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SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Testing specifications – Testing specifications for Cloud computing

Cloud computing infrastructure capabilities interoperability testing – part 1: Interoperability testing between the CSC and CSP

Recommendation ITU-T Q.4041.1

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Recommendation ITU-T Q.4041.1

Cloud computing infrastructure capabilities interoperability testing – part 1: Interoperability testing between the CSC and CSP

Summary

Recommendation ITU-T Q.4041.1 specifies the cloud computing infrastructure capabilities type interoperability testing between the CSC and CSP, including interoperability testing of computing services, storage services, network services and related management functions, based on the functional requirements specified in Recommendation ITU-T Y.3513. The test cases of cloud computing infrastructure capabilities type interoperability testing between the CSC and CSP have also been introduced.

Keywords

Cloud computing, infrastructure capabilities, interoperability testing.

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Cloud computing infrastructure capabilities interoperability testing – part 1: Interoperability testing between the CSC and CSP

1 Scope

This Recommendation specifies the cloud computing infrastructure capabilities type interoperability testing between the CSC and CSP, including interoperability testing of computing services, storage services, network services and related management functions, based on the functional requirements specified in [ITU-T Y.3513].

The scope of this Recommendation consists of:

– Overview of cloud computing infrastructure capabilities type interoperability testing between the CSC and CSP;

– computing service interoperability testing between the CSC and CSP;

– storage service interoperability testing between the CSC and CSP;

– network service interoperability testing between the CSC and CSP.

NOTE – This Recommendation is the first part of cloud computing infrastructure capabilities type interoperability testing, which focuses on validating the infrastructure capabilities type functions provided by the CSP to the CSC. The second part focuses on validating the interaction between CSPs in the inter-cloud environment.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Q.4040]   Recommendation ITU-T Q.4040 (2016), *The framework and overview of cloud computing interoperability testing.*

[ITU-T Y.101]   Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions.*

[ITU-T Y.3500]   Recommendation ITU-T Y.3500 (2014) | ISO/IEC 17788:2014, *Information technology –Cloud computing – Overview and vocabulary.*

[ITU-T Y.3502]   Recommendation ITU-T Y.3502 (2014) | ISO/IEC 17789:2014, *Information technology – Cloud computing – Reference architecture.*

[ITU-T Y.3513]   Recommendation ITU-T Y.3513 (2014), *Cloud computing – Functional requirements of Infrastructure as a Service.*

[ISO/IEC 19941]   ISO/IEC 19941 (2017), *Information technology – Cloud computing – Interoperability and portability.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 activity [ITU-T Y.3502]: A specified pursuit or set of tasks.

3.1.2 cloud interoperability [ITU-T Q.4040]: The capability to interact between CSCs and CSPs or between different CPSs, including the ability of CSCs to interact with cloud services and exchange information, the ability for one cloud service to work with other cloud services, and the ability for CSCs to interact with the cloud service management facilities of the CSPs.

3.1.3 cloud interoperability testing [ITU-T Q.4040]: Verifying functions and interaction that realize the cloud interoperability.

3.1.4 cloud service [ITU-T Y.3500]: One or more capabilities offered via cloud computing invoked using a defined interface.

3.1.5 cloud service customer [ITU-T Y.3500]: Party which is in a business relationship for the purpose of using cloud services.

3.1.6 cloud service provider [ITU-T Y.3500]: Party which makes cloud services available.

3.1.7 cloud service user [ITU-T Y.3500]: Natural person, or entity acting on their behalf, associated with a cloud service customer that uses cloud services.

NOTE – Examples of such entities include devices and applications.

3.1.8 interoperability [ITU-T Y.101]: The ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CPU	Central Processing Unit
CSC	Cloud Service Customer
CSP	Cloud Service Provider
DHCP	Dynamic Host Configuration Protocol
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
IaaS	Infrastructure as a Service
IOPS	Input/Output operations Per Second
I/O	Input/Output
IP	Internet Protocol
LUN	Logical Unit Number
NAT	Network Address Translation

NIC	Network Interface Card
OVF	Open Virtualization Format
QCOW2	QEMU Copy On Write version 2
QEMU	Quick Emulator
QoS	Quality of Service
SLA	Service Level Agreement
SSH	Secure Shell
VLAN	Virtual Local Area Network
VM	Virtual Machine
VMDK	Virtual Machine Disk
VNC	Virtual Network Computing

5 Conventions

In this Recommendation, the keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

6 Overview of cloud computing infrastructure capabilities type interoperability testing between the CSC and CSP

Cloud interoperability is the ability of a CSC's system to interact with a cloud service, or the ability of one cloud service to interact with another cloud service, by exchanging information according to a prescribed method to obtain predictable results [ISO/IEC 19941]. The goal for cloud infrastructure capabilities type interoperability testing is to devise and implement testing methods and conduct a basic set of functional tests for infrastructure capabilities type interoperability in a hybrid cloud environment using both private and public clouds [ITU-T Q.4040].

The cloud computing infrastructure capabilities type interoperability testing can be divided into two parts; the first part focuses on validating the infrastructure capabilities type functions provided by the CSP to the CSC, and the second part focuses on validating the interaction between CSPs in the inter-cloud environment. The scope of this Recommendation is to validate the interaction between the CSC and CSP with infrastructure capabilities.

Infrastructure as a Service (IaaS) provides computing service functions, storage service functions and network service functions to the CSC [ITU-T Y.3513]. All the functional requirements specified in [ITU-T Y.3513] should be validated. It is recommended to consider the following for cloud computing infrastructure capabilities type interoperability testing:

• Computing service interoperability testing between the CSC and CSP

   – It is recommended to verify that the CSP provides a computing service to the CSC, including virtual machine (VM) configuration, VM migration, VM snapshot, VM clone, VM time synchronization, VM reservation, VM image, VM template, VM scaling and VM backup.

   – It is recommended to verify that the CSP provides computing service related management functions to the CSC, including life cycle management of the VM and physical machine, and VM and physical machine configuration inquiring.

- Storage service interoperability testing between the CSC and CSP
  - It is recommended to verify that the CSP provides a storage service to the CSC, including storage migration, storage snapshot, storage backup, storage resource reservation and I/O performance.
  - It is recommended to verify that the CSP provides storage service related management functions to the CSC, including storage life cycle management, storage utilization status inquiring.
- Network service interoperability testing between the CSC and CSP
  - It is recommended to verify that the CSP provides network service to the CSC, including network policy migration, network QoS, network address translation (NAT), network isolation, IP address allocation, IP address reservation, load balance, firewall and multipath routing.
  - It is recommended to verify that the CSP provides network service related management function to the CSC, including network information inquiring.

This Recommendation describes cloud computing infrastructure capabilities type interoperability testing from the functional perspective without distinguish five facets (transport, syntactic, semantic data, behavioural and policy) which were defines by [ISO/IEC 19941]. However, all the considerations described in [ISO/IEC 19941] are taking into account for better understanding of the cloud computing infrastructure capabilities type interoperability testing.

7 Computing service interoperability testing between the CSC and CSP

Computing service interoperability testing between the CSC and CSP valuates the interaction between the CSC and CSP for computing service and related management functions, which include VM configuration, VM migration, VM snapshot, VM clone, VM time synchronization, VM reservation, VM image, VM template, VM scaling, VM backup, life cycle management of the VM and physical machine, and VM and physical machine configuration inquiring. For a description of related functional requirements refer to [ITU-T Y.3513].

7.1 Interoperability testing of VM configuration between the CSC and CSP

The test object of VM configuration is to verify that the CSC configures the VM with processors, hard disks, memory and NIC parameters. The test case of VM configuration can be found in Appendix II.1.1.

7.2 Interoperability testing of VM migration between the CSC and CSP

The test object of VM migration is to verify that the CSC migrates the VM from a particular host to another host. The test case of VM migration can be found in Appendix II.1.2.

7.3 Interoperability testing of VM snapshot between the CSC and CSP

The test object of VM snapshot is to verify that the CSC captures the state (VM memory, settings, and virtual disks) of the VM by taking snapshots of it and rolling back to the previous VM state when needed. The test case of VM snapshot can be found in Appendix II.1.3.

7.4 Interoperability testing of VM clone between the CSC and CSP

The test object of VM clone is to verify that the CSC clones a particular VM and the cloned VM has identical configuration and CSP/CSC data as the original one. The test case of VM clone can be found in Appendix II.1.4.

7.5 Interoperability testing of VM time synchronization between the CSC and CSP

The test object of VM time synchronization is to verify that the CSC sets VM time synchronization manually or automatically. The test case of VM time synchronization can be found in Appendix II.1.5.

7.6 Interoperability testing of VM reservation between the CSC and CSP

The test object of VM reservation is to verify that the CSC reserves available computing resources (CPU, memory) for particular VM before it is initiated. The test case of VM reservation can be found in Appendix II.1.6.

7.7 Interoperability testing of VM image between the CSC and CSP

The test object of VM image is to verify that the CSC creates a new VM by VM image, which consists of infrastructure configuration and CSP data, CSC data or both. The test case of VM image can be found in Appendix II.1.7.

7.8 Interoperability testing of VM template between the CSC and CSP

The test object of VM template is to verify that the CSC creates VMs by VM template, including the open virtualization format (OVF). The test case of VM template can be found in Appendix II.1.8.

7.9 Interoperability testing of VM scaling between the CSC and CSP

The test object of VM scaling is to verify that the CSC changes the scale of VMs dynamically based on the scaling policies and monitored events of the VM; this includes configuration change (e.g., CPU, memory, network bandwidth increased or decreased) and components change (new VM added or removed). The test case of VM scaling can be found in Appendix II.1.9.

7.10 Interoperability testing of VM backup between the CSC and CSP

The test object of VM backup is to verify that the CSC obtains the configuration and data of a particular VM by making a backup and restoring the VM. The test case of VM backup can be found in Appendix II.1.10.

7.11 Interoperability testing of VM life cycle management between the CSC and CSP

The test object of VM life cycle management is to verify that the CSC manages the VM with various operations including start, shutdown, restart, suspend and resume VM. The test case of VM life cycle management can be found in Appendix II.1.11.

7.12 Interoperability testing of physical machine life cycle management between the CSC and CSP

The test object of physical machine life cycle management is to verify that the CSC manages the physical machine with various operations including start, shutdown, hibernate and wake-up. The test case of physical machine life cycle management can be found in Appendix II.1.12.

7.13 Interoperability testing of VM configuration inquiring between the CSC and CSP

The test object of VM configuration inquiring is to verify that the CSC inquires VM configuration with the CPU number, memory allocated, NIC number and IP address allocated. The test case of VM configuration inquiring can be found in Appendix II.1.13.

7.14 Interoperability testing of physical machine configuration inquiring between the CSC and CSP

The test object of physical machine configuration inquiring is to verify that the CSC inquires physical machine configuration with the number of CPU cores, memory size, disk size and NIC number. The test case of physical machine configuration inquiring can be found in Appendix II.1.14.

8 Storage service interoperability testing between the CSC and CSP

Storage service interoperability testing between the CSC and CSP valuates the interaction between the CSC and CSP for storage service and related management functions; these include storage migration, storage snapshot, storage backup, storage resource reservation, I/O performance, storage life cycle management and storage utilization status inquiring. For a description of related functional requirements refer to [ITU-T Y.3513].

8.1 Interoperability testing of storage migration between the CSC and CSP

The test object of storage migration is to verify that the CSC migrates data of the VM to different storage media without any loss. The test case of storage migration can be found in Appendix II.2.1.

8.2 Interoperability testing of storage snapshot between the CSC and CSP

The test object of storage snapshot is to verify that the CSC preserves and recovers the state and data of storage. The test case of storage snapshot can be found in Appendix II.2.2.

8.3 Interoperability testing of storage backup between the CSC and CSP

The test object of storage backup is to verify that the CSC backs up and restores data when faulty or data loss occurs. The test case of storage backup can be found in Appendix II.2.3.

8.4 Interoperability testing of storage resource reservation between the CSC and CSP

The test object of storage resource reservation is to verify that the CSC reserves available storage resources (e.g., storage space and LUN) for the VM. The test case of storage resource reservation can be found in Appendix II.2.4.

8.5 Interoperability testing of I/O performance between the CSC and CSP

The test object of I/O performance is to verify that the CSC constrains the I/O traffic of a particular VM with a specified level. The test case of I/O performance can be found in Appendix II.2.5.

8.6 Interoperability testing of storage life cycle management between the CSC and CSP

The test object of storage life cycle management is to verify that the CSC manages storage with various operations including create, attach, detach, query and delete storage. The test case of storage life cycle management can be found in Appendix II.2.6.

8.7 Interoperability testing of storage utilization status inquiring between the CSC and CSP

The test object of storage utilization status inquiring is to verify that the CSC inquires storage utilization status information including used space and unused space of storage. The test case of storage utilization status inquiring can be found in Appendix II.2.7.

9 Network service interoperability testing between the CSC and CSP

Network service interoperability testing between the CSC and CSP valuates the interaction between the CSC and CSP for network service and related management functions, which include network policy migration, network QoS, network address translation, network isolation, IP address allocation, IP address reservation, load balance, firewall, multipath routing and network information inquiring. For a description of related functional requirements refer to [ITU-T Y.3513].

9.1 Interoperability testing of network policy migration between the CSC and CSP

The test object of network policy migration is to verify that the CSC migrates the VM while the network policy (generally includes access control list, bandwidth limitation and priority policy) is consistent before and after VM migration. The test case of network policy migration can be found in Appendix II.3.1.

9.2 Interoperability testing of network QoS between the CSC and CSP

The test object of network QoS is to verify that the CSC configures network QoS for the VM, including bandwidth limitation, bandwidth reservation, traffic shaping, traffic classification and congestion avoidance. The test case of network QoS can be found in Appendix II.3.2.

9.3 Interoperability testing of network address translation between the CSC and CSP

The test object of network address translation is to verify that the CSC configures the mapping between an internal IP address and external IP address of a specific VM. The test case of network address translation can be found in Appendix II.3.3.

9.4 Interoperability testing of network isolation between the CSC and CSP

The test object of network isolation is to verify that the CSC's tenant network is isolated even though the network address is overlapped with another tenants' network. The test case of network isolation can be found in Appendix II.3.4.

9.5 Interoperability testing of IP address allocation between the CSC and CSP

The test object of IP address allocation is to verify that the CSC allocates an IP address to the VM statically or dynamically. The test case of IP address allocation can be found in Appendix II.3.5.

9.6 Interoperability testing of IP address reservation between the CSC and CSP

The test object of IP address reservation is to verify that the CSC reserves an IP address or a range of IP addresses for specific VM(s). The test case of IP address reservation can be found in Appendix II.3.6.

9.7 Interoperability testing of load balance between the CSC and CSP

The test object of load balance is to verify that the CSC deploys a load balance mechanism for multiple VMs in order to achieve scalability and fault tolerance of an application. The test case of load balance can be found in Appendix II.3.7.

9.8 Interoperability testing of firewall between the CSC and CSP

The test object of firewall is to verify that the CSC monitors and controls incoming and outgoing VM traffic based on predetermined security rules. The test case of firewall can be found in Appendix II.3.8.

9.9   Interoperability testing of multipath routing between the CSC and CSP

The test object of multipath routing is to verify that the CSC accesses cloud services through multiple network paths. The test case of multipath routing can be found in Appendix II.3.9.

9.10   Interoperability testing of network information inquiring between the CSC and CSP

The test object of network information inquiring is to verify that the CSC inquires network information from the CSP with network device(s) specification, network traffic performance (in terms of throughput, jitter, loss, delay) and network topology. The test case of network address inquiring can be found in Appendix II.3.10.

Appendix I

Test case template

(This appendix does not form an integral part of this Recommendation.)

Table I.1 provides a test case template to describe cloud computing infrastructure capability type interoperability testing between the CSC and CSP. The test case template is designed with reference to relevant technical specifications. As shown in the table, an interoperability test case consists of test purpose, reference, test sequence and test verdict.

–   Test purpose is a statement that specifies which test case to verify.

–   Reference of the test case provides list of references to the base specification clause(s), use case(s), requirement(s), etc. which are either used in the test or define the functionality being tested.

–   The test sequences provide the steps required to perform the test. There are two types of test step. A stimulus corresponds to an event that triggers a specific action on the object under test. There is no need to provide result for a stimulus step. A check consists of observing that the object under test behaves as described. A result must be provided for every check step. If the object under test behaves as described in the description of the check step, the result should be recorded as OK, otherwise the result should be recorded as fail.

–   For every test case, test verdict should be provided to indicate whether the test is passed.

Table I.1 – Test case template

Interoperability test description				
Test purpose	A concise summary of the test reflecting its purpose and allowing readers to easily distinguish this test from any other test in the document.			
Reference	List of references to the base specification clause(s), use case(s), requirement(s), etc., which are either used in the test or define the functionality being tested.			
Test sequences	Step	Type	Description	Result
	1	Stimulus	A stimulus corresponds to an event that triggers a specific action on the object under test. There is no need to provide 'Result' for a stimulus step.	There is no need to provide 'Result' for a stimulus step.
	2	Check	A check consists of observing that the object under test behaves as described. A result must be provided for every check step. If the object under test behaves as described in the description of the check step, the result should be recorded as OK, otherwise the result should be recorded as fail.	A result must be provided for every check step.
Test verdict	It is deemed as successfully terminated if all/or one check(s) is (are) successful, otherwise it is deemed as failed.			

Appendix II

Test cases for cloud computing infrastructure capabilities interoperability testing between the CSC and CSP

(This appendix does not form an integral part of this Recommendation.)

II.1 Test cases for computing service interoperability testing between the CSC and CSP

II.1.1 Test case: VM configuration

Table II.1 – Test case: VM configuration

VM configuration test description				
Test purpose	To verify that the CSC configures the VM with processors, hard disks, memory and NIC parameters.			
Reference	[ITU-T Y.3513] clause 7.1.2			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures the processor parameters of the VM, in the permissible range of physical resources conditions.	
	2	Check	Processor parameters configuration is in effect. The processor of the VM is consistent with the parameters specified in step 1.	
	3	Stimulus	The CSC configures the hard disk parameters of the VM, in the permissible range of physical resources conditions.	
	4	Check	Hard disk parameters configuration is in effect. The hard disks of the VM are consistent with the parameters specified in step 3.	
	5	Stimulus	The CSC configures the NIC parameters of the VM, in the permissible range of physical resources conditions.	
	6	Check	NIC parameters configuration is in effect. The NIC of the VM is consistent with parameters specified in step 5.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.2   Test case: VM migration

Table II.2 shows the test case for VM migration.

Table II.2 – Test case: VM migration

VM migration test description				
Test purpose	To verify that the CSC migrates the VM from a particular host to another host.			
Reference	[ITU-T Y.3513] clause 7.1.3			
	Step	Type	Description	Result
	1	Stimulus	The CSC migrates the VM in power off state to another host.	
	2	Stimulus	The CSC starts the VM.	
	3	Check	The VM is running on the target host without any changes.	
	4	Stimulus	The CSC migrates the running VM to another host.	
	5	Check	The VM is running on the target host without any changes; the service carried by the VM is still on during the migration.	
Test verdict	It is deemed as successfully terminated if at least one check is successful, otherwise it is deemed as failed.			

II.1.3   Test case: VM snapshot

Table II.3 shows the test case for VM snapshot.

Table II.3 – Test case: VM snapshot

VM snapshot test description				
Test purpose	To verify that the CSC captures the state (VM memory, settings and virtual disks) of the VM by taking snapshots and rolling back to the previous VM state when needed.			
Reference	[ITU-T Y.3513] clause 7.1.5			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC uses an application running on a VM.	
	2	Stimulus	The CSC takes a snapshot (with memory state) of the VM, called snapshot A.	
	3	Stimulus	The CSC makes some changes to the application and closes it, and reconfigures the VM.	
	4	Stimulus	The CSC takes another snapshot (with memory state) of the VM, called snapshot B.	
	5	Stimulus	The CSC restores snapshot A.	
	6	Check	The VM's virtual disk, configurations and memory state are consistent with the state when snapshot A was taken. The application is running on the VM without any changes.	
	7	Stimulus	The CSC deletes snapshot A and restores snapshot B.	

Table II.3 – Test case: VM snapshot

<table>
<tr><td colspan="5" align="center">VM snapshot test description</td></tr>
<tr><td></td><td>8</td><td>Check</td><td>The VM's virtual disk, configurations and memory state are consistent with the state when snapshot B was taken. The application is not running on the VM.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="3">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td><td></td></tr>
</table>

II.1.4 Test case: VM clone

Table II.4 shows the test case for VM clone.

Table II.4 – Test case: VM clone

<table>
<tr><td colspan="5" align="center">VM clone test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC clones a particular VM and the cloned VM has identical configuration and CSP/CSC data as the original one.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.1.6</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
<tr><td></td><td>1</td><td>Stimulus</td><td>The CSC clones VM A, called VM A-1.</td><td></td></tr>
<tr><td></td><td>2</td><td>Stimulus</td><td>The CSC starts VM A.</td><td></td></tr>
<tr><td></td><td>3</td><td>Stimulus</td><td>The CSC starts VM A-1.</td><td></td></tr>
<tr><td></td><td>4</td><td>Check</td><td>VM A and VM A-1 can run independently without affecting each other.</td><td></td></tr>
<tr><td></td><td>5</td><td>Check</td><td>Configuration and CSP/CSC data of VM A-1 is consistent with VM A.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="3">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td><td></td></tr>
</table>

II.1.5 Test case: VM time synchronization

Table II.5 shows the test case for VM time synchronization.

Table II.5 – Test case: VM time synchronization

<table>
<tr><td colspan="5" align="center">VM time synchronization test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC sets VM time synchronization manually or automatically.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.1.8</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
<tr><td></td><td>1</td><td>Stimulus</td><td>The CSC synchronizes the VM A system time to a specified time manually.</td><td></td></tr>
<tr><td></td><td>2</td><td>Check</td><td>The system time of VM A is consistent with the specified time in step 1.</td><td></td></tr>
<tr><td></td><td>3</td><td>Stimulus</td><td>The CSC configures the synchronization of VM A's time along with that of the host automatically.</td><td></td></tr>
</table>

Table II.5 – Test case: VM time synchronization

<table>
<tr><td colspan="4">VM time synchronization test description</td></tr>
<tr><td></td><td>4</td><td>Stimulus</td><td>The CSC logs in VM A and adjusts the system time to a different time.</td><td></td></tr>
<tr><td></td><td>5</td><td>Check</td><td>The system time of VM A is synchronized with the host that the VM is running on.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="3">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td><td></td></tr>
</table>

II.1.6 Test case: VM reservation

Table II.6 shows the test case for VM reservation.

Table II.6 – Test case: VM reservation

<table>
<tr><td colspan="5">VM reservation test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC reserves available computing resources (CPU, memory) for a particular VM before it is initiated.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.1.9</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
<tr><td></td><td>1</td><td>Stimulus</td><td>The CSC configures VM reservation, which includes the configuration of guaranteed minimum allocation of CPU and memory for a specified VM, called VM A.</td><td></td></tr>
<tr><td></td><td>2</td><td>Stimulus</td><td>The CSC runs an application to perform heavy consumption of CPU and memory on other VMs hosted in the same host except for VM A. Consumption of CPU and memory is close to the amount of the host computing resource.</td><td></td></tr>
<tr><td></td><td>3</td><td>Stimulus</td><td>The CSC performs heavy consumption of CPU and memory on VM A.</td><td></td></tr>
<tr><td></td><td>4</td><td>Check</td><td>CPU and memory resources reserved for VM A are not occupied by other VMs.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="4">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td></tr>
</table>

II.1.7 Test case: VM image

Table II.7 shows the test case for VM image.

Table II.7 – Test case: VM image

<table>
<tr><td colspan="5">VM image test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC creates a new VM by VM image, which consists of infrastructure configuration and CSP data, CSC data or both.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.1.10</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
</table>

Table II.7 – Test case: VM image

			VM image test description	
	1	Stimulus	The CSC creates an image, called image A. Image A is converted from existing VM1.	
	2	Stimulus	The CSC creates a VM based on image A.	
	3	Check	New VM (VM2) can be created based on image A. The configuration, CSP data and CSC data of new VMs are consistent with VM1.	
	4	Stimulus	The CSC exports image A as exported image in different supporting format, such as QCOW2, VMDK, etc.	
	5	Stimulus	The CSC imports the exported image as image B.	
	6	Stimulus	The CSC creates a VM based on image B.	
	7	Check	A new VM can be created based on image B. The configuration, CSP data and CSC data of new VMs created based on the VM image are consistent with the VM image.	
	8	Stimulus	The CSC updates image B by modifying the name of the image.	
	9	Check	The name of the image changes to a specified name.	
	10	Stimulus	The CSC deletes image B.	
	11	Check	The VMs created which are based on image B still exist.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.8 Test case: VM template

Table II.8 shows the test case for VM template.

Table II.8 – Test case: VM template

			VM template test description	
Test purpose	To verify that the CSC creates VMs by VM template, including open virtualization format (OVF).			
Reference	[ITU-T Y.3513] clause 7.1.11			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC creates a VM template by exporting a VM as VM template in OVF format.	
	2	Check	The exported VM template conforms to the format of OVF.	
	3	Stimulus	The CSC imports the VM template to create a new VM.	
	4	Check	The configuration and data of the new VM created in step 3 are consistent with the VM template.	
	5	Stimulus	The CSC updates the VM template by modifying the VM template's name.	

Table II.8 – Test case: VM template

VM template test description				
	6	Check	The name of VM template changes to a specified name.	
	7	Stimulus	The CSC deletes the VM template.	
	8	Check	The VM created which is based on the VM template still exists.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.9 Test case: VM scaling

Table II.9 shows the test case for VM scaling.

Table II.9 – Test case: VM scaling

VM scaling test description				
Test purpose	To verify that the CSC changes the scale of VMs dynamically based on the scaling policies and monitored events of the VM; this includes configuration change (e.g., CPU, memory, network bandwidth increased or decreased) and components change (new VM added or removed).			
Reference	[ITU-T Y.3513] clause 7.1.4			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures VM A; checks the VM status, such as CPU, memory resources allocation and its components.	
	2	Stimulus	The CSC configures the configuration change based scaling policy that when memory consumed is more than 90%, it allocates twice the memory for VM A automatically.	
	3	Stimulus	The CSC runs an application on VM A to perform more than 90% consumption of memory on VM A to trigger auto-scaling.	
	4	Check	VM A is allocated with twice as much memory as before.	
	5	Stimulus	The CSC configures the components change based scaling policy that when the CPU has consumed more than 90%, add a new VM with the same resource configuration as VM A automatically.	
	6	Stimulus	The CSC runs an application on VM A to perform more than 90% consumption of CPU on VM A to trigger auto-scaling.	
	7	Check	A new VM with the same resource configuration as VM A is added.	
	8	Stimulus	The CSC configures the configuration change based scaling policy that when memory consumed is less than	

Table II.9 – Test case: VM scaling

			VM scaling test description	
			10%, reduce memory allocation by half for VM A automatically.	
	9	Check	The CSC performs low(less than 10%) consumption of memory on VM A to trigger auto-scaling.	
	10	Stimulus	Memory allocation for VM A is reduced by half.	
	11	Check	The CSC configures the components change based scaling policy that when the CPU consumed less than 10%, remove a VM automatically.	
	12	Stimulus	The CSC performs low(less than 10%) consumption of CPU on VM A to trigger auto-scaling.	
	13	Check	VM A is terminated.	
	14	Stimulus	The CSC configures events monitoring based components change for VM A that when VM A is suspended, add a new VM with the same resource configuration as VM A automatically.	
	15	Stimulus	The CSC suspends VM A.	
	16	Check	A new VM with the same resource configuration as VM A is added.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.10 Test case: VM backup

Table II.10 shows the test case for VM backup.

Table II.10 – Test case: VM backup

			VM backup test description	
Test purpose	To verify that the CSC obtains the configuration and data of a particular VM by making a backup and restoring the VM.			
Reference	[ITU-T Y.3513] clause 7.1.7			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC makes a backup of VM A, called backup A.	
	2	Stimulus	The CSC changes the configuration and data of VM A.	
	3	Stimulus	The CSC restores VM A with backup A.	
	4	Check	Configuration and data of VM A is consistent with the state when backup A was taken.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.11 Test case: VM life cycle management

Table II.11 shows the test case for VM life cycle management.

Table II.11 – Test case: VM life cycle management

VM life cycle management test description				
Test purpose	To verify that the CSC manages the VM with various operations including start, shutdown, restart, suspend and resume VM.			
Reference	[ITU-T Y.3513] clause 7.1.2			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC shuts down a VM which has its power on.	
	2	Check	The state of the VM is power off.	
	3	Stimulus	The CSC starts the VM.	
	4	Check	The state of the VM is power on.	
	5	Stimulus	The CSC restarts the VM.	
	6	Check	The state of the VM is power on.	
	7	Stimulus	The CSC suspends the VM, tries to log in VM's operating system through SSH, VNC or other tools provided by the CSP.	
	8	Check	The state of the VM is suspended and VM's activity is paused. The CSC cannot log in the VM's operating system through SSH, VNC or other tools.	
	9	Stimulus	The CSC resumes the VM, then checks the power states of the VM, tries to log in VM's operating system through SSH, VNC or other tools provided by the CSP.	
	10	Check	The state of the VM is power on and the VM's activity is consistent with the moment before suspend operation.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.12 Test case: physical machine life cycle management

Table II.12 shows the test case for physical machine life cycle management.

Table II.12 – Test case: physical machine life cycle management

Physical machine life cycle management test description				
Test purpose	To verify that the CSC manages a physical machine with various operations including start, shutdown, hibernate and wakeup.			
Reference	[ITU-T Y.3513] clause 7.1.1			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC shuts down a physical machine which has its power on.	
	2	Check	The state of the physical machine is power off.	
	3	Stimulus	The CSC starts the physical machine.	
	4	Check	The state of the physical machine is power on.	

Table II.12 – Test case: physical machine life cycle management

			Physical machine life cycle management test description	
	5	Stimulus	The CSC hibernates a physical machine which is in power on state.	
	6	Check	The state of the physical machine is hibernate.	
	7	Stimulus	The CSC wakes up the physical machine which is in hibernate state.	
	8	Check	The state of the physical machine is power on.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.13 Test case: VM configuration inquiring

Table II.13 shows the test case for VM configuration inquiring.

Table II.13 – Test case: VM configuration inquiring

			VM configuration inquiring test description	
Test purpose	To verify that the CSC inquires VM configuration with CPU number, memory allocated, NIC number, IP address allocated.			
Reference	[ITU-T Y.3513] clause 7.1.2			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC queries the CPU number of the VM.	
	2	Check	The CSC receives the information of a particular VM's CPU number that is consistent with the number of the CPU allocated for the VM.	
	3	Stimulus	The CSC queries memory size of the VM from the CSP.	
	4	Check	The CSC receives the information of a particular VM's memory size that is consistent with the size of memory allocated for the VM.	
	5	Stimulus	The CSC queries the NIC number of the VM from the CSP.	
	6	Check	The CSC receives the information of a particular VM's NIC number that is consistent with the number of the NIC allocated for the VM.	
	7	Stimulus	The CSC queries the IP address of the VM from the CSP.	
	8	Check	The CSC receives the information of a particular VM's IP address that is consistent with the IP address allocated for the VM.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.1.14 Test case: physical machine configuration inquiring

Table II.14 shows the test case for physical machine status inquiring.

Table II.14 – Test case: physical machine status inquiring

Physical machine configuration inquiring test description				
Test purpose	To verify that the CSC inquires physical machine configuration with the number of CPU cores, memory size, disk size and NIC number.			
Reference	[ITU-T Y.3513] clause 7.1.1			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC queries the CPU's cores number of the physical machine from the CSP.	
	2	Check	The CSC receives the information of a particular physical machine's CPU cores number that is consistent with the CPU cores number of the physical machine.	
	3	Stimulus	The CSC queries memory size of the physical machine from the CSP.	
	4	Check	The CSC receives the information of a particular physical machine's memory size that is consistent with the memory size of the physical machine.	
	5	Stimulus	The CSC queries the disk size of the physical machine from the CSP.	
	6	Check	The CSC receives the information of a particular physical machine's disk size that is consistent with the disk size of the physical machine.	
	7	Stimulus	The CSC queries The NIC number of the physical machine from the CSP.	
	8	Check	The CSC receives the information of a particular physical machine's NIC number that is consistent with the NIC number of the physical machine.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.2 Test cases for storage service interoperability testing between the CSC and CSP

II.2.1 Test case: storage migration

Table II.15 shows the test case for storage migration.

Table II.15 – Test case: storage migration

Storage migration test description				
Test purpose	To verify that the CSC migrates data of the VM to different storage media without any loss.			
Reference	[ITU-T Y.3513] clause 7.2.1			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC migrates the VM's data from local storage to shared storage.	

Table II.15 – Test case: storage migration

Storage migration test description				
	2	Check	The VM uses the shared storage after migration is done without affecting the service running on the VM.	
	3	Stimulus	The CSC migrates the VM's data from shared storage to local storage.	
	4	Check	The VM uses the local storage after migration is done without affect the service running on the VM.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.2.2　Test case: storage snapshot

Table II.16 shows the test case for storage snapshot.

Table II.16 – Test case: Storage snapshot

Storage snapshot test description				
Test purpose	To verify that the CSC preserves and recovers the state and data of storage.			
Reference	[ITU-T Y.3513] clause 7.2.2			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC takes a storage snapshot of storage A, called snapshot A.	
	2	Stimulus	The CSC changes the data of storage A.	
	3	Stimulus	The CSC takes another storage snapshot of storage A, called snapshot B.	
	4	Stimulus	The CSC restores snapshot A.	
	5	Check	Storage A's state and data are consistent with the states when snapshot A was taken.	
	6	Stimulus	The CSC deletes snapshot A.	
	7	Check	Snapshot A can be deleted without affecting snapshot B.	
	8	Stimulus	The CSC restores snapshot B.	
	9	Check	Storage A's state and data are consistent with the states when snapshot B was taken.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.2.3　Test case: storage backup

Table II.17 shows the test case for storage backup.

Table II.17 – Test case: storage backup

Storage backup test description				
Test purpose	To verify that the CSC backs up and restores data when faulty or data loss occurs.			
Reference	[ITU-T Y.3513] clause 7.2.3			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC takes a storage backup of storage A, called backup storage A.	
	2	Stimulus	The CSC changes the data in the storage A.	
	3	Stimulus	The CSC restores storage A with storage backup A.	
	4	Check	Configuration and data of backup storage A is consistent with storage A.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.2.4 Test case: storage resource reservation

Table II.18 shows the test case for storage resource reservation.

Table II.18 – Test case: storage resource reservation

Storage resource reservation test description				
Test purpose	To verify that the CSC reserves available storage resource (e.g., storage space and LUN) for the VM.			
Reference	[ITU-T Y.3513] clause 7.2.5			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures storage reservation for VM A, which has guaranteed minimum allocation of storage space.	
	2	Stimulus	The CSC runs an application to perform heavy consumption of storage usage on VMs hosting in the same host except for VM A. The total consumption of storage is close to the amount of the storage available for the host.	
	3	Stimulus	The CSC performs heavy consumption of storage usage on VM A.	
	4	Check	VM A can get the storage resource.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.2.5 Test case: I/O performance

Table II.19 shows the test case for I/O performance.

Table II.19 – Test case: I/O performance

			I/O performance test description		
Test purpose			To verify that the CSC constrains I/O traffic of a particular VM with a specified level.		
Reference			[ITU-T Y.3513] clause 7.2.4		
Test sequence	Step	Type	Description		Result
	1	Stimulus	The CSC runs an application to perform heavy reading and writing of storage on VM A. It records the actual IOPS obtained by VM A.		
	2	Stimulus	The CSC configures I/O performance limitation for VM A. The IOPS limit configured is significantly lower than the IOPS obtained in step 1.		
	3	Stimulus	The CSC runs an application to perform heavy reading and writing on VM A.		
	4	Check	The actual IOPS obtained by VM A does not exceed the limitation.		
Test verdict			It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.		

II.2.6 Test case: storage life cycle management

Table II.20 shows the test case for storage life cycle management.

Table II.20 – Test case: Storage life cycle management

			Storage life cycle management test description		
Test purpose			To verify that the CSC manages storage with various operations including create, attach, detach, query and delete storage.		
Reference			[ITU-T Y.3513] clause 7.2		
Test sequence	Step	Type	Description		Result
	1	Stimulus	The CSC creates storage space called storage A with different types, such as block level, file-system level and object-based storage according to a service level agreement (SLA).		
	2	Check	The created storage A is accessible to the CSC.		
	3	Stimulus	The CSC attaches storage A to VM A.		
	4	Check	The VM can use storage A.		
	5	Stimulus	The CSC detaches storage A from VM A.		
	6	Check	VM A cannot use storage A anymore but storage A could be used for other VMs.		
	7	Stimulus	Deletes storage A.		
	8	Check	Storage A cannot be used.		
Test verdict			It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.		

II.2.7   Test case: storage utilization status inquiring

Table II.21 shows the test case for storage utilization status inquiring.

Table II.21 – Test case: Storage utilization status inquiring

<table>
<tr><td colspan="5">Storage utilization status inquiring test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC inquires storage utilization status information including used space and unused space of storage.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.2</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
<tr><td></td><td>1</td><td>Stimulus</td><td>The CSC queries utilization status of storage, including used space and unused space of storage.</td><td></td></tr>
<tr><td></td><td>2</td><td>Check</td><td>The CSC receives the information of a particular storage's used space and unused space that is consistent with the actual utilization status of the storage.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="4">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td></tr>
</table>

II.3   Test cases for network service interoperability testing between the CSC and CSP

II.3.1   Test case: network policy migration

Table II.22 shows the test case for network policy migration.

Table II.22 – Test case: network policy migration

<table>
<tr><td colspan="5">Network policy migration test description</td></tr>
<tr><td>Test purpose</td><td colspan="4">To verify that the CSC migrates the VM while the network policy (generally includes access control list, bandwidth limitation and priority policy) is consistent before and after VM migration.</td></tr>
<tr><td>Reference</td><td colspan="4">[ITU-T Y.3513] clause 7.3.1</td></tr>
<tr><td>Test sequence</td><td>Step</td><td>Type</td><td>Description</td><td>Result</td></tr>
<tr><td></td><td>1</td><td>Stimulus</td><td>The CSC configures the network policy for VM A, including configuring the access control list, bandwidth limitation and priority policy for VM A.</td><td></td></tr>
<tr><td></td><td>2</td><td>Stimulus</td><td>The CSC migrates VM A to another host.</td><td></td></tr>
<tr><td></td><td>3</td><td>Check</td><td>The access control list configuration of VM A is consistent with the original configuration before migration.</td><td></td></tr>
<tr><td></td><td>4</td><td>Check</td><td>The bandwidth limitation configuration of VM A is consistent with the original configuration before migration.</td><td></td></tr>
<tr><td></td><td>5</td><td>Check</td><td>The priority policy configuration of VM A is consistent with original the configuration before migration.</td><td></td></tr>
<tr><td>Test verdict</td><td colspan="4">It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.</td></tr>
</table>

II.3.2 Test case: network QoS

Table II.23 shows the test case for network QoS.

Table II.23 – Test case: network QoS

Network QoS test description				
Test purpose	To verify that the CSC configures network QoS for the VM, including bandwidth limitation, bandwidth reservation, traffic shaping, traffic classification and congestion avoidance.			
Reference	[ITU-T Y.3513] clause 7.3.2			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures the bandwidth limitation for the interworking between two VMs.	
	2	Check	Network throughput between the two VMs does not exceed the bandwidth specified in step 1.	
	3	Stimulus	The CSC configures bandwidth reservation for the interworking between two VMs.	
	4	Check	Network throughput between the two VMs is not less than the reserved bandwidth specified in step 3.	
	5	Stimulus	The CSC configures traffic shaping for the specified interface of VM A.	
	6	Check	The traffic of a specified interface of VM A is sent at a more stable rate with lower jitter than before.	
	7	Stimulus	The CSC configures traffic classification for the specified interface of VM A.	
	8	Check	The traffic of a specified interface of VM A is automatically categorized into a number of traffic classes.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.3.3 Test case: network address translation

Table II.24 shows the test case for network address translation.

Table II.24 – Test case: network address translation

Network address translation test description				
Test purpose	To verify that the CSC configures the mapping between an internal IP address and external IP address of a specific VM.			
Reference	[ITU-T Y.3513] clause 7.3.3			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures NAT to map the VM's private network address to the public network address.	
	2	Check	The private IP address of the VM is translated to specify a public address while accessing the Internet.	

Table II.24 – Test case: network address translation

		Network address translation test description		
	3	Stimulus	The CSC configures NAT to map the public network address to the VM's private network address.	
	4	Check	The public IP address of the VM is translated to the private network address.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.3.4 Test case: network isolation

Table II.25 shows the test case for network isolation.

Table II.25 – Test case: Network isolation

		Network isolation test description		
Test purpose	To verify that the CSC's tenant network is isolated even though the network address is overlapped with another tenants' network.			
Reference	[ITU-T Y.3513] clause 7.3.4			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC logs in as tenant A and creates a VM called VM A.	
	2	Stimulus	The CSC creates a VM called VM C assigned with the network address of the same subnet as VM A.	
	3	Stimulus	The CSC logs in as tenant B and creates a VM called VM B assigned with the network address of the same subnet as VM A.	
	4	Check	VM A can communicate with VM C.	
	5	Check	VMA and VM B cannot communicate with each other.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.3.5 Test case: IP address allocation

Table II.26 shows the test case for IP address allocation.

Table II.26 – Test case: IP address allocation

		IP address allocation test description		
Test purpose	To verify that the CSC allocates an IP address to the VM statically or dynamically.			
Reference	[ITU-T Y.3513] clause 7.3.3			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC allocates specified IP addresses for the VM statically.	
	2	Check	The VM gets the IP as requested by the CSC.	

Table II.26 – Test case: IP address allocation

IP address allocation test description				
	3	Stimulus	The CSC allocates IP addresses for the VM through dynamic allocation (DHCP) with a specified IP addresses pool.	
	4	Check	VMs get the IP within the range of the IP pool specified by the CSC.	
Test verdict	It is deemed as successfully terminated if at least one check is successful, otherwise it is deemed as failed.			

II.3.6 Test case: IP address reservation

Table II.27 shows the test case for IP address reservation.

Table II.27 – Test case: IP address reservation

IP address reservation test description				
Test purpose	To verify that the CSC reserves an IP address or a range of IP addresses for specific VM(s).			
Reference	[ITU-T Y.3513] clause 7.3.3			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC reserved a particular IP address for VM A.	
	2	Check	The reserved IP address will not be assigned to VMs other than VM A.	
	3	Stimulus	The CSC reserved a range of IP addresses for VM B.	
	4	Check	The reserved IP addresses will not be assigned to VMs other than VM B.	
Test verdict	It is deemed as successfully terminated if at least one check is successful, otherwise it is deemed as failed.			

II.3.7 Test case: load balance

Table II.28 shows the test case for load balance.

Table II.28 – Test case: load balance

Load balance test description				
Test purpose	To verify that the CSC deploys a load balance mechanism for multiple VMs in order to achieve scalability and fault tolerance of an application.			
Reference	[ITU-T Y.3513] clause 7.3.6			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures a round-robin based load balance for HTTP traffic among VMs.	
	2	Check	The HTTP request is forwarded to each server in turn based on a round-robin load balancing policy in step 1.	

Table II.28 – Test case: load balance

Load balance test description				
	3	Stimulus	The CSC configures a least-connection scheduling based load balance for FTP traffic among VMs.	
	4	Check	The FTP workload is balanced by assigning a new connection request to the VM with the smallest number of connections based on a least-connection scheduling load balancing policy in step 3.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.3.8 Test case: firewall

Table II.29 shows the test case for firewall.

Table II.29 – Test case: Firewall

Firewall test description				
Test purpose	To verify that the CSC monitors and controls incoming and outgoing VM traffic based on predetermined security rules.			
Reference	[ITU-T Y.3513] clause 7.3.7			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC configures the VM's network policies to reject all incoming traffic.	
	2	Check	The VM's incoming traffic is dropped by the firewall.	
	3	Stimulus	The CSC configures the VM's network policy to reject all outgoing traffic.	
	4	Check	The VM's outgoing traffic is dropped by the firework.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

II.3.9 Test case: multipath routing

Table II.30 shows the test case for multipath routing.

Table II.30 – Test case: multipath routing

Multipath routing test description				
Test purpose	To verify that the CSC accesses a cloud service through multiple network paths.			
Reference	[ITU-T Y.3513] clause 7.3.6			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC enables a multipath routing function for a particular cloud service.	
	3	Stimulus	One network path is unavailable.	
	4	Check	The particular service is still accessed with the SLA guaranteed by another network path.	

Table II.30 – Test case: multipath routing

Multipath routing test description		
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.	

II.3.10 Test case: network information inquiring

Table II.31 shows the test case for network information inquiring.

Table II.31 – Test case: network information inquiring

Network information inquiring test description				
Test purpose	To verify that the CSC inquires network information from the CSP with network device(s) specification, network traffic performance (in terms of throughput, jitter, loss, delay) and network topology.			
Reference	[ITU-T Y.3513] clause 7.3			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The CSC queries the network device's information.	
	2	Check	The CSC receives the information of a particular network's device specification that is consistent with the actual status of the network.	
	3	Stimulus	CSC queries network traffic performance.	
	4	Check	The CSC receives the information of a particular network's traffic performance status that is consistent with the actual status of the network.	
	5	Stimulus	The CSC queries network topology.	
	6	Check	The CSC receives the information of a particular network's topology that is consistent with the actual status of the network.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, otherwise it is deemed as failed.			

Appendix III

Alignment analysis with [ITU-T Y.3513]

(This appendix does not form an integral part of this Recommendation.)

[ITU-T Y.3513] introduces the concept of Infrastructure as a Service (IaaS) and describes its functional requirements. As one of the cloud computing service categories, IaaS provides infrastructure capabilities as services by cloud service providers. It is necessary to ensure that the test cases cover requirements in [ITU-T Y.3513]. Alignment analysis with requirements in [ITU-T Y.3513] is provided as Table III.1.

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
1	7 Functional requirement	– It is recommended that the IaaS CSP provides to the CSC IaaS functions, such as a composition of processing, storage, and networking resources with service logic, specific service level agreements (SLAs) and charging model.	Too general, not involved.
2		– It is required that the IaaS CSP provides the CSC with operations handling mechanisms related to provisioned infrastructure resources, such as assign, modify, query and release.	Too general, not involved.
3		– It is recommended that the IaaS CSP provides status information about the infrastructure in response to queries from the CSC.	Too general, not involved.
4		– It is recommended that the IaaS CSP provides a template to the CSC, related to instantiation of infrastructure, which allows for provision processing, storage and networking resources that could be implemented based on the configuration.	Too general, not involved.
5		– It is recommended that the IaaS CSP provides the CSC with operations handling mechanisms related to infrastructure templates to allow modification of infrastructure, such as upload, update, disable, enable, query or release.	Too general, not involved.
6	7.1 Computing service functional requirements	– It is required that the IaaS CSP provides computing functions with specific SLAs and charging model to the CSC.	Too general, not involved.

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
7	7.1.1 Physical machine	– It is recommended that the IaaS CSP provides specific hardware specifications of a physical machine to the CSC according to the SLA.	– 7.12 Interoperability testing of physical machine life cycle management between the CSC and CSP
8		– It is recommended that the IaaS CSP provides the CSC with operation handling mechanisms related to a physical machine, such as start, shutdown, hibernate and wakeup.	– 7.12 Interoperability testing of physical machine life cycle management between the CSC and CSP
9		– It is recommended that the IaaS CSP provides physical machine related information in response to queries from the CSC.	– 7.14 Interoperability testing of physical machine configuration inquiring between the CSC and CSP
10	7.1.2 Virtual machine	– It is recommended that the IaaS CSP provides a virtual machine based on the VM template.	– 7.8 Interoperability testing of VM template between the CSC and CSP
11		– The IaaS CSP can optionally provide a virtual machine based on the configurations specified by the CSC.	– 7.1 Interoperability testing of VM configuration between the CSC and CSP
12		– It is required that the IaaS CSP provides the CSC with operations handling mechanisms related to the VM, including, but not limited to, create, delete, start, shutdown, suspend, restore, hibernate and wakeup.	– 7.11 Interoperability testing of VM life cycle management between the CSC and CSP
13		– It is recommended that the IaaS CSP provides VM-related information in response to queries from the CSC.	– 7.13 Interoperability testing of VM configuration inquiring between the CSC and CSP
14	7.1.3 VM migration	– It is recommended that the IaaS CSP provides a virtual machine with migration functions. Based on migration policies, the virtual machine can be migrated from one host to another.	– 7.2 Interoperability testing of VM migration between the CSC and CSP
15	7.1.4 VM scaling	– It is recommended that the IaaS CSP provides a virtual machine with scaling functions based on the scaling policies and monitored events of the virtual machine.	– 7.9 Interoperability testing of VM scaling between the CSC and CSP
16	7.1.5 VM snapshot	– It is recommended that the IaaS CSP provides a virtual machine with snapshot functions. Schedule of snapshots taken from the virtual machine can be performed automatically or manually.	– 7.3 Interoperability testing of VM snapshot between the CSC and CSP

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
17	7.1.6 VM clone	– It is recommended that the IaaS CSP provides a virtual machine with clone functions. The cloned VM has identical configuration and CSP/CSC data as the original one.	– 7.4 Interoperability testing of VM clone between the CSC and CSP
18	7.1.7 VM backup	– It is recommended that the IaaS CSP provides a virtual machine with backup functions. When the VM becomes faulty or its data is lost, the VM can be restored using its backup stored according to the CSC policy.	– 7.10 Interoperability testing of VM backup between the CSC and CSP
19	7.1.8 VM time synchronizat ion	– It is recommended that the IaaS CSP provides time synchronization functions, which allow the CSC to control the VM time.	– 7.5 Interoperability testing of VM time synchronization between the CSC and CSP
20	7.1.9 VM reservation	– It is recommended that the IaaS CSP provides processing resources reservation (such as CPU, memory) functions. Resources reservation is used to reserve available resources from IaaS infrastructure before VM is initiated.	– 7.6 Interoperability testing of VM reservation between the CSC and CSP
21	7.1.10 VM image	– It is recommended that the IaaS CSP offers the ability for the CSC to provide and use virtual machine images. A VM image consists of infrastructure configuration and CSP data, CSC data or both.	– 7.7 Interoperability testing of VM image between the CSC and CSP
22		– It is recommended that the IaaS CSP supports a different machine image format.	– 7.7 Interoperability testing of VM image between the CSC and CSP
23		– It is required that the IaaS CSP provides operation handling mechanisms related to image，including, but not limited to, add, import, store, register, deregister, query, update, delete and export.	– 7.7 Interoperability testing of VM image between the CSC and CSP
24	7.1.11 VM template	– It is recommended that the IaaS CSP supports the open virtualization format (OVF) template, which is a packaging standard designed to address the portability and deployment of virtual appliances.	– 7.8 Interoperability testing of VM template between the CSC and CSP
25		– It is recommended that the IaaS CSP provides operations handling mechanisms related to machine templates, such as upload, update,	– 7.8 Interoperability testing of VM template between the CSC and CSP

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
		disable, enable, query and delete to the CSC.	
26	7.2 Storage service functional requirements	– It is recommended that the IaaS CSP provides storage functions, such as block level storage, file level storage and object-based storage, with specific SLAs and charging model to the CSC. The storage functions can be provided to the CSC directly or used by the virtual machine as attached storage.	– 8.6 Interoperability testing of storage life cycle management between the CSC and CSP
27		– It is recommended that the IaaS CSP provides the CSC with operations handling mechanisms related to storage, such as create, attach, detach, query and delete a volume of storage at either block level or file-system level, write, read and delete data for a given storage.	– 8.6 Interoperability testing of storage life cycle management between the CSC and CSP
28		– It is recommended that the IaaS CSP provides storage utilisation information in response to queries from the CSC.	– 8.7 Interoperability testing of storage utilization status inquiring between the CSC and CSP
29	7.2.1 Storage migration	– It is recommended that the IaaS CSP provides storage migration functions. Based on migration policies, data can be migrated between different logical unit numbers (LUNs), different storage devices, local storage to shared storage and vice versa.	– 8.1 Interoperability testing of storage migration between the CSC and CSP
30	7.2.2 Storage snapshot	– It is recommended that the IaaS CSP provides storage with snapshot functions. Snapshot can be realized at either block or file-system levels. The data can be restored using the snapshot.	– 8.2 Interoperability testing of storage snapshot between the CSC and CSP
31	7.2.3 Storage backup	– It is recommended that the IaaS CSP provides storage with backup functions. Backup can be realized at block level, file level or object-based storage.	– 8.3 Interoperability testing of storage backup between the CSC and CSP
32	7.2.4 I/O performance	– It is recommended that the IaaS CSP provides input/output (I/O) limitation for each VM.	– 8.5 Interoperability testing of I/O performance between the CSC and CSP
33	7.2.5 Storage resource reservation	– It is recommended that the IaaS CSP provides storage resource (e.g., storage space and LUN) reservation functions.	– 8.4 Interoperability testing of storage resource reservation between the CSC and CSP

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
34	7.3 Network service functional requirements	– It is recommended that the IaaS CSP provides network functions, such as IP address, VLAN, virtual switch, load balance, firewall, with specific SLAs or charging model. Network functions are applied to access and interconnect processing and storage resources.	– 9.7 Interoperability testing of load balance between the CSC and CSP – 9.8 Interoperability testing of firewall between the CSC and CSP
35		– It is recommended that the IaaS CSP provides network information in response to queries from the CSC.	– 9.10 Interoperability testing of network information inquiring between the CSC and CSP
36	7.3.1 Network policy migration	– It is recommended that the IaaS CSP provides network policy migration along with virtual machine migration. In this case, the network policy of the migrated virtual machine is the same as before the migration.	– 9.1 Interoperability testing of network policy migration between the CSC and CSP
37	7.3.2 Network QoS	– It is recommended that the IaaS CSP provides operation handling mechanisms related to the network quality of service (QoS), such as bandwidth limit, bandwidth reservation, traffic shaping, traffic classification, congestion avoidance, at port level, device level and network level.	– 9.2 Interoperability testing of network QoS between the CSC and CSP
38	7.3.3 IP Address	– It is recommended that the IaaS CSP provides IP address reservation.	– 9.6 Interoperability testing of IP address reservation between the CSC and CSP
39		– It is required that the IaaS CSP allows the CSC to apply, bind, unbind, query, release an IP address to processing resources or storage resources.	– 9.5 Interoperability testing of IP address allocation between the CSC and CSP
40		– It is recommended that the IaaS CSP allows the CSC to allocate IP addresses to provisioned processing resources or storage resources with a dynamic or static method.	– 9.5 Interoperability testing of IP address allocation between the CSC and CSP
41		– The IaaS CSP can optionally provide network address translation (NAT).	– 9.3 Interoperability testing of network address translation between the CSC and CSP

Table III.1 – Alignment analysis with functional requirements in [ITU-T Y.3513]

	Functional requirements in [ITU-T Y.3513]		Test objects in this Recommendation
42	7.3.4 Network isolation	– It is required that the IaaS CSP provides the CSC with isolated tenants' networks.	– 9.4 Interoperability testing of network isolation between the CSC and CSP
43		– It is recommended that the IaaS CSP provides the CSC with operations handling mechanisms related to isolated tenants' networks, such as create, query and release.	– 9.4 Interoperability testing of network isolation between the CSC and CSP
44	7.3.5 Virtual Networking	– It is recommended that the IaaS CSP manages virtual networking to provide network connectivity amongst various processing and storage resources.	– 9.4 Interoperability testing of network isolation between the CSC and CSP
45	7.3.6 Load balance	– It is recommended that the IaaS CSP optimizes infrastructure resources utilization by providing load balance related functions, such as throughput, response time, to avoid overload of any one of the infrastructure resources.	– 9.7 Interoperability testing of load balance between the CSC and CSP
46		– The IaaS CSP can optionally provide multipath routing to achieve an optimized traffic management (e.g., to improve network utilization, to guarantee QoS at network congestion or fault).	– 9.9 Interoperability testing of multipath routing between the CSC and CSP
47	7.3.7 Firewall	– It is recommended that the IaaS CSP delivers a physical or virtual firewall to the CSC.	– 9.8 Interoperability testing of firewall between the CSC and CSP
48	7.3.8 Gateway	– It is recommended that the IaaS CSP provides necessary network interworking functions so that the CSC uses provisioned infrastructure resources as if they are at the CSC's premises.	– 9.4 Interoperability testing of network isolation between the CSC and CSP
49	7.3.9 Network configuration	– It is recommended that the IaaS CSP provides the CSC with operations handling mechanisms related to the network configurations according to the objectives of the SLA.	See other network related testing objects: – 9.5 Interoperability testing of IP address allocation between the CSC and CSP – 9.2 Interoperability testing of network QoS between the CSC and CSP – 9.3 Interoperability testing of network address translation between the CSC and CSP

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