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Systems and software engineering — Guidelines for the utilization of ISO/IEC/IEEE 15288 in the context of system of systems (SoS)

Ingénierie des systèmes et du logiciel — Lignes directrices pour l'utilisation de l'ISO/IEC/IECC 15288 dans le contexte d'un système de systèmes (SdS)

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Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative References **1**

3 Terms, definitions, and abbreviated terms **1**
3.1 Terms and definitions 1
3.2 Abbreviated terms 3

4 Relationship to other standards **3**

5 Key concepts and application **4**
5.1 Differences between systems and SoS 4
5.2 Managerial and operational independence 7

6 Application of system life cycle processes to SoS **10**
6.1 Agreement processes 10
6.1.1 General 10
6.1.2 Acquisition process 12
6.1.3 Supply process 13
6.2 Organizational project-enabling processes 15
6.2.1 General 15
6.2.2 Life cycle model management process 16
6.2.3 Infrastructure management process 17
6.2.4 Portfolio management process 18
6.2.5 Human resource management process 20
6.2.6 Quality management process 21
6.2.7 Knowledge management process 22
6.3 Technical management processes 23
6.3.1 General 23
6.3.2 Project planning process 24
6.3.3 Project assessment and control process 25
6.3.4 Decision management process 27
6.3.5 Risk management process 28
6.3.6 Configuration management process 29
6.3.7 Information management process 30
6.3.8 Measurement process 31
6.3.9 Quality assurance process 32
6.4 Technical processes 33
6.4.1 General 33
6.4.2 Business or mission analysis process 36
6.4.3 Stakeholder needs and requirements definition process 37
6.4.4 System requirements definition process 39
6.4.5 Architecture definition process 41
6.4.6 Design definition process 44
6.4.7 System analysis process 46
6.4.8 Implementation process 47
6.4.9 Integration process 48
6.4.10 Verification process 49
6.4.11 Transition process 51
6.4.12 Validation process 52
6.4.13 Operation process 54
6.4.14 Maintenance process 55
6.4.15 Disposal process 56

Bibliography **58**

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IEEE notices and abstract **59**

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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).

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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.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Systems and software 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.

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.

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Introduction

Application of systems engineering to systems of systems has become increasingly important for the realization and sustainability of large and persistent sociotechnical systems in domains as varied as healthcare, transportation, energy, and defense, and contexts such as corporations, cities, and government. This has been intensified in the last fifteen years by the pervasiveness of information technology (IT), illustrated by new technologies and paradigms such as Sensor Networks, Cloud Computing, the Internet of Things, Big Data, Smart Devices and Ambient Intelligence. It is, for instance, the application of these technologies to cities that transform them into smarter cities.

This document provides guidance for the utilization of ISO/IEC/IEEE 15288 in the context of SoS. While ISO/IEC/IEEE 15288 applies to systems in general (including constituent systems), this document 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 ISO/IEC/IEEE 15288. This document is intended to be used in conjunction with ISO/IEC/IEEE 15288, ISO/IEC/IEEE 21839 and ISO/IEC/IEEE 21841 and is not intended to be used without them.

For example, ISO/IEC/IEEE 21841 provides a taxonomy for SoS, providing specific viewpoints that align with stakeholder concerns. Using a taxonomy in conjunction with this document facilitates better communications among the various stakeholders that are involved in activities like governance, engineering, operation, and management of these SoS. However, this document does not require the use of any specific taxa in ISO/IEC/IEEE 21841.

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Systems and software engineering — Guidelines for the utilization of ISO/IEC/IEEE 15288 in the context of system of systems (SoS)

1 Scope

This document provides guidance on the application of processes in ISO/IEC/IEEE 15288 to systems of systems (SoS). The scope of this document is the same as ISO/IEC/IEEE 15288, which addresses more than systems engineering activities.

NOTE 1 Throughout the document, there is mixed use of "system of systems" and "systems of systems". "SoS" could refer to a system of systems or systems of systems. Similarly, "CS" could refer to a constituent system or constituent systems.

This document provides general guidance for each ISO/IEC/IEEE 15288 process and process outcome in the context of SoS, but it does not address specific activities, tasks, methods, or procedures. Additional processes and process outcomes unique to SoS can still be needed and are not covered by this document.

This document explores the similarities and differences between systems and SoS and, by extension, the similarities and differences between engineering of systems and SoS. The guidance contained in this document is expected to evolve as the discipline matures.

NOTE 2 In many cases, this document notes that ISO/IEC/IEEE 15288 processes or process outcomes "... applies as stated to SoS." Some interpretation within the context of SoS can still be needed.

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.

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.

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 http://www.electropedia.org/

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

3.1.1
capability
measure of capacity and the ability of an entity (*system* (3.1.8), person or organization) to achieve its objectives

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

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3.1.2
constituent system
independent *system* (3.1.8) that forms part of a *system of systems* (SoS) (3.1.10)

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* (3.1.5), utilization, goals, and resources, but interacts within the SoS to provide the unique *capability* (3.1.1) of the SoS.

[SOURCE: ISO/IEC/IEEE 21839:2019, 3.1.1]

3.1.3
emergence
principle that entities exhibit properties which are meaningful only when attributed to the whole, not to its parts

Note 1 to entry: These properties cannot be reduced or decomposed back down to the those of any individual *constituent system* (3.1.2).

Note 2 to entry: The definition is adapted from Reference [9].

3.1.4
governance
process of establishing and enforcing strategic goals and objectives, organizational policies, and performance parameters

[SOURCE: ISO/IEC 24765:2017, 3.1757, modified — The article "the" at the beginning of the definition has been removed.]

3.1.5
management
system (3.1.8) of controls and processes required to achieve the strategic objectives set by the organization's governing body

Note 1 to entry: Management is subject to the policy guidance and monitoring set through corporate *governance* (3.1.4).

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.2338]

3.1.6
satisficing
decision technique that discards any alternative with an attribute value outside an acceptable range

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3601]

3.1.7
stage
period within the life cycle 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 15288:2015, 4.1.43, modified — The expression "this International Standard" has been replaced with "this document".]

3.1.8
system
combination of interacting elements organized to achieve one or more stated purposes

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.46, modified — Note 1, 2, and 3 to entry have been removed.]

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3.1.9
system-of-interest
system (3.1.8) whose life cycle is under consideration

Note 1 to entry: In this document, the system-of-interest is a *system of systems* (3.1.10).

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.48, modified — The words "in the context of this International Standard" have been removed; Note 1 to entry has been added.]

3.1.10
system of systems
set of *systems* (3.1.8) and system 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 interaction of the constituent systems in the system of systems.

[SOURCE: ISO/IEC/IEEE 21839:2019, 3.1.4, modified — The abbreviated term "SoS" has been removed.]

3.1.11
system life cycle
period that begins when a *system* (3.1.8) is conceived and ends when the system is no longer available for use

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.4108]

3.1.12
taxonomy
scheme that partitions a body of knowledge and defines the relationships among the pieces

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.4167, modified — Note 1 to entry has been removed.]

3.2 Abbreviated terms

CS constituent system, constituent systems

SE systems engineering

SOI system of interest

SoS system of systems, systems of systems

SoSE system of systems engineering

4 Relationship to other standards

This document is part of a set of documents that are intended to be used together:

ISO/IEC/IEEE 15288 provides the fundamental basis for this document by establishing a model set of system life cycle processes.

ISO/IEC/IEEE 21839 addresses SoS considerations in life cycle stages of a system.

This document provides guidance on the use of ISO/IEC/IEEE 15288 in the context of SoS, including considerations for how CS relate to each other within the SoS. However, the use of any specific taxa in ISO/IEC/IEEE 21841 is not required.

ISO/IEC/IEEE 21841 provides a taxonomy for SoS, providing specific viewpoints that align with management and governance concerns. Using a taxonomy in conjunction with this document facilitates better communications among the various stakeholders that are involved in activities like governance, engineering, operation, and management of these SoS.

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