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Information technology — Software process assessment —

Part 5:
An assessment model and indicator guidance

Technologies de l'information — Évaluation de processus de logiciel —
Partie 5: Un modèle d'évaluation et guide des indicateurs

Reference number
ISO/IEC TR 15504-5:1999(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, where 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 Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.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 15504-5, which is a Technical Report of type 2, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC7, *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 E of this part of ISO/IEC TR 15504 are for information only.

Introduction

This part of ISO/IEC TR 15504 provides an example of assessment model for supporting process assessment. It also contains guidance of good software engineering practices to be considered when interpreting the intent of the reference model defined in ISO/IEC TR 15504-2. This guidance is provided in the form of indicators contained in this assessment model. These indicators may also be used when performing a process improvement program or to help evaluate and select an assessment model, method, methodology or tools.

An integral part of conducting an assessment is to use a model constructed for that purpose, compatible with the reference model defined in ISO/IEC TR 15504-2. The reference model cannot be used alone 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 process capability. Used in this way, in conjunction with a reliable method, consistent and repeatable ratings of process capability will be possible.

This assessment model is compatible with the reference model described in ISO/IEC TR 15504-2. As an example, it embodies the core characteristics that could be expected of any compatible assessment model. Use of this assessment model is not required to meet the requirements of this ISO/IEC TR 15504; other models meeting the requirements of ISO/IEC TR 15504-2 may be used in a conformant assessment.

Within this part of ISO/IEC TR 15504 :

— clause 4 provides a detailed description of the structure and key components of the assessment model;

— clause 5 uses the definitions from ISO/IEC TR 15504-2, categorizing processes into 3 life cycle process groupings, five process categories and describing each process in terms of its purpose. It expands these definitions by including a set of base practices for each process. Annex A is directly linked to this clause as it continues the work of defining indicators of process performance by associating work products with each process. Annex C is also linked directly to annex A as it defines the work product characteristics;

— clause 6 repeats the definitions of the capability levels and process attributes from ISO/IEC TR 15504-2, that describe the capability of processes. It expands these definitions through the inclusion of sets of management practices for each attribute. Annex B is directly linked to this clause as it completes the work of defining indicators of process capability by associating practice performance characteristics and, resource and infrastructure characteristics to each management practices;

— clause 7 contains a declaration that the assessment model is compatible with the reference model and fully meets the requirements defined in ISO/IEC TR 15504-2;

— annex A contains the input and output work products associated with each process in this assessment model;

— annex B contains the process performance, resources and infrastructure characteristics and related processes associated with each management practice;

— annex C contains the characteristics for each work product;

— annex D contains a style guide for defining base practices;

— annex E contains a style guide for defining management practices;

— the Bibliography contains a list of informative references.

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

Information technology — Software process assessment —

Part 5:
An assessment model and indicator guidance

1 Scope

This part of ISO/IEC TR 15504 :

— defines an example of assessment model that meets the requirements of ISO/IEC TR 15504 and that supports the performance of an assessment by providing indicators for guidance on the interpretation of the process purposes and process attributes defined in ISO/IEC TR 15504-2;

— provides guidance, by example, on the definition, selection and use of assessment indicators.

Any model meeting the requirements of ISO/IEC TR 15504-2 may be used for assessment. Different models and methods may be needed to address differing business needs. The assessment model in this part of ISO/IEC TR 15504 is provided as an example of a compatible model.

The indicators are used as guides in collecting the objective evidence that enables an assessor to assign ratings to process attributes. The set of indicators included in this part of ISO/IEC TR 15504 is not intended to be an all inclusive set nor is it intended to be applicable in its entirety. Subsets that are appropriate to the context and scope of the assessment should be selected, and possibly augmented with additional indicators.

By providing the assessment model, this part of ISO/IEC TR 15504 is directed at assessment sponsors and competent assessors who wish to select a model, and associated method, for assessment (for either capability determination or process improvement). Additionally it may be of use to model developers in the construction of a compatible model, by providing examples of good software engineering practice.

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/IEC TR 15504-2:1998, *Information technology — Software process assessment — Part 2: A reference model for processes and process capability.*

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

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 and the following definitions apply.

3.1
attribute indicator
an *assessment indicator* that supports the judgement of the extent of achievement of a specific *process attribute*

3.2
base practice
a software engineering or management activity that, when consistently performed, contributes to achieve the purpose of a particular process

3.3
management practice
a management activity or task that addresses the implementation or institutionalisation of a specific process attribute

3.4
tailored process
a defined process developed by tailoring a standard process definition.

4 Overview of the exemplar assessment model

4.1 Introduction

This part of ISO/IEC TR 15504 provides an exemplar assessment model that includes examples of appropriate indicators.

The reference model defined in ISO/IEC TR 15504-2 provides a common basis for performing assessments of software process capability, allowing for the reporting of results using a common rating scale.

The reference model defines a two-dimensional model of process capability. In one dimension, the process dimension, the processes associated with software are defined and classified into five process categories. In the second dimension, the capability dimension, a series of process attributes grouped into capability levels are defined. The process attributes provide the measurable characteristics of process capability.

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

The exemplar assessment model defined in this part of ISO/IEC TR 15504 is based upon and is compatible with the reference model, and can be used as the basis for conducting an assessment of software process capability.

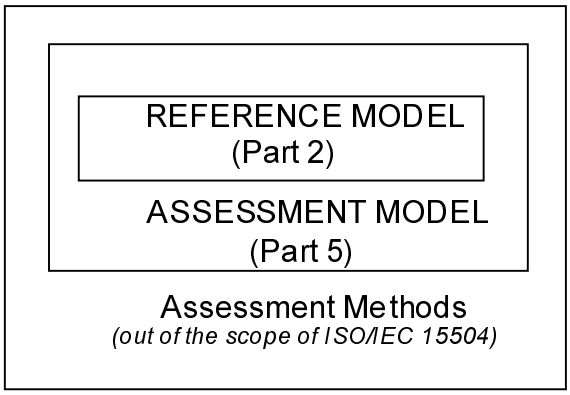

Figure 1 — The relationship between the reference model, the assessment model, and assessment methods

In order to meet the requirements of ISO/IEC TR 15504, a documented process supporting the requirements of ISO/IEC TR 15504-3 is also required. This need may be met, for example, by the adoption of a supportive method for conducting assessments (see Figure 1). The definition of an example method is outside the scope of this part of ISO/IEC TR 15504.

4.2 Structure of the assessment model

This clause describes the structure of the model and its key components. Clause 5, together with its associated annexes A and C, describes the components of the process dimension and clause 6, with its associated annex B, describes the components of the capability dimension. Clause 7 provides a demonstration of compatibility that fully meets the requirements of ISO/IEC TR 15504-2.

The basic structure of this assessment model is identical to that of the reference model defined in ISO/IEC TR 15504-2. There is a one to one correspondence between the process categories, processes, purpose statements, process capability levels and process attributes of the reference model and those of this assessment model.

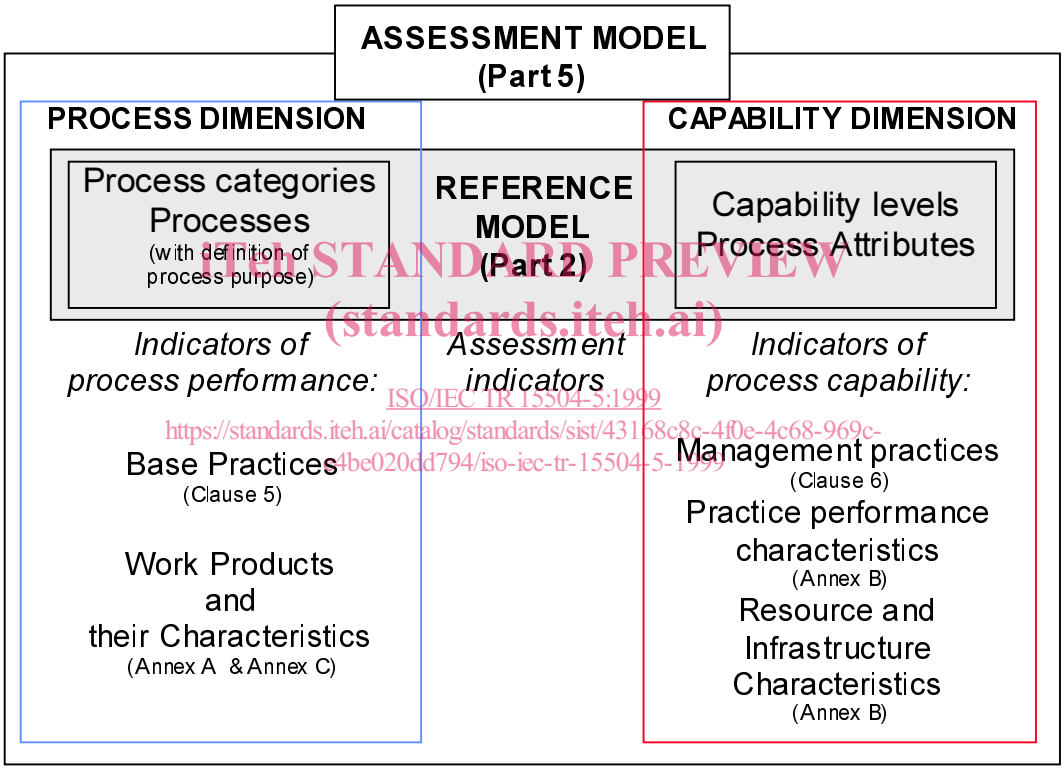

Figure 2 — Relationship between the reference model and the assessment model

This assessment model expands the reference model by adding the definition and use of assessment indicators (see Figure 2). Assessment indicators are defined to support an assessor's judgement of the performance and capability of an implemented process.

4.2.1 Indicators of process performance – the process dimension

Base practices, input and output work products and their associated characteristics relate to the processes defined in the process dimension of the reference model, and are chosen to explicitly address the achievement of the defined process purpose.

The base practices and work products are indicators of a level 1 process performance. The presence of the work products with the existence of the characteristics of the work products, and evidence of performance of the base practices, provide objective evidence of the achievement of the purpose of the process.

4.2.2 Indicators of process capability – the capability dimension

Management practices relate to the process attributes defined in the process capability dimension of the reference model. Evidence of their effective performance supports the judgement of the degree of achievement of the attribute. Management practices are the principal indicators of process capability.

Management practices are linked with attribute indicator sets which are:

a) practice performance characteristics that provide guidance on the implementation of the practice;

b) resource and infrastructure characteristics that provide mechanisms for assisting in the management of the process; and

c) associated processes from the process dimension that support the management practice.

The set of management practices is intended to be applicable to all processes in the process dimension of the model. Evidence of the performance of the defined management practices can be derived from the practice performance characteristics. The practice performance characteristics and resource & infrastructure characteristics help to establish objective evidence of the extent of achievement of the specified process attribute.

4.3 Principles of the assessment model

The assessment model is based on the principle that the capability of a process can be assessed by demonstrating the achievement of process attributes. Each process in the process dimension has a set of associated base practices, the performance of which provides an indication of the extent of achievement of the process purpose. Similarly, each process attribute in the capability dimension has a set of associated management practices, the performance of which provides an indication of the extent of achievement of the attribute in the instantiated process.

The indicators defined in the assessment model represent types of objective evidence that might be found in an instantiation of a process and therefore could be used to judge achievement of capability.

4.4 The view of process performance – the process dimension

The assessment model groups the processes in the process dimension into five process categories, according to the type of activity they address. The groupings are identical to those in the reference model defined in ISO/IEC TR 15504-2.

The **Customer-Supplier** process category (CUS) 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 (ENG) consists of processes that directly specify, implement, or maintain the software product, its relation to the system and its customer documentation.

The **Support** process category (SUP) 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 **Management** process category (MAN) 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 (ORG) 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.

There are a number of processes associated with each process category. Each process in the assessment model is described in terms of a purpose statement. These statements contain the unique functional objectives of the process when instantiated in a particular environment. Satisfying the purpose statements of a process represents the first step in building a level 1 process capability. The process categories and their associated processes are described in Clause 5.

A base practice is an activity that addresses the purpose of a particular process. Consistently performing the base practices associated with a process will help to consistently achieve its purpose. A coherent set of base practices is associated with each process in the process dimension.

The base practices are described at an abstract level, identifying "what" should be done without specifying "how". Implementing only the base practices of a process may be of minimal value and represents only the first step in building process capability, but the base practices represent the unique, functional activities of the process, even if that performance is not systematic. Performance of the base practices may be ad hoc, unpredictable, inconsistent, poorly planned, and/or result in products that do not meet their requirements. The performance of a process, however, produces work products that are at least marginally usable in achieving the purpose of the process. In this assessment model, each work product has a defined set of characteristics that may be used to assess the effective implementation of a process.

Clause 5 contains a complete description of the base practices. Annex A lists the processes and their related work products. Annex C lists the key characteristics of the work products.

4.5 The view of process capability – the capability dimension

Evolving process capability is expressed in the assessment model in terms of process attributes grouped into capability levels. The attributes and capability levels are identical to those defined in the reference model.

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 a set of process 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 and are defined in ISO/IEC TR 15504-2.

There are six capability levels in the reference model, incorporating nine process attributes.

Level 0: Incomplete. There is general failure to attain the purpose of the process. There are little 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 recognise 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 defined 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 defined 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 defined 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.

Within the assessment model, the measure of capability is based upon the nine process attributes (PA) of the reference model. Process attributes are used to determine whether a process has reached a given capability. Each attribute measures a particular aspect of the process capability.

At each level there is no ordering between the process attributes; each attribute addresses a specific aspect of the capability level.

The process attributes themselves are evaluated on a four point ordinal scale of achievement, as defined in ISO/IEC TR 15504-2. They therefore provide insight into the specific aspects of process capability required to support process improvement and capability determination. The list of process attributes is shown in Table 1.

Table 1 — Capability levels and process attributes

Process Attribute ID	Capability Levels and Process Attributes
	Level 0 : Incomplete process
	Level 1 : Performed process
PA 1.1	Process performance
	Level 2 : Managed process
PA 2.1	Performance management
PA 2.2	Work product management
	Level 3 : Established process
PA 3.1	Process definition
PA 3.2	Process resource
	Level 4 : Predictable process
PA 4.1	Measurement
PA 4.2	Process control
	Level 5 : Optimizing process
PA 5.1	Process change
PA 5.2	Continuous improvement

The management practices are activities of a generic type, and are intended to be applicable to all processes. They are designed around the achievement of the principal management functions of planning, organizing, resourcing and controlling. There are usually, but not necessarily, four management practices for each attribute.

Associated with each management practice are practice performance characteristics and associated resource and infrastructure characteristics that represent the type of evidence that would substantiate judgements of the extent to which the management practice is performed.

Annex B contains a complete description of the set of indicators of process capability.

4.6 Use of indicators in rating processes

An indicator is defined as an objective attribute or characteristic of a practice or work product that supports the judgement of the performance or capability of an implemented process. The assessment indicators, and their relationship to process performance and process capability, are shown in Figure 3.

The output from a process assessment is a set of process profiles, one for each instance of each process within the scope of the assessment. Each process profile consists of a set of the process attribute ratings for an assessed process. Each attribute rating represents a judgement by the assessor of the extent to which the attribute is achieved. In order to maximise the objectivity of these judgements, thereby improving the reliability and repeatability of the assessment, the judgements of the assessor are based upon a coherent set of documented objective evidence.

The indicators in this model give examples of evidence that an assessor might obtain, or observe, in the course of an assessment. The evidence obtained in the assessment, through observation of the implemented process, can be mapped onto the set of indicators to enable correlation between the implemented process and the processes defined in this assessment model. These indicators provide guidance for assessors in accumulating the necessary objective evidence to support their judgements of capability. They are not intended to be regarded as a mandatory set of check-list to be followed, but as guidance for an assessor in accumulating the necessary objective evidence to support they judgement of capability.

The evidence obtained should be recorded in a form that clearly identifies the indicators types and classes, so that the support for the assessor's judgement can be readily confirmed or verified as required by ISO/IEC TR 15504-3.

Indicators are used to confirm that certain practices are performed, having been able to collect possible objective evidence during an assessment. All such evidence comes either from the examination of work products of the processes assessed, or from statements made by the performers and managers of the processes.

The existence of base practices, work products, and work product characteristics, provide evidence of the performance of the processes associated with them. Similarly, the existence of management practices provides evidence of process capability.

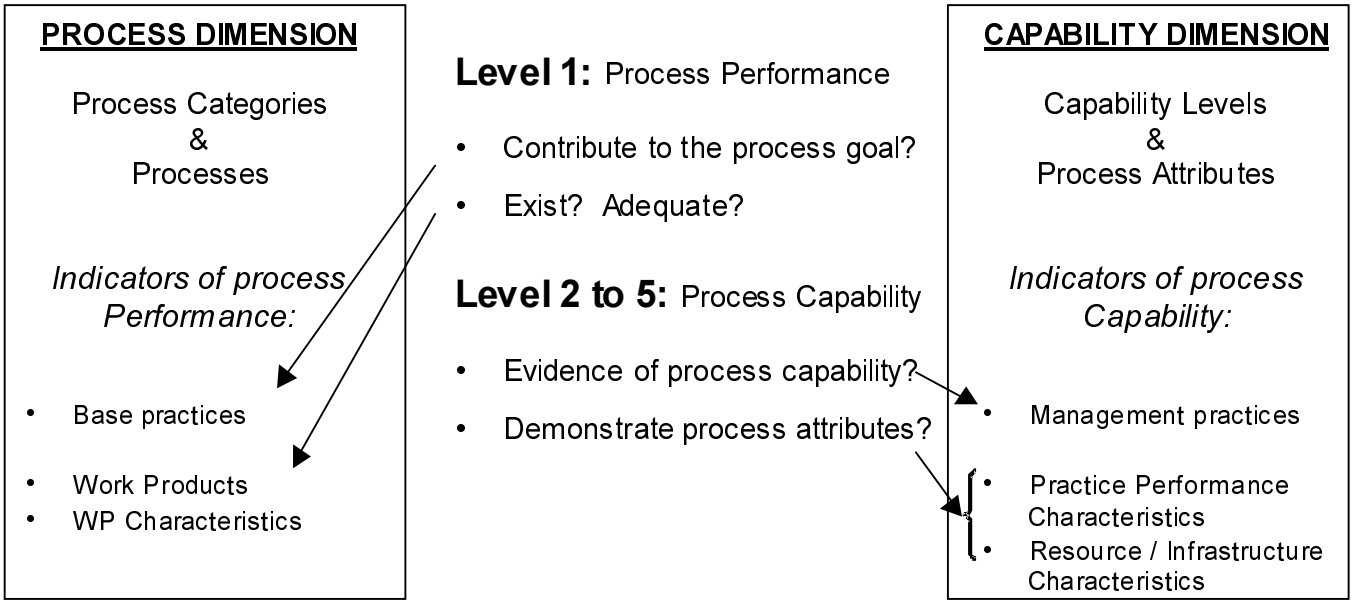

Figure 3 — The relationship between assessment indicators and process capability.

4.7 Identification

4.7.1 Identification for elements of the assessment model

A nomenclature for practices is defined in order to identify them unambiguously and relate them to the architecture of the model. The nomenclature for base practices facilitates the identification of process categories, the processes that belong to each process category, and the base practices that belong to each process. For management practices, the nomenclature facilitates the identification of capability levels, the process attributes that belong to each capability level, and the management practices that belong to each process attribute. In software process assessments using the assessment model, the nomenclature and identifiers contained in this model should be used to identify practices referenced as evidence justifying the rating of a process attribute.

Each practice is linked to its parent entity, whether a process or a process attribute, through a numbering scheme, based upon the identifiers for processes and process attributes in the reference model.

Each practice is assigned an identifier consisting of a multi-part alphanumeric code.

For a base practice, the identifier is of the form : PC.PR.**BP**PN.

For a management practice, the identifier is of the form: **MP**CL.PA.PN.

Where the codes are:

- PC process category identifier
- PR process number (within the process category)
- BP the text "BP" used to signify Base Practice
- MP the text "MP" used to signify Management Practice
- CL capability level number
- PA process attribute number (within the capability level)
- PN practice number (within the process or process attribute)

For example, “ENG.1.3.BP1” denotes the base practice number 1 (Develop software architectural design) in the process category ENG (Engineering) for the process number 1.3 (Develop software design).

Similarly, “MP 2.2.1” denotes the management practice number 1 (Identify requirements) for the process attribute number 2 (Work product management attribute), capability level number 2 (Managed process).

Templates for constructing definition of new base practices and management practices are given in annex D and annex E respectively.

4.7.2 Work product identification

Each work product is assigned a sequential number based upon the listing in the table of work product characteristics in Annex C. Several work products listed are of a generic type (e.g. “Requirement specification (52)”). Where a specific instantiation of this generic type is included as an indicator, this is shown by the use of *italics* to indicate the specific reference (e.g. “*Software* requirement specification (52)”). Annex C gives a complete definition of the work product nomenclature.

5 The process dimension

This clause defines the process dimension of the assessment model. The process dimension is directly mapped to that of the reference model, and adopts the same process definitions and structure given by the reference model.

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

The process dimension contains five process categories which are:

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

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

The individual processes are described in terms of six components as defined in ISO/IEC TR 15504-2 : Process Identifier, Process Name, Process Type, Process Purpose, Process Outcomes and Process Notes.

In addition the process dimension of the assessment model provides information in the form of

a) a set of base practices for the process providing a definition of the tasks and activities needed to accomplish the process purpose and fulfil the process outcomes;

b) a number of input and output work products associated with each process;

c) characteristics associated with each work product.

The process purposes, outcomes and base practices are included in this clause. The work products associated with the processes and work product characteristics are contained in annex A and annex C respectively. The base practices, work products and work product characteristics constitute the set of indicators of process performance.

The process categories, processes and process type included in the process dimension of the assessment model are listed in table 2.

Table 2 — Processes and process categories

Process Category		**Process**	
ID	**Title**	**ID**	**Title and (Type of process)**
Primary Life Cycle processes			
CUS	**Customer Supplier process category**		
		CUS.1	Acquisition (basic)
		CUS.1.1	Acquisition preparation (component)
		CUS.1.2	Supplier selection (component)
		CUS.1.3	Supplier Monitoring (component)
		CUS.1.4	Customer Acceptance (component)
		CUS.2	Supply (basic)
		CUS.3	Requirements Elicitation (new)
		CUS.4	Operation (extended)
		CUS.4.1	Operational use (extended component)