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Cloud computing interoperability activities

ITU-T Q-series Recommendations – Supplement 65

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

For further details, please refer to the list of ITU-T Recommendations.

Supplement 65 to ITU-T Q-series Recommendations

Cloud computing interoperability activities

Summary

Supplement 65 to ITU-T Q-series Recommendations provides the summary information for cloud computing interoperability activities of existing standards development organizations (SDOs) and the groups, forums and open sources developing the specifications that have the potential to utilize cloud computing interoperability testing tools. This supplement should also be helpful for the development of cloud testing specifications.

History

Edition	Recommendation	Approval	Study Group	Unique ID[*]
1.0	ITU-T Q Suppl. 65	2014-07-16	11	11.1002/1000/12212

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[*] To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Cloud computing interoperability activities

1   Scope

This supplement describes the summary information of cloud computing interoperability activities of existing standards development organizations (SDOs) and the groups, forums and open sources developing the specifications that have potential to utilize cloud computing interoperability testing tools. This supplement also provides summary list of activities by the SDOs including those of cloud computing interoperability testing areas.

2   References

ITU-T references

[ITU-T Y.3500]	Recommendation ITU-T Y.3500 (2014), *Information technology –Cloud computing – Overview and vocabulary*.
[ITU-T Y.3501]	Recommendation ITU-T Y.3501 (2013), *Cloud computing framework and high-level requirements*.
[ITU-T Y.3502]	Recommendation ITU-T Y.3502 (2014), *Information technology — Cloud computing -Reference architecture*.
[ITU-T Y.3510]	Recommendation ITU-T Y.3510 (2013), *Cloud computing infrastructure requirements*.
[ITU-T Y.3512]	Recommendation ITU-T Y.3512 (2014), *Cloud computing - Functional requirements of Network as a Service*.
[ITU-T Y.3513]	Recommendation ITU-T Y.3513 (2014), *Cloud computing - Functional requirements of Infrastructure as a Service*.
[ITU-T Y.3520]	Recommendation ITU-T Y.3520 (2013), *Cloud computing framework for end to end resource management*.

ETSI references

[ETSI TR 102 997]	ETSI TR 102 997 V1.1.1 (2010), *CLOUD; Initial analysis of standardization requirements for Cloud services*.
[ETSI TR 103 125]	ETSI TR 103 125 V1.1.1 (2012), *CLOUD; SLAs for Cloud services*.
[ETSI TR 103 126]	ETSI TR 103 126 V1.1.1 (2012), *CLOUD; Cloud private-sector user recommendations*.
[ETSI TS 103 142]	ETSI TS 103 142 V1.1.1 (2013), *CLOUD; Test Descriptions for Cloud Interoperability*.

IEEE references

[IEEE P2301]	IEEE P2301, *Guide for Cloud Portability and Interoperability Profiles (CPIP)*.
[IEEE P2302]	IEEE P2302, *Standard for Intercloud Interoperability and Federation (SIIF)*.

IETF references

[IETF RFC 2330]	IETF RFC 2330 (1998), *Framework for IP Performance Metrics*

| [IETF RFC 4110] | IETF RFC 4110 (2005), *A Framework for Layer 3 Provider-Provisioned Virtual Private Networks*. |
| [IETF RFC 6749] | IETF RFC 6749 (2012), *The OAuth 2.0 Authorization Framework*. |

NIST references

[NIST SP 500-292]	NIST SP 500-292 (2011), *NIST Cloud Computing Reference Architecture*.
[NIST SP 500-293vol1]	NIST SP 500-293, *US Government Cloud Computing Technology Roadmap Volume I Release 1.0: High-Priority Requirements to Further USG Agency Cloud Computing Adoption*.
[NIST SP 500-293vol2]	NIST SP 500-293, *US Government Cloud Computng Technology Roadmap Volume II Release 1.0: Useful Information for Cloud Adopters*.
[NIST SP 800-145]	NIST SP 800-145 (2011), *The NIST Definition of Cloud Computing*.

OASIS references

| [OASIS TOSCA-v1.0] | OASIS TOSCA-v1.0, *Topology and Orchestration Specification for Cloud Applications Version 1.0*. |

TM Forum references

[TMF GB917]	TMF GB917, *SLA Management Handbook*.
[TMF GB963]	TMF GB963, *Cloud SLA Application Note*.
[TMF TR174]	TMF TR174, *Enterprise-Grade External Compute IaaS Requirements*.
[TMF TR178]	TMF TR178, *Enabling End-to-End Cloud SLA Management*.
[TMF TR194]	TMF TR194, *Multi-Cloud Service Management Accelerator Pack-Introduction*.

3 Abbreviations and acronyms

This supplement uses the following abbreviations and acronyms:

3CPP	China Cloud Computing Promotion and Policy Forum
BPaaS	Business Process as a Service
CCI	Cloud Computing Interoperability
CDMI	Cloud Data Management Interface
CIMI	Cloud Infrastructure Management Interface
CMI	Cloud Management Initiative
CPIP	Cloud Portability and Interoperability Profile
CSC	Cloud Service Customer
CSMIC	Cloud Services Measurement Initiative Consortium
CSP	Cloud Service Provider
CT-CCVOCAB	Collaborative Teams on Cloud Computing Overview and Vocabulary
DAPS	Distributed Application Platforms and Services
DMTF	Distributed Management Task Force
ENISA	European Network Information Security Agency

ETSI	European Telecommunications Standards Institute
GICTF	Global Inter-Cloud Technology Forum
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
IT	Information Technology
NaaS	Network as a Service
NIST	National Institute of Standards and Technology
OASIS	Organization for the Advancement of Structured Information Standards
OCC	Open Cloud Consortium
OCCI	Open Cloud Computing Interface
OCCI-WG	OCCI Working Group
ODCA	Open Data Center Alliance
OGF	Open Grid Forum
OVF	Open Virtualization Format
PaaS	Platform as a Service
PoC	Proof of Concept
REST	Representational State Transfer
SaaS	Software as a Service
SAJACC	Standards Acceleration to Jumpstart the Adoption of Cloud Computing
SCIM	System for Cross-domain Identity Management
SDO	Standards Development Organization
SIIF	Standard for Inter-cloud Interoperability and Federation
SLA	Service Level Agreement
SMI	Simple Management Interface
SNIA	Storage Networking Industry Association
SOA	Service Oriented Architecture
SPEC	Standard Performance Evaluation Corporation
VM	Virtual Machine

NOTE – Abbreviations not described in this supplement can be found in [ITU-T Y.3500] and other reference documents listed in clause 2.

4 Introduction

The purpose of this supplement is to provide the list of existing cloud computing interoperability and testing related activities. Clause 5 describes cloud computing interoperability activities by different standards development organizations (SDOs) while clause 6 identifies potential cloud computing

interoperability testing areas. This supplement is intended to be of help for developing cloud computing interoperability testing Recommendations.

5   Existing cloud computing interoperability activities

5.1   Standards development organizations for cloud computing interoperability

Many SDOs are developing cloud standards. Some of them are listed in ITU-T FG-Cloud technical reports. From an interoperability testing perspective, some SDOs do not conduct testing themselves but conduct joint/collaborative/sponsored testing groups as described in clause 5.2. For example, Distributed Management Task Force (DMTF), European Telecommunications Standards Institute (ETSI), Organization for the Advancement of Structured Information Standards (OASIS), Storage Networking Industry Association (SNIA) and some SDOs sponsored Cloud Plugfest as part of the Cloud Interoperability Week where, during the testing of specifications, they improved such Cloud standards as cloud data management interface (CDMI), open cloud computing interface (OCCI), cloud infrastructure management interface (CIMI) and open virtualization format (OVF). Open Data Center Alliance (ODCA) proof of concept (PoC) shows how OASIS topology and orchestration specification for cloud applications (TOSCA) standard can be used to fulfil industry requirements for application portability in the enterprise cloud. TM Forum, OASIS, W3C cover platform as a service (PaaS)/software as a service (SaaS) level cloud interoperability and testing to some extent.

This clause lists and briefly describes representative cloud computing SDOs' activities/specifications which are used in cloud interoperability testing.

5.1.1   DMTF

The mission of Distributed Management Task Force (DMTF) is to create standards that enable interoperability among multi-vendor systems, tools and solutions within the enterprise.

DMTF works on cloud computing management interface related aspects of common core identifiers (CCIs).

DMTF's cloud management initiative (CMI) is focused on developing interoperable cloud infrastructure, management standards and promoting adoption of those standards in the industry.

Cloud management working group (CMWG) and Open virtualization format working group (OVFWG) of DMTF are developing cloud computing interoperability related standards. The CIMI developed by CMWG is a self-service interface for infrastructure clouds, allowing cloud users to dynamically provision, configure and administer their cloud usage using a high level interface that abstracts away much of complexity of system management. OVF developed by OVFWG is a packaging standard designed to address the portability and deployment of virtual appliances. OVF enables simplified and error-free deployment of virtual appliances across multiple virtualization platforms.

Table 5-1 – DMTF documents and work items related to CCI

Reference	Name/Title	Status
DSP-IS0101	Interoperable clouds	Published
DSP0264	CIMI-CIM specification	Published
DSP0263	CIMI model and RESTful HTTP-based protocol	Published
DSP0243	Open virtualization format specification	Published

5.1.2 ETSI

The European Telecommunications Standards Institute (ETSI) is an independent, non-profit, standardization organization in the telecommunications industry (equipment makers and network operators) in Europe, with worldwide projection.

The goal of ETSI Technical Committee CLOUD (ETSI TC CLOUD, TC GRID renamed TC CLOUD in 2010) is to address issues associated with the convergence between information technology (IT) and telecommunications, paying particular attention to the lack of interoperable cloud solutions.

ETSI works on definitions, service level agreements (SLAs) and testing methodologies related to aspects of CCI.

ETSI TC CLOUD has developed technical reports on standardization requirements for cloud services. Portability and interoperability of clouds is one of the main requirements [ETSI TR 102 997].

ETSI TC CLOUD have also developed CCI testing related standards including interoperability testing specification for OCCI and CDMI [ETSI TS 103 142] and cloud specific SLA standards [ETSI TR 103 125].

Test descriptions for cloud interoperability [ETSI TS 103 142] specifies interoperability test descriptions for OCCI and CDMI standards.

SLAs for cloud services [ETSI TR 103 125] aims to review previous work on SLAs and to derive potential requirements for cloud specific SLA standards.

Table 5-2 – ETSI documents and work items related to CCI

Reference	Name/Title	Status
[ETSI TS 103 142]	CLOUD; Test descriptions for cloud interoperability	Published
[ETSI TR 103 125]	CLOUD; SLAs for cloud services	Published
[ETSI TR 103 126]	CLOUD; Cloud private-sector user recommendations	Published
[ETSI TR 102 997]	CLOUD; Initial analysis of standardization requirements for Cloud services	Published

5.1.3 GICTF

Global Inter-Cloud Technology Forum (GICTF) aims to promote standardization of network protocols and the interfaces through which cloud systems interwork with each other and to enable the provision of more reliable cloud services.

GICTF works on standardization of inter-cloud interoperability, including functional requirements and interface.

GICTF has developed requirements for inter-cloud computing and inter-cloud interface specification. The functional requirements of inter-cloud systems have been identified and the inter-cloud interface has been developed. Three reference points for the interface specified in GICTF's documents are the interface between inter-cloud service controls, the interface between inter-cloud service controls and data centre operation systems, and the interface between the inter-cloud service controls and the network operation systems.

Table 5-3 – GICTF documents and work items related to CCI

Reference	Name/Title	Status
GICTF WhitePaper 2012-2	Intercloud interface specification draft (Cloud resource data model)	published

Table 5-3 – GICTF documents and work items related to CCI

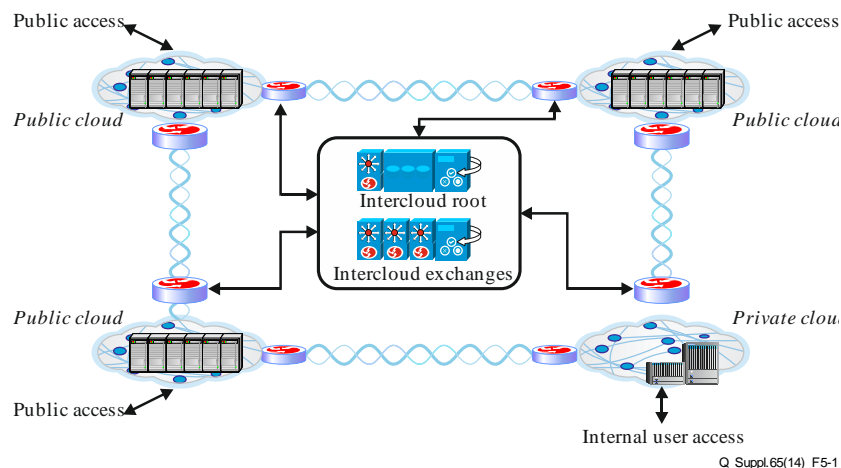| Reference	Name/Title	Status
GICTFWhitePaper 2012-2	Intercloud interface specification draft (Intercloud protocol)	published
GICTF White Paper 2012-1	Technical requirements for supporting the inter-cloud networking	published
GICTF WhitePaper	Use cases and functional requirements for inter-cloud Computing	published

5.1.4 IEEE

The Institute of Electrical and Electronics Engineers (IEEE) is a professional association that is dedicated to advancing technological innovation and excellence.

IEEE works on inter-cloud related aspects of CCI.

The IEEE cloud computing initiative (CCI) is a broad-based collaborative project for the cloud to be introduced by IEEE. Several products and services that are now being introduced by IEEE CCI, including a website, conferences, continuing education courses, publications, standards and a platform for testing cloud computing applications.

Two major cloud computing standards of IEEE CCI are currently in process: [IEEE P2301] Guide for Cloud Portability and Interoperability Profiles (CPIPs) and [IEEE P2302] Standard for Intercloud Interoperability and Federation (SIIF). The purpose of CPIP is to advise cloud computing ecosystem participants (cloud vendors, service providers and users) of standards-based choices in areas such as application interfaces, portability interfaces, management interfaces, interoperability interfaces, file formats, and operation conversions. CPIP groups these choices into multiple logical profiles, which are organized to address different cloud personalities.

SIIF defines topology, functions and governance for cloud-to-cloud interoperability and federation. Topological elements include clouds, roots, exchanges (which mediate governance between clouds) and gateways (which mediate data exchange between clouds). Functional elements include name spaces, presence, messaging, resource ontologies (including standardized units of measurement), and trust infrastructure. Governance elements include registration, geo-independence, trust anchor, and potentially compliance and audit. The standard does not address intra-cloud (within cloud) operation, as this is cloud implementation-specific, nor does it address proprietary hybrid-cloud implementations.

Figure 5-1 – Reference network inter-cloud topology

(Reference: IEEE Cloud Computing Initiative: http://cloudcomputing.ieee.org/intercloud)

Table 5-4 – IEEE documents and work items related to CCI

Reference	Name/Title	Status
IEEE P2301	Guide for Cloud Portability and Interoperability Profiles (CPIP)	In process
IEEE P2302	Standard for Intercloud Interoperability and Federation (SIIF)	In process

Another area IEEE plans to explore involves developing environments for creating and testing protocols for the IEEE P2302 Draft Standard for intercloud interoperability and federation. IEEE has partnered with universities and research institutions around the world that already have cloud computing resources. The goal is to create a well-connected standards-based platform.

5.1.5   IETF

The IETF is an international organization that develops standards and specifications applicable to the Internet.

IETF works on cloud computing interface, and testing methodology related aspects of CCI Cloud related working groups are:

• IETF/l3vpn (Layer 3 Virtual Private Networks);

• IETF/oauth (Web Authorization Protocol);

• IETF/scim (System for Cross-domain Identity Management);

• IETF/ippm (IP Performance Metrics).

The L3VPN, OAUTH, system for cross-domain identity management (SCIM) working groups work on cloud computing protocol related aspects of CCI.

The L3VPN working group is responsible for defining, specifying and extending BGP/MPLS IP VPNs solutions for supporting provider-provisioned L3VPN.

The OAUTH working group develops OAuth for authorization. OAuth provides client applications a 'secure delegated access' to server resources on behalf of a resource owner.

The SCIM working group is developing SCIM specification that is designed to make managing user identity in cloud based applications and services easier.

The IPPM working group works on testing methodology related aspects of CCI.

The IPPM working group develops and maintains standard metrics that can be applied to the quality, performance, and reliability of Internet data delivery services and applications running over transport layer protocols (e.g., TCP, UDP) over IP.

Some CCI related individual Internet drafts have also been submitted to IETF.

The draft Cloud Reference Framework presents a cloud reference framework that intends to provide a basis for designing interoperable cloud services and their integration into existing open Internet and enterprise IT infrastructures [draft-khasnabish-cloud-reference-framework].

Table 5-5 – IETF documents and work items related to CCI

Reference	Name/Title	Status
IETF RFC 2330	Framework for IP Performance Metrics	Published
IETF RFC 4110	A Framework for Layer 3 Provider-Provisioned Virtual Private Networks	Published
IETF RFC 6749	The OAuth 2.0 Authorization Framework	Published
I-D. draft-ietf-scim-core-schema-03	System for Cross-domain Identity Management: Core Schema	Draft

Table 5-5 – IETF documents and work items related to CCI

Reference	Name/Title	Status
I-D. draft-khasnabish-cloud-reference-framework	Cloud Reference Framework	Draft

5.1.6   ISO/IEC JTC1

ISO/IEC JTC 1 is the Joint Technical Committee 1 of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Its purpose as a technical committee is to develop, maintain, promote, and facilitate standards in the fields of IT and information and communication technology (ICT).

The scope of JTC1/SC38 (subcommittee 38 of JTC1, distributed application platforms and services (DAPS)) is standardization for interoperable DAPS including web services, service oriented architecture (SOA) and cloud computing.

The WG3 (working group on Cloud Computing) of JTC1/SC38 works on definitions related aspects of CCI. JTC1/SC38 developed Overview and Vocabulary [ISO/IEC WD 17788] and Reference Architecture of cloud computing [ISO/IEC DIS 17789].

ISO/IEC JTC 1/SC 38 (specifically WG 3: Cloud Computing) and ITU-T/SG 13 form the Collaborative Teams on Cloud Computing Overview and Vocabulary (CT-CCVOCAB) and Cloud Computing Reference Architecture (CT-CCRA). The purpose of the collaboration is to develop a common text, in the form of a new standard, between the two groups based on two documents: Draft new Recommendation Y.CCdef Cloud Computing Definition and Vocabulary (from ITU-T Q.26/13), and ISO/IEC WD 17788 – Cloud Computing Vocabulary and ISO/IEC WD 17789 – Cloud Computing Reference Architecture (from ISO/IEC JTC 1/SC 38/WG 3).

Cloud computing interoperability (CCI) is defined in CT-CCVOCAB as follows:

Interoperability in the context of cloud computing includes the ability of a cloud service customer (CSC) to interact with a cloud service and exchange information according to a prescribed method and obtain predictable results.

Interoperability also includes the ability for one cloud service to work with other cloud services, either through a cloud service provider-to-provider relationship, or where a CSC uses multiple different cloud services in some form of composition to achieve their business goals.

Interoperability stretches beyond the cloud services themselves and also includes the interaction of the CSC with the cloud service management facilities of the cloud service provider (CSP). Ideally, the CSC should have a consistent and interoperable interface to the cloud service management functionality and be able to interact with two or more CSPs without needing to deal with each provider in a specialized way.

Table 5-6 – ISO/IEC documents and work items related to CCI

Reference	Name/Title	Status
ISO/IEC WD 17788	Cloud Computing Vocabulary	Published
ISO/IEC DIS 17789	Information technology -- Cloud computing -- Reference architecture	Published

5.1.7   ITU-T

The ITU Telecommunication Standardization Sector (ITU-T) is one of the three sectors (divisions or units) of the International Telecommunication Union (ITU); it coordinates standards for telecommunications.

Cloud computing is an important part of ITU-T Study Group (SG) 13 work and the group develops standards that detail requirements and functional architectures of the cloud computing ecosystem, covering inter- and intra-cloud computing and technologies supporting X as a service (XaaS).

ITU-T works on definition, cloud computing management interface related aspects of CCI.

This work of SG 13 includes infrastructure and networking aspects of cloud computing models, as well as deployment considerations and requirements for interoperability and data portability.

SG 13 also develops standards enabling consistent end-to-end, multi-cloud management and monitoring of services exposed by and across different service providers' domains and technologies.

Table 5-7 – ITU-T documents and work items related to CCI

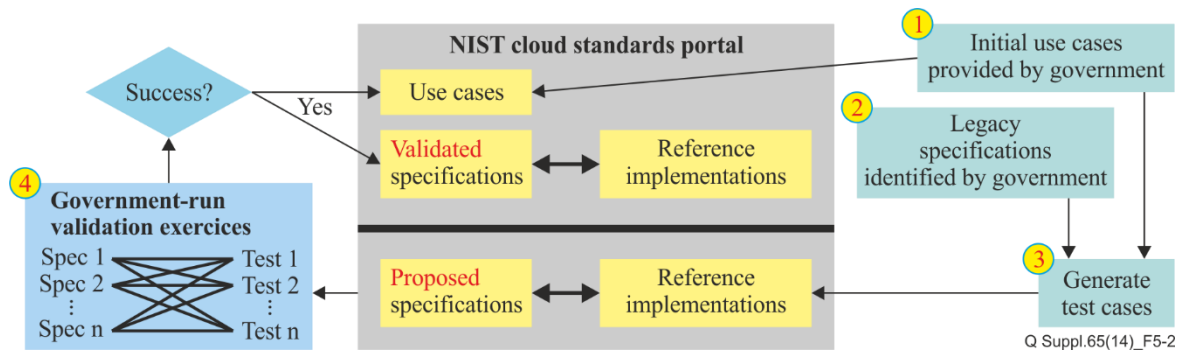| Reference	Name/Title	Status
ITU-T Y.3500	Recommendation ITU-T Y.3500 (2014), Information technology -Cloud computing – Overview and vocabulary	Published
ITU-T Y.3501	Recommendation ITU-T Y.3501 (2013), Cloud computing framework and high-level requirements	Published
ITU-T Y.3502	Recommendation ITU-T Y.3502 (2014), Information technology -Cloud computing - Reference architecture	Published
ITU-T Y.3510	Recommendation Y.3510 (2013), Cloud computing infrastructure requirements	Published
ITU-T Y.3512	Recommendation Y.3512 (2014), Cloud computing – Functional requirements of Network as a Service.	Published
ITU-T Y.3513	Recommendation Y.3513 (2014), Cloud computing – Functional requirements of Infrastructure as a service.	Published
ITU-T Y.3520	Recommendation Y.3520 (2013), Cloud computing framework for end to end resource management	Published
ITU-T Y.e2ecslm-Req	End-to-end cloud service lifecycle management	Draft
ITU-T Y.e2ecmrgb	Common Model for End-to-End Cloud Computing Resource Management	Draft

5.1.8 NIST

The National Institute of Standards and Technology (NIST) is a measurement standards laboratory, also known as a National Metrological Institute (NMI), which is a non-regulatory agency of the United States Department of Commerce.

NIST standards acceleration to jumpstart the adoption of cloud computing (SAJACC) working group: Focused on use case definition and refinement to produce testable cloud computing scenarios.

NIST SAJACC: Phase I is published project to define testable use cases that provide the basis for independent evaluation of cloud standards, products and processes. The output of the working group report "SAJACC Working Group Recommendations to NIST" has been delivered in February 2013.

Working group continues with Phase II to define and refine use cases with greater technical detail. SAJACC Phase II launched February 2013 to refine and extend Phase I use case test cases based on priority action plan.

Figure 5-2 shows the NIST Cloud Portal (currently in the form of a community Wikipedia website) and the main steps of starting the SAJACC process. SAJACC has completed several iterations of steps 1-3, and exploratory activities conducted in a community setting for the process described in step 4 of the figure, resulting in output that has been documented in the NIST Cloud Standards Wiki.

Figure 5-2 – NIST cloud standards portal (Reference: NIST cloud computing website)

Table 5-8 – NIST documents and work items related to CCI

Reference	Name/Title	Status
NIST SAJACC Internal Group Report	SAJACC working group recommendations to NIST	Published
NIST SAJACC White Paper	Virtual machine portability white paper	Draft
NIST SP 800-145	The NIST Definition of Cloud Computing	Published
NIST SP 500-292	NIST Cloud Computing Reference Architecture	Published
NIST SP 500-293vol1	US Government Cloud Computing Technology Roadmap Volume I Release 1.0: High-Priority Requirements to Further USG Agency Cloud Computing Adoption	Draft
NIST SP 500-293vol2	US Government Cloud Computing Technology Roadmap Volume II Release 1.0: Useful Information for Cloud Adopters	Draft

5.1.9 OASIS

OASIS is a non-profit consortium that drives the development, convergence and adoption of open standards for the global information society.

OASIS works on the TOSCA project which is cloud interoperability initiative related aspects of CCI.

Cloud includes several technical projects, such as OASIS TOSCA project which enhances the portability and management of cloud applications and services across their lifecycle. TOSCA will enable the interoperable description of application and infrastructure cloud services, the relationships between parts of the service and the operational behaviour of these services (e.g., deploy, patch, shutdown).

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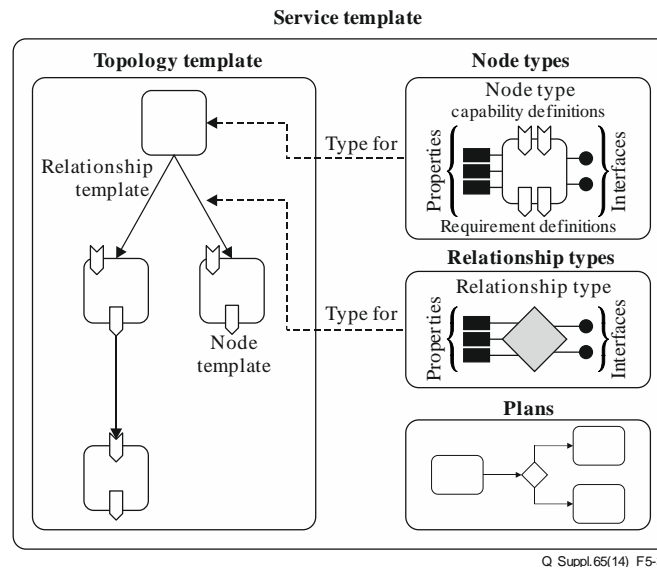
Figure 5-3 – Structural elements of a service template and their relations (Ref. Topology and orchestration specification for cloud applications version 1.0 OASIS standard)

Table 5-9 – OASIS documents and work items related to CCI

Reference	Name/Title	Status
OASIS TOSCA-v1.0	Topology and orchestration specification for cloud applications (TOSCA) Version 1.0	Published

5.1.10 ODCA

The ODCA is an independent organization created in October 2010 with the assistance of Intel Corporation to coordinate the development of standards for cloud computing. The organization has created a usage model roadmap featuring 19 prioritized usage models. The usage models provide detailed requirements for data centre and cloud solutions, and will include detailed technical documentation discussing the requirements for technology deployments.

Four CCI related usage models have been published by ODCA, while ODCA also initiated a new PoC project to determine where the virtual machine (VM) industry currently is in meeting interoperability requirements outlined in the ODCA VM interoperability usage model in 2013.

Table 5-10 – ODCA documents and work items related to CCI

Reference	Name/Title	Status
ODCA SAAS_Interop_UM_Rev1.0	Software as a service (SaaS) interoperability	published
ODCA PAAS_Interop_UM_Rev1.0	Platform as a service (PaaS) interoperability	published
ODCA VM_Interoperability_in_a Hybrid_Cloud_Enviroment_rev1.2	Virtual machine (VM) Interoperability in a hybrid cloud environment	published
ODCA VM_Interop_PoC_White_Paper	Implementing the Open Data Center Alliance Virtual Machine Interoperability Usage Model	published

A team led by T-Systems Telekom Innovation Laboratories, the FZI research team from the University of Karlsruhe and supported by Intel Corporation carried out a PoC project to implement the usages described in the document: Implementing the ODCA Virtual Machine Interoperability Usage Model.

The Implementing the ODCA Virtual Machine Interoperability Usage Model POC was developed within the ODCA Manageability and Services Workgroup and includes specifications for interoperability developed by DMTF, an ODCA partner organization.

The POC outlines testing criteria and procedures for documenting how hypervisor and VM solutions from both ODCA members and non-members interoperated in real-world enterprise cloud scenarios.

5.1.11 OGF

The Open Grid Forum (OGF) is a community of users, developers, and vendors leading the global standardization effort for distributed computing (including clusters, grids and clouds).

OGF works on OCCI that resource management interface related aspects of CCI.

The open cloud computing interface working group (OCCI-WG) of the OGF was established in 2009. The purpose of this group is the creation of a practical solution to interface with cloud infrastructures exposed as a service. It focuses on the creation of an API for interfacing infrastructure as a service (IaaS) cloud computing facilities, which is sufficiently complete to allow for the creation of interoperable implementations.

The OCCI developed by OGF OCCI-WG is a set of specifications for cloud computing service providers. OCCI has a set of implementations that act as proofs of concept. It builds upon world wide web fundamentals by using the representational state transfer (REST) approach for interacting with services.
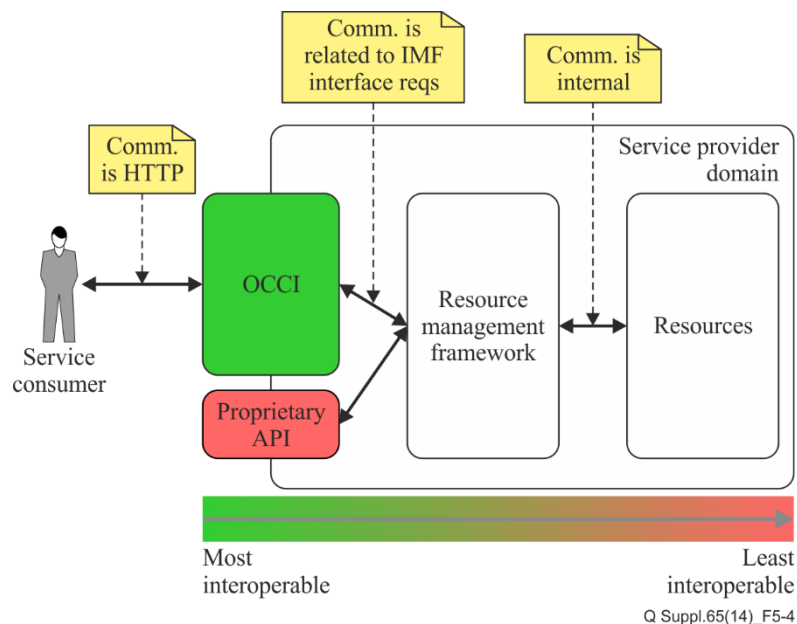
Figure 5-4 – OCCI's place in a provider's architecture (Reference: GFD-P-R.183 OCCI-WG Open Cloud Computing Interface – Core)

Table 5-11 – OGF documents and work items related to CCI

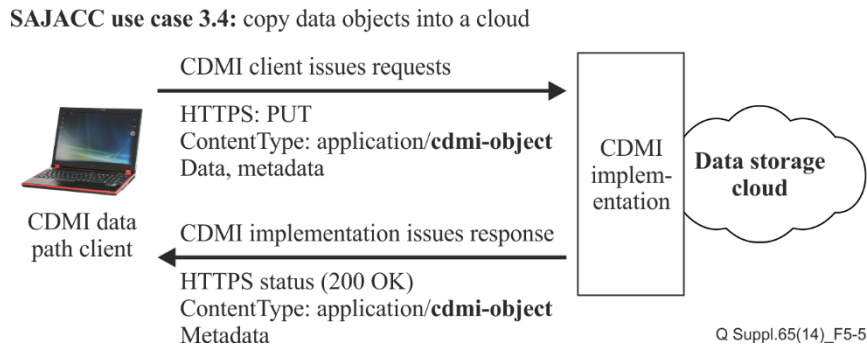| Reference	Name/Title	Status
OGF GFD.183	Open Cloud Computing Interface - Core	published
OGF GFD.184	Open Cloud Computing Interface - Infrastructure	published
OGF GFD.185	Open Cloud Computing Interface - RESTful HTTP Rendering	published
OGF GFD.192	Web Services Agreement Specification (WS-Agreement)	published
OGF GFD.193	WS-Agreement Negotiation	published

5.1.12 SNIA

SNIA is a SDO, published the CDMI as an SNIA architecture (April 2010) and also moving to standardization. SNIA is also a trade association for storage industry promoting the Cloud storage market overall and promoting the adoption of the CDMI standard, and promoting interoperability implementations (Plugfest, test suites, conformance programs). SNIA also produces open source software; CDMI reference implementation is available under BSD license.

SNIA works on cloud computing interface related aspects of the CCI.

CDMI standard defines an interoperable format for moving data and associated metadata between cloud providers interoperability. CDMI is an HTTP/RESTful protocol with TLS support for securing the data, metadata and communications.

SAJACC use case 3.4: copy data objects into a cloud

CDMI client issues requests

HTTPS: PUT
ContentType: application/**cdmi-object**
Data, metadata

CDMI data path client

CDMI implementation issues response

HTTPS status (200 OK)
ContentType: application/**cdmi-object**
Metadata

CDMI implementation

Data storage cloud

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Figure 5-5 – SAJACC Use Case: Copy data objects into a cloud (Reference: SNIA, NIST)

Table 5-12 – SNIA documents and work items related to CCI

Reference	Name/Title	Status
ISO 17826:2012	Cloud data management interface v1.0.2	Published

5.1.13 TM Forum

TM Forum (formerly TeleManagement Forum) is the world's leading industry association focused on improving business effectiveness for service providers and their suppliers, including the production of best practices and standards.

TM Forum works on SLA management related aspects of CCI.

TM Forum published SLA related documents such as SLA Management Handbook [TMF GB917], Cloud SLA Application Note [TMF GB963] and Enterprise-Grade External Compute IaaS Requirements [TMF TR174].

SLA Management Handbook [TMF GB917] provides a full set of definitions, rules and methodology for the specification, deployment and management of SLAs, as well as useful tools and best practices, for use by both customers and service providers.

Cloud SLA Application Note [TMF GB963] is intended for enterprise CSPs desiring to offer a commercially credible SLA based on ECLC "Enterprise-Grade External Compute IaaS v1.0", and for an enterprise customer seeking enterprise-grade SLAs.

Enterprise-Grade External Compute IaaS Requirements [TMF TR174] describes the requirements for enterprise-grade external compute IaaS from the perspective of the enterprise consumer. SLA clarity and cross-service provider commonality of service level definitions are specified in this document as one of the key requirements of enterprise-grade IaaS.

Enabling End-to-End Cloud SLA Management [TMF TR178] recommends a set of business considerations and architecture design principles that are required to support end-to-end cloud SLA

management with the aim to facilitate discussion regarding SLA consistency across cloud deployment models and services models.

Quick Start Pack for Cloud: Trouble to Resolve [TMF GB960] focuses on the detailed specification and delivery of a set of process flows, defined in business process management notation (BPMN), that utilize all currently defined business process framework level 3 process elements within project scope.

Table 5-13 – TM Forum documents and work items related to CCI

Reference	Name/Title	Status
TMF GB917	SLA Management Handbook	Published
TMF GB960	Quick Start Pack for Cloud: Trouble to Resolve	Published
TMF GB963	Cloud SLA Application Note	Published
TMF TR174	Enterprise-Grade External Compute IaaS Requirements	Published
TMF TR178	Enabling End-to-End Cloud SLA Management	Published
TMF TR194	Muli-Cloud Service Management Accelerator Pack-Introduction	Published

5.2 Testing groups, open sources and tools for cloud computing testing

5.2.1 Testing groups

3CPP

China Cloud Computing Promotion and Policy Forum (3CPP) is a non-profit organization initiated by the cloud industry. The objectives of 3CPP include facilitating the communication between government and the industry, and promoting the research on the standards, policies, plans and laws in cloud computing area in China. 3CPP has more than 60 members including Chinese cloud service and infrastructure providers.

3CPP works on cloud computing testing methodology related aspects of CCI.

3CPP initiated "Trusted Cloud Service Certification" in 2013, and established related documents including "Assessment Method for Trusted Cloud Service Certification" and "Cloud Computing Service Level Agreement Reference Framework", etc. In these documents, some evaluation indexes and evaluation methods are defined.

Table 5-14 – 3CPP documents and work items related to CCI

Reference	Name/Title	Status
3CPP TCSA Operation Method	Operation method of trusted cloud service assessment	Published
3CPP TCSC Assessment Method	Assessment method for trusted cloud service certification	Published
YDB144-2014	Cloud service agreement reference framework	Published

http://www.3cpp.org/lab/cloud/trustedcloudev/index.shtml

Cloud Plugfests

The Cloud Interoperability Plugfest series (or "Cloud Plugfests" for short) was originated out of community-based interoperability efforts started by OGF and SNIA in 2011, and expanded to include a variety of support tools provided by these organizations and ETSI to support the community. ETSI joined the Cloud Plugfest series as a full supporting partner in 2012. Furthermore, Cloud Plugfests

developed into a cooperative venue to encourage interoperability on implementations of several relevant cloud software stacks, products and multiple cloud-related standards.

Cloud Plugfests works on cloud computing testing methodology related aspects of CCI. Test descriptions for cloud interoperability delivered by Cloud Plugfest specifies interoperability test descriptions for OCCI and CDMI standards. The test descriptions cover the OCCI and CDMI protocol specifications where relevant and more specifically: 1) OCCI interoperability testing, to prove that end-to-end functionality is as required by the standard. 2) CDMI interoperability testing, to prove that end-to-end functionality is as required by the standard. 3) OCCI + CDMI interworking testing, to prove that end-to-end functionality is as required by the standards. Cloud Plugfests works on cloud computing testing methodology related aspects of CCI.

Table 5-15 – Cloud Plugfests documents and work items related to CCI

Reference	Name/Title	Status
ETSI TS 103 142	CLOUD; Test Descriptions for Cloud Interoperability	Published

CSMIC

Cloud Services Measurement Initiative Consortium (CSMIC) is a consortium formed in May 2010 led by Carnegie Mellon University to address the need for industry-wide, globally accepted measures for calculating the benefits and risks of cloud-computing services.

CSMIC works on cloud computing testing methodology related aspects of CCI.

CSMIC defined service management index (SMI) for measuring any type of cloud services (IaaS, PaaS, SaaS, business process as a service (BPaaS) and big data). Service measurement index framework released in November 2012 and has been updated to version 2 in January 2014 by CSMIC.

The SMI is a hierarchical framework. The top level divides the measurement space into seven categories. Each category is further refined by three or more attributes. Then within each attribute a set of KPIs are defined that describe the data to be collected for each measure/metric.

Table 5-16 – CSMIC documents and work items related to CCI

Reference	Name/Title	Status
SMI Framework Version 2.0 draft	Service measurement index framework Version 2.0 draft	Published

OCC

The Open Cloud Consortium (OCC) is a non-profit organization that manages and operates cloud computing infrastructure to support scientific, medical, health care and environmental research.

The OCC is organized into different working groups. The open cloud testbed (OCT) working group (OCTWG) of OCC manages and operates the OCT. The OCT is a geographically distributed cloud testbed spanning four data centres and connected with 10 G and 100 G network connections. The OCT is used to develop new cloud computing software and infrastructure.

A current focus of the OCC OCTWG is on developing an OpenFlow enabled version of Hadoop, a project support by the National Science Foundation (NSF).

Reports and tools: http://etics.res.eng.it/tools/etics-gui/

OCEAN

Open Cloud for Europe, jApan and beyoNd (OCEAN), a FP7-ICT Support Action Project was established in August 2011 to foster the emergence of sustainable open source Cloud offering and

boost market innovation in Europe, by generating greater efficiency and economics of scale among European FP7 collaborative research projects on open source cloud computing, and to support collaboration between Japanese and European research and open source projects on cloud computing.

SPEC

The Standard Performance Evaluation Corporation (SPEC) is a non-profit corporation formed to establish, maintain and endorse a standardized set of relevant benchmarks.

SPEC released SPECvirt_sc2010 in July 2010. The SPECvirt_sc2010 addresses performance evaluation of data centre servers used in virtualized server consolidation. It measures the end-to-end performance of all system components including the hardware, virtualization platform, and the virtualized guest operating system and application software. SPECvirt_sc2010 enables comparing of system performance across multiple hardware, virtualization platforms and applications.

SPECvirt_sc2010 measures the maximum number of workloads that a platform can simultaneously run while maintaining specific quality of service metrics. Each workload consists of a specific set of virtual machines. The benchmark utilizes several SPEC workloads representing applications that are common targets of virtualization and server consolidation. Scaling is achieved by running additional sets of virtual machines, called "tiles", until overall throughput reaches a peak.

SPEC release SPECvirt_sc2013, the new version of SPECvirt, was issued in May 2013. It utilizes heavier and busier workloads and further stress the system's ability to meet the benchmark's quality of service requirements.

SPECvirt_sc2013 shares the general benchmark architecture from SPECvirt_sc2010, including the benchmark harness and most of the application workloads and VM types. Heavier and more bursty workloads that require virtual machines with more memory and vCPUs and further stress the system's ability to meet the benchmark's quality of service requirements have been added in SPECvirt_sc2013.

Many computer system vendors have submitted SPECvirt benchmark results to SPEC.

5.2.2 Open sources

OpenStack

OpenStack is a global collaboration of developers and cloud computing technologists producing the ubiquitous open source cloud computing platform for public and private clouds. The project aims to deliver solutions for all types of clouds by being simple to implement, massively scalable, and feature rich. The technology consists of a series of interrelated projects delivering various components for a cloud infrastructure solution.

Figure 5-6 – The OpenStack API
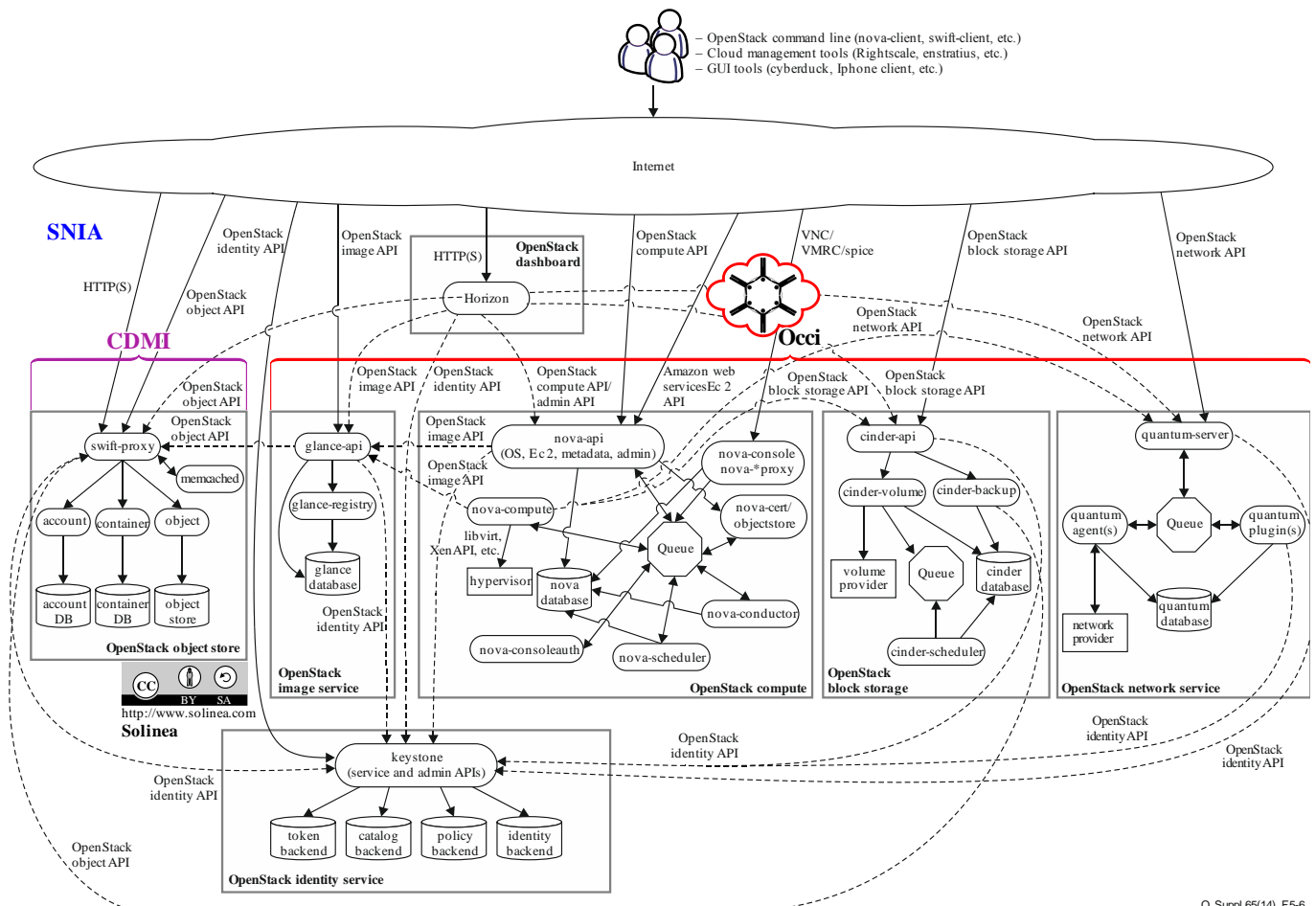
OpenStack works on cloud computing interface related aspects of CCI. It is expected that OpenStack will provide a set of test for cloud computing functions.

Cloud interoperability is one of the most important targets in OpenStack project. In order to provide cloud interoperability, except for native APIs support, OpenStack project also support standardized API implementations in OpenStack project for interoperability insurance. By now, CDMI [ISO 17826:2012] and OCCI [OGF GFD.183] implementation is available for OpenStack. CDMI is used by OpenStack to support container creation, object upload and object retrieve and so on. OCCI is used by OpenStack to support authentication, instance creation, volume attachment and so on. Since OpenStack have implemented standard interoperable cloud API such as CDMI and OCCI, it can provide a suitable cloud interoperability testing environment for specific protocol and helping the study on cloud interoperability testing methodology. Details CDMI implementation for OpenStack refer to https://github.com/osaddon/cdmi. Details OCCI implementation for OpenStack refer to https://github.com/tmetsch/occi-os .

5.2.3 Tools

VMmark

VMmark is a free tool that hardware vendors, virtualization software vendors and other organizations use to measure the performance and scalability of applications running in virtualized environments. VMmark is a free virtual machine benchmark software suite provided by VMware, which is a commercial company that provides cloud and virtualization software and service.

VMware release Vmmark v1 in July 2007. VMmark v1 comprises a series of "sub-tests" that are derived from commonly used load-generation tools. The VMmark benchmark refers to this unit of

work as a tile. The total number of tiles that a system can accommodate provides a coarse-grain measure of that system's consolidation capacity.

VMware released the new version Vmmark, Vmmark v2 in October 2010. VMmark 2 generates a realistic measure of virtualization platform performance by incorporating a variety of platform-level workloads such as dynamic virtual machine relocation (vMotion) and dynamic datastore relocation (storage vMotion), in addition to traditional application-level workloads. The benchmark system in VMmark 2 comprises a series of "sub-tests" that are derived from commonly used load-generation tools and commonly initiated virtualization administration tasks. The VMmark 2 benchmark features a tile-based scheme for measuring application performance and provides a consistent methodology that captures both the overall scalability and individual application performance. The total number of tiles that a multi-host platform can accommodate and the performance of each individual workload within the tile determine the overall benchmark score.

More than ten computer systems have submitted VMmark V2 benchmark results to VMware by now.

5.3 Cloud security standardization activities

Cloud security is an important subject with interoperability testing for the whole areas of CCI. This clause information is for future study in order to take into account the security interoperability aspects.

Several SDOs have begun to study cloud security and several governments are also leading the discussion, releasing documents from a wide security point of view taking into account many stakeholders. For example, European Network Information Security Agency (ENISA) issued Cloud computing security assessment and NIST started Fedramp. Cloud security includes also political aspects because it faces security threats affecting personal and organizational properties. As a result, this supplement lists major SDOs, and references appropriate security-related specifications case by case.

ENISA, CSA, DMTF, NIST, ISO/IEC JTC1/SC27, SC38, ITU-T SG 17, OASIS (Identity in the Cloud TC) are discussing Cloud security.

- CSA https://cloudsecurityalliance.org/
- DMTF http://www.dmtf.org/
- ENISA http://www.enisa.europa.eu/
- ISO/IEC JTC1/SC27 and SC38 http://www.iso.org/iso/jtc1_home.html
- ITU-T SG 17 http://www.itu.int/en/ITU-T/studygroups/2013-2016/17/Pages/default.aspx
- NIST http://www.nist.gov/itl/cloud/
- OASIS https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=id-cloud

In ITU-T, Study Group 17 (SG 17) has been designated the lead study group for "Telecommunication Security" which includes developing and maintaining security outreach material; coordination of security-related work; and identification of needs and assignment and prioritization of work to encourage timely development of telecommunication security Recommendations.

6 Potential interoperability testing areas of cloud computing

Cloud computing involves a wide variety of technologies, from distributed processing to virtualization. The types of capabilities offered are also diverse: from IaaS, in which the cloud capabilities type provided to the CSC is an infrastructure capabilities type, and PaaS, in which the cloud capabilities type provided to the CSC is a platform capabilities type, to SaaS, in which the cloud capabilities type provided to the CSC is an application capabilities type.

The targets of cloud computing standardization are so diverse that many standards organizations are studying cloud computing focusing on their respective areas of expertise. Taking into consideration

the targets of interoperability testing in clause 5, it is possible to identify the targets for interoperability testing as the follows:

•   Target area A: Interaction between CSC and CSP (between user layer and access layer);

•   Target area B: Collaboration among different cloud services (between service layers including inter-cloud);

•   Target area C: Consistent and interoperable of manage interface (between multi-layer functions (e.g., BSS/OSS) and cloud services);

•   Target area D: Collaboration with legacy network.

NOTE – Collaboration with legacy network is not defined in [ITU-T Y.3502]. Target area D is not illustrated in Figure 6-1.

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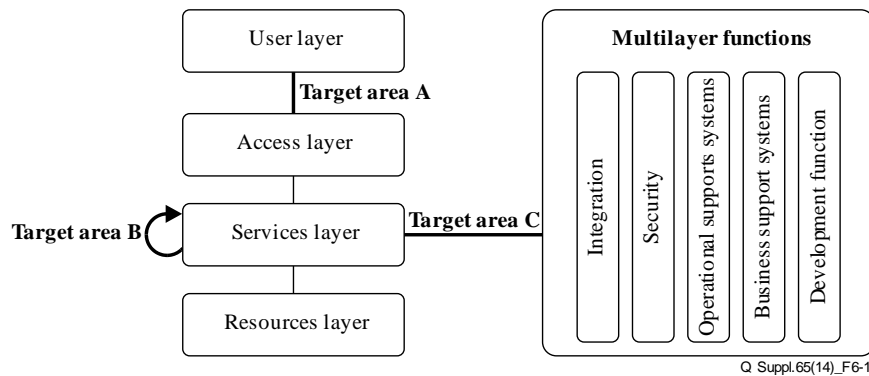
Figure 6-1 – Potential cloud computing interoperability target areas

There are three different cloud computing capabilities types:

•   Infrastructure capabilities type ;

•   Platform capabilities type ;

•   Application capabilities type.

Different cloud capabilities types have different interoperability testing.

Table 6-1 shows the potential interoperability testing target areas of cloud computing with different cloud computing capabilities types. It is useful to identify the target areas. Each target area should include functional testing as well as performance testing.

Table 6-1 Potential cloud computing interoperability testing areas

Capability type / Target areas	Infrastructure capabilities type	Platform capabilities type	Application capabilities type
Target area A: CSC – CSP			
Target area B: CSP – CSP			
Target area C: CSP – management interface			
Target area D:CSP – legacy network			
"CSC – CSP" means interaction between CSC and CSP. "CSP – CSP" means collaboration among different cloud services. "CSP – management interface" means consistent and interoperable management interface. "CSP – legacy network" means collaboration with legacy network.			

Appendix I

Summaries of referenced documents

I.1 3CPP references and associated summaries

[3CPP TCSA Operation Method] – Operation method of trusted cloud service assessment

[3CPP TCSC Assessment Method] – Assessment method for trusted cloud service certification

[YDB144-2014] – Cloud service agreement reference framework

I.2 CSMIC references and associated summaries

[SMI Framework Version 2.0 draft] – Service measurement index framework Version 2.0 draft

I.3 DMTF references and associated summaries

[DSP-IS0101] – Interoperable clouds

This white paper describes a snapshot of the work being done in the DMTF Open Cloud Standards Incubator, including use cases and reference architecture as they relate to the interfaces between a CSP and a cloud service consumer. The goal of the Incubator is to define a set of architectural semantics that unify the interoperable management of enterprise and cloud computing. This paper summarizes the core use cases, reference architecture and service lifecycle. These building blocks will be used to specify the cloud provider interfaces, data artefacts and profiles to achieve interoperable management.

[DSP0264] – CIMI-CIM specification

This document defines a CIM representation for the CIMI logical model.

[DSP0263] –CIMI model and RESTful HTTP-based protocol

This specification describes the model and protocol for management interactions between a cloud IaaS provider and the consumers of an IaaS service. The basic resources of IaaS (machines, storage and networks) are modelled with the goal of providing consumer management access to an implementation of IaaS and facilitating portability between cloud implementations that support the specification. This document specifies a REST-style protocol using HTTP. However, the underlying model is not specific to HTTP, and it is possible to map it to other protocols as well.

[DSP0243] – Open virtualization format specification

This document describes an open, secure, portable, efficient and extensible format for the packaging and distribution of software to be run in virtual machines.

I.4 ETSI references and associated summaries

[ETSI TS 103 142] – CLOUD: Test descriptions for Cloud Interoperability

This document specifies interoperability test descriptions for OCCI and CDMI standards. The test descriptions cover the OCCI and CDMI protocol specifications where relevant and more specifically: 1) OCCI interoperability testing, to prove that end-to-end functionality is as required by the standard. 2) CDMI interoperability testing, to prove that end-to-end functionality is as required by the standard. 3) OCCI + CDMI interworking testing, to prove that end-to-end functionality is as required by the standards.

[ETSI TR 103 125] – CLOUD: SLAs for Cloud services

This document aims to review previous work on SLAs including ETSI guides from TC USER and contributions from EuroCIO, etc. and to derive potential requirements for cloud specific SLA standards.

[ETSI TR 103 126] – CLOUD: Cloud private-sector user recommendations

This document provides an overview of private sector user recommendations for cloud services especially from the viewpoint of large enterprises in the European context.

[ETSI TR 102 997] – CLOUD: Initial analysis of standardization requirements for Cloud services

This document describes standardization requirements for cloud services. It is based on the outcome of the ETSI TC GRID workshop, "Grids, Clouds and Service Infrastructures", 2nd and 3rd of December 2009. This event brought together key stakeholders of the grid, cloud and telecommunication domains to review state of the art and current trends. Needs for standardization, with a particular focus on the emerging area of cloud computing and services, were discussed. This document introduces and expands on the conclusions reached.

I.5   GICTF references and associated summaries

Intercloud interface specification draft (cloud resource data model)

The purpose of this document is to identify the functional requirements of inter-cloud systems and describe an inter-cloud interface in specific terms.

Intercloud interface specification draft (intercloud protocol)

The purpose of this document is to identify the functional requirements of inter-cloud systems and describes an inter-cloud interface in specific terms.

Technical requirements for supporting the intercloud networking

This paper attempts to clarify the "Technical requirements for the inter-cloud network which interconnects among cloud systems" and the "Expected functions in cloud systems from network perspective".

Use cases and functional requirements for inter-cloud computing

This document describes the required functionalities for inter-cloud systems and the requirements for inter-cloud interfaces.

I.6   IEEE references and associated summaries

[IEEE P2301] – Guide for Cloud Portability and Interoperability Profiles (CPIP)

The purpose of CCIP is to advise cloud computing ecosystem participants (cloud vendors, service providers, and users) of standards-based choices in areas such as application interfaces, portability interfaces, management interfaces, interoperability interfaces, file formats, and operation conversions. CCIP group these choices into multiple logical profiles, which are organized to address different cloud personalities.

[IEEE P2302] – Standard for Intercloud Interoperability and Federation (SIIF)

SIIF is to define topology, functions, and governance for cloud-to-cloud interoperability and federation. Topological elements include clouds, roots, exchanges (which mediate governance between clouds), and gateways (which mediate data exchange between clouds). Functional elements include name spaces, presence, messaging, resource ontologies (including standardized units of measurement), and trust infrastructure. Governance elements include registration, geo-independence,

trust anchor and potentially compliance and audit. The standard does not address intra-cloud (within cloud) operation, as this is cloud implementation-specific, nor does it address proprietary hybrid-cloud implementations.

I.7   IETF references and associated summaries

[IETF RFC 2330] – Framework for IP Performance Metrics

[IETF RFC 4110] – A Framework for Layer 3 Provider-Provisioned Virtual Private Networks

[IETF RFC 6749] – The OAuth 2.0 Authorization Framework

[I-D. draft-ietf-scim-core-schema-03] – System for Cross-domain Identity Management: Core Schema

[I-D. draft-ietf-scim-core-schema-03] – System for Cross-domain Identity Management: Core Schema

[I-D. draft-khasnabish-cloud-reference-framework] – Cloud reference framework

I.8   ISO/IEC JTC 1 references and associated summaries

[ISO/IEC WD 17788] – Cloud Computing Vocabulary

[ISO/IEC DIS 17789] – Topology and orchestration specification for cloud applications (TOSCA) Version 1.0

I.9   NIST references and associated summaries

[NIST SAJACC Internal Group Report] – SAJACC working group recommendations to NIST

This document describes the work done by the SAJACC working group so far, which has resulted in a set of preliminary use cases developed for the first pass through the SAJACC process and a set of initial demonstration validation evaluations. Through a series of open workshops, and through public comment and feedback, NIST will continue to refine these use cases and add new use cases as appropriate.

[NIST SAJACC White Paper] – Virtual machine portability white paper

This white paper describes the current technologies, formats and tools that support virtual machine (VM) portability. It identifies challenges and opportunities for further improvements to interoperability, and presents a high-level summary of key VM portability problems faced by cloud consumers today.

[NIST SP 800-145] – The NIST Definition of Cloud Computing

The NIST definition characterizes important aspects of cloud computing and is intended to serve as a means for broad comparisons of cloud services and deployment strategies, and to provide a baseline for discussion from what is cloud computing to how to best use cloud computing. The service and deployment models defined form a simple taxonomy that is not intended to prescribe or constrain any particular method of deployment, service delivery or business operation.

[NIST SP 500-292] – NIST Cloud Computing Reference Architecture

This document presents the NIST cloud computing reference architecture (RA) and taxonomy (Tax) that will accurately communicate the components and offerings of cloud computing. The guiding principles used to create the RA were 1) develop a vendor-neutral architecture that is consistent with the NIST definition and 2) develop a solution that does not stifle innovation by defining a prescribed technical solution.

[NIST SP 500-293vol1] – US Government Cloud Computing Technology Roadmap Volume I Release 1.0: High-Priority Requirements to Further USG Agency Cloud Computing Adoption

Volume I to the US Government Cloud Computing Technology Roadmap, an interagency document developed to foster adoption of cloud computing by federal agencies and supports the private sector, and reduces uncertainty by improving the information available to decision.

[NIST SP 500-293vol2] – US Government Cloud Computing Technology Roadmap Volume II Release 1.0: Useful Information for Cloud Adopters

Volume I to the US Government Cloud Computing Technology Roadmap, an interagency document developed to foster adoption of cloud computing by federal agencies and supports the private sector, and reduces uncertainty by improving the information available to decision.

I.10   OASIS references and associated summaries

[OASIS TOSCA-v1.0] – Topology and Orchestration Specification for Cloud Applications Version 1.0

I.11   ODCA references and associated summaries

[ODCA SAAS_Interop_UM_Rev1.0] – Software as a service (SaaS) interoperability

This usage model outlines five usage scenarios based on two perspectives of interoperability, along with success and failure scenarios for each. In addition, service provider requirements and an industry call to action are presented.

[ODCA PAAS_Interop_UM_Rev1.0] – Platform as a service (PaaS) interoperability

This paper outlines five usage scenarios, along with success and failure scenarios for each. Finally, CSP requirements and an industry call to action are presented.

[ODCA VM_Interoperability_in_a Hybrid_Cloud_Enviroment_rev1.2] – Virtual machine (VM) Interoperability in a hybrid cloud environment

This document addresses a number of important additional dimensions including extending the portability concept, extending the life cycle model with states and conditions, and increased alignment with external activities such as that of the OVF specification

[ODCA VM_Interop_PoC_White_Paper] – Implementing the open data center alliance virtual machine interoperability usage model

A team led by T-Systems Telekom Innovation Laboratories, the FZI research team from the University of Karlsruhe and supported by Intel Corporation carried out a PoC project to implement the usages described in the document, described in this report.

I.12   OGF references and associated summaries

[OGF GFD.183] Open Cloud Computing Interface – Core

The OCCI core specification defines the OCCI core model. The OCCI core model can be interacted with renderings (including associated behaviours) and expanded through extensions.

[OGF GFD.184] – Open Cloud Computing Interface – Infrastructure

OCCI Infrastructure contains the definition of the OCCI Infrastructure extension for the IaaS domain. The specification defines additional resource types, their attributes and the actions that can be taken on each resource type.

[OGF GFD.185] – Open Cloud Computing Interface – RESTful HTTP Rendering

The OCCI HTTP rendering defines how to interact with the OCCI core model using the RESTful OCCI API. The specification defines how the OCCI core model can be communicated and thus serialized using the HTTP protocol.

[OGF GFD.192] – Web Services Agreement Specification (WS-Agreement)

The web services agreement specification (WS-Agreement), a web services protocol for establishing agreement between two parties, such as between a service provider and consumer.

[OGF GFD.193] – WS-Agreement Negotiation

The WS-Agreement Negotiation specification, a web services protocol for multi-round negotiation of an agreement between two parties, such as between a service provider and consumer. Works on top of WS-Agreement.

I.13   SNIA references and associated summaries

[ISO 17826:2012] – Cloud Data Management Interface

CDMI specifies the interface to access cloud storage and to manage the data stored therein. It is applicable to developers who are implementing or using cloud storage.

I.14   TMF references and associated summaries

[TMF GB917] – SLA Management Handbook

This document provides a full set of definitions, rules and methodology for the specification, deployment and management of SLAs, as well as useful tools and best practices, for use by both customers and service providers.

[TMF GB963] – Cloud SLA Application Note

This document is intended for enterprise CSPs desiring to offer a commercially credible SLA based on ECLC "Enterprise-Grade External Compute IaaS v1.0", and for an enterprise customer seeking enterprise-grade SLAs.

[TMF TR174] – Enterprise-grade IaaS requirements

This document describes the requirements for enterprise-grade external compute IaaS from the perspective of the enterprise consumer. SLA clarity and cross-service provider commonality of service level definitions are specified in this document as one of the key requirements of enterprise-grade IaaS.

[TMF TR178] – Enabling End-to-End Cloud SLA Management

This documents describes the requirements for enabling end-to-end cloud SLA management, which recommends a set of business considerations and architecture design principles that are required to support end-to-end cloud SLA management with the aim to facilitate discussion regarding SLA consistency across cloud deployment models and services models.

[TMF TR194] – Muli-Cloud Service Management Accelerator Pack-Introduction

Overview of multi-cloud management business challenges and how TM Forum is addressing them.

I.15   ITU-T draft Recommendation

[ITU-T Y.3512] – Cloud computing – Functional requirements of Network as a Service

This Recommendation provides use cases and functional requirements of network as a service (NaaS), one of the representative cloud service categories. This Recommendation covers the following:

•   High level concept of NaaS;

•   Functional requirements for NaaS;

•   Typical use cases for NaaS.

This Recommendation provides use cases and requirements of NaaS application, NaaS platform and NaaS connectivity services. General requirements on NaaS can be found at [ITU-T Y.3501].

[ITU-T Y.3513] – Cloud computing – Functional requirements of Infrastructure as a service

This Recommendation provides use cases and functional requirements of IaaS, one of the representative cloud service categories. This Recommendation covers the following:

•   General description of IaaS;

•   Functional requirements for IaaS;

•   Typical use cases for IaaS.

[ITU-T Y.e2ecslm-Req] – ITU-T draft Recommendation Y.35xx, End-to-end cloud service lifecycle management

This draft Recommendation describes the functional requirement of the lifecycle for service management aspects of cloud services. The cloud service lifecycle management involves charging events management, policy management, management of role related information, service/application provisioning, resource management, context management and content management

[ITU-T Y.e2ecmrgb] – ITU-T draft Recommendation Y.35xx, Common model for End-to-End Cloud Computing Resource Management

This draft Recommendation:

–   Provides a model, based on SES simple management interfaces (SMIs), for all layers of cloud computing reference architecture.

–   Demonstrates how such approach would result in development and deployment of fundamentally manageable cloud computing applications and solutions, in an end-to-end, multi-cloud environment, independent of choice of technology, run-time, programming language or tools made to develop the solutions.

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