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# Software engineering — Software life cycle processes — Maintenance

*Ingénierie du logiciel — Processus du cycle de vie du logiciel — Maintenance*

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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/IEC 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.

ISO/IEC/IEEE 14764 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.

This third edition cancels and replaces the second edition (ISO/IEC 14764:2006), which has been technically revised.

The main changes compared to the previous edition are as follows:

— alignment of the standard with ISO/IEC/IEEE 12207:2017 and updates to other ISO/IEC JTC1/SC7 standards;

— introduction of modern approaches to “maintenance”.

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.

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# Introduction

This document provides guidance on the software maintenance process. Maintenance is a technical process in the life cycle of a software product, as described in ISO/IEC/IEEE 12207. The maintenance process contains the activities and tasks of the maintenance organization. This document is the result of the harmonization of ISO/IEC 14764 and IEEE Std 1219, and the update for ISO/IEC/IEEE 12207:2017.

Because maintenance consumes a major share of a software life cycle financial resources, it should be an important project consideration.

During operation of the software, problems may be detected that were not detected during verification, validation and acceptance. Therefore, a maintenance effort is needed to cope with these problems. This maintenance effort also covers software improvements needed to meet new or modified user requirements. Software maintenance is commonly needed when upgrading system components, such as operating systems and databases, as well as when changes are made to external software and systems' interfaces. Software maintenance is typically a significant portion of life cycle costs, even when a part of the system under maintenance includes COTS software.

Software maintenance organizations uses a number of specific tools, methods, and techniques. This document does not specify how to implement or perform the activities and tasks in the software maintenance process since these are dependent upon the formal agreement and organizational requirements. Maintenance is required on all types of software, whatever the technology, technique, or tool used to create it.

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# Software engineering — Software life cycle processes — Maintenance

## 1 Scope

### 1.1 Overview

This document provides guidance for the maintenance of software, based on the maintenance process and its activities and tasks defined in ISO/IEC/IEEE 12207:2017, 6.4.13. Moreover, this document describes the maintenance process in greater detail and establishes definitions for the various types of maintenance. This includes maintenance for multiple software products with the same maintenance resources. "Maintenance" in this document means software maintenance unless otherwise stated.

The document does not address the operation of software and the operational functions, e.g. backup, recovery, system administration, which are normally performed by those who operate the software. However, it does include the related disposal process defined in ISO/IEC/IEEE 12207:2017, 6.4.14.

This document is written primarily for managers, maintenance organizations, quality managers, users and acquirers of systems containing software.

Many of the activities and tasks discussed in this document apply equally to maintenance services, as well as to maintained software products. For example, in a COTS intensive system, maintenance services are performed to sustain the product in operations.

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While the scope of this document is software maintenance, hardware and hardware costs are important considerations for maintenance.

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### 1.2 Purpose

This document provides guidance on the maintenance process. It identifies how the maintenance process can be invoked during acquisition and operation. This document also emphasizes the following in the maintenance process: the maintainability of software products; the need for maintenance service models; and the need for a maintenance strategy.

### 1.3 Field of application

This document is intended to provide guidance for the planning for and maintenance of software products or services, whether performed internally or externally to an organization. It is not intended to apply to the operation of the software.

This document is intended to provide guidance for two-party situations and can be equally applied where the two parties are from the same organization. This document is intended to also be used by a single party as self-imposed tasks (ISO/IEC/IEEE 12207).

This document is not intended for software products that are "throw-away" or a "short-term" solution.

This document is intended for self-imposition by organizations that develop off-the-shelf software products to maintain such products. Maintenance is applied to computer programs, code, data, documents, and records. It is intended to apply to software products created during the development of the software product. This can include, for example, the test software, test databases, the software test environment (STE), or the software engineering environment (SEE).

This document is intended for use in all maintenance efforts, regardless of the life cycle model (e.g. incremental, waterfall, evolutionary, spiral, agile, continuous iterative development). This document is not restricted by size, complexity, criticality, reliability, or application of the software product.

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### 1.4 Limitations

This document describes the framework of the maintenance process but does not specify the details of how to implement or perform the activities and tasks included in the process.

In this document, there are a number of lists. None of these is presumed to be exhaustive. They are intended as examples.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC/IEEE 12207, *Systems and Software engineering — Software life cycle processes*

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/IEC/IEEE 12207 and the following 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

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**3.1.1**
**adaptive maintenance**
modification of a software product, performed after delivery, to keep a software product usable in a changed or changing environment

Note 1 to entry: Adaptive maintenance provides *enhancements* (3.1.7) necessary to accommodate changes in the environment in which a software product operates. These changes help keep pace with the changing environment, e.g. an upgrade to the operating system results in changes in the applications.

**3.1.2**
**additive maintenance**
modification of a software product performed after delivery to add functionality or features to enhance the usage of the product

Note 1 to entry: Additive maintenance may be excluded from the definition of maintenance in the context of dependability that addresses recovery of a system to previous operational, functional and performance level, e.g. definition, monitor or measurement of availability, recoverability, or MTBF (mean time between failure).

Note 2 to entry: "Additive maintenance" type is distinguished from *"perfective maintenance"* (3.1.9) type and recognized as a different maintenance type to be able to:

— provide additional new functions or features to improve software usability, performance, *maintainability* (3.1.6), or other software attributes for the future;

— add functionality or features with relatively large additions or changes on software for improving software attributes after delivery with identified opportunities to negotiate any of additions or changes on maintenance strategy, methods, resources, agreements, or service levels between suppliers and acquirers.

Note 3 to entry: Additions or *enhancements* (3.1.7) can be handled through the maintenance process, while larger changes can involve a new development effort.


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**3.1.3**
**correction**
<software> change that addresses and implements problem resolutions to recover gaps and to make software operational enough to meet defined operational requirements

Note 1 to entry: In this document, the term “correction” is mainly used as a maintenance type and to classify *modification requests (MR)* (3.1.8).

**3.1.4**
**corrective maintenance**
modification of a software product performed after delivery to correct discovered problems

Note 1 to entry: The modification repairs the software product to satisfy defined system requirements.

**3.1.5**
**emergency maintenance**
unscheduled modification performed to temporarily keep a system operational, pending *corrective maintenance* (3.1.4)

Note 1 to entry: Emergency maintenance may be performed to make a software system partially operational. It may include various modifications to the software or its parameters in order to limit operations, functionalities, inputs, outputs, interfaces, usability, etc.

Note 2 to entry: Emergency maintenance can be regarded as a corrective maintenance type.

**3.1.6**
**maintainability**
degree of effectiveness and efficiency with which a product or system can be modified

Note 1 to entry: Modifications can include *corrections* (3.1.3), improvements or adaptation of the software to changes in environment, and in requirements and functional specifications. Modifications include those carried out by specialized support staff, and those carried out by business or operational staff, or end users.

Note 2 to entry: Maintainability includes installation of updates and upgrades.

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Note 3 to entry: Maintainability can be interpreted as either an inherent capability of the product or system to facilitate maintenance activities, or the quality in use experienced by the maintainers for the goal of maintaining the product or system.

[SOURCE: ISO/IEC 25010:2011, 4.2.7, modified —"by the intended maintainers" at the end of the definition has been removed.]

**3.1.7**
**enhancement**
software change that addresses and implements a new requirement

Note 1 to entry: There are three types of software enhancements: adaptive, perfective and additive. An enhancement is not a software *correction* (3.1.3).

Note 2 to entry: In this document, the term “enhancements” is mainly used as a maintenance type and to classify *modification requests (MR)* (3.1.8).

**3.1.8**
**modification request**
**MR**
information item that identifies and describes proposed changes(s) to a product or service

Note 1 to entry: The MR may later be classified as a *correction* (3.1.3) or *enhancement* (3.1.7) and identified as *corrective maintenance* (3.1.4), *preventive maintenance* (3.1.10), *adaptive maintenance* (3.1.1), *additive maintenance* (3.1.2) or *perfective maintenance* (3.1.9). MRs are also referred to as change requests. See Figure 1.

Note 2 to entry: When formulating an MR, incidents, events and complaints should be reviewed as well as failure occurrence *problem reports* (3.1.11) and stakeholder’s maintenance requests.

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Note 3 to entry: When classifying MRs, methods for prioritizing problems and root case analyses can be applied; and various approaches for preventing failure reoccurrences can be considered. For example, reoccurrence of similar failures can be prevented by preventive maintenance requests to fix potential latent faults, while similar failures in future can be avoided by perfective maintenance to enhance user interface preventing human error.

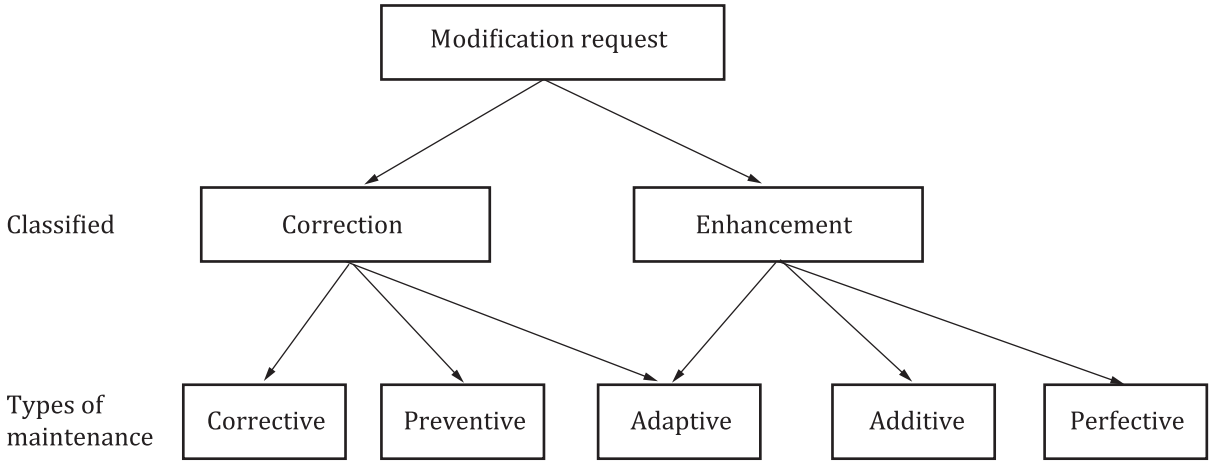



**Figure 1 — Modification request**

Note 4 to entry: In some organizations, adaptive maintenance is not considered to be an enhancement.

Note 5 to entry: Adaptive maintenance can be requested from MRs classified as enhancement, when the software is to be adapted to its evolving and changing environment or different environments on which the software is not initially intended to operate. Additionally, adaptive maintenance can be requested from MRs classified as correction, when the software is to be adapted to its environment that has already changed.

Note 6 to entry: Additive is an enhancement type that some organizations use and different from perfective in that some changes to existing software or systems is made.

Note 7 to entry: Some organizations sub-divide each type into “scheduled”, “unscheduled” and “emergency” types.

Note 8 to entry: Another way to classify MR’s is by “reactive” or “proactive” maintenance as used in SWEBOK. Reactive includes corrective and adaptive types; and proactive includes preventive, perfective and additive types.

### 3.1.9
**perfective maintenance**
modification of a software product to provide *enhancements* (3.1.7) for users, improvements of information for users, and recording to improve software performance, *maintainability* (3.1.6) or other software attributes

### 3.1.10
**preventive maintenance**
modification of a software product after delivery to correct latent faults in the software product before they occur in the live system

### 3.1.11
**problem report**
**PR**
document used to identify and describe problems detected in a software product

Note 1 to entry: PRs are either submitted directly to denote faults or established after impact analysis is performed on *modification requests* (3.1.8) and faults are found.


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**3.1.12**
**software maintenance**
totality of activities required to provide support to a software system

Note 1 to entry: Activities are performed during the pre-delivery stage as well as the post-delivery stage.

Note 2 to entry: Pre-delivery activities include, for example, planning for post-delivery operations, supportability, and logistics determination. Post-delivery activities include, for example, software modification, training, and operating a help desk.

Note 3 to entry: In the context of dependability, maintenance is a combination of all technical and management actions intended to retain an item in, or restore it to, a state in which it can perform as required.

**3.1.13**
**software sustainment**
activities to support, maintain and operate a software system to ensure that the software system or service remains operational

Note 1 to entry: Software sustainment includes processes, procedures, people, material and information required to support, maintain and operate the software aspects of a system.

Note 2 to entry: Sustainment is defined in ISO/IEC/IEEE 24765 as activities performed to ensure that a product or service remains operational. In this document, software sustainment is defined to emphasize that activities for supporting, maintaining and operating are performed more concurrently and iteratively to sustain operational software systems.

**3.1.14**
**transition**
activities involved in moving a new or changed service, system, or component to or from an environment

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## 3.2 Abbreviated terms

| | |
|---|---|
| CM | configuration management |
| COTS | commercial-off-the-shelf software |
| MBSE | model-based systems engineering |
| SEE | software engineering environment |
| STE | software test environment |

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# 4 Conformance

This document provides guidance for the implementation of the maintenance process of ISO/IEC/IEEE 12207. The guidance in this document is completely consistent with ISO/IEC/IEEE 12207. Conformance cannot be claimed to this document but can be claimed to the ISO/IEC/IEEE 12207 maintenance process and related tailoring. The only mandatory clauses in this document come from ISO/IEC/IEEE 12207. The mandatory clauses contain requirements; and each requirement from ISO/IEC/IEEE 12207 that is duplicated in this document is boxed. The related ISO/IEC/IEEE 12207 clause number is listed after the boxed ISO/IEC/IEEE 12207 requirements.

# 5 Application of this document

## 5.1 General

This clause presents the maintenance process that is required to maintain software products.

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## 5.2 Maintenance process

Maintenance is one of the technical life cycle processes that may be performed during the life cycle of software (ISO/IEC/IEEE 12207). The acquisition and supply agreement life cycle processes of ISO/IEC/IEEE 12207 may initiate the process implementation activity of the maintenance (life cycle) process through an agreement or contract. The operation process may call for maintenance through a modification request or problem report. The maintenance (life cycle) process invokes the technical life cycle processes of ISO/IEC/IEEE 12207 to develop any required enhancement, as a part of the maintenance strategy. The technical management processes, such as project planning, configuration management and quality assurance of ISO/IEC/IEEE 12207 are used by the maintenance (life cycle) process.

NOTE Significant maintenance changes can be treated as a software development project using the design definition, implementation, integration, and transition processes, among others.

Figure 2 shows the connection of the maintenance process in ISO/IEC/IEEE 12207 to other maintenance-related processes and the elaboration of the maintenance process into its defined activities. These maintenance activities are discussed in detail in Clause 6.

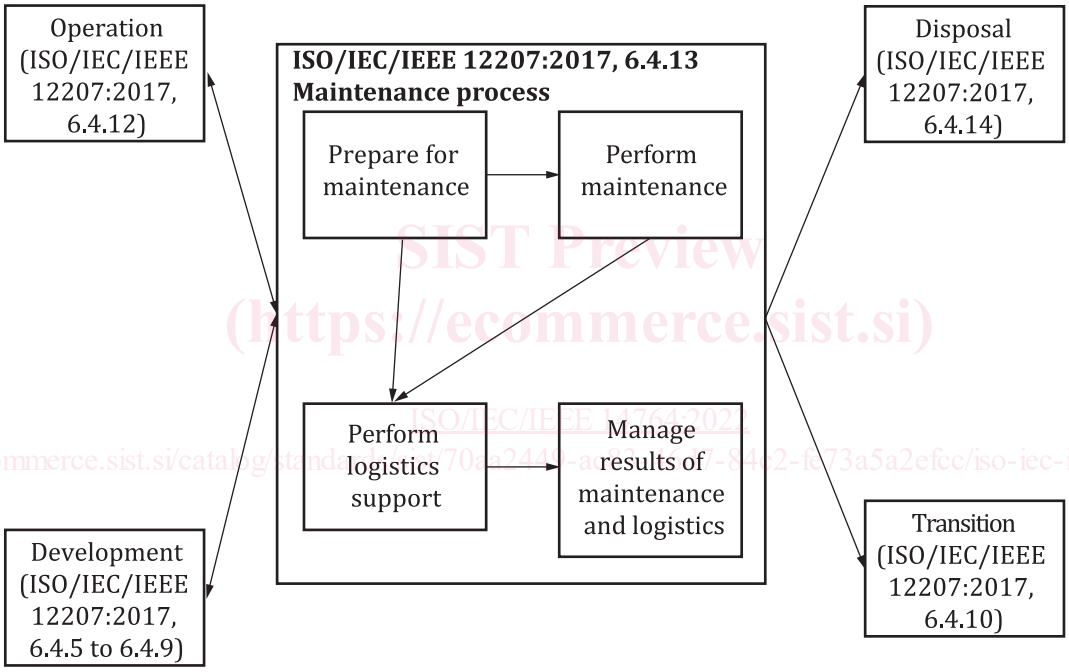



**Figure 2 — Relationship between maintenance process and other processes of ISO/IEC/IEEE 12207 by clause number**

## 5.3 Organization of this document

Clauses 6 to 9 provide an elaboration of the maintenance process from ISO/IEC/IEEE 12207. The boxed text preceding elaboration text contains the numbered clauses from ISO/IEC/IEEE 12207.

Clause 6 provides the details of the maintenance process including activities and tasks needed to implement the maintenance process. Clause 7 includes considerations, and issues encountered when planning maintenance, Clause 8 describes implementation issues. Clause 9 provides details for a maintenance plan.

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# 6 Maintenance process

## 6.1 Maintenance activities and tasks

### 6.1.1 General

**6.4.13 Maintenance process**

**6.4.13.1 Purpose**

The purpose of the Maintenance process is to sustain the capability of the system to provide a service.

This process monitors the system's capability to deliver services, records incidents for analysis, takes corrective, adaptive, perfective and preventive actions and confirms restored capability.

[ISO/IEC/IEEE 12207:2017]

Software maintenance may be considered part of software sustainment, where support, maintenance and operation processes are managed and performed together.

**6.4.13.1 Purpose (cont'd)**

For software systems, the Maintenance process makes corrections, changes, and improvements to deployed software systems and elements. The software systems maintenance approach differs for systems that are freely available, in wide commercial distribution, or operating in a small number of controlled environments.

The need for software system maintenance can arise from multiple causes other than latent system defects, such as changes to interfaced systems or infrastructure, evolving security threats, and technical obsolescence of system elements and enabling systems over the system life cycle. Often the extension of capability, mid-life upgrade, or evolution of legacy systems becomes a new software system development project that will apply the set of processes within an appropriate life cycle. If so, the Portfolio Management process is the starting point to initiate the work. In other cases, software system maintenance is performed as a continuing series of prioritized work items, possibly on a level of effort basis. Maintenance of software system elements can include hardware, software, and services, such as communication or web services. Maintenance is closely connected with the Configuration Management process and software asset management and is performed concurrently with the other Technical processes.

NOTE ISO/IEC/IEEE 14764:2006 *Software Engineering — Software Life Cycle Processes — Maintenance* and ISO/IEC 16350, *Information technology — Systems and software engineering — Application management*, provide additional detail. The SWEBOK, Guide to the Software Engineering Body of Knowledge, Software Maintenance knowledge area discusses software maintenance fundamentals, key issues, measurement, techniques, maintenance process and support activities, and tools. The guide also discusses models, techniques and measures that support software reliability.

[ISO/IEC/IEEE 12207:2017]

The boxed text and notes from ISO/IEC IEEE 12207 are considered sufficient guidance for this subclause.

**6.4.13.2 Outcomes**

As a result of the successful implementation of the Maintenance process:

a) Maintenance constraints that influence system requirements, architecture, or design are identified.

b) Any enabling systems or services needed for maintenance are available.

c) Replacement, repaired, or revised system elements are made available.

d) The need for changes to address corrective, perfective, or adaptive maintenance is reported.

e) Failure and lifetime data, including associated costs, is determined.

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