
**Software and systems engineering —
Methods and tools for product line
configuration management**

*Ingénierie du logiciel et des systèmes — Méthodes et outils pour la
gestion des configurations de gammes de produits*

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

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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*.

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.

Introduction

Software and systems product line (SSPL) engineering and management creates, exploits, and manages a common platform to develop a family of products (e.g. software products, systems architectures) at a lower cost, with reduced time to market and better quality. As a result, it has gained increasing global attention since the 1990s.

SSPL engineering and management maintain changes of commonality and variability of a product line as well as multiple different products derived from the product line. The impacts of the changes in commonality and variability are on each product of a product line, and they are different for each product. Thus, the complexity of configuration management in SSPL is high, and configuration management for a single system that is not aware of these aspects cannot manage configurations of a product line. This document deals with configuration management methods and tools that are aware of these aspects.

This document can be used in the following modes:

- to provide guidance on how to identify, control, report, and evaluate configurations of a product line by organizations that want to adopt SSPL for producing their products;
- to provide guidance on the evaluation and selection for methods and tools for product line configuration management by a product line organization;
- to provide guidance on implementing or developing methods and/or tools by specifying a comprehensive set of methods and tools capabilities for supporting product line configuration management by either providers of methods or tools, or both.

The ISO/IEC 26550 family of standards addresses both engineering and management processes and capabilities of methods and tools in terms of the critical characteristics of product line development. This document provides processes and capabilities of methods and tools for configuration management in product lines.

Other standards in the ISO/IEC 26550 family are as follows: ISO/IEC 26550, ISO/IEC 26551, ISO/IEC 26552, ISO/IEC 26553, ISO/IEC 26554, ISO/IEC 26555, ISO/IEC 26556, ISO/IEC 26557, ISO/IEC 26558, ISO/IEC 26559, ISO/IEC 26560, ISO/IEC 26561, ISO/IEC 26562 and ISO/IEC 26564.

- Processes and capabilities of methods and tools for domain requirements engineering and application requirements engineering are provided in ISO/IEC 26551.
- Processes and capabilities of methods and tools for domain design and application design are provided in ISO/IEC 26552.
- Processes and capabilities of methods and tools for domain realization and application realization are provided in ISO/IEC 26553.
- Processes and capabilities of methods and tools for domain testing and application testing are provided in ISO/IEC 26554.
- Processes and capabilities of methods and tools for technical management are provided in ISO/IEC 26555.
- Processes and capabilities of methods and tools for organizational management are provided in ISO/IEC 26556.
- Processes and capabilities of methods and tools for variability mechanisms are provided in ISO/IEC 26557.
- Processes and capabilities of methods and tools for variability modelling are provided in ISO/IEC 26558.

- Processes and capabilities of methods and tools for variability traceability are provided in ISO/IEC 26559.
- Processes and capabilities of methods and tools for product management are provided in ISO/IEC 26560.
- Processes and capabilities of methods and tools for product line transition management are provided in ISO/IEC 26562.
- Processes and capabilities of methods and tools for product line measurement are provided in ISO/IEC 26564.

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Software and systems engineering — Methods and tools for product line configuration management

1 Scope

This document, within the context of methods and tools that support the configuration management (CM) capability of software and systems product line engineering:

- specifies processes for product line CM (the processes are described in terms of purpose, inputs, tasks, and outcomes);
- specifies method capabilities to support the defined tasks of each process;
- specifies tool capabilities that automate or semi-automate tasks and methods.

This document does not concern the processes and capabilities of tools and methods for a single system but rather deals with those for a family of products.

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 and IEC 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/>

3.1

application asset

output of a specific application engineering process (e.g. application realization) that may be exploited in other lifecycle processes of application engineering and may be adapted as a *domain asset* (3.3) based on a product management decision

[SOURCE: ISO/IEC 26550:2015, 3.2, modified — Notes to entry have been removed.]

3.2

common configuration item

entity within a configuration that is common to all products

3.3

domain asset

output of domain engineering life cycle processes and can be reused in producing products during application engineering

[SOURCE: ISO/IEC 26550:2015, 3.11, modified — The alternative preferred term "core asset" and notes to entry have been removed.]

3.4 product line configuration
snapshot of the product line that contains a collection of revisions of every *domain asset* (3.3) and member product in the product line

3.5 product line configuration delta
difference between the two versions of *product line configuration* (3.4)

3.6 product line configuration item
resulting artefacts that make up a product line

Note 1 to entry: Product line configuration item is a generic term for configuration items of domain engineering, application engineering, and managerial support.

3.7 product line configuration management
coordinated activities to direct and control *product line configuration* (3.4)

Note 1 to entry: Product line configuration management includes configuration management activities for domain engineering, application engineering, and organization and technical management.

[SOURCE: ISO/IEC TR 18018:2010, 3.7, modified — "product line" has been added in the term and in the definition; the abbreviated term has been removed; note 1 to entry has been added.]

3.8 variation in time
existence of different versions of a common or variable artefact at different times

Note 1 to entry: The variation in time dimension is synchronous with software evolution[24].

3.9 variable configuration item
entity within a configuration that is variable among products

3.10 variation in space
existence of different versions of a variable artefact in different shapes and used by different products

3.11 variability model
explicit definition for product line variability

[SOURCE: ISO/IEC 26550:2015, 3.27, modified — Note 1 to entry has been removed.]

4 Abbreviated terms

CM	configuration management
ConOps	concept of operations
PL	product line
SSPL	software and systems product line

5 Reference model for product line configuration management

5.1 Overview

CM is an essential prerequisite for being able to cope with the complexity of products in different versions. SSPL consists of many common and variable parts in different versions, so the complexity of CM is very high. Therefore, sophisticated CM is essential to succeeding in SSPL engineering and management.

In SSPL, CM is performed for domain engineering and application engineering, unlike CM for single system development. At any moment, some products use different versions of reusable domain assets. Furthermore, adaptations, additions, or deletions of commonality and variability make CM more complex.

Like CM for single system development, product line CM should support the management of configuration items, versions, branches, baselines, and branched baselines. It also should support change control and release control. However, product line CM should support:

- a) management of snapshots of common and variable domain assets uniquely identified at a given reference point so that member products reuse them consistently called variants in time;
- b) management of artefacts for a variation point and its variants, namely different snapshots of artefacts that can replace the variation point called variants in space;
- c) management of snapshots of a member product, including reused domain assets and product-specific artefacts.

The product line CM process and its supporting methods and tools should have capabilities to maintain the integrity of the configuration items of software and systems produced during product line engineering and management.

5.2 Constituents of reference model for product line configuration management

The reference model specifies the structure of supporting processes and subprocesses for a product line CM. [Figure 1](#) shows that a product line CM is structured into three processes: product line CM, PL configuration operationalization, and product line CM support. In the rest of this document, tasks, methods, and tools are described for processes and subprocesses defined in the reference model.

Each process is divided into subprocesses, and each subprocess is described in terms of the following attributes:

- the title of the subprocess;
- the purpose of the subprocess;
- the inputs to produce the outcomes;
- the tasks to achieve the outcomes;
- the outcomes of the subprocess.

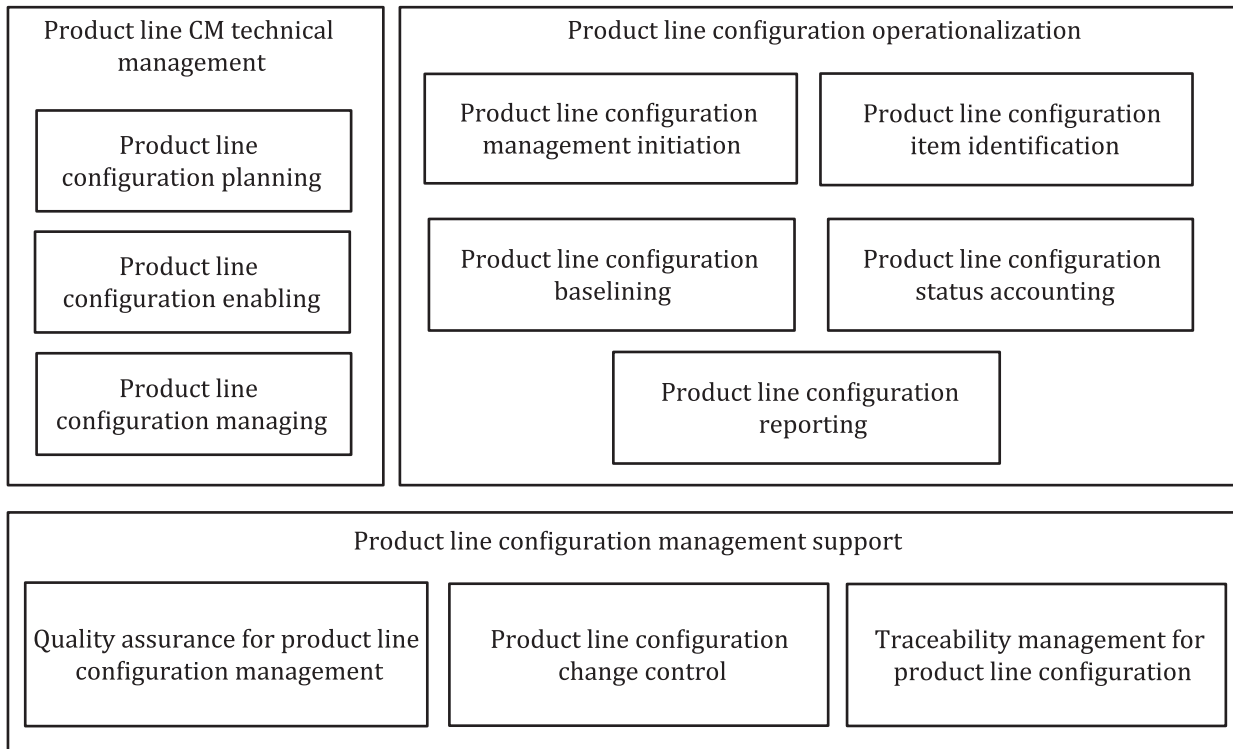


Figure 1 — Reference model for the product line configuration management

The product line CM technical management process provides managerial supports for planning PL configuration (e.g. CM strategy, resource estimation, responsibility allocation, success measures), supports for providing necessary resources, tools, and infrastructures for realizing CM plans and supports for analysing the plan versus the actual status of CM. The product line CM technical management includes the following:

- product line configuration planning establishes plans for initiating, operationalizing and supporting product line CM; PL configuration plan contains PL configuration strategy, CM responsibilities and authorities, criteria for identifying configuration items, applicable policies, PL-specific CM process, rules for change and release control, success measures to judge the success of CM, schedule, tools, and resources;
- product line configuration enabling defines, maintains, and assures the availability of environments, guidance, and measurement necessary to performing product line CM; product line CM environments should support coordination and cooperation among participants of domain engineering and application engineering processes so that participants of domain engineering can do their roles and responsibilities without interfering with the progress of application engineering and vice versa; the environments should clarify whether member products can be allowed to change domain configuration items they are reusing; guidance for stabilizing and making changes on configuration items of domain engineering is essential to preventing risks due to the reuse of inconsistent or destabilized versions of domain configuration items;
- product line configuration managing provides integrated management for product line configuration operationalization; this subprocess reviews the product line configuration operationalization's actual status against plans, controls issues, and takes corrective actions if necessary.

The PL configuration operationalization process performs operations for establishing and maintaining configurations of product line engineering and management. This process deals with the identification of PL configuration items, baselining, change and release control of PL configuration items and

baselines, and managing for commonality and variability to apply and undo PL configuration changes. The PL configuration operationalization includes the following:

- product line CM initialization identifies and mobilizes PL configuration participants to initiate the integrated PL configuration operation; Initialization includes the selection of mechanisms and tools for the handling configurations of all PL engineering artefacts;
- product line configuration item identification identifies the software and system items managed under the product line CM; configuration items include common, variable, and product-specific items of software and systems;
- product line configuration baselining creates baselines of product line configurations with configuration descriptions; product line configuration includes configuration of domain assets, including commonality and variability and configuration of an individual product;
- product line configuration status accounting manages differences of one version of a product line from another; deltas between PL configurations are complex because changes and evolutions occur at multiple dimensions such as domain asset changes and evolutions in time, domain asset variations in space, and changes and evolutions in member products; methods and tools should support correct and complete propagation of configuration deltas of domain assets across all member products;
- product line configuration reporting records and reports the status of product line configuration items and change requests. This subprocess reviews PL configuration activities for validating the correctness and completeness of status of PL configurations and maintaining consistency among the common and variable domain assets by ensuring that domain assets are in an appropriate state throughout the entire product line lifecycle.

The product line CM support process provides supports required for coping with the complexity of product line CM in change and traceability management and for assuring the quality of complex product line CM technical management activities. To achieve these, the product line CM support includes the following:

- quality assurance for product line CM objectively evaluates the activities of product line CM that they adhere to the guidance, release and change control rules, and defined CM process; and this subprocess assures that PL configuration items, versions, baselines, and releases as the results of product line CM activities are correct, complete, and consistent;
- product line configuration change control evaluates and manages change requests of common and variable domain assets in time and space and changes performed on each member product specifically;
- traceability management for product line configuration establishes and manages traces among different but relevant configurations of a product line to ensure the integrity of configurations of a product line; traceability of the product line configuration should be of a degree that can support recoverability.

Identifying and analysing the key differentiators between single-system engineering and management and product line engineering and management can help the organizations understand the product line and formulate a strategy for the successful implementation of product line engineering and management. The key aspects are defined in ISO/IEC 26550; and [Table 1](#) shows the category of the key aspects.

Table 1 — Key aspects for identifying product line CM tasks

Category	Aspects
Reuse management	application engineering, domain assets, domain engineering, product management, platform, reusability
Variability management	binding, variability