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Software engineering — Certification of software engineering professionals — Comparison framework

Ingénierie du logiciel — Certification des professionnels de l'ingénierie du logiciel — Cadre comparatif

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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.

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

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 24773 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

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Introduction

Over the past several decades, software systems have become critical components of most aspects of life. At the same time, these systems have become increasingly complex. One response to this situation has been the recognition and codification of effective practices for software development processes and products. This effort has led to the development of systems and software engineering standards by ISO and IEC, by professional societies, and by national standards bodies. It has also led to the definition of an internationally recognized body of knowledge for software engineering [1].

At the same time, there has been a broad-based effort to increase the professionalism of developers of software systems. This effort has included the extension of professional engineering qualifications (e.g. licensed or chartered status) to software engineers and the creation of certification schemes for software engineering professionals. All certifications assess candidates' competencies, either by examination or by review of a candidate's competencies, including education, experience, and mastery of specific skills.

The increasing globalization of the software industry implies that a software engineering professional is likely to work in different countries over the course of a career. It is therefore important to develop ways to increase the portability of professional certifications in this domain. This International Standard will respond to the needs of multi-national organizations or suppliers for developing software for a foreign customer (including offshoring) that requires software engineering professional certifications.

This International Standard will facilitate the portability of software engineering professional certifications between different countries. At present, different countries have adopted different approaches on the topic that are implemented by means of regulations and bylaws. The intention of this International Standard is to be open to these national approaches by providing a framework for expressing them in a common scheme that can lead to understanding between different countries.

This International Standard refines and supplements the processes for certification of individuals included in ISO/IEC 17024:2003, *Conformity Assessment – General requirements for bodies operating certification of persons.* The management and implementation of the Scheme developed under this International Standard can also take into account the processes and definitions of ISO/IEC 17024.

A **certification body** for software engineering professionals seeking accreditation as such will be required to demonstrate conformance to ISO/IEC 17024 and to this International Standard. This does not preclude a certification body for software engineering professionals from using this International Standard alone to compare its Scheme with other certification bodies as a basis for a mutual recognition agreement.

In some countries, governments and other bodies assess the qualifications of software engineering professionals by evaluating candidates' knowledge, skills and job experience and issuing certificates of qualification to those demonstrating competence as defined by an assessing organization. Such an organization is defined as **qualification body** in this International Standard. A qualification body can use appropriate components of Clauses 4.1 to 4.6, 5 and 6 of this standard for comparison with other such schemes or as a delegated qualification body under Clause 7 of this International Standard. Educational organisations can also use a Scheme developed under this International Standard for comparison purposes.

The Guide to the body of knowledge, ISO/IEC TR 19759:2005, *Software Engineering – Guide to the Software Engineering Body of Knowledge* [1] is utilized in this International Standard for comparison of software engineering bodies of knowledge. Education bodies, qualification or examination bodies and certification bodies are not required to use, or comply with, SWEBOK, but are required to map a software engineering body of knowledge to SWEBOK. This will enable comparisons between the software engineering component (Clause 5.1.1) of the body of knowledge in the Scheme.

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This International Standard is not intended to discourage or diminish the role of universities and other educational bodies in developing and offering diverse and innovative software engineering programs. Rather, it encourages universities and other educational bodies to participate in the initial and continuing development of software engineering professionals. At the same time, certification bodies are encouraged to consult with and work with universities and other educational bodies in establishing schemes under this International Standard.

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Software engineering — Certification of software engineering professionals — Comparison framework

1 Scope

1.1 Purpose

This International Standard establishes a framework for comparison of schemes for certifying software engineering professionals. A certification scheme is a set of certification requirements for software engineering professionals. This International Standard specifies the items that a scheme is required to contain and indicates what should be defined for each item.

1.2 Field of application

This International Standard has a number of intended users, as follows:

— **Educators**, **academics and course developers**: will use Clauses 4.1 to 4.6, 5 and 6 of this International Standard to map their course structure and design against another course or educational requirement; develop new courses; make decisions about mutual recognition.

— **Examining bodies**: will use Clauses 4.1 to 4.6, 5 and 6 of this International Standard to construct examination and/or evaluation schemes; make decisions about mutual recognition.

— **Industry and professional bodies**: will use this International Standard to develop and maintain certification schemes; make decisions about mutual recognition.

— **Government bodies**: will use this International Standard for policy development; funding decisions; skills assessment; regulation of professionals; facilitation of trade agreements between countries.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 17024:2003, *Conformity assessment — General requirements for bodies operating certification of persons*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 17024:2003 and the following apply.

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3.1
body of knowledge
collection of knowledge items or areas generally agreed to be essential to understanding a particular subject

3.2
certification body
body certifying persons against the requirements in Clauses 4 to 9 of this International Standard, including the development and maintenance of a Scheme

3.3
cognitive level
qualitative assessment of an individual's familiarity with a given topic

3.4
qualification body
entity issuing certificates of qualification under Clauses 4.1 to 4.6, 5 and 6 of this International Standard

4 Requirements for a Certification Scheme

The certification body shall produce a certification scheme **(the Scheme)** that contains a description of the software engineering professionals to be certified. The Scheme shall include the following:

4.1 a title which expresses and reflects the knowledge and skills that are required and that is recognized in the relevant professional community. This Clause should also list any alternate titles that may be included with the title and any alternate titles that are explicitly excluded from the certification;

4.2 a list of the tasks that the software engineering professional described in the title would be expected to undertake;

4.3 a description of the level of accountability, responsibility, autonomy, authority and complexity of the work associated with this title;

4.4 a description of the competences appropriate for the title, expressed in terms of the body of knowledge, cognitive levels, skills, and performance levels (See Clause 5);

4.5 any minimum educational qualification or experience;

4.6 a description of how the competences are evaluated (See Clause 6);

4.7 details of any delegations to a qualification body (See Clause 7);

4.8 a description of the codes of ethics and professional practices required (See Clause 8);

4.9 a description of how the certification is maintained and renewed (See Clause 9);

4.10 any other information that will assist the relevant professional community in identifying the software engineering professionals to whom the certification applies.

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5 Knowledge and skills

5.1 Body of knowledge

The evaluation component of the Scheme shall be based on a body of knowledge. For each component (Clauses 5.1.1 to 5.1.4) of this body of knowledge, the scheme shall state the cognitive level expected of a successful candidate for certification. Where the Scheme includes a body of knowledge other than SWEBOK it should identify the source and authority of that body of knowledge.

NOTE The Scheme should describe processes for maintaining currency and relevance of the body of knowledge.

5.1.1 Software engineering body of knowledge

The software engineering component of the body of knowledge required by Clause 5.1 shall be identified and mapped to Chapters 2 to 11 of ISO/IEC TR 19759:2005 [1].

NOTE It is not the intent of this International Standard to restrict in any way the freedom of academics or others to develop courses or certification schemes based on what they feel is appropriate. The use of SWEBOK is included only to provide a common reference point for comparison.

5.1.2 Other technical knowledge requirements

If the certification body has determined that the statement of job capabilities/requirements warrants the inclusion of technical knowledge requirements not listed in Clause 5.1.1, the Scheme shall also identify those requirements.

5.1.3 Knowledge of appropriate standards

The statement of job capabilities/requirements referred to in Clause 4.2 identifies standards that may be applicable. The Scheme shall include these standards.

5.1.4 Domain knowledge

If the software engineering professional is to operate in a particular industry or product domain, the Scheme shall identify any appropriate knowledge requirements.

5.2 Cognitive levels

For each knowledge component described in Clause 5.1, the breadth and depth of the knowledge required shall be expressed in terms of a taxonomy of cognitive and knowledge processing levels.

5.3 Skills

5.3.1 Software engineering skills

The evaluation component of the Scheme shall include the skills required by a software engineering professional.

5.3.2 Generic professional skills

The Scheme shall identify those generic professional skills expected of a professional in the environment in which the candidate will operate.

At a minimum, those skills shall include the following:

a) the ability to apply the knowledge and skills of software engineering in a larger systems context;

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b) the ability to communicate effectively;

c) the ability to identify, formulate and solve problems;

d) the ability to function effectively as an individual and in a team;

e) the ability to evaluate the probable social, commercial, cultural, ethnic and environmental consequences of a software engineering professional's work.

5.4 Performance levels

The Scheme shall identify appropriate performance levels for the required skills described in Clause 5.3.

6 Evaluation of competence

The certification body shall consolidate the information described in Clause 5 into a set of competences that are required for the certified software engineering professional.

6.1 The Scheme shall explain how each competence can be attained or mastered. Competences are often attained through training, education and/or experience, but there are some competences that can only be attained through experience.

6.2 The Scheme shall define which competences are to be treated and how each treated competence is to be demonstrated and evaluated. Possible modes of evaluation include examination, referee reports, interview, and employer assessment.

6.3 The Scheme shall include procedures for handling candidates in the case of changing competence requirements.

7 Delegation

7.1 Where a certification body relies on an external organization to determine qualification it shall document its accreditation and/or quality control processes within the scheme.

7.2 A certification body may only delegate its evaluation of competence to a qualification body that complies with Clauses 4.1 to 4.6, 5 and 6 of this International Standard.

8 Code of ethics and professional practice

8.1 The Scheme shall include a code of professional behavior including a code of ethics and accepted standards and practices for the software engineering professional. The code of ethics must outline the moral principles and ideals of a good software engineering professional, and the commitment requirement for each professional covered by the Scheme.

8.2 Although ethics is always potentially subject to dispute, and varies between cultures, this International Standard provides a specific set of matters that should be included in any code of ethics for software engineering professionals. These include descriptions of the minimum standards of conduct and occupational ideals that guide the actions of software engineering professionals, the goals of the software engineering profession, and the rights and duties of software engineering professionals with respect to the public, employers, peers, and clients.

8.3 The code of ethics could include the following:

a) an assertion that the software engineering professional shall obey the just and reasonable laws of the community in which they operate;

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b) a commitment to the principle of individual autonomy, comprising freedom of action and action in the workplace;

c) a commitment to non-discrimination on any basis other than merit;

d) treat competitors and suppliers respectfully and honestly;

e) exercise care to avoid conflicts of interest or appearance of conflicts of interest;

f) a commitment to obeying the just and reasonable rules and regulations of the certifying body, including codes of ethics and practice;

g) an integrity statement, asserting that the software engineering professional will tell the truth and do what they say they will do;

h) a commitment that a software engineering professional will only undertake work they are competent to undertake;

i) a commitment that a software engineering professional will undertake their work conscientiously, striving for efficiency and effectiveness;

j) a commitment to build one's professional reputation based on merit;

k) a commitment to continuous professional development and currency of competences;

l) a commitment to report any failure to meet the standards established by the certifying body;

m) a commitment to the complaint and discipline process (see Clause 8.5).

8.4 The Scheme shall include a statement outlining the extent to which the code of ethics contains principles consistent with those listed in Clause 8.3.

8.5 The Scheme shall include a statement on how compliance with the codes is or is not monitored.

9 Maintenance of certification

A certification scheme shall include requirements for maintaining and renewing certification.

9.1 Renewal of certification

9.1.1 The Scheme shall state the period of the certification and requirements for renewal.

9.1.2 The renewal process shall include a declaration by the software engineering professional that they have complied with all requirements of certification.

9.1.3 The renewal process shall require a recommitment to the codes of ethics and practice required by the Scheme.

9.2 Continuing professional development

The Scheme shall include:

9.2.1 a requirement for continuing professional development appropriate to the titles that are certified, including the number of hours required;

9.2.2 a justification for the continuing professional development requirement, especially in relation to any risks that the requirement is designed to minimize;

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9.2.3 a description of how changes to the requirements for certification are applied to persons already certified under the scheme;

9.2.4 a description of how compliance with the continuing professional development requirement is monitored;

9.2.5 sanctions for non-compliance with the continuing professional development requirement.

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Bibliography

[1] ISO/IEC TR 19759:2005, *Software Engineering – Guide to the Software Engineering Body of Knowledge (SWEBOK)*

[2] Royal Academy of Engineering and British Computer Society: *The Challenges of Complex IT Projects*, 2004.

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