INTERNATIONAL STANDARD

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Software engineering — Software measurement process

Ingénierie du logiciel — Méthode de mesure des logiciels

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of the joint technical committee 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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 15939 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and system engineering*.

Annexes A to G of this International Standard are for information only.

Introduction

Software measurement supports the management and improvement of software processes and products. Measurement is a primary tool for managing software life cycle activities, assessing the feasibility of project plans, and monitoring the adherence of project activities to those plans. Software measurement is also a key discipline in evaluating the quality of software products and the capability of organisational software processes. It is becoming increasingly important in two party business agreements, where it provides a basis for specification, management, and acceptance criteria.

Continual improvement requires change within the organisation. Evaluation of change requires measurement. Measurement itself does not initiate change. Measurement should lead to action, and not be employed purely to accumulate data. Measurements should have a clearly defined purpose.

This International Standard defines a software measurement process applicable to all software-related engineering and management disciplines. The process is described through a model that defines the activities of the measurement process that are required to adequately specify what measurement information is required, how the measures and analysis results are to be applied, and how to determine if the analysis results are valid. The software measurement process is flexible, tailorable, and adaptable to the needs of different users.

Software engineering — Software measurement process

1 Scope

1.1 Purpose

This International Standard identifies the activities and tasks that are necessary to successfully identify, define, select, apply, and improve software measurement within an overall project or organisational measurement structure. It also provides definitions for measurement terms commonly used within the software industry.

This International Standard does not catalogue software measures, nor does it provide a recommended set of measures to apply on software projects. It does identify a process that supports defining a suitable set of measures that address specific information needs.

1.2 Field of application

This International Standard is intended to be used by software suppliers and acquirers. Software suppliers include personnel performing management, technical, and quality management functions in software development, maintenance, integration, and product support organisations. Software acquirers include personnel performing management, technical, and quality management functions in software procurement and user organisations.

The following are examples of how this International Standard can be used:

- By a supplier to implement a software measurement process to address specific project or organisational information requirements.
- By an acquirer (or third-party agents) for evaluating conformance of the supplier's software measurement process to this International Standard.
- By an acquirer (or third-party agents) to implement a software measurement process to address specific technical and project management information requirements related to the acquisition.
- In a contract between an acquirer and a supplier as a method for defining the software process and product measurement information to be exchanged.

1.3 Tailoring this International Standard

This International Standard contains a set of activities and tasks that comprise a software measurement process that meets the specific needs of software organisations and projects. The tailoring process consists of modifying the non-normative descriptions of the tasks to achieve the purpose and outcomes of the software measurement process. All normative clauses shall be satisfied. New activities and tasks not defined in this International Standard may be added as part of tailoring.

1.4 Conformance

Conformance to this International Standard is defined as satisfying the purpose and outcomes of the measurement process and all of the normative clauses within the tasks in Clause 5. Any organisation imposing this International Standard as a condition of trade is responsible for specifying and making public all task-specific criteria to be imposed in conjunction with this International Standard.

Throughout this International Standard, “shall” is used to express a provision that is binding on the party that is applying this International Standard, “should” to express a recommendation among other possibilities, and “may” to indicate a course of action permissible within the limits of the International Standard.

It is the responsibility of the organisation to maintain appropriate evidence of satisfaction of the normative clauses for purposes of demonstrating conformance.

1.5 Limitations

This International Standard does not assume or prescribe an organisational model for measurement. The user of this International Standard should decide, for example, whether a separate measurement function is necessary within the organisation, whether the measurement function should be integrated within individual software projects, or across projects, based on the current organisational structure, culture, and prevailing constraints.

This International Standard is not intended to prescribe the name, format, or explicit content of the documentation to be produced. The International Standard does not imply that documents be packaged, or combined in some fashion. These decisions are left to the user of the International Standard.

The measurement process should be appropriately integrated with the organisational quality system. Not all aspects of internal audits and non-compliance reporting are covered explicitly in this International Standard, as they are assumed to be in the domain of the quality system.

This International Standard is not intended to conflict with any organisational policies, standards, or procedures that are already in place. However, any conflict should be resolved and any overriding conditions and situations need to be cited in writing as exceptions to the application of the International Standard.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO, International Vocabulary of Basic and General Terms in Metrology, 1993

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply within the context of software measurement.

3.1
acquirer
individual or organisation that procures a system, software product, or software service from a supplier

NOTE Based on the definition in [ISO/IEC 12207:1995].

3.2
attribute
property or characteristic of an entity that can be distinguished quantitatively or qualitatively by human or automated means

3.3
base measure
measure defined in terms of an attribute and the method for quantifying it

NOTE 1 A base measure is functionally independent of other measures.

NOTE 2 Based on the definition in [International Vocabulary of Basic and General Terms in Metrology, 1993].

3.4
data
collection of values assigned to base measures, derived measures, and/or indicators

3.5
data provider
individual or organisation that is a source of data

3.6
data store
organised and persistent collection of data and information that allows for its retrieval

3.7
decision criteria
thresholds, targets, or patterns used to determine the need for action or further investigation, or to describe the level of confidence in a given result

3.8
derived measure
measure that is defined as a function of two or more values of base measures

NOTE Based on the definition in [International Vocabulary of Basic and General Terms in Metrology, 1993].

3.9
entity
object that is to be characterised by measuring its attributes

EXAMPLE An object can be a process, product, project, or resource.

3.10
indicator
measure that provides an estimate or evaluation of specified attributes derived from a model with respect to defined information needs

3.11
indicator value
numerical or categorical result assigned to an indicator

3.12
information need
insight necessary to manage objectives, goals, risks, and problems

3.13
information product
one or more indicators and their associated interpretations that address an information need

EXAMPLE A comparison of a measured defect rate to planned defect rate along with an assessment of whether or not the difference indicates a problem.

3.14
measure (noun)
variable to which a value is assigned as the result of measurement

NOTE The term “measures” is used to refer collectively to base measures, derived measures, and indicators.

3.15
measure (verb)
to make a measurement

[ISO/IEC 14598-1:1996]

3.16
measurable concept
abstract relationship between attributes of entities and information needs

3.17
measurement
set of operations having the object of determining a value of a measure

NOTE Based on the definition in [International Vocabulary of Basic and General Terms in Metrology, 1993].

3.18
measurement analyst
individual or organisation that is responsible for the planning, performance, evaluation, and improvement of measurement

3.19
measurement experience base
data store that contains the evaluation of the information products and the measurement process as well as any lessons learned during the measurement process

3.20
measurement function
algorithm or calculation performed to combine two or more base measures

3.21
measurement librarian
individual or organisation that is responsible for managing the measurement data store(s)

3.22
measurement method
logical sequence of operations, described generically, used in quantifying an attribute with respect to a specified scale

NOTE 1 The type of measurement method depends on the nature of the operations used to quantify an attribute. Two types may be distinguished:

subjective — quantification involving human judgement

objective — quantification based on numerical rules

NOTE 2 Based on the definition in [International Vocabulary of Basic and General Terms in Metrology, 1993].

3.23
measurement procedure
set of operations, described specifically, used in the performance of a particular measurement according to a given method

[International Vocabulary of Basic and General Terms in Metrology, 1993]

3.24
measurement process
the process for establishing, planning, performing and evaluating software measurement within an overall project or organisational measurement structure

3.25
measurement process owner
individual or organisation responsible for the measurement process

3.26
measurement sponsor
individual or organisation that authorises and supports the establishment of the measurement process

3.27
measurement user
individual or organisation that uses the information products

3.28
model
algorithm or calculation combining one or more base and/or derived measures with associated decision criteria

3.29
observation
instance of applying a measurement procedure to produce a value for a base measure

3.30
operator
individual or organisation that operates the system

NOTE Based on the definition in [ISO/IEC 12207:1995].

3.31
organisational unit
the part of an organisation that is the subject of measurement

NOTE An organisational unit deploys one or more processes that operate within a coherent set of business goals.

[ISO/IEC TR 15504-9:1998]

3.32
process
set of interrelated activities that transform inputs into outputs

[ISO/IEC TR 15504-9:1998]

3.33
scale
ordered set of values, continuous or discrete, or a set of categories to which the attribute is mapped

NOTE 1 The type of scale depends on the nature of the relationship between values on the scale. Four types of scales are commonly defined:

Nominal — the measurement values are categorical. For example, the classification of defects by their type does not imply order among the categories

Ordinal — the measurement values are rankings. For example, the assignment of defects to a severity level is a ranking

Interval — the measurement values have equal distances corresponding to equal quantities of the attribute. For example, cyclomatic complexity has the minimum value of one, but each increment represents an additional path. The value of zero is not possible

Ratio — the measurement values have equal distances corresponding to equal quantities of the attribute where the value of zero corresponds to none of the attribute. For example, the size of a software component in terms of LOC is a ratio scale because the value of zero corresponds to no lines of code and each additional increments represents equal amounts of code

NOTE 2 These are just examples of the types of scales. Roberts [12] defines more types of scales.

NOTE 3 Based on the definition in [International Vocabulary of Basic and General Terms in Metrology, 1993].

3.34
software product
set of computer programs, procedures, and associated documentation and data

NOTE Based on the definition in [ISO/IEC 12207:1995].

3.35
software service
performance of activities, work, or duties connected with a software product, such as its development, maintenance, and operation

[ISO/IEC 12207:1995]

3.36
stakeholder
individual or organisation that sponsors measurement, provides data, is a user of the measurement results or otherwise participates in the measurement process

3.37
supplier
organisation that enters into an agreement with the acquirer for the supply of a system, software product or software service under the terms of that agreement

NOTE 1 The term “supplier” is synonymous with “contractor”, “producer”, “seller”, or “vendor”.

NOTE 2 The acquirer may designate a part of its organisation as supplier.

NOTE 3 Based on the definition in [ISO/IEC 12207:1995].

3.38
system
integrated composite that consists of one or more of the processes, hardware, software, facilities and people, that provides a capability to satisfy a stated need or objective

[ISO/IEC 12207:1995]

3.39
unit of measurement
particular quantity, defined and adopted by convention, with which other quantities of the same kind are compared in order to express their magnitude relative to that quantity

[International Vocabulary of Basic and General Terms in Metrology, 1993]

3.40
user
individual or organisation that uses the system to perform a specific function

NOTE Based on the definition in [ISO/IEC 12207:1995].

3.41
value
numerical or categorical result assigned to a base measure, derived measure, or indicator

4 Application of this International Standard

This clause presents an overview of the software measurement process. The objective is to orient the users of this International Standard so that they can apply it properly within context.

4.1 Purpose and outcomes of the software measurement process

The purpose of the software measurement process defined in this International Standard is to collect, analyse, and report data relating to the products developed and processes implemented within the organisational unit, to support effective management of the processes, and to objectively demonstrate the quality of the products [ISO/IEC TR 15504-2:1998]. As a result of successful implementation of the measurement process:

- organisational commitment for measurement will be established and sustained;
- the information needs of technical and management processes will be identified;
- an appropriate set of measures, driven by the information needs will be identified and/or developed;
- measurement activities will be identified;
- identified measurement activities will be planned;
- the required data will be collected, stored, analysed, and the results interpreted;
- information products will be used to support decisions and provide an objective basis for communication;
- the measurement process and measures will be evaluated; and
- improvements will be communicated to the measurement process owner.

4.2 Overview of this International Standard

This International Standard defines the activities and tasks necessary to implement a software measurement process. An activity is a set of related tasks that contributes towards achieving the purpose and outcomes of the software measurement process (see Clause 4.1). A task is a well-defined segment of work. Each activity is comprised of one or more tasks. This International Standard does not specify the details of *how* to perform the tasks included in the activities.

The properties of the activities of the measurement process that are defined in this International Standard are the same properties defined in ISO/IEC 12207:1995. This means that other properties such as entry and exit criteria for each of the activities are *not* defined in this International Standard.

The software measurement process consists of four activities as illustrated in the process model in Figure 1. The activities are sequenced in an iterative cycle allowing for continuous feedback and improvement of the measurement process. The measurement process model in Figure 1 is an adaptation of the Plan-Do-Check-Act cycle commonly used as the basis for quality improvement. Within activities, the tasks are also iterative.

The “Technical and Management Processes” of an organisational unit or project are not within the scope of this International Standard, although they are an important external interface to the measurement activities that are included in this International Standard.

Two activities are considered to be the Core Measurement Process: Plan the Measurement Process, and Perform the Measurement Process. These activities mainly address the concerns of the measurement user. The other two activities, Establish and Sustain Measurement Commitment and Evaluate Measurement, provide a foundation for the Core Measurement Process and provide feedback to it. These latter two activities address the concerns of the measurement process owner.