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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*



Reference number  
ISO/IEC/IEEE 15288:2023(E)



**Documents**

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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](http://www.iso.org/directives) or [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs)).

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

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. 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](http://www.iso.org/patents)) or the IEC list of patent declarations received (see <https://patents.iec.ch>).

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](http://www.iso.org/iso/foreword.html). In the IEC, see [www.iec.ch/understanding-standards](http://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](http://www.iso.org/members.html) and [www.iec.ch/national-committees](http://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 Overview~~

### 1 Scope

This [document](#) ~~International Standard~~ establishes a common framework of process descriptions for describing the life cycle of systems created by humans, [defining](#) ~~It defines~~ 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](#) ~~at any level in the hierarchy of a system's structure~~. Selected sets of these processes can be applied throughout the ~~life cycle for managing and performing the~~ stages of a system's life cycle. This is accomplished through the involvement of ~~all~~ 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 ~~International Standard also provides~~ 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 International Standard concerns those systems that are man-made and may be configured with one or more of the following system elements: hardware, software, data, humans, processes (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials and naturally occurring entities.~~

~~When a system element is software, the software life cycle processes in ISO/IEC/IEEE 12207:2015 may be used to implement that system element. The two standards are harmonized for concurrent use on a single project or in a single organization.~~

### 1.2 Purpose

~~The purpose of this International Standard is to provide a defined set of processes to facilitate communication among acquirers, suppliers and other stakeholders in the life cycle of a system.~~

This [document](#) ~~International Standard~~ applies to organizations in their roles as both acquirers and suppliers. ~~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.~~

~~The processes in this International Standard can be used as a basis for establishing business environments, e.g., methods, procedures, techniques, tools and trained personnel. Annex A provides normative direction regarding the tailoring of these system life cycle processes.~~

### **~~1.3~~ Field of application**

This [document](#) ~~International Standard~~ 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](#) ~~International Standard~~ can be applied iteratively and concurrently [to a system and](#) recursively to [the](#) system ~~and incrementally to its~~ elements.

[This document](#) ~~There is a wide variety of systems in terms of their purpose, domain of application, complexity, size, novelty, adaptability, quantities, locations, life spans and evolution. This International Standard describes the processes that comprise the life cycle of man-made systems. It therefore~~ applies to one-of-a-kind systems, mass-produced systems, and customized ~~customized~~, 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 International Standard provides a process reference model characterized in terms of the process purpose and the process outcomes that result from the successful execution of the activity tasks. Annex B lists examples of artifacts and information items that may be associated with various processes. This International Standard can therefore be used as a reference model to support process assessment as specified in ISO/IEC 15504 2:2003. Annex C provides information regarding the use of the system life cycle processes as a process reference model. Annex D describes the process constructs for use in the process reference model.~~

## 1.4 Limitations

This ~~International Standard~~ does not prescribe a specific system life cycle model, development methodology, method, [modelling approach](#) ~~model~~ or technique. ~~The users of this International Standard are responsible for selecting a life cycle model for the project and mapping the processes, activities, and tasks in this International Standard into that model. The parties are also responsible for selecting and applying appropriate methodologies, methods, models and techniques suitable for the project.~~

~~Although this International Standard 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 20000-1:2011 (IEEE Std 20000-1:2013), and the information security management system provided by ISO/IEC 27000.~~

This [document](#) ~~International Standard~~ 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.](#)

~~None.~~

## 3 Terms, definitions, and abbreviated terms

### ~~4.1 Terms and definitions~~

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 ~~typically~~ can be found in ISO/IEC/IEEE 24765, available at [www.computer.org/sevocab](http://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**

~~<system>~~ fundamental concepts or properties of a *system* [\(3.46\)](#) in its *environment* [\(3.16\)](#) ~~embodied in its elements, relationships,~~ and ~~governing in the~~ principles [for the realization of its design](#) 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. ~~42010:2011~~]

## 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.]

### ~~architecture framework~~

~~conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders~~

~~EXAMPLE 1 Generalized Enterprise Reference Architecture and Methodologies (GERAM) [ISO 15704] is an architecture framework.~~

~~EXAMPLE 2 Reference Model of Open Distributed Processing (RM-ODP) [ISO/IEC 10746] is an architecture framework.~~

~~[SOURCE: ISO/IEC/IEEE 42010:2011]~~

## ~~4.1.7~~

### ~~architecture view~~

~~work product expressing the architecture of a system from the perspective of specific system concerns [SOURCE: ISO/IEC/IEEE 42010:2011]~~

### 4.1.8

#### **architecture viewpoint**

~~work product establishing the conventions for the construction, interpretation and use of architecture views to frame specific system concerns~~

~~[SOURCE: ISO/IEC/IEEE 42010:2011]~~

### 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

~~[SOURCE: ISO 24765:2010]~~

### 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 ~~.The concept is designed to~~ [achieve](#) ~~give~~ an [organizational performance objective](#) ~~overall picture of the organization operations~~. See also *operational concept* [\(3.23\)](#).

Note 2 to entry: [The concept of operations](#) ~~It~~ 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.](#) ~~G-043A-2012e~~]

### 3.10

#### concern

[matter of](#) ~~<system>~~ interest [or importance](#) ~~in a system relevant~~ to [a stakeholder](#) [\(3.44\)](#) ~~one or more of its stakeholders~~

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.](#) ~~42010:2011~~]

### 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* [\(3.27\)](#)

~~[SOURCE: ISO/IEC/IEEE 24765:2010, modified to include “item”]~~

### 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.

~~[SOURCE: ISO 9000:2005, modified — added ‘service’]~~

### 4.1.15

#### **design, verb**

~~<process> to define the architecture, system elements, interfaces, and other characteristics of a system or system element~~

~~[SOURCE: ISO/IEC/IEEE 24765:2010, modified—changed 'components' to 'system elements']~~

### 3.13

#### **design, noun**

~~result of the process in 4.1.15~~

~~Note 1 to entry: Information, including~~ 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, behavior ~~behavior~~, temporal relationships, and other attributes of system elements.

~~[SOURCE: ISO/IEC/IEEE 24765:2010]~~

### 3.14

#### **design characteristics ~~characteristic~~**

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

~~[SOURCE: ISO/IEC/IEEE 24765:2010]~~

### 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    **a** 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](#) ~~International Standard~~ 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* [\(3.46\)](#)

~~[ISO/IEC/IEEE 42010:2011]~~

### 4.1.20

#### **facility**

~~physical means or equipment for facilitating the performance of an action, e.g., buildings, instruments, tools~~

### 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. ~~15289:2011~~ ]

### **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 ~~also acts~~ 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 ~~perspective~~. 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. ~~G-043A-2012e~~ ]

## 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](#) ~~and facilities~~ with ~~an arrangement of~~ responsibilities, authorities, and relationships [to achieve its objectives](#)

EXAMPLE Company, corporation, firm, enterprise, [manufacturer](#), institution, charity, sole trader, association, or parts or combination thereof.

~~Note 1 to entry: — An identified part of an organization (even as small as a single individual) or an identified group of organizations can be regarded as an organization if it has responsibilities, authorities and relationships. A body of persons organized for some specific purpose, such as a club, union, corporation, or society, is an organization.~~

[SOURCE: ISO 9000: [2015, 3.2.1](#) ~~2005~~, modified — [Notes](#) ~~Note 1~~ to entry [have been removed](#); [EXAMPLE](#) has been added.]

## ~~4.1.28~~

### ~~party~~

~~organization entering into an agreement~~

~~Note 1 to entry: — In this International Standard, the agreeing parties are called the acquirer and the supplier.~~

## 3.26

### problem

difficulty, uncertainty, or otherwise [realised](#) ~~realized~~ 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](#) ~~transforms~~ inputs into outputs

~~[SOURCE: ISO 9000:2005]~~

## [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\* \(3.12\)](#)

~~result of a process~~

Note 1 to entry: [The dominant element of a product is that it is](#) ~~Note 1 to entry: There are four agreed generic product categories: hardware (e.g., engine mechanical part); software (e.g., computer program); services (e.g., transport); and processed materials (e.g., lubricant). Hardware and processed materials are generally tangible products, while software or services are generally intangible.~~

[SOURCE: ISO 9000:[2015, 3.7.6, modified — Notes 1 and 3 to entry have been removed. 2005](#) ]

### 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 ~~co~~-coordinated and controlled *activities* [\(3.3\)](#) and composed of activities from the [Technical Management Project Processes](#) and Technical Processes defined in this [document International Standard](#).

[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.](#) ~~2005~~ ]

### 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* [\(3.36\)](#)

~~Note 1 to entry: Critical quality characteristics commonly include those related to health, safety, security, assurance, reliability, availability and supportability.~~

[SOURCE: ISO 9000: [2015, 3.10.2](#) ~~2005~~, modified — ‘object’ has been replaced with ‘product, service, process, or system’; notes to entry have been removed. ~~Note 1 to entry added~~ ]

#### 4.1.36

### quality management

~~coordinated activities to direct and control an organization with regard to quality~~

~~[SOURCE: ISO 9000:2005]~~

#### 3.36

### requirement

statement [which](#) ~~that~~ 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, 2011](#) ]

#### 3.37

### resource

asset that is [utilised](#) ~~utilized~~ 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, ~~definition~~ 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 ~~— A composite of four attributes~~

Note 1 to entry: Security includes authenticity, accountability, confidentiality, integrity, availability, non-repudiation, and reliability ~~— plus aspects of a fifth, usability~~, 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)

~~performance of activities, work, or duties~~

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

Note 2 to entry: A service ~~is self-contained~~, 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 ~~International Standard~~, 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) ~~supplier organizations and~~, 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.

### 3.46

#### system

[arrangement of parts or elements that together exhibit a stated behaviour or meaning that the individual constituents do not](#)

~~combination of interacting elements organized to achieve one or more stated purposes~~

Note 1 to entry: A system is sometimes considered as a *product* [\(3.32\)](#) or as the *services* [\(3.42\)](#) it provides.

Note 2 to entry: In practice, the interpretation of its meaning is frequently clarified by the use of an associative noun, e.g., aircraft system. Alternatively, the word “system” is substituted simply by a context-dependent synonym (e.g., aircraft), though this potentially obscures a system principles perspective.

Note 3 to entry: A complete system includes all of the associated equipment, facilities, material, computer programs, firmware, technical documentation, *services* [\(3.42\)](#), and personnel required for operations and support to the degree necessary for self-sufficient use in its intended *environment* [\(3.16\)](#).

### 3.47

#### system element

[discrete part of a system \(3.46\) that can be implemented to fulfil specified requirements \(3.36\)](#)

~~member of a set of elements that constitute a system~~

EXAMPLE Hardware, software, data, humans, *processes* (3.27) [e.g., processes for providing *service* (3.42) to users (3.53)], procedures [e.g., operator (3.24) instructions], facilities, materials, and naturally occurring entities or any combination.

~~Note 1 to entry: A system element is a discrete part of a system that can be implemented to fulfill specified requirements.~~

## 3.48

### system-of-interest

#### SoI

*system* (3.46) whose *life cycle* (3.21) is under consideration ~~in the context of this International Standard~~

## 3.49

### system of systems

#### SoS

set of *systems* (3.46) or *system elements* (3.47) that interact to provide a unique capability that none of the constituent systems can accomplish on its own

[SOURCE: ISO/IEC/IEEE 21839:2019, 3.1.4]

## 3.50

### systems engineering

transdisciplinary and integrative approach to enable the successful realization, use, and *retirement* (3.38) of engineered *systems* (3.46) using systems principles and concepts and scientific, technological and management methods

[SOURCE: INCOSE-TP-2020-002-06]

~~interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution throughout its life~~

### 3.51

#### **task**

required, recommended, or permissible action, intended to contribute to the achievement of one or more outcomes of a *process* [\(3.27\)](#)

### [3.52](#)

#### [\*\*traceability\*\*](#)

[discernible association among two or more logical entities, such as \*requirements\* \(3.36\), \*system elements\* \(3.47\), \*verifications\* \(3.55\), or \*tasks\* \(3.51\)](#)

[\[SOURCE: ISO/IEC TR 29110-1:2016, 3.71, modified — "discernible" has been added; EXAMPLE has been removed.\]](#)

### ~~4.1.51~~

#### ~~**trade-off**~~

~~decision-making actions that select from various requirements and alternative solutions on the basis of net benefit to the stakeholders~~

### 3.53

#### **user**

individual or group that interacts with a *system* [\(3.46\)](#) or benefits from a system during its utilization

Note 1 to entry: The role of user and the role of *operator* [\(3.24\)](#) are sometimes vested, simultaneously or sequentially, in the same individual or *organization* [\(3.25\)](#).

[\[SOURCE: ISO/IEC 25010:2011, 4.3.16, modified — The original Note 1 to entry has been replaced by a new one. \]](#)

## 3.54

### validation

confirmation, through the provision of objective evidence, that the *requirements* (3.36) for a specific intended use or application have been fulfilled

Note 1 to entry: In a life cycle (3.21) context, validation involves the set of activities (3.3) for gaining confidence that a system (3.46) is able to accomplish its intended use, goals, and objectives (i.e., meet stakeholder requirements) in an environment (3.16) like the intended operational environment. The right system was built.

[SOURCE: ISO 9000:2015, 3.8.13 2005, modified — Notes 1 to 3 to entry have been removed; a new Note 1 to entry has been added.]

## 3.55

### verification

confirmation, through the provision of objective evidence, that specified *requirements* (3.36) have been fulfilled

Note 1 to entry: Verification is a set of *activities* (3.3) that compares a *system* (3.46) or *system element* (3.47) against the required characteristics. This includes, but is not limited to, specified requirements, *design* (3.13) description, and the system itself. The system was built right.

[SOURCE: ISO 9000: 2015, 3.8.12 2005, modified — Notes 1 to 3 to entry have been removed; a new Note 1 to entry has been added.]

## 3.56

### view

representation of a system (3.46) from the perspective of a related set of concerns (3.10)

Note 1 to entry: A view can be an operational, functional, or architectural representation of a system.

[SOURCE: ISO/IEC/IEEE 24774:2021, 3.21, modified — removed 'whole' from the definition and the original Note 1 to entry has been replaced by a new one.]

## 3.57

### viewpoint

specification of the conventions for constructing and using a *view* (3.56)

[SOURCE: ISO/IEC/IEEE 24774:2021, 3.22, modified — Notes 1 to 3 to entry have been removed.]

## 4 Conformance

### 4.1 Intended usage

The requirements in this document ~~International Standard~~ are contained in Clause 6 and Annex A. This document ~~International Standard~~ provides requirements for a number of processes suitable for usage during the life cycle of a system ~~or product~~. It is possible ~~recognized~~ that particular projects or organizations ~~may not~~ need only some ~~to use all~~ of the processes provided by this document ~~International Standard~~. Therefore, implementation of this document ~~International Standard~~ typically involves selecting and declaring a set of processes suitable to the organization or project. There are two ways that an implementation can be claimed to conform to the provisions of this document ~~International Standard~~ – full conformance and tailored conformance.

There are two criteria for claiming full conformance. Achieving either criterion suffices for conformance, although the chosen criterion (or criteria) shall ~~is to~~ be stated in the claim. Claiming “full conformance to tasks” asserts that all of the requirements of the activities and tasks of the declared set of processes are achieved. Alternatively, claiming “full conformance to outcomes” asserts that all of the required outcomes of the declared set of processes are achieved. Full conformance to outcomes permits greater freedom in the implementation of conforming processes and can ~~may~~ be useful for implementing processes to be used in the context of an innovative life cycle model.

NOTE 1 Options for conformance are provided for needed flexibility in the application of this document ~~International Standard~~. Each process has a set of objectives (phrased as “outcomes”) and a set of activities and tasks that represent one way to achieve the objectives.

NOTE 2 Users who implement the activities and tasks of the declared set of processes can assert full conformance to tasks of the selected processes. Some users, however, ~~can might~~ have innovative process variants that achieve the objectives (i.e., the outcomes) of the declared set of processes without implementing all of the activities and tasks. These users can assert full conformance to the outcomes of the declared set of processes. The two criteria – conformance to task and conformance to outcome – are necessarily not equivalent since specific performance of activities and tasks ~~can may~~ require, in some cases, a higher level of capability than just the achievement of outcomes.

~~NOTE 3 — When this International Standard is used to help develop an agreement between an acquirer and a supplier, clauses of this International Standard can be selected for incorporation in the agreement with or without modification. In this case, it is more appropriate for the acquirer and supplier to claim compliance with the agreement than conformance with this International Standard.~~

NOTE 3 An organization (~~e.g. for example~~, national, industrial association, company) imposing this ~~document International Standard~~ as a condition of trade can specify and make public the minimum set of required processes, outcomes, activities, and tasks, which constitute suppliers' compliance with the conditions of trade.

NOTE 4 Requirements of this ~~document International Standard~~ are marked by the use of the verb "shall". Recommendations are marked by the use of the verb "should". Permissions are marked by the use of the verb "may". However, despite the verb that is used, the requirements for conformance are selected as described previously.

## 4.2 Full conformance

### 4.2.1 Full conformance to outcomes

A claim of full conformance declares the set of processes for which conformance is claimed. Full conformance to outcomes is achieved by demonstrating that all of the outcomes of the declared set of processes have been achieved. In this situation, the provisions for activities and tasks of the declared set of processes are guidance rather than requirements, regardless of the verb form that is used in the provision.

NOTE One intended use of this [document](#) ~~International Standard~~ is to facilitate process assessment and improvement. For this purpose, the objectives of each process are written in the form of 'outcomes' compatible with the provisions of [the ISO/IEC 33000 family of standards](#) ~~15504-2 and ISO/IEC 33002~~. Those standards provide for the assessment of the processes of this [document](#) ~~International Standard~~, providing a basis for improvement. Users intending process assessment and improvement ~~can may~~ use the process outcomes written in this [document](#) ~~International Standard~~ as the "process reference model" required by ~~ISO/IEC 15504-2 and~~ ISO/IEC 33002.

## 4.2.2 Full conformance to tasks

A claim of full conformance declares the set of processes for which conformance is claimed. Full conformance to tasks is achieved by demonstrating that all of the requirements of the activities and tasks of the declared set of processes have been achieved. In this situation, the provisions for the outcomes of the declared set of processes are guidance rather than requirements, regardless of the verb form that is used in the provision.

NOTE A claim of full conformance to tasks ~~can may~~ be appropriate in contractual situations where an acquirer or a regulator requires detailed understanding of the suppliers' processes.

## 4.3 Tailored conformance

When this [document](#) ~~International Standard~~ is used as a basis for establishing a set of processes that do not qualify for full conformance, the [processes in Clause 6](#) ~~clauses~~ of this [document shall be](#) ~~International Standard are~~ selected or modified in accordance with the tailoring process prescribed in Annex A. The tailored [set of processes](#) ~~text~~, for which tailored conformance is claimed, ~~are is~~ declared. Tailored conformance is achieved by demonstrating that the outcomes, activities, and tasks, as tailored, have been achieved.

**NOTE 1** ~~Annex A, which is normative, defines the basic activities needed to perform tailoring of this International Standard. Note that~~ Tailoring ~~can may~~ diminish the perceived value of a claim of conformance to this [document](#) ~~standard. This is~~ because it is difficult for other organizations to understand the extent to which tailoring ~~can may~~ have deleted desirable provisions

**NOTE 2** An organization asserting a ~~single-party~~ claim of conformance to this [document can standard-may](#) find it advantageous to claim full conformance to a smaller list of processes rather than tailored conformance to a larger list of processes.

**NOTE 3** [An organization can also choose to claim full conformance to a selected set of processes as well as tailored conformance to other processes.](#)

## **4.2 ~~Abbreviated terms~~**

~~CM Configuration Management~~

~~CCB Configuration Control Board~~

~~COTS Commercial Off The Shelf~~

~~FCA Functional Configuration Audit~~

~~NDI Non-developmental Items~~

~~PCA Physical Configuration Audit~~

~~QA Quality Assurance~~

~~SDP Software Development Plan~~

~~SEMP Systems Engineering Management Plan~~

~~SOI System of Interest~~

~~SoS System of Systems~~

## **5 Key concepts and [their](#) application ~~of this International Standard~~**

### **5.1 [General](#) ~~Introduction~~**

This clause [highlights and explains](#) ~~is included to highlight and to help explain~~ essential concepts on which this [document](#) ~~International Standard~~ is based. Further elaboration of these concepts can be found in the ISO/IEC [/IEEE TR 24748-1 and ISO/IEC/ \(IEEE Std 24748-2, which provide guidelines 1-2011\) and 24748-2 \(IEEE Std 24748-2 2012\) guides](#) on the application of life cycle management.

## 5.2 System concepts

### 5.2.1 Systems

A system is an arrangement of parts or elements that together exhibit behaviour or meaning that the individual constituents do not. Systems can be either physical or conceptual, or a combination of both. Systems in the physical universe are composed of matter and energy, may embody information encoded in matter-energy carriers, and exhibit observable behaviour. Conceptual systems are abstract systems of pure information, and do not directly exhibit behaviour, but exhibit “meaning”. In both cases, the system’s properties (as a whole) result or emerge from the parts or elements and their individual properties and the relationships and interactions between and among the parts, the system and its environment.

~~The systems considered in this International Standard are man-made, created and utilized to provide products or services in defined environments for the benefit of users and other stakeholders. These systems may be configured with one or more of the following system elements: hardware, software, data, humans, processes (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials and naturally occurring entities. As viewed by the user, they are thought of as products or services.~~

The perception and definition of a particular system, its architecture and its system elements depend on a stakeholder's interests and responsibilities. One stakeholder's system-of-interest ([SoI](#)) can be viewed as a system element in another stakeholder's [SoI](#) ~~system-of-interest~~. Furthermore, [an SoI](#) ~~a system-of-interest~~ can be viewed as being part of the environment for another stakeholder's [SoI](#). Also, an SoI can be viewed as a constituent system in an SoS ~~system-of-interest~~.

The following are key points regarding the characteristics of the [SoI](#) (also see [Figure 1](#) and [Figure 2](#)) ~~systems-of-interest~~ :

- a) defined boundaries encapsulate meaningful needs and practical solutions;
- b) there is a hierarchical or other relationship between system elements;
- c) an entity at any level in the [SoI](#) ~~system-of-interest~~ can be viewed as a system;
- d) a system comprises an integrated, defined set of subordinate system elements;

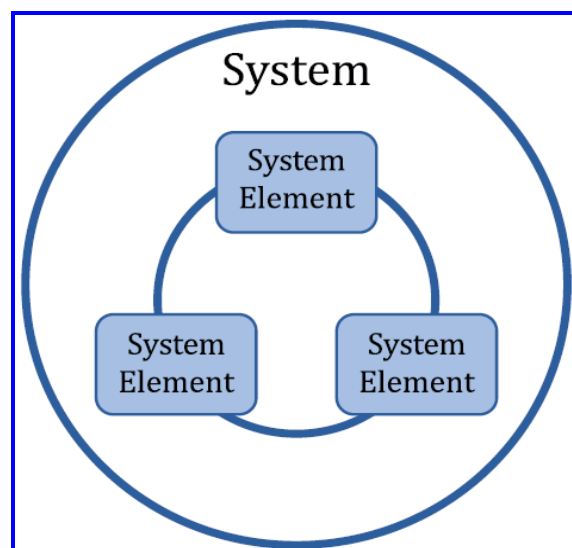
- e) humans can be viewed as both users external to a system (e.g. [users](#)) and as system elements (~~i.e.~~ operators) within a system;
- f) a system can be viewed in isolation as an entity, i.e. ~~a~~ product; or as a collection of functions capable of interacting with its surrounding environment, i.e. ~~a~~ set of services.

NOTE Services, hardware elements, and software elements can be products or services if they are either individual SoIs or constituents in an SoS. Consideration of services and products integrated within a system is sometimes called a product-service system[65]. Product-service systems provide a means for organizations to offer services related to their products.

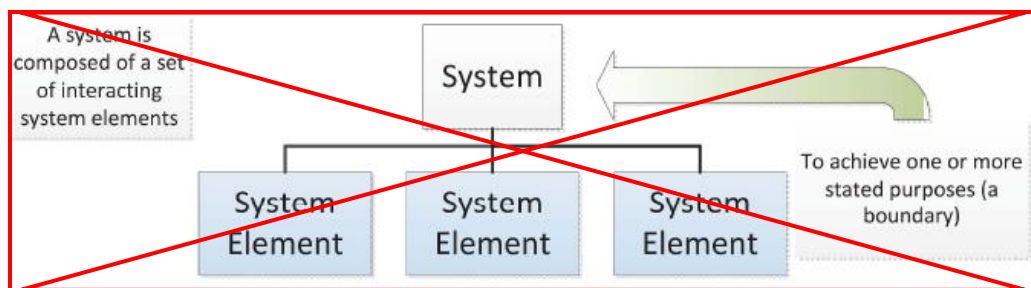
Whatever the boundaries chosen to define the system, the concepts in this [document](#) ~~International Standard~~ are generic and permit a practitioner to correlate or adapt individual instances of life cycles to its system principles.

## 5.2.2 System structure

The system life cycle processes in this [document](#) ~~International Standard~~ are described in relation to a system (see Figure 1) ~~which that~~ is composed of a set of interacting system elements, each of which can be implemented to ~~fulfil fulfill~~ its respective specified requirements. System elements may include software elements, hardware elements, services, and utilization and support resources. Responsibility for the implementation of any system element may ~~therefore~~ be delegated to another party through an agreement.



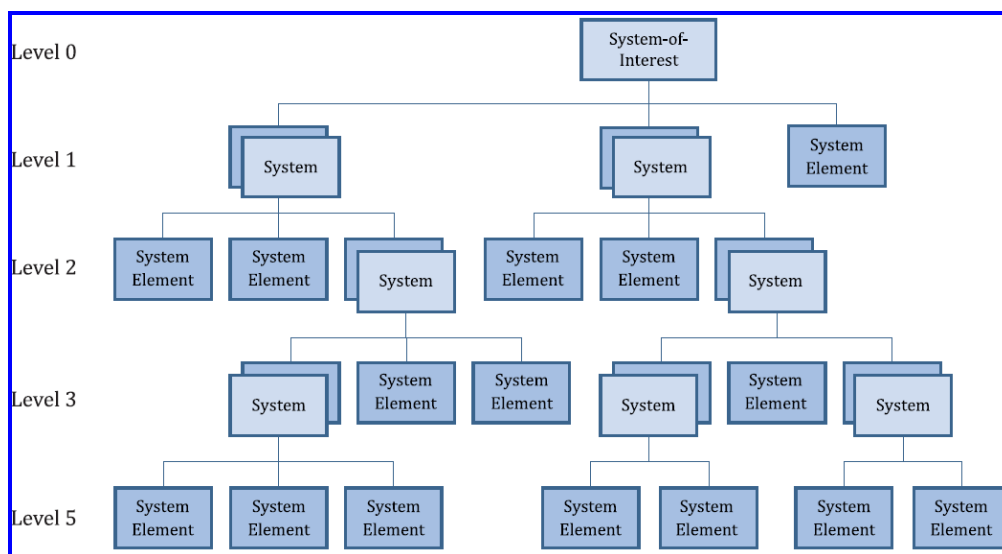
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**Figure 1 — System and system element relationship**

The relationship between ~~the system and its complete set of~~ system elements can typically be ~~expressed~~ ~~represented~~ in ~~many forms, including hierarchies or networks~~ ~~a hierarchy for the simplest of systems of interest~~. For more complex ~~SoIs~~ ~~systems of interest~~, a prospective system element may itself need to be considered as a system (that in turn is comprised of system elements) before a complete set of system elements can be defined with confidence (see Figure 2). In this manner, the appropriate system life cycle processes are applied recursively to ~~an SoI~~ ~~a system of interest~~ to resolve its structure to the point where understandable and manageable system elements can be implemented (made, bought, or reused). While Figures 1 and 2 imply a hierarchical relationship, in reality there are an increasing number of systems that, from one or more aspects, are not hierarchical, such as networks and other distributed systems. ~~5.4 Annex G~~ discusses the concept of a system of systems (SoS).



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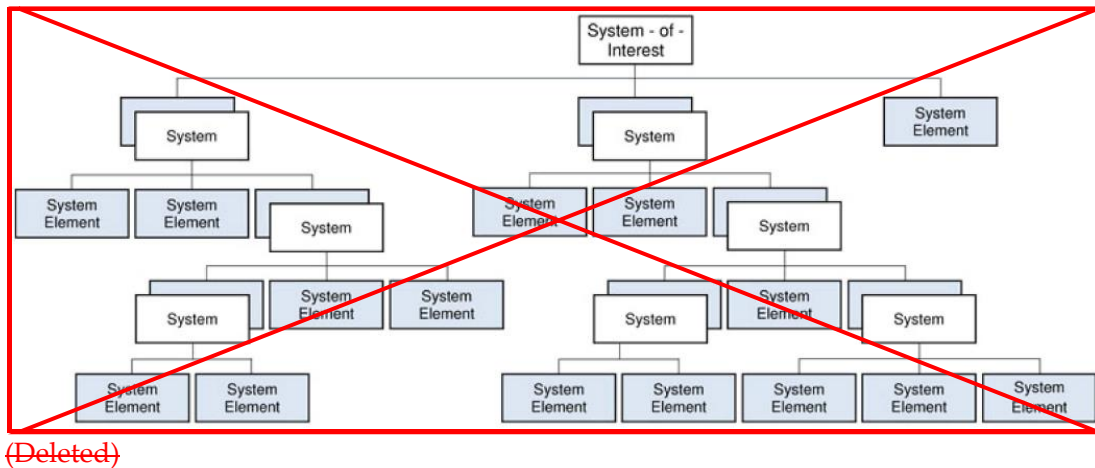


**Figure 2 — System-of-interest structure**

### 5.2.3 Interfacing, enabling, and interoperating systems

Any system sharing an interface (data or information, energy, resource, physical) with the SoI during any stage of the SoI's life cycle is an interfacing system and needs to be considered in the system development. Humans can be system elements of the SoI (e.g. an operator) or can be interfacing externally to the SoI (e.g. a user requesting information) throughout the SoI's life cycle stages.

Throughout the life cycle of an SoI ~~a system-of-interest~~, essential services are required from enabling systems, ~~that are not directly a part of the operational environment of the system-of-interest~~, e.g., mass-production system, training system, maintenance system. Each of these systems ~~enables a part e.g., a stage of the~~ lifecycle processes of the SoI ~~system-of-interest~~ to be conducted. SoIs often have interfaces with other systems that are used during ~~Termed "enabling systems", they facilitate progression of the system-of-interest through its~~ life cycle supports one or more stages other than operations. Some of these interfaces can be exclusive to that stage and not used during operation.

Systems that interact to perform a function are called interoperating systems, which are an important aspect in the context of systems of systems (see 5.4). Interoperating systems are a subset of the interfacing systems. While interoperability can involve the exchange and use of information, physical and other types of interoperability can be important. For example, many kinds of electronic devices now have power adapters appropriate for the user's location.

NOTE Interoperating systems can exchange information to enable an SoI to operate reliably, securely, usefully or efficiently, or to improve accessibility or usability. An interoperating system can also receive information from the SoI for use by other systems or SoS.

~~The relationship between the services delivered to the operational environment by the system of interest and the services delivered by the enabling systems to the system of interest are shown in Figure 3. Enabling systems can be seen to contribute indirectly to the services provided by the system of interest.~~

The interrelationships between the SoI ~~system of interest~~ and the interfacing, enabling, and interoperating systems can be bi-directional or a one-way ~~relationship. In addition to interacting with enabling systems, the system of interest may also interact with other systems in the operating environment, shown as Systems A, B, and C.~~ Requirements for the interrelationships ~~interfaces with enabling systems and other systems in the operational environment will~~ need to be included in the requirements for the SoI ~~system of interest~~.

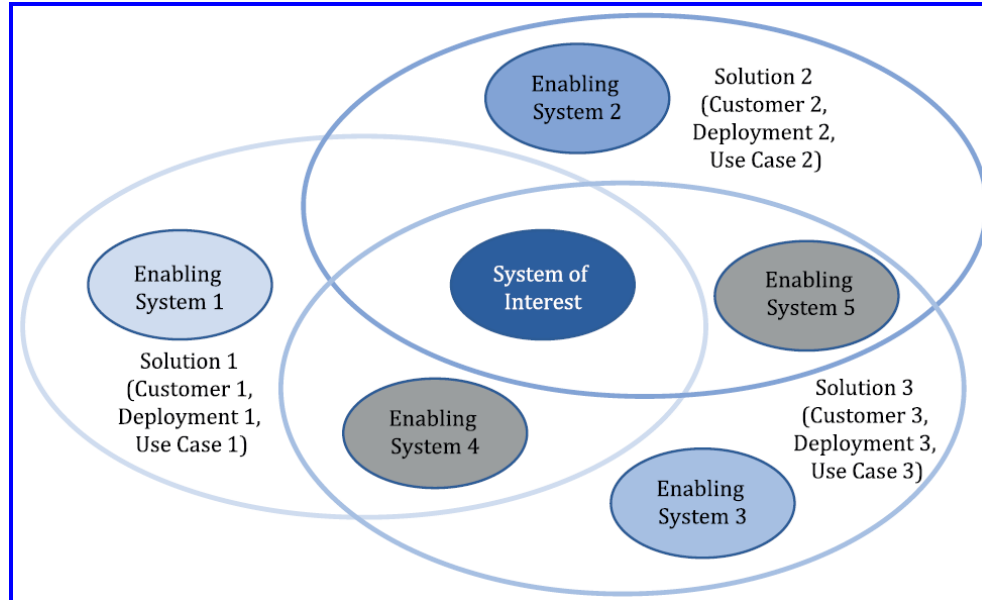
Further elaboration of these concepts can be found in the ISO/IEC/IEEE ~~TR~~ 24748-1 and ISO/IEC/IEEE 24748-2, which provide guidelines ~~guides~~ on the application of life cycle processes.

## 5.2.4 Concepts related to the system solution context

An SoI and its enabling systems are normally thought of as a solution addressing stakeholder concerns. The concerns of stakeholders are related to their business models. In particular, the concerns of an SoI supplier, an acquirer, and a user are different; this drives the need for them to consider different enabling systems to make the SoI viable in their own system solution context. Thus, the solution needs to consider the different stakeholder needs and business models.

EXAMPLE A manufacturing system is necessary for the supplier and is usually not considered by users and acquirers.

In this perspective, for a given SoI, the business or mission analysis process is intended to address the set of solution contexts (see Figure 3).



(New)

**Figure 3 — System solution contexts**

**NOTE** Several operational concepts, acquisition contexts and deployments can be associated with a given SoI. This multi-dimensional life description is provided in ISO 15704.

Variants and options shall be specified for the SoI to address the set of solution contexts. Products and services are often considered in system families and product lines with identification of elements common to different projects, and variants and options per project (see ISO/IEC 26550 for more details). Development of systems, products, and services often benefit from the identification of reuse opportunities between projects, including the establishment of product lines, families of products, systems, and systems of systems. These assets available for the projects are managed through the application of the knowledge management process.

### 5.2.5 Product line engineering (PLE)

When an organization develops a product line, engineering the product line holistically is much more effective and efficient than engineering each of the individual systems. This requires engineering the product line as a single SoI, with variations defined to support the individual system instances, for much of the life cycle. However, at the point in the life cycle where a specific system instance is developed, validated, and deployed into operation – an individual member of the product line – that system becomes an SoI itself that can continue with its own post-development life cycle, which can include production, support, utilization, retirement, and more. Variation management models are applied to manage the definition and production of the system instances. Whereas PLE generally focuses on the benefits of using a common platform with reusable assets for a product family, feature-based PLE addresses PLE in a holistic and automated manner (see ISO/IEC 26580).

In this approach, all of the system life cycle processes apply both when the product line is viewed as the SoI and when each instance of the product line with its variations is considered the SoI. From the holistic product line SoI perspective, many of the artefacts developed through the life cycle processes are shared across multiple members of the product line, which adds to the efficiency.

The following are key tenets of feature-based PLE:

- A collective set of features for the system instances in the product line (called the feature catalogue in ISO/IEC 26580) captures the distinguishing characteristics of how the members of the product line differ from each other and provides a common language of variation throughout the organization. The feature catalogue is a special type of MBSE (model-based systems engineering) model that helps to analyse and address the variations in the product line (see Annex D).
- The features selected for a system instance in a product line portfolio are specified in a collection of features applicable to that instance (called the bill of features in ISO/IEC 26580).

- All engineering artefacts that support the creation, design, implementation, deployment, and operation of products are identified and maintained as a single copy of all content used in any system in the product line – i.e. no duplication (called shared asset supersets in ISO/IEC 26580). Content used in all products is common content, which is managed collectively for the product line. Content that varies in one or more system instances is encapsulated with its variations (called the variation points in ISO/IEC 26580), which can be included, omitted, generated, or transformed for a given system instance, based on selected features.
- A system instance is comprised of the variation points, automatically derived according to the selected features for the instance, plus all common content.

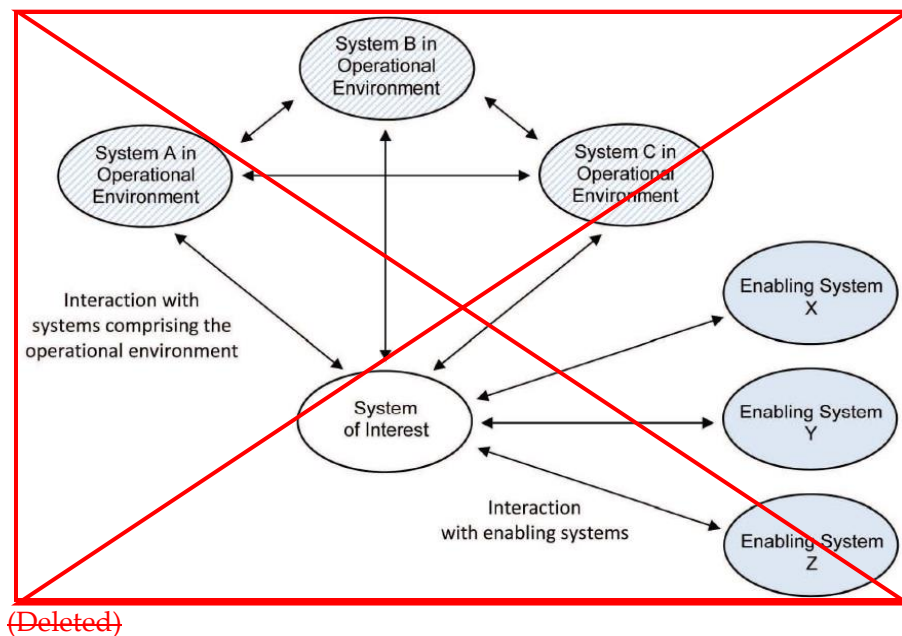


**Figure 3—System-of-interest, its operational environment and enabling systems**

During a stage in the system life cycle, the relevant enabling systems and the system of interest are considered together. Since they are interdependent, they can also be viewed as a system. When a suitable enabling system does not already exist, the project that is responsible for the system of interest can also be directly responsible for creating and using the enabling system. Creating the enabling systems can be viewed as a separate project and subsequently another system of interest. Further elaboration of these concepts can be found in the ISO/IEC/IEEE TR 24748 guides, on the application of life cycle processes.

## 5.3 Organizational concepts ~~Organization and project~~

### 5.3.1 Organizations

When an organization, as a whole or a part, enters into an agreement, it is sometimes called a “party” to the agreement. Parties can ~~may~~ be from the same organization or from separate organizations. An organization can ~~may~~ be as small as a single individual, if the individual is assigned responsibilities and authorities.

In informal terms, the organization that is responsible for executing a process is sometimes referred to by the name of that process. For example, the organization executing the acquisition process is sometimes called the “acquirer”. Other examples include supplier, implementer, maintainer, and operator.

A few other terms are applied to organizations in this document ~~standard~~: “user” can be the organization that benefits from the utilization of the product or service; “customer” refers to the user and acquirer collectively; and “stakeholder” refers to an individual or organization with an interest in the system.

The processes and organizations are only related functionally. This document ~~The standard~~ does not dictate or imply a structure for an organization, nor does it specify that particular processes are to be executed by particular parts of the organization. It is the responsibility of the organization that implements this document ~~the standard~~ to define a suitable structure for the organization and assign appropriate roles and responsibilities for the execution of processes.

The processes in this document ~~standard~~ form a comprehensive set to serve various organizations. An organization, small or large, depending on its ~~business~~ purpose or its acquisition strategy, can select an appropriate set of the processes (and associated activities and tasks) to fulfil ~~fulfill~~ that purpose. An organization may perform one process or more than one process.

This document ~~standard~~ is intended to be applied by an organization internally or ~~externally~~ by two or more organizations. When applied internally, the two agreeing parties typically act under the terms of an agreement that may vary in formality under different circumstances. When applied externally, the two agreeing parties typically act under the terms of a contract. This document ~~standard~~ uses the term “agreement” to apply to either situation.

For the purpose of this [document standard](#), any project is assumed to be conducted within the context of an organization. This is important because a project is dependent upon various outcomes produced by the [business](#) processes of the organization, e.g., employees to staff the project and facilities to house the project. For this purpose, this [document standard](#) provides a set of “organizational project-enabling” processes. These processes are not assumed to be adequate to operate [an organization a-business](#); instead, the processes, considered as a collection, are intended to state the minimum set of dependencies that the project places upon the organization.

### 5.3.2 Organization and project-level adoption

Modern [organizations businesses](#) strive to develop a robust set of life cycle processes that are applied repeatedly to the projects of the [organization business](#). Therefore, this [document standard](#) is intended to be useful for adoption at either the organization level or at the project level. An organization would adopt [this document the-standard](#) and supplement it with appropriate procedures, practices, tools, and policies. A project of the organization would typically conform to the organization's processes rather than conform directly to this [document standard](#).

In some cases, projects may be executed by an organization that does not have an appropriate set of processes adopted at the organizational level. Such a project may [directly adopt apply](#) the provisions of this [document standard directly to the project](#).

### 5.3.3 Organization and collaborative activities

Due to the increasing complexities of system solutions, it is often useful to employ collaborative and concurrent engineering approaches across the system life cycle. The following are some considerations:

- System life cycle activities are performed in a collaborative manner by involving stakeholders and subject matter experts concurrently, as practical.
- A collaborative framework can be defined within an organization or between organizations to facilitate the involvement of the range of stakeholders and experts. A collaborative framework includes shared methods, tools, and other resources, and establishes an environment for better communication and shared vision and values.
- Collaborative engineering is an essential element of iterative or incremental development approaches to help ensure timely feedback and communication across the stakeholders.

## **5.4 System of systems concepts**

### **5.4.1 Differences between systems and SoS**

An SoS is a set of systems that interact to provide a unique capability that none of the constituent systems can accomplish on its own. In the context of SoS, the relevant pieces of the SoI are, by definition, systems themselves. An SoS consists of some number of constituent systems, plus any inter-system infrastructure, facilities, and processes necessary to enable the constituent systems to integrate or interoperate.

Within an SoS, each constituent system is an independent system that forms part of an SoS. Constituent systems can be part of one or more SoS. Each constituent system is a useful system by itself, having its own development, management, utilization, goals, and resources, but interacts within the SoS to provide the unique capability of the SoS. These additional attributes are what distinguish SoS from a collection of systems.

A system may interact as part of one or more SoS in support of multiple capabilities. In this document, when the interaction of an SoI with an SoS is discussed, this may include one or more SoS in support of one or more capabilities.

The differences between systems and SoS are not in the structure or arrangement of the individual elements, but rather in the behavioural and managerial characteristics of those elements.

### **5.4.2 Managerial and operational independence**

Systems operate within a context of managerial control subject to governance. Organizations govern a portfolio of programmes through goals and objectives, subject to laws, regulations, and external agreements such as contracts. Programmes manage some number of projects to achieve those goals and objectives. Relationships between constituent systems affect the SoS. Systems that do not have any interactions with the constituent systems of a subject SoS are not part of that SoS.

An essential characteristic of the SoS is that constituent systems within the SoS are operationally independent. That is, the constituent systems can (and do) operate independently to fulfil some number of purposes on their own, separate from the SoS. While constituent systems operate independently from each other for their own purposes, they also operate interdependently with each other and other elements to produce the SoS outputs. Constituent systems are never totally independent, yet they are also never totally subservient to the SoS.

Another essential characteristic is that constituent systems within the SoS are both managerially independent and interdependent. Managerial independence suggests that the constituent systems can be managed by organizations that retain some degree of independence even though they are interdependent while participating in SoS. The implication is that these organizations can have goals and objectives for the constituent systems that differ from those of the SoS and the other constituent systems. If so, there is likely some degree of independence and interdependence of governance, as well as some degree of independence and interdependence of management.

Regardless of the means of managing the organizations, alignment (or lack thereof) in the goals and objectives affects the SoS. While some constituent systems are directed or influenced to belong to SoS, some constituent systems can be unaware of the SoS. Some constituent systems choose to belong on a cost/benefits basis, also to cause greater fulfilment of their own purposes, and because of their belief in the overarching SoS purpose.

### **5.4.3 Taxonomy of SoS**

Using essential characteristics to partition the various types of SoS provides an abbreviated nomenclature for thinking about SoS. ISO/IEC/IEEE 21841 defines a normalised taxonomy for systems of systems (SoS) to facilitate communications among stakeholders. It also briefly explains what a taxonomy is and how it applies to the SoS to aid in understanding and communication. There are many characteristics such as scale and scope, around which taxonomies can be derived.

The SoS taxonomy in ISO/IEC/IEEE 21841 organizes the relevant aspects or essential characteristics of SoS, providing specific viewpoints that align with stakeholder concerns. This organization facilitates communications between the various stakeholders that are involved with activities like governance, engineering, operation, and management of these SoS, and provides a reference for other related standards.

ISO/IEC/IEEE 21841 can be useful when describing an SoS or comparing SoS.

#### **5.4.4 SoS considerations in life cycle stages of a system**

ISO/IEC/IEEE 21839 provides a set of SoS considerations to be addressed at key points in the life cycle of the SoI. The considerations and key points align with those which are introduced in this document. Selected subsets of these considerations can be applied throughout the life of systems through the involvement of stakeholders. The ultimate goal is to achieve stakeholder satisfaction, so that when delivered, the SoI operates effectively in the operational environment which is typically characterized as one or more systems of systems.

A constituent system can be an entity in more than one SoS. An SoS is often comprised of existing constituent systems along with new constituent systems which are developed and integrated into the SoS. The focus of ISO/IEC/IEEE 21839 is a constituent system as the SoI. The considerations provided in ISO/IEC/IEEE 21839 are with respect to what is necessary to account for the life cycle of the constituent system to enable it to interact in the anticipated SoS configurations.

ISO/IEC/IEEE 21839 can be useful as an augmentation to this document when the SoI is a constituent system within an SoS, which is the typical situation for current systems.

#### **5.4.5 Application of this document to SoS**

ISO/IEC/IEEE 21840 provides guidance for the utilization of this document in the context of SoS. While this document applies to systems in general (including constituent systems), ISO/IEC/IEEE 21840 provides guidance on the application of these processes to the special case of SoS. However, ISO/IEC/IEEE 21840 is not a self-contained SoS replacement for this document. ISO/IEC/IEEE 21840 is intended to be used in conjunction with this document, ISO/IEC/IEEE 21839, and ISO/IEC/IEEE 21841 and is not intended to be used as standalone guidance.

When the SoI is part of an SoS, the application of the processes in this document is dependent on the type of SoS life cycle and impact of the SoS interactions on the SoI. In some cases, there can be “waves” of SoS revision. In other cases, SoS changes occur continually, with many processes operating on a continuous basis to implement evolutionary change.

## 5.5 Life cycle concepts

### 5.5.1 System life cycle model

Every system has a life cycle. A life cycle can be described using an abstract functional model that represents the conceptualization of a need for the system, its realization, utilization, evolution, and disposal.

A system progresses through its life cycle as the result of actions, performed and managed by people in organizations, using processes for execution of these actions. The detail in the life cycle model is expressed in terms of these processes, their outcomes, relationships, and sequence. This [document International Standard](#) does not prescribe any particular life cycle model. Instead, it defines a set of processes, termed life cycle processes, that can be used in the definition of the system's life cycle. [The processes described in this document support sequential as well as iterative and incremental development models.](#) Also, this [document International Standard](#) does not prescribe any particular sequence of processes within the life cycle model. The sequence of the processes is determined by project objectives and by selection of the system life cycle model.

### 5.5.2 System life cycle stages

Life cycles vary according to the nature, purpose, use, and prevailing circumstances of the system. Each stage has a distinct purpose and contribution to the whole life cycle and is considered when planning and executing the system life cycle. [The life cycle model comprises one or more stages, as needed. It is assembled as a sequence of stages that can be iterative, concurrent, or overlapping, as appropriate for the Sol's scope, magnitude, complexity, changing needs, and opportunities.](#)

The stages represent the major life cycle periods associated with a system and they relate to the state of the system description or the system itself. The stages describe the major progress and achievement milestones of the system through its life cycle. They give rise to the primary decision gates of the life cycle. These decision gates apply specific decision criteria and are used by organizations to understand and manage the inherent uncertainties and risks associated with business case, costs, schedule, performance, or ~~and~~ functionality of ~~when creating or utilizing~~ a system. The stages thus provide ~~organizations with~~ a framework within which organization management has high-level visibility and control of technical management ~~project~~ and technical processes. ~~Per~~ ISO/IEC/IEEE TR 24748-1 describes the application of these processes in any stage, provides more details on decision gates, and defines ~~(IEEE Std 24748-1-2011) the~~ typical system life cycle stages, including ~~include~~

- concept;<sub>z</sub>
- development;<sub>z</sub>
- production;<sub>z</sub>
- utilization;<sub>z</sub>
- support;<sub>z</sub> ~~and~~
- retirement.

Note that there are significant differences between life cycle stages (e.g. utilization, support, retirement) and processes (e.g. operation, maintenance, disposal).

Organizations employ stages differently to satisfy contrasting ~~business and risk mitigation~~ strategies. The life cycle stages often occur concurrently, especially in continuous, incremental, or evolutionary approaches. Using stages concurrently and in different orders can lead to life cycle forms with distinctly different characteristics.

Further elaboration of these concepts can be found in ~~the~~ ISO/IEC/IEEE TR 24748-1 and ISO/IEC/IEEE 24748-2, which provide guidelines ~~guides~~, on the application of life cycle management.

NOTE The set of events, occurrences, and evolution across the life cycle is sometimes referred to as the system life history. Per ISO 15704, the life history is the actual, recorded and configuration managed sequence of steps the system has gone through during its lifetime.