Approach to Develop Quality Model of Cloud Services

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***Abstract*— SQuaRE Series provides practical quality models for system and software products. However, it does not fit completely with aspects of new technologies. There are unique characteristics of cloud services, so we need special considerations when measuring and evaluating them. Therefore, a new project for standardization has started to develop a quality model and measures that guide the quality evaluation of cloud services. In this paper, we would like to share the approach we used to define the quality model for cloud services.**

Keywords—SQuaRE, cloud computing, standardization, SaaS, quality model

I. INTRODUCTION

ISO/IEC JTC1/SC7 is the international standardization organization responsible for standardizing software and systems engineering, which consists of 13 working groups and 5 ad-hoc groups. WG6, Working Group 6, is in charge of software product measurement and evaluation. The standards developed by WG6 are named as SQuaRE (Software product Quality Requirements and Evaluation).

SQuaRE Series provides practical quality models for system and software products. However, it does not fit completely with aspects of new technologies. There are unique characteristics of cloud services, so we need special considerations when measuring and evaluating them. Even though SC38, responsible for the standardization of cloud computing, has developed many standards for cloud computing, there is no standard for quality evaluation. It is the reason why SC7/WG6 started a new project to develop a quality model and measures that guide the quality evaluation of cloud services.

Because it is the first time to apply the existing quality models to new technology, it is important to decide how to define the new model based on the existing models. It was also important to consider alignment with standards for cloud services. With these considerations, we proposed a methodology to defining a quality model for cloud services. In this paper, we would like to share the approach we has proposed to define the quality model for cloud services.

II. WHAT IS QUALITY AND QUALITY MODELS?

A. Definition and Concepts

ISO/IEC 25000 of SQuaRE Series provides quality models as a defined set of quality characteristics. It provides a good framework when specifying requirements and evaluating software quality. Quality characteristic is a category of attributes relevant to software quality.

Systems and software products have eight quality characteristics that are functional suitability, performance efficiency, compatibility, usability and so on[1]. Each quality characteristic is divided into sub-characteristics. A set of quality characteristics is named as Quality Model. Figure 1 shows the structure of Quality Model.

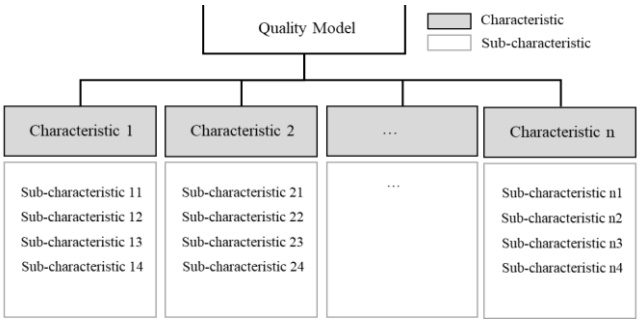

FIGURE 1. QUALITY MODEL STRUCTURE

A set of quality measures is defined in ISO/IEC 2502n which can be used to evaluate quality characteristics[2]. ISO/IEC 2502n refers to 25021, 25022, 25023, 25024 and 25025. For example, sub-characteristic 'functional correctness' has a measure 'functional correctness'.

Measurement is an activity of determining a quality value against a software product based on quality model. After measurement, we can get objective values.

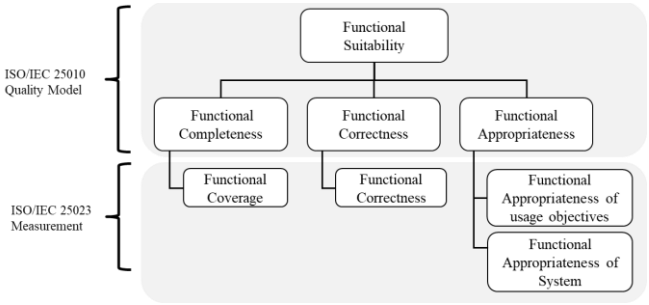

FIGURE 2. RELATIONSHIP BETWEEN QUALITY MODEL AND MEASUREMENT

Table I shows the example of measures, defined in ISO/IEC 25023, which consists of a name, description, measurement function and so on[3].

TABLE I. FUNCTIONAL CORRECTNESS MEASURE DEFINED IN ISO/IEC 25023

ID	Name	Description	Measurement function
FCr-1-G	Functional Correctness	What proportion of functions provides the correct results?	X = 1-A/B A = Number of functions that are incorrect B= Number of functions considered

B. SC7/WG6 Standards

Table II shows International Standards and Technical Specification developed by SC7/WG6. SC7/WG6 name these standards as SQuaRE (Software product Quality Requirements and Evaluation). There are five divisions that are 1) Product Quality General, 2) Quality Model, 3) Quality Measurement, 4) Quality Requirements and 5) Evaluation.

Until now, four quality models have been developed. ISO/IEC 25010[1] defines two quality models of system & software products, ISO/IEC 25011[4] defines the IT service quality model and ISO/IEC 25012 [5] defines the data quality model.

TABLE II. SC7/WG6 STANDARDS (NAMED SQUARE SERIES)

Standard #	Name of Standards	Division
ISO/IEC 25000	Guide to SQuaRE	Product Quality General
ISO/IEC 25001	Planning and Management	
ISO/IEC 25010	System and Software Quality Models	Quality Model
ISO/IEC TS 25011	IT Service Quality Model	
ISO/IEC 25012	Data Quality Model	
ISO/IEC 25020	Measurement Reference Model	Quality Measurement
ISO/IEC 25022	Measurement of Quality in Use	
ISO/IEC 25023	Measurement of Sys. & SWP Quality	
ISO/IEC 25024	Measurement of Data Quality	
ISO/IEC TS 25025	Measurement of IT Service Quality (TS)	
ISO/IEC 25030	Quality Requirement	Quality Requirement
ISO/IEC 25040	Quality Evaluation Process	Evaluation
ISO/IEC 25041	Evaluation Guide for Developers, Acquirers and Independent Evaluators	
ISO/IEC 25045	Evaluation Module for Recoverability	

III. DEVELOPMENT APPROACH

In SQuaRE Series, there are well-defined quality models for measuring and evaluating system & software products, IT service, data, and so on. To define the quality model of cloud services, we can first use the existing models and then add new quality characteristics based on SC38 standards.

Figure 3 shows the methodology to develop the quality model of cloud services. To define the quality model, we propose to take the following steps for the quality model development.

- Step 1) Select quality characteristics from the existing quality models of SQuaRE Series
- Step 2) Suggest new quality sub-characteristics based on SC38 standards
- Step 3) Classify the sub-characteristics into appropriate characteristics

After the quality model is defined, the next steps to develop quality measures and a guideline are as follows:

- Step 4) Select appropriate quality measures from the existing measurement standards
- Step 5) Add new measures for the newly defined characteristics
- Step 6) Provide the guideline for the model and measurement standards

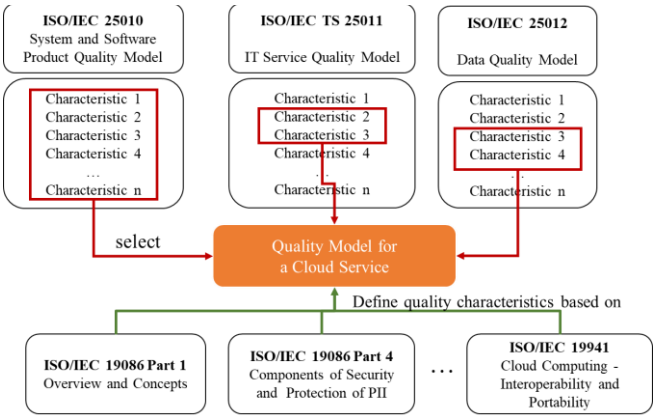

FIGURE 3. APPROACH TO DEVELOP THE QUALITY MODEL OF CLOUD SERVICES

IV. QUALITY MODEL DEVELOPMENT OF CLOUD SERVICES

In this chapter, we describe in detail the three steps to define the quality model.

A. (Step 1) Selecting Sub-characteristics from Existing Quality Models for Cloud Services Provided by CSP

1) Application of Product Quality Model

Since CSP(Cloud Service Provider) provides a software, platform and infrastructure as a service, cloud services provided by CSP can be evaluated by system and software product quality model, called 'product quality model', defined in ISO/IEC 25010 [1].

As explained earlier, the product quality model is applicable to both computer systems and software products. The computer system includes computer hardware, software and data, not communication systems. With the cloud computing point of view, we can interpret the computer system and software products as infrastructure, platform and application provided by CSP. For this reason, we can apply this model to cloud services.

2) Application of IT Services Quality Model

There are two types of IT services which are defined in ISO/IEC TS 25011 [4]:

- Services completely automated provided by an IT system (type a)
- Services provided by a human using an IT system (type b)

According to the types of IT services, cloud services provided by CSP are highly related to 'type a' because they have the following characteristics:

- CSC(Cloud Service Customer) provisions computing capabilities automatically or with minimal interaction with CSP
- One or more capabilities offered via cloud computing invoked using a defined interface. In other words, the capabilities are offered with minimal interaction

As well as type a), we also should consider type b) in some sense, because there are sub-roles of CSP, customer support and care representative that provide customer services to CSC. For this reason, we can partially apply the IT service quality model.

There are similar sub-characteristics between the product quality model and IT service quality model. For this case, we suppose that the product quality model takes precedent over the service model because CSP provides the services by using the existing functions rather than implementing new components. That is why the yellow circle is in front of the rectangle and triangle in Figure 4. Because we partially apply the IT service quality model, the partial blue rectangle is used for defining quality model of cloud services.

Because the product and data quality model can be fully applied, a full circle and triangle are used in Figure 4. Figure 5 shows SQuaRE view of the quality model development approach.

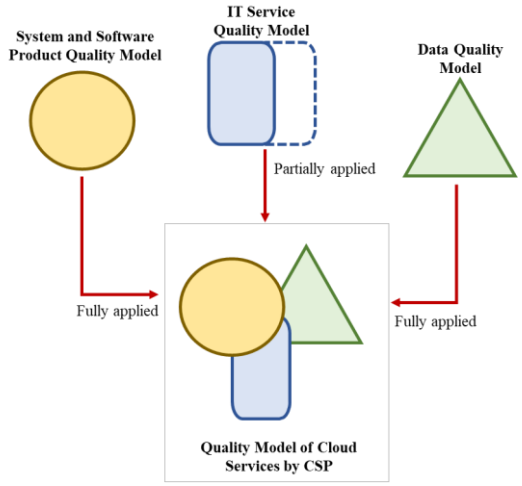

FIGURE 4. QUALITY MODEL DEVELOPMENT APPROACH OF CLOUD SERVICES BY CSP

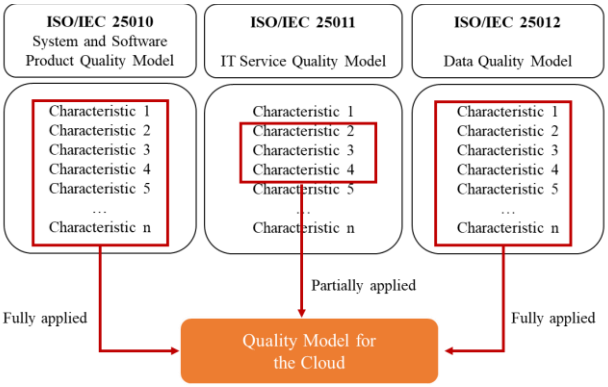

FIGURE 5. QUALITY MODEL DEVELOPMENT APPROACH OF CLOUD SERVICES BY CSP WITH SQUARE VIEW

3) Application of Data Quality Model

Although quality characteristics for data are implicitly connected to the product quality model, data quality model has been defined to complement the product quality model.

In case of system software such as operating systems, data quality is more crucial than application software. This is the reason why we should be concerned with the data quality for PaaS and IaaS because they handle data intensively. For this reason, we will apply the data quality model for PaaS and IaaS. In case of SaaS, it is enough to apply the product quality model without the data quality model. Figure 6 and 7 show the suggested application scope of the quality models of SaaS, PaaS and IaaS.

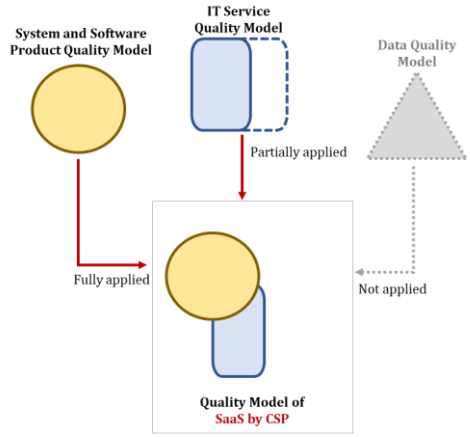

FIGURE 6. QUALITY MODEL OF SAAS BY CSP

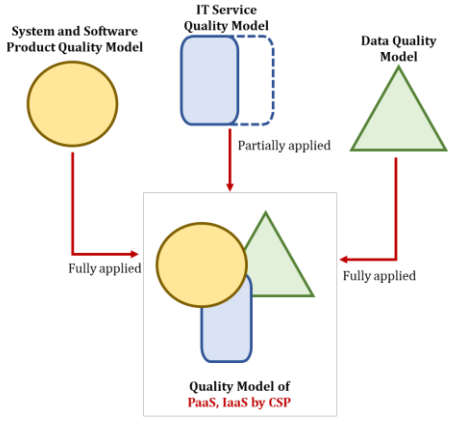

FIGURE 7. QUALITY MODEL OF PAAS AND IAAS BY CSP

B. (Step 2) Adding New Sub-characteristics based on SC38 Standards

For Step 2, we define new quality sub-characteristics by analyzing the following aspects of cloud computing that are specified in the standards of SC38 (See Figure 8).

- Key Characteristics of Cloud Computing described in ISO/IEC 22123-1 [6]
- Cross-Cutting Aspects of Cloud Computing described in ISO/IEC 17789 [7]
- Cloud Service Level Agreement (SLA) described in ISO/IEC 19086-1 [8], 19086-2 [9], 19806-3 [10] and 19086-4 [11]
- Interoperability and Portability described in ISO/IEC 19941 [12]
- Data Flow, Data Categories and Data Use described in ISO/IEC 19944 [13]

For example, one of the key characteristics of cloud computing is ‘measured service’ because CSC pays for cloud

services based on how much they use resources through measured service. To provide measured service, the resource usage should be monitored, controlled, reported, and billed. To evaluate this feature, we suggest the measured services as the new sub-characteristics.

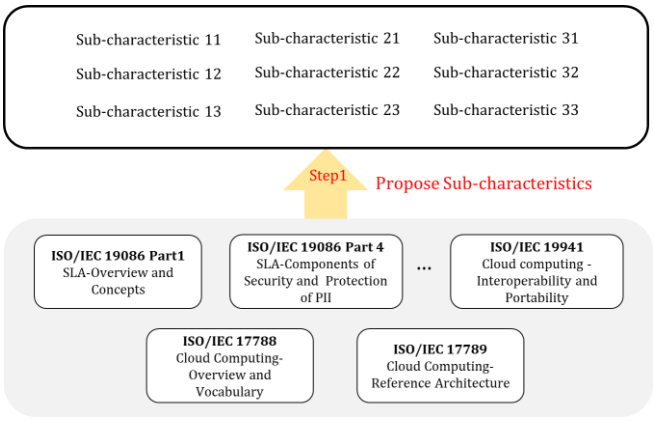

FIGURE 8. STEP 2 TO DEFINE THE QUALITY MODEL FOR CLOUD SERVICES

C. *(Step 3) Sub-characteristics Classification to Appropriate Characteristics*

In the previous chapter, we suggested the full set of quality sub-characteristics for CSP. In Step3, we classify the newly defined sub-characteristics into appropriate characteristics. If there is no appropriate characteristic, we propose the new one.

Figure 9 explains the key idea of sub-characteristics classification into the appropriate characteristics. After taking Step 3, we will have a quality model of cloud services provided by CSP.

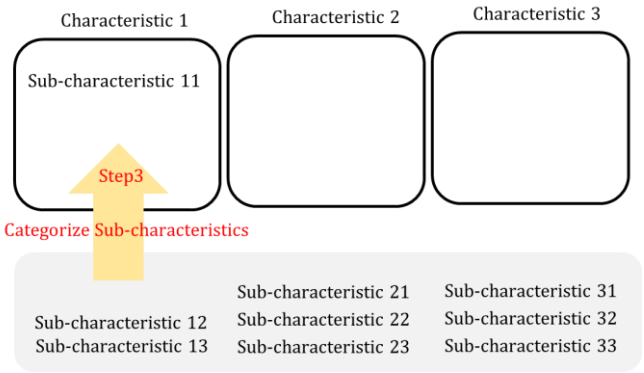

FIGURE 9. STEP 3 TO DEFINE THE QUALITY MODEL FOR CLOUD SERVICES

V. CONCLUSION AND FUTURE WORK

The SQuaRE standards provide a basis for evaluating systems and software products. However, since it does not fit well with the new technology. For this reason, this paper proposed an approach to develop the quality model of cloud services.

In this paper, we proposed three steps to develop a quality model of cloud services. As the first step, we selected the appropriate quality sub-characteristics from the existing quality models with consideration of the characteristics of cloud services. The second step reflects the characteristics of cloud services into the quality model, so we suggested how to define new quality sub-characteristics for cloud computing. Last step classifies the quality sub-characteristics into characteristics. To apply the existing quality model to cloud services, the second step is the most important in defining a cloud quality model. For this reason, we need to conduct further studies on which kinds of quality sub-characteristics should be included in the quality model of cloud services by analyzing the key aspects of cloud computing.

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