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Cloud Computing

Cloud computing – Functional requirements for cloud service brokerage

Recommendation ITU-T Y.3506

International Telecommunication Union

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Recommendation ITU-T Y.3506

Cloud computing – Functional requirements for cloud service brokerage

Summary

Cloud service brokerage is a service that arbitrates, delivers and manages cloud services provided by cloud service providers for cloud service customers. Recommendation ITU-T Y.3506 provides functional requirements for cloud service brokerage. To provide functional requirements for cloud service brokerage, this Recommendation specifies the overview including service model and configuration of the cloud service brokerage. Various use cases are also identified to derive the functional requirements.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3506	2018-05-29	13	11.1002/1000/13612

Keywords

Cloud computing, cloud service brokerage, cloud service broker, functional requirement.

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Recommendation ITU-T Y.3506

Cloud computing – Functional requirements for cloud service brokerage

1 Scope

This Recommendation provides functional requirements for cloud service brokerage (CSB). It addresses the following subjects:

– Overview of cloud service brokerage;

– Functional requirements of cloud service brokerage;

– Use cases of cloud service brokerage.

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 X.1601] Recommendation ITU-T X.1601 (2015), *Security framework for cloud computing.*

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

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

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

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

3.1.3 cloud service broker [ITU-T Y.3500]: Cloud service partner that negotiates relationships between cloud service customers and cloud service providers.

3.1.4 inter-cloud provider [ITU-T Y.3502]: A sub-role of cloud service provider that relies on one or more peer cloud service providers to provide part or all of the cloud services offered to cloud service customers.

3.1.5 product catalogue [ITU-T Y.3502]: A listing of all the cloud service products which cloud service providers make available to cloud service customers.

3.1.6 service level agreement [b-ISO/IEC 19086-1]: Documented agreement between the cloud service provider and cloud service customer that governs the covered service(s).

NOTE – A cloud service agreement can consist of one or more parts recorded in one or more documents.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 cloud service brokerage: A service that arbitrates, delivers, and manages cloud services provided by CSPs for CSCs.

NOTE – Cloud service brokerage is realized by cloud service broker with new activities. The new activities are (i) assist CSC for accessing service and (ii) check and control service status.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API Application Programming Interface

CSB Cloud Service Brokerage

CSC Cloud Service Customer

CSN Cloud Service Partner

CSP Cloud Service Provider

ID Identification

OS Operating System

SLA Service Level Agreement

SLO Service Level Objectives

URL Uniform Resource Locator

5 Conventions

In this Recommendation:

The keywords "is required" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

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 service brokerage

6.1 Introduction to cloud service broker

The cloud service broker is a sub-role of cloud service partner (CSN) that negotiates relationships between cloud service customers (CSCs) and cloud service providers (CSPs). The cloud service broker is not itself a cloud service provider and should not be confused with the role of inter-cloud provider [ITU-T Y.3502]. The role of cloud service broker could be combined with or operate independently of the role of inter-cloud provider. Only three activities of cloud service broker have been identified in [ITU-T Y.3502] such as (i) acquire and assess customers, (ii) assess marketplace and (iii) set up legal agreement. A detailed description for these activities follows:

– **acquire and assess customers**: The cloud service broker provides CSCs with available cloud services accompanied by associated information such as service level agreements (SLAs) and contract terms. The cloud service broker also assesses CSC's needs and requirements;

– **assess marketplace**: The cloud service broker constructs product catalogues by surveying the product offerings with technical and business information from CSPs. Any changes of

the contents of corresponding product catalogues are notified to the cloud service broker. If there is a request on cloud service from a CSC, the cloud service broker performs a matching process between product offerings and CSC's requirements including technical, business and regulatory aspects;

– **set up legal agreement**: The cloud service broker negotiates service agreements between the CSC and the CSP in terms of legal agreements as well as terms and prices to complete a contract.

After the contract between a CSC and a CSP by the "set up legal agreement" activity, the CSC uses the selected cloud services. In order for the CSC to use the cloud services, additional considerations are required as follows:

– A CSC uses cloud services from CSPs through access information delivered by the cloud service broker;

– The cloud service broker also manages and monitors the cloud services.

To enhance the operations of the cloud service broker, its activities defined in [ITU-T Y.3502] need to be extended to cover features such as how to access cloud services, how to manage and how to monitor the cloud services.

6.2 Introduction to cloud service brokerage

A cloud service brokerage (CSB) is a service between CSCs and CSPs, in which the cloud service broker arbitrates, delivers and manages the cloud services from the CSPs to the CSCs. The objectives of CSB are to provide a single access, easily managed and value-added service to CSCs from multiple CSPs.

As shown in Figure 6-1, the CSB premises the multiple CSCs and CSPs environment. In CSB, a CSP registers cloud services to a cloud service broker and the cloud service broker configures a product catalogue with the registered cloud services. The cloud service broker also registers cloud services during the configuration of the product catalogue. Three service models (see clause 6.3) are implemented depending on how the product catalogue is configured in cloud service brokerage.

When, a CSC requests a cloud service with CSC's requirements to the cloud service broker, the cloud service broker searches for best-matched cloud services.

Once the CSC agrees with the conditions (e.g. terms and price) of a cloud service by the cloud service broker, the cloud service broker makes a contract with the CSC for brokering a cloud service. On behalf of the CSC, the cloud service broker requests to launch a cloud service to the CSPs and the access information from the CSPs is delivered to the CSC. Using the access information, the CSC accesses and utilizes the cloud service. During the use of the cloud service, the cloud service broker monitors and controls the cloud service on behalf of the CSC.

NOTE – The more detailed overall behaviour of the cloud service brokerage with specific steps is described in Table I.1 and Table I.9 of Appendix I for a general use case and a use case for cloud service management, respectively.

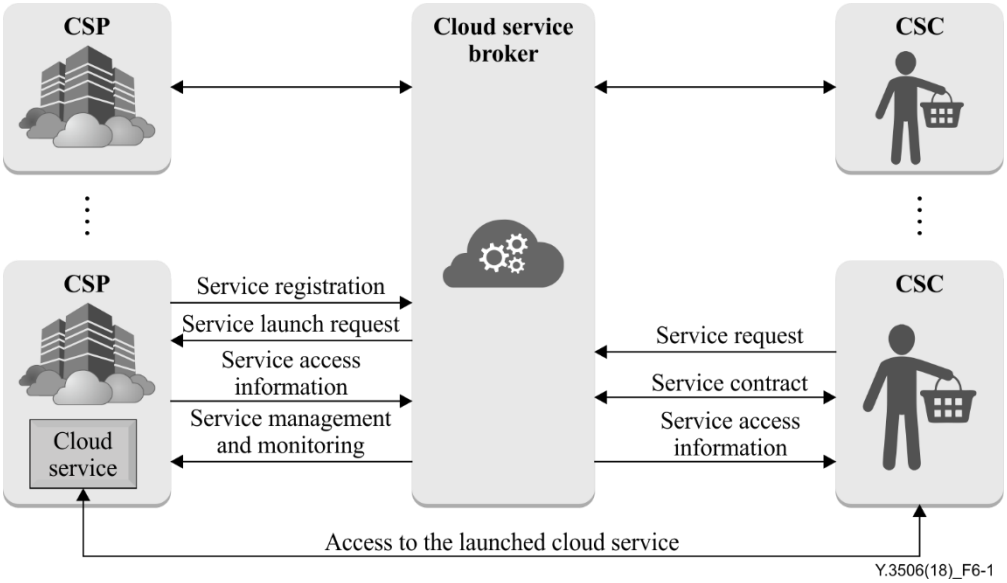


Figure 6-1 – Basic concept of cloud service brokerage

In addition to the three activities of the cloud service broker of [ITU-T Y.3502], the cloud service brokerage needs new activities of the cloud service broker. These new activities are described below.

– **Assist CSC for accessing service**: It includes acquiring access information for a cloud service from CSPs who provide the cloud service, and forwarding the access information to the CSC who requests the cloud service to understand access and usage of the cloud service. In order to assist a CSC to access a cloud service, access information is transmitted securely.

– **Check and control service status**: It supports CSCs to control cloud services, such as stopping, resuming and terminating the cloud services. Also, this activity involves checking the status of running cloud services by monitoring so that the cloud service broker enforces service qualities agreed in a SLA instead of CSCs.

6.3 Service model of cloud service brokerage

The cloud services registered in the product catalogue of cloud service brokerage are categorized in the following three service models:

– **Cloud service aggregation**: As shown in Figure 6-2, cloud service aggregation brings together cloud services from multiple CSPs to CSCs without any changes in a product catalogue. The detailed description of cloud service aggregation is introduced in Table I.2 of Appendix I;

– **Cloud service integration**: As shown in Figure 6-3, cloud service integration collects registered cloud service in a product catalogue, making them work together to provide new cloud services in a product catalogue. The detailed description of cloud service integration is introduced in Table I.3 of Appendix I;

– **Cloud service customization**: As shown in Figure 6-4, cloud service customization performs customized development by a cloud service broker on existing multiple cloud services in a product catalogue according to CSCs' demands. The detailed description of cloud service customization is introduced in Table I.4 of Appendix I.

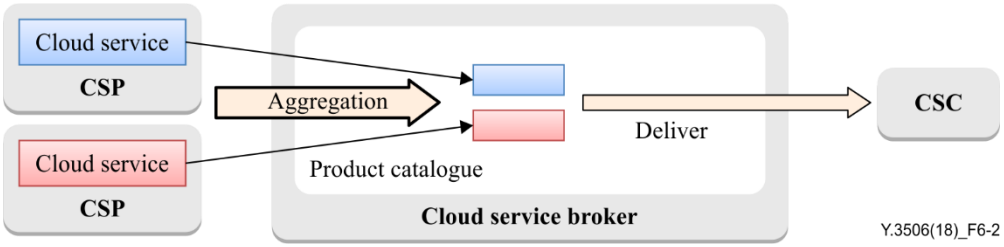


Figure 6-2 – Cloud service aggregation model

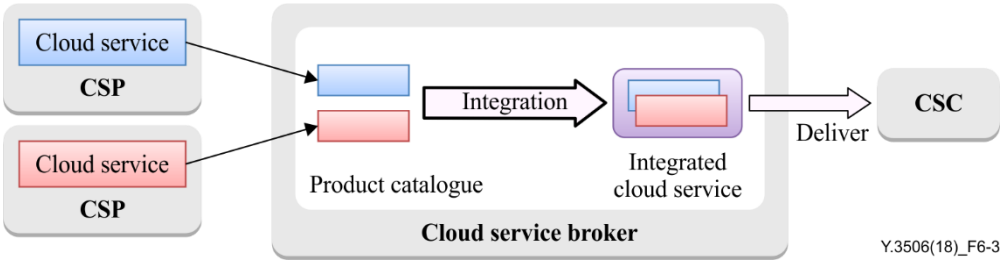


Figure 6-3 – Cloud service integration model

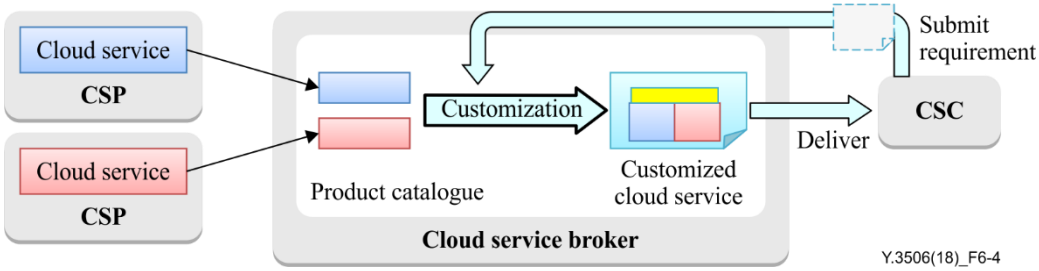


Figure 6-4 – Cloud service customization model

6.4 Configuration of cloud service brokerage

Figure 6-5 shows logical components of CSB. The logical components consist of workspace, product catalogue management, contract management, service access management and service management.

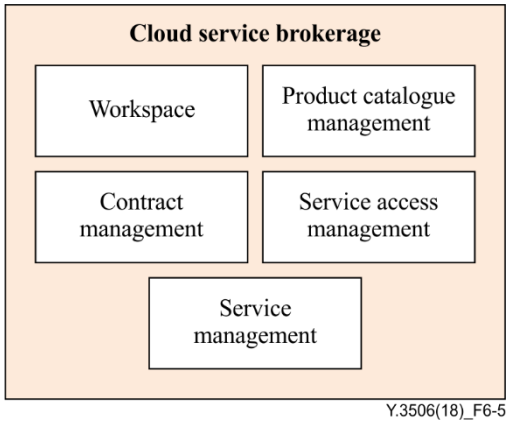


Figure 6-5 – Configuration of cloud service brokerage

NOTE – Relationship between the logical components and the activities of the cloud service broker for CSB is described in Appendix II.

6.4.1 Workspace

A workspace logical component manages user accounts in CSB and provides user interfaces for CSPs and CSCs. This logical component handles authentication of users (i.e., CSPs and CSCs) and grants authorization for them to access other logical components in CSB. CSPs and CSCs perform requests and responses for all their operations through the user interfaces provided by this logical component.

NOTE 1 – CSP's operations include registering and deregistering cloud service. CSC's operations include delivering cloud service requirements, requesting a cloud service launching, checking status of launched cloud services and paying for the usage cost.

NOTE 2 – Since there are CSPs who provide cloud services and CSCs who use the cloud services, a market trading cloud services is formed in a CSB. Whereas marketplace mentioned in [ITU-T Y.3502] is not a logical component of CSB, a CSB itself becomes a marketplace in that CSPs provide cloud services and CSCs use cloud services in the CSP through CSB and the workspace is used as a user interface of marketplace. A CSP registers cloud services to a product catalogue and a CSC use CSP's cloud service by using workspace.

6.4.2 Product catalogue management

A product catalogue management logical component provides registering, deregistering and searching cloud services within a product catalogue in CSB to select cloud service by CSCs. Cloud services from multiple CSPs through workspace are registered and deregistered in the product catalogue. This logical component performs supporting the three service models of CSB described in clause 6.3 by managing registration into the product catalogue.

NOTE – To support service models of CSB, this logical component performs (i) aggregation of cloud services by registering original cloud services from multiple CSPs into the product catalogue, (ii) integration of cloud services by registering a new integrated cloud service that consists of multiple cloud services into the product catalogue and (iii) customization of cloud services by registering a new customized cloud service into the product catalogue to comply with CSC's requirements.

This logical component also provides searching for the best matched cloud service.

6.4.3 Contract management

A contract management logical component manages contracts between CSPs and CSCs in terms of cloud SLA.

NOTE – Cloud SLA includes entire agreements regarding contracts such as specification of cloud services, service level in terms of quality, price of cloud service, remedies for failures to meet the terms of the SLA and so on.

For the establishment of a contract, this logical component needs to create a cloud SLA document by using CSP's SLA and notifies it to the contracted CSC. This logical component registers an agreed service level to the service management logical component to guarantee the contracted service quality. If the cloud service fails to meet the service level, this logical component enforces remedies for failures to meet the terms of the SLA.

6.4.4 Service access management

A service access management logical component requests to launch a contracted cloud service to the designated CSP. This logical component also manages access information of cloud services. In order to use to a cloud service, a CSC requires to get access information. After a CSP launches a cloud service, the CSP provides access information to a cloud service broker and this logical component manages the information and delivers the access information to the CSC.

NOTE – The access information is required for a CSC to access a cloud service. The access information may include an access point such as Internet protocol address or uniform resource locator (URL) of the cloud service and authentication methods such as a certificate or identification (ID) and password to access the cloud service.

6.4.5 Service management

A service management logical component manages the controls and status of running cloud services. This logical component delivers control requests for the running cloud services to CSPs in order to stop, resume and terminate them on behalf of a CSC. This logical component also checks the status of running cloud services by monitoring and enforces the service level agreed in a SLA. If a cloud service fails to meet the service level, this logical component needs to take an action to handle the situation by interacting with a contract management logical component.

7 Functional requirements of cloud service brokerage

7.1 Functional requirements for workspace

– **Authentication and authorization for workspace:** It is required that a CSN: cloud service broker have authentication and authorization mechanisms to authorize CSPs and CSCs access to workspace.

– **Account management:** It is required that a CSN: cloud service broker manage the accounts of CSCs and CSPs.

– **User interface for CSCs:** It is recommended that a CSN: cloud service broker provide a user interface for CSCs to search, select, request, launch, monitor, manage and pay for the cloud services from the multiple CSPs.

– **User interface for CSPs:** It is recommended that a CSN: cloud service broker provide a user interface for CSPs to register information about the CSPs and cloud services to a CSN: cloud service broker.

NOTE – The information about a CSP includes a name of the CSP, entry point URL of the CSP at which a CSN: cloud service broker gains access to and communicates with the CSP, geographical location of the CSP, access account to the CSP and so on.

7.2 Functional requirements for product catalogue management

– **Registration of cloud service:** It is required that a CSN: cloud service broker provide registration of cloud services in the product catalogue.

NOTE 1 – Depending on the service models, the subject and way of registration are different. For a cloud service aggregation model, cloud services in CSPs are registered in a product catalogue. For cloud service integration and customization models, a CSN: cloud service broker registers new cloud services to a product catalogue by integrating the registered cloud services according to the broker and CSC's requirements, respectively.

– **Cloud service deregistration:** By the agreement between a CSP and a CSN: cloud service broker, it is required that the CSN: cloud service broker deregister the cloud services in a product catalogue.

NOTE 2 – The deregistration of a cloud service includes disabling the cloud service from the product catalogue, notifying the deregistration of the cloud service to related CSCs, stopping all running cloud services and deleting the cloud service from the product catalogue.

– **Automation of service deregistration:** It is recommended that a CSN: cloud service broker provide automatic cloud service deregistration to perform deregistration procedures conveniently and safely.

– **Notification of service deregistration:** It is required that a CSN: cloud service broker provide the notification of the service deregistration to CSCs not to use the deregistered service.

– **Request for maintaining cloud service:** It is recommended that a CSN: cloud service broker request the related CSP to maintain the deregistered service until the CSCs finish using the cloud service.

– **Providing cloud service requirement template:** It is recommended that a CSN: cloud service broker provide a template for service requirements to CSCs for receiving CSC's requirements.

NOTE 3 – The requirement template reflects information about CSC's requirements.

NOTE 4 – The CSC's requirement includes SLA information of the cloud service such as quality, price of cloud service, remedies for failures to meet the terms of the SLA and so on. The CSC's requirement also includes information about specifications of the cloud service such as virtual machine, operating system (OS) type, applications, etc.

– **Cloud service requirement validation:** It is recommended that a CSN: cloud service broker provide validation of the contents in the cloud service requirement template.

– **Cloud service search:** It is required that a CSN: cloud service broker provide searching a cloud service in the product catalogue to meet the requirements of CSCs.

NOTE 5 – The requirements of a CSC are used as search criteria that include specifications and service level of a cloud service that a CSC wants to use.

– **Providing the best matched cloud service:** It is recommended that a CSN: cloud service broker provide CSCs with the best matched cloud services and information about the CSPs who provide the cloud services reflecting the CSC's requirements.

– **Cloud service alteration:** It is recommended that a CSN: cloud service broker request CSPs to alter registered services for cloud service customization.

– **Cloud service substitution for integrated cloud service**: It is recommended that a CSN: cloud service broker provide alternative cloud services in a product catalogue for an integrated cloud service.

NOTE 6 – Based on the alternative cloud services in a product catalogue, a CSN: cloud service broker provides the substitution of cloud service as a member of an integrated cloud service.

– **Equivalent cloud service selection:** It is recommended that a CSN: cloud service broker provide an equivalent cloud service in the product catalogue with the registered service to migrate to keep service equivalence after migration.

7.3 Functional requirements for contract management

– **Cloud service charging:** It is recommended that a CSN: cloud service broker provide billing information to CSCs by reorganizing billing information gathered from related CSPs.

NOTE 1 – The billing information is used to generate invoices for the usage of a cloud service. The billing information includes business information related to payment, such as methods for payment and biller and costs for the usage of the cloud service based on price and metering.

– **Configuration of cloud service for contract:** It is recommended that a CSN: cloud service broker configure a cloud service through selecting elements of the cloud service by a CSC.

NOTE 2 – Examples of elements for cloud service specification are virtual machines, OS type, applications, etc.

– **Service level objectives (SLO) selection:** It is recommended that a CSN: cloud service broker provide selection of service level objectives to a CSC according to business requirements of the CSC.

– **SLA document management:** It is recommended that a CSN: cloud service broker provide generation of a SLA document according to the agreement to share the SLA document with the related CSC.

– **SLA description model:** It is recommended that a CSN: cloud service broker provide a SLA description model to describe terms and conditions.

NOTE 3 – Examples of terms and conditions are guaranteed service levels and remedies for failures to meet the terms of the SLA.

– **Remedies for failures to meet the terms of the SLA:** It is recommended that a CSN: cloud service broker provide agreed remedies for failures to meet the terms of the SLA.

NOTE 4 – Examples of a remedies are migration, scale up, performance extension and so on.

7.4 Functional requirements for cloud service access management

– **Delivering cloud service provision request:** It is recommended that a CSN: cloud service broker deliver the provisioning request to CSPs as requested by the CSC.

– **Delivering cloud resource request:** When a CSC needs more cloud resources of a cloud service, it is recommended that a CSN: cloud service broker deliver the CSC's request for resources to a CSP.

– **Access information forwarding:** It is required that a CSN: cloud service broker forward the access information of a cloud service from a CSP to the authorized CSC.

– **Prohibiting access information storing:** It is recommended that a CSN: cloud service broker provide prohibiting of the access information for a cloud service not to open or store.

7.5 Functional requirements for cloud service management

– **Cloud service SLA management:** It is recommended that a CSN: cloud service broker provide SLA management of running cloud service across multiple CSPs.

– **Cloud service monitoring:** It is recommended that a CSN: cloud service broker monitor the status of cloud services by using gathered monitoring information of the cloud service from multiple CSPs.

NOTE 1 – The monitoring information is gathered periodically or aperiodically at runtime to check conditions or status of cloud services. The monitoring information includes measured data for metrics of service levels in SLA or resource utilization of cloud services.

NOTE 2 – A CSN: cloud service broker monitors status of logical resources (e.g., virtual machine) of cloud services.

– **Delivering request of cloud service control:** It is recommended that a CSN: cloud service broker deliver requests of control actions for a cloud service from a CSC to a CSP for managing status of the cloud service.

– **Validation of result for request of cloud service control:** It is recommended that a CSN: cloud service broker validate the status of cloud service whether the status is changed correctly or not in accordance with the delivered request for a control action of a cloud service by a CSC.

NOTE 3 – Since changing status of cloud service takes time according to the circumstance of the CSP, a CSN: cloud service broker does not know the result of the control request instantly. Therefore, to validate the status of cloud service, the CSN: cloud service broker needs to check periodically the current status of cloud service by communicating with the CSP until the validation is finished.

– **Initiation of validation:** It is recommended that a CSN: cloud service broker initiate cloud service control status validation only after the CSN: cloud service broker receives an acknowledgement for a cloud service control request from a CSP.

NOTE 4 – The acknowledgement for a service control request is a message from a CSP to inform receipt of a request for a service control from a CSN: cloud service broker.

– **Status checking period for validation:** It is recommended that a CSN: cloud service broker provide checking periods in service control status validation by predicting the completion time of the cloud service control to reduce communication overhead between the CSN: cloud service broker and a CSP.

NOTE 5 – Service control checking period is the duration of time of one cycle for checking status of the service. The checking period is determined probabilistically by statistically predicting the completion time of the cloud service control.

NOTE 6 – To predict the completion time of a cloud service control, statistical methods, such as moving average and variance, are applied to accumulated history of completion time of previous control requests for the same or similar services. Using the statistical methods, a CSN: cloud service broker generates a probability distribution for completion of service control at a given time.

NOTE 7 – The service control checking periods are determined by a normal probability distribution. The CSN: cloud service broker increases the frequency of checking status of service when the probability of service control completion is high. The CSN: cloud service broker decreases the frequency when the probability of service control completion is low.

– **History of cloud service control status validation:** It is recommended that a CSN: cloud service broker manage history of validation results as well as required time for completing cloud service controls.

– **Notification of result for request of cloud service control:** It is recommended that a CSN: cloud service broker provide notification of the result of cloud service control to a CSC.

– **Detection of failures to meet the terms of the SLA:** It is required that a CSN: cloud service broker detect failures to meet the terms of the SLA through monitoring and to verify the service level.

NOTE 8 – To detect failures to meet the terms of the SLA, monitoring includes one or more measurable information such as storage speeds, memory capacity and performance, computing speeds, network speeds, service response time, etc.

NOTE 9 – If a failure to meet the terms of the SLA is found in the integrated cloud service, a CSN: cloud service broker identifies the cloud service that caused the failure.

– **Prevention of service termination during migration:** It is recommended that a CSN: cloud service broker provide postponing of the termination of a running cloud service until the CSN: cloud service broker verifies ready status of a new service to prevent loss of data during migration process.

8 Security considerations

Security aspects for consideration within the cloud computing environment, are addressed by security challenges for the CSPs as described in [ITU-T X.1601]. In particular, [ITU-T X.1601] analyses security threats and challenges and describes security capabilities that could mitigate these threats and meet the security challenges.

Appendix I

Use cases of cloud service brokerage

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

Table I.1 – A general use case for cloud service brokerage

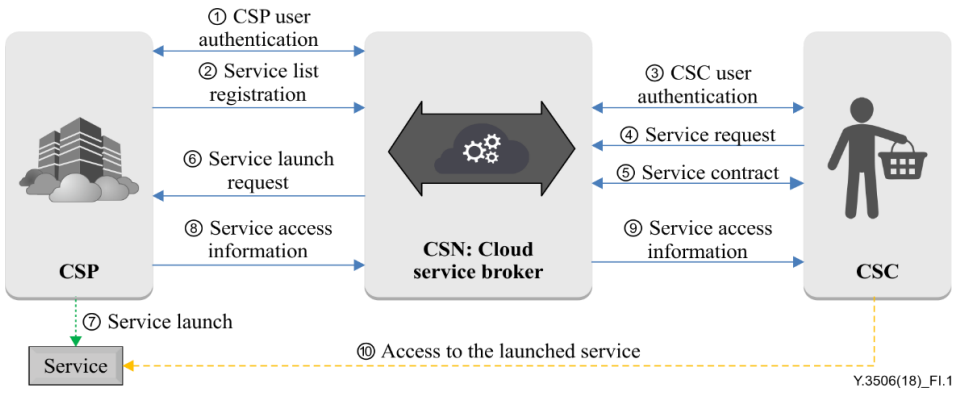
Title	A general use case for cloud service brokerage.
Description	(1) A CSP determines to sell cloud services though a CSN: cloud service broker and accesses a workspace operated by the CSN: cloud service broker such as a web portal by using an authorized account. (2) The CSP registers cloud service list to a product catalogue of the CSN: cloud service broker though a user interface of the workspace. (3) A CSC accesses the workspace by using an authorized account to find and use a cloud service through the CSN: cloud service broker. (4) The CSC requests a cloud service with service requirements to the CSN: cloud service broker. Then, the CSN: cloud service broker searches the best-matched cloud service out of the CSN: cloud service broker's product catalogue. (5) The CSN: cloud service broker notifies the searched result and suggests detailed cloud service conditions to the CSC. Once the CSC agrees with the suggested condition, the CSN: cloud service broker makes a contract with the CSC for brokering a cloud service. (6) On behalf of the CSC, the CSN: cloud service broker requests to launch a cloud service to the CSP who can accommodate the service requirements. (7) The requested CSP launches a cloud service according to the service requirements (8) The CSP informs on a launch of the cloud service and provides information for accessing the cloud service such as service access point, ID and password to the CSN: cloud service broker. (9) The CSN: cloud service broker forwards the access information to the authorized CSC. (10) Using the access information, the CSC accesses and utilizes the launched cloud service.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSP is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSC is a member of the CSN: cloud service broker and has an account for accessing CSB workspace.

Table I.1 – A general use case for cloud service brokerage

Post-conditions (optional)	The CSN: cloud service broker monitors status of the brokered service to comply with the contracted service agreement.
Derived requirements	– Authentication and authorization for workspace (See clause 7.1) – Account management (See clause 7.1) – User interface for CSCs (See clause 7.1) – User interface for CSPs (See clause 7.1) – Access information forwarding (See clause 7.4) – Prohibiting access information storing (See clause 7.4)

Table I.2 – A general use case of cloud service aggregation

Title	A general use case of cloud service aggregation.
Description	The CSN: cloud service broker aggregates the various cloud services of the multiple CSPs and publishes these services to the CSCs without any change. The difference between the general use case for cloud service brokerage in Table I.1 and this use case is that cloud service aggregation brokerage provides the CSC a product catalogue which consists of multiple services hosted by CSPs and an aggregated management view, i.e., workspace, for ordered multiple services. The CSPs register cloud services to the CSN: cloud service broker in product catalogue, which is the unique one provided to a CSC by the CSN: cloud service broker with all CSPs' cloud services. The synchronization of the product catalogue can be triggered by the registered CSPs or the CSN: cloud service broker itself in case of modification in the cloud services. The CSC accesses the CSB workspace, selects and purchases different cloud services from multiple CSPs. The CSN: cloud service broker completes ordering processing of multiple CSPs, instead of the CSC. After the CSC individually selects and orders multiple services from the product catalogue, the CSN: cloud service broker shows the list of ordered multiple services to the CSC so that the CSC can request controls for the cloud services to the CSN: cloud service broker. The CSC can use workspace to manage the ordered multiple services together or individually. For instance, the CSC can pause all the aggregated services at once and checks the overall usage cost of the aggregated services. The CSN: cloud service broker can help the CSC to provision all the selected cloud services together to simplify the process. For instance, to launch multiple virtual machines in multiple CSPs' cloud environment. The CSN: cloud service broker can manage controls and status of multiple cloud services in aggregated manner and/or each cloud services individually. All monitor information can be collected by the CSN: cloud service broker to provide the CSC with an overall view of cloud services together. The unified charges can be proved to the CSC by the CSN: cloud service broker.

Table I.2 – A general use case of cloud service aggregation

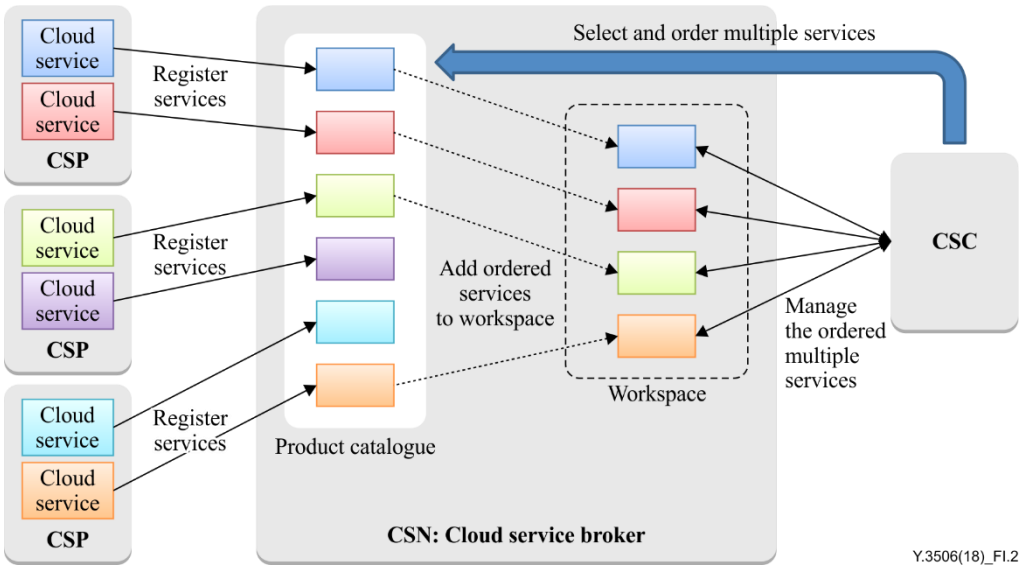
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSN: cloud service broker and multiple CSPs achieve a cooperation agreement and the CSN: cloud service broker can sell these CSPs' cloud services. The CSN: cloud service broker adapts the different cloud application programming interfaces (APIs) of multiple CSPs.
Post-conditions (optional)	The CSCs can order and use the cloud services of multiple CSPs through a CSB workspace.
Derived requirements	– User interface for CSCs (See clause 7.1) – Delivering cloud service provision request (See clause 7.4) – Cloud service SLA management (See clause 7.5) – Cloud service charging (See clause 7.3) – Cloud service monitoring (See clause 7.5) – Registration of cloud service (See clause 7.2)

Table I.3 – A general use case of cloud service integration

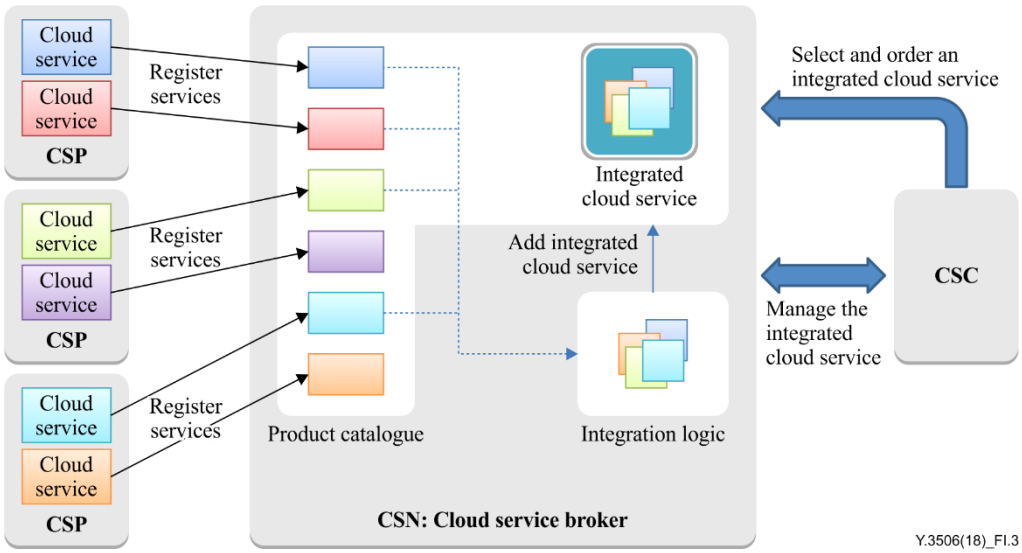
Title	A general use case of cloud service integration.
Description	The CSN: cloud service broker collects multiple cloud services provided by different CSPs, orchestrates the multiple cloud services and provides value-added cloud services to CSCs through The CSN**:** cloud service broker's cloud product catalogue. The CSPs register cloud services to the CSN: cloud service broker in product catalogue, which is the unique one provided to the CSC by the CSN: cloud service broker with all CSPs cloud services. The synchronization of the product catalogue can be triggered by the registered CSPs or the CSN: cloud service broker itself in case of modification in the cloud services. The CSN: cloud service broker integrates the cloud services from CSPs by an integration logic and provides the value-added services in the product catalogue. NOTE – The integration logic describes interactions among the cloud services and specifies the method to enable the interactions. After the CSC selects and orders the integrated cloud service from the product catalogue, the CSN: cloud service broker makes requests for service creation to CSPs for all cloud services which are subservices of integrated cloud service. After all cloud services are created, the CSN: cloud service broker enables interactions among cloud services by utilizing the integration logic. Once the integration procedure has been finished, the CSN: cloud service broker sends service access information to the CSC so that the CSC can accesses to the integrated cloud services. The CSN: cloud service broker manages controls and status of the integrated cloud service and each subservice is managed simultaneously. The cloud services on multiple CSPs are interacted with each other based on the service integration logic. All monitor information can be collected by the CSN**:** cloud service broker to provide the CSC with an overall view of cloud services together. The unified charges can be proved to the CSC by the CSN**:** cloud service broker.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSN: cloud service broker and multiple CSPs achieve a cooperation agreement and the CSN: cloud service broker can sell these CSPs' cloud services. The CSN: cloud service broker adapts the different cloud APIs of multiple CSPs.

Table I.3 – A general use case of cloud service integration

Post-conditions (optional)	The CSCs can build application systems upon integrated cloud environment upon multiple CSPs based on the brokerage capabilities provided by the CSN: cloud service broker.
Derived requirements	– User interface for CSCs (See clause 7.1) – Delivering cloud service provision request (See clause 7.4) – Cloud service monitoring (See clause 7.5) – Registration of cloud service (See clause 7.2)

Table I.4 – A general use case of cloud service customization

Title	A general use case for cloud service customization in cloud service brokerage.
Description	This use case describes a general use case for cloud service customization. Cloud service customization in cloud service brokerage is a service model to search, compose and provide a customized cloud service to a CSC according to the CSC' service requirements. If a CSN: cloud service broker cannot discover a service that fulfils CSC's service requirements in the product catalogue, the CSN: cloud service broker integrates and configures existing services to composite a new customized service. Such as, layering new data and process functions, visibility and analytics, or incorporating a new look and feel to the service. CSC's service requirements can consist of multiple parameters such as service names, the amount of required resources, required service levels, required software, required configurations and so on. The CSN: cloud service broker collects multiple cloud services provided by different CSPs, performs customization on these cloud services according to CSCs' requirements. (1) When a CSC could not find a satisfied service from the product catalogue, the CSC requests a cloud service with service requirements to a CSN: cloud service broker. (2) The CSN: cloud service broker searches a cloud service, which fulfils the CSC's requirements, from product catalogue. (3) If the CSN: cloud service broker cannot find an appropriate service from the service list registered in the product catalogue, the CSN: cloud service broker initiates customization process in order to generate a customized service according to the CSC's requirements. The CSN: cloud service broker integrates and/or configures (such as, layering new data and process functions) existing services. (4) Then, the CSN: cloud service broker registers the customized service in the product catalogue. (5) Finally, through workspace, the CSN: cloud service broker notifies description of the customized service to the CSC so that the CSC determines whether to use the customized service or not.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC

Table I.4 – A general use case of cloud service customization

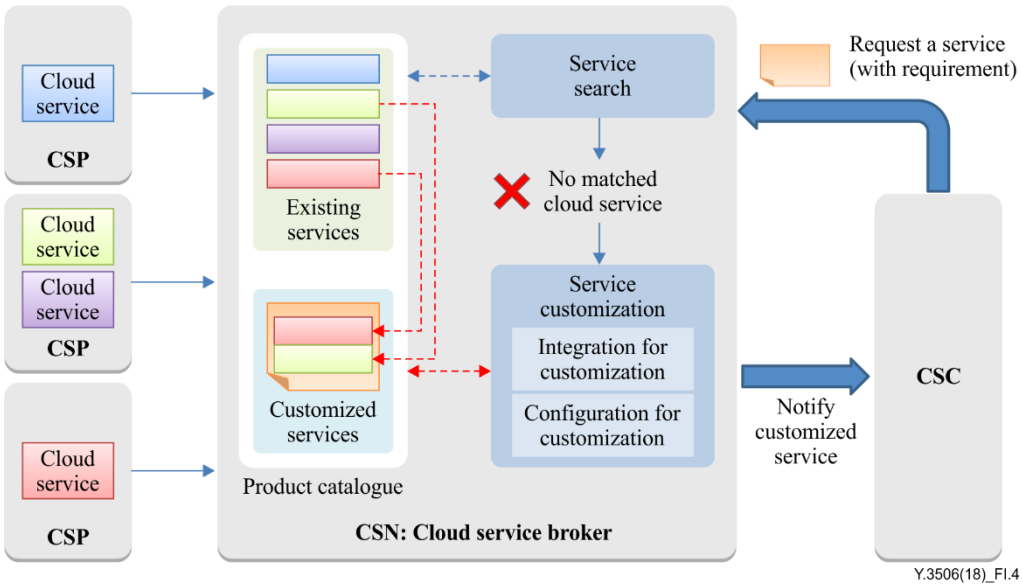
Figure	
Pre-conditions (optional)	The CSP has an account for accessing CSB workspace. There are existing services registered in the product catalogue. The CSC has an account for accessing CSB workspace. The CSC could not find a satisfied service from the product catalogue.
Post-conditions (optional)	The CSC selects a customized service to utilize. The CSN: cloud service broker and CSC establish an SLA for using the customized service. The CSC accesses to the customized service and performs necessary operations.
Derived requirements	– Providing cloud service requirement template (See clause 7.2) – Cloud service requirement validation (See clause 7.2) – Cloud service search (See clause 7.2) – Registration of cloud service (See clause 7.2) – Cloud service alteration (See clause 7.2)

Table I.5 – A use case for registration of cloud services at CSP side

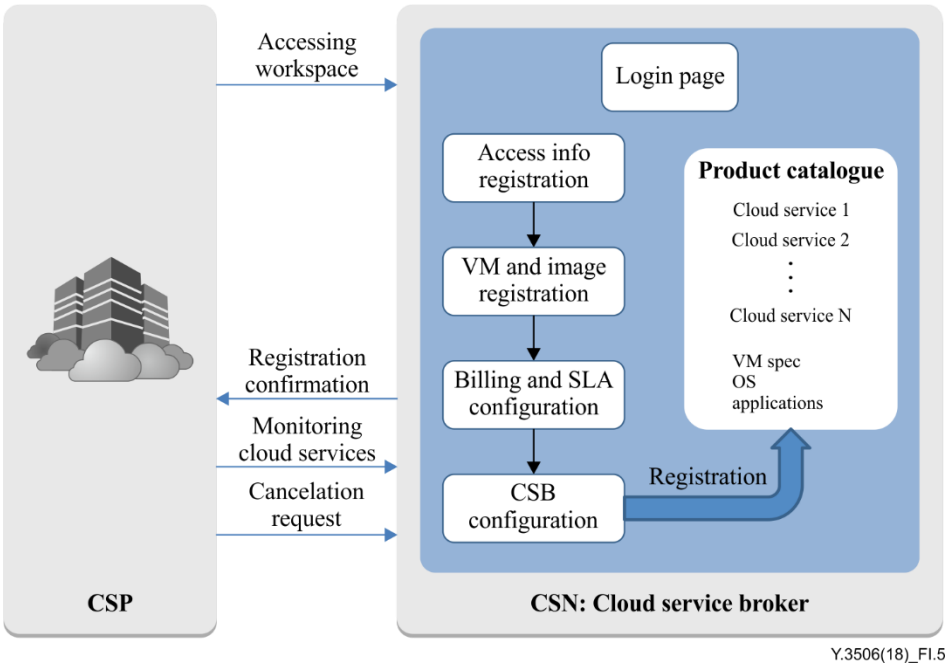
Title	A use case for registration and deregistration of cloud services at CSP side.
Description	A CSP accesses a login page in the CSB workspace using previously registered IDs and passwords. The CSP registers access information of the cloud services that will be listed in the product catalogue. The access information of the cloud services would be connection ID, connection password, endpoint URL and location. Then, the CSP defines the unit of cloud service by enrolling the information of its cloud services. The unit of cloud service encompasses its name, specification of virtual machine, images including a particular OS, agent software and related applications. The CSP can defines various types of unit of cloud services in the workspace. For example, the specification of virtual machine can varies depending on the number of virtual central processing unit (CPU), size of random access memory and size of storage. The images also can be diverse in accordance with OS types, OS version and presence of specific applications. On each constructed unit of cloud services, the CSP registers the billing information and SLA. After registering cloud services, the CSP asks a CSN: cloud service broker to add the cloud services into product catalogues in the workspace in the CSC side. The CSN: cloud service broker validates each SLA and security aspects of the cloud services and, if there is no problem, performs the confirmation of the registration.
Roles/sub-roles	CSP, CSN: cloud service broker
Figure	
Pre-conditions (optional)	The CSP is a member of the CSN: cloud service broker and has an account for accessing CSB workspace.
Post-conditions (optional)	The CSC can select cloud services on product catalogue.
Derived requirements	– Registration of cloud service (See clause 7.2) – User interface for CSPs (See clause 7.1)

Table I.6 – A use case of cloud service selection and configuration from CSC

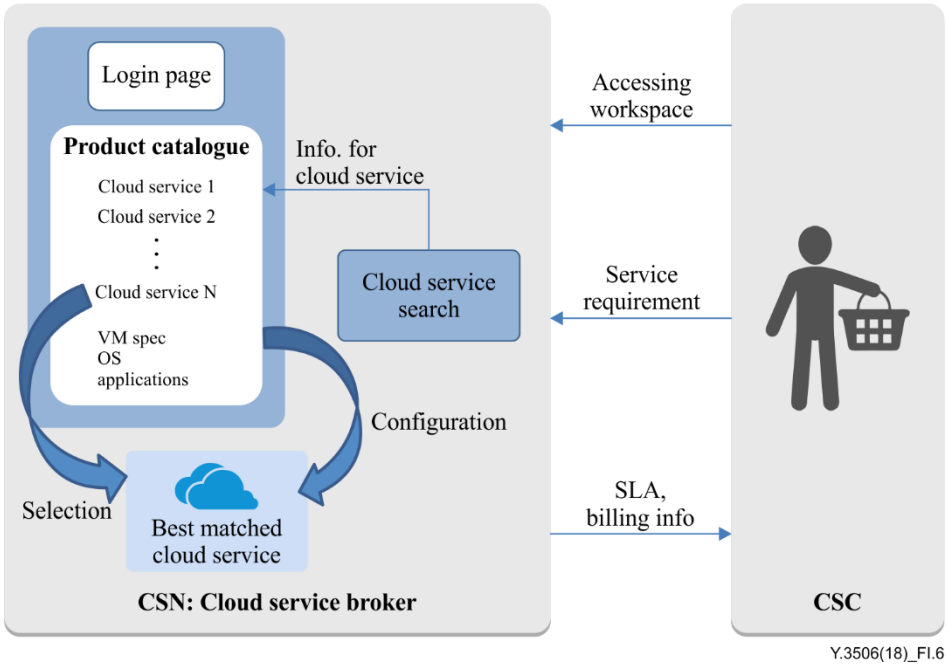
Title	A use case of cloud service selection and configuration from CSC.
Description	A CSC accesses a workspace provided by a CSN: cloud service broker with previously registered IDs and passwords. Cloud services shown in a product catalogue are usually managed in the form of images that packages a virtual machine, OS and applications. To search cloud services that the CSC wants to use, the CSC inputs information of the cloud services into the workspace. The information of the cloud services would be CSP's location, prices, hardware specification of virtual machine, OS types, applications, SLA, etc. The CSN: cloud service broker can automatically find the services best matched with search terms from the CSC. The CSB workspace also provides the interfaces where the CSC can search the cloud services in a product catalogue manually. In some cases, a CSC can configure a cloud service by selecting separate elements of the cloud service not by choosing a full packaged cloud service. After searching or configuring a cloud service, a CSC receives corresponding SLAs and billing information adjusted by the CSN: cloud service broker. On CSC's acceptance, the contract phase begins, otherwise the CSC can search and configure cloud services again.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSC is a member of the CSN: cloud service broker and has an account for accessing CSB workspace.
Post-conditions (optional)	The contract between the CSC and CSN: cloud service broker is established.
Derived requirements	– Providing the best matched cloud service (See clause 7.2) – Configuration of cloud service for contract (See clause 7.3)

Table I.7 – A use case for cloud service cancellation

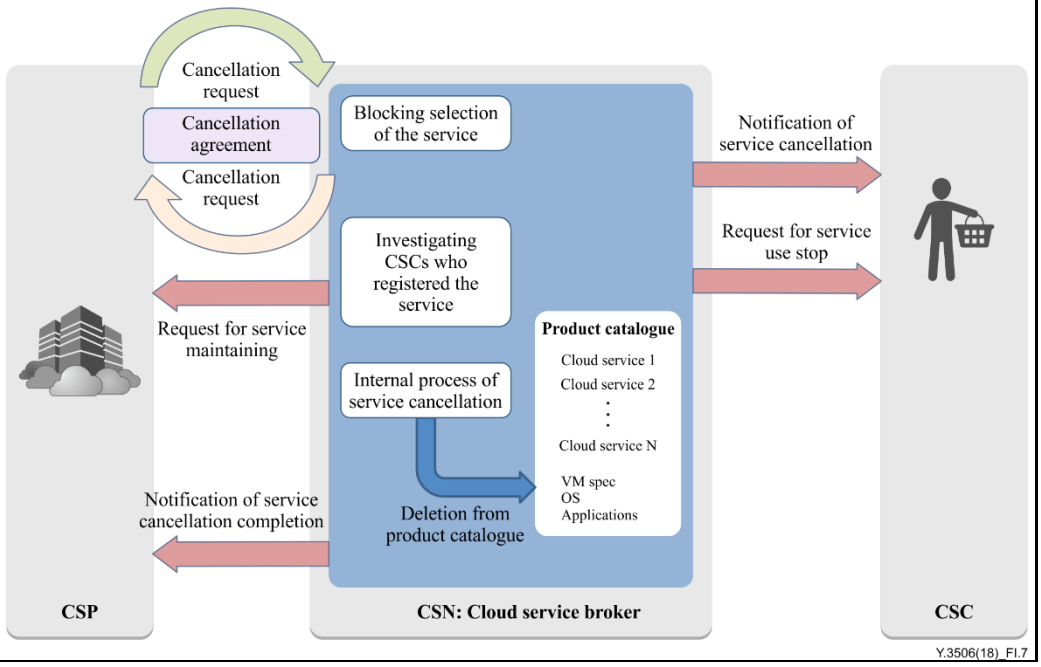
Title	A use case for deregistration of cloud services
Description	This use case assumes that cloud service deregistration is performed when the contract between a CSP and a CSN: cloud service broker is cancelled during normal contract agreement. The contract cancellation is out of scope and the abnormal situations such as bankruptcy and service disruption of the CSP are not considered in this contribution. Service deregistration can be done by the request from a CSP or a CSN: cloud service broker. A CSP initiates deregistration of the cloud service for some internal situations (e.g., modification or unavailability of the cloud service) during the cloud service. A CSN: cloud service broker can also request to deregister the cloud service, e.g., violation of contract requirement by CSPs. When the service deregistration is agreed with each other between a CSP and a CSN: cloud service broker and it is confirmed, the CSN: cloud service broker stops the CSCs search and selects the service targeted to be deregistered and stops posting the service list at the workspace from the product catalogue. The CSN: cloud service broker also investigates the CSCs that have contacted to use the service and, if they exist, notifies deregistration of the service to the registered CSCs. When CSCs are using the service currently, the CSN: cloud service broker requests the CSP to maintain the service until the CSCs finish using the service. After that, the CSN: cloud service broker cancels the contract corresponding to the cloud service between the CSN: cloud service broker and the CSC and, if needed, renews the contract between them. To complete the service deregistration, the CSN: cloud service broker can start the internal process of deregistration. The CSN: cloud service broker deregisters the service on a product catalogue and invalidates all related information such as monitoring, metering, CSC's account, SLA, etc. CSP's APIs that allow the CSC to interact with the CSP are also disabled so as not to access the service any more. The CSN: cloud service broker finally notifies the CSP deregistration that the cloud service is completed.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	

Table I.7 – A use case for cloud service cancellation

Pre-conditions (optional)	A CSP registered a cloud service to the list of a product catalogue in a CSN: cloud service broker. A CSC signed a contract with a CSN: cloud service broker for cloud service.
Post-conditions (optional)	A CSC cannot search the cloud services on product catalogue and cannot use the cloud service.
Derived requirements	– Cloud service deregistration (See clause 7.2) – Automation of service deregistration (See clause 7.2) – Notification of service deregistration (See clause 7.2) – Request for maintaining cloud service (See clause 7.2)

Table I.8 – A use case for SLA establishment in cloud service brokerage

Title	A use case for SLA establishment in cloud service brokerage.
Description	This use case describes SLA establishment among a CSN: cloud service broker, CSPs and CSCs. SLA is a part of the cloud service agreement that includes cloud service level objectives (SLO) and cloud service qualitative objectives for the covered cloud service(s) [b-ISO/IEC 19086-1]. Since a CSC communicates with a CSN: cloud service broker to consume a cloud service, the CSN: cloud service broker is responsible for establishing a SLA with the CSC. Also, CSPs need to provide service level information to the CSN: cloud service broker so that the CSN: cloud service broker understands feasible service levels. A CSP determines to sell cloud services though a CSN: cloud service broker and the CSP registers cloud service information including service level in CSB workspace. For instance, the CSP can provide "service availability" service level which can be expressed as a percentage of uptime to total usage time of a cloud service. The CSP registers a lower limit for the availability service level (ex: 99.99%) and remedies (e.g., discounting service price) for failure to meet the SLA to the CSN: cloud service broker. The CSN: cloud service broker verifies that all services with service level descriptions are correctly registered by the CSP. The CSN: cloud service broker repackages services, registered by the CSP, into brokerage services according to business needs such as service customization or service integration. The CSN: cloud service broker needs to provide service levels of a service which the CSC requests to the CSN: cloud service broker. For instance, the CSN: cloud service broker repackages a service and offers 99.98% of service availability where the service level of the original service registered by the CSP is 99.99%. The CSC, who needs an IaaS service satisfying at least 99.90% availability, connects to CSB workspace and selects a cloud service according to the business requirements. After the CSC selects a cloud service, the CSN: cloud service broker generates a SLA document and shares the SLA document to CSC. Once the CSC accepts terms and conditions in the SLA document, a SLA between the CSN: cloud service broker and the CSC is established. After the SLA between the CSN: cloud service broker and the CSC is established, the CSN: cloud service broker makes a request to the CSP to initiate the service. When the CSN: cloud service broker makes the request, it is assumed that a SLA between the CSP and the CSN: cloud service broker is established according to the service level descriptions registered by the CSP.

Table I.8 – A use case for SLA establishment in cloud service brokerage

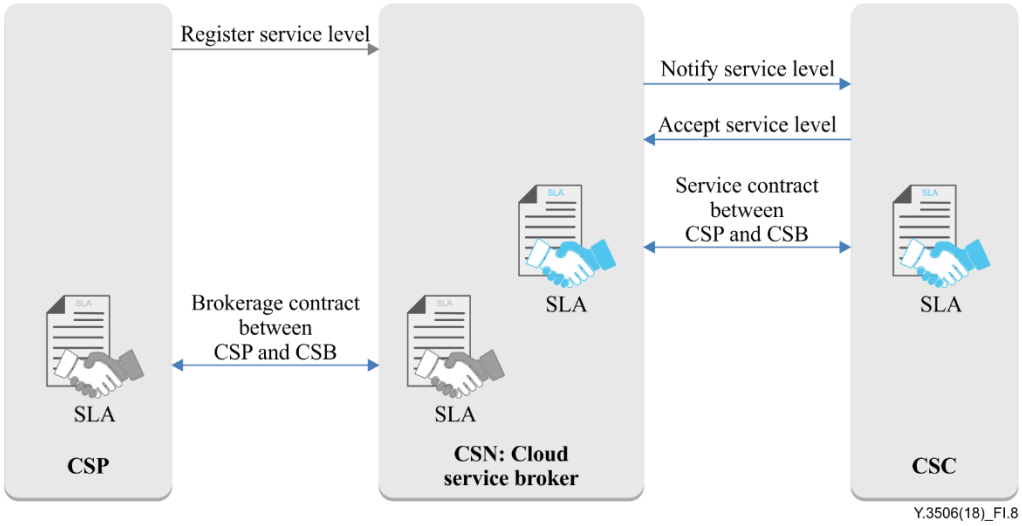
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSP is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSC is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSP registered cloud service information including service level in CSB workspace.
Post-conditions (optional)	The CSN: cloud service broker makes a request for provisioning of a service, which complies with the contracted SLA, to a CSP. The CSN: cloud service broker monitors status of the brokered service to comply with SLA.
Derived requirements	– Service level objectives selection (See clause 7.3) – SLA document management (See clause 7.3) – SLA description model (See clause 7.3)

Table I.9 – A use case for cloud service management in CSB

Title	A use case for cloud service management in CSB.
Description	This use case describes providing a cloud service to a CSC and a service management during the service period. (1) On behalf of the CSC, the CSN: cloud service broker requests to create a service to the CSP that can accommodate the service requirements. (2) The requested CSP creates a service according to the service requirements. (3) The CSP informs on a creation of the service and provides information for accessing the service such as service access point, ID and password to the CSN: cloud service broker. (4) The CSN: cloud service broker forwards the access information to the authorized CSC. (5) Using the access information, the CSC accesses and utilizes the created service. (6) During the service period, the CSN: cloud service broker manages SLA. A. The CSN: cloud service broker periodically monitors the service about service level (e.g., availability should be higher than 99.98%) described in the SLA established between the CSN: cloud service broker and the CSC. B. When the CSN: cloud service broker detects service level is lower than the agreed service level (e.g., measured availability becomes lower than 99.98%), the CSN: cloud service broker notifies the failure to meet the SLA to the CSC. Also, according to the SLA, the CSN: cloud service broker performs remedies (e.g., provides bonus point to the CSC or scales up the service) C. Finally, if the failure to meet the SLA is caused by the CSP who operates the service, the CSN: cloud service broker and the CSP settle the failure. (7) During the service period, the CSC makes a request to the CSN: cloud service broker to control (e.g., pause, resume, or restart) the service. A. The CSN: cloud service broker records the request information from the CSC. B. The CSN: cloud service broker makes a control request (e.g., pause, resume, or restart) to the CSP, who is operating the service. C. The CSP controls the service according to the request from the CSN: cloud service broker and replies with a result of control to the CSN: cloud service broker. D. The CSN: cloud service broker verifies the control request is correctly performed. E. Through the CSB workspace, the CSC is notified that the request has been performed. (8) During the service period, the CSC makes a request to the CSN: cloud service broker to stop and terminate the service. A. The CSN: cloud service broker records the termination request information from the CSC. B. The CSN: cloud service broker makes a termination request to the CSP, who is operating the service. C. The CSP stops and terminates the service according to the request from CSN: cloud service broker and replies with a result of termination to the CSN: cloud service broker. D The CSN: cloud service broker verifies the service is correctly terminated. E Through the CSB workspace, the CSC is notified the termination has been performed and the cost of the service usage.

Table I.9 – A use case for cloud service management in CSB

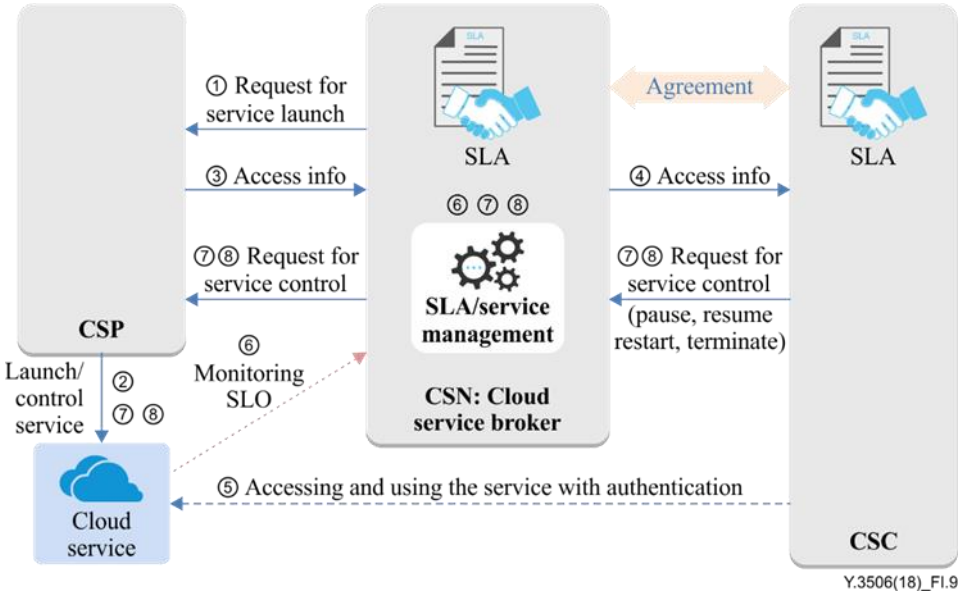
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSP is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSC is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSC selected a cloud service to utilize. The CSN: cloud service broker and the CSC established a SLA.
Post-conditions (optional)	
Derived requirements	– Delivering request of cloud service control (See clause 7.5) – Validation of result for request of cloud service control (See clause 7.5) – History of cloud service control status validation (See clause 7.5) – Cloud service monitoring (See clause 7.5) – Detection of failures to meet the terms of the SLA (See clause 7.5) – Remedies for failures to meet the terms of the SLA (See clause 7.3) – Delivering cloud resource request (See clause 7.4)

Table I.10 – A use case of cloud service control status validation

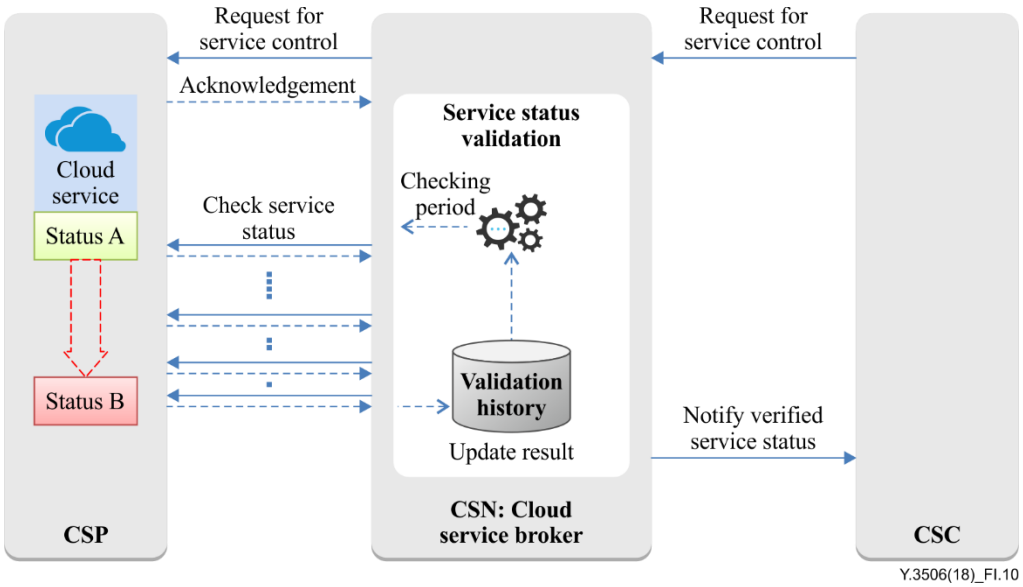
Title	A use case for cloud service control status validation in cloud service brokerage.
Description	This use case describes a validation of legitimate service status after a CSN: cloud service broker made a request for an action (e.g., create, pause, resume, or restart) to change service status on behalf of a CSC. Since a CSP and a CSN: cloud service broker are not tightly coupled, the CSN: cloud service broker does not know the result of the control request instantly. So, a CSN: cloud service broker needs to keep checking status of service by communicating with the CSP until the CSN: cloud service broker verifies whether the control request is correctly performed or not. (1) On behalf of the CSC, the CSN: cloud service broker makes a control request (e.g., create, pause, resume, restart, or terminate) to the CSP who is hosting the service. (2) The requested CSP sends an acknowledgement to the CSN: cloud service broker for the service control request and starts to control a service accordingly. (3) After the CSN: cloud service broker receives the acknowledgement, the CSN: cloud service broker sets a time window to wait and periodically verify the service status. The CSN: cloud service determines an efficient period to repeat a communication with the CSP to get information on the latest service status. (4) The CSN: cloud service broker verifies that the current service status complies with the ideal service status by the request from the CSC. The CSN: cloud service broker keeps communicating with the CSP until the service status becomes ideal status or error status, or a certain deadline is over. (5) Finally, through the workspace, the CSN: cloud service broker notifies the result of service control to the CSC.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	The CSP has an account for accessing CSB workspace. The CSC has an account for accessing CSB workspace. The CSC selected a cloud service to utilize. CSN: cloud service broker and CSC established a SLA.

Table I.10 – A use case of cloud service control status validation

Post-conditions (optional)	
Derived requirements	– Initiation of validation (See clause 7.5) – Validation of result for request of cloud service control (See clause 7.5) – History of cloud service control status validation (See clause 7.5) – Status checking period for validation (See clause 7.5) – Notification of result for request of cloud service control (See clause 7.5)

Table I.11 – A use case for cloud service migration in cloud service brokerage

Title	A use case for cloud service migration in cloud service brokerage.
Description	This use case describes cloud service migration in cloud service brokerage during the service period. The CSC is using a cloud service provided by the CSP(A) under a contract with a CSN: cloud service broker. The CSC determines to change the physical location of the service according to some usage requirements. For instance, the CSC, who operates a business using the cloud service, may determine to move business location to another country. The CSC makes a request to migrate the cloud service to the CSN: cloud service broker. The CSN: cloud service broker searches product catalogue to select a CSP candidate (CSP(B)) who provides an equivalent service with the existing service. The CSN: cloud service broker and the CSC negotiate to determine the most appropriate service for the migration. After the CSN: cloud service broker reaches an agreement, the CSN: cloud service broker notifies the updated service information due to the service migration. On behalf of the CSC, the CSN: cloud service broker requests to create a service to the CSP(B) that can accommodate the service requirements. The requested CSP(B) creates a service according to the service requirements. The CSN: cloud service broker makes a request for service migration to the CSP(A) so that the CSP(A) migrates data and the status of the existing service to the service created by the CSP(B). After the CSN: cloud service broker confirms that the migration of status and data was accomplished, the CSP(B) initiates the created service using the transferred data and status. The CSP(B) informs on a creation of the service and provides information for accessing the service such as service access point, ID and password to the CSN: cloud service broker. Using the access information, the CSC accesses and utilizes the created service. Finally, the CSN: cloud service broker requests termination of the existing service to the CSP(A) and ends their contract.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC

Table I.11 – A use case for cloud service migration in cloud service brokerage

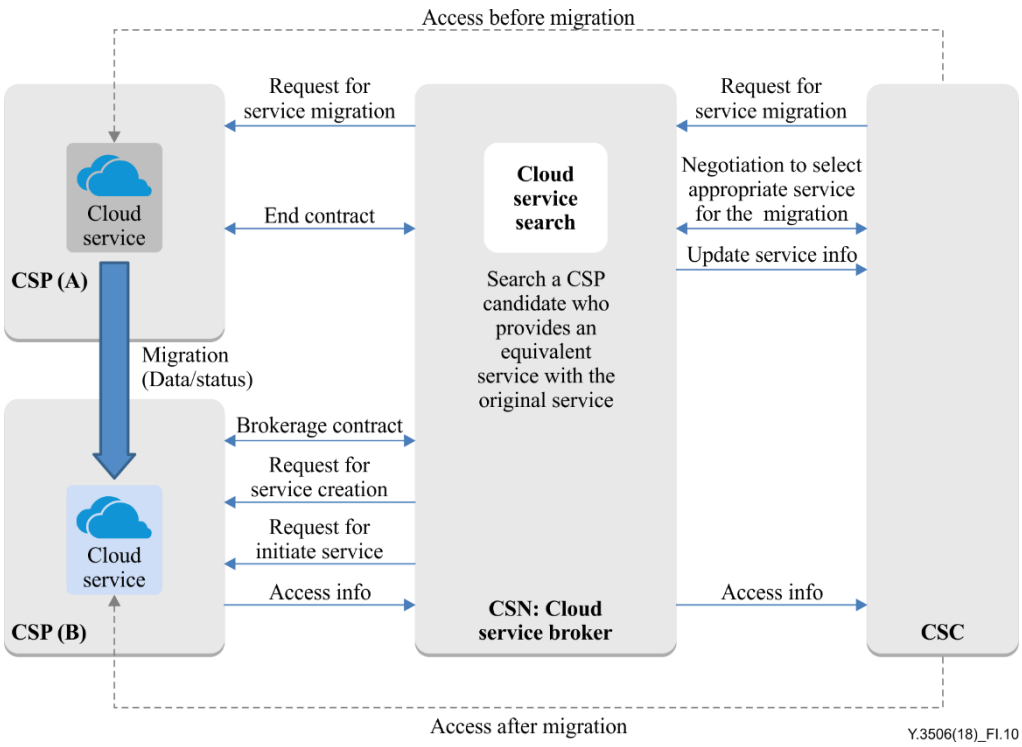
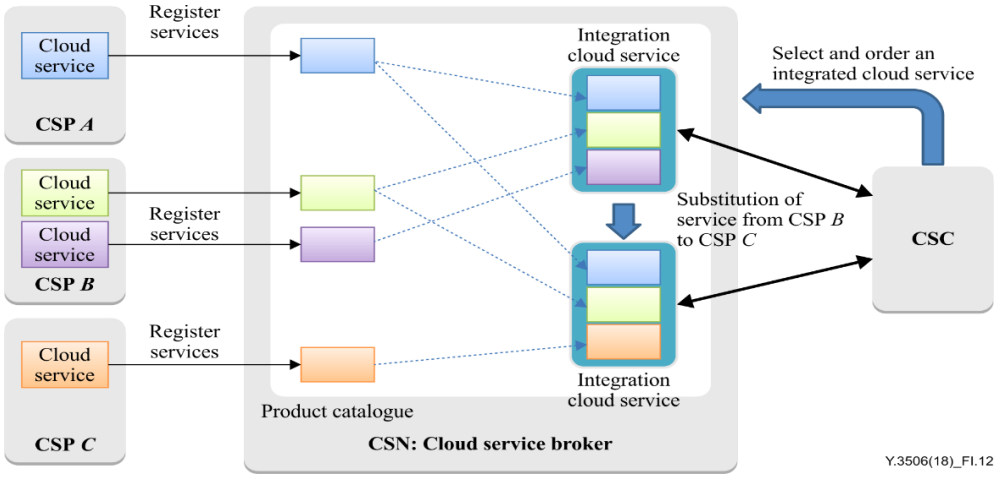
Figure	
Pre-conditions (optional)	The CSP is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSC is a member of the CSN: cloud service broker and has an account for accessing CSB workspace. The CSN: cloud service broker and the CSC established a SLA. The CSC is using a cloud service provided by the CSP(A) though the CSN: cloud service broker.
Post-conditions (optional)	
Derived requirements	– Equivalent cloud service selection (See clause 7.2) – Prevention of service termination during migration (See clause 7.5)

Table I.12 – A use case of cloud service substitution

Title	A use case of cloud service substitution.
Description	This use case describes a substitution of cloud service used as a member of an integrated cloud service in cloud service brokerage to keep the SLA between a CSN: cloud service broker and a CSC. Various CSPs in the market can register their services with the CSN: cloud service broker. Different CSPs can register services, which provide the same functionalities to the CSN: cloud service broker. The CSN: cloud service broker registers a catalogue which describes integrated cloud service based on multiple cloud services from the different CSPs. The registered catalogue is provided as a new integrated cloud service through the CSN: cloud service broker. The CSC selects a cloud service from the CSN: cloud service broker's product catalogue and use that cloud service according to SLA. (1) The CSN: cloud service broker monitors the integrated cloud service in real time to check whether it satisfies the SLA. In addition, real-time monitoring is performed on a member of an integrated cloud service to cope with SLA violation or unavailability situations. (2) If the integrated cloud service does not meet the SLA continuously, the CSN: cloud service broker detects the member cloud service that provides the cause. (3) The CSN: cloud service broker provisions another integrated cloud service which can substitute original one, based on the product catalogue description. At this time, when a large number of candidates for alternative integrated cloud services are searched, priority is evaluated for them and the CSN: cloud service broker makes a final decision for alternative integrated cloud service based on SLA in the aspect of service stability. (4) The CSN: cloud service broker substitutes the provisioned service for the previous one to satisfy the SLA.
Roles/sub-roles	CSP, CSN: cloud service broker, CSC
Figure	
Pre-conditions (optional)	– The CSPs register services to the CSN: cloud service broker. – The CSN: cloud service broker registers an integrated cloud to product catalogue.
Post-conditions (optional)	
Derived requirements	– Cloud service substitution for integrated cloud service (See clause 7.2) – Detection of failures to meet the terms of the SLA (See clause 7.5)

Appendix II

Relationship between the logical components and the activities of cloud service broker for CSB

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

Activities of cloud service broker for CSB consist of (1) acquire and assess customers, (2) assess marketplace, (3) set up legal agreement, (4) assist CSC for accessing service and (5) check and control service status.

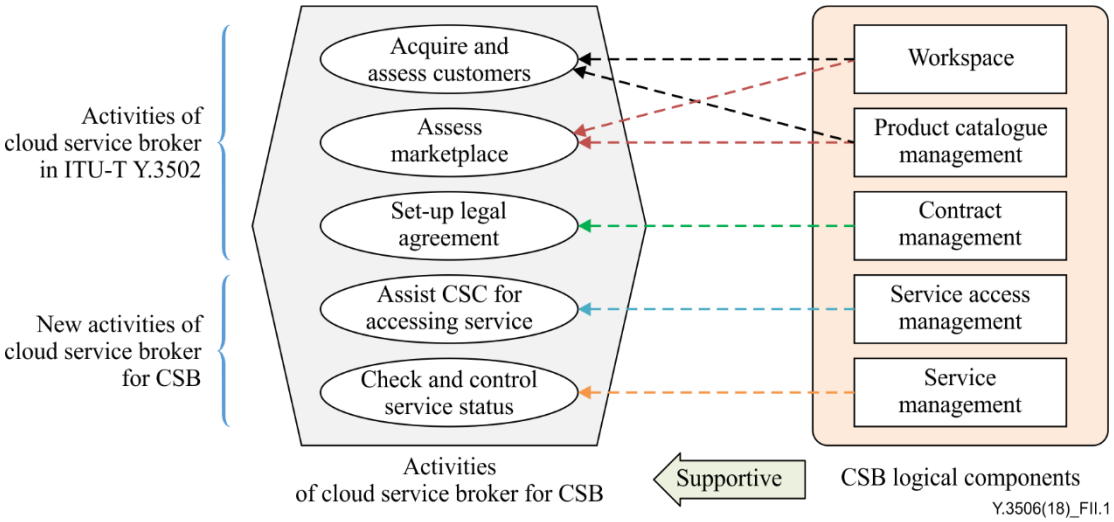


Figure II.1 – Relationship between the logical components and the activities of cloud service broker for CSB

NOTE – Figure II.1 identifies reused activities from [ITU-T Y.3502] as well as new activities needed to support cloud service brokerage.

(1) **Logical components that can cover the acquire and assess customers activity:** The acquire and assess customers activity includes the tasks required to market and sell cloud services up to the point where a cloud service customer agrees a contract to use one or more services, see clause 8.4.2.6 in [ITU-T Y.3502]. The workspace and the product catalogue management logical components cover the acquire and assess customers activity. The workspace logical component (clause 6.4.1) provides a user interface for CSCs to help to present service requirements and to request a cloud service. Also the product catalogue management logical component (clause 6.4.2) provides information to potential CSCs about available services and associated SLAs and contract terms. So, both logical components support the marketing and selling of cloud services up to the point where a cloud service customer agrees a contract to use one or more services.

(2) **Logical components that can cover the assess marketplace activity:** The assess marketplace activity focuses on assessing the current cloud services marketplace to find cloud service(s) that meet the customers' requirements see clause 8.4.2.7 in [ITU-T Y.3502]. The workspace logical component (clause 6.4.1) and the product catalogue management logical component (clause 6.4.2) cover the assess marketplace activity. The workspace logical component provides a user interface for CSPs. In workspace, a CSP can register, modify and remove a service list to be sold through a cloud service broker. Also the product catalogue management logical component gathers cloud services from multiple CSPs through workspace, registers those cloud services and, if needed, cancels the registered cloud services. So, both logical components support

assessing the current cloud services marketplace to find cloud service(s) that meet the customers' requirements.

(3) **Logical components that can cover the set up legal agreement activity:** The set up legal agreement activity concerns the service agreement between the cloud service customer and the chosen cloud service provider(s) see clause 8.4.2.8 in [ITU-T Y.3502]. The contract management logical component (clause 6.4.3) manages all contracts in CSB in terms of SLA. So, the contract management logical component fully covers the set up legal agreement activity.

(4) **Logical components that can cover the assist CSC for accessing service activity:** The assist CSC for accessing service activity focuses on acquiring access information for a cloud service from a CSP who provides the cloud service and forwarding of the access information to the CSC who requested the cloud service so that the CSC understands how to access to and use the service. The service access manager logical component (clause 6.4.4) manages access information of cloud services brokered by a cloud service broker by acquiring access information from the CSP. Also, the service access management logical component is capable of forwarding access information to a proper CSC. So, the service access management logical component fully supports the assist CSC for accessing service activity.

(5) **Logical components that can cover the check and control service status activity:** The check and control service status activity focuses on assisting CSCs in cloud service controls such as stopping, resuming and terminating cloud services. Also, this activity involves checking status of running cloud services by monitoring so that a cloud service broker enforces service qualities agreed in a SLA instead of CSCs. Since the service management logical component (clause 6.4.5) is a logical component to manage controls and status of running cloud services brokered by a cloud service broker, the service management logical component fully supports the check and control service status activity.

Bibliography

[b-ISO/IEC 19086-1] ISO/IEC 19086-1:2016, *Information technology - Cloud computing - Service Level Agreement (SLA) framework - Part 1:Overview and concepts*. https://www.iso.org/standard/67545.html

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