabling systems of its environment.

A system element is a discrete part of a system that can be implemented to fulfil specified requirements (for example, hardware, software, data, humans, processes, procedures, facilities, materials or any combination thereof).


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