# Towards Standardised SLAs

John Kennedy

Intel, Ireland
John.M.Kennedy@intel.com

**Abstract.** This paper introduces the concept of standardised Service Level Agreements. It describes the state of the art in four areas that need to be progressed to make standardised SLAs a commercial reality: SLA-aware interfaces, SLA data models, SLA vocabularies and legal frameworks. A summary of SLA-related initiatives within standards development organisations is also presented.

**Keywords:** Standards, Service Level Agreements, SLAs, Cloud Computing, Interfaces, Data Models, Vocabularies.

## 1 Introduction

As more and more business moves to the cloud, or has the potential to move to the cloud, the agreements between consumers and providers of cloud-based services become ever more important. These agreements define the service to be consumed, the quality of service to be provided, any restrictions on the usage of the service, and recourse should the agreed terms not be met by either party. Depending on the importance to the consumer of the service being hosted on the cloud, the often innocuous-looking set of terms and conditions can quickly become a Service Level Agreement (SLA) on which the viability of the consumer's business may depend. Similarly, the SLA becomes a significant document for cloud providers, differentiating them from their competition.

Businesses recognising the importance of their SLAs appreciate that they require careful consideration. Depending on the details, the consumers of the cloud may even decide to re-architect their systems to maximise their system availability given the nature of the commitments, and any compensation, the provider offers. From a provider perspective, any personalisation they can offer to accommodate the individual needs of their consumers may give them a competitive advantage. Careful monitoring of actual service performance versus SLA commitments may reveal opportunities to maximise internal efficiencies.

However, the number of clients of a cloud-scale provider typically means that personalised SLAs cannot be offered or accommodated. From a consumer point of view, significant manual effort must be spent reviewing the precise language in each of the SLAs offered by their potential providers. Each potential SLA needs to be reviewed by a person or team of people who can appreciate the legal, business and technical subtleties of the SLA.

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The labour-intensive nature of dealing with SLAs prevents providers from offering personalised SLAs, and consumers from easily identifying and comparing the offerings of their potential providers. The lack of standards for SLAs in cloud computing is frustrating adoption of the cloud.

Progress towards standardised SLAs is required to tackle this problem. There are several distinct areas in which progress is required. Interfaces need to be agreed so that SLA-related operations such as discovery, negotiation and agreement can be more automated. The SLAs need to have an agreed structure: an agreed SLA model. The terms inside the SLA need to have a shared understanding: an agreed vocabulary. The legal framework in which the SLA exists must also be robust and unambiguous.

This paper introduces the state of the art in these four areas. Some current and proposed standardisation initiatives related to SLAs are also introduced.

## 2 What Is an SLA?

The international standard for Information Technology Service Management, ISO/IEC 20000-1:2011 [1], formally defines an SLA to be "a documented agreement between the service provider and customer that identifies services and service targets". It further elaborates that an SLA "can also be established between providers and suppliers etc., can be included in a contract or other form of documented agreement.

Cloud SLAs obviously relate to services provided by a cloud service provider, and in practical terms often include not just definitions of services and service targets, but also details of things such as the recourse in the event of an SLA being broken, the nature of support available for the service, and any requirements that may be imposed on the consumer of the cloud.

In SLAware [2] the author Keven Kearney describes that "SLAs are negotiated agreements between service providers and customers specifying their respective responsibilities and obligations in respect of service delivery and service usage. In addition to providing details of agreement parties, services and SLA duration, SLAs may, among other things, specify prices & costs, quality of service & other performance objectives, help-desk details, schedules for regular maintenance, penalties for SLA violations, exclusion clauses and termination conditions".

The ISO sub-committee responsible for Cloud Computing standards, ISO/IEC JTC 1/SC 38 Distributed application platforms and services (DAPS) [3], is at the time of writing drafting a vocabulary for cloud computing which may include a formalised cloud-specific SLA definition.

In any event, commercial SLAs such as those for Amazon EC2 [4], Windows Azure [5] and Google Apps [6] are today arbitrary in nature. They are typically verbose, complex, static documents – sometimes nested – and of several pages in length. They are published by the cloud provider and describe details of services being offered from the cloud provider point of view.

The development of standards for SLAs has the potential to help automate discovery, negotiation, composition and monitoring of SLAs. The disposition of violations can also be automated. Cloud Consumers can be empowered with the ability to negotiate personalised SLAs tuned to their precise needs – against a selection of providers. Cloud providers can propose flexible offerings and appeal to a wider customer base. Given that various terms in each SLA can be automatically tracked and monitored, providers also have the opportunity to maximise internal efficiencies, safe in the knowledge that their myriad of SLA commitments are being met.

## 3 SLA-Aware Interfaces

SLAs must be discovered, retrieved, parsed, negotiated, approved, provisioned, monitored and complied with. To reduce or even remove the manual intervention currently required in these various phases of the SLA life-cycle, these various interactions need to be exposed through software interfaces. Whether the interactions are performed by software or by a person using a suitably streamlined user interface, the SLAs need to be exposed and be manipulated by software through an Application Programming Interface – an API.

To avoid unnecessary complication of the standards landscape in Cloud Computing, it is appropriate to consider whether existing standards in Cloud Management can be extended to be made SLA-aware. Two relevant standards currently exist: the Cloud Infrastructure Management Interface (CIMI) [7] published by the Distributed Management Task Force (DMTF) [8], and the Open Cloud Computing Interface (OCCI) [9] published by the Open Grid Forum (OGF) [10].

DMTF is a largely industry-driven organisation developing standards to resolve challenges in the management of distributed computing. CIMI is a relatively new standard designed to enable the management of cloud infrastructure. CIMI is completely focused on Infrastructure as a Service (IaaS) resource management and has IaaS specific semantics: concepts like Machines, Volumes and Networks are all explicitly defined in the formal specification. CIMI is thus designed to accommodate all the typical needs of today's cloud infrastructure stack. Additionally, it can be extended should a provider want to expose additional non-standardised functionality. Although support exists for monitoring, CIMI does not have support for broader SLA concerns at the moment. SLA support would be a valuable addition to the standard should CIMI start to be widely adopted.

OGF, largely an academic and research-institute driven standards organisation, is focused on the needs of the grid computing community. In an attempt to standardise the management of cloud resources, OCCI was first published in 2011, offering a generic RESTful API for managing remote resources. OCCI is a set of three standards (at the time of writing). These define a generic core model, an extension aimed at managing IaaS deployments in particular, and a HTTP rendering. OCCI is designed to be extensible, and so revisions of the formal standard are not required to introduce support for new functionality. There are implementations of OCCI for various cloud

management stacks including OpenStack and OpenNebula, and the community is actively working on an XML rendering, a JSON rendering and a monitoring extension. There are tentative plans to extend the API with support for SLAs in 2014. The current intent is to allow SLAs to be defined, negotiated and agreed, and then assigned to particular provisioning requests. It should also be noted that OCCI is used as the core protocol for the CompatibleOne cloud brokering solution [11]. This open-source project has used the extension mechanism to allow SLA terms to be defined and passed between internal components, and brokered systems.

## 4 SLA Data Models

Whilst an SLA-aware API allows SLAs to be passed between consumers and providers, the internal structure of the SLA itself must also be agreed. There is a need for standardised SLA Data Models.

Numerous projects have begun to tackle this area and the European Commission's "Cloud Computing SLAs – Exploitation of Research Results" report [12] highlights the following research projects which have produced the associated assets that are listed below:

- 4CaaSt: Blueprint Concept
- BREIN: Semantic Annotation in SLA templates
- CloudScale: Scalability Specification
- Cloud-TM: SLA Definition and Enforcement in Transactional Data Stores
- CONTRAIL: SLA Specification and Quality Model
- EGI: Service Catalogue in a Federated Environment
- IRMOS: SLAs at Different Levels
- OPTIMIS: Service Manifest
- Q-ImPrESS: QoS-oriented SLA Specification
- PrestoPRIM : SLA Specification for Preservation Services (risk of data loss)
- SLA@SOI: Service Description
- VISION Cloud: Content-related Terms in SLAs

The SLA@SOI [13] project in particular was explicitly crafted to research, design and demonstrate machine readable SLAs over Service Oriented Infrastructure – now known as cloud computing. As well as constructing an SLA Framework for integration into IaaS offerings, it also tackled the challenge of defining a suitable SLA model.

The resulting model, SLA *, is a generic SLA model designed to accommodate arbitrary SLA terms. It can accommodate both functional and non-functional (e.g. monitoring) parameters, arbitrarily complex expressions, and arbitrary domain-specific vocabularies. It is an abstract model, and so can be rendered in arbitrary formats – BNF, XML, and JSON renderings have all been demonstrated. The most recent version of SLA * is described in the SLA@SOI SLA Management and Foundations deliverable [14]. Software to support the SLA Model has been published open source and is documented on the SLA@SOI SourceForge project wiki [15].

Whilst the SLA* Model focused on syntax, the ongoing FI-WARE [16] project, a European Commission supported Public Private Partnership project, has built on SLA* to develop a model that also comprehends semantics. SLAware is currently a work in progress, but a version has been made publically available [2]. It includes a line-by-line analysis of the Amazon WS SLA, with illustrated examples of how the various terms can be modelled using the SLAware model.

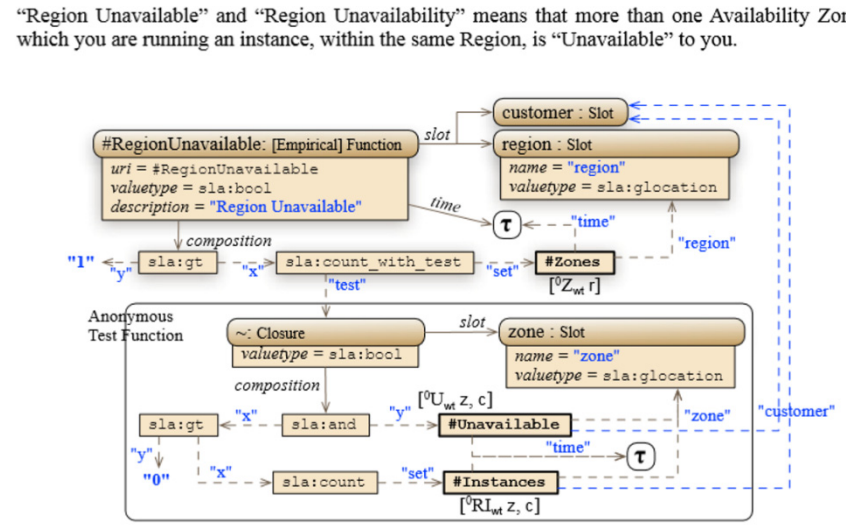


**Fig. 1.** A clause from the Amazon EC2 SLA, and the clause modelled using SLAware

## 5 SLA Vocabularies

Whilst an agreed SLA Model allows SLAs to be constructed, it primarily provides a structure and does not necessarily define the individual terms that may be included within. Both parties of an agreement must share an understanding of the terms in the SLA. This can only be achieved by agreeing on a common vocabulary.

There is the potential to agree common terms in a standardised, formal industry wide Cloud vocabulary, perhaps as an evolution to the one currently being developed jointly by ISO SC38 and the ITU-T SG13. However, to accommodate the possibility of arbitrary SLA terms being included in standardised SLAs, additionally flexibility is required. Communities of cloud consumers and providers will need the ability to define and manage their own domain-specific SLA vocabularies. This will allow clusters of cloud providers and consumers in domains such as healthcare, federal government, high-performance grid computing, and small and medium sized business to all maintain their own independent vocabularies, dealing with terms of importance to them, perhaps extending higher level vocabularies that have been agreed across the industry.

The SLA@SOI work previously referred to includes formal definitions of many cloud computing terms. Other related work includes the library of Open Data Center Alliance (ODCA) Usage Models [17] which documents numerous examples of how cloud consumers wish to consume Cloud Computing. The NIST Cloud Computing Technology Roadmap [18] illustrates both Business and Service Level Objectives that SLAs could be required to accommodate. The Intel Cloud Finder [19] is a comprehensive online tool that helps match cloud consumers with cloud providers based on a detailed list of questions which illustrate potential differentiators that should be accommodated in an SLA vocabulary.

## 6 Legal Framework

Businesses operate within a legal framework, or multiple legal frameworks should numerous jurisdictions be involved in a transaction, and so progress towards standardised SLAs must also address how legal considerations can best be met.

Legal aspects include such items as legal constraints on the data being transferred from cloud consumer to provider, legal constraints on software hosted by the cloud provider, as well as the more traditional legal concerns regarding business contracts.

These issues are all the more important given the relative ease at which international (and thus legal) borders can be crossed via the internet. Whilst a consumer may upload to a provider server within their jurisdiction, the technology exists for their data to be transferred to some other jurisdiction by the cloud provider. Each jurisdiction may have its own rules about what type of data may or may not cross national borders.

An additional level of complication arises in the European Union, where not just national laws apply, but European legislation reducing barriers to business is also relevant.

The European Commissioner for the Digital Agenda, Neelie Kroes, recognises these challenges for business and has acknowledged them in her Davos keynote address in January 2012: “Standards, certification, data protection, interoperability, lock-in, legal certainty and others […] where these barriers exist, I am determined to overcome them”. [20]

The European Commission have since published and launched a European Cloud Computing Strategy to “Unleash the potential of Cloud Computing in Europe” [21]. This strategy includes clarifying the “jungle of standards”, and a European Cloud Partnership which will include a pre-commercial procurement consortium on which a commercial cloud ecosystem can be validated. From the legal point of view, the strategy is also specifically developing model safe and fair contract terms for the cloud. This latter initiative is now underway, and is expected to feed into the Cloud for Europe [22] project of the European Cloud Partnership [23] which is due to tender for partners to build its infrastructure during 2014.

# 7 SLA Standardisation Initiatives

Whilst the preceding discussion has focused mostly on the state of the art towards standardised SLAs, it is the standards development organisations (SDOs) that will ultimately ratify and publish any such standards. Several SDOs recognise this need and have recently become active in the field of standardised SLAs.

## 7.1 TM Forum

The TM Forum [24] have published numerous SLA-related documents including GB917 SLA Management Handbook, TR178 Enabling End to End Cloud SLA Management and TR197 Multi-Cloud Service Management Pack–SLA Business Blueprint. All are specifically designed to meet the particular SLA needs of the Telecommunications industry.

## 7.2 NIST

The recently published NIST Cloud Computing Standards Roadmap [25] discusses the potential for standardised SLAs. Version 2.0 of the NIST Cloud Computing Taxonomy, a work in progress, is expected to include a newly defined SLA taxonomy to support US Government procurement of Cloud Computing. Version 1.0 of the NIST Cloud Computing Technology Roadmap [18] includes SLA concept maps.

## 7.3 EU/ETSI

The European Commission has recently published a report summarising SLA related results from numerous research projects it has funded: Cloud Computing Service Level Agreements - Exploitation of Research Results [12]. It includes recommendations for the Commission's Cloud Select Industry Group on SLAs to consider, for potential rollup to the ETSI Cloud Standards Coordination (CSC) [26] initiative. The report details outputs from more than 21 projects and provides 11 specific recommendations for progressing SLAs. The ETSI CSC is coordinating the European strategy to address cloud standards.

## 7.4 OGF

The WS Agreement and WS-Agreement Negotiation standards can provide the basis for an SLA negotiation protocol. The OCCI working group [27] is planning to develop SLA extensions to the OCCI standard during 2014.

## 7.5 ISO

A New Work Item on SLA Framework and Terminology has been proposed. The scope for this work includes an overview of SLAs for Cloud Services, the

relationship between a master agreement and SLAs, SLA components, commonly used terms, definitions and contexts. Note that a technically rich standard structure for SLAs is currently not in scope.

## 8 Conclusion

Progress towards standardised SLAs is required to maximise cost-effectiveness and efficiencies for Cloud Consumers and Providers alike. Ultimately this requires challenges to be addressed in the areas of SLA-aware cloud interfaces, SLA data models, SLA vocabularies, and legal frameworks. Although still in its infancy, progress is being made. Ultimately, significant federal initiatives such as the NIST suite of Cloud Computing initiatives and the European Cloud Computing Strategy may become the key drivers towards the standardisation of SLAs.

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