TECHNICAL REPORT

ISO/IEC TR 15504-2

First edition
1998-08-15

Information technology — Software process assessment —

Part 2:
A reference model for processes and process capability

Technologies de l'information — Évaluation des procédés du logiciel —
Partie 2: Un modèle de référence pour les procédés et l'aptitude de procédé

Reference numbe
ISO/IEC TR 15504-2:1998(E)

Contents

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC TR 15504-2, which is a Technical Report of type 2, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology,* Subcommittee SC 7, *Software engineering*.

ISO/IEC TR 15504 consists of the following parts, under the general title *Information technology — Software process assessment* :

— *Part 1: Concepts and introductory guide*

— *Part 2: A reference model for processes and process capability*

— *Part 3: Performing an assessment*

— *Part 4: Guide to performing assessments*

— *Part 5: An assessment model and indicator guidance*

— *Part 6: Guide to competency of assessors*

— *Part 7: Guide for use in process improvement*

— *Part 8: Guide for use in determining supplier process capability*

— *Part 9: Vocabulary*

Annexes A to C of this part of ISO/IEC TR 15504 are for information only.

Introduction

This part of ISO/IEC TR 15504 documents the set of universal software engineering processes that are fundamental to good software engineering and that cover best practice activities, providing a reference model which can be used by the other parts of ISO/IEC TR 15504. The reference model describes processes that an organization may perform to acquire, supply, develop, operate, evolve and support software, and the process attributes that characterize the capability of those processes. In performing a process assessment, an assessor uses a model(s) of the processes being assessed that is compatible with this reference model, so that a common basis for judgment is employed. This document also describes the requirements that an assessment model(s) needs to address to be compatible with the reference model.

The purpose of the reference model is to provide a common basis for different models and methods for software process assessment, ensuring that results of assessments can be reported in a common context. The use of models compatible with the reference model will ensure a common context for the reporting of assessment ratings. The use of a common reference model forms a basis on which assessments can be compared.

The reference model architecture is two dimensional. The first dimension is the process dimension which is characterized by a set of purpose statements. The process purpose statements describe in measurable terms what has to be achieved in order to attain the defined purpose of the process. The processes have been defined in alignment with ISO/IEC 12207:1995, *Information technology - Software life cycle processes*. The second dimension is the process capability dimension which characterizes the level of capability that an organization unit has attained for a particular process, or which may be used by the organization unit as a target to be attained.

Within this part of the ISO/IEC TR 15504:

— clause 4, titled “Structure of the reference model”, provides a detailed description of the structure and key components of the reference model;

— clause 5, titled “The process dimension”, categorizes life cycle processes into groups of process categories and then describes each process in terms of its purpose;

— clause 6, titled “The capability dimension”, defines the capability levels and process attributes that describe the capability of the processes listed in clause 5;

— clause 7, titled “Compatibility with the reference model”, contains the requirements for demonstrating that a model of software processes and process capability is compatible with this reference model;

— annex A contains a detailed mapping of the ISO/IEC 12207 to ISO/IEC TR 15504 processes;

— annex B contains summary lists of the processes and the process attributes that comprise the reference model;

— annex C contains a style guide for defining additional processes.

Information technology — Software process assessment —

Part 2:
A reference model for processes and process capability

1 Scope

This part of ISO/IEC TR 15504 defines a reference model for software processes and process capability that forms the basis for software process assessment. The reference model defines at a high level, the fundamental objectives that are essential to good software engineering. The high-level objectives describe what is to be achieved, not how to achieve them.

This reference model is applicable to any software organization wishing to establish and subsequently improve its capabilities in the acquisition, supply, development, operation, evolution and support of software. The model does not presume particular organizational structures, management philosophies, software life cycle models, software technologies, or development methodologies.

The architecture of this reference model organizes the processes to help software personnel understand and use them for continuous improvement of the management of software processes.

For software process assessment, an assessor uses a more detailed model(s) compatible with this reference model, containing a comprehensive set of indicators of process performance and process capability, to make judgments about the capability of the organization's processes. This part of ISO/IEC TR 15504 specifies the requirements to be met in order for a model(s) to be compatible with the reference model.

ISO/IEC TR 15504 is not intended to be used in any scheme for the certification/registration of the process capability of an organization.

Table 1 shows the main audiences for this part of ISO/IEC TR 15504, why each group needs the reference model, and how and when it will be used.

NOTE Copyright release for the Reference Model: Users of this part of ISO/IEC TR 15504 may freely reproduce the detailed descriptions contained in the reference model as part of any Assessment Model based upon the reference model, or as part of any demonstration of compatibility with this reference model, so that it can be used for its intended purpose.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC TR 15504. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/IEC TR 15504 are encouraged to investigate the possibility of applying the most recent editions of the normative documents 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 9001:1994, *Quality systems — Model for quality assurance in design, development, production, installation and servicing.*

ISO/IEC 12207:1995, *Information technology — Software life cycle processes.*

ISO/IEC TR 15504-9:1998, *Information technology — Software process assessment — Part 9: Vocabulary.*

Table 1 — Use of this reference model

Who	Why	How	When
Assessment Model Developers	Develop models compatible with the reference model	As a reference for the structure of the model	During the development of a model
	Demonstrate compatibility of a developed model with the reference model	As a set of criteria for demonstration of capability	Following development, and prior to use in conducting assessments
Software organization	Understand what to do to improve software processes	As a working guide to management about software processes and capabilities to implement	During the implementation of the organization's software processes
		As a reference guide to highlight process and process capability considerations	During the development/review of the organization's software processes and as a part of continuous improvement activities
		As a training document	During the development/review of the organization's software processes and as a part of continuous improvement activities
	Determine the capability of its processes for demonstration to customers	As a reference framework to permit a valid basis for comparison	As an internal initiative for marketing actions
			During response to call for proposal
	Understand which processes and capabilities an assessor may evaluate	As a process and process capability checklist	Prior to an assessment
Software process assessors	Conduct a conformant software process assessment of an organization	As a process and process capability checklist & develop the knowledge of the reference model	Prior to and during a software process assessment
	Establish compatibility of an assessment model	As a reference for the purpose of performing model compatibility	Prior to an assessment or assessment program
Tool Developers	Develop a software process assessment tool	As a reference for and requirements of an assessment tool	Prior to and during the development of an assessment tool

3 Terms and definitions

For the purposes of this part of ISO/IEC TR 15504, the terms and definitions given in ISO/IEC TR 15504-9 apply.

4 Structure of the reference model

The reference model architecture is made up of two dimensions:

— the **process dimension**, which is characterized by process purpose statements which are the essential measurable objectives of a process;

— the **process capability dimension**, which is characterized by a series of process attributes, applicable to any process, which represent measurable characteristics necessary to manage a process and improve its capability to perform.

4.1 Process dimension

The reference model groups the processes in the process dimension into three life cycle process groupings which contain five process categories, according to the type of activity they address.

The **Primary life cycle processes** consist of the process categories **Customer-Supplier** and **Engineering** and are described as follows:

> The **Customer-Supplier** process category consists of processes that directly impact the customer, support development and transition of the software to the customer, and provide for the correct operation and use of the software product and/or service.
>
> The **Engineering** process category consists of processes that directly specify, implement, or maintain the software product, its relation to the system and its customer documentation.

The **Supporting life cycle processes** consist of the process category **Support** and this category is described as follows:

> The **Support** process category consists of processes which may be employed by any of the other processes (including other supporting processes) at various points in the software life cycle.

The **Organizational life cycle processes** consist of the process categories **Management** and **Organization** and are described as follows:

> The **Management** process category consists of processes which contain practices of a generic nature which may be used by anyone who manages any type of project or process within a software life cycle.
>
> The **Organization** process category consists of processes that establish the business goals of the organization and develop process, product, and resource assets which, when used by the projects in the organization, will help the organization achieve its business goals.

Process categories and processes provide a grouping by type of activity. Each process in the reference model is described in terms of a purpose statement. These statements comprise the unique functional objectives of the process when instantiated in a particular environment. The purpose statement includes additional material identifying the outcomes of successul implementation of the process. Satisfying the purpose of a process represents the first step in building process capability.

The reference model does not define how, or in what order, the elements of the process purpose statements are to be achieved. The process purposes will be achieved in an organization through various detailed activities, tasks and practices being carried out to produce work products. These performed tasks, activities and practices, and the characteristics of the work products produced, are the indicators that demonstrate whether the specific process purpose is being achieved.

4.2 Process capability dimension

Evolving process capability is expressed in terms of process attributes grouped into capability levels. Process attributes are features of a process that can be evaluated on a scale of achievement, providing a measure of the capability of the process. They are applicable to all processes. Each process attribute describes a facet of the

overall capability of managing and improving the effectiveness of a process in achieving its purpose and contributing to the business goals of the organization.

A capability level is characterized by a set of attribute(s) that work together to provide a major enhancement in the capability to perform a process. Each level provides a major enhancement of capability in the performance of a process. The levels constitute a rational way of progressing through improvement of the capability of any process.

There are six capability levels in the reference model.

Level 0: *Incomplete.*

There is general failure to attain the purpose of the process. There are few or no easily identifiable work products or outputs of the process.

Level 1: *Performed.*

The purpose of the process is generally achieved. The achievement may not be rigorously planned and tracked. Individuals within the organization recognize that an action should be performed, and there is general agreement that this action is performed as and when required. There are identifiable work products for the process, and these testify to the achievement of the purpose.

Level 2: *Managed.*

The process delivers work products according to specified procedures and is planned and tracked. Work products conform to specified standards and requirements. The primary distinction from the Performed Level is that the performance of the process now delivers work products that fulfil expressed quality requirements within defined timescales and resource needs.

Level 3: *Established.*

The process is performed and managed using a defined process based upon good software engineering principles. Individual implementations of the process use approved, tailored versions of standard, documented processes to achieve the process outcomes. The resources necessary to establish the process definition are also in place. The primary distinction from the Managed Level is that the process of the Established Level is using a defined process that is capable of achieving its process outcomes.

Level 4: *Predictable.*

The defined process is performed consistently in practice within defined control limits, to achieve its defined process goals. Detailed measures of performance are collected and analyzed. This leads to a quantitative understanding of process capability and an improved ability to predict and manage performance. Performance is quantitatively managed. The quality of work products is quantitatively known. The primary distinction from the Established Level is that the defined process is now performed consistently within defined limits to achieve its process outcomes.

Level 5: *Optimizing.*

Performance of the process is optimized to meet current and future business needs, and the process achieves repeatability in meeting its defined business goals. Quantitative process effectiveness and efficiency goals (targets) for performance are established, based on the business goals of the organization. Continuous process monitoring against these goals is enabled by obtaining quantitative feedback and improvement is achieved by analysis of the results. Optimizing a process involves piloting innovative ideas and technologies and changing non-effective processes to meet defined goals or objectives. The primary distinction from the Predictable Level is that the defined and standard processes now dynamically change and adapt to effectively meet current and future business goals.

The reference model alone cannot be used as the basis for conducting reliable and consistent assessments of process capability since the level of detail is not sufficient. The descriptions of process purpose and capability attributes in the reference model need to be supported with a comprehensive set of indicators of process

performance and capability. In this way, consistent ratings of process capability will be possible. An exemplar model that incorporates such a set of indicators is provided as ISO/IEC TR 15504-5. Clause 7 of this part of ISO/IEC TR 15504 sets out the requirements to be met by other process assessment models to be compatible with this reference model.

5 The process dimension

This clause provides a classification of the processes normally undertaken by organizations concerned with the development, maintenance, acquisition, supply and operation of software. The classification recognizes five process categories each of which contains a number of processes. The process categories and processes are strongly aligned with those defined in ISO/IEC 12207, *Information technology - Software life cycle processes* (refer to Annex A for a mapping of 15504 to ISO/IEC 12207) but some additional processes not included in ISO/IEC 12207 are introduced.

Figure 1 provides an overview of the structure of the process dimension. It shows the three principal groupings of life cycle processes - primary, supporting and organizational - as defined in ISO/IEC 12207, and shows the process categories and processes within each grouping. Figure 1 is designed in a similar fashion to Figure 1 in ISO/IEC 12207, so that the similarities and differences between the two models are apparent. In particular, the linkage between the Supporting Processes concerned with Quality Assurance and Quality Control can be seen.

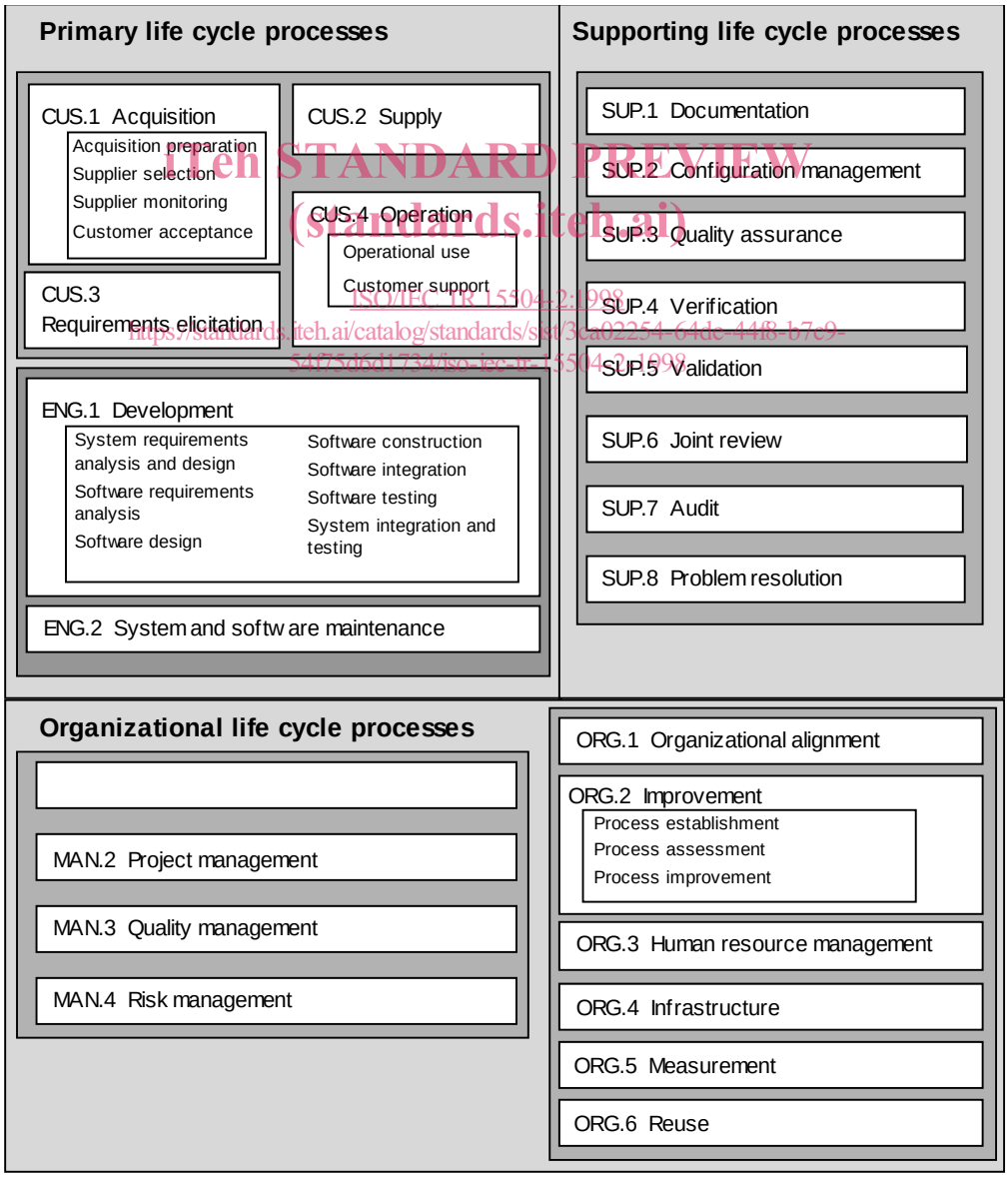

Figure 1 — The processes in the Process Dimension

The principal difference evident from Figure 1 is the presence in this reference model of a number of additional processes and the definition of two levels of process definition. The details of the differences are further described later in this clause. A complete list of the process categories and processes in the model is provided in Annex B.

The three life cycle process groupings are:

The **Primary life cycle processes** consisting of the process categories **Engineering** and **Customer-Supplier**.

The **Supporting life cycle processes** consisting of the process category **Support**.

The **Organization life cycle processes** consisting of the process categories **Management** and **Organization**.

The five process categories are:

CUS	**Customer-Supplier**	**MAN**	**Management**
ENG	**Engineering**	**ORG**	**Organization**
SUP	**Support**		

The description of each process category includes a characterization of the processes it contains, followed by a list of the process names.

The individual processes are described in terms of six components:

Process Identifier This identifies the process category and the sequential number within that category. The numbering scheme distinguishes between top-level processes and second-level processes. The identifier consists of two parts: a process category abbreviation (e.g. ENG for the Engineering process category) and a number (e.g. CUS.1 denotes the Acquisition process and CUS.1.2 denotes the Supplier Selection Process, a second level process which is a component process of the Acquisition Process).

Process Name A descriptive phrase that encapsulates the principal concern of the process (e.g. Supplier Selection).

Process Type There are five types of process. 3 top-level (basic, extended and new) and 2 second-level (component and extended component), and these are as follows:

1. *Basic* Processes identical in intent to the processes in ISO/IEC 12207;
2. *Extended* Processes that are expansions of ISO/IEC 12207 processes;
3. *New* Processes that are outside the scope of ISO/IEC 12207;
4. *Component* Processes (a group of one or more ISO/IEC 12207's activities from the same process);
5. *Extended Component* Processes that are one or more of ISO/IEC 12207's activities from the same process, with additional material. These would normally be Component Processes of Extended Processes.

Process Purpose A paragraph that states the purpose of the process indicating at a high level the overall objectives of performing the process. Optionally an additional paragraph may be included to further define the purpose statement.

Process Outcomes A process outcome is an observable result of the successful implementation of a process. The process outcomes for each process are contained in a list which appears in the description of each process immediately after the phrase, "As a result of successful implementation of the process:"

Process Notes An optional list of informative notes regarding the process and its relation to other processes.

The style guide in Annex C provides guidelines which may be used when extending process definitions or defining new processes.

5.1 Primary life cycle processes

The **Primary life cycle processes** consist of two process categories:

CUS Customer-Supplier

ENG Engineering

5.1.1 Customer-Supplier process category (CUS)

The *Customer-Supplier* process category consists of processes that directly impact the customer, support development and transition of the software to the customer, and provide for the correct operation and use of the software product and/or service.

The processes belonging to the Customer-Supplier process category are:

CUS.1 Acquisition Process

CUS.1.1 Acquisition Preparation Process

CUS.1.2 Supplier Selection Process

CUS.1.3 Supplier Monitoring Process

CUS.1.4 Customer Acceptance Process

CUS.2 Supply Process

CUS.3 Requirements Elicitation Process

CUS.4 Operation Process

CUS.4.1 Operational Use Process

CUS.4.2 Customer Support Process

5.1.1.1 CUS.1 Acquisition process

Basic process

The purpose of the *Acquisition process* is to obtain the product and/or service that satisfies the need expressed by the customer. The process begins with the identification of a customer need and ends with the acceptance of the product and/or service needed by the customer. As a result of successful implementation of the process:

- acquisition needs, goals, acceptance criteria and acquisition strategies will be defined;
- a contract will be developed that clearly expresses the expectation, responsibilities and liabilities of both the customer and the supplier;
- a product and/or service will be produced that satisfies the customer's stated need;
- the acquisition will be monitored so that specified constraints such as cost, schedule and quality are met;
- supplier deliverables will be accepted.