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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Cloud Computing

Cloud computing – Functional architecture for cloud service brokerage

Recommendation ITU-T Y.3536

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Recommendation ITU-T Y.3536

Cloud computing – Functional architecture for cloud service brokerage

Summary

Recommendation ITU-T Y.3536 describes functional architecture for cloud service brokerage (CSB) based on functional requirements defined in Recommendation ITU-T Y.3506. This Recommendation also provides the reference points among CSB functions, and the relationship between the CSB functional architecture and the cloud computing reference architecture specified in Recommendation ITU-T Y.3502.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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FOREWORD

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Cloud computing – Functional architecture for cloud service brokerage

1 Scope

This Recommendation specifies the functional architecture for cloud service brokerage (CSB) based on the functional requirements defined in [ITU-T Y.3506]. It addresses the following subjects:

– Functions of cloud service brokerage;

– Functional architecture of cloud service brokerage;

– Relationship between the CSB functional architecture and the cloud computing reference architecture.

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

[ITU-T Y.3506] Recommendation ITU-T Y.3506 (2018), *Information technology – Cloud computing – Functional requirements for cloud service brokerage.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

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

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

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

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

3.1.5 cloud service 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.

3.1.6 cloud service brokerage [ITU-T Y.3506]: A service that arbitrates, delivers, and manages cloud services provided by cloud service providers (CSPs) for cloud service customers (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.

3.1.7 cloud service level agreement [b-ISO/IEC 19086-1]: Part of the cloud service agreement (clause 3.1.5) that includes cloud service level objectives (clause 3.1.8) and cloud service qualitative objectives (clause 3.1.9) for the covered cloud service(s).

3.1.8 cloud service level objective [b-ISO/IEC 19086-1]: Commitment a cloud service provider makes for a specific, quantitative characteristic of a cloud service, where the value follows the interval scale or ratio scale.

NOTE – A cloud service level objective commitment may be expressed as a range.

3.1.9 cloud service qualitative objective [b-ISO/IEC 19086-1]: Commitment a cloud service provider makes for a specific, qualitative characteristic of a cloud service, where the value follows the nominal scale or ordinal scale.

NOTE 1 – A cloud service qualitative objective may be expressed as an enumerated list.

NOTE 2 – Qualitative characteristics typically require human interpretation.

NOTE 3 – The ordinal scale allows for existence/non-existence.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Programming Interface
BM-F	Business Management Function
CSAM-F	Cloud Service Access information Management Function
CSAM-FG	Cloud Service Agreement Management Function Group
CSB	Cloud Service Brokerage
CSC	Cloud Service Customer
CSC-F	Cloud Service Configuration Function
CSD-F	Cloud Service Deregistration Function
CSM-F	Cloud Service Monitoring Function
CSN	Cloud Service Partner
CSP	Cloud Service Provider
CSR-F	Cloud Service Registration Function
CSRM-F	Cloud Service Requirement Management Function
CSS-F	Cloud Service Search Function
OS	Operating System
PCM-FG	Product Catalogue Management Function Group
RD-F	Request Delivering Function
RV-F	Request Validation Function
SC-FG	Service Control Function Group
SDM-F	SLA Document Management Function

SLA	Service Level Agreement
SLO	Service Level Objectives
SM-F	SLA Management Function
SQO	Service Qualitative Objectives
UAM-F	User Account Management Function
UAUTH-F	User Authentication and authorization Function
UIM-F	User Interface Management Function
UM-FG	User access Management Function Group
URL	Uniform Resource Locator

5 Conventions

Throughout this Recommendation, the term "CSB user" stands for "CSP and CSC".

6 Relationship between CSB logical components and CSB functions

A cloud service broker described in [ITU-T Y.3506] is a sub-role of cloud service partner (CSN) that negotiates relationships between cloud service customers (CSCs) and cloud service providers (CSPs). A cloud service brokerage (CSB) as described in [ITU-T Y.3506] 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 cloud service brokerage (CSB) are to provide a single access, easily managed and value-added service to CSCs from multiple CSPs. There are five CSB logical components in [ITU-T Y.3506]:

– workspace;
– product catalogue management;
– contract management;
– service access management;
– service management.

These CSB logical components are realized by the following CSB function groups:

– user access management function group: provides authentication of CSB users and grants authorization to access other CSB functions;
– product catalogue management function group: supports registering, deregistering, searching cloud services within the CSB product catalogue, and allowing CSCs to select cloud services;
– cloud service agreement management function group: manages contracts between CSPs and CSCs including cloud service level agreements (SLAs);
– service control function group: requests CSPs to initiate contracted cloud services accompanied by access information and, also, requests service controls (such as initiate, resume/suspend, create, and stop) and monitors the status of running cloud services.

Table 6-1 shows the relationship between CSB logical components and CSB function groups in this Recommendation. The mapping between the functional requirements of each of the CSB logical components in [ITU-T Y.3506] and CSB functions in clause 7 of this Recommendation is described in Appendix I.

Table 6-1 – Relationship between CSB logical components and CSB function groups

CSB logical components in [ITU-T Y.3506]	CSB function groups in this Recommendation
workspace	user access management function group (see clause 7.1)
product catalogue management	product catalogue management function group (see clause 7.2)
contract management	cloud service agreement management function group (see clause 7.3)
service access management	service control function group (see clause 7.4)
service management	service control function group (see clause 7.4)

7 CSB functions

Figure 7-1 shows the CSB function groups and corresponding CSB functions.

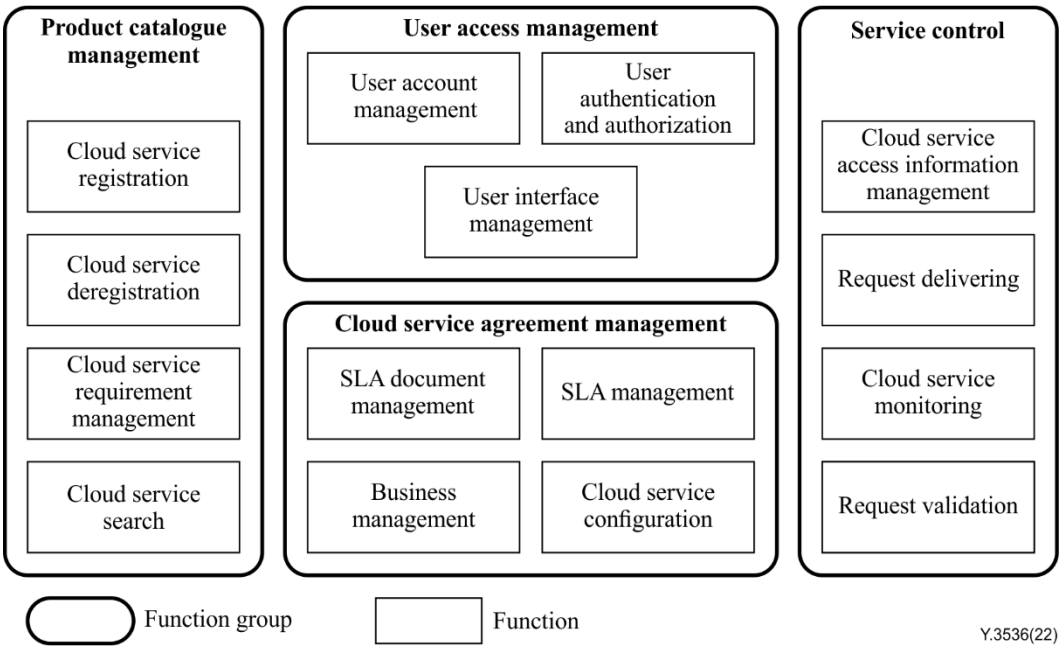


Figure 7-1 – CSB function groups and CSB functions

7.1 User access management function group

The user access management function group manages user accounts including user authentication and authorization in CSB and provides user interfaces for CSPs and CSCs.

7.1.1 User authentication and authorization

The user authentication and authorization function supports CSB user's authentication and authorization. This function supports the following:

– confirming CSB user's identity to allow or deny access to the user interface for user authentication;

– determining whether the authenticated CSB user has access rights to the particular CSB functions and services for user authorization;

– performing authentication/authorization for CSCs and CSPs by using user account information maintained in the user account management function.

NOTE – User account information is a collection of data associated with a particular CSB user. Each user account information comprises identities (e.g., a username and password), and defines access levels, storage space, etc.

7.1.2 User account management

The user account management function supports the following:

– maintaining accounts of CSB users;

– supporting creation, modification, and deletion of user accounts;

– providing user account information to the user authentication and authorization function.

7.1.3 User interface management

The user interface management function supports the following:

– providing interfaces of CSB functions to authenticated and authorized CSPs and CSCs.

NOTE 1 – A user interface is an access point to CSB functions. CSPs and CSCs perform their operations through this function.

NOTE 2 – CSPs operate registration/deregistration and CSCs search, select, and order cloud services by using interfaces provided by this function.

This function provides CSP's interface for:

– registering cloud services to the CSB product catalogue by delivering registration information (see clause 7.2.1) to the cloud service registration function;

– deregistering cloud services from the CSB product catalogue by transferring deregistration control actions (see clause 7.2.2) to the cloud service deregistration function;

– providing subscription and billing information (see clause 7.3.4) to the business management function;

– supporting the adaptation of the different cloud services application programming interfaces (APIs) of multiple CSPs.

NOTE – The format of the cloud service API provided by the CSPs is transformed into the CSB's API format.

This function provides the CSC's interface for:

– receiving a cloud SLA document (see clause 7.3.3) from the SLA document management function;

– receiving an invoice and performing subscription management from the business management function (see clause 7.3.4);

– obtaining access information (see clause 7.4.1) from the access information management function;

– requesting searching or deploying of cloud services with associated CSC's requirements (see clause 7.2.3) to cloud service requirement management function;

– requesting control actions for cloud services (see clause 7.4) to the request delivering function (see clause 7.4.3);

– monitoring the status of running cloud services by delivering monitoring information (see clause 7.4.2) from the cloud service monitoring function.

7.2 Product catalogue management function group

The product catalogue management function group provides registering and deregistering for CSPs, managing cloud service requirements, and searching the best matched cloud service for CSCs.

7.2.1 Cloud service registration

The cloud service registration function supports the following:

− registering CSP's cloud services to the CSB product catalogue by using registration information;

NOTE – The registration information for a CSP delivered from the user interface management function includes an identity, uniform resource locator (URL), access account of the CSP, and so on.

− collecting multiple cloud services registered in the CSB product catalogue and orchestrating the cloud services to make them work together for the cloud service integration model, so as to provide value-added cloud services to the CSCs according to requirements from a cloud service broker defined in clause 8.4.1.3 of [ITU-T Y.3502];

− performing customized development on existing multiple cloud services in the CSB product catalogue on demand for the cloud service customization model;

− sending the new integrated value-added or customized cloud services to the CSPs after the cloud service integration and customization registration, to check that the new cloud services are correct and available.

7.2.2 Cloud service deregistration

The cloud service deregistration function supports the following:

− disabling the cloud service from the CSB product catalogue;

− notifying deregistration of the cloud service to related CSCs;

− requesting the related CSCs to stop all running cloud services;

− deleting the cloud service from the CSB product catalogue;

− notifying the service deregistration to all CSCs not to use the deregistered service;

− requesting the related CSPs to maintain the deregistered service until the CSCs finish using the cloud service.

NOTE – Deregistration control actions regarding notifications and requests to related CSCs and CSPs are performed through the user access management function group.

7.2.3 Cloud service requirement management

The cloud service requirement management function supports the following:

− managing CSC's requirements based on a cloud service requirement template;

− validating CSC's requirements from the contents using the cloud service requirement template;

− managing cloud SLA information of the cloud service and delivering the information to the SLA management function for a contract.

NOTE 1 – The CSC's requirement includes cloud SLA information for the cloud service such as cloud service qualitative objectives (SQO), price of the requested cloud service, remedies for failures to meet the terms of the cloud SLA, and so on. The CSC's requirement also includes information about specifications of the cloud service such as virtual machine, OS type, applications, etc.

NOTE 2 – The cloud SLA ordinarily contains a collection of cloud service level objectives (SLOs) and cloud SQOs relating to the cloud service. This might include availability, reliability, performance, security, data protection, compliance and data handling defined in [b-ISO/IEC 19086-1].

7.2.4 Cloud service search

The cloud service search function supports the following:

- supporting searching of cloud services in the CSB product catalogue to match with CSC's requirements received from the cloud service requirement management function;
- providing priorities of cloud services for CSCs to easily select, if there exist multiple cloud services matched with CSC's requirements;
- initiating integration and/or configuration of registered cloud services from CSPs if it fails to find a matching cloud service for the cloud service customization;

NOTE – The initiations of cloud service integration and configuration are delivered to the cloud service registration function.

7.3 Cloud service agreement management function group

The cloud service agreement management function group provides the cloud SLA and cloud SLA document management, cloud service configuration management, and business management between CSPs and CSCs.

The cloud service agreement management function group establishes a contract in terms of the cloud service agreement which includes the cloud SLA and manages the contracted service level by monitoring cloud services for cloud SLO and performing actions to remedy failures to meet the contracted service level.

This function group creates a cloud SLA document based on the CSC's cloud service requirements and the corresponding CSP's cloud SLA and notifies it to the contracted CSC. This function group also registers an agreed service level to the service control function group to guarantee the contracted service quality. If the cloud service fails to meet the service level, this function group enforces remedies for failures to meet the terms of the cloud SLA.

NOTE – The cloud SLA includes agreements 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 cloud SLA, and so on.

7.3.1 SLA management

The SLA management function is involved during the establishment of a cloud service agreement and manages cloud SLA by monitoring cloud services for cloud SLO to verify the service level, by detecting failures to meet the terms of the cloud SLA through monitoring, and by providing agreed remedies for failures to meet the terms of the cloud SLA.

NOTE 1 – Monitoring includes one or more measurable information such as storage speeds, memory capacity and performance, computing speeds, network speeds, service response time, etc.

NOTE 2 – Examples of a remedy are migration, scale up, performance extension and so on. If a failure to meet the terms of the cloud SLA is found in the integrated cloud service, the SLA management function identifies the cloud service that caused the failure.

This function supports the following:

- receiving CSC's requirements to establish cloud SLA of the cloud service from the cloud service requirement management function of the product catalogue management function group;
- delivering CSC's requirements to the cloud service configuration function to configure the cloud service according to the CSC's requirements;
- providing selection of cloud SLOs to the CSC according to business requirements of the CSC;
- delivering the service specifications and cloud SLO to the SLA document management function after the configuration is finished and the CSC confirms the cloud service with detail configurations and cloud SLO so that the SLA document management function generates a cloud SLA document;

- establishing cloud SLA with the CSC based on the cloud SLA document by sharing it with the CSC through the user interface management function;

NOTE 3 – The cloud SLA document includes selection of cloud SLO from a CSC according to business requirements of the CSC.

- delivering a request for initiating the cloud service to the request delivering function in the service control function group after the cloud service agreement is established;
- checking cloud services for cloud SLO to verify the service level by receiving monitoring data from the cloud service monitoring function after service control function group initiates the cloud service;
- detecting failures to meet the terms of the cloud SLA;
- providing agreed remedies for failures to meet the terms of the cloud SLA;
- notifying failures and remedies regarding the cloud SLA to the CSC through the user interface management function.

7.3.2 Cloud service configuration

The cloud service configuration function supports the following:

- configuring a cloud service by specifying elements of the cloud service selected by a CSC;
- receiving specification for elements of the cloud service, from the SLA management function;
- returning a service manifest, which is used by the service control function group to initiate the cloud service with the specified elements, to the SLA management function.

NOTE – Examples for configurable elements of a cloud service include virtual machine specifications, OS types, applications, etc.

7.3.3 SLA document management

The SLA document management function supports the following:

- providing the cloud SLA description model to describe terms and conditions for a CSC;
- generating a cloud SLA document according to the agreement to share the cloud SLA document with the related CSC;
- receiving a request from the SLA management function to generate a cloud SLA document along with information for the service specifications and cloud SLO which the CSC selects;
- returning a cloud SLA document which complies with the cloud SLA description model to describe terms and conditions.

7.3.4 Business management

The business management function supports the following:

- gathering billing information from related CSPs;
- generating an invoice for the usage of a cloud service by reorganizing the billing information gathered from related CSPs;
- providing the generated invoices to CSCs through the user interface management function;

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 costs for the usage of the cloud service based on price and metering.

− handling the subscriptions of the CSCs of the cloud services provided by multiple CSPs through the user interface management function, allowing for managing (e.g., creating, modifying, updating, deleting and querying) the subscriptions.

NOTE 2 – the subscription provides a complete view of CSCs' cloud service ordering records information of the cloud services from multiple CSPs, including cloud service ordering type (e.g., new purchase, renewal, upgrading, refunding, cancelling, etc.), ordering time, billing information, discount information, payment status, related CSPs information, detailed cloud services information, etc.

7.4 Service control function group

The service control function group provides cloud service delivering, validation, monitoring and cloud service access information management between CSCs and CSPs, so as to satisfy the requirements of the cloud service control actions of the CSCs.

The service control function group requests to deploy a cloud service to a CSP and provides the access information to a CSC so that the CSC is able to use the cloud service after the contract phase. In addition, this function group requests service control actions for running cloud services from CSCs to CSPs and monitors the status of the cloud services to check for failure of the services such as cloud SLA violation.

This function group receives service control requests from the cloud service agreement management function group or the user access management function group. The request delivering function in this function group achieves service controls by delivering the CSC's request to the corresponding CSP. This function group validates the status of a cloud service whether the status is changed correctly or not in accordance with the delivered request for a control action of the cloud service.

NOTE – The control actions for cloud services vary according to each cloud service. Examples of a control actions for a cloud service include create, initiate, suspend/resume, and stop of the cloud service.

7.4.1 Cloud service access information management

The cloud service access information management function supports the following:

− managing the access information of the cloud services received from the CSP through the request delivering function;

− forwarding the access information of the cloud service from the CSP to the contracted CSC.

NOTE – The access information is required for a CSC to access a cloud service. The access information includes an access point such as an Internet protocol address or URL of the cloud service and authentication methods such as a certificate or identification and password to access the cloud service.

7.4.2 Cloud service monitoring

The cloud service monitoring function supports the following:

− gathering monitoring information periodically or aperiodically at runtime to check the status of cloud services;

− delivering monitoring information to the SLA management function, business management function, and the user interface management function to notify monitoring information to a CSC.

NOTE – The monitoring information includes measured data for metrics of service levels in the cloud SLA, resource utilization, and the status of logical resources (e.g., virtual machine) of cloud services.

7.4.3 Request delivering

The request delivering function supports the following:

− delivering provisioning requests to CSPs as requested by the CSC;

- delivering requests for control actions (see Note in clause 7.4) for a cloud service from a CSC to a CSP;
- delivering the CSC's request for resources to a CSP when a CSC needs more cloud resources of a cloud service;
- receiving an acknowledgement for the cloud service control request from the CSP;
- delivering the cloud service identification, target status, and the acknowledgement to the request validation function to validate the status of a cloud service whether the status is changed correctly or not in accordance with the delivered request for a control action of the cloud service;
- receiving cloud service status verification information from the request validation function after the control action of the cloud service is verified by the request validation function;
- notifying the result of cloud service control to a CSC;
- initiating monitoring of the cloud service by invoking the cloud service monitoring function;
- delivering the access information of the initiated cloud service to the access information management function so that an authorized CSC can use the cloud service.

7.4.4 Request validation

The request validation function validates the status of a cloud service whether the status is changed correctly or not in accordance with the delivered request for a control action of the cloud service by a CSC. Since changing the status of the cloud service takes time according to the circumstance of a CSP, a cloud service broker does not know the result of the control request instantly. Therefore, to validate the status of cloud service, the request validation function needs to check periodically the current status of the cloud service by communicating with the CSP until the validation is finished. This function supports the following:

- initiating service control status validation after the request delivering function delivers a control request to a CSP and receives an acknowledgement from the CSP to inform of receipt of a request for the service control;
- checking periodically the current status of a cloud service by communicating with the CSP until the operation for the service control is finished;
- updating the current status of the cloud service according to a result of the communication with the CSP for checking status on a service control request;
- predicting a completion time of the cloud service control to reduce communication overhead between the cloud service broker and the CSP;

NOTE 1 – To predict the completion time of a cloud service control, statistical methods, such as moving average and variance, are applied to history information of completion time of previous control requests for the same or similar services. Using the statistical methods, the request validation function calculates a probability distribution for completion of service control at a given time.

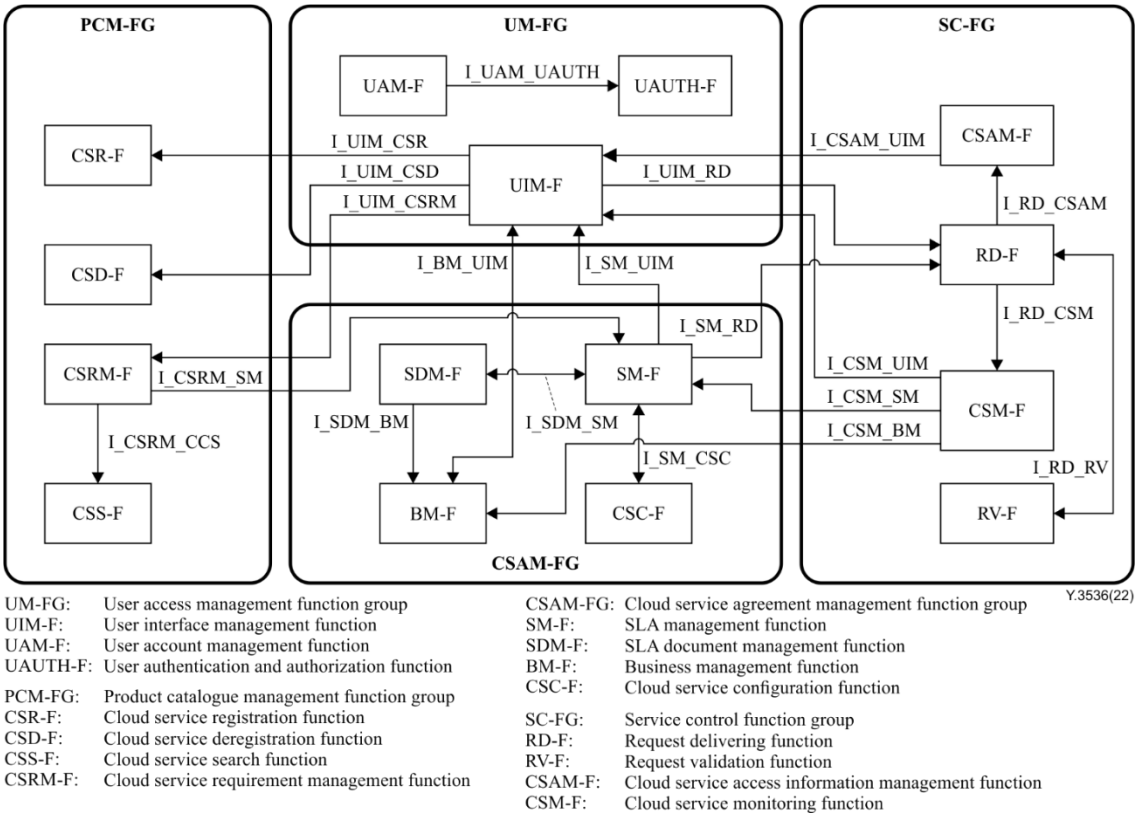
- generating a service control checking period which is the duration of time of one cycle for checking status of the service;

NOTE 2 – The service control checking periods are determined by a probability distribution. The request validation function sets the number of checking for completion of a service controls for each time interval based on the probability distribution, and the number of checks is converted into the service control status checking period. Therefore, the request validation function increases the frequency of checking status of service when the probability of service control completion is high and decreases the frequency when the probability of service control completion is low.

– storing the history information of required time for completing cloud service controls and cloud service control status validation results.

8 CSB functional architecture

Figure 8-1 shows the CSB functional architecture.



UM-FG: User access management function group
UIM-F: User interface management function
UAM-F: User account management function
UAUTH-F: User authentication and authorization function

PCM-FG: Product catalogue management function group
CSR-F: Cloud service registration function
CSD-F: Cloud service deregistration function
CSS-F: Cloud service search function
CSRM-F: Cloud service requirement management function

CSAM-FG: Cloud service agreement management function group
SM-F: SLA management function
SDM-F: SLA document management function
BM-F: Business management function
CSC-F: Cloud service configuration function

SC-FG: Service control function group
RD-F: Request delivering function
RV-F: Request validation function
CSAM-F: Cloud service access information management function
CSM-F: Cloud service monitoring function

Figure 8-1 – CSB functional architecture

The CSB functional architecture comprises four function groups of user access management function group (UM-FG), product catalogue management function group (PCM-FG), cloud service agreement management function group (CSAM-FG), and service control function group (SC-FG), which correspond with clause 7.1 to clause 7.4, respectively.

The CSB functions within each function group are defined in clause 7. The CSB functions have the relationships (see Appendix II) and interact with each other by the reference points depicted in the Figure 8-1.

8.1 CSB function groups

The UM-FG comprises three functions: user interface management function (UIM-F), user account management function (UAM-F), and user authentication and authorization function (UAUTH-F). The UM-FG interacts with PCM-FG, CSAM-FG, and SC-FG.

The PCM-FG comprises four functions: cloud service registration function (CSR-F), cloud service deregistration function (CSD-F), cloud service search function (CSS-F), and cloud service requirement management function (CSRM-F). The PCM-FG interacts with UM-FG and CSAM-FG.

The CSAM-FG comprises four functions: SLA management function (SM-F), SLA document management function (SDM-F), business management function (BM-F), and cloud service configuration function (CSC-F). The CSAM-FG interacts with UM-FG, FCM-FG and SC-FG.

The SC-FG comprises four functions: request delivering function (FD-F), request validation function (RV-F), cloud service access information management function (CSAM-F), and cloud service monitoring function (CSM-F). The SC-FG interacts with UM-FG and CSAM-FG.

8.2 Reference points

8.2.1 Reference points between PCM-FG and UM-FG

The reference points between PCM-FG and UM-FG are summarized as follows:

I_UIM_CSR reference point between UIM-F and CSR-F. Registration information for registering CSP's cloud services to the CSB product catalogue is delivered through this reference point.

I_UIM_CSD reference point between UIM-F and CSD-F. Through this reference point, UIM-F requests deregistering cloud services from the CSB product catalogue by transferring deregistration control actions.

I_UIM_CSRM reference point between UIM-F and CSRM-F. Through this reference point, UIM-F requests searching or deploying cloud services with the associated CSC's requirements.

8.2.2 Reference points between CSAM-FG and UM-FG

The reference points between CSAM-FG and UM-FG are summarized as follows:

I_BM_UIM reference point between BM-F and UIM-F. Subscription information for a cloud service is delivered through this reference point. Invoice for the usage of a cloud service is also delivered from BM-F to UIM-F through this reference point.

I_SM_UIM reference point between SM-F and UIM-F. Notifications for failures to meet the terms of the cloud SLA and remedies regarding the cloud SLA are delivered from SM-F to UIM-F through this reference point.

8.2.3 Reference points between SC-FG and UM-FG

The reference points between SC-FG and UM-FG are summarized as follows:

I_UIM_RD reference point between UIM-F and request delivering function (RD-F). Through this reference point, UIM-F requests control actions for cloud services.

I_CSM_UIM reference point between CSM-F and UIM-F. Monitoring information is delivered from CSM-F to UIM-F through this reference point.

I_CSAM_UIM reference point between CSAM-F and UIM-F. Access information of the cloud services is delivered from CSAM-F to UIM-F through this reference point.

8.2.4 Reference points between PCM-FG and CSAM-FG

The reference point between PCM-FG and CSAM-FG is summarized as follows:

I_CSRM_SM reference point between CSRM-F and SM-F. CSC's requirement with cloud SLA information of the cloud service is delivered through this reference point.

8.2.5 Reference points between SC-FG and CSAM-FG

The reference points between SC-FG and CSAM-FG are summarized as follows:

I_CSM_SM reference point between CSM-F and SM-F. Monitoring information is delivered from CSM-F to SM-F through this reference point.

I_CSM_BM reference point between CSM-F and BM-F. Monitoring information is delivered from CSM-F to BM-F through this reference point.

I_SM_RD reference point between SM-F and RD-F. cloud service initiation and control requests are delivered from SM-F to RD-F through this reference point.

8.2.6 Reference points within UM-FG

The reference point within UM-FG is summarized as follows:

I_UAM_UAUTH reference point between UAM-F and UAUTH-F. Through this reference point, UAM-F sends user access information for CSB user authentication and authorization.

8.2.7 Reference points within PCM-FG

The reference point within PCM-FG is summarized as follows:

I_CSRM_CCS reference point between CSRM-F and CSS-F. Through this reference point, CSRM-F sends CSC's requirement for searching cloud services in the CSB product catalogue.

8.2.8 Reference points within CSAM-FG

The reference points within CSAM-FG are summarized as follows:

I_SDM_SM reference point between SDM-F and SM-F. Requests to generate cloud SLA documents along with information for the service specifications and cloud SLO are delivered from SM-F to SDM-F through this reference point. Generated cloud SLA documents are delivered from SDM-F to SM-F through this reference point.

I_SDM_BM reference point between SDM-F and BM-F. Information for agreed service price is delivered from SDM-F to BM-F through this reference point.

I_SM_CSC reference point between SM-F and CSC-F. Information for a selected cloud service and its specification is delivered from SM-F to CSC-F through this reference point. Service manifests configured with specified elements are delivered from CSC-F to SM-F through this reference point.

8.2.9 Reference points within SC-FG

The reference points within SC-FG are summarized as follows:

I_RD_CSAM reference point between RD-F and CSAM-F. Access information of cloud services is delivered from RD-F to CSAM-F through this reference point.

I_RD_CSM reference point between RD-F and CSM-F. Cloud service identifications and access information of cloud services for monitoring the services are delivered from RD-F to CSM-F through this reference point.

I_RD_RV reference point between RD-F and RV-F. Identification, control request, target status, and the acknowledgement of cloud services for request validation are delivered from RD-F to RV-F through this reference point. Information for cloud service status verification is delivered from RV-F to RD-F through this reference point.

9 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

Relationship between functional requirements and CSB functions

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

[ITU-T Y.3506] defines a total of 36 functional requirements. Table I.1 shows analysis of the key phrases and related CSB functions for each requirement in [ITU-T Y.3506].

Table I.1 – Relationship between functional requirements and CSB functions

CSB local component in Y.3506	CSB functional Req. in ITU-T Y.3506	Key phrases	Related functions in this Recommendation
Workspace	Authentication and authorization for workspace	authentication and authorization	User authentication and authorization
	Account management	accounts of CSCs and CSPs	User account management
	User interface for CSCs	user interface for CSCs to search, select, request, launch, monitor, manage, and pay	User interface management
	User interface for CSPs	user interface for CSPs to register information	User interface management
Product catalogue management	Registration of cloud service	registration of cloud services in the product catalogue	Cloud service registration
	Cloud service deregistration	deregister the cloud services in a product catalogue	Cloud service deregistration
	Automation of service deregistration	automatic cloud service deregistration	Cloud service deregistration
	Notification of service deregistration	notification of the service deregistration to CSCs	Cloud service deregistration
	Request for maintaining cloud service	request the related CSP to maintain the deregistered service	Cloud service deregistration
	Providing cloud service requirement template	template for service requirement	Cloud service requirement management
	Cloud service requirement validation	validation of the contents in cloud service requirement template	Cloud service requirement management
	Cloud service search	searching a cloud service in the product catalogue	Cloud service search
	Providing the best matched cloud service	best matched cloud services and information about the CSPs	Cloud service search
	Cloud service alteration	alter registered services for cloud service	Cloud service registration

Table I.1 – Relationship between functional requirements and CSB functions

CSB local component in Y.3506	CSB functional Req. in ITU-T Y.3506	Key phrases	Related functions in this Recommendation
		customization	
	Cloud service substitution for integrated cloud service	provide alternative cloud services	Cloud service search
	Equivalent cloud service selection	migrate to keep service equivalence after migration	Cloud service search
Contract management	Cloud service charging	billing information to CSCs	Business management
	Configuration of cloud service for contract	configure a cloud service through selecting elements	Cloud service configuration
	Service level objectives (SLO) selection	selection of service level objectives to a CSC	SLA document management
	SLA document management	generation of a SLA document according to the agreement to share the SLA document	SLA document management
	SLA description model	SLA description model to describe terms and conditions	SLA document management
	Remedies for failures to meet the terms of the SLA	agreed remedies for failures to meet the terms of the SLA	SLA management
Cloud service access management	Delivering cloud service provision request	deliver the provisioning request to CSPs as requested by the CSC	Request delivering
	Delivering cloud resource request	deliver the CSC's request for resources to a CSP	Request delivering
	Access information forwarding	forward the access information	Cloud service access information management
	Prohibiting access information storing	prohibiting of the access information for a cloud service not to open or store	Cloud service access information management
Cloud service management	Cloud service SLA management	SLA management of running cloud service	SLA management
	Cloud service monitoring	monitor the status of cloud services by using gathered monitoring information	Cloud service monitoring
	Delivering request of cloud service control	deliver requests of control actions for a cloud service from a CSC to a CSP	Request delivering
	Validation of result for request of cloud service control	validate the status of cloud service whether the status is changed correctly or not in accordance with the delivered request for a control action	Request validation

Table I.1 – Relationship between functional requirements and CSB functions

CSB local component in Y.3506	CSB functional Req. in ITU-T Y.3506	Key phrases	Related functions in this Recommendation
	Initiation of validation	initiate cloud service control status validation only after the broker receives an acknowledgement	Request validation
	Status checking period for validation	checking periods in service control status validation	Request validation
	History of cloud service control status validation	manage history of validation results as well as required time for completing cloud service controls	Request validation
	Notification of result for request of cloud service control	notification of the result of cloud service control to a CSC	Request validation
	Detection of failures to meet the terms of the SLA	detect failures to meet the terms of the SLA through monitoring and to verify the service level	SLA management
	Prevention of service termination during migration	postponing the termination of running cloud service until the broker verifies ready status of a new service	SLA management

Appendix II

Relationship among CSB functions

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

Figure II.1 depicts the summary of the relationships among the CSB functions described in clause 7.1 through clause 7.4. The interaction with related information between two functions is represented as each link.

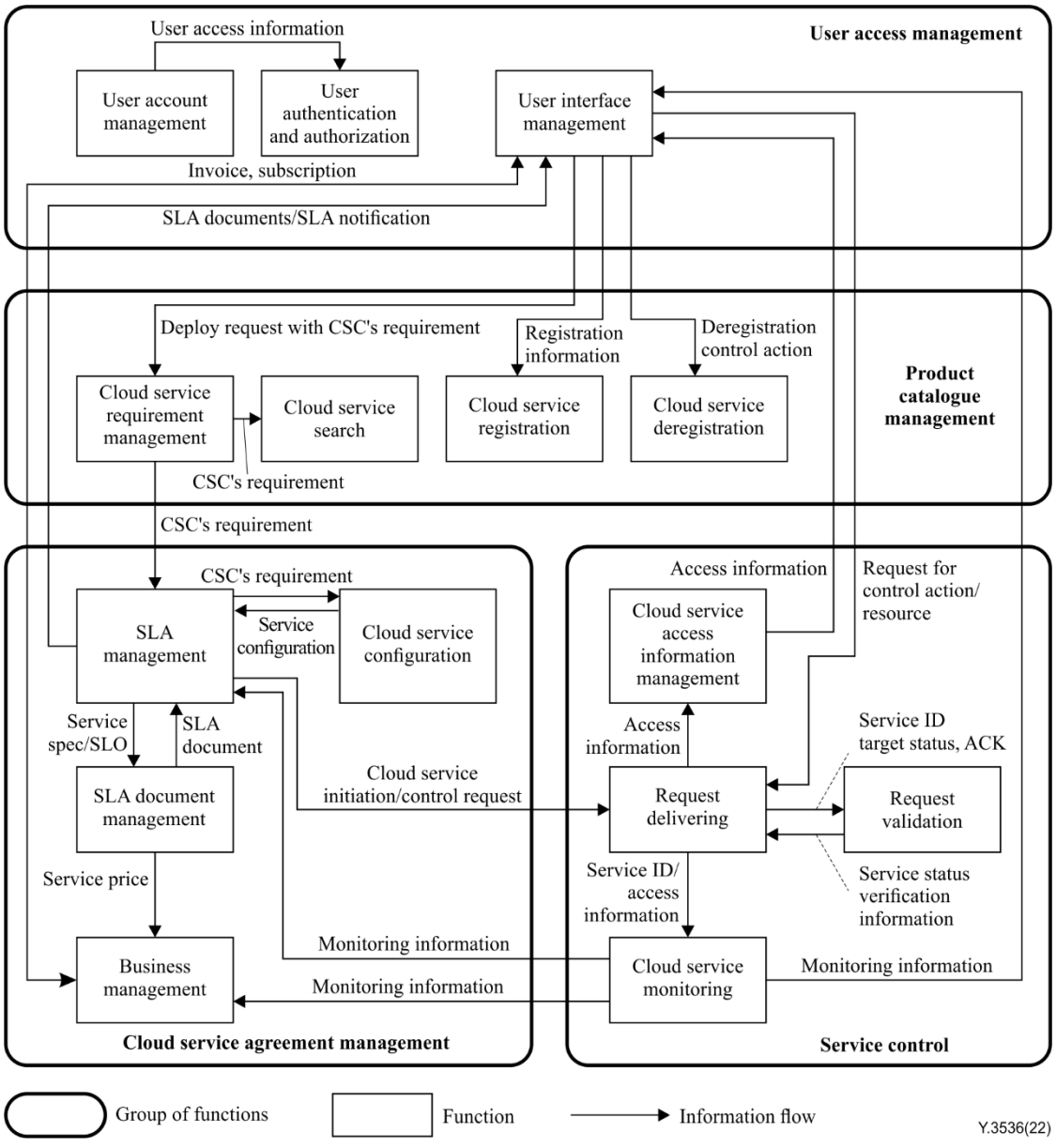


Figure II.1 – Relationship among CSB functions

Appendix III

Relationship between CSB functions and functional components of cloud computing reference architecture

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

The cloud computing reference architecture [ITU-T Y.3502] provides an architectural framework that is effective for describing the cloud computing roles, sub-roles, cloud computing activities, cross-cutting aspects, as well as functional components of cloud computing.

The functional architecture for cloud service brokerage follows the architectural framework of [ITU-T Y.3502], and in the meantime, extends the functions and functional components of [ITU-T Y.3502] to satisfy the functional requirements of CSB [ITU-T Y.3506]. The mapping relationship between functions in CSB and functional components in cloud computing reference architecture is shown in Figure III.1.

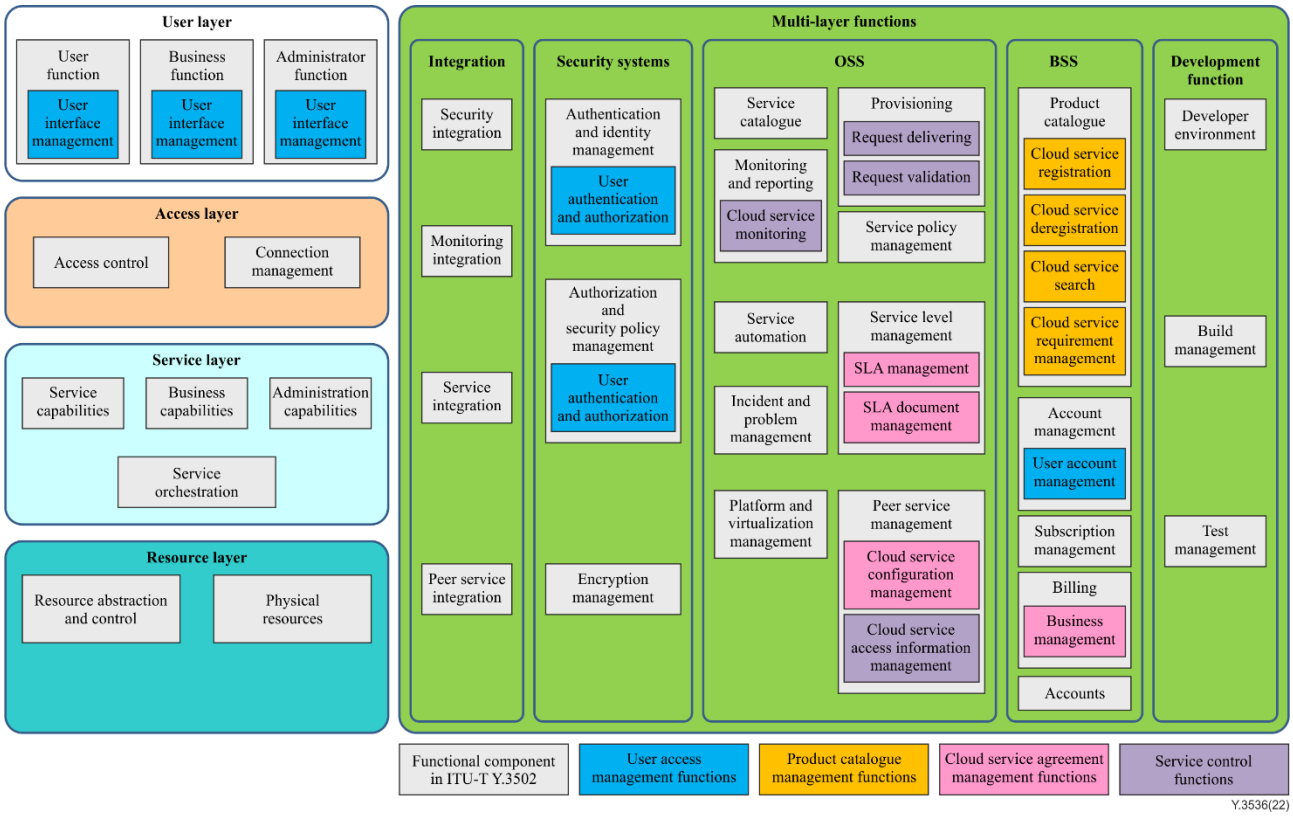


Figure III.1 – Relationship between functions in cloud service brokerage and functional components in cloud computing reference architecture

The user access management functions of CSB correspond to and extend the user layer, security systems, and account management functional component of cloud computing reference architecture.

The product catalogue management functions of CSB correspond to and extend the product catalogue functional component of cloud computing reference architecture.

The cloud service agreement management functions of CSB correspond to and extend the service level management, peer service management, and billing functional component of cloud computing reference architecture.

The service control functions of CSB correspond to and extend the provisioning, monitoring and report, and peer service management functional component of cloud computing reference architecture.

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

[b-ISO/IEC 19086-1] ISO/IEC 19086-1:2016, *Information technology – Cloud computing – Service Level Agreement (SLA) framework – Part 1: Overview and concepts.*

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