

ISO/IEC 15504 - EVOLUTION TO AN INTERNATIONAL STANDARD

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Accepted for publication in *Software Process: Improvement and Practice*.

Abstract

This paper describes the work currently being undertaken to progress ISO/IEC TR 15504 to the status of a full International Standard, and outlines the changes in design that are to be incorporated in the revision. It describes the inputs for the design decisions that were taken; identifies the fundamental changes in the architecture of the Standard; and briefly describes the current status of the development of the Standard.

Introduction

ISO/IEC 15504 [1] is the International Standard for Process Assessment. Its development, with the parallel empirical studies of its use by the SPICE Project [22, 23], has spanned 10 years – the initial Study Group established by JTC1/SC7 to explore the needs and requirements for the standard reported in 1992 [12].

The first version of the Standard was published in 1998 as a Technical Report (Type 2) [2]. This was a deliberate decision, recommended by the original Study Group report, and based upon the JTC1¹ Directives [3] which state, "When the subject in question is still under technical development or where for any other reason there is the possibility of an agreement at some time in the future, JTC 1 may decide that the publication of a TR would be more appropriate." At the 1998 Plenary Meeting of ISO/IEC JTC1/SC7, Working Group 10 (WG10), responsible for standards in the domain of Process Assessment, and thus for the development and ongoing maintenance of ISO/IEC TR 15504, resolved to initiate a revision of the document set, with the goal of preparing a revised version for full International Standard status within the three-year period allowed for the revision of Technical Reports. JTC1/SC7 adopted the following resolution:

JTC1/SC7 authorizes its WG10 to develop Project Requirements and Schedule for the revision of TR15504 (Software Process Assessment). The intent is to evolve the TR into an IS, seeking in the process as wide a representation as possible with the user community of TR 15504. Further, JTC1/SC7 instructs WG10 to liaise with WG7 and WG13² for this work. [4]

This paper identifies the key inputs to this revision, and sets out the design of the solution that was determined for this revision. It concludes with a brief report on the current schedule for publication of the Standard, and describes recommendations for transition to the new version.

User Views

A Web-based survey of user opinions on the revision commenced in 1998. The survey was initiated by WG10, which approved the content of the questions. The survey was promoted widely among relevant interest groups; responses were collected through a web-based interface hosted by the Software Quality Institute at Griffith University. The survey provided useful insights into user opinions on the usability and usefulness of the Technical Report; of considerable interest was the divergence of opinion on some key issues of usability.

A total of 89 responses were received (by December 2000) and analysed. The respondents to the survey covered a wide range of industry groups and occupations; Figures 1 and 2 show an analysis of the respondents.

¹ 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. Sub-Committee 7 (SC7) of JTC1 is responsible for standards in the domain of systems and software engineering.

² Within SC7, WG7 is responsible for standards relating to software and systems life cycle processes; WG13 was responsible for a standard for the Software Measurement Process.

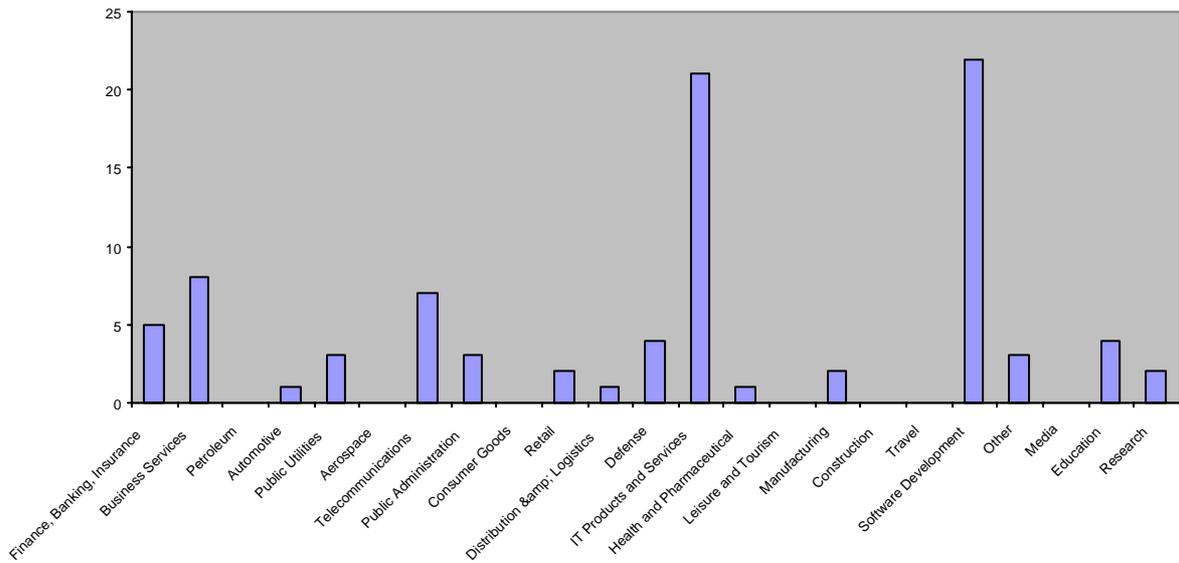


Figure 1 - Analysis of survey respondents by industry

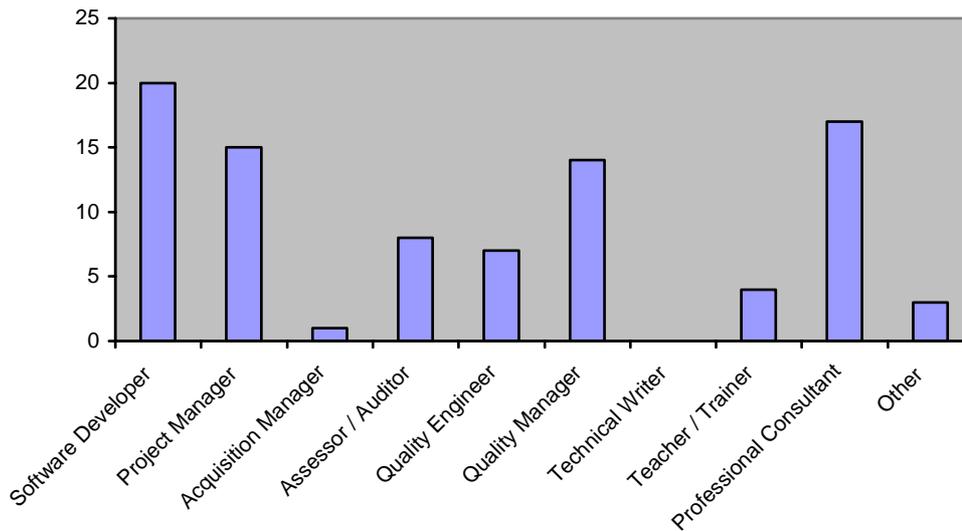


Figure 2 - Analysis of survey respondents by occupation

The respondents reported (generally) good knowledge of ISO/IEC TR 15504 and other relevant standards - ISO 9000:1994 [5] and ISO/IEC 12207 [6]. For ISO 9000, this was evidenced by regular use of the standard; the most common response for others was "knowledge but limited experience". Those with experience of ISO/IEC TR 15504 were divided almost evenly between SPICE Trials Participants [7] and others. Respondents were familiar with a wide range of different assessment approaches: the SW-CMM [8]; Trillium [9]; Bootstrap [10] and Process Professional [11] approach. Figure 3 shows the various assessment approaches used; data on ISO/IEC TR 15504 include both Trials participants and others. Respondents could record familiarity with more than one approach, so the total responses are not consistent with other questions.

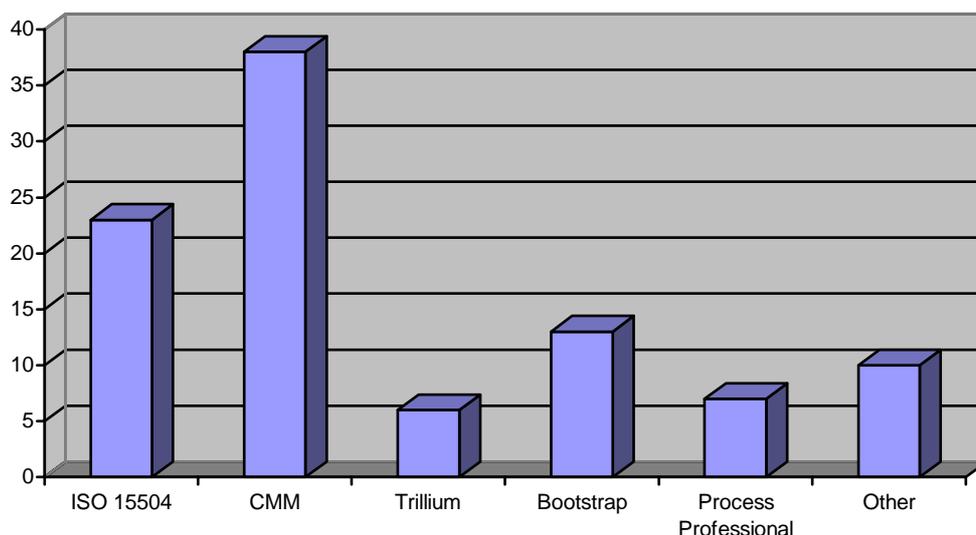


Figure 3 - Experience of respondents with different assessment approaches

Questions in the survey were designed to establish:

- opinions on the content and usability of the existing Technical Report;
- views on the role and content of a standard for process assessment;
- views on the requirements originally established for ISO/IEC TR 15504 (and documented in SC7 N944R) [13].

The survey content is set out in Table 1; the results of the survey (as at 1 December 2000) are shown in Figures 4, 5 and 6. The questions in the survey were divided into the three categories described above; Figures 4 - 6 show the distribution of responses to each question.

Table 1 - Survey Questions

Usability of ISO/IEC TR 15504	
No	Question
1	ISO/IEC TR 15504 contains the right amount of information for its purpose
2	ISO/IEC TR 15504 is about the right size for the information needed
3	ISO/IEC TR 15504 presents information in an understandable form
4	ISO/IEC TR 15504 benefits from having an overview document (Part 1) relating the various parts
5	The requirements for performing assessments in ISO/IEC TR 15504-3 are easy to understand and follow
6	The process dimension of the reference model in ISO/IEC TR 15504-2 achieves its purpose
7	The scale for measurement of process capability in ISO/IEC TR 15504-2 is easy to understand and apply
8	The results of assessments performed using ISO/IEC TR 15504 are easy to understand
9	The results of assessments performed using ISO/IEC TR 15504 are easy to analyse providing a basis for action
10	The guidance on performing assessments in ISO/IEC TR 15504-4 is useful and relevant
11	The guidance on achieving and validating assessor competency in ISO/IEC TR 15504-6 is useful and relevant
12	The guidance on process improvement in ISO/IEC TR 15504-7 is useful and relevant
13	The guidance on process capability determination in ISO/IEC TR 15504-8 is useful and relevant

14	The availability of a separate consolidated vocabulary in ISO/IEC TR 15504-9 is valuable
15	ISO/IEC TR 15504-5 is useful as a guide for developing and evaluating other assessment models
16	ISO/IEC TR 15504-5 is useful as a model for use in performing assessments
Role of the Standard for Process Assessment	
No	Question
1	It is important for a Process Assessment standard to harmonise different assessment methods
2	An assessment standard should define the only approach to assessment, replacing all other methods
3	It is important to be able to compare the results of assessments that used different methods
4	It is important to be able to select processes for assessment from a standard
5	It is important to be able to consistently add new organization-specific processes to an assessment standard
6	It is important to be able to categorise or classify work products
Requirements for the Standard	
No	Question
1	The results of a process assessment should reflect the organization's ability to set and realize defined, achievable goals for productivity and/or development cycle time linked to business needs and project requirements
2	Process assessment is an important technique for an organization to achieve a repeatable software process
3	A standard for process assessment should contain guidance on using assessment results to achieve process improvement
4	A standard for process assessment should contain guidance on using assessment results in determining process capability for assessment of risks in acquisition and development
5	A standard for process assessment should be expected to lead to more reliable and consistent performance of assessment
6	A standard for process assessment should be usable in any organization involved in software development, regardless of application domain, business needs or size of organization
7	A standard for process assessment should reflect current best practice in software engineering
8	Process assessment is useful for assessing both projects and organizations
9	Process assessment is primarily concerned with evaluating adherence to defined procedures
10	The results of process assessment must inevitably be subjective views of the assessor
11	The results of process assessment should be able to be presented as process profiles allowing views at different levels of detail
12	The results of a process assessment should be able to be expressed as a single value for the organization as a whole
13	The standard for process assessment should include information on the competency expected of assessors
14	Assessment results should be available as defined process capabilities certified by a third party
15	Assessments should preferably be performed in-house with results that can be independently verified

The first component of the survey addressed the usability of the original Technical Report. Responses were obtained from the 35 respondents with familiarity with ISO/IEC TR 15504. The results are shown in Figure 4.

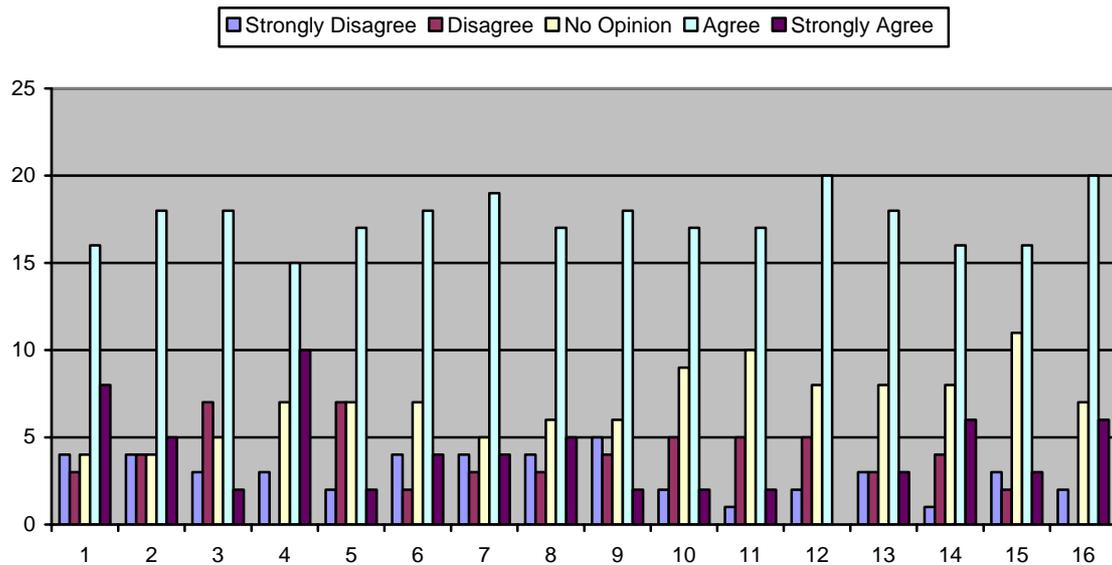


Figure 4 - Survey Responses: Usability of ISO/IEC TR 15504

The respondents had a generally positive opinion of the existing Technical Report; the most common response was "Agree", and the proportion of positive responses ("Agree" or "Strongly agree") ranges from 54% to 74% of all responses.

The second component of the survey addressed the role of a Standard for Software Process Assessment. In particular, this section addressed the relationship between the Standard and other assessment approaches.

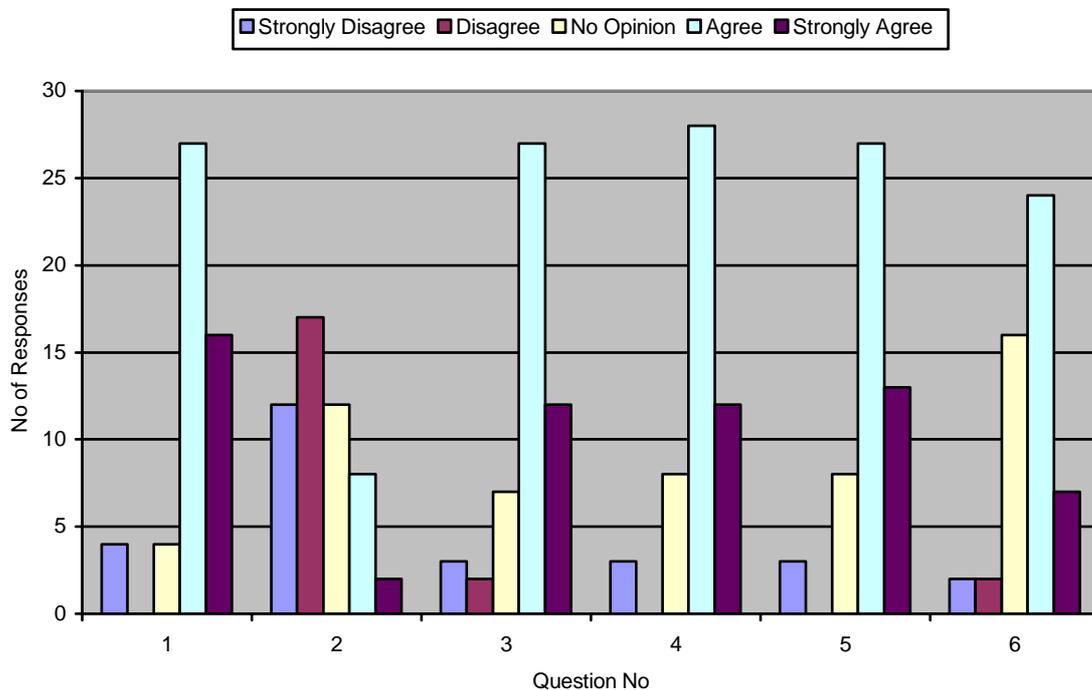


Figure 5 - Survey Responses - Role of the Standard for Process Assessment

The results, shown in Figure 5, generally confirmed the view that the Working Group has taken over the course of the Project - that a Standard should not seek to be the "one and only" approach to assessment, but should rather provide a mechanism for harmonising different approaches. The importance of comparability of assessment results is endorsed;

the concept that it should be possible to scope each assessment to a limited set of processes also found support.

The third section of the survey was used to validate key requirements defined for the Standard in the original study, and documented in the Report of the Study Group [12] in 1992.

The results, shown in Figure 6, broadly supported the original defined requirements. Responses to Question 12 showed significant support for the expression of organisational maturity, an issue not addressed in these terms by ISO/IEC TR 15504. Another interesting issue was the high degree of support for certification of assessment results (Question 14); this was an area that the working group (for political rather than technical reasons) had generally agreed should not be within the domain of the Standard.

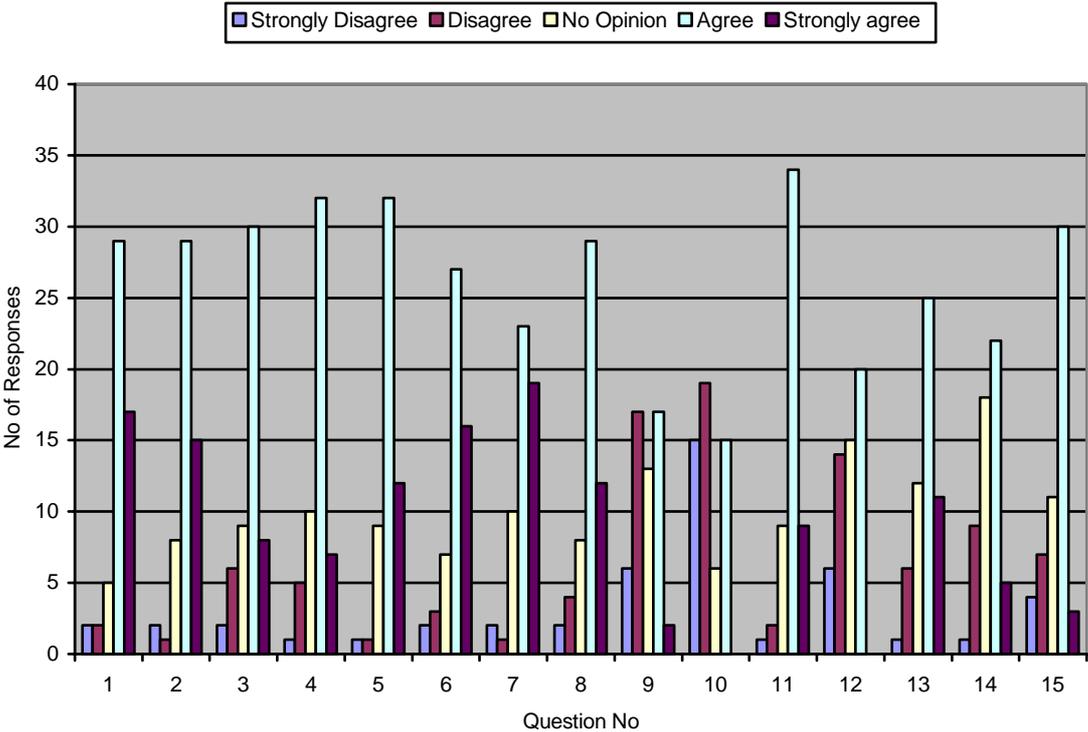


Figure 6 - Survey Responses - Requirements for the Standard

Design Inputs

National bodies participating in WG10 were invited to submit proposals for the revision; discussion papers were received from the USA, Japan, and Australia. There was a general acknowledgement of the need to reduce the overall size of the Standard; there were significant variations in the proposals for the extent and nature of any reduction, with one view being for the removal of all material relating to guidance on use (process improvement and capability determination). There was also a general acknowledgement of the need to expand the scope of the Standard beyond the software life cycle processes, following on the emergence of ISO/IEC 15288 - *Systems Life Cycle Processes* [14] and ISO 18529 - *Human-centred lifecycle process descriptions* [15]. The need to maintain compatibility with these current and emerging standards was seen as of significant importance in all submissions, and a desire to increase the flexibility of application of the Standard was evident.

At meetings held in October 1998 and March 1999, WG10 developed a detailed proposal for the review of ISO/IEC TR 15504, including a complete statement of requirements and documented strategy for the review [16]. The proposal was distributed throughout the Software Engineering Standards community, and was subsequently approved by JTC1. The

defined requirements have been maintained throughout the development of the Standard; in the latest version (29 October 1999) 27 functional and 12 non-functional requirements are defined. Many of these re-affirm the original recommendations of the Study Group report; there are however some significant changes of direction. The principal of these is a decision to remove the "process dimension" of the Reference Model of ISO/IEC TR 15504-2 from the scope of the Standard, relying on external sources for definitions of processes to be assessed. This was seen as critical to achieving the stated wish to make the standard more flexible and extend its scope of application. In line with this goal, the title of the Standard has been modified – from "Software Engineering – Software Process Assessment" to "Information Technology – Process Assessment".

The Revised Framework

A high level design for the revised document set was developed. The design envisages considerable simplification of the conceptual model for process assessment, with substantial more flexibility in the range of process areas included in the domain of the standard. The experiences with the use of the initial document set, monitored through the SPICE Trials, together with the ongoing maturity of understanding of process management in systems and software engineering, led to a significant re-design of the assessment framework. The most significant change is to remove the Process Dimension of the Reference Model (the current Part 2 of the document set) from the scope of the Standard. Instead, requirements are defined for Process Reference Models that can be met by current and emerging standards within the domain of JTC1/SC7 - in particular, the Amendment to ISO/IEC 12207- Software Life Cycle Processes [13], and the standard for System Life Cycle Processes, ISO/IEC 15288 [14]. The new framework is shown in Figure 2.

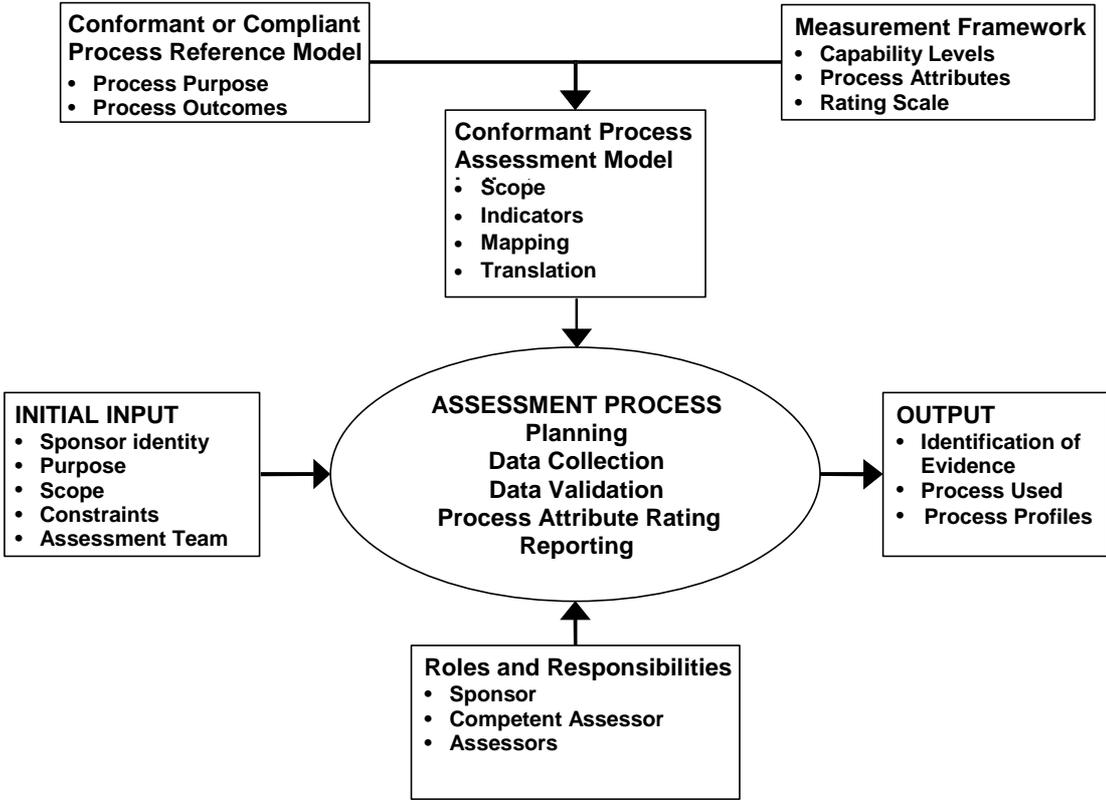


Figure 2 - Revised View of the Assessment Process

The major benefit of this change is that it expands the available scope of the standard. Instead of being constrained to the processes of the software life cycle, it now will define a common assessment process that can be applied to any processes defined in the required manner. Processes defined through an appropriate Process Reference Model are assessed in relation to the measurement scale for capability set out in the Standard. The scale is

based upon the existing Capability Dimension of ISO/IEC TR 15504-2, but has been modified and strengthened to address weaknesses identified through use of the Technical Report. The issue of alignment to the new version of ISO 9001 [19] has also been considered, and the revised Measurement Framework is strongly aligned to this Standard.

The Technical Report [2] was published with nine parts [23]:

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

The International Standard [1] is considerably reduced in size, and also in complexity, having five parts. The overall structure of ISO/IEC 15504 is as follows:

Part 1 - Concepts and Vocabulary

Part 2 - Performing an Assessment

Part 3 - Guidance on Performing an Assessment

Part 4 - Guidance on Using Assessment Results

Part 5 - An Exemplar Process Assessment Model

In general, the new Part 1 contains material from Parts 1 and 9 of the Technical Report; Part 2 amalgamates issues from Parts 2 and 3; Part 3 draws upon Parts 4 and 6; and Part 4 combines the contents of the existing Parts 7 and 8. There is maintenance of the existing level of guidance, but the detail in some aspects of the guidance has been reduced and the advice made less verbose. Part 5 is not seen as "guidance" in the same sense as the other parts, but as a usable exemplar of a key element in the overall framework.

Process Models in the Revision

Two different classes of process models are identified in the revised framework. These have been implicitly recognised in the current version, but the decision to rely on external sources for process descriptions has made the difference clearer and more explicit. The two classes are:

1. **Process Reference Models:** The purpose of these models is to provide the descriptions of the process entities to be evaluated - to define what is to be measured. Process Reference Models are in a very real sense standards, in that they provide a common terminology and description of scope for process assessment.
2. **Process Assessment Models:** The purpose of these models is to support the conduct of an assessment. Process Assessment Models may have significant differences in structure and content, but can be referenced to a common source (a Process Reference Model), providing a mechanism for harmonisation between different approaches to assessment.

In ISO/IEC TR 15504 there is a requirement for the selected assessment model to be compatible with the "reference model" contained in ISO/IEC TR 15504-2. The effect of this is to limit the scope of ISO/IEC TR 15504-conformant assessments to processes associated with the software life cycle. With the development of the new standard for system life cycle

processes (ISO/IEC 15288) and assessment approaches covering Systems Engineering, such as the CMM Integration project [17], expansion of this scope was essential. This led to a decision to rely on external sources for definitions of processes within the SC7 terms of reference. Accordingly, there are two different classes of requirement: *compliance* requirements for suitable Process Reference Models, and *conformance* requirements for Process Assessment Models.

Conformity is fulfilment by a product, process or service of specified requirements [21]. *Compliance*, within the context of international standardisation, is defined as "adherence to those requirements contained in standards and technical reports which specify requirements to be fulfilled by other standards, technical reports or ISP³s (eg. reference models and methodologies)". [18] To a significant extent, this mandates a degree of compatibility between standards employed for process assessment, providing defined rules where previously there was only a general agreement.

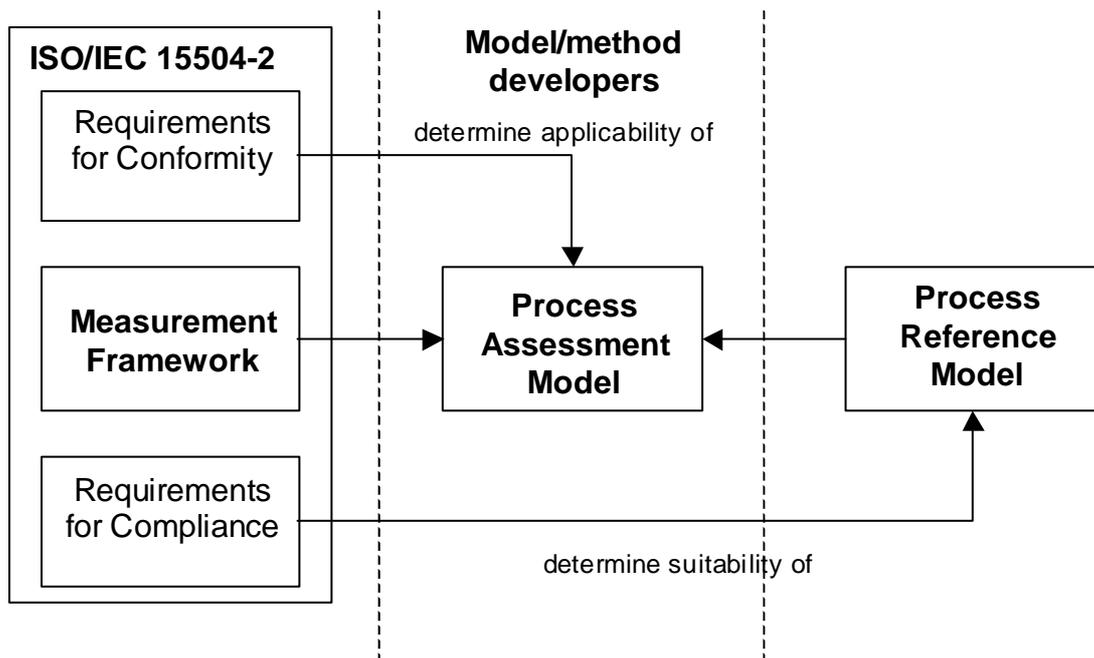


Figure 4 - ISO/IEC 15504 requirements and the Assessment Model

As shown in Figure 4, a Process Reference Model provides the basis for conformance of any Process Assessment Model. The reference model contributes the overall definitions of the processes within the scope of the Process Assessment Model. The derivation of requirements for the definition of processes is an essential element of the derivation of the framework. The requirements for compliance / conformance of reference models represent the principal new material required for the standard.

Conventionally, in most relevant standards, a process is seen as a set of activities or tasks, converting inputs into outputs – see for example, definitions in ISO 9000 and ISO/IEC 12207. This definition, however, is not generally suited for the assessment of process capability; there may be many different sets of distinct activities that achieve the same transformation. For the purpose of assessing process capability, it is of more value to explore the purpose for which the process is employed. Implementing a process results in the achievement of a number of observable outcomes, which together demonstrate achievement of the process purpose.

The purpose may be expressed in terms of the transformation of inputs into outputs; it may involve elaboration, evaluation, or even some change of state of the inputs. This approach is used to specify processes in a Process Reference Model; the model contains a set of

³ International Standardized Profile. An ISP is an internationally agreed-to, harmonized document which identifies a standard or group of standards, together with options and parameters, necessary to accomplish a function or set of functions.

processes described in terms of their purpose and the outcomes resulting from implementation.

The requirement that processes are described in terms of Process Purpose and Process Outcomes is the critical innovation in ISO/IEC 15504. It provides for a form of definition that is independent of implementation concerns, and that focuses on the results of process performance. The use of this approach has been endorsed by SC7 for general use across all of its process-oriented standards; as a result, all of these Standards are effectively harmonised with ISO/IEC 15504. In particular, the two central life-cycle standards – ISO/IEC 12207, *Software Life Cycle Processes (Amd 1)* [13], and ISO/IEC 15288, *Systems Life Cycle Process* [14] – formally constitute Process Reference Models for the purposes of ISO/IEC 15504.

Other forms of process model may describe sets of activities or other elements that result in achievement of the purpose; these are outside the concern of ISO/IEC 15504. A Process Assessment Model describes processes in terms of the evidence that may be identified that demonstrates that the process has in fact been implemented; they generally comprise sets of practices and descriptions of work products that serve as indicators of process performance and process capability.

As shown in Figure 5, there can be multiple Process Assessment Models for each accepted Process Reference Model. The requirements for conformance of Process Assessment Models in the revised Standard are based upon the existing requirements in ISO/IEC TR 15504-2, but have been re-worked in the light of experience. Conformance is on the basis of relationships between the Process Assessment Model and both the external Process Reference Model and the in-built measurement framework of ISO/IEC 15504.

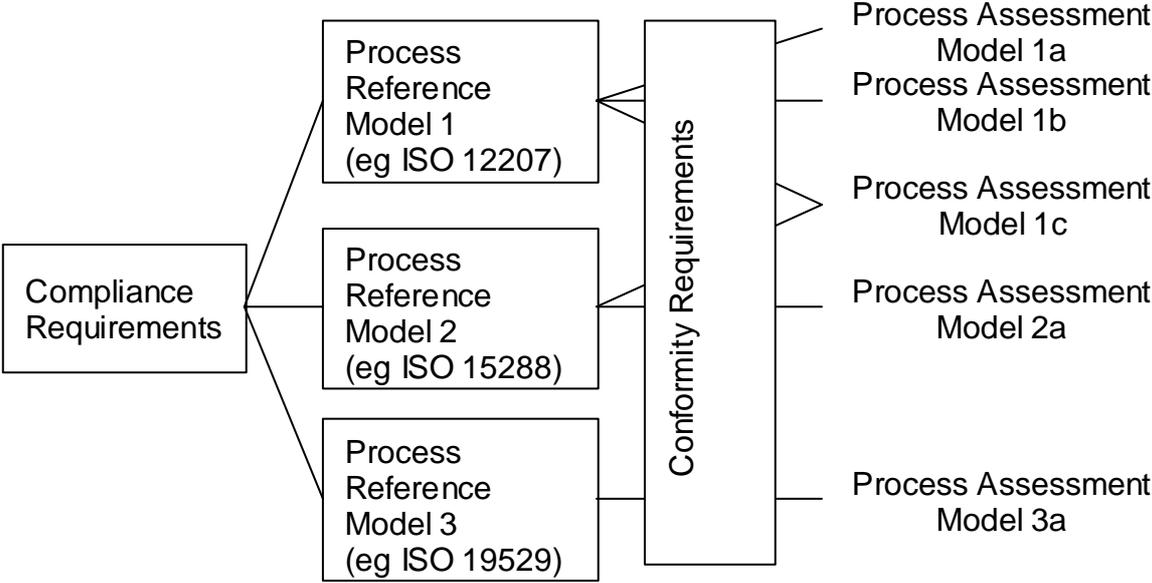


Figure 5: Process Models in the revised framework

Assessment models - as in the existing framework - will be developed independently by model and method developers, in conformity with the requirements of the Standard. The generalisation of the framework, with the extension to cover additional Process Reference Models, provides more opportunities for model developers, providing suitable Process Reference Models exist. With ISO/IEC 15504 providing the criteria for but not defining the processes that may be assessed, the requirements for the resulting Process Assessment Models will be sufficient to ensure that any process from an acceptable Process Reference Model can be measured. As with the current Technical Report, the new ISO/IEC 15504

contains an exemplar Process Assessment Model, with a scope equivalent to that of the Process Reference Model defined in ISO/IEC 12207, Amd 1.

There is a potential for significant multiplicity of different Process Reference Models if the status of these key entities is not controlled in some manner. It should also be noted that the requirements for conformance are of necessity more complex than in the Technical Report. Clear distinction is made between the mapping requirements to the Process Reference Model(s) and those to the measurement framework elements. The availability of different Process Reference Models also contains implications for the comparability of assessment results; in general, results are comparable only for processes within the same Process Reference Model.

Measurement Framework

In the course of the revision of ISO/IEC 15504, there has been a detailed review and revision of the definitions of the Process Attributes in the Capability Dimension. As shown in Figure 4 (above), the measurement framework remains a core element of ISO/IEC 15504, and is seen as applicable across multiple different process domains. In the early drafts of the revision, the whole intent and structure of the original Capability Dimension from the Technical Report was retained, although there were several changes to increase clarity.

Following comments from the UK National Body and other sources in the course of balloting, an Other Working Group with broad international participation was established to undertake a full review of the Measurement Framework, with explicit attention being paid to issues of harmonisation with ISO 9001: 2000 [19]. The general structure of the restructured framework is given in Table 4, along with the original structure from the Technical Report. It can be seen that the changes at the top level of the framework are limited: one of the attributes at Level 3, and both of the attributes at Level 5, have been renamed. At a lower level of detail, however, the changes are much more significant.

The major alterations in the details of the measurement framework are at Capability Levels 2 and 3. At Level 2, a much greater level of detail has been incorporated, and more formal traceability to ISO 9001:2000 has been incorporated. At Level 3, although the overall capabilities associated with the level have not changed, a different perspective on the distribution of attributes has been adopted. The concepts for Level 4 and Level 5 capability are generally unchanged, though the specifications have been modified to improve clarity and understanding.

Table 4: Revised Measurement Framework

Capability Level	Technical Report	International Standard
Level 1 – Performed Process	PA 1.1 – Process performance attribute	PA 1.1 – Process performance attribute

Level 2 – Managed Process	PA 2.1 - Performance management attribute	PA 2.1 - Performance management attribute
	PA 2.2 - Work product management attribute	PA 2.2 - Work product management attribute
Level 3 – Established Process	PA 3.1 - Process definition attribute	PA 3.1 - Process definition attribute
	PA 3.2 - Process resource attribute	PA 3.2 - Process deployment attribute
Level 4 – Predictable Process	PS 4.1 - Process measurement attribute	PA 4.1 - Process measurement attribute
	PA 4.2 - Process control attribute	PA 4.2 - Process control attribute
Level 5 – Optimising Process	PA 5.1 - Process change attribute	PA 5.1 - Process innovation attribute
	PA 5.2 - Continuous improvement attribute	PA 5.2 - Process optimization attribute

Table 5 shows the changes in the attributes at Level 2. It can be seen that the description of Performance Management is significantly more detailed, with 6 distinct characteristics identified, against 4 in the Technical Report. Characteristics for Work Product Management have been clarified, removing explicit reference to "dependencies" and making terminology consistent with usage in ISO 9001.

Table 5 – Characteristics for Capability Level 2

Attribute	Technical Report	International Standard
PA 2.1	<p>Performance management</p> <p>a. the objectives for the performance of the process will be identified (e.g. quality, time-scale, cycle time and resource usage);</p> <p>b. the responsibility and authority for developing the work products of the process will be assigned;</p> <p>c. the performance of the process will be managed to produce work products that meet the defined objectives.</p>	<p>Performance management</p> <p>a. objectives for the performance of the process are identified;</p> <p>b. performance of the process is planned and monitored;</p> <p>c. performance of the process is adjusted to meet plans;</p> <p>d. responsibilities and authorities for performing the process are defined, assigned and communicated;</p> <p>e. resources and information necessary for performing the process are identified, made available, allocated and used;</p> <p>f. interfaces between the involved parties are managed to ensure both effective communication and also clear assignment of responsibility.</p>

Attribute	Technical Report	International Standard
PA 2.2	<p>Work product management</p> <ol style="list-style-type: none"> 1. the requirements (functional and non-functional) of the specified work products of the process will be defined; 2. the requirements for the documentation and control of the work products will be defined; 3. the dependencies among the controlled work products will be identified; 4. work products will be appropriately identified and documented, and changes will be controlled.; 5. the work products will be verified and adjusted to meet the defined requirements. 	<p>Work product management</p> <ol style="list-style-type: none"> 1. requirements for the work products of the process are defined; 2. requirements for the documentation and control of the work products are defined; 3. work products are appropriately identified, documented, and controlled; 4. work products are reviewed in accordance with planned arrangements and adjusted as necessary to meet requirements.

Level 3 attributes are shown in Table 6. In the Technical Report, the distribution of characteristics was on the basis that one attribute addressed the "process" elements (procedures, etc) in relation to both the definition of a standard process and its deployment, while the other addressed the definition and deployment of resources and infrastructure. In the new draft, PA3.1 is associated with the existence and availability of a set of standard process assets (including resources and infrastructure), while PA3.2 addresses the deployment of these assets as a "defined process". The set of characteristics distributed across the two attributes are basically the same. Terminology is clarified and made more consistent.

Table 6 – Characteristics for Capability Level 3

Attribute	Technical Report	International Standard
PA 3.1	<p>Process definition</p> <ol style="list-style-type: none"> 1. a standard process including appropriate guidance on tailoring will be defined, that supports the execution of the managed process; 2. performance of the process will be conducted in accordance with appropriately selected and/or tailored standard process documentation; 3. historical process performance data will be gathered to establish and refine the understanding of the process behaviour (e.g. in order to estimate the process performance resource needs); 4. experiences of using the defined process will be used to 	<p>Process definition</p> <ol style="list-style-type: none"> 1. a standard process, including appropriate tailoring guidelines, is defined that describes the fundamental elements that must be incorporated into a defined process; 2. the sequence and interaction of the standard process with other processes is determined; 3. required competencies and roles for performing a process are identified as part of the standard process; 4. required infrastructure and work environment for performing a process are identified as part of the standard process; 5. suitable methods for monitoring the effectiveness and suitability

Attribute	Technical Report	International Standard
	refine the standard process.	of the process are determined.
PA 3.2	<p>Process resource</p> <ol style="list-style-type: none"> 1. roles, responsibilities and competencies required for performing the process will be identified and documented; 2. the process infrastructure required for performing the process will be identified and documented; 3. the required resources will be available, allocated and used to support the performance of the defined process. 	<p>Process deployment</p> <ol style="list-style-type: none"> 1. a defined process is deployed based upon an appropriately selected and/or tailored standard process; 2. required roles, responsibilities and authorities for performing the defined process are assigned and communicated; 3. personnel performing the defined process are competent on the basis of appropriate education, training, and experience; 4. required resources and information necessary for performing the defined process are made available, allocated and used; 5. required infrastructure and work environment for performing the defined process are made available, managed and maintained; 6. appropriate data are, collected and analysed as a basis for understanding the behaviour of, and to demonstrate the suitability and effectiveness of the process, and to evaluate where continuous improvement of the process can be made.

At higher levels of capability, the process characteristics described are essentially unchanged, although further clarification of terminology has been adopted. Tables 7 and 8 show the characteristics for Capability Levels 4 and 5 respectively. At Level 4, the description of PA4.2 has been expanded significantly, but without change to its intent. The description of PA 4.1 has been clarified, and the links to concepts of statistical process control made more explicit.

Table 7 – Characteristics for Capability Level 4

Attribute	Technical Report	International Standard
PA 4.1	<p>Measurement</p> <ol style="list-style-type: none"> a. product and process goals and measures will be identified in line with relevant business goals; b. product and process measures will be collected to monitor the extent to which the defined goals are met; 	<p>Process measurement</p> <ol style="list-style-type: none"> a. process information needs in support of relevant defined business goals are established; b. process measurement objectives are derived from process information needs; c. quantitative objectives for process performance in support

Attribute	Technical Report	International Standard
	<ul style="list-style-type: none"> c. process performance trends across the organization will be analyzed; d. process capability will be measured and maintained across the organization. 	<ul style="list-style-type: none"> of relevant business goals are established; d. measures and frequency of measurement are identified and defined in line with process measurement objectives and quantitative objectives for process performance; e. results of measurement are collected, analysed and reported in order to monitor the extent to which the quantitative objectives for process performance are met; f. measurement results are used to characterise process performance.
PA 4.2	<p>Process control</p> <ul style="list-style-type: none"> a. suitable analysis and control techniques will be identified; b. in-process product and process measures will be collected and analyzed to support control of process performance within defined limits; c. process performance will be managed quantitatively. 	<p>Process control</p> <ul style="list-style-type: none"> a. analysis and control techniques are determined and applied where applicable; b. control limits of variation are established for normal process performance; c. measurement data are analysed for special causes of variation; d. corrective actions are taken to address special causes of variation; e. control limits are re-established (as necessary) following corrective action.

At Capability Level 5, the characteristics described are essentially the same; however, the order and names of the attributes have been changed. Again, concepts have been clarified and the linkage to statistical process control concepts made more explicit.

Table 8 – Characteristics for Capability Level 5

Attribute	Technical Report	International Standard
PA 5.1	<p>Process change</p> <ul style="list-style-type: none"> a. the impact of all proposed changes will be assessed against the defined product and process goals of the defined and standard processes; b. the implementation of all agreed changes will be managed to ensure that any disruption to the process performance is understood and acted upon; 	<p>Process innovation</p> <ul style="list-style-type: none"> a. process improvement objectives for the process are defined that support the relevant business goals; g. appropriate data are analysed to identify common causes of variations in process performance; h. appropriate data are analysed to identify opportunities for best

Attribute	Technical Report	International Standard
	c. the effectiveness of process change on the basis of actual performance will be evaluated against the defined product and process goals and adjustments made as needed.	practice and innovation; i. improvement opportunities derived from new technologies and process concepts are identified; j. an implementation strategy is established to achieve the process improvement objectives.
PA 5.2	<p>Continuous improvement</p> <p>a. the process improvement goals for the process will be defined that support the relevant business goals of the organization;</p> <p>k. the sources of real and potential problems will be identified;</p> <p>l. improvement opportunities will be identified;</p> <p>m. an implementation strategy will be established and deployed to achieve the process improvement goals across the organization.</p>	<p>Process optimization</p> <p>a. impact of all proposed changes is assessed against the objectives of the defined process and standard process;</p> <p>n. implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon;</p> <p>o. effectiveness of process change on the basis of actual performance is evaluated against the defined product requirements and process objectives to determine whether results are due to common or special causes.</p>

The impact of the changes to the measurement framework should be a significant improvement in clarity of the attribute descriptions, resulting in improved consistency of rating and better reliability of the assessment process. It should be simpler, with the use of more consistent terminology, to establish the conformance of new assessment models (for example, those developed by the CMMI Development Project [17]) more readily.

Transition from the Technical Report

The Working Group has considered the issue of transition from the existing Technical Report to the new International Standard. At its meeting in March 2003, the following recommendations were developed:

1. It is recommended that assessment approaches that support conformance with the requirements of ISO/IEC TR 15504 commence to transition to support conformance with the requirements of ISO/IEC FDIS 15504-2.
2. The transition should be implemented as soon as possible after approval for publication of ISO/IEC 15504-2. The requirements include the use of the new measurement framework for process capability.
3. Assessment approaches that are currently using the exemplar assessment model in ISO/IEC TR 15504-5 may use the process dimension in ISO/IEC TR 15504-2 as the basis for a Process Reference Model (PRM) and use ISO/IEC TR 15504-5 as the basis for a Process Assessment Model (PAM) in relation to the PRM.
4. It is recommended that assessment approaches that are currently using the exemplar assessment model in ISO/IEC TR 15504-5 commence to transition to use the exemplar Process Assessment Model in ISO/IEC 15504-5 in conjunction with Process Reference

Model in ISO/IEC 12207:1995 AMD as soon as ISO/IEC 15504-5 is distributed for CD ballot .

5. It is noted that the exemplar Process Assessment Model (ISO/IEC 15504-5) is expected for publication early in 2005.

Summary and Conclusion

As of June 2003, the development of ISO/IEC 15504 is proceeding towards finalisation. Part 2 of the International Standard has been approved for publication, and two of the remaining parts of the standard – Parts 3 and 4 - are at the stage of Final Draft International Standard. Parts 1 and 5 were delayed in development because of dependencies on the other material; both are currently registered as Committee Draft. The normative element of the Standard (Part 2) will be published in 2003, while the current schedule indicates that the complete document set will be published and available early in 2005.

The development of ISO/IEC 15504 has drawn together the best of international expertise in process assessment, and through the synergy of these relationships it has led to significant advances in the state of the art and in the theoretical underpinning for process assessment [20]. New techniques for conducting assessments are emerging, and ISO/IEC 15504 provides a framework within which they can be validated and evaluated for their benefits to the industry. The overall impact of the work has been a significant boost to the improvement of software engineering practice internationally.

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