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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/IEC/IEEE DIS 21839

Systems and software engineering — System of systems (SoS) considerations in life cycle stages of a system

*Ingénierie du logiciel et des systèmes — Études du système des
systèmes (SdS) dans les étapes du cycle de vie d'un système*

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ISO/IEC JTC 1/SC 7

Secretariat: **BIS**

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2025-12-03

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Foreword

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

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 documents should be noted. This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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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/IEC 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.

ISO/IEC/IEEE 21839 is one of three standards dealing with systems of systems. The relationship among the three standards is described in [Annex C](#).

This second edition cancels and replaces the first edition (ISO/IEC/IEEE 21839:2019), which has been technically revised.

The main changes are as follows:

- added references for interfacing and interoperating systems and general updates from ISO/IEC/IEEE 15288:2023 and ISO/IEC/IEEE 24748-2:2024;
- updated content based on updates to ISO/IEC/IEEE 24748-1:2024, including more recent life cycle models such as DevOps.

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.

Systems and software engineering — System of systems (SoS) considerations in life cycle stages of a system

1 Scope

1.1 Purpose

This document provides a set of critical system of systems (SoS) considerations to be addressed at key points in the life cycle of the system of interest (SoI). This document refers to considerations that apply to an SoI that is a constituent system (CS) that interoperates in an SoS. This document considers the generic life cycle model defined in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 24748-1. Selected subsets of these considerations can be applied throughout the life of systems through the involvement of stakeholders. The ultimate goal is to achieve customer satisfaction, so that when delivered, the SoI will operate effectively in the operational or business environment which is typically characterized as one or more SoS.

This document concerns those systems that are human-made and are configured with one or more of the following: hardware, software, humans, procedures and facilities.

NOTE This document also can be productively applied by users of ISO/IEC/IEEE 12207.

1.2 Field of application

This document addresses SoS considerations that apply to systems at each stage of their respective life cycles.

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 document is concerned with describing the SoS considerations that apply to a system that is the SoI; that is a CS within an SoS. It applies to one-of-a-kind systems, mass produced systems or customized, adaptable systems.

1.3 Limitations

This document does not detail the approach to addressing SoS considerations in terms of methods or procedures.

This document does not detail the described documentation in terms of name, format, explicit content and recording media of documentation.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/>
- IEC Electropedia: available at <https://www.electropedia.org/>

— IEEE Standards Dictionary Online: available at <https://ieeexplore.ieee.org/xpls/dictionary.jsp>

NOTE For additional terms and definitions in the field of systems and software engineering, see ISO/IEC/IEEE 24765, which is published periodically as a “snapshot” of the SEVOCAB (Systems and software Engineering Vocabulary) database and which is publicly accessible at www.computer.org/sevocab.

3.1.1

capability

measure of capacity and the ability of an entity (*system* (3.1.6)), person or organization) to achieve its objectives

[SOURCE: ISO/IEC 19770-1:2017, 3.10, modified — Note 1 to entry has been removed]

3.1.2

constituent system

CS

independent *system* (3.1.6) that forms part of a *system of systems* (3.1.8) (SoS)

Note 1 to entry: 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* (3.1.1) of the SoS.

Note 2 to entry: While CS operate independently from each other for their own purposes, they also operate interdependently with each other and other elements to produce the SoS outputs. CS are never totally independent, since they work interdependently when operating as part of the SoS. However, they are never totally subservient to the SoS. Because CS have their own stakeholders and CS remain managerially independent, CS managers generally are not motivated to make adjustments to address SoS-desired capabilities.

[SOURCE: ISO/IEC/IEEE 21840, 2025, 3.1.2]

3.1.3

governance

process of establishing and enforcing strategic goals and objectives, organizational policies, and performance parameters

[SOURCE: ISO/IEC/IEEE 21840:2025, 3.1.4]

3.1.4

life cycle

evolution of a *system* (3.1.6), product, service, project or other human-made entity from conception through retirement

[SOURCE: ISO/IEC/IEEE 24748-1:2024, 3.24]

3.1.5

stage

period within the *life cycle* (3.1.4) 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.

[SOURCE: ISO/IEC/IEEE 24748-1:2024, 3.43]

3.1.6

system

arrangement of parts or elements that together exhibit a stated behaviour or meaning that the individual constituents do not

Note 1 to entry: A system is sometimes considered as a product or as the services 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, and personnel required for operations and support to the degree necessary for self-sufficient use in its intended environment.

[SOURCE: ISO/IEC/IEEE 15288:2023, 3.46]

3.1.7

system of interest

SoI

system (3.1.6) whose *life cycle* (3.1.4) is under consideration

[SOURCE: ISO/IEC/IEEE 15288:2023, 3.48]

3.1.8

system of systems

SoS

set of systems or system (3.1.6) elements that interact to provide a unique *capability* (3.1.1) that none of the *constituent systems* (3.1.2) can accomplish on its own

Note 1 to entry: System elements can be necessary to facilitate the interaction of the constituent systems in the system of systems.

Note 2 to entry: A collection of systems is not always an SoS. The differences between a system and an SoS are not in the structure of the parts, but rather in the behavioural and managerial independence of those parts. There is no distinct boundary that separates systems from SoS, as the transition between the two is often gradual and context dependent.

[SOURCE: ISO/IEC/IEEE 21840, 2025, 3.1.10]

3.1.9

systems of systems engineering

SoS engineering

process of planning, analysing, organizing, developing and integrating the capabilities of a mix of existing and new systems (3.1.6), including inter-system infrastructure, facilities, and overarching processes into a system-of-systems *capability* (3.1.1) that is greater than the sum of the capabilities of the *constituent systems* (3.1.2)

Note 1 to entry: SoSE also includes testing, modification, maintenance and other post-integration activities.

[SOURCE: ISO/IEC/IEEE 21840, 2025, 3.11]

3.2 Abbreviated terms

CS	constituent system
SoI	system of interest
SoS	system of systems
SoSE	system of systems engineering

4 Concepts

4.1 System of systems

Both individual systems and SoS conform to the accepted definition of a system in that each consists of parts, relationships and a whole that is greater than the sum of the parts; however, while all SoS are systems, not all systems are SoS, even if multiple systems are interacting with each other.

Maier^[12] postulated five key characteristics (not criteria) of SoS: operational independence of constituent systems (CS), managerial independence of CS, geographical distribution, emergent behaviour and evolutionary development processes. Maier identified operational independence and managerial independence as the two principal distinguishing characteristics for applying the term “systems of systems”. A system that does not exhibit these two characteristics is not an SoS regardless of the complexity or geographic distribution of its constituents.

An essential characteristic is that each CS within the SoS is operationally independent. While CS operate independently from each other for their own purposes, they also operate interdependently with each other and other elements to produce the SoS outputs. CS are never totally independent, since they work interdependently when operating as part of the SoS. However, they are never totally subservient to the SoS.

In an SoS, systems are also managerially independent. That is, each CS is likely to be managed by organizations with a level of independence, with potentially different goals and objectives for the CS.

In some cases, there can be a designated entity with some type of responsibility that spans an SoS. These managerial arrangements can be loosely defined or more highly structured depending on the particular situation. In other cases, no such entity exists. Because CS have their own stakeholders and CS remain managerially independent, CS managers generally are not motivated to make adjustments to address SoS-desired capabilities.

4.2 Constituent systems

An essential concept is that the SoS is comprised of CS (and can include other elements) that interact to provide capabilities that no one system or element in the SoS can provide by itself. Each CS is an independent system that provides capabilities to meet its specified mission or business objective and has its own life cycle, management and governance, and technical requirements. CS include systems which are often considered as infrastructure, such as communications systems. A CS can be an entity in more than one SoS. An SoS is often comprised of existing CS along with new CS which are developed and integrated into the SoS. The focus of this document is a CS as the SoI, as is shown in [Figure 1](#). The considerations provided in this document are with respect to what is necessary to account for the life cycle of the CS or SoI to enable it to interact in the anticipated SoS configurations.

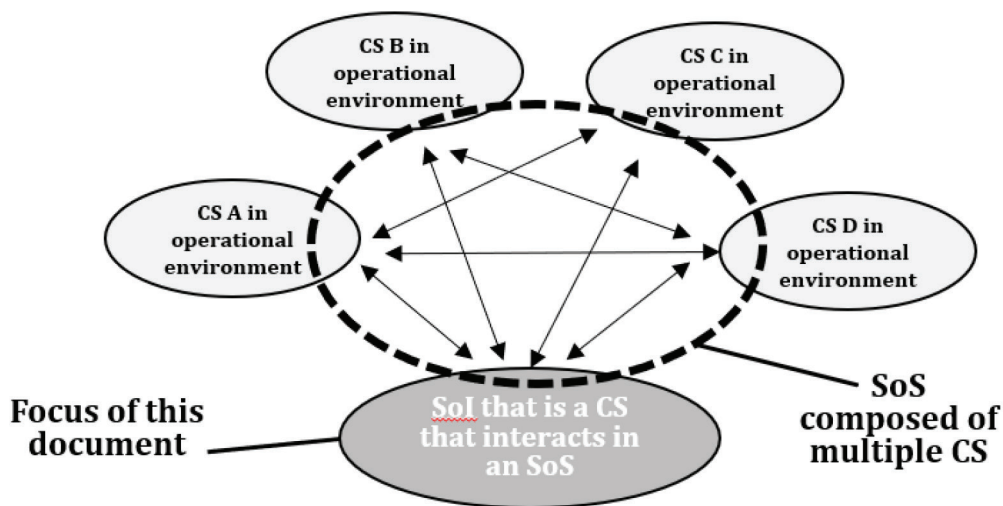
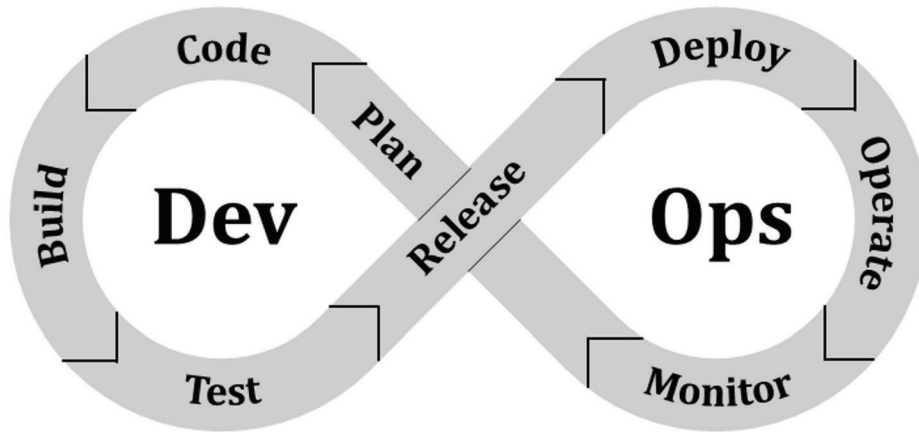


Figure 1 — Focus of this document is on the CS in an SoS

SoS and CS can apply to any domain. For example, in an air transportation SoS, CS can include the air traffic management systems, airports and aircraft. In a money transfer SoS (see an example in [Annex B](#)), CS can include different banks. In a military SoS, weapons and communication systems can be considered CS. This document addresses the SoS considerations for the life cycle stages of systems (new or evolving) which are constituents of one or more SoS.

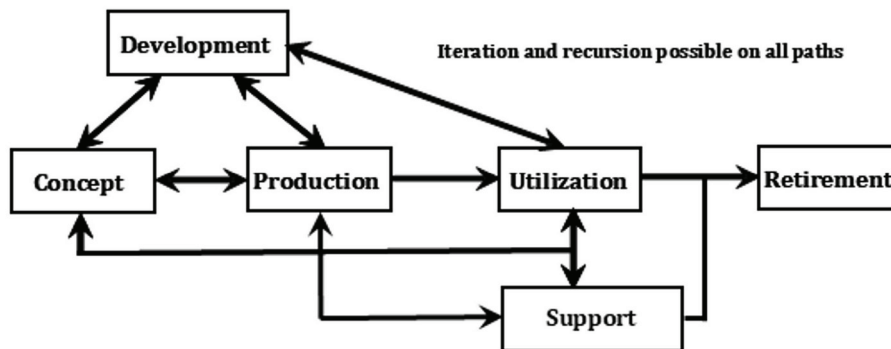
4.3 System life cycle stages

As an SoS evolves, each CS follows representative life cycle stages for its own evolution. A generic system life cycle model defined in ISO/IEC/IEEE 24748-1 includes the stages: concept, development, production, utilization, support and retirement. These stages should not be construed to mean a sequence or a linear progression between stages. An alternate system life cycle model is shown in [Figure 2](#). These stages can be implemented in different progression with iteration and recursion possible, one example of which is shown in [Figure 3](#). [Table 1](#) summarizes the main purpose of each life cycle stage and shows decision options common across all life cycle stages.



NOTE See ISO/IEC/IEEE 24748-1:2024, Figure 5.

Figure 2 — Development and operations (DevOps) example life cycle stages



NOTE See ISO/IEC/IEEE 24748-1:2024, Figure 6.

Figure 3 — Possible progress of life cycle stages