BS ISO/IEC/IEEE 24748-2:2018

BSI Standards Publication

Systems and software engineering - Life cycle management

Part 2: Guidelines for the application of ISO/IEC/IEEE 15288 (System life cycle processes)

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National foreword

This British Standard is the UK implementation of ISO/IEC/IEEE 24748-2:2018. It supersedes PD ISO/IEC TR 24748-2:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee IST/15, Software and systems engineering.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2019

ISBN 978 0 580 95693 5

ICS 35.080

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2019.

Amendments/corrigenda issued since publication

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INTERNATIONAL STANDARD

ISO/IEC/IEEE 24748-2

First edition
2018-12

Systems and software engineering — Life cycle management —

Part 2: Guidelines for the application of ISO/IEC/IEEE 15288 (System life cycle processes)

Ingénierie des systèmes et du logiciel — Gestion du cycle de vie —

Partie 2: Lignes directrices pour l'application de l'ISO/IEC/IEEE 15288 (Processus du cycle de vie du système)

Reference number
ISO/IEC/IEEE 24748-2:2018(E)

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Published in Switzerland

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of ISO/IEC JTC 1 is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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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 Software and Systems Engineering Standards Committee of the IEEE Computer Society, under the Partner Standards Development Organization cooperation agreement between ISO and IEEE.

This first edition cancels and replaces ISO/IEC TR 24748-2:2011. The changes to this edition reflect changes in ISO/IEC/IEEE 15288:2015 from the 2008 edition, as well as the movement of concept material to ISO/IEC/IEEE 24748-1:2018.

A list of all parts in the ISO/IEC/IEEE 24748 series can be found on the ISO website.

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

This document and its companion, ISO/IEC TR 24748-3 *Guide to the application of ISO/IEC 12207 (Software life cycle processes)* specifically support use of ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207, respectively. These two guidelines continue and make use of the alignment effort evident in the two revised International Standards. Terminology, structure and content in the guidelines are aligned consistent with that in the two International Standards. Consequently, the users of ISO/IEC/IEEE 12207 and ISO/IEC/IEEE 15288 will benefit from having documents complementarily addressing all aspects of services or products over their life cycle.

Besides the above, there is also increasing recognition of the importance of ensuring that all life cycle stages, and all aspects within each stage, are supported with thorough guidance enabling alignment with process documents that focus on areas besides systems and software. This can include hardware, humans, data, processes (e.g. review process), procedures (e.g. operator instructions), facilities and naturally occurring entities (e.g. water, organisms, minerals). The concept and structure of the ISO/IEC/IEEE 24748 series is intended to allow its extension to such additional domains where that will provide value to users.

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Systems and software engineering — Life cycle management —

Part 2: Guidelines for the application of ISO/IEC/IEEE 15288 (System life cycle processes)

1 Scope

This document is a guideline for the application of ISO/IEC/IEEE 15288:2015. It addresses system, life cycle, organizational, project, and process, concept application, principally through reference to ISO/IEC/IEEE 24748-1 and ISO/IEC/IEEE 15288:2015. It gives guidance on applying ISO/IEC/IEEE 15288:2015 from the aspects of strategy, planning, application in organizations, and application on projects. It also provides comparison of the differences between ISO/IEC/IEEE 15288:2015 and the prior versions, ISO/IEC 15288:2008.

This document is intended to be consistent with both ISO/IEC/IEEE 24748-1 and ISO/IEC/IEEE 15288:2015 in its treatment of life-cycle concepts and systems engineering processes.

NOTE Systems engineering for defense programs is addressed in IEEE Std 15288.1, *Application of Systems Engineering on Defense Programs*.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC/IEEE 15288:2015 apply.

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

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

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

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

4 Overview of ISO/IEC/IEEE 15288:2015

4.1 General

ISO/IEC/IEEE 15288:2015 *Systems and software engineering — System life cycle processes*, establishes a common framework for system life cycle processes, with well-defined terminology, that can be referenced by any party, particularly those having any involvement or interest in the system life cycle or performance of systems engineering activities. It applies to the acquisition of systems, which can be comprised of products, services, or both, as well as to the supply, development, operation, maintenance, and disposal of systems, whether performed internally or externally to an organization.

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ISO/IEC/IEEE 15288:2015 may be used stand-alone or jointly with other International Standards, such as ISO/IEC/IEEE 12207:2017, and supplies a process reference model that supports process capability assessment in accordance with ISO/IEC 33002:2015 (Process assessment).

The purpose of ISO/IEC/IEEE 15288:2015 is to provide a defined set of processes to facilitate communication among acquirers, suppliers and other stakeholders in the life cycle of a system. ISO/IEC/IEEE 15288:2015 is written for acquirers of systems and for suppliers, developers, operators, maintainers, managers, quality assurance managers, and users of systems.

4.2 Structure of ISO/IEC/IEEE 15288:2015

ISO/IEC/IEEE 15288:2015 contains requirements in two clauses:

1) Clause 6, which defines the requirements for the system life cycle processes;

2) Annex A that provides requirements for tailoring of ISO/IEC/IEEE 15288:2015.

Six informative annexes support the use of ISO/IEC/IEEE 15288:2015 or its harmonization with ISO/IEC 12207:2008:

1) Annex B provides information on possible information items that may be associated with each process in ISO/IEC/IEEE 15288:2015.

2) Annex C provides information about use of the ISO/IEC/IEEE 15288:2015 system life cycle processes as a process reference model to support process assessment.

3) Annex D provides an informative description of the process constructs used in ISO/IEC/IEEE 15288:2015.

4) Annex E provides information on the process view concept and examples of its use from two different process viewpoints.

5) Annex F provides information on the Architecture Definition and Design Definition processes in ISO/IEC/IEEE 15288:2015 as they relate to the Architectural Design process in the 2008 version of ISO/IEC/IEEE 15288.

6) Annex G provides information on application of system life cycle processes to a system of systems.

Readers of ISO/IEC/IEEE 15288:2015 are advised to consult Clause 5 of that International Standard to gain understanding of the key concepts used.

4.3 Context of ISO/IEC/IEEE 15288:2015

ISO/IEC/IEEE 15288:2015 has a focus on the processes that are used by or for a project that exists in a defined relationship with the organization, other projects and enabling systems. A project is assigned responsibility that encompasses one or more life cycle stages of the system-of-interest. ISO/IEC/IEEE 15288:2015 is applicable to organizations and projects whether they act as the acquirer or the supplier of a system and whether the system is comprised of products, services, or a combination of both.

The context of ISO/IEC/IEEE 15288:2015 is illustrated in Figure 1. As the figure indicates, a single project may involve multiple organizations working together as partners. The project for the system-of-interest may also interact with other projects, either for other systems that will interoperate with the system-of-interest, or for enabling systems. Such a project should use ISO/IEC/IEEE 15288:2015 to establish common terminology, as well as information flows and interfaces among the several organizations, to enhance communications.

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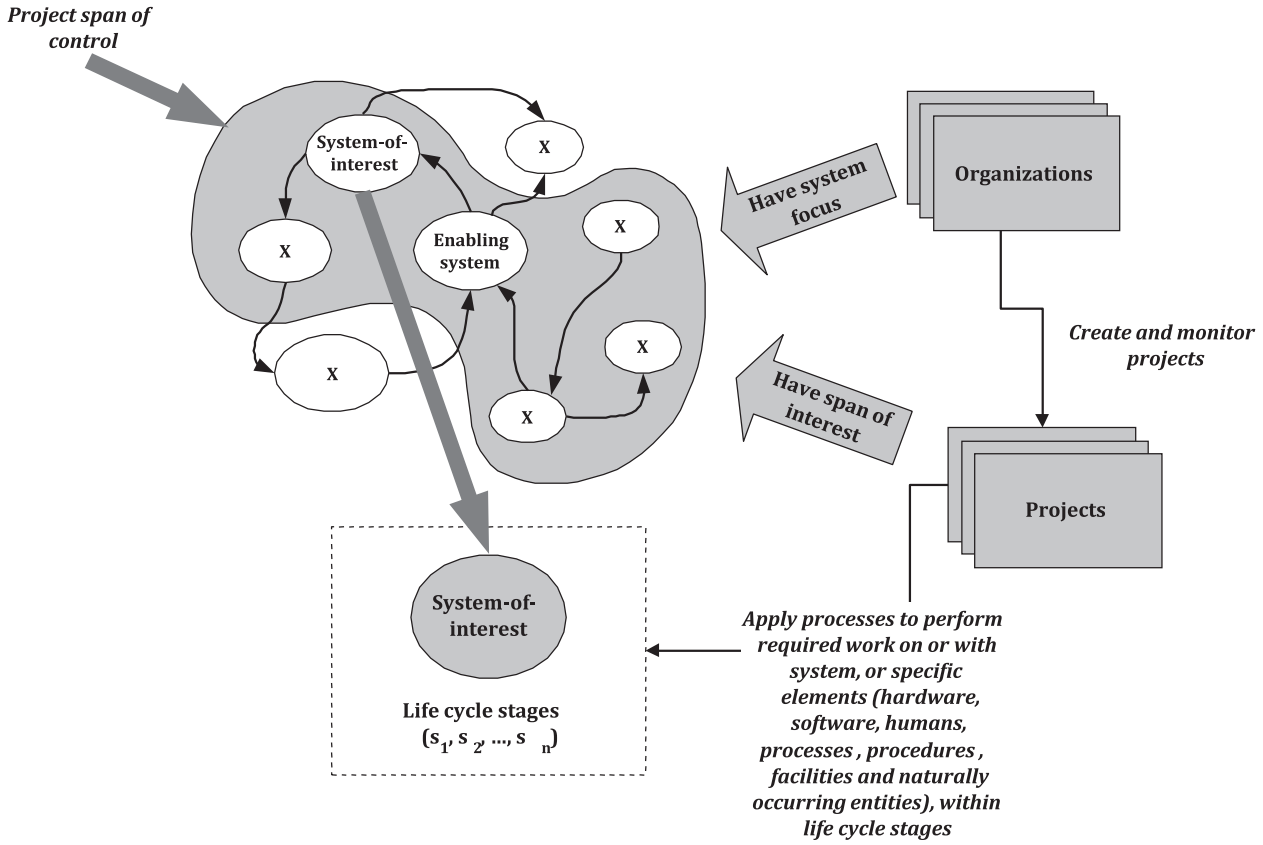

Figure 1 — Context of ISO/IEC/IEEE 15288:2015

When an organization applies ISO/IEC/IEEE 15288:2015 to a particular system that system becomes the system-of-interest. The system-of-interest has a life cycle that consists of multiple stages through which the system passes during its lifetime, denoted in the figure as s_1, s_2, … s_n. These stages are not necessarily sequential and their execution can be completely or partially in parallel, as well as iterative or recursive. An example of typical stages is:

— s_1: concept;

— s_2: development;

— s_3: production;

— s_4: utilization;

— s_5: support; and

— s_6 retirement.

NOTE 1 Stages are described in ISO/IEC/IEEE 15288:2015, 5.4.2 and in ISO/IEC/IEEE 24748-1:2018, 4.3.2 and 5.

NOTE 2 The management of the transition from one stage to another is not necessarily a linear, sequential, progression and engineering activities are associated with providing appropriate work products and decision-making information in each stage.

A number of enabling systems are deployed throughout the system life cycle to provide the system-of-interest with support as needed. Each life cycle stage can require one or more enabling systems. It is important to note that an enabling system has its own life cycle and that when ISO/IEC/IEEE 15288:2015 is applied to it, it then becomes a system-of-interest.

NOTE 3 The role and use of enabling systems are described in 6.3.4 and 6.7.4.6 of this document.

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NOTE 4 For related material on enabling systems, see also ISO/IEC/IEEE 15288:2015, 5.2.3 and ISO/IEC/IEEE 24748-1:2018, 4.2.4.

ISO/IEC/IEEE 15288:2015 is applicable at any level of the structure associated with a system-of-interest. As a system is decomposed recursively into its system elements, the processes of ISO/IEC/IEEE 15288:2015 may be used for each system and system element in the system structure, including enabling systems. Each system and system element has a life cycle of its own and its own set of enabling systems.

NOTE 5 For related material on system structure, see ISO/IEC/IEEE 15288:2015, 5.2.2 and ISO/IEC/IEEE 24748-1:2018, 4.2.3.

In order to perform needed operations and transformations upon systems during their life cycles, the organization creates and monitors projects. Projects have a defined scope, resources (including time) and focus. The scope can involve managing all of the stages of the life cycle, a subset of the stages, one or more defined processes or one or more process activities. The time scale can be of varying duration, for example a few weeks or tens of years. The focus of the project is related to the system-of-interest and its systems and system elements in some form of system structure or stage partitioning.

NOTE 6 System life cycle concepts are described in ISO/IEC/IEEE 24748-1:2018, 4.3.

Organizations focus on systems that are created or transformed by projects within the organization or in conjunction with other organizations. Projects have a span of interest that includes the system-of-interest and its related enabling systems. Some enabling systems are under direct control of the project. The system-of-interest and those enabling systems make up the project span of control.

The work performed by projects is on or with the system-of-interest within one or more life cycle stages. ISO/IEC/IEEE 15288:2015 includes the requirement to define an appropriate life cycle for a system, the selection of processes to be applied throughout the life cycle and the application of these processes to fulfil agreements and achieve customer satisfaction.

ISO/IEC/IEEE 15288:2015 can be applied to all types of product- or service-focused systems and system elements consisting of one or more of the following: hardware, software, humans, processes, procedures, facilities, and naturally occurring entities. The use of ISO/IEC/IEEE 15288:2015 for systems within this broad scope is one of its main advantages.

The use of the standard may be adapted to accommodate the varying project requirements in treating system life cycles.

NOTE 7 This can be performed by adapting the life cycle as described in ISO/IEC/IEEE 24748-1:2018, Clause 5 and tailoring described in ISO/IEC/IEEE 15288:2015, Annex A.

4.4 Comparison of ISO/IEC/IEEE 15288:2015 to prior versions

This clause compares the 2008 and 2015 versions of International Standard ISO/IEC/IEEE 15288. Changes have been made to the processes at the structural level (i.e., processes have been added, renamed, or combined with others, with resultant renumbering). These structural changes in the ISO/IEC/IEEE 15288 process set are summarized in Table 1 and the reasons for each structural change are given in Table 2.

Table 1 — Mapping of process sets between ISO/IEC 15288:2008 and ISO/IEC/IEEE 15288:2015

ISO/IEC 15288:2008		ISO/IEC/IEEE 15288:2015		
Clause	**Process**	**Clause**	**Process**	**Structural Changes**
6.2.3	Project Portfolio Management Process	6.2.3	Portfolio management process	Title changed
		6.2.6	Knowledge management process	Added process
6.3	Project Processes	6.3	Technical management processes	Title changed

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Table 1 *(continued)*

ISO/IEC 15288:2008		ISO/IEC/IEEE 15288:2015		
Clause	**Process**	**Clause**	**Process**	**Structural Changes**
		6.3.8	Quality assurance process	Added process
		6.4.1	Business or mission analysis process	Added process
6.4.1	Stakeholder Requirements Definition Process	6.4.2	Stakeholder needs and requirements definition process	Title changed; numbering;
6.4.2	Requirements Analysis Process	6.4.3	System requirements definition process	Title changed; numbering;
6.4.3	Architectural Design Process	6.4.4	Architecture definition process	Title changed; numbering
		6.4.5	Design definition process	Added process
		6.4.6	System analysis process	Added process
6.4.4	Implementation Process	6.4.7	Implementation process	Numbering
6.4.5	Integration Process	6.4.8	Integration process	Numbering
6.4.6	Verification Process	6.4.9	Verification process	Numbering
6.4.7	Transition Process	6.4.10	Transition process	Numbering
6.4.8	Validation Process	6.4.11	Validation process	Numbering
6.4.9	Operation Process	6.4.12	Operation process	Numbering
6.4.10	Maintenance Process	6.4.13	Maintenance process	Numbering
6.4.11	Disposal Process	6.4.14	Disposal process	Numbering

Table 2 — Basis for change of process set in ISO/IEC/IEEE 15288:2015

Title change between ISO/IEC 15288:2008 and ISO/IEC/IEEE 15288:2015	Reason for change
6.2.3 Project Portfolio Management Process (2008) Changed to: 6.2.3 Portfolio management process (2015)	The purpose of the Portfolio Management process is to initiate and sustain necessary, sufficient and suitable projects in order to meet the strategic objectives of the organization. Accordingly, it is done outside the scope of any one project and further, it is inappropriate to speak of the project portfolio of a single project.
6.2.6 Knowledge management process (2015) [ADDED]	This was activity 6.2.4.3 d) under process 6.2.4 Human Resource Management Process in the 2008 version. The change to a process in ISO/IEC/IEEE 15288:2015 reflects the greater appreciation that an organizations knowledge is more than what its human resources possess and that the outcomes, activities and tasks need to be more inclusive to reflect this fact.
6.3 Project Processes (2008) Changed to 6.3 Technical Management Processes (2015)	Reflects that the processes under this heading relate to the technical management of a project, but are not the full set of processes involved in managing a project.
6.3.8 Quality assurance process (2015) [ADDED]	In the 2008 version of 15288, quality assurance was task 6.3.2.3 a) 2) under process 6.3.2, Project Assessment and Control Process. It is now recognized as having a broader contribution, under process group 6.3, Technical processes, to the successful realization of the system over its life cycle.

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Table 2 *(continued)*

Title change between ISO/IEC 15288:2008 and ISO/IEC/IEEE 15288:2015	Reason for change
6.4.1 Business or mission analysis process (2015) [ADDED]	This is a critical precursor to determining needs and defining requirements. It was not explicitly addressed in ISO/IEC 15288:2008 and has now been added as a separate process in the 2015 version.
6.4.1 Stakeholder Requirements Definition Process (2008) Changed to: 6.4.2 Stakeholder needs and requirements definition process (2015)	The change clarifies that stakeholder needs must first be determined, then used as a basis for deriving stakeholder requirements. That is: a) needs and requirements are related but different b) that both must be addressed to provide a system that responds to stakeholders, c) the stakeholders' views of what they desire that the system provide them in terms of products and services drives the requirements that express the intended interaction the system will have with its operational environment, and d) the stakeholders' requirements are derived by analysis of the stakeholder needs This is consistent with ISO/IEC/IEEE 29148:2011, Systems and software engineering — Life cycle processes — Requirements engineering, Clause 5.2.3, paragraph 1, Transformation of needs into requirements.
6.4.2 Requirements Analysis Process (2008) Changed to: 6.4.3 System requirements definition process (2015)	The process title in the 2008 version of 15288 did not reflect the full scope of what must be done to define system requirements: analysis is only a part of it. In addition, the scope of the process itself is broadened in the 2015 version of 15288 to include the preparation and maintenance of system requirements, not just the initial definition itself.
6.4.3 Architectural Design Process (2008) Changed to: 6.4.4 Architecture definition process (2015)	The process in the 2015 version of 15288 gives a more encompassing view of all the activities and tasks required to architect a system, whereas the 2008 version focuses on the narrower aspect of architecture design.
6.4.5 Design definition process (2015) [ADDED]	Design was inferred in ISO/IEC 15288:2008 process 6.4.3, Architectural Design Process. However, the 2015 version treats architecting (process 6.4.4) and design (6.4.5) as two distinct sets of effort, with outcomes, activities and tasks appropriate to each.
6.4.6 System analysis process (2015) [ADDED]	System analysis was inferred in ISO/IEC 15288:2008 process 6.4.3, Architectural Design Process. In the 2015 version, it is treated explicitly. Further, the process in the 2015 version of 15288 recognizes that system analysis can be performed in conjunction with more processes than just system design.

In addition to the above, the preponderance of changes in the 2015 edition of ISO/IEC/IEEE 15288 are refinements to the purpose, outcomes, activities and tasks of the processes in the International Standard. All of these changes reflect further experience with the International Standard since publication of the 2008 edition. Table 3 illustrates the extent of these changes for one process, using the Purpose, Outcomes and the first part of the Activities and Tasks in the Acquisition Process as an example, highlighting the specific changes with an underline. It is critical that the user of 15288 conduct a detailed comparison of each process in ISO/IEC/IEEE 15288:2015 compared to ISO/IEC 15288:2008.

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Table 3 — Illustration of detail level process changes from ISO/IEC 15288:2008 to ISO/IEC/IEEE 15288:2015

Acquisition process in ISO/IEC 15288:2008	Acquisition process in ISO/IEC/IEEE 15288:2015
6.1.1.1 Purpose The purpose of the Acquisition Process is to obtain a product or service in accordance with the acquirer's requirements.	**6.1.1.1 Purpose** The purpose of the Acquisition process is to obtain a product or service in accordance with the acquirer's requirements. NOTE As part of this process, the agreement is modified when a change request is agreed to by both the acquirer and supplier.
6.1.1.2 Outcomes As a result of the successful implementation of the Acquisition Process: a) A strategy for the acquisition is established. b) One or more suppliers are selected. c) Communication with the supplier is maintained. d) An agreement to acquire a product or service according to defined acceptance criteria is established. e) A product or service complying with the agreement is accepted. f) Payment or other consideration is rendered.	**6.1.1.2 Outcomes** As a result of the successful implementation of the Acquisition process: a) A request for supply is prepared. b) One or more suppliers are selected. c) An agreement is established between the acquirer and supplier. d) A product or service complying with the agreement is accepted. e) Acquirer obligations defined in the agreement are satisfied. f) [DELETED]
6.1.1.3 Activities and tasks The acquirer shall implement the following activities and tasks in accordance with applicable organizational policies and procedures with respect to the Acquisition Process. NOTE The activities and tasks in this process can apply to one or more suppliers. a) **Prepare for the acquisition**. This activity consists of the following tasks: 1) Establish a strategy for how the acquisition will be conducted. NOTE This strategy includes reference to the life cycle model, a schedule of milestones and selection criteria if the supplier is external to the acquiring organization.	**6.1.1.3 Activities and tasks** The acquirer shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Acquisition process. NOTE The activities and resulting agreement from this process often apply to suppliers in the supply chain, including subcontracted suppliers. a) **Prepare for the acquisition.** This activity consists of the following tasks: 1) Define a strategy for how the acquisition will be conducted. NOTE This strategy describes or references the life cycle model, risks and issues mitigation, a schedule of milestones, and selection criteria if the supplier is external to the acquiring organization. It also includes key drivers and characteristics of the acquisition, such as responsibilities and liabilities; specific models, methods, or processes; level of criticality; formality; and priority of relevant trade factors.

Besides thoroughly reviewing all processes in ISO/IEC/IEEE 15288:2015 versus those in the 2008 edition, it may be useful for the user to recognize that a number of the processes changes reflect a significant change in the thoroughness with which the processes for requirements identification, architecting, design, and analysis are treated. Table 4 shows the overall scope of this major change in the "front end" processes.

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Table 4 — Comparison of requirements, architecting, design and analysis processes between ISO/IEC 15288:2008 and ISO/IEC/IEEE 15288:2015

Requirements, architecting, design and analysis processes in ISO/IEC 15288:2008	Requirements, architecting, design and analysis processes in ISO/IEC/IEEE 15288:2015
	6.4.1 Business or mission analysis process
6.4.1 Stakeholder Requirements Definition Process; 6.4.2 Requirements Analysis Process	6.4.2 Stakeholder needs and requirements definition process (includes analysis of stakeholder requirements); 6.4.3 System requirements definition process (includes analysis of system requirements)
6.4.3 Architectural Design Process	6.4.4 Architecture definition process;
	6.4.5 Design definition process
	6.4.6 System analysis process

5 Application concepts

5.1 Overview

This document provides guidelines for life cycle management in the field of systems. This clause highlights and explains essential concepts on which this document is based, and introduces key concepts useful in reading and applying ISO/IEC/IEEE 15288:2015.

NOTE ISO/IEC/IEEE 24748-1 provides more information on concepts related to life cycle management in general.

5.2 System concepts

Application of ISO/IEC/IEEE 15288 presupposes an understanding of system concepts.

NOTE System concepts for systems that are any mix of products and services are introduced in ISO/IEC/IEEE 15288:2015, 5.2. Additional discussion is in ISO/IEC/IEEE 24748-1:2018, 4.2.

5.3 Life cycle concepts

Application of ISO/IEC/IEEE 15288 presupposes an understanding of life cycle concepts.

NOTE 1 Life cycle concepts are introduced in ISO/IEC/IEEE 15288:2015, 5.4. Additional discussion is in ISO/IEC/IEEE 24748-1:2018 4.3.

NOTE 2 ISO/IEC/IEEE 24748-1 provides more information on concepts related to life cycle management in general.

5.4 Process concepts

Application of ISO/IEC/IEEE 15288 presupposes an understanding of process concepts.

NOTE Process concepts are introduced in ISO/IEC/IEEE 15288:2015, 5.5. Additional discussion is in ISO/IEC/IEEE 24748-1:2018, Annex A.

5.5 Organizational concepts

Application of ISO/IEC/IEEE 15288 presupposes an understanding of organizational concepts.

NOTE Organizational concepts are introduced in ISO/IEC/IEEE 15288:2015, 5.3. Additional discussion is in ISO/IEC/IEEE 24748-1:2018, Annex B.

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5.6 Project concepts

Application of ISO/IEC/IEEE 15288 presupposes an understanding of organizational concepts.

NOTE Project concepts are introduced in ISO/IEC/IEEE 15288:2015, 5.3. Additional discussion is in ISO/IEC/IEEE 24748-1:2018, Annex C.

6 Applying ISO/IEC/IEEE 15288:2015

6.1 Overview

Understanding concepts does not give the ability to immediately apply them without further thought and work. The following clauses give guidance on what should be done to bridge the gap between concept and practical use in different project, organizational and life cycle environments, starting with planning the application of ISO/IEC/IEEE 15288:2015.

Modern businesses strive to develop a robust set of life cycle processes that are applied repeatedly to the projects of the business. To accommodate that need, ISO/IEC/IEEE 15288:2015 is intended to be useful for application at either the organization level, or at the project level. An organization should adopt the standard and supplement it with appropriate procedures, practices, tools and policies. A project of the organization should typically conform to the organization's processes rather than conform directly to this document.

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 apply the provisions of ISO/IEC/IEEE 15288:2015 directly to the project.

6.2 Application strategy

6.2.1 Overview

ISO/IEC/IEEE 15288:2015 may be applied for a variety of reasons, such as to:

a) define the processes, activities and tasks required for use on a specific project;

b) improve processes used by an organization across multiple projects; and

c) provide guidance on system life cycle processes usable within a larger process, such as an organization’s acquisition process or maintenance process.

Whatever the reason for application of ISO/IEC/IEEE 15288:2015, a suggested application strategy consists of the following:

a) plan the application;

b) adapt ISO/IEC/IEEE 15288:2015, if applicable;

c) conduct pilot project(s);

d) formalize the approach; and

e) institutionalize the approach.

This strategy is typical of the approach that should be followed when introducing changes into an organization or project. The application strategy described above may be repeated several times within a project or across an organization as additional processes are addressed and/or improved.

Whether the existing basis for system life cycle processes is ISO/IEC 15288:2008 or some other reference point, the fundamental starting point is to identify all the changes to go from that basis to

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ISO/IEC/IEEE 15288:2015. If the existing process basis is ISO/IEC 15288:2008, the amount of changes will be noticeably less than if a different process basis is in use.

Bringing all the stakeholders together in this effort is critical: even one area left out that should have been in the planning can materially disrupt applying the new basis. One way of proceeding is for a small group to develop a checklist of things that should be considered in applying ISO/IEC/IEEE 15288:2015. This may include, and possibly will not be limited to:

a) documentation changes, including flow and nomenclature;

b) staff training needs;

c) responsibility changes, including need for new agreements;

d) impacts on tools and databases; and

e) changes in the inputs required by and outputs from each process.

The initial checklist should then be used by an immediately subsequent, larger, group of all stakeholders to work through what other items need to be added and what the specific changes are for each item on the checklist. Repeated reviews of checklist drafts should be held to find the final few surprises.

Once there is a detailed listing of the changes derived in this, or equivalent, manner, the time and cost impacts of each need to be assessed and adjusted for the risks of each change and various groupings of change. Then further analysis of the sequence of implementing the changes is necessary. The group should explore phasing in changes in a way that minimizes cost, project disruption and the potential for adverse human reactions. Readiness criteria should be developed for starting each step of a phase-in, as well as checks for successful completion after each step of phasing in the changes. Quantitative metrics should be developed and used.

Throughout, a core group should be maintained to oversee the change from one basis to another, with periodic meetings of the entire group of stakeholders.

When a project or organization is already in a steady state, i.e. where the processes have been established and institutionalized, then the implementation strategy can be shortened and should probably include the following:

a) plan the application;

b) adapt ISO/IEC/IEEE 15288:2015, if applicable (for the risk level of the work); and

c) conduct the project(s).

6.2.2 Planning the application

Applying ISO/IEC/IEEE 15288:2015 should be considered as a specific project and planned as such.

The following are examples of items to consider while planning the application project:

a) define the scope of the project. Possibilities include:

   1) a single project either internal to an organization or as part of a two party contract;

   2) concentration on some key processes or even a single process where there is expected to be some gain for an organization. This approach can be used where a weakness has been detected previously and can lead to a full application of ISO/IEC/IEEE 15288:2015 at some future point. Conversely, the approach can be of benefit where significant process refinements or additions have been made, so that in depth revisions of a single process will be necessary;

   3) adoption of ISO/IEC/IEEE 15288:2015 across a range of projects with probably a staged introduction. Here the organization should probably have no or few defined processes and should be standardizing on ISO/IEC/IEEE 15288:2015;

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4) adoption of ISO/IEC/IEEE 15288:2015 across all projects and within all parts of the organization. It is unlikely that any organization except a very small one should take this approach. It should be relevant though for a new subsidiary of an existing organization that has adopted ISO/IEC/IEEE 15288 into working practice previously.

b) identify the project goals and determine how they fit into the organization-wide business goals. If no obvious link is established between this project and the organization's business focus, then lasting commitment to achieve the application project goals will be difficult if not impossible to maintain;

c) identify roles and responsibilities of the project team/organization, assigning a single point of responsibility for each process. In many cases, one individual or organization may be responsible for more than one process, particularly in small projects or organizations;

d) identify the resources available for the application of ISO/IEC/IEEE 15288:2015, such as time, money, people and equipment;

e) create and document the project management plan for applying ISO/IEC/IEEE 15288:2015.

6.2.3 Conduct pilot project(s)

When introducing ISO/IEC/IEEE 15288:2015 in an organization across many projects, some pilot use in key areas and for key processes will help to limit the risk exposure of the organization. A successful introduction should usually include such approaches as the following:

a) identify pilot projects that can utilize the processes selected. These pilot projects should be chosen on the basis of high priority work, that will result in significant improvements, with a high probability of success, and that can be expected to provide quick, visible results;

b) select a team of volunteers to conduct the pilot projects then publicize and reward their efforts;

c) train all involved. Awareness can be aided by regular communication of progress in the implementation process, in addition to formal training classes;

d) plan the pilot projects and identify critical success factors and measures of success;

e) for each pilot project, incorporate the selected adapted process or processes into the project management plan. Reference or include as appropriate, the necessary documentation, e.g. the adaptation decisions and rationale; and

f) execute the pilot project(s), tracking and documenting the performance against the critical success factors. Capture knowledge gained from each pilot project in the knowledge management process, including lessons learned throughout the pilot project(s). Incorporate the lessons learned into revised processes.

6.2.4 Formalize the approach

Formalizing involves the introduction of a new process across several projects or across the organization. Issues such as training, documentation, provision of enabling systems, such as support tools for the processes, and the tracking and oversight of the new processes use and acceptance. Planning for the transition to the new processes for any project that is already up and running should be addressed.

NOTE Improvements can be made within a project by monitoring at the project level. They can also be made by comparing one project against another to determine approaches which were successful and which should be incorporated into future projects.

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6.2.5 Institutionalize the approach

Institutionalization focuses on what is involved in ensuring that a process is used consistently and automatically throughout the project or organization. This also involves measuring performance of the process, and implementing process improvement again as necessary.

6.3 Application of system concepts

6.3.1 General

ISO/IEC/IEEE 15288:2015 provides a set of processes that support realizing and using a system. This clause focuses on those processes that most directly apply the system concepts stated in ISO/IEC/IEEE 15288:2015, 5.2 and in further expanded in ISO/IEC/IEEE 24748-1:2018, 4.2. To support the discussions in 6.3.2 and 6.3.3, Table 5 shows the processes being discussed, the general purpose for using them, and key points to consider.

Table 5 — ISO/IEC/IEEE 15288:2015 processes used to directly apply system concepts

24748-2 Clause	15288 Processes	Purpose	Key Points
6.3.2	6.4.1 Business or mission analysis process 6.4.2 Stakeholder needs and requirements definition process 6.4.3 System requirements definition process 6.4.6 System analysis process	Understand why there needs to be a system, its boundaries, users and other stakeholders Develop the understanding into, first a statement of needs and requirements as seen by stakeholders, then translate those into requirements for a system that should satisfy the stakeholder needs	This work does not, and should not, seek to determine architecture or design of the system It is critical to identify and meaningfully involve all who will be stakeholders over the systems life cycle
6.3.3	6.4.4 Architecture definition process 6.4.5 Design definition process 6.4.6 System analysis process	Translate the system requirements into an understanding of how an actual system can be realized, first as seen from outside the system and in its elements and their relationship (architecture) and then in terms of specifics of the insides of the system (design)	Maintaining stakeholder involvement throughout is still critical There will be a great deal of recursion and iteration when doing this work, as well as questions that may require revision of the work in 6.3.1

6.3.2 Systems

To determine how to provide products, services, or both, for the benefit of users and other stakeholders, the starting point should be to define the purpose of the system, its boundaries, and those who should be its stakeholders. At that point, neither the structure nor the composition of the system is known, nor should they be the focus of interest. For those reasons, users of ISO/IEC/IEEE 15288:2015 should start with an analysis of the business or mission of the proposed system, applying the ISO/IEC/IEEE 15288:2015, 6.4.1 process of that International Standard, then use this as a bounding framework to define stakeholder needs and requirements, applying process ISO/IEC/IEEE 15288:2015, 6.4.2. These processes may need to be applied iteratively, or recursively and may be applied to new systems, existing systems where changes are being considered, and enabling systems.

Applying a systems concept should mean that the analysis and determination mentioned above are then used to define the requirements of some collection of interacting elements that should satisfy the analysis and determination, applying process ISO/IEC/IEEE 15288:2015, 6.4.3. Note that, once again, the specific structure of the system is not known at this point, nor is the manner in which that structure will be implemented (i.e. hardware, software, humans, processes, procedures, facilities, or naturally occurring entities). The user should determine, possibly iteratively or recursively, the functional, logical, timing, thermal, mass, and other properties of the system of interest and its enabling systems.

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For any of this work, process 6.4.6, Systems Analysis Process, of ISO/IEC/IEEE 15288:2015 may be useful to apply.

6.3.3 System structure

With a thorough understanding of the purpose and benefits of the system-of-interest, its boundaries and stakeholders, as well as their needs and requirements, plus the resulting system requirements that have been derived from these, the user of ISO/IEC/IEEE 15288:2015 should next apply this system to progressively define the structure of the system (its architecture) and the specific ways in which that architecture can be realized.

More specifically, the user of ISO/IEC/IEEE 15288:2015 should apply process 6.4.4, Architecture Definition, and then process 6.4.5, Design Definition. In applying these processes, probably iteratively and recursively, the user of ISO/IEC/IEEE 15288:2015 should understand that characteristic properties at a system's boundary arise from the interactions between subordinate systems. What this means in practice is that the interfaces between parts of the system should be understood first, then the parts themselves should be architected and then designed to respond to the requirements imposed by the interface. This process should be continued from the most general understanding of the system structure progressively downward to the most detailed level. Process 6.4.6, System Analysis, may need to be applied at any step along the way.

Briefly stated, the user of ISO/IEC/IEEE 15288:2015 should work from the interfaces inward, and from the top downward (downward implying a greater level of detail, but not necessarily a hierarchical system structure). This applies to the system of interest and its enabling systems, whether new or under consideration for change. Accordingly, the application of the processes described above can be done at any stage of a system's life cycle.

For any of this work, process 6.4.6, Systems Analysis Process, of ISO/IEC/IEEE 15288:2017 may be useful to apply.

6.3.4 Structure in systems and projects

The user of ISO/IEC/IEEE 15288:2015 should determine the project scope, or the scopes of the set of projects, that best supports definition, realization and use of the system of interest and its enabling systems. To do this, the user of ISO/IEC/IEEE 15288:2015 should draw on the results of applying, directly or with adaptation the Agreement Processes (6.1), Organizational Project-Enabling Processes (6.2) and Technical Management Processes (6.3) that are already in place for the organization within which the projects will be executed. For example, the possible need to define a new system should result in reconsideration of the organization's infrastructure, portfolio, human resource, quality, and knowledge management capabilities under various possible project structures to find the best relationship of the set of projects versus the possible scope of the system of interest and its enabling systems.

6.3.5 Enabling systems

The applications of system concepts described in the preceding clauses apply directly to enabling systems, with the following clarifications:

a) in considering the scope and structure of the projects to support actualization of a system of interest, it is critical to also consider all enabling systems;

b) the understanding of enabling systems follows the understanding of the system of interest, at each level of that understanding;

c) the user of ISO/IEC/IEEE 15288:2015 should re-use, possibly with adaptation, existing enabling systems wherever possible; and

d) the use of existing enabling systems can constrain the realization of the system of interest, therefore the user of ISO/IEC/IEEE 15288:2015 should perform the appropriate system analyses to

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determine if it is more beneficial to adapt the enabling system to the system of interest, or constrain the system of interest to accommodate the existing enabling system.

6.4 Application of life cycle concepts

6.4.1 Overview

ISO/IEC/IEEE 15288:2015 requires the establishment of a life cycle model to provide a framework in which the processes of the International Standard are performed [See 6.2.1.2 c)]. It also requires the definition of purpose and outcomes for each stage in the established life cycle model. ISO/IEC/IEEE 24748-1:2018 provides (in Clause 4) a description, including the purpose and outcomes, of a life cycle model with a set of six life cycle stages. This model is included in Figure 2 as a reference for two related views of the system life cycle – the organizational view and the engineering view.

NOTE 1 For simplicity of exposition, the life cycle model in Figure 2 is drawn as if the stages were sequential and equal in length. In actuality, as described in ISO/IEC/IEEE 24748-1:2018, 4.3.1, stages can be interdependent and overlapping, can be of differing durations and can iterate or be applied recursively.

NOTE 2 There can also be a project view, and possibly other views, of the life cycle model.

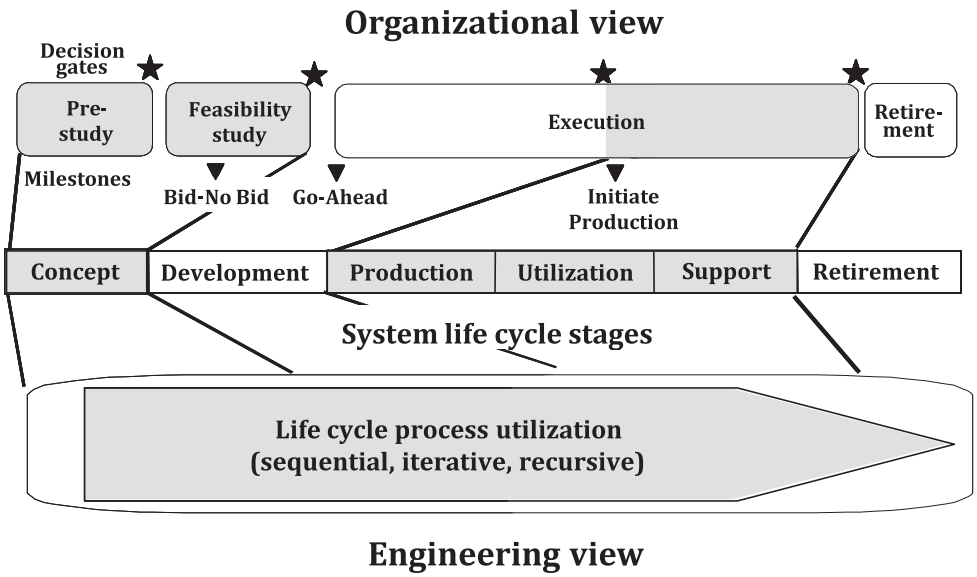

Figure 2 — Organizational and engineering views related to representative system life cycle model

The system life cycle model illustrated in Figure 2 does not imply any application precedence or sequence for the application of ISO/IEC 15288:2008 life cycle processes. The order of use of the life cycle processes is influenced by multiple factors such as social responsibilities, world trade laws, organizational cultures and technical considerations. Each of these factors can vary during the life of a system. A manager of a system life cycle stage typically selects the appropriate set of life cycle processes to meet entry or exit criteria and other stage objectives. For example, during any of the later life cycle stages a manager can use the Operation Process, Maintenance Process and Disposal Process to manage the system while it performs its required functions or is serviced to meet system requirements. During earlier life cycle stages the same processes can be used to help manage the development of the system as well as affect the disposal of waste products or work products that are no longer needed.

To determine which processes to select and apply during a system life cycle stage, a user of ISO/IEC/IEEE 15288:2015 is guided by the purpose and outcomes for each of the stages (see ISO/IEC/IEEE 24748-1:2018, Clause 4). The selection of the appropriate processes enables the system's progression through its life cycle to be managed. The system life cycle model of Figure 2 can be considered as an illustration

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of an orderly passage associated with a system going from one stage of life to another. Both the organization and engineering views of Figure 2 can be helpful in enabling this passage.

An organization (for example an automobile company or medical equipment supplier) or a domain group of an organization (for example a government defence agency or industry group) often has a unique view of the system life cycle to control the passage from one system life cycle stage to the next. The organizational view illustrated includes management-focused activities that are used to form both milestones and decision gates.

The organization uses these milestones and gates as decision points where investment decisions can be made as to whether a system should be continued to the next system life cycle stage or be modified, be cancelled or retired or have the plans for the next stage revised before approval. These milestones and decision gates can be used by organizations to contain the inherent uncertainties and risks associated with costs, schedule and functionality when a system is created or utilized.

The views of Figure 2 provide an example framework in which different approaches can be used to meet organization goals and objectives. In order to meet the exit criteria of a decision gate, the appropriate artefacts need to be produced to provide decision-making information and required deliverables. Thus, planned engineering activities need to take place during each system life cycle stage to obtain the outcomes and meet the purpose of the stage or a set of stages.

The framework and example approaches for the views of Figure 2 are described in 6.4.3 below.

6.4.2 Decision gates

The organizational view of Figure 2 can vary according to the nature, purpose, use and prevailing circumstance of the system-of-interest or the business of the organization. Nevertheless, despite a necessary and apparently limitless variety in such views, there is an underlying notional set of characteristic milestones and decision gates that exists. Each milestone and decision gate has a distinct purpose and contribution to the system life cycle. These milestones and decision gates should be considered when planning and executing the system life cycle.

NOTE Examples of decision options and their purpose for each stage of a life cycle are shown in, of ISO/IEC/IEEE 24748-1:2018, Table 1.

Milestones provide an opportunity for management to review progress and decide to declare that milestone as satisfactorily completed and proceed to the next milestone. If the milestone marks the end of a stage, then a decision gate is reached to proceed to the next stage or select one of the other options from ISO/IEC/IEEE 24748-1:2018. The decision gates provide a framework within which organization management has high-level visibility and control of the project.

During each system life cycle stage, management can use established decision gates to determine whether the objectives (financial as well as technical) of that system life stage were satisfactorily completed and whether the system is ready to progress to another stage or, alternatively, hold or continue in the present stage, return to a previous point in the present stage, or return to another stage or stages.

The specific rationale for the decision may vary for each stage. For example, during later life cycle stages while the system is being used (utilization and support), the decision as to whether to continue in that stage or if the system should be appropriately retired (move to the Retirement stage) can be based on:

a) whether system technology should and can be refreshed (change to the baseline configuration without changing performance); and

b) whether new system technology should and can be inserted (change to system performance).

Decision gates to move to another stage can occur at more than one point in a given stage. Examples of when decision gates can be appropriate for the Concept Stage are:

a) after a period of pre-study; and

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