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Systems and software engineering — Taxonomy of systems of systems

Ingénierie système et logiciel — Taxonomie des systèmes de systèmes

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Foreword

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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 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 21841:2019) which has been technically revised.

The main changes are as follows:

— the text has been updated to be aligned with ISO/IEC/IEEE 15288:2023 and ISO/IEC/IEEE 21840.

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

Systems of systems engineering (SoSE) is a concept that is increasingly thought of as a discipline important for the realization and sustainability of large and persistent sociotechnical systems in areas as diverse as healthcare, transportation, energy, defence, corporations, cities and government.

While SoSE applies broadly to hardware, software, and middleware as well as embedded, cyber-physical and digital systems, the importance of SoSE has been heightened in the last fifteen years by the rapid increase in 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 artificial intelligence. It is, for instance, the application of these technologies to cities that transform them into smarter cities.

This pervasiveness of IT was not only driven by the availability of these technologies, but also more importantly by the requirements in our resource and environmentally-constrained world for increased and sustainable economic development and, ultimately, personal well-being.

SoSE goes well beyond IT and potentially applies to all types of systems, including hardware and cyber physical systems where IT is an enabler. SoSE addresses functionality, performance and interdependencies of the systems as well as their connectivity. The interconnectivity of systems has become pervasive in large command and control systems, defence systems, communications systems, transportation systems and medical/health systems, among others. The accelerating need to share information and leverage capabilities from other systems has changed how systems need to be viewed and engineered.

In the context of systems of systems (SoS), the relevant elements of the system of interest are, by definition, systems themselves. Using essential characteristics to partition the various types of SoS provides an abbreviated nomenclature for thinking about SoS. Based on taxonomies, different approaches to the engineering of SoS are possible, improving the effectiveness and efficiency of SoSE.

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Systems and software engineering — Taxonomy of systems of systems

1 Scope

This document defines a normalized 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.

2 Normative references

There are no normative references in this document.

3 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 http://dictionary.ieee.org

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 is publicly accessible at www.computer.org/sevocab.

3.1 General terms

3.1.1
capability
measure of capacity and the ability of an entity (*system* (3.1.7)), person or *organization* (3.1.6)) 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* (3.1.7) that forms part of a *system of systems* (3.1.9) (SoS)

Note 1 to entry: Constituent systems can be part of one or more SoS. Each *CS* 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.

Note 2 to entry: While CS operate independently from each other for their own purposes, they also operate interdependently with each other and other *system elements* (3.1.8) 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. CS have their own stakeholders and CS remain managerially and operationally independent; managers of CS or CS projects can be unaware, unable or unwilling to make adjustments to address SoS-desired *capabilities* (3.1.1)

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