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Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE): cloud services —

Part 1: Quality model

Ingénierie des systèmes et du logiciel — Exigences de qualité et évaluation des systèmes et du logiciel (SQuaRE): services en nuage —

Partie 1: Modèles de qualité

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Foreword

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

A list of all parts in the ISO/IEC TS 25052 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

In the SQuaRE series, there are well-defined quality models for measuring and evaluating system and software products, IT services, data, etc. Although the SQuaRE series provides practical quality models, it does not fit new technologies well. To support the evaluation of new technologies, this document provides the quality model of cloud services, which is the extension to the quality models defined in ISO/IEC 2501n. In order to provide a practical guideline for quality evaluation of cloud services, this document has reflected special considerations on cloud computing, which are key characteristics, and cross-cutting aspects described in ISO/IEC 17788, and service level agreement (SLA) framework described in ISO/IEC 19086 (all parts).

Compared to the information and communication technology (ICT) systems, cloud computing has different characteristics. The followings are the key characteristics of cloud computing described in ISO/IEC 17788.

— Broad network access: physical or virtual resources are available when needed through the network using a variety of client devices.

— Measured service: resources are measured and paid for on a usage basis.

— Multi-tenancy: physical and virtual resources are allocated to multiple tenants, and their computations and data are isolated, therefore inaccessible from one another.

— On-demand self-service: cloud services are provisioned by cloud service customers automatically or with minimal interaction with cloud service providers.

— Rapid elasticity and scalability: resources are increased or decreased rapidly and elastically, and scalable horizontally and vertically.

— Resource pooling: physical or virtual resources are aggregated to provide services to one or more cloud service customers.

The quality model in this document is to support the non-functional specification and evaluation of cloud services from different perspectives by those associated with cloud service selection, requirements analysis, development, use, evaluation, support, maintenance, quality assurance and control, and audit.

For example, activities during cloud service selection that can benefit from the use of the quality model include:

— identifying cloud services requirements;

— establishing cloud service selection criteria;

— defining service coverage and service objectives;

— establishing service level agreements;

— establishing measures of quality characteristics in support of these activities.

Activities during cloud service development that can benefit from the use of the quality model include:

— identifying cloud service requirements;

— validating comprehensiveness of requirement definitions;

— identifying cloud service design objectives;

— identifying cloud service testing objectives;

— identifying quality control criteria as part of quality assurance;

— identifying acceptance criteria for a cloud service;

— establishing measures of quality characteristics in support of these activities.

Figure 1 (adapted from ISO/IEC 25000) illustrates the organization of the SQuaRE series representing families of standards, further called divisions. This document belongs to extension division 25050 to 25099.

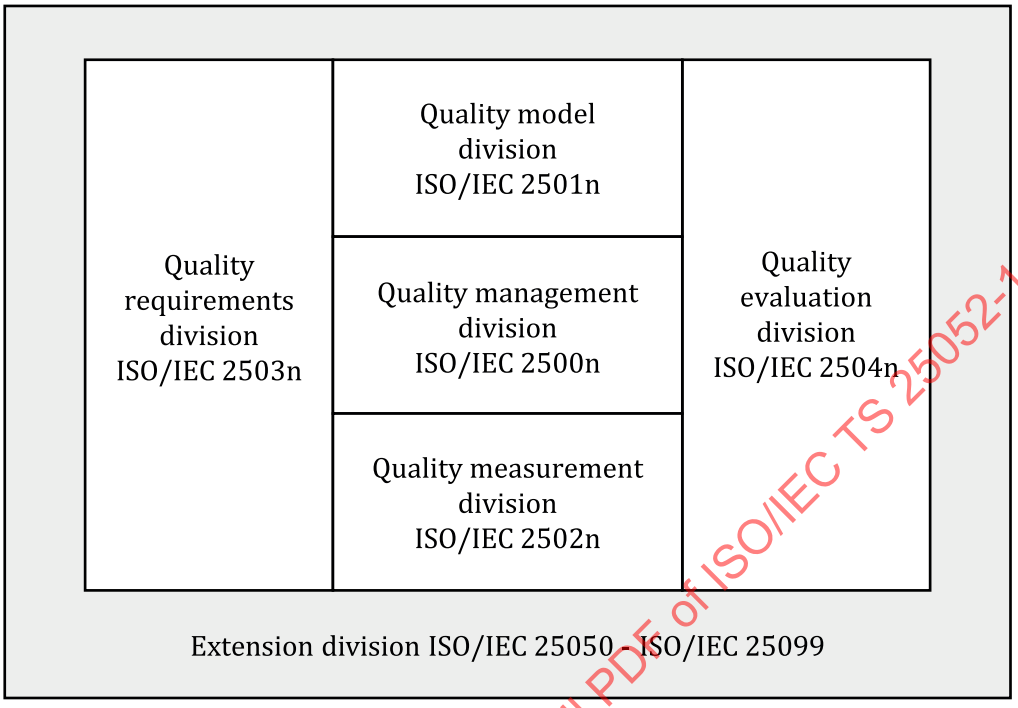

Figure 1 — Organization of the SQuaRE series of International Standards

The divisions within the SQuaRE series are:

— **ISO/IEC 2500n - Quality management division.** The International Standards that form this division define all common models, terms and definitions further referred to by all other International Standards from the SQuaRE series. The division also provides requirements and guidance for a supporting function that is responsible for the management of the requirements, specification and evaluation of software product quality.

— **ISO/IEC 2501n - Quality model division.** The International Standards that form this division present detailed quality models for computer systems and software products, quality in use, and data. Practical guidance on the use of the quality models is also provided.

— **ISO/IEC 2502n - Quality measurement division.** The International Standards that form this division include a quality model framework, mathematical definitions of quality measures, and practical guidance for their application. Examples are given of quality measures for software quality, and measures for quality in use. Quality measure elements (QME) forming foundations for these measures are defined and presented.

— **ISO/IEC 2503n - Quality requirements division.** The International Standards that form this division help specify quality requirements, based on quality models and quality measures. These quality requirements can be used in the process of quality requirements elicitation for a software product to be developed or as input for an evaluation process.

— **ISO/IEC 2504n - Quality evaluation division.** The International Standards that form this division provide requirements, recommendations and guidelines for software product evaluation, which are performed by evaluators, acquirers or developers. The support for documenting a measure as an evaluation module is also presented.

— **ISO/IEC 25050 to ISO/IEC 25099 - SQuaRE extension division.** This division includes International Standards specifying requirements for quality of ready to use software product and common industry formats for usability reports, as well as this document.

Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE): cloud services —

Part 1: Quality model

1 Scope

This document defines the quality model of cloud services.

The quality model of cloud services is composed of nine characteristics (some of which are further subdivided into subcharacteristics), which provide consistent terminology for specifying, measuring and evaluating cloud services so that the stakeholders, cloud service customer (CSC), cloud service provider (CSP) and cloud service partner (CSN) have a common understanding.

Since the quality model in this document is the extension to the existing quality models defined in ISO/IEC 2501n, it can be used with the product quality model, IT service quality model, data quality model, and quality-in-use model according to evaluation purposes. As there are several cloud service categories, this document focuses on the quality model of SaaS (Software as a Service).

NOTE Future documents are intended to address PaaS (Platform as a Service) and IaaS (Infrastructure as a Service).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 25000, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Guide to SQuaRE*

ISO/IEC 22123-1, *Information technology — Cloud computing — Part 1: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 25000, ISO/IEC 22123-1, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Quality model of cloud services

3.1.1
service performance efficiency
degree to which a cloud service meets performance requirements under stated conditions

3.1.1.1
time-behaviour
degree to which a cloud service meets the requirements of the response times and throughput rates of a cloud service, when concurrent users take advantage of the cloud service

[SOURCE: ISO/IEC 25010:2011, 4.2.2.1, modified — "a cloud service meets the requirements of" has been added, "a product or system" has been replaced by "a cloud service" and "when performing its functions, meet requirements" by "when concurrent users take advantage of the cloud service"]

3.1.1.2
aggregated resource utilization
degree to which a cloud service utilizes efficiently aggregated resources from resource pooling in order to support multi-tenancy

Note 1 to entry: Resource pooling is the feature where physical or virtual resources can be aggregated to provide a cloud service to one or more cloud service customers.

Note 2 to entry: Resources include CPU, memory, disk and network.

3.1.1.3
capacity
degree to which the maximum limits of a cloud service's parameters meet requirements in SLA (Service Level Agreement)

Note 1 to entry: Parameters can include the limit of simultaneous cloud service connections, the limit of available cloud service resources, cloud service throughput and cloud service bandwidth.

[SOURCE: ISO/IEC 25010:2011, 4.2.2.3, modified — "a product or system parameter" has been replaced by "a cloud service's parameters" and "in SLA (Service Level Agreement)" has been added]

3.1.1.4
scalability
degree to which physical and virtual resources are available automatically and immediately, when they are needed, subject to constraints of service agreements

3.1.1.5
elasticity
degree to which a cloud service adjusts rapidly and elastically the amount of resources that are allocated to an instance of the service

3.1.2
service compatibility
degree to which a cloud service can exchange information with CSC's systems or other cloud services and/or perform its required functions

[SOURCE: ISO/IEC 25010:2011, 4.2.3, modified- "a product, system or component" has been replaced by "a cloud service" and "other products, systems or components" by "CSC's systems or other cloud services", and "while sharing the same hardware or software environment" has been deleted.]

3.1.2.1
cloud interoperability
degree to which a cloud service interacts with CSC's systems, or interacts with other cloud services, by exchanging information according to a prescribed method to obtain predictable results

[SOURCE: ISO/IEC 22123-1: 2021, 3.7.2, modified — "ability of a CSC's system to interact with a cloud service, or the ability for one cloud service to interact" has been replaced by "degree to which a cloud service interacts with CSC's systems, or interacts"]

3.1.3
service usability
degree to which a cloud service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

[SOURCE: ISO/IEC 25010:2011, 4.2.4, modified — "a product or system" has been replaced by "a cloud service"]

3.1.3.1
accessibility
degree to which a cloud service can be accessed by a variety of client devices over a network through standard mechanisms

3.1.4
service reliability
degree to which a cloud service performs specified functions under specified conditions for a specified period of time

[SOURCE: ISO/IEC 25010:2011, 4.2.5, modified — "a system, product or component" has been replaced by "a cloud service"]

3.1.4.1
availability
degree to which a cloud service is accessible and usable upon demand by an authorized entity

[SOURCE: ISO/IEC 22123-1: 2021, 3.14.7, modified — "property of being" has been replaced by "degree to which a cloud service is"]

3.1.4.2
resilience
degree to which a cloud service recovers operational condition quickly after a fault occurs

[SOURCE: ISO/IEC 19086-1:2016, 3.19, modified — "ability of" has been replaced by "degree to which"]

3.1.4.3
recoverability
degree to which a cloud service supports its critical business functions to an acceptable level within a predetermined period of time following a disaster

[SOURCE: ISO/IEC 19086-1:2016, 3.7, modified — "ability of the ICT elements of an organization to support" has been replaced by "degree to which a cloud service supports"]

3.1.5
service security
degree to which a cloud service protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization

[SOURCE: ISO/IEC 25010:2011, 4.2.6, modified — "a product or system" has been replaced by "a cloud service"]

3.1.5.1
confidentiality
degree to which a cloud service ensures that data are accessible only to those authorized to have access

[SOURCE: ISO/IEC 25010:2011, 4.2.6.1, modified — "a product or system" has been replaced by "a cloud service"]

3.1.5.2
accountability
degree to which the actions of an entity can be traced back uniquely to the entity

[SOURCE: ISO/IEC 25010:2011, 4.2.6.4 — "back" has been added]

3.1.5.3
isolation
degree to which computations and data of a cloud service are isolated from and inaccessible to one another in the situation that physical and virtual resources are shared by multi-tenants

3.1.5.4
PII protection conformance
personally identifiable information protection conformance
degree to which a cloud service conforms to the standards, laws, or regulations applied to collection, processing and disposal of PII (personally identifiable information)

Note 1 to entry: The scope of PII is determined by laws or regulations of the country where a cloud service is provided. If privacy data, such as race, religion, and health, is considered PII, a cloud service needs to address compliance with relating laws or regulations to protect the privacy data.

3.1.5.5
security responsibility
degree to which the security responsibilities of both CSC and CSP are clearly defined and security incidents are detected and reported by either party

3.1.5.6
asset protection
degree to which a cloud service has processes to protect physical facilities used to provide the covered services from loss of data, connectivity and availability of necessary infrastructure and IT equipment, and to secure the covered services during operation

Note 1 to entry: Connections to cloud services should be protected, and therefore far less vulnerable to virus or other malware attacks. They should also be strong enough to withstand determined distributed denial of service (DDoS) attacks from hackers and botnets.

3.1.6
service maintainability
degree of effectiveness and efficiency with which a cloud service can be modified by the intended maintainers

Note 1 to entry: Modifications can include corrections, improvements or adaptation of a cloud service to changes in environment, and in requirements and functional specifications. Modifications include those carried out by specialized support staff, and those carried out by business or operational staff, or end users.

Note 2 to entry: Maintainability includes installation of updates and upgrades.

[SOURCE: ISO/IEC 25010:2011, 4.2.7, modified — "a product or system" has been replaced by "a cloud service"]

3.1.6.1
maintenance compliance and versioning
degree to which a cloud service provides maintenance according to the SLA, and a new version is assigned and published after maintenance

Note 1 to entry: Maintenance is the process of modifying a system or component after delivery to correct flaws, improve performance or other attributes, or adapt to a changed environment.

3.1.6.2
reversibility
degree to which a cloud service provides the process for the CSC to retrieve their data and application artifacts and for the CSP to delete all CSC data as well as contractually specified cloud service derived data after the agreed upon period

[SOURCE: ISO/IEC 22123-1:2021, 3.14.8, modified — "degree to which a cloud service provides" is added and "an agreed period" has been replaced by "the agreed upon period"]

3.1.6.3
monitorability
degree to which a cloud service provides monitoring parameters and tools to monitor the performance of the service

3.1.7
portability
degree of a cloud service provides the ability to move data and migrate applications from one cloud service to another

3.1.7.1
cloud data portability
degree to which a cloud service provides the ability to move their data from one cloud service to another

[SOURCE: ISO/IEC 22123-1:2021, 3.9.3, modified — "data portability" has been deleted, and "degree to which a cloud service provides the ability to move their data" has been added]

3.1.7.2
cloud application portability
degree to which a cloud service provides the ability to migrate their applications from one cloud service to another

[SOURCE: ISO/IEC 22123-1:2021, 3.9.1, modified — "degree to which a cloud service provides" has been added]

3.1.8
service provisionability
degree to which a cloud service is provisioned by the CSC, as needed, automatically or with minimal interaction with the CSP

3.1.8.1
service measurability
degree to which a cloud service provides metered delivery of cloud services such that usage can be monitored, controlled, reported and billed

[SOURCE: ISO/IEC 22123-1:2021, 3.5.1, modified — "degree to which a cloud service provides" has been added]

3.1.8.2
auditability
degree to which a cloud service collects and provides available necessary evidential information related to the operation and use of a cloud service for the purpose of conducting an audit

[SOURCE: ISO/IEC 22123-1:2021, 3.14.11, modified — "capability of collecting and making" has been replaced by "degree to which a cloud service collects and provides"]

3.1.8.3
governability
degree to which the provision and use of a cloud service is directed and controlled by a system, and which the cloud service complies with the regulations applied in the countries where the cloud service is used

3.1.8.4
self-provisioning
degree to which a cloud service supports on-demand self-service

3.1.8.5
SLA information completeness
service level agreement information completeness
degree to which SLA include the essential information required to set up the quality level of the cloud services

Note 1 to entry: The essential information includes covered services, SLO (service level objectives) and SQO (service qualitative objectives).

3.1.8.6
SLA satisfaction
service level agreement satisfaction
degree to which a cloud service satisfies the cloud SLOs and SQOs specified in SLA

3.1.9
service responsiveness
degree to which a cloud service responds to CSC requests and provides outcomes in a prompt and timely way

[SOURCE: ISO/IEC TS 25011:2017, 3.2.6, modified — "an IT service" has been replaced by "a cloud service", and "to CSC request" has been added]

3.1.9.1
service supportiveness
degree to which a cloud service supports CSC activities according to the service support scope specified in SLA

3.1.9.2
reactiveness
degree to which a cloud service promptly responds to user requests

[SOURCE: ISO/IEC TS 25011:2017, 3.2.6.2, modified — "an IT service" has been replaced by "a cloud service"]

3.1.9.3
continuity
degree to which a cloud service is provided under all foreseeable circumstances, including mitigating the risks resulting from interruption to an acceptable level

[SOURCE: ISO/IEC TS 25011:2017, 3.2.4.1, modified — "an IT service" has been replaced by "a cloud service"]

3.2 Terms relating to software quality

3.2.1
software quality
capability of a software product to satisfy stated and implied needs when used under specified conditions

[SOURCE: ISO/IEC 25000:2014 4.33]

3.2.2
quality model
defined set of characteristics, and of relationships between them, which provides a framework for specifying quality requirements and evaluating quality

[SOURCE: ISO/IEC 25000:2014 4.27]

3.2.3
cloud service quality characteristic
category of cloud service quality attributes that bears on cloud quality

Note 1 to entry: Cloud service quality characteristics may be refined into multiple levels of subcharacteristics and finally into cloud service quality attributes.

[SOURCE: ISO/IEC 25000:2014 4.34, modified — "software" has been replaced by "cloud service"]

3.2.4
measure
variable to which a value is assigned as the result of measurement

Note 1 to entry: The term “measures” is used to refer collectively to base measures, derived measures, and indicators.

[SOURCE: ISO/IEC 25000:2014 4.18]

3.2.5
measurement
set of operations having the object of determining a value of a measure

[SOURCE: ISO/IEC 25000:2014 4.20]

3.3 Terms relating to cloud computing

3.3.1
cloud computing
paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand

Note 1 to entry: Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

[SOURCE: ISO/IEC 22123-1:2021 3.2.1]

3.3.2
cloud service
one or more capabilities offered via cloud computing invoked using a defined interface

[SOURCE: ISO/IEC 22123-1:2021 3.2.2]

3.3.3
cloud service customer
party which is in a business relationship for the purpose of using cloud services

Note 1 to entry: A business relationship does not necessarily imply financial agreements.

[SOURCE: ISO/IEC 22123-1:2021 3.4.2]

3.3.4
cloud service provider
party which makes cloud services available

[SOURCE: ISO/IEC 22123-1: 2021 3.4.3]

3.3.5
cloud service partner
party which is engaged in support of, or auxiliary to, activities of either the cloud service provider or the cloud service customer, or both

[SOURCE: ISO/IEC 22123-1:2021 3.4.5]

3.3.6
service level agreement
SLA
documented agreement between the service provider and customer that identifies services and service targets

Note 1 to entry: SLA can also be established between the service provider and a supplier, an internal group or a customer acting as a supplier.

Note 2 to entry: SLA can be included in a contract or another type of documented agreement.

[SOURCE: ISO/IEC 22123-1:2021 3.8.1]

3.3.7
cloud service qualitative objective
cloud SQO
commitment a cloud service provider makes for a specific, qualitative characteristic of a cloud service, where the value follows the nominal scale or ordinal scale

Note 1 to entry: A cloud service qualitative objective may be expressed as an enumerated list.

Note 2 to entry: Qualitative characteristics typically require human interpretation.

Note 3 to entry: The ordinal scale allows for existence/nonexistence.

[SOURCE: ISO/IEC 22123-1:2021 3.8.5]

3.3.8
cloud service level objective
cloud SLO
commitment a cloud service provider makes for a specific, quantitative characteristic of a cloud service, where the value follows the interval scale or ratio scale

Note 1 to entry: An SLO commitment may be expressed as a range.

[SOURCE: ISO/IEC 22123-1: 2021 3.8.7]

3.3.9
cloud service agreement
documented agreement between the cloud service provider and cloud service customer that governs the covered cloud service(s)

Note 1 to entry: A cloud service agreement can consist of one or more parts recorded in one or more documents.

[SOURCE: ISO/IEC 22123-1: 2021 3.8.8]

3.3.10
personally identifiable information
PII
any information that (a) can be used to identify the PII principal to whom such information relates, or (b) is or might be directly or indirectly linked to a PII principal

Note 1 to entry: To determine whether a PII principal is identifiable, account should be taken of all the means which can reasonably be used by the privacy stakeholder holding the data, or by any other party, to identify that natural person.

[SOURCE: ISO/IEC 29100:2011, 2.9]

4 Abbreviated terms

CSC	Cloud service customer
CSP	Cloud service provider
CSN	Cloud service partner
SLA	Service level agreement
SaaS	Software as a Service
PaaS	Platform as a Service
IaaS	Infrastructure as a Service
PII	Personally identifiable information

5 Quality model framework

5.1 Overview

There are four quality models in the quality model division of SQuaRE series which provide a set of quality characteristics and sub-characteristics:

a) the product quality model in ISO/IEC 25010;

b) the IT service quality model ISO/IEC TS 25011;

c) the data quality model in ISO/IEC 25012;

d) the quality in use model in ISO/IEC 25010.

As an extension to these four quality models, this document defines the quality model of cloud services. As shown in Figure 2, the quality model in this document consists of modified subcharacteristics which are derived from ISO/IEC 25010 and ISO/IEC TS 25011, and newly added subcharacteristics which are derived from the key characteristics and cross-cutting aspects described in ISO/IEC 17788, and service level agreement (SLA) framework described in ISO/IEC 19086.

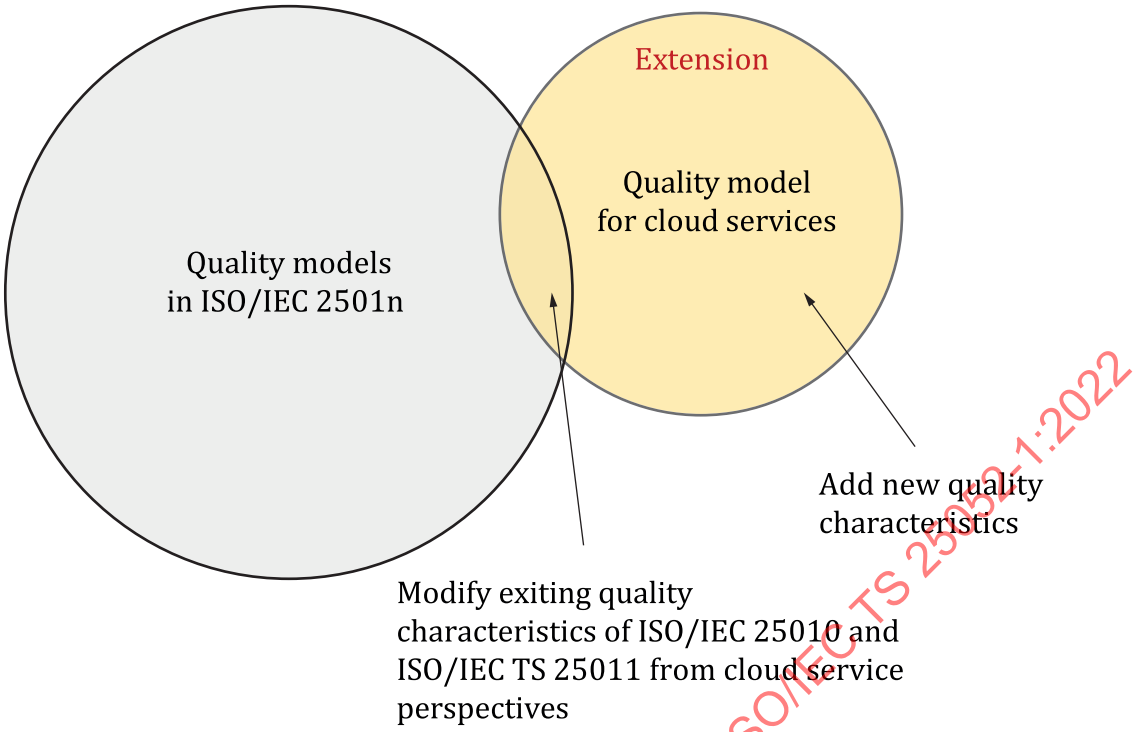

Figure 2 — Relationship between the quality models in ISO/IEC 2501n and quality model of cloud services

Annex A shows the original source of characteristics of the quality model of cloud services.

ISO/IEC 17788 describes the key characteristics and cross-cutting aspects of cloud computing. The key characteristics of cloud computing are broad network access, measured service, multi-tenancy, on-demand self-service, rapid elasticity and scalability, and resource pooling. The cross-cutting aspects of cloud computing as architectural and operational considerations are auditability, availability, governance, interoperability, maintenance and versioning, performance, portability, protection of PII (personally identifiable information), regulatory, resiliency, reversibility, security, and service levels and service level agreement. The key characteristics and cross-cutting aspects of cloud computing can be regarded as quality considerations, so they have been reflected in the quality models defined in this document.

The SLA framework in ISO/IEC 19086 consists of SLO (service level objectives) and SQO (service qualitative objectives). As quality goals to be achieved, SLO and SQO should be considered during measurement. For this reason, new sub-characteristics are added to the model based on SLO and SQO. The additions are monitorability, reversibility, governability, SLA information completeness, PII protection conformance, asset protection, and service supportiveness.

5.2 Relationships between quality model of cloud services and other quality models

Figure 3 shows the relationships between the quality model of cloud services and other quality models in ISO/IEC 2501n. As the extension to the four quality models in ISO/IEC 2501n, the quality model in this document covers the quality characteristics and subcharacteristics of cloud services provided via cloud computing.

Since cloud services provide one or more capabilities as a service, the scope of evaluation can be extended to their capabilities as well as the service provided by the CSP according to the evaluation purposes. In that case, it is recommended to use the product quality model defined in ISO/IEC 25010 and data quality model defined in ISO/IEC 25012 in conjunction with the quality model described in this document.

When there are no appropriate applications provided by the CSP, or a hybrid cloud is required for the CSC, the CSN is engaged in support of these CSC's activities. In these cases, cloud service developer, as one of the sub-roles of the CSN, plays an important role because they compose existing services or implement new service components according to the CSC requirements. For this reason, the quality of the CSN's artefacts including software applications should also be evaluated, as well as the quality of the service the CSN provides. In this case, it is recommended to use both the product quality model in ISO/IEC 25010 and IT service model in ISO/IEC TS 25011 in conjunction with the quality model in this document.

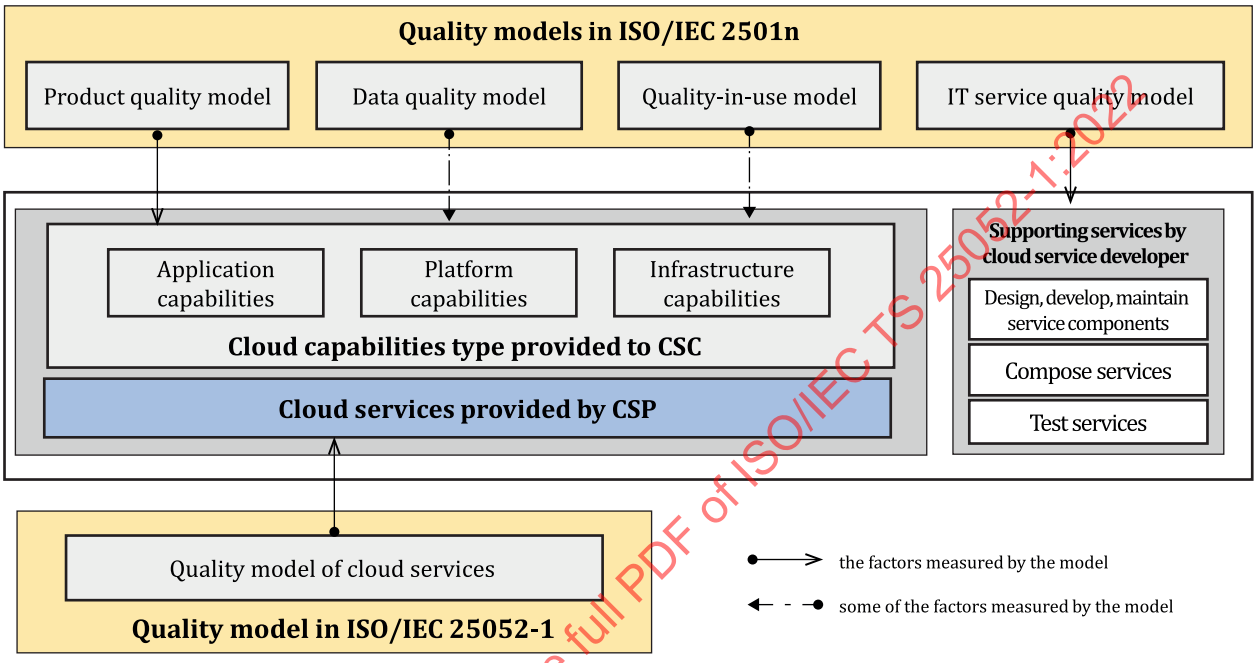

Figure 3 — Relationships between quality model of cloud services and other quality models

5.3 Quality model of cloud services

The quality of cloud services is the degree to which the properties of cloud services can satisfy stated and implied needs when used under specified conditions.

The quality model of cloud services shown in Figure 4 categorizes the quality properties of cloud services into nine characteristics: service performance efficiency, service compatibility, service usability, service reliability, service security, service maintainability, portability, service provisionability, and service responsiveness.