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Systems and software engineering — System life cycle processes

Ingénierie des systèmes et du logiciel — Processus du cycle de vie du système

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialised 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.

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/IEC 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 or www.iec.ch/members_experts/refdocs).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/JTC 1, *Information technology,* Subcommittee SC 7, *Software and systems engineering,* in cooperation with the Systems and Software Engineering Standards Committee of the IEEE Computer Society, under the Partner Standards Development Organization cooperation agreement between ISO and IEEE.

This second edition cancels and replaces the first edition (ISO/IEC/IEEE 15288:2015), which has been technically revised.

The main changes are as follows:

— improvements to selected technical processes including business or mission analysis, system architecture definition, system analysis, implementation, integration, operations, and maintenance;

— improvements to selected technical management processes including risk management and configuration management;

— updates to Clause 5, key concepts, including a better description of iteration, recursion, system-of-systems, quality characteristics, etc.;

— new content in Clause 5 on concept and system definition, and expanded content on process application and system concepts;

— updates to the terms and definitions;

— a new annex addressing model-based systems engineering (MBSE).

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 and www.iec.ch/national-committees.

Introduction

The complexity of systems continues to increase to unprecedented levels. This has led to new opportunities, but also to increased challenges for the organizations that create and utilise systems. These challenges exist throughout the life cycle of a system and at all levels of architectural detail. This document provides a common process framework for describing the life cycle of systems, adopting a systems engineering approach. This document concerns systems that can be configured with one or more of the following system elements: hardware elements, software elements, data, humans, processes, services, procedures, facilities, materials, and naturally occurring entities.

This document focuses on defining stakeholder needs, concerns, priorities, and constraints for the required functionality early in the development cycle, establishing requirements, then proceeding with design synthesis and system validation while considering the complete problem. It integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from conception through production to operation. It considers the needs of all stakeholders with the goal of providing a quality product that meets the needs of users and other applicable stakeholders. It provides the processes for acquiring and supplying systems. It helps to improve communication and cooperation among the parties that create, utilise, and manage modern systems in order that they can work in an integrated, coherent fashion. Finally, this document provides the framework for assessment and improvement of the life cycle processes.

There is a wide variety of systems in terms of their purpose, domain of application, complexity, size, novelty, adaptability, quantity, location, life span, and evolution. The processes in this document form a comprehensive set from which an organization can construct system life cycle models appropriate to its products and services. An organization, depending on its purpose, can select and apply an appropriate subset to fulfil that purpose.

This document can be used in one or more of the following modes:

— By an organization — to help establish an environment of desired processes. These processes can be supported by an infrastructure of methods, procedures, techniques, tools, and trained personnel. The organization may then employ this environment to perform and manage its projects and progress systems through their life cycle stages. In this mode this document is used to assess conformance of a declared, established environment to its provisions. It can be used by a single organization in a self-imposed mode or in a multi-party situation. Parties can be from the same organization or from different organizations and the situation can range from an informal agreement to a formal contract.

— By a project — to help select, structure, and employ the elements of an established environment to provide products and services. In this mode this document is used in the assessment of conformance of the project to the declared and established environment.

— By an acquirer and a supplier — to help develop an agreement concerning processes and activities. Via the agreement, the processes and activities in this document are selected, negotiated, agreed to, and performed. In this mode this document is used for guidance in developing the agreement.

— By process assessors — to serve as a process reference model for use in the performance of process assessments that can be used to support organizational process improvement.

In the context of this document and ISO/IEC/IEEE 12207, there is a continuum of human-made systems from those that use little or no software to those in which software is the primary interest. When software is the predominant system or element of interest, ISO/IEC/IEEE 12207 should be used. Both documents have the same process model, share most activities and tasks, and differ primarily in descriptive notes.

Although this document does not establish a management system, it is intended to be compatible with the quality management system provided by ISO 9001, the service management system provided by ISO/IEC 20000 series, the IT asset management system provided by the ISO/IEC 19770 series, and the information security management system provided by ISO/IEC 27000.

Systems and software engineering — System life cycle processes

1 Scope

This document establishes a common framework of process descriptions for describing the life cycle of systems created by humans, defining a set of processes and associated terminology from an engineering viewpoint. These processes can be applied to systems of interest, their system elements, and to systems of systems. Selected sets of these processes can be applied throughout the stages of a system's life cycle. This is accomplished through the involvement of stakeholders, with the ultimate goal of achieving customer satisfaction.

This document defines a set of processes to facilitate system development and information exchange among acquirers, suppliers, and other stakeholders in the life cycle of a system.

This document specifies processes that support the definition, control, and improvement of the system life cycle processes used within an organization or a project. Organizations and projects can use these processes when acquiring and supplying systems.

This document applies to organizations in their roles as both acquirers and suppliers.

This document applies to the full life cycle of systems, including conception, development, production, utilization, support and retirement of systems, and to the acquisition and supply of systems, whether performed internally or externally to an organization. The life cycle processes of this document can be applied iteratively and concurrently to a system and recursively to the system elements.

This document applies to one-of-a-kind systems, mass-produced systems, and customised, adaptable systems. It also applies to a complete stand-alone system and to systems that are embedded and integrated into larger more complex and complete systems.

This document does not prescribe a specific system life cycle model, development methodology, method, modelling approach or technique.

This document does not detail information items in terms of name, format, explicit content, and recording media. ISO/IEC/IEEE 15289 addresses the content for life cycle process information items (documentation).

2 Normative references

There are no normative references in this document.

3 Terms, definitions, and abbreviated terms

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

ISO, IEC, and IEEE maintain terminology databases for use in standardization at the following addresses:

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

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

— IEEE Standards Dictionary Online: available at: https://dictionary.ieee.org/

NOTE Definitions for other system and software engineering terms can be found in ISO/IEC/IEEE 24765, available at www.computer.org/sevocab.

3.1
acquirer
stakeholder (3.44) that acquires or procures a *system* (3.46), *product* (3.32) or *service* (3.42) from a *supplier* (3.45)

Note 1 to entry: Other terms commonly used for an acquirer are buyer, *customer* (3.12), owner, purchaser, or internal/organizational sponsor.

3.2
acquisition
process (3.27) of obtaining a *system* (3.46), *product* (3.32) or *service* (3.42)

3.3
activity
set of cohesive *tasks* (3.51) of a *process* (3.27)

3.4
agreement
mutual acknowledgement of terms and conditions under which a working relationship is conducted

EXAMPLE Contract, memorandum of agreement.

3.5
architecture
fundamental concepts or properties of a *system* (3.46) in its *environment* (3.16) and governing principles for the realization and evolution of this system and its related *life cycle* (3.21) *processes* (3.27)

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.3, modified — ‘entity’ has been replaced with ‘system’; notes to entry have been removed.]

3.6
artefact
work *product* (3.32) that is produced and used during a project to capture and convey information

EXAMPLE Models, stakeholder requirements, system/software requirements, architecture descriptions, design descriptions, source code, implemented system elements, verified or validated system.

[SOURCE: ISO 19014-4:2020, 3.9, modified — EXAMPLE has been added.]

3.7
audit
independent examination of a work *product* (3.32) or set of work products to assess compliance with specifications, standards, contractual *agreements* (3.4), or other criteria

3.8
baseline
formally approved version of a *configuration item* (3.11), regardless of media, formally designated and fixed at a specific time during the configuration item's *life cycle* (3.21)

[SOURCE: IEEE Std 828-2012]

3.9
concept of operations
verbal and graphic statement, in broad outline, of an *organization’s* (3.25) assumptions or intent in regard to an operation or series of operations of new, modified, or existing organizational *systems* (3.46)

Note 1 to entry: The concept of operations frequently is embodied in long-range strategic plans and annual operational plans. In the latter case, the concept of operations in the plan covers a series of connected operations to be carried out simultaneously or in succession to achieve an organizational performance objective. See also *operational concept* (3.23).

Note 2 to entry: The concept of operations provides the basis for bounding the operating space, system capabilities, *interfaces* (3.19), and operating *environment* (3.16).

[SOURCE: ANSI/AIAA G-043B-2018, 5.2, modified — The second definition has been used; the last two sentences of Note 1 to entry have been removed; Note 2 to entry has been added.]

3.10
concern
matter of interest or importance to a *stakeholder* (3.44)

Note 1 to entry: A concern pertains to any influence on a *system* (3.46) in its *environment* (3.16), including developmental, technological, business, operational, organizational, political, economic, legal, regulatory, ethical, ecological, and social influences.

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.8, modified — EXAMPLE has been removed; Note 1 to entry has been added.]

3.11
configuration item
item or aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management *process* (3.27)

3.12
customer
organization (3.25) or person that receives a *product* (3.32) or *service* (3.42)

EXAMPLE Consumer, client, *user* (3.53), *acquirer* (3.1), buyer, or purchaser.

Note 1 to entry: A customer can be internal or external to the organization.

3.13
design, noun
specification of *system elements* (3.47) and their relationships, that is sufficiently complete to support a compliant implementation of the *architecture* (3.5)

Note 1 to entry: Design provides the detailed implementation-level physical structure, behaviour, temporal relationships, and other attributes of system elements.

3.14
design characteristics
design attributes or distinguishing features that pertain to a measurable description of a *product* (3.32) or *service* (3.42)

3.15
enabling system
system (3.46) that supports a *system-of-interest* (3.48) during its *life cycle* (3.21) *stages* (3.43) but does not necessarily contribute directly to its function during operation

EXAMPLE Production-enabling system, which is required when a system-of-interest enters the production stage.

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

3.16
environment
<system> context determining the setting and circumstances of all influences upon a *system* (3.46)

3.17
incident
anomalous or unexpected event, set of events, condition, or situation at any time during the *life cycle* (3.21) of a *project* (3.33), *product* (3.32), *service* (3.42), or *system* (3.46)

Note 1 to entry: An incident is elevated and treated as a *problem* (3.26) when the cause of the incident needs to be analysed and corrected to prevent reoccurrence to avoid or minimise loss of life, or damage of property or natural *resources* (3.37).

3.18
information item
separately identifiable body of information that is produced, stored, and delivered for human use

[SOURCE: ISO/IEC/IEEE 15289:2019, 3.1.12, modified — The preferred term "information product" has been removed; notes to entry have been removed.]

3.19
interface
point at which two or more logical, physical, or both, *system elements* (3.47) or software system elements meet and act on or communicate with each other

[SOURCE: ISO/IEC/IEEE 24748-6: —, 3.1.3]

3.20
interoperating system
system (3.46) that exchanges information with the *system-of-interest* (3.48) and uses the information that has been exchanged

3.21
life cycle
evolution of a *system* (3.46), *product* (3.32), *service* (3.42), *project* (3.33) or other human-made entity from conception through *retirement* (3.38)

3.22
life cycle model
framework of *processes* (3.27) and *activities* (3.3) concerned with the *life cycle* (3.21) which can be organized into *stages* (3.43), acting as a common reference for communication and understanding

3.23
operational concept
verbal and graphic statement of an *organization's* (3.25) assumptions or intent in regard to an operation or series of operations of a specific *system* (3.46) or a related set of specific new, existing or modified systems

Note 1 to entry: The operational concept is designed to give an overall picture of the operations using one or more specific systems, or set of related systems, in the organization's operational *environment* (3.16) from the *users'* (3.53) and *operators'* (3.24) perspectives. See also *concept of operations* (3.9).

Note 2 to entry: The operational concept is about systems, while a *concept of operations* (3.9) typically refers to organizations.

[SOURCE: ANSI/AIAA G-043B-2018, 5.2, modified — The third definition has been used; the first sentence in Note 1 to entry has been removed; Note 2 to entry has been added.]

3.24
operator
individual or *organization* (3.25) that performs the operations of a *system* (3.46)

Note 1 to entry: The role of operator and the role of *user* (3.53) can be vested, simultaneously or sequentially, in the same individual or organization.

Note 2 to entry: An individual operator combined with knowledge, skills, and procedures can be considered as an element of the system.

Note 3 to entry: An operator may perform operations on a system that is operated, or of a system that is operated, depending on whether or not operating instructions are placed within the system boundary.

3.25
organization
person or group of people that has its own functions with responsibilities, authorities, and relationships to achieve its objectives

EXAMPLE Company, corporation, firm, enterprise, manufacturer, institution, charity, sole trader, association, or parts or combination thereof.

[SOURCE: ISO 9000:2015, 3.2.1, modified — Notes to entry have been removed; EXAMPLE has been added.]

3.26
problem
difficulty, uncertainty, or otherwise realised and undesirable event, set of events, condition, or situation that requires investigation and corrective action

3.27
process
set of interrelated or interacting *activities* (3.3) that transform inputs into outputs

3.28
iteration
<process> repeating the application of the same *process* (3.27) or set of processes on the same level of the *system* (3.46) structure

3.29
process purpose
high level objective of performing the *process* (3.27) and the likely outcomes of effective implementation of the process

Note 1 to entry: The purpose of implementing the process is to provide benefits to the *stakeholders* (3.44).

3.30
process outcome
observable result of the successful achievement of the *process purpose* (3.29)

3.31
recursion
<process> repeating the application of the same *process* (3.27) or set of processes to successive levels of *system elements* (3.47) in the system structure

3.32
product
output of an *organization* (3.25) that can be produced without any transaction taking place between the organization and the *customer* (3.12)

Note 1 to entry: The dominant element of a product is that it is generally tangible.

[SOURCE: ISO 9000:2015, 3.7.6, modified — Notes 1 and 3 to entry have been removed.]

3.33
project
endeavour with defined start and finish criteria undertaken to create a *product* (3.32) or *service* (3.42) in accordance with specified *resources* (3.37) and *requirements* (3.36)

Note 1 to entry: A project is sometimes viewed as a unique *process* (3.27) comprising coordinated and controlled *activities* (3.3) and composed of activities from the Technical Management and Technical Processes defined in this document.

Note 2 to entry: Continuous development approaches such as agile and DevOps can use different terminology for the creation of product and services.

3.34
quality assurance
QA
part of quality management focused on providing confidence that quality *requirements* (3.36) will be fulfilled

[SOURCE: ISO 9000:2015, 3.3.6, modified — The abbreviated term has been added.]

3.35
quality characteristic
inherent characteristic of a *product* (3.32), *service* (3.42), *process* (3.27), or *system* (3.46) related to a *requirement* (3.36)

[SOURCE: ISO 9000:2015, 3.10.2, modified — 'object' has been replaced with 'product, service, process, or system'; notes to entry have been removed.]

3.36
requirement
statement which translates or expresses a need and its associated constraints and conditions

[SOURCE: ISO/IEC/IEEE 29148:2018, 3.1.19, modified — Notes to entry have been removed.]

3.37
resource
asset that is utilised or consumed during the execution of a *process* (3.27)

Note 1 to entry: Resource includes diverse entities such as funding, personnel, facilities, capital equipment, tools and utilities such as power, water, fuel, and communication infrastructures.

Note 2 to entry: Resources include those that are reusable, renewable or consumable.

3.38
retirement
<system> withdrawal of active support by the operation and maintenance *organization* (3.25), partial or total replacement by a new *system* (3.46), or installation of an upgraded system, or final decommissioning and disposal

3.39
risk
effect of uncertainty on objectives

Note 1 to entry: An effect is a deviation from the expected — positive or negative. A positive effect is also known as an opportunity.

Note 2 to entry: Objectives can have different aspects [such as financial, health and *safety* (3.40), and environmental goals] and can apply at different levels [such as strategic, organization-wide, project, *product* (3.32) and *process* (3.27)].

Note 3 to entry: Risk is often characterized by reference to potential events and consequences, or a combination of these.

Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

Note 5 to entry: Uncertainty is the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood.

[SOURCE: ISO Guide 73:2009, 1.1, modified — The last sentence in Note 1 to entry has been added.]

3.40
safety
expectation that a *system* (3.46) does not, under defined conditions, lead to a state in which human life, health, property, or the *environment* (3.16) is endangered

Note 1 to entry: The term is alternatively defined as freedom from *risk* (3.39) which is not tolerable.

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.48, modified — Note 1 to entry has been added.]

3.41
security
protection against intentional subversion or forced failure

Note 1 to entry: Security includes authenticity, accountability, confidentiality, integrity, availability, non-repudiation, and reliability, all of which have the related issue of their assurance.

[SOURCE: NATO AEP-67, modified — Note 1 to entry has been updated.]

3.42
service
output of an *organization* (3.25) with at least one *activity* (3.3) necessarily performed between the organization and the *customer* (3.12)

Note 1 to entry: The dominant elements of a service are generally intangible.

Note 2 to entry: A service is coherent, discrete, and can be composed of other services.

[SOURCE: ISO 9000:2015, 3.7.7, modified — Notes 2, 3, and 4 to entry have been replaced by a new Note 2 to entry.]

3.43
stage
period within the *life cycle* (3.21) of an entity that relates to the state of its description or realization

Note 1 to entry: As used in this document, stages relate to major progress and achievement milestones of the entity through its life cycle.

Note 2 to entry: Stages often overlap.

3.44
stakeholder
individual or *organization* (3.25) having a right, share, claim, or interest in a *system* (3.46) or in its possession of characteristics that meet their needs and expectations

EXAMPLE End *users* (3.53), end user organizations, supporters, developers, *customers* (3.12), producers, trainers, maintainers, disposers, *acquirers* (3.1), *suppliers* (3.45), regulatory bodies, and people influenced positively or negatively by a system.

Note 1 to entry: Some stakeholders can have interests that oppose each other or oppose the system.

3.45
supplier
organization (3.25) or an individual that enters into an *agreement* (3.4) with the *acquirer* (3.1) for the supply of a *product* (3.32) or *service* (3.42)

Note 1 to entry: Other terms commonly used for supplier are contractor, producer, seller or vendor.

Note 2 to entry: The acquirer and the supplier sometimes are part of the same organization.