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

Testing specifications – Testing specifications for Cloud computing

Cloud interoperability testing for web applications – part 1: Interoperability testing between the CSC and CSP

Recommendation ITU-T Q.4042.1

International Telecommunication Union

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Recommendation ITU-T Q.4042.1

Cloud interoperability testing for web applications – part 1: Interoperability testing between the CSC and CSP

Summary

Cloud interoperability for web applications refers to the interaction between the cloud service customer (CSC) and the cloud service provider (CSP) to obtain predictable results, collaboration among different web applications and consistency and interoperability of a management interface across different web applications.

Recommendation ITU-T Q.4042.1, which is part 1, specifies the cloud interoperability test objectives for web applications between the CSC and CSP.

These test objectives are developed on the basis of cloud computing interoperability testing objectives specified in Recommendation ITU-T Q.4040. The test cases for cloud interoperability testing for web applications are also introduced in the appendices.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.4042.1	2018-12-14	11	11.1002/1000/13800

Keywords

Cloud computing, interoperability testing, web application.

* 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.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Cloud interoperability testing for web applications – part 1: Interoperability testing between the CSC and CSP

1 Scope

The scope of this Recommendation comprises:

– an overview of cloud interoperability testing for web applications,

– cloud interoperability testing for web applications between the CSC and CSP including QoE testing, performance testing, transaction testing, cookies testing, link testing and account management testing.

NOTE – This Recommendation is the first part of cloud computing interoperability testing for web applications, which focuses on validating the web application interoperability function provided by the CSP to the CSC.

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.1401] Recommendation ITU-T Y.1401 (2008), *Principles of interworking.*

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

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

[ITU-T Y.4108] Recommendation ITU-T Y.4108/Y.2213 (2008), *NGN service requirements and capabilities for network aspects of applications and services using tag-based identification.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 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.

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

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

3.1.4 cloud service provider (CSP) [ITU-T Y.3500]: Party which makes cloud services available.

3.1.5 inter-cloud computing [ITU-T Y.3511]: The paradigm for enabling the interworking between two or more cloud service providers.

3.1.6 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.

3.1.7 interworking [ITU-T Y.1401]: The term "interworking" is used to express interactions between networks, between end systems, or between parts thereof, with the aim of providing a functional entity capable of supporting an end-to-end communication.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 HTML link validator: The testing tool to check the links in the web application and mark erroneously linked files.

3.2.2 web application: Software as a service (SaaS) application that uses browser and server mode (B/S).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API Application Programming Interface

B/S Browser and Server Mode

CSC Cloud Service Customer

CSP Cloud Service Provider

HTTP Hypertext Transfer Protocol

QoE Quality of Experience

SaaS Software as a Service

SLA Service Level Agreement

TCP Transmission Control Protocol

UDP User Datagram Protocol

URL Uniform Resource Locator

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 interoperability testing for web applications

6.1 Cloud interoperability for web applications

Web applications belong to the software as a service (SaaS) category, which use browser and server mode (B/S) and are provided by the cloud service provider CSP. The cloud service customer (CSC) can select the required web applications and access them through a browser according to the application function description information.

Based on cloud computing interoperability presented in [ITU-T Q.4040], cloud interoperability for web applications refers to the interaction between the CSC and the CSP to obtain predictable results, collaboration among different web applications and consistency and interoperability of management interfaces across different web applications.

As shown in Figure 6-1, the cloud interoperability testing for web applications can be divided into three parts, the first part focuses on the web application interaction between the CSC and the CSP, second part focuses on the interaction between CSPs and the third part focuses on the interaction between the CSP and management functions [ITU-T Q.4040].

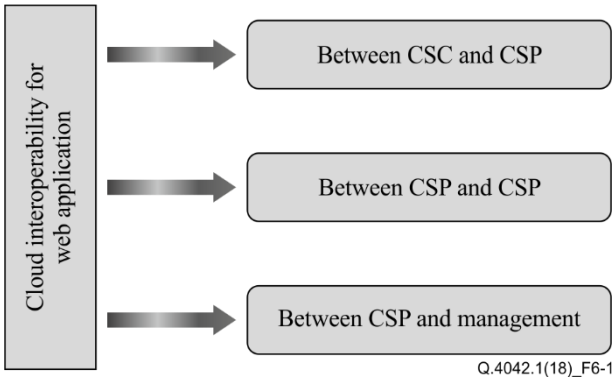

Figure 6-1 – Cloud interoperability testing framework for web applications

This Recommendation which is part 1, specifics cloud interoperability testing for web applications between the CSC and CSP. The remaining parts, including ineroperability testing between CSP and CSP, and between CSP and management, will be introduced respectively as part 2 and part 3 of cloud interoperability testing for web applications.

6.2 Relationship with cloud interoperability testing

Cloud ineroperability for web applications between the CSC and CSP is developed based on [ITU-T Q.4040]. Figure 6-2 describes the relationship with [ITU-T Q.4040] as follows:

– QoE related interaction between CSC and CSP is developed based on the test objectives of service integration and service access defined in [ITU-T Q.4040].

– Performance related interaction between CSC and CSP is developed based on the test objectives of monitoring and reports and physical resources test objectives defined in [ITU-T Q.4040].

– Transaction related interaction between CSC and CSP is developed based on the test objectives of authorization and security policy, service capabilities and resource abstraction and control defined in [ITU-T Q.4040].

– Cookies related interaction between CSC and CSP is developed based on the test objectives of resource abstraction and control, authentication and identities management defined in [ITU-T Q.4040].

– Link related interaction between CSC and CSP is developed based on the test objectives of the product catalogue defined in [ITU-T Q.4040].
– Account management related interaction between CSC and CSP is developed based on the test objectives of account management and subscription management defined in [ITU-T Q.4040].

Detailed information can be found in Appendix III.

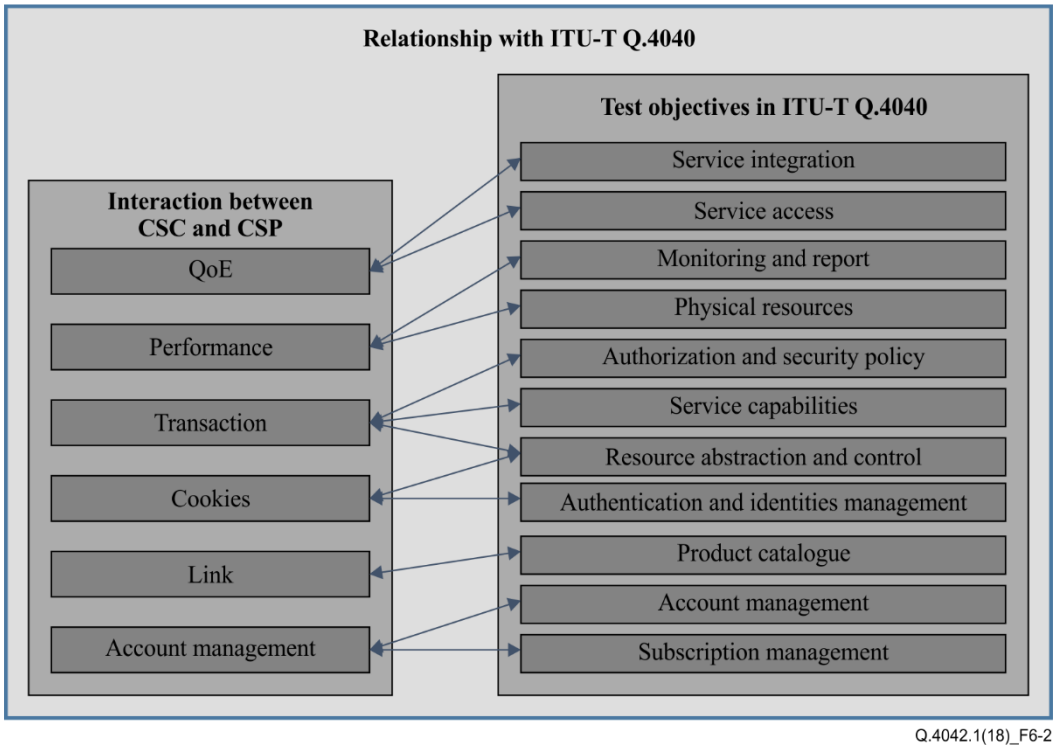

Figure 6-2 – Relationship with [ITU-T Q.4040]

6.3 Cloud interoperability testing framework for web applications between CSC and CSP

Figure 6-3 illustrates the cloud interoperability testing framework for web applications between CSC and CSP.

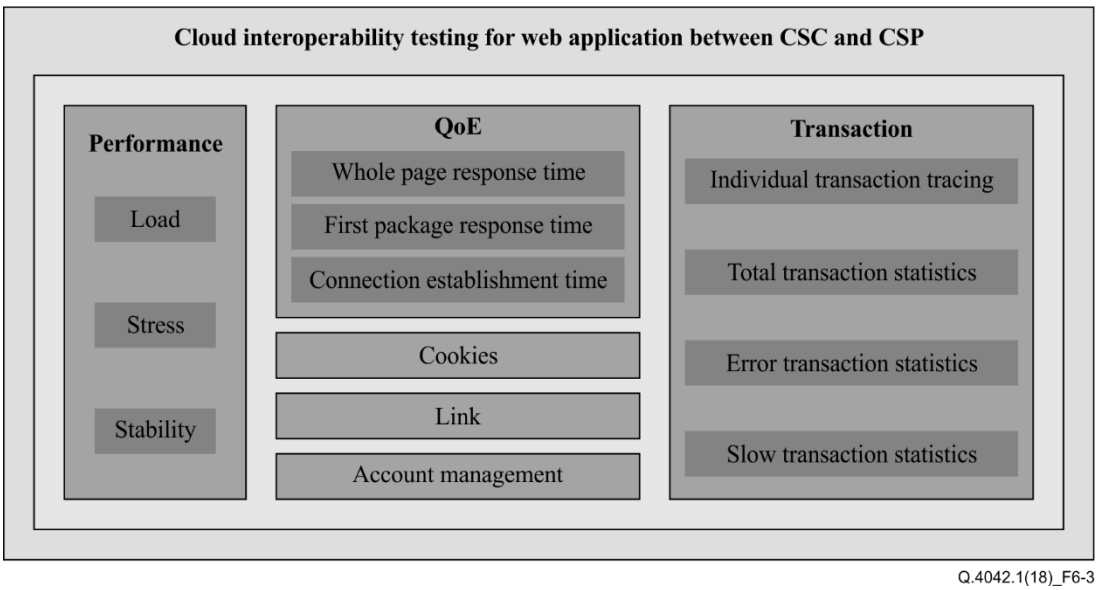

Figure 6-3 – Cloud interoperability testing framework for web applications between CSC and CSP

The test objectives of cloud interoperability testing for web applications between CSC and CSP include:

– **QoE testing**: Quality of experience (QoE) refers to the user's subjective perception of web application quality. It is recommended to verify that CSP provides a satisfactory web application service to the CSC using metrics including connection establishment time, first package response time and whole page response time.

– **Performance testing**: Performance includes a set of non-functional facets relating to the operation of a web application [ITU-T Y.3502]. It is recommended to verify the quality attributes of the web application using the metrics of responsiveness and stability under various workloads, including load testing, stress testing and stability testing.

– **Transaction testing**: Transaction refers to the individual and indivisible operations in the interaction processing of web applications. It is recommended to verify usability of web applications by tracing each web application request from the CSC and the implementation inside the web application. It is recommended to verify transaction testing using metrics including individual transaction tracing, total transaction statistics, slow transaction statistics and error transaction statistics.

– **Cookies testing**: Cookies provide a way to store specific information of the CSC in web applications. It is recommended to verify cookies work properly and that the information of the CSC stored in cookies can be read and identified successfully.

– **Link testing**: Link instructs the CSC to jump to the specified website according to the keywords displayed on the web without knowing the address of the website. It is recommended to verify that all links point to the special designated page according to the instructions.

– **Account management testing**: Account management provides capabilities for managing web application customer relationships to the CSC [ITU-T Y.3502]. It is recommended to verify that the CSP provides management capabilities for web applications to the CSC.

7 Cloud interoperability testing for web applications between the CSC and CSP

7.1 QoE testing for web applications between the CSC and CSP

7.1.1 Connection establishment time testing

The connection establishment time is the time to establish the connection such as transmission control protocol (TCP) and user datagram protocol (UDP) between the CSP and CSC. The test objective is to verify the connection establishment time and whether it exceeds the limitation configured by the CSC or not. The test case of connection establishment time can be found in Appendix II.1.

7.1.2 First package response time testing

The first package response time is the elapsed time when the first data package is received by CSP after the HTTP request from the CSC. The test objective is to verify the variation of the first package response time, whether it exceeds the limitation configured by CSC or not. The test case of first package response time can be found in Appendix II.2.

7.1.3 Whole page response time testing

The whole page response time is the time that the whole page of a web application is loaded on the browser when the CSC accesses the web application. The test objective is to verify the whole page response time, whether it exceeds the limitation configured by the CSC or not. The test case of the whole page response time can be found in Appendix II.3.

7.2 Performance testing for web applications between the CSC and CSP

7.2.1 Load testing

Load performance refers to how the web application behaves in different load conditions. The test objective is to verify the limitation of the load condition of the web application and its server environment when the load performance meets the CSC's requirements. The test case of load testing can be found in Appendix II.4.

7.2.2 Stress testing

Stress performance refers to how the web application behaves under critical load conditions. The test objective is to verify maximum of the numbers of concurrent CSCs, online transactions per CSC in unit time and data load per transaction processed by the CSP when the server environment runs out. The test case of stress testing can be found in Appendix II.5.

7.2.3 Stability testing

Stability performance refers to how the web application behaves for a long time (pre-defined by the CSC) under certain load conditions (pre-defined by the CSC). The test objective is to verify the status of the web application with a certain load for a given long time period. The test case of stability can be found in Appendix II.6.

7.3 Transaction testing for web applications between the CSC and CSP

7.3.1 Individual transaction tracing

Individual transaction tracing refers to tracing the flow path of each CSC request inside the web application. The test objective is to verify individual transactions are processed successfully. The test case of individual transaction can be found in Appendix II.7.

7.3.2 Total transaction statistics

Based on transaction tracing, total transaction statistics refers to the overall transaction processing information inside the web application during the given time period. The test objective is to verify

the number of the transactions between the frontend web server and the backend databased over a certain time period. The test case of total transaction statistics can be found in Appendix II.8.

7.3.3 Slow transaction statistics

Slow transaction statistics sort the response time of each CSC's request to the web application, list the first few slowest transactions according to CSC's configuration and give the reasons for each of them. The test objective is to verify the factor affecting slowest transactions. The test case of slow transaction statistics can be found in Appendix II.9.

7.3.4 Error transaction statistics

When a CSC's requests to access the web application failed or the actual response time of the user request exceeds some pre-defined limitation, it is recognized as an error transaction. An error transaction may be caused by the failure to call an external service application programming interface (API), or the code errors as well as implementation exceptions inside the web application. Error transaction statistics refer to records of the error transaction statistics over a certain time period. The test objective is to verify the error transaction statistics over a certain time period. The test case of error transaction statistics can be found in Appendix II.10.

7.4 Cookies testing for web applications between the CSC and CSP

Cookies provide a way to store specific information of CSC in web applications. When a CSC uses the web application, a file called a cookie will be created in the CSC's device and the partial information (page, accessed login user name and password) will be taken into account, to identify the state of the CSC. If the CSC visits the web application again, it will be able to read the contents of this file and correctly identify information of the CSC. The test objective is to verify the CSC's information is saved according to the scheduled time as cookies. The test case of cookies can be found in Appendix II.11.

7.5 Link testing for web applications between the CSC and CSP

Link testing can be divided into three aspects. Firstly, verify all links point to the special designated page according to the instructions. Secondly, verify the existence of the pages, which the links point to. Finally, ensure that there is no isolated page for the web application.

NOTE – The isolated page means no link to this page and the page only can be accessed when the correct URL address is known.

The test objective is to verify that the links of the web application point to a valid page under instructions and that there is no isolated page of the web application. The test case of link can be found in Appendix II.12.

7.6 Account management testing for web applications between the CSC and CSP

Account management provides capabilities for managing web application customer relationships to the CSC, including: subscription to web applications provided by the CSP, entitlements, web application pricing which can involve customer-specific terms such as discounts and policies that apply to the treatment of CSC's data [ITU-T Y.3502]. The test objective is to verify that the CSP provide capabilities for managing customer relationships of web applications to the CSC. The test case of account management can be found in Appendix II.13.

Appendix I

Test case template

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

Table I.1 provides test case template to descript cloud computing infrastructure capability type interoperability testing between the CSC and CSP. The test case template is designed with reference to relevant technical specifications, such as ETSI GS NFV-TST 002 V1.1. As show in Table I.1, an interoperability test case consists of a test purpose, reference, test sequence and test verdict.

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

The 'Reference' of the test case provides a 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 three 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 a 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 description of the check step, the result should be recorded as OK, otherwise the result should be recorded as fail.

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

Table I.1 – Test of interoperability

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	Record	A record consists of the specific data or statistic in certain transactions. There is no need to provide Result for a Record Step.	There is no need to provide Result for a Record Step.
	3	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 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 the checks are successful, else it is deemed as failed.			

Appendix Ⅱ

Test cases for cloud interoperability testing for web applications between the CSC and CSP

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

II.1 Test case: Connection establishment time testing

Table II.1 – Connection establishment time testing

Connection establishment time test case				
Test purpose		To verify the connection establishment time, whether exceed limitation configured by CSC or not.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	Delete all cookies and other caches in the testing environment.	
	2	Stimulus	CSC configures the timeout limitation for web application A.	
	3	Stimulus	CSC accesses web application A to capture the first SYN message and the last ACK message of TCP.	
	4	Record	Record the time difference T between the first SYN message and the last ACK message of TCP as the connection establishment time of web application A.	
	5	Check	The connection establishment time is lower than the timeout limitation configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.2 Test case: First package response time testing

Table II.2 – First package response time testing

First package response time test case				
Test purpose		To verify the first package response time, whether exceed limitation configured by CSC or not.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	Delete all cookies and other caches in the testing environment.	
	2	Stimulus	CSC configures timeout limitation for web application A.	
	3	Stimulus	CSC accesses the web application A and sends an HTTP request to capture the first package response.	
	4	Record	Record the time difference between sending an HTTP request and the first data package is received by CSC as the first package response time of web application A.	
	5	Check	The first package response time is lower than the timeout limitation configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.3 Test case: The whole page response time

Table II.3 – Whole page response time testing

Whole page response time test case				
Test purpose		To verify the whole page response time of web application, whether exceed limitation configured by CSC or not.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	Delete all cookies and other caches in the testing environment	
	2	Stimulus	CSC configures timeout limitation for web application A.	
	3	Stimulus	CSC accesses the web application A.	
	4	Stimulus	Capture the first sending package and the last response package when the whole page of web application is loaded on the browser.	
	5	Record	Record the time difference between the first sending package and the last response package as the whole page response time of web application A.	
	6	Check	The whole page response time is lower than the timeout limitation configured by CSC	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.4 Test case: Load testing

Table II.4 – Load testing

Load test case				
Test purpose		To verify the limitation of load condition of the web application and its server environment when the load performance meet the CSC's requirements.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of load testing parameters including the numbers of concurrent CSCs, online transactions per CSC in unit time and data load per transaction processed by CSP of web application A.	
	2	Stimulus	CSC accesses the web application and start the pressure simulation tool (used to simulate various conditions, such as HTTP connections).	
	3	Stimulus	Change the parameters of pressure simulation tool to simulate various conditions gradually and repeat step 2 until the load performance meet the CSC's requirements.	

Table II.4 – Load testing

Load test case				
	4	Record	Record the numbers of concurrent CSCs, online transactions per CSC in unit time, and data load per transaction processed by CSP of web application A when the performance parameters meet CSC's requirements.	
	5	Check	The numbers of concurrent CSCs, online transactions per CSC in unit time and data load per transaction processed by CSP are higher than the limitations configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.5 Test case: Stress testing

Table II.5 – Stress testing

Stress test case				
Test purpose		To verify maximum of the numbers of concurrent CSCs, online transactions per CSC in unit time, and data load per transaction processed by CSP when the server environment runs out		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the minimum limitation of load testing parameters including the numbers of concurrent CSCs online transactions per CSC in unit time, and data load per transaction processed by CSP of web application A.	
	2	Stimulus	CSC accesses the web application and start the pressure simulation tool (used to simulate various conditions, such as HTTP connections).	
	3	Stimulus	Change the parameters of pressure simulation tool to simulate various conditions gradually and repeat step 2 until the environment runs out.	
	4	Record	Record the numbers of concurrent CSCs, online transactions per CSC in unit time, and data load per transaction processed by CSP when the environment runs out.	
	5	Check	The numbers of concurrent CSCs, online transactions per CSC in unit time and data load per transaction processed by CSP are higher than the limitations configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.6 Test case: Stability testing

Table II.6 – Stability testing

Stability test case				
Test purpose		The test object is to verify the status of the web application with a certain load for a given long time period		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of the time that the web application runs stably on a certain load.	
	2	Stimulus	CSC accesses the web application and start the pressure simulation tool (used to simulate various conditions, such as HTTP connections).	
	3	Stimulus	Change the parameters of pressure simulation tool to simulate various conditions gradually and repeat step 2 until the environment runs out or the load performance change significantly.	
	4	Record	Record the time that the web application run before the environment runs out or the load performance change significantly.	
	5	Check	The time that the web application run stably on a certain load is higher than the limitation configured by CSC	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.7 Test case: Individual transaction tracing testing

Table II.7 – Individual transaction tracing testing

Individual transaction tracing test case				
Test purpose		To verify individual transactions are processed successfully.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC makes a request for the web application	
	2	Check	Check the tracing of this individual transaction.	
	3	Check	The individual transaction request is obtained by web server, middleware cache server and backend database.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.8 Test case: Total transaction statistics testing

Table II.8 – Total transaction statistics testing

Total transaction statistics test case				
Test purpose		To verify the number of the transactions between the frontend web server and the backend database over a certain time period.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configure the limitation of the number of the totally transaction.	
	2	Stimulus	CSC accesses web application A and make transactions normally for a certain time period such as 30 minutes.	
	3	Record	Record total transaction statistics between the frontend web server and the backend database.	
	4	Check	Total transaction statistics is higher than the limitation configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.9 Test case: Slow transaction statistics testing

Table II.9 – Slow transaction statistics testing

Slow transaction statistics test case				
Test purpose		To verify the factor affecting slowest transactions.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	Run the system of the web application and make transactions normally for a certain time period such as 30 minutes.	
	2	Record	Record and sort the response time of each CSC's request to the web application. List the first few slowest transactions	
	3	Check	Check the factor affecting slowest transactions.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.10 Test case: Error transaction statistics testing

Table II.10 – Error transaction statistics testing

Error transaction statistics test case				
Test purpose		To verify the error transaction statistics over a certain time period.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of the number of the error transaction.	
	2	Stimulus	CSC accesses web application A and make transactions normally for a certain time period such as 30 minutes.	
	3	Record	Record error transaction statistics between the frontend web server and the backend database.	
	4	Check	Error transaction statistics is higher than the limitation configured by CSC.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.11 Test case: Cookies testing

Table II.11 – Cookies testing

Cookies test case				
Test purpose		To check whether the cookie works properly and whether the content is saved according to the scheduled time.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of the time that the web application runs normally on a certain load.	
	2	Stimulus	CSC accesses web application and creates a cookie file.	
	3	Stimulus	CSC accesses this web application again, and reads the content of that cookie file.	
	4	Record	Record the partial information such as page, accessed login user name and password.	
	5	Check	Check whether the partial information is correct.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.12 Test case: Link testing

Table II.12 – Link testing

Link test case				
Test purpose		To verify that the links of web application point to a valid page under instructions and there is no isolated page of the web application system.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of the time that the web application runs normally on a certain load.	
	2	Stimulus	CSC accesses the specified website according to the keywords displayed on the web without knowing the address of the website.	
	3	Record	Record the information of link such as titles and pictures.	
	4	Check	Check whether the links of web application point to a valid page.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

II.13 Test case: Account management testing

Table II.13 – Account management testing

Account management test case				
Test purpose		To verify that CSP can provide capabilities for managing cloud service customer relationships to CSC.		
Reference		[ITU-T Q.4040] clause 6		
Test sequence	Step	Type	Description	Result
	1	Stimulus	CSC configures the limitation of the time that the web application runs normally on a certain load.	
	2	Check	CSC accesses web application and sets up normally customer relationship.	
	3	Record	Record the information of customer relationship, such as contracts account information, subscription information, entitlement, service prices and policies of services.	
	4	Check	Check whether the customer relationship is valid.	
Test verdict	It is deemed as successfully terminated if all the checks are successful, else it is deemed as failed.			

Appendix III

Alignment analysis with Recommendation ITU-T Q.4040

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

According to [ITU-T Q.4040], verification of interworking between CSC and CSP, CSP and CSP, CSP and management are required in cloud interoperability testing for web applications. The scope of this Recommendation focuses on cloud interoperability testing for web applications between the CSC and CSP. The relationships with the 11 interoperability test objectives between the CSC and CSP in [ITU-T Q.4040] is provided in Table III.1.

Table III.1 – Relationship with [ITU-T Q.4040]

	Interworking between CSC and CSP and interoperability test objective in ITU-T Q.4040		**The testing described in this Recommendation**
1	Interworking between CSC and CSP's service integration component	Test objective is to verify that CSP can provide connections to CSP's services for CSC.	7.1 QoE testing for web application between CSC and CSP
2	Interworking between CSC and CSP's authentication and identities management component	Test objective is to verify that CSP can provide capabilities relating to user identities and the credentials required to authenticate users are provided when CSC access cloud services and related administration and business capabilities.	7.4 Cookies testing for web application between CSC and CSP
3	Interworking between CSC and CSP's authorization and security policy management component	Test objective is to verify that CSP can provide capabilities for the control and application of authorization for CSC to access specific capabilities or data.	7.3 Transaction testing for web application between CSC and CSP
4	Interworking between CSC and CSP's product catalogue component	Test objective is to verify that the CSP can provide capabilities for browsing available service list, and capabilities for management of the content of catalogue.	7.5 Link testing for web application between CSC and CSP
5	Interworking between CSC and CSP's account management CSC	Test objective is to verify that the CSP can provide capabilities for managing cloud service relationships, including management of contracts, subscription to cloud service, entitlements, service pricing and policies that apply to the treatment of CSC data.	7.6 Account management testing for web application between CSC and CSP

Table III.1 – Relationship with [ITU-T Q.4040]

	Interworking between CSC and CSP and interoperability test objective in ITU-T Q.4040		The testing described in this Recommendation
6	Interworking between CSC and CSP's subscription management component	Test objective is to verify that the CSP can handle subscriptions from CSC to particular cloud services, aiming to record new or changed subscription information from the customer and ensure the delivery of the subscribed service(s) to the customer.	7.6 Account management testing for web application between CSC and CSP
7	Interworking between CSC and CSP's monitoring and report component	Test objective is to verify that CSP can provide capabilities monitoring the cloud computing activities of other functional components throughout the CSP's system and providing reports on the behaviour of the cloud service provider's system.	7.2 Performance testing for web application between CSC and CSP
8	Interworking between CSC and CSP's service access	Test objective is to verify that CSP can provide service access capabilities that provide access offered by CSP, perform authentication of the CSC and establish authorization to use particular capabilities of the cloud service. If authorized, the service access capabilities invoke the cloud service implementation which performs the request.	Duplicate with row 1 and 2 in the table. 7.1 QoE testing for web application between CSC and CSP 7.4 Cookies testing for web application between CSC and CSP
9	Interworking between CSC and CSP's service capabilities	Test objective is to verify that CSP can provide service capabilities which consist of the necessary software required to implement the service offered to CSC.	7.3 Transaction testing for web application between CSC and CSP
10	Interworking between CSC and CSP's Resource abstraction and control	Test objective is to verify that CSP can provide access to the physical computing resources through software abstraction and to offer qualities such as rapid elasticity, resource pooling and on-demand self-service.	7.3 Transaction testing for web application between CSC and CSP
11	Interworking between CSC and CSP's Physical resources	Test objective is to verify that the operational support systems can manage all elements of the physical resources (computing resources, storage resources and network resources).	7.2 Performance testing for web application between CSC and CSP

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