INTERNATIONAL STANDARD

ISO/IEC/IEEE 15939

First edition
2017-05

Systems and software engineering — Measurement process

Ingénierie des systèmes et du logiciel — Processus de mesure

Reference number
ISO/IEC/IEEE 15939:2017(E)

© ISO/IEC 2017
© IEEE 2017



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2017, Published in Switzerland

© IEEE 2017

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO or IEEE at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Institute of Electrical and Electronics Engineers, Inc
3 Park Avenue, New York
NY 10016-5997, USA

stds.ipr@ieee.org
www.ieee.org

Contents

Page

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 Conformance 6
4.1 Intended usage 6
4.2 Tailoring this document 6
4.3 Full conformance to outcomes 6
4.4 Full conformance to tasks 7
4.5 Tailored conformance 7

5 Application of this document 7

6 Measurement Process 10
6.1 Purpose 10
6.2 Outcomes 10
6.3 Activities and Tasks 10
6.3.1 Establish and sustain measurement commitment. 10
6.3.2 Prepare for measurement. 11
6.3.3 Perform measurement. 15
6.3.4 Evaluate measurement 17

Annex A (informative) **The measurement information model** 19
A.1 General 19
A.2 Model description 20
A.2.1 Entity 20
A.2.2 Attribute 20
A.2.3 Base measure 20
A.2.4 Derived measure 21
A.2.5 Indicator 21
A.2.6 Measurable concept 22
A.3 Examples 22
A.3.1 A productivity example 22
A.3.2 A quality example 23
A.3.3 A project progress example 24

Annex B (informative) **Measurement process information items and records** 26

Annex C (informative) **Example criteria for selecting measures** 28

Annex D (informative) **Example criteria for evaluating an information product** 30
D.1 General 30
D.2 Use of information products 30
D.3 Confidence in an information product 30
D.4 Evidence of fitness for purpose of an information product 30
D.5 Understandability of information products 31
D.6 Satisfaction of the assumptions of an indicator model 31
D.7 Accuracy of a measurement procedure 31
D.8 Repeatability of a measurement method 32
D.9 Reproducibility of a measurement method 32

Annex E (informative) **Example criteria for evaluating the performance of the measurement process** 33
E.1 General 33
E.2 Timeliness 33
E.3 Efficiency 33
E.4 Defect containment 33
E.5 Customer satisfaction 33
E.6 Process compliance 33

© ISO/IEC 2017 – All rights reserved

© IEEE 2017 – All rights reserved

Annex F (informative) **Example elements of measurement planning** **34**
Annex G (informative) **Guidelines for reporting information items** **35**

List of Figures

Figure 1 Measurement process model **9**
Figure A.1 — Key relationships in the measurement information model **19**
Figure A.2 — Measurement construct for "productivity" **23**
Figure A.3 — Measurement construct for "quality" **24**
Figure A.4 — Measurement construct for "progress" **25**
Figure B.1 — Information items and records of measurement activities **27**

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

Attention is called to the possibility that implementation of this standard may require the use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. ISO/IEC and IEEE are not responsible for identifying essential patents or patent claims for which a license may be required, for conducting inquiries into the legal validity or scope of patents or patent claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance or a Patent Statement and Licensing Declaration Form, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from ISO or the IEEE Standards Association.

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.

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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.

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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:

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

— 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.

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved

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.

© ISO/IEC 2017 – All rights reserved
© IEEE 2017 – All rights reserved