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Software and systems engineering — Methods and tools for product line measurement

Ingénierie du logiciel et des systèmes — Méthodes et outils pour les mesures de gammes de produits

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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

For the successful adoption of the SSPL approach, quantitative management of a product line is essential. For quantitative management, the quality of product line processes and their work products should be measured. This is important because a product line deals with products as a portfolio, and its quality is not limited to a single product but multiple different products. Product line measurements deal with the quality of domain assets, the quality of individual products associated with the quality of a product line, and the quality of a product. Besides, for variability management, a product line should measure the number of variabilities and their impacts on the success of a product line. Methods and tools of product line measurements should consider these product line specific aspects.

This document can be used in the following modes:

— to provide guidance on how to perform product line measurement 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 measurement 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 measurement 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 variability modelling 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 26563.

— 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 technical probe are provided in ISO/IEC 26561.

— 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 configuration management are provided in ISO/IEC 26563.

Software and systems engineering — Methods and tools for product line measurement

1 Scope

This document, within the context of methods and tools that support the product line measurement and management and that demonstrate the quality of the products and a product line:

— specifies processes for product line measurement (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
commonality index
index that captures the level of commonality of a feature, subsystem, component or a product line

Note 1 to entry: Commonality index is calculated as a formula such as *measure* (3.4) or combination of measures (function). The formula for calculating the commonality index reflects the relative size, effort, complexity, or importance of features, subsystems, components, or a product line as weights.

Note 2 to entry: Function points is one of the candidate cost estimation methods used to calculate efforts required for establishing core assets or product line development. A commonality index is used in conjunction with a function point.

Note 3 to entry: Annex A elaborates on the meaning of commonality and commonality index of the product line.

3.3
domain asset
output of domain engineering life cycle processes that 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
measure
variable to which a value is assigned as the result of *measurement* (3.5)

Note 1 to entry: The term "measures" is used to refer collectively to base measures, derived measures, and indicators.

[SOURCE: ISO/IEC 25000:2014, 4.18]

3.5
measurement
set of operations having the object of determining a value of a *measure* (3.4)

Note 1 to entry: Measurement can include assigning a qualitative category such as the language of a source program (ADA, C, Java, etc.).

[SOURCE: ISO/IEC 25000:2014, 4.20]

3.6
variability index
index that captures the level of variations across features, subsystems, components, products, or product lines

Note 1 to entry: Variability index is calculated as a formula such as *measure* (3.4) or combination of measures (function). The formula for calculating the variability index reflects the relative size, effort, complexity, or importance of features, subsystems, components, or product lines as weights.

Note 2 to entry: Function points is one of the candidate cost estimation methods used to calculate the additional efforts required for product development. A variability index is used in conjunction with a function point.

Note 3 to entry: Annex A elaborates on the meaning of variability and variability index of the product line.

4 Reference model for product line measurement

4.1 Overview

Measurements allow an organization to manage characteristics of software or systems quantifiably or countably. Measurements are necessary for measuring performance, estimating and planning work items, and measuring productivity. Software and systems product line (SSPL) engineering and management manage common platforms and variability and derive individual products based on the common platform and managed variability. These concepts are not necessary for the development of single systems and are not considered in single system measurement.

NOTE ISO/IEC/IEEE 15939 describes concepts of measurement for software and systems engineering projects.

In SSPL, different measures from single system measurement should be established to characterize the properties of SSPL. Product line (PL) measurements include commonality- and variability-aware measurement processes, tasks, and their supporting methods' and tools' capabilities. Product line measurement also includes measurements for the variability model because they are linked to all processes of product line lifecycles.

Product line measurement aims to establish and improve a product line organization's ability to achieve product line objectives through measurement results to planning, organizing, controlling, or evolving a product line.

4.2 Reference model for product line measurement

The reference model specifies the structure of supporting processes and subprocesses for a product line measurement. Figure 1 shows that a product line measurement can be structured into three processes: product line measurement management, product line measurement operationalization, and product line measurement 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.

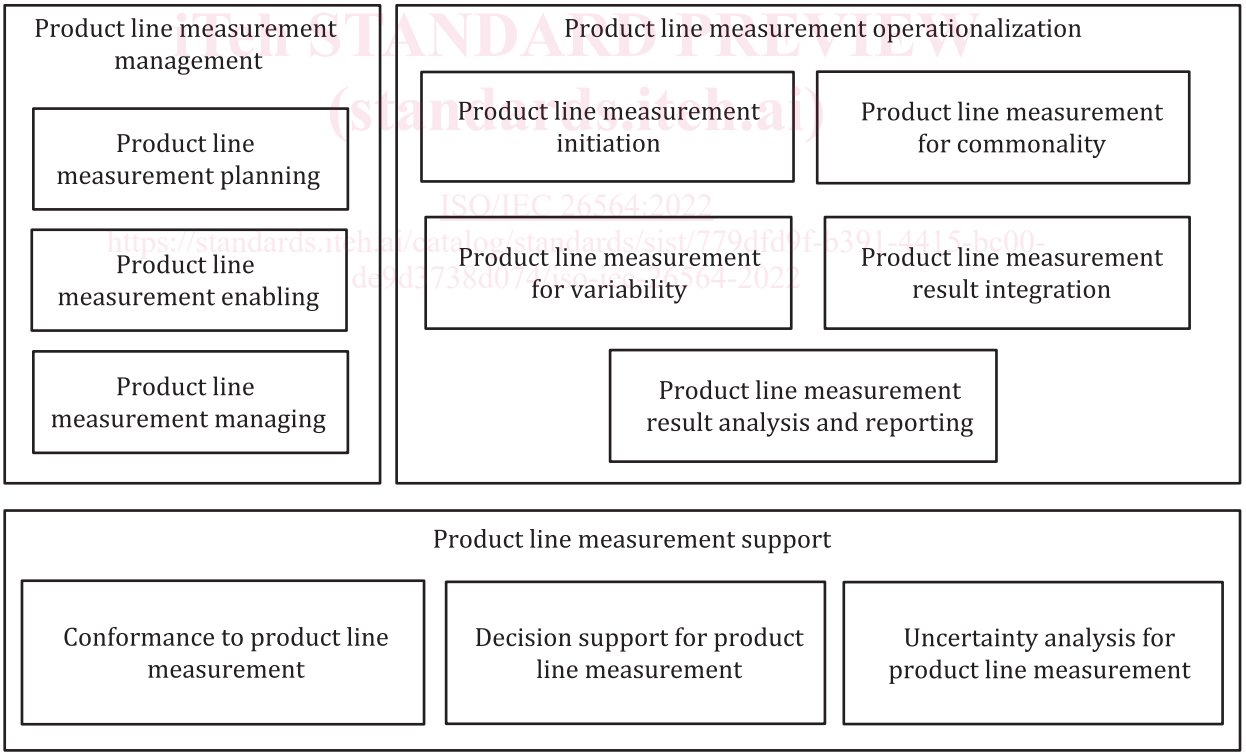

Figure 1 — Reference model for the product line measurement

The product line measurement management process provides managerial supports for planning product line measurement (e.g. resource estimation, responsibility allocation, success measures), supports for providing necessary resources, tools, and infrastructures for deploying measurement plans, and supports for analysing the plan versus the actual status of product line measurement. The product line measurement management does the following:

— product line measurement planning establishes plans for initiating, operationalizing, and supporting product line measurement; product line measurement plan includes scope, measurement

and performance objectives, and strategies of product line measurement, outcomes of major measurement activities, schedules for product line measurement, and required resources;

— product line measurement enabling defines, maintains, and assures the availability of environments, guidance, and resources necessary to performing product line measurement; environments include tools to automate the measurement process, collaborative environment, repository to store and maintain historical data, collected data, calculated results, and reports;

— product line measurement managing provides integrated management for the measurement operationalization; this subprocess reviews the measurement operationalization's actual status against plans, measurement and performance objectives, controls issues, and takes corrective actions if necessary.

The product line measurement operationalization process performs measurement operations for quantifiable or countable management of product line engineering and management. This process performs measurements for variability model, commonality, variability, and individual products and integrates results to assess product line engineering and management processes and identify opportunities for improvements. The product line measurement operationalization does the following:

— product line measurement initiation performs pilot PL measurements and gradually expands PL measurement throughout the entire PL organization; during initiation, participants with specific responsibilities for data collection are identified; resources are mobilized to start PL measurement; the PL measurement enablers can be improved after pilot PL measurement;

— product line measurement for commonality performs measurements for processes and artefacts concerning commonality of a product line; commonality index and formula are defined and measured throughout domain engineering and application engineering;

— product line measurement for variability performs measurements for processes and artefacts concerning variabilities of a product line; variability index and formula are defined and measured throughout domain engineering and application engineering;

— product line measurement result integration integrates measurement results of commonality and variability to characterize properties of a PL; integration protocol is applied to integrate measurement results of commonality and variability that have gaps in relative sizes, complexities, and efforts;

— product line measurement results analysis and reporting perform statistical analysis of measurement results from process stability, capability, and performance; create analysis reports, and communicate with stakeholders to identify improvement opportunities for stable and capable product line process appropriate to achieve PL objectives.

The product line measurement support process provides the supports required to perform the product line measurement operations and produce reliable measurement results for a product line. To achieve these, the product line measurement support does the following:

— conformance to product line measurement objectively evaluates the conformance to the measurement of relevant domain engineering assets and application engineering assets; actions are taken to resolve nonconformity issues;

— decision support for product line measurement supports decision making required during product line measurement operations such as selecting appropriate measures, interpreting measurement results, and fining improvement opportunities;

— uncertainty analysis for product line measurement calculates uncertainties of measurement processes and measurement components used to determine the acceptability of product line measurement; acceptability of product line measurement is assessed through confidence interval of commonality and variability measurement results.

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 have been defined in ISO/IEC 26550; and Table 1 shows the category of the critical aspects.

Table 1 — Key aspects for identifying product line measurement tasks

Category	Aspects
Reuse management	application engineering, domain assets, domain engineering, product management, platform, reusability
Variability management	binding, variability
Complexity management	collaboration, configuration, enabling technology support, reference architecture, texture, traceability
Quality management	measurement and tracking, cross-functional verification and validation

The following is the description for each aspect concerning product line measurement. The product line measurement processes and tasks shall be identified based on these aspects. The product line measurement concerns are to enable the organization to understand product line measurement processes, subprocesses, tasks, methods, and tools' capabilities.

— Application engineering: Not only individual products produced through application engineering need to be measured like a single system, but application engineering processes should also participate in measurements of variability models, commonality, and variability.

— Binding: Impacts of binding times on product line objectives such as reusability and flexibility should be measured or considered when a product line is characterized.

— Collaboration: Participants of domain and application engineering should closely collaborate with each other and with management roles because product line measurement activities are performed between relevant subprocesses of two engineering processes.

— Configuration: Measures to characterize configuration complexity, configuration space, or configurability should be selected, and appropriate data should be collected.

— Domain asset: Measures to characterize domain assets should be selected, and proper data should be obtained.

— Domain engineering: Domain engineering processes should participate in measurements of variability models, commonality, and variability.

— Enabling technology support: Resources and infrastructures necessary to initiate, operate, and support product line measurement should be enabled.

— Measurement and tracking: Product line measurement processes and their artefacts should be measured and controlled.

— Platform: Measures to characterize platforms are selected, and appropriate data should be collected.

— Product management: Decisions and outcomes of product management should be measured to determine their influences on the achievement of product line objectives.

— Reference architecture: The impact of decisions made for designing a reference architecture should be measured for identifying improvement opportunities.

— Reusability: Reusability is one of the significant measurement objects in product line measurement.

— Texture: Measurements for commonality and variability should consider textures concerning their efficiencies, supporting the reusability of a product line.

— Traceability: Traceability is one of the significant measurement objects in product line measurement.