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Systems and software engineering — Measurement process

Ingénierie des systèmes et du logiciel — Processus de mesure

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Foreword

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ISO/IEC 15939 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Systems and software engineering*, in cooperation with the Software & 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 15939:2007, which has been revised to align with revisions of ISO/IEC/IEEE 15288:2015.

Introduction

Measurement supports the management and improvement of processes and products. Measurement is a primary tool for managing system and software life cycle activities, assessing the feasibility of project plans, and monitoring the adherence of project activities to those plans. System and software measurement is also a key discipline in evaluating the quality of products and the capability of organizational 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 organization. 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 document defines a measurement process applicable to system and software 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 measurement process is flexible, tailorable, and adaptable to the needs of different users.

The measurement process defined in this document, while written for system and software domains, can be applied in other domains.

The purpose of this document is to describe the activities and tasks that are necessary to successfully identify, define, select, apply and improve measurement within an overall project or organizational measurement structure. It also provides definitions for measurement terms commonly used within the system and software disciplines.

This document does not catalog measures, nor does it provide a recommended set of measures to apply on projects. It does identify a process that supports defining a suitable set of measures that addresses specific information needs.

This document is intended to be used by suppliers and acquirers. Suppliers include personnel performing management, technical and quality management functions in system and software development, maintenance, integration and product support organizations. Acquirers include personnel performing management, technical and quality management functions in procurement and user organizations.

The following are examples of how this document can be used:

— by a supplier to implement a measurement process to address specific project or organizational information requirements;

— by an acquirer (or third-party agents) for evaluating conformance of the supplier’s measurement process to this document;

— by an acquirer (or third-party agents) to implement a 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 process and product measurement information to be exchanged.

Systems and software engineering — Measurement process

1 Scope

This document establishes a common process and framework for measurement of systems and software. It defines a process and associated terminology from an engineering viewpoint. The process can be applied to the project and products across the life cycle. The measurement process can be applied throughout the life cycle to aid the planning, managing, assessing, and decision-making in all stages of a system or software life cycle.

This document also provides activities that support the definition, control and improvement of the measurement process used within an organization or a project.

This document does not assume or prescribe an organizational model for measurement. The user of this document decides, for example, whether a separate measurement function is necessary within the organization and whether the measurement function should be integrated within individual projects or across projects, based on the current organizational structure, culture and prevailing constraints.

This document does not prescribe a specific set of measures, method, model or technique. The users of this document are responsible for selecting a set of measures for the project and defining the application of those measures across the process, products, and other elements of the life cycle. The parties are also responsible for selecting and applying appropriate methods, models, tools and techniques suitable for the project.

This document is not intended to prescribe the name, format, explicit content, or recording media of the information items to be produced. This document does not imply that documents be packaged or combined in some fashion. These decisions are left to the user of this document. ISO/IEC/IEEE 15289 addresses the content for life cycle process information items (documentation).

The measurement process is supposed to be appropriately integrated with the organizational quality system. Not all aspects of internal audits and non-compliance reporting are covered explicitly in this document as they are assumed to be in the domain of the quality system.

This document is not intended to conflict with any organizational 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 this document.

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, 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://ieeexplore.ieee.org/xpls/dictionary.jsp

NOTE Definitions for other terms typically can be found in ISO/IEC/IEEE 24765, available at <www.computer.org/sevocab>.

3.1
acquirer
stakeholder that acquires or procures a product or service from a supplier

Note 1 to entry: Other terms commonly used for an acquirer are buyer, customer, owner, purchaser or internal/organizational sponsor.

[SOURCE: ISO/IEC/IEEE 15288:2015]

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 to entry: A base measure is functionally independent of other measures.

Note 2 to entry: Based on the definition of "base quantity" in the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012.

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

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

3.6
data store
organized 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 1 to entry: Adapted from the definition of "derived quantity" in the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012.

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

Note 1 to entry: An entity 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
measurable concept
abstract relationship between attributes of entities and information needs

3.15
measure, noun
variable to which a value is assigned as the result of measurement

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

3.16
measure, verb
make a measurement

[SOURCE: ISO/IEC 25000:2014]

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

Note 1 to entry: Adapted from the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012.

3.18
measurement analyst
individual or organization 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 method
logical sequence of operations, described generically, used in quantifying an attribute with respect to a specified scale

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

— subjective: quantification involving human judgment; and

— objective: quantification based on numerical rules.

Note 2 to entry : Based on the definition of "method of measurement" in the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012.

3.22
measurement procedure
set of operations, described specifically, used in the performance of a particular measurement according to a given method

[SOURCE: International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012, Modified, editorially revised.]

3.23
measurement process
process for establishing, planning, performing and evaluating measurement within an overall project or organizational measurement structure

3.24
measurement process owner
individual or organization responsible for the measurement process

3.25
measurement sponsor
individual or organization that authorizes and supports the establishment of the measurement process

3.26
measurement user
individual or organization that uses the measurement information products

3.27
model
algorithm or calculation combining one or more base or derived measures with associated decision criteria

3.28
observation
instance of applying a measurement procedure to produce a value for a base measure

3.29
operator
entity that performs the operation of a system

3.30
organizational unit
part of an organization that is the subject of measurement

3.31
process
set of interrelated or interacting activities that use inputs to deliver an intended result

[SOURCE: ISO 9000:2015 Modified, Notes to entry 1, 2, 3, 4, 5 and 6 have been removed.]

3.32
product
result of a process

Note 1 to entry: Adapted from the definition of "Output" in ISO 9001:2015.

3.33
project
endeavor with defined start and finish criteria undertaken to create a product or service in accordance with specified resources and requirements

Note 1 to entry : A project is sometimes viewed as a unique process comprising coordinated and controlled activities and composed of activities from the Technical Management Processes and Technical Processes defined in ISO/IEC/IEEE 15288:2015.

[SOURCE: ISO/IEC/IEEE 15288:2015, Modified, Note 1 to entry editorially revised.]

3.34
scale
ordered set of values, continuous or discrete, or a set of categories to which the attribute is mapped

Note 1 to entry: The type of scale depends on the nature of the relationship between values on the scale. Four types of scale are commonly defined:

— nominal: the measurement values are categorical;

— ordinal: the measurement values are rankings;

— interval: the measurement values have equal distances corresponding to equal quantities of the attribute; and

— 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.

These are just examples of the types of scale. Roberts [17] defines more types of scale. Annex A contains examples of each type of scale.

Note 2 to entry: Based on the definition of "scale (of a measuring instrument)" in the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012.

3.35
service
performance of activities, work or duties

[SOURCE: ISO/IEC/IEEE 15288:2015, Modified, Notes 1 and 2 to entry have been removed.]

3.36
stakeholder
individual or organization having a right, share, claim or interest in a system or in its possession of characteristics that meet their needs and expectations

Note 1 to entry: Within this document, an individual or organization that sponsors measurement, provides data, is a user of the measurement results or otherwise participates in the measurement process.

[SOURCE: ISO/IEC/IEEE 15288:2015, Modified, EXAMPLE has been removed and Note 1 to entry has been editorially revised.]

3.37
supplier
organization or an individual that enters into an agreement with the acquirer for the supply of a product or service

Note 1 to entry: Other terms commonly used for supplier are contractor, producer, seller or vendor.

Note 2 to entry: The acquirer and the supplier sometimes are part of the same organization.

[SOURCE: ISO/IEC/IEEE 15288:2015]

3.38
system
combination of interacting elements organized to achieve one or more stated purposes

Note 1 to entry: A system is sometimes considered as a product or as the services it provides.

[SOURCE: ISO/IEC/IEEE 15288:2015, Modified, Notes 2 and 3 to entry have been removed.]

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

[SOURCE: International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, 2012]

3.40
user
individual or group that interacts with a system or benefits from a system during its utilization

[SOURCE: ISO/IEC/IEEE 15288:2015, Modified, Note 1 to entry has been removed.]

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

4 Conformance

4.1 Intended usage

The requirements in this document are contained in Clause 6. There are two ways that an implementation can be claimed to conform to the provisions of this document – full conformance and tailored conformance.

There are two criteria for claiming full conformance. Achieving either criterion suffices for conformance, although the chosen criterion (or criteria) is to be stated in the claim. Claiming "full conformance to tasks" asserts that all of the requirements of the activities and tasks of the measurement process are achieved. Alternatively, claiming "full conformance to outcomes" asserts that all of the required outcomes of the measurement process are achieved.

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

NOTE The process has a set of objectives (phrased as "outcomes") and a set of activities and tasks that represent one way to achieve the objectives. Users who implement the activities and tasks can assert full conformance to tasks. Some users, however, might have innovative process variants that achieve the objectives (i.e., the outcomes) of the declared set of processes without implementing all of the activities and tasks. These users can assert full conformance to the outcomes. The two criteria—conformance to task and conformance to outcome—are not necessarily equivalent since specific performance of activities and tasks may require, in some cases, a higher level of capability than just the achievement of outcomes.

4.2 Tailoring this document

This document contains a set of activities and tasks that comprise a measurement process that meets the specific needs of organizations and projects. An organization tailoring this document may delete content that is not applicable, and may also add new activities and tasks.

4.3 Full conformance to outcomes

Full conformance to outcomes is achieved by demonstrating that all of the outcomes have been achieved. In this situation, the provisions for activities and tasks are guidance rather than requirements, regardless of the verb form that is used in the provision.

4.4 Full conformance to tasks

Full conformance to tasks is achieved by demonstrating that all of the requirements of the activities and tasks have been achieved. In this situation, the provisions for the outcomes are guidance rather than requirements, regardless of the verb form that is used in the provision.

4.5 Tailored conformance

When this document is tailored per 4.2, the tailored text, for which tailored conformance is claimed, is declared. Tailored conformance is achieved by demonstrating that the outcomes, activities, and tasks, as tailored, have been achieved.

5 Application of this document

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

This document defines the activities and tasks necessary to implement a measurement process. An activity is a set of related tasks that contributes towards achieving the purpose and outcomes of the measurement process (see 6.1 and 6.2). A task is a well-defined segment of work. Each activity is comprised of one or more tasks. This document 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 document are the same properties defined in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207. This means that other properties such as entry and exit criteria for each of the activities are *not* defined in this document.

NOTE 1 This measurement process supports the measurement requirement defined in ISO 9001:2015, 8.2.

NOTE 2 This document provides an elaboration of the measurement process from ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207. More detail is provided via additional activities and tasks. As part of this elaboration, one additional outcome (commitment is established and sustained) is added, with associated activities and tasks. This outcome is addressed in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207 at the organization level.

The 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 organizational unit or project are not within the scope of this document, although they are an important external interface to the measurement activities that are included in this document.

Two activities are considered to be the Core Measurement Process: Prepare the Measurement Process, and Perform the Measurement Process. These activities are included in the Measurement process in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207 and 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. They are included in the set of life cycle processes as activities in the Project Planning process and the Quality Assurance process, respectively. At the organization level, this is handled by the Life Cycle Model Management process, which evaluates and improves the organization’s processes.