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Cloud computing — Service level agreement (SLA) framework

Part 2: Metric model

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Preface

This Standard was prepared by the Standards Australia Committee IT-038, Cloud Computing and Distributed Platforms.

The objective of this document is to establish common terminology, define a model for specifying metrics for cloud SLAs, and includes applications of the model with examples. This document establishes a common terminology and approach for specifying metrics.

This document is for the benefit of and use for both cloud service providers (CSPs) and cloud service customers (CSCs). This document is intended to complement AS ISO/IEC 19086.1, AS ISO/IEC 19086.3 and ISO/IEC 19086-4.

This document does not mandate the use of a specific set of metrics for cloud SLAs.

This document is identical with, and has been reproduced from, ISO/IEC 19086-2:2018, *Information technology — Cloud computing — Service level agreement (SLA) framework — Part 2: Metric model,* and its Amendment No. 1 (2023) which has been added at the end of the source text.

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The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC1, *Information technology*, Subcommittee SC 38, *Cloud Computing and Distributed Platforms*.

A list of all parts in the ISO 19086 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.

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Introduction

The measurement of properties of cloud services, especially for the purpose of cloud service level agreements (SLAs), presents many challenges, which inhibit the uptake of cloud services and inhibit the overall effectiveness of the cloud services marketplace. Metrics in practice are usually described using natural languages, typically in 'plain English', which is often difficult to understand, compare, and implement. Such definitions of metrics lead to many problems. Typical concerns include:

— **Clarity:** The metric definition may be incomplete, ambiguous, illogical, self-contradictory, or not defined at all. For example, cases exist where 'availability' is defined in ways which have little to do with generally accepted definitions of 'availability'; where the definition is such that the service can be unavailable for the majority of the time yet the metric will show 100 % availability; where the metric requires continuous monitoring, which is actually not possible; or where the provider is able to determine at its sole discretion what the result is.

— **Comparability:** It may be impractical or effectively impossible to compare different services in terms of their promised service levels because of the significant inconsistency in how their respective metrics and SLOs/SQOs are defined.

— **Implementation:** It may be impractical or even impossible to measure the metric in practice, and to determine whether promised service levels have been met or not.

This document has been developed to help address these and similar concerns. It includes technical content, but the high-level concepts are expected to be understandable by non-technical individuals who understand the business context for metrics. It provides a metric model that defines the conditions and rules for performing a measurement and understanding the result.

A metric complying with the model defined by this document addresses the concerns above:

— **Clarity:** A definition of a metric eliminates the ambiguities which currently exist in natural language descriptions.

— **Comparability:** The structured nature of the metric facilitates the comparison of different metrics and SLOs/SQOs based on a metric.

— **Implementation:** The structured representation of the information needed to measure a characteristic facilitates the process of developing measurement tools. Likewise, if the metric is found not to be implementable, then the metric will need to be revised so that it can be implemented, and the structure of the technical specification is expected to facilitate this revision process.

The focus of this document is on metrics for cloud SLAs, but it is also usable for cloud service metrics (CSMs) that are not included in cloud SLAs [such as ones used by cloud service providers (CSPs) for their internal performance monitoring], and may also be usable for non-CSMs.

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Cloud computing — Service level agreement (SLA) framework

Part 2: Metric model

1 Scope

This document establishes common terminology, defines a model for specifying metrics for cloud SLAs, and includes applications of the model with examples. This document establishes a common terminology and approach for specifying metrics.

This document is for the benefit of and use for both cloud service providers (CSPs) and cloud service customers (CSCs). This document is intended to complement ISO/IEC 19086-1, ISO/IEC 19086-3 and ISO/IEC 19086-4.

This document does not mandate the use of a specific set of metrics for cloud SLAs.

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 17788, | ITU-T Y.3500, *Information technology — Cloud computing — Overview and vocabulary*

ISO/IEC 19086-1, *Information technology — Cloud computing — Service level agreement (SLA) framework — Part 1: Overview and concepts*

W3C Recommendation 28 October 2004. *XML Schema Part 1: Structures Second Edition*. http://www.w3.org/TR/xmlschema-1/

W3C Recommendation 28 October 2004. *XML Schema Part 2: Datatypes Second Edition*. http://www.w3.org/TR/xmlschema-2/

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 17788 and the following definitions apply.

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

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

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

3.1
cloud service characteristic
qualitative or quantitative property of a cloud service

3.2
cloud service metric
metric (3.6) used to assess a *cloud service characteristic* (3.1)

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3.3
cloud service objective
SO
commitment a cloud service provider (CSP) makes for a specific characteristic of a cloud service

Note 1 to entry: The set of SOs is the union of the set of cloud service level objectives (SLOs) and the set of cloud service qualitative objectives (SQOs).

3.4
measurement
set of operations having the objective of determining a *measurement result* (3.5)

Note 1 to entry: Based on the definition of measurement in ISO/IEC/IEEE 15939:2017. Also used here to describe an actual instance of execution of these operations leading to the production of a measurement result instance.

3.5
measurement result
value that expresses a qualitative or quantitative assessment of a *cloud service characteristic* (3.1)

3.6
metric
standard of measurement that defines the conditions and the rules for performing the *measurement* (3.4) and for understanding the *measurement result* (3.5)

Note 1 to entry: The metric describes what the result of the measurement means, but not how the measurement implements the metric.

Note 2 to entry: A metric is to be applied in practice within a given context that requires specific properties to be measured, at a given time(s) for a specific objective.

Note 3 to entry: The metrics model proposed in this document supports the definition of composite metrics, which can be defined in terms of one or more underlying (reusable) metrics.

[SOURCE: ISO/IEC 19086-1:2016, 3.10, modified — Notes to entry have been modified.]

3.7
unit
real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the second quantity to the first one as a number

[SOURCE: ISO/IEC 80000-1:2009, modified — NOTES 1 to 5 have not been included.]

4 Symbols and abbreviated terms

CSA Cloud Service Agreement

CSC Cloud Service Customer

CSM Cloud Service Metric

CSP Cloud Service Provider

PII Personally Identifiable Information

SLA Service Level Agreement

SLO Cloud Service Level Objective

SO Cloud Service Objective

SQO Cloud Service Qualitative Objective

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5 Conformance

A metric specification is in conformance with this document when the specification of the metric uses the data-types and relationships described in Clause 8. If the XML namespace at http://standards.iso.org/iso-iec/19086/-2/ed-1/en is used for an XML document representing a metric, that document shall be valid per the schema in Annex D.

6 Metrics overview

6.1 General

This document describes metrics, metrics usage, and defines a model for the consistent specification of metrics for cloud SLAs. The underlying model and template is important for those defining metrics and implementing measurement systems based on specific metrics.

6.2 Background

Cloud computing is an integral part of IT, yet it is still difficult to define the properties and performance of a cloud service. A CSC purchases cloud services for one overarching reason – to achieve organization goals. To this end, it is important for a CSC to understand the properties of a cloud service, to understand the service capabilities for these properties, and to understand if it will meet the CSC's requirements necessary to achieve the CSC's organization goals. Likewise it is important to a CSP to be able to communicate the properties and performance of a cloud service so CSCs will be able to determine whether any given service meets their requirements.

Typical categories of cloud service characteristics that the CSC might be interested in include: performance, availability, information security, accessibility, cloud service support, termination of service, governance, service changes, service reliability, attestations/certifications, data management, and PII protection. A description of each along with associated SLOs/SQOs is included in ISO/IEC 19086-1 and ISO/IEC 19086-4.

The cloud procurement process may be split into three basic aspects:

a) selecting a cloud service that meets the CSC's requirements;

b) agreement (CSA, which includes the cloud SLA) between the CSP and the CSC on the properties and performance of the cloud service;

c) operational management, where the operation of the cloud service is monitored to ensure the service is operating within the constraints specified within the cloud SLA/CSA.

6.2.1 Choosing a cloud service

Currently, CSPs create their own methods to define the representation of a cloud service characteristic, and therefore influence the understanding of the characteristic itself. This makes comparing cloud service characteristics across CSPs (and sometimes within a CSP) difficult or impossible. The cloud service characteristics are often described using ambiguous text descriptions and are not only difficult to compare, but difficult to understand. This makes transferring a set of requirements into an agreement between the CSC and CSP difficult; resulting in an agreement that might not meet the needs of either party.

As described in ISO/IEC 19086-1, a commitment written into a cloud SLA takes the form of either an SLO or an SQO. SLOs are quantitative commitments for representations of cloud service characteristics, while SQOs are qualitative commitments for representations of cloud service characteristics.

A text description of availability might look something like:

— **Commitment**

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The cloud service will be available 99,9 % of the time in a given billing cycle. If we fail to meet this commitment, you will be eligible to receive a credit to your account.

— **Unavailability**

Unavailability means: a) The cloud service provides no response, or b) the cloud service returns a server error response to a valid user request during two or more consecutive one minute intervals, or c) the cloud service fails to deliver an average download time for a reference document of one second or less as measured by a third party. Unavailability due to ***scheduled maintenance*** is excluded from these conditions and does not contribute towards unavailability calculations.

This is a good example to consider since it is fundamental to all cloud services (CSCs want the service to be available for their use). Although a number (percentage) is given for availability it is not clear how this number is calculated. A definition of unavailability is provided, but it is not clear how the availability percentage is calculated from unavailability. Another provider could use the concept of availability and calculate it differently, making comparison of an SO or measured service levels impossible.

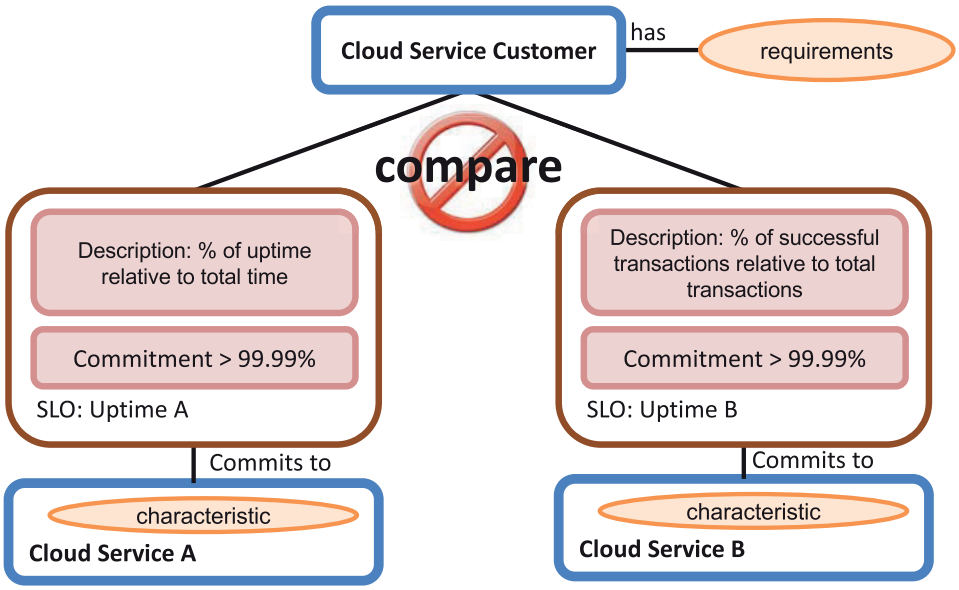

Figure 1 — Side by side comparison of availability commitment from two different providers

Figure 1 shows a CSC comparing availability for two services. While the characteristic (availability) and commitment level (99,99 %) seem identical; the text defining uptime for the two services is fundamentally different. Cloud service A uses a time based description for availability while cloud service B uses a transaction based description for availability. The CSC is therefore unable to evaluate how these two services differ.

6.2.2 Convert requirements to agreement

Once a CSC has chosen a service that meets their requirements, the CSP will work with the CSC to come to an agreement on what exactly will be provided and at what level. The requirements will be codified into a set of SLOs and SQOs written in a cloud SLA. As with the service capability descriptions used during the decision making process, the SLOs/SQOs are currently described using natural language and take different forms depending on the CSP. This not only adds ambiguity to the process, it adds additional time and complexity to the process as each SO must be thoroughly reviewed and assessed in each case.

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6.2.3 Ensure the agreement is being met

Once an agreement is in place and the cloud service is provisioned for the CSC, the CSC users will start using the service or services. During operation, both the CSP and the CSC will monitor the services to ensure that it is operating as expected. The CSP will provide tools to measure the cloud service characteristics of the service and/or provide the data to the CSC. The CSC will compare these service level measurement results to the SO specified in the agreement. Due to the ambiguous and inconsistent nature of how SLOs/SQOs and metrics are currently described, it is difficult for the CSC to have confidence that these measurement results are calculated in the same manner as defined in the cloud SLA.

6.3 Metrics

A metric, or standard of measurement, helps to clarify cloud service characteristics by providing details about how a cloud service characteristic is measured. A metric provides a definition (e.g. expression, unit, rules, parameters) of the measurement of the characteristic, and therefore, provides knowledge about the characteristic itself. It provides the necessary information for repeatability, reproducibility, and comparability of measurements and measurement results.

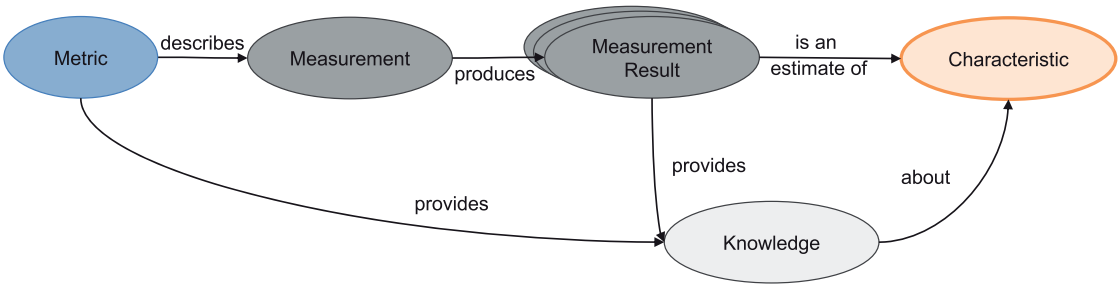

Figure 2 — Measurement process

The metric describes a cloud service characteristic and the details (parameters, data, rules, expressions, additional details) necessary to use it. For example, an "availability" metric will define the practical aspects of how to perform the measurement necessary to calculate availability, how to measure downtime, exclusion rules, etc. The measurement result is a value that results from making a measurement that follows a given metric. The measurement result is an estimate of a characteristic that is being observed. As shown in Figure 2, metric defines the rules so a measurement can be made in a repeatable, comparable manner. A measurement produces a measurement result that, combined with the information in the metric, provides knowledge about the characteristic. Characteristics of cloud services are almost never exactly known. Instead, an approximation of the characteristic is estimated (based on one or more measurements) with some understanding of the uncertainty between the approximation and the actual value of the characteristic. This uncertainty is directly tied to the measurement process used. In other words, a metric is a standard set of rules that allow a measurement process that follows the rules to generate repeatable, comparable estimates of a characteristic.

Since the metric provides both understanding of the characteristic and the information necessary to make repeatable and comparable measurements, it can be used not only for the measurement process, but in the conceptual understanding of a given characteristic.

What level of detail is included in a metric is up to the stakeholders. A metric may be only the basic equations needed to calculate a measurement result or it may include the detailed measurement process itself.

6.4 Cloud service metrics (CSMs)

Example scenarios for cloud services include the application of an availability metric for a SLO commitment of 99 % in a cloud SLA or the application of an accessibility metric for a service quality objective of "high" in a decision process scenario. In this manner CSMs help CSPs communicate the

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properties of their cloud services, help CSCs and CSPs agree on what will be provided, and allow cloud service features to be measured to ensure the agreement is met.

Cloud services can use metrics in many different ways. Metrics can be used at different layers of a cloud service (e.g. hardware layers, logic layers, governance layers or service layers). They can also be used at different stages of the cloud service life cycle (e.g. selection, procurement, operation, audit and termination).

Although the metric model described in Clause 8 is designed for general use, in this document the focus is on metrics used in cloud SLAs.

The definition and usage of appropriate metrics with their underlying measures are essential components of the cloud SLA and the SLOs/SQOs, which are constituents of the cloud SLA. Within a cloud SLA, the metrics are used to set the boundaries and margins of errors the provider of the service commits to deliver, and their limitations. Standardized metrics and metric templates for cloud SLAs makes it easier and quicker to develop cloud SLAs and the included SLOs/SQOs. Once the cloud SLA is in place, metrics could be used at runtime to measure the services levels and determine if the service is meeting the commitments in the cloud SLA.

Metrics for cloud services have several uses for CSCs and CSPs including but not limited to:

— Metrics can be used by CSPs to describe the performance of a cloud service.

— Metrics help CSCs to compare offerings from different CSPs (when CSPs uses the same metrics to describe the performance of a cloud service).

— Metrics can be used to describe SLOs and SQOs within a cloud SLA.

— Metrics can be used by CSCs to determine if the CSP is meeting their commitments as described in the cloud SLA and to claim remedies if the commitments are not being met.

6.4.1 Major stakeholders

This subclause describes stakeholder types that have an interest in cloud SLA metrics. Each stakeholder type represents a different set of interests and related concerns. Each stakeholder type uses metrics in a different way to address those interests.

Attorney

Negotiates agreements for cloud services between CSP and CSC. Uses this document as reference for specifying metrics in cloud SLAs.

Auditors

Evaluate cloud services for performance against a set of requirements and commitments. Use ISO/IEC 19086-2 based metrics to define and measure cloud service characteristics that relate to the requirements. A specific type of auditor may also use this document to evaluate the measurement system itself. Needs to understand the metric used to measure a cloud service characteristic.

Certification authority

Develop certification criteria for cloud services. Use metrics based on this document to develop repeatable certification processes. Use ISO/IEC 19086-2 based metrics to describe auditing results to show compliance or non-compliance against the certification criteria.

CSC procurement

Works on the contract negotiation between the CSC and the CSP. Uses metrics based on this document to help review the service capabilities and compare one service to another. It is worth noting that the CSC procurement officers do not need a full understanding of the metric, rather an understanding of the basic description and the identifier for the metric is all that is required.

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CSP operations

Monitors the covered services using metrics based on this document and ensures the service is operating according to SLO or SQO commitments in the cloud SLA. Needs to know the metric used for a given SO and needs monitoring to be done using the same metric.

CSP sales team

Assist CSC procurement experts in evaluating and acquiring cloud services. Use CSMs to help review the service capabilities and compare one service to another.

CSP service risk manager

Ensure the CSP service will meet certification and auditing (both internal and external) requirements and other controls. Use metrics based on this document to measure and compare cloud service characteristics.

CSP support and care representative

Evaluate claims that a given SO has not been met.

Development teams

Implement measurement systems based on metrics to monitor performance of the covered services and determine if the commitments in the CSA are being met.

Service integrator

Combines services to create new services. Determine performance of hybrid service by combining performance metrics based on this document from two or more services.

Third party monitors

Monitors the covered services using metrics based on this document. Needs to know the metric used for a given SLO or SQO and needs monitoring to be done using the same metric. Can be leveraged by the CSP, the CSC or other entities to perform measurement of metrics based on this document.

6.4.2 CSM usage categories

This subclause describes general usage categories for metrics based on this document.

6.4.2.1 Describing cloud services

Metrics can be used by the CSP to describe the characteristics of a cloud service in a standardized way. By using a standardized way (based on a metric) of representing the characteristics, CSCs can compare the characteristics of one service offering to another service offering.

CSPs should use the standard description model provided in this document in order to specify the metrics they offer in their cloud SLAs, abiding to the various necessary fields and the format of the information within each field and associate these metrics to SLOs or SQOs.

6.4.2.2 Comparing cloud services

While metric descriptions for a similar cloud service characteristic may vary between CSPs, metrics based on this document will help CSCs compare services from different CSPs. This document provides a model for expressing metrics consistently that will enable CSCs to understand the service characteristics for a given service and compare it to other services that use the same metrics to describe the service characteristics. In the case where the metrics used are different, using a consistent model to define metrics will help the CSC have a better understanding of how the defined characteristics differ.

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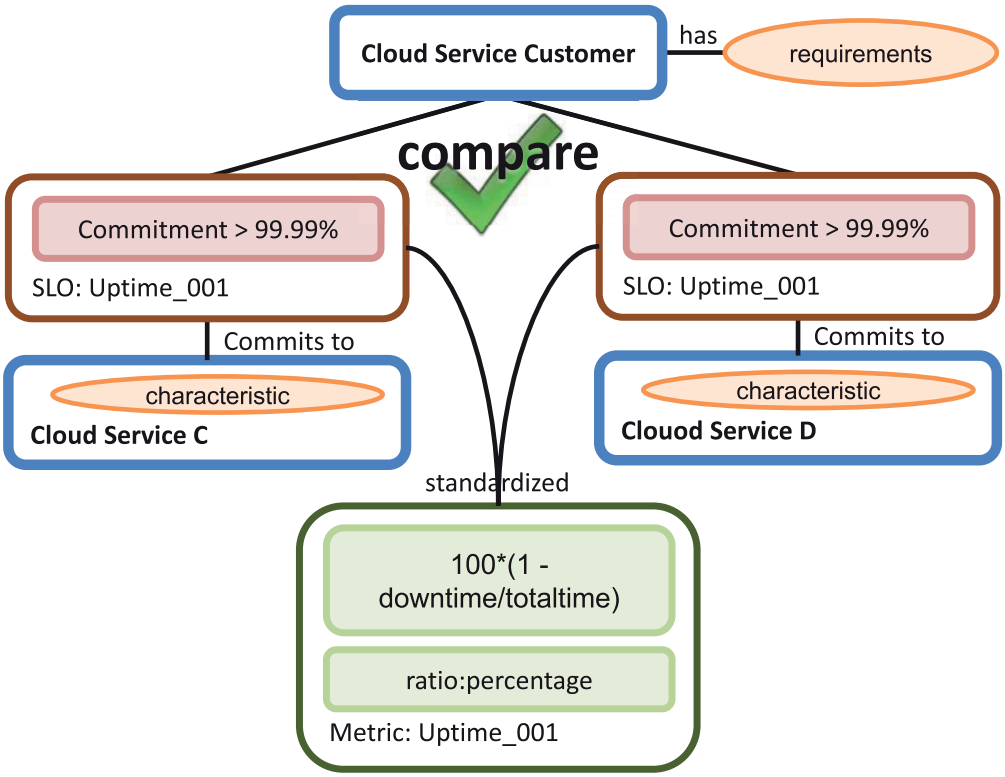

Figure 3 — CSC compares two services using the same metric

Since a CSM describes not only the requirements for measuring a characteristic but it also describes the characteristic itself, as shown in Figure 3, CSCs may use standardized metrics to understand and compare service offerings for different cloud services (note that not all the information for the metric is shown in the figure due to space constraints). As in Figure 1, Figure 3 shows a CSC comparing two services, but in this case the CSC is able to compare the two services because they use a standardized model to describe the same metric for uptime SLO and therefore, the CSC can determine the service that best meets its requirements.

CSCs or third parties (e.g. service brokers, consultants, service selectors on behalf of the CSCs) may use the standardized metric descriptions in order to compare different cloud SLAs and potentially rate them. Comparison between cloud SLAs could also be performed in an automated, tool-supported fashion.

The CSC can even define their requirements using the same metrics making it more likely that the chosen service will fit their requirements.

6.4.2.3 Understanding cloud service agreements (CSAs)

Once a CSC has chosen a cloud service based on analysing the service characteristics and their own requirements, this information may be included in a cloud SLA for the service. A cloud SLA has SOs for the characteristics of concern.

An SO provides a value understood to have a specific meaning, which relates a characteristic of a service to a specific level that should be met by the provider of the service. A metric for a characteristic provides a way of understanding what a given SO value means and gives guidance in how to make the measurement. A metric does not prescribe a specific method for making a measurement; rather it provides some rules on how to make the measurement.

By using SOs to describe the performance level for each characteristic based on metrics defined using this document both the CSC and the CSP will have a clear understanding on the performance of the cloud service and how to monitor the set of service properties.

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6.4.2.4 Developing performance monitoring tools

This document defines a model for specifying metrics in a consistent way that will help development teams understand how to create tools for obtaining and interpreting measurement results based on the metric.

Metric templates and machine-readable description instances are key for tool developers to provide tools for automating some or all of the aforementioned processes (especially the cloud SLA instantiation, cloud SLA auditing and comparison usages).

CSCs (or third parties such as cloud SLA auditors) may use metric descriptions to develop runtime service monitoring mechanisms to detect violations of the agreement (in most cases CSCs monitor the covered services themselves and claim remedies when the CSP fails to meet their commitments).

6.4.2.5 Monitoring service performance

This document provides a model for expressing metrics in a consistent way that helps operations centres develop monitoring tools necessary to measure a cloud service characteristic and interpret measurement results (which represent the service level) against the SO commitments made in CSAs.

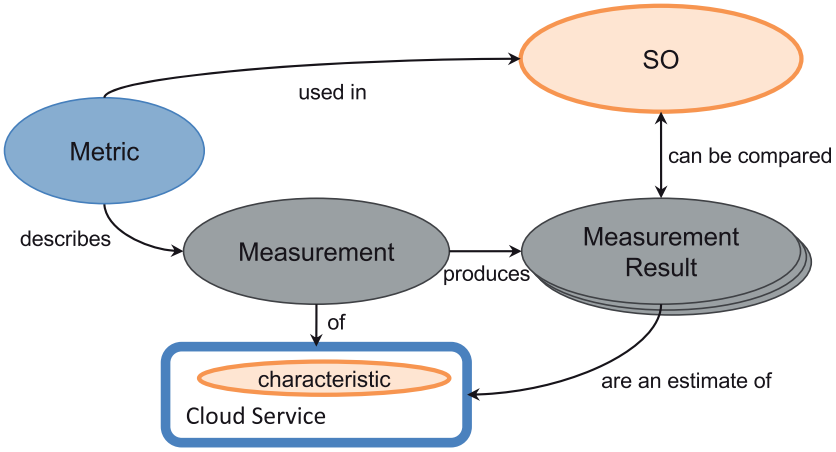

Figure 4 — Using metrics to verify the cloud SLA

6.4.2.6 Verifying the cloud SLA

A measurement produces a measurement result – a value estimating the characteristic. Since the measurement is based on the same metric that is used to describe the characteristic in the cloud SLA (via an SO included in the SLA) it is possible to compare the measurement result (representing the service level) to the SO commitment (shown in Figure 4). If the service level does not meet the SO, then the commitment is not met and a remedy, as described in the cloud SLA or CSA, will likely be sought as shown in Figure 5 below.

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